ELECTRONIC AUTOMOBILE IGNITION CIRCUIT

Filed Oct. 14, 1969
ELECTRONIC AUTOMOBILE IGNITION CIRCUIT
Arnold Mirot, 30 Grand Ravine Road, Suite 3, Downsview, Ontario, Canada
U.S. Cl. 123—148 E

ABSTRACT OF THE DISCLOSURE
An internal combustion engine ignition circuit with an output power transistor for driving the coil, and a flip-flop circuit triggered by the breaker points for driving the output transistor.

BACKGROUND OF THE INVENTION
This invention relates to an electronic automobile ignition system.

During the past few years, with the advent of transistors, silicon controlled rectifiers, and other small and relatively rugged electronic components, a number of attempts have been made to improve the conventional automobile internal combustion engine ignition system by using various electronic components and circuits. Most of these proposals have been predicated on the recognition that a conventional automobile ignition system fails to provide adequate sparking voltage at high engine speeds, and may also fail to provide adequate sparking voltage when the battery voltage is considerably below rated voltage, as may frequently occur in cold weather.

The simplest solution, and therefore an attractive solution from the standpoint of economy and reliability, is to provide a power transistor in series with the ignition coil input winding, using the breaker points to fire the power transistor, and thus to obtain a high voltage through the ignition coil at all times. Unfortunately, because such device operates merely as a single-stage amplifier whose input is provided by the breaker points, the output of the power transistor can be irregular or weak if the breaker points are dirty or corroded.

Another proposal involves adding to the simple system one or more additional amplifier stages so that the power transistor is not directly driven by the breaker points but is driven by a second transistor which is in turn driven by the breaker points. While adding another amplifier stage may permit the use of lower power transistors and may possibly reduce the current through the breaker points, the disadvantage remains that the signal eventually amplified by the power transistor is provided by the breaker points themselves, and the problem remains that if the points are corroded or dirty, the power transistor output may be unsatisfactory.

Another alternative proposed involves the use of a discharge capacitor in series with the ignition coil primary winding, which is charged by a high-voltage D.C. source and is usually discharged through a silicon controlled rectifier which is in turn triggered by the breaker points.

The difficulty with this type of system is chiefly the cost of components, which include not only an expensive capacitor and silicon controlled rectifier but additionally an oscillator including at least a pair of transistors, a transformer and a bridge rectifier for providing a rectified high voltage for charging the capacitor.

G. O. Hontzinger in United States Pat. No. 3,357,416 issued Dec. 12, 1967, described an ignition system utilizing an AC-coupled multivibrator circuit as a drive, the output transistor operating in class A amplifier mode rather than being saturated. However, this system is characterized by at least three disadvantages, in addition to complexity. The first two of these, namely, diminished low engine speed performance and variation of the timing of transistor triggering with engine speed, are caused by the AC coupling. The third disadvantage is increased likelihood of output transistor failure, caused by failure to saturate the output transistor.

SUMMARY OF THE INVENTION
According to the present invention, an improvement on the simple system above is provided which involves relatively low extra cost and which greatly reduces the dependency of the power transistor output on the cleanliness or state of corrosion of the breaker points. According to the invention, a DC-coupled flip-flop circuit is provided between the power transistor and the breaker points, the breaker points being used to drive the flip-flop circuit into one of its two bistable conditions on the opening of the points and driving the flip-flop circuit into the other of its two bistable conditions on the closing of the breaker points. The power transistor is saturated in the ON condition and is driven by the flip-flop circuit. As in the simple system, the power transistor is connected to the primary winding of the ignition coil to provide spark-generating impulses. Because the flip-flop circuit must be either fully in one of its bistable conditions or fully in the other of its bistable conditions, the cleanliness of the breaker points or the stage of corrosion of the breaker points is of relatively minor significance. If the points are exceptionally dirty or corroded, the circuit may not function satisfactorily, but of course this is equally true of a conventional automobile ignition system. However, as long as the points are not unreasonably dirty or corroded, sufficient triggering signal will be provided on the opening and closing of the points to flip the flip-flop circuit from one of its bistable conditions to the other. Because the voltage output of the flip-flop circuit is independent of the magnitude of the trigger signal applied, provided only that the trigger signal is sufficient to flip the flip-flop circuit, then in going from one of its bistable conditions to the other, the flip-flop circuit provides a drive to the power transistor of constant magnitude. Accordingly, the impulse provided to the ignition coil will be satisfactory over a wide range of states of cleanliness of the breaker points.

Thus, the present invention provides in or for use with an automobile ignition system having a source of direct
3,621,827

current, breaker points, and an ignition coil whose secondary winding provides current to one or more spark plugs, and an ignition coil whose secondary winding provides current to one or more spark plugs, and a positive pulse applied to the base of the transistor Q1 cuts off the transistor Q1, and Q2 is turned on by a positive pulse at its base. Because of the described flip-flop circuit adapted to be provided with electrical energy from the source of direct current, and connected and responsive to the breaker points such that when the points open, the flip-flop circuit is switched to one of its two bistable states and when the points close the flip-flop circuit is switched to the other of its two bistable states; a power transistor driven by the flip-flop circuit so as to conduct current preferably in saturated condition, when the flip-flop circuit is in one of its two bistable conditions and not to conduct current when the flip-flop circuit is in the other of its bistable states, and connected to the primary winding of the ignition coil thereby to provide a sparking impulse via the secondary winding of the ignition coil in response to the breaker points. (Generally, in conventional systems, the sparking impulse is provided to a spark plug via the distributor when the points open.)

SUMMARY OF THE DRAWING

The accompanying drawing is a schematic circuit diagram of a preferred embodiment of an electronic automobile ignition circuit according to the present invention, showing its connection to a conventional ignition coil, breaker points, and source of direct current.

DETAILED DESCRIPTION WITH REFERENCE TO THE DRAWING

An ignition coil T1 has its primary winding connected in series with a power transistor Q3, and its secondary winding connected between the positive terminal B1 of a conventional 12 volt automobile battery (not shown) and a conventional automobile distributor (not shown) which distributes the secondary winding impulses to spark plugs (not shown). The emitter of the transistor Q3 and the negative terminal of the battery (not shown) are connected to ground. The base of transistor Q3 is driven by a flip-flop circuit comprising transistors Q1, Q2 and resistors R1, R2, R3, R4, R5, R6 and R7. The flip-flop circuit is of conventional DC-coupled design, the particular design having been selected to minimize the cost of components. The flip-flop circuit is in turn driven by the breaker points P conventionally located in the distributor housing, one contact of the points being connected to ground and to the emitters of the two transistors Q1 and Q2, and the other contact of the points being connected to the base of transistor Q2.

Resistors R3 and R4 act as biasing resistors for the bases of the two transistors Q1 and Q2 respectively. The necessary feedback between the two transistors is effected via resistors R2 and R5 each of which connects the base of one transistor to the collector of the other, as illustrated. The other resistors function as voltage-divider resistors, and as current limiters. A Zener diode Z1 connected in parallel with the emitter-collector path of transistor Q3 is provided to prevent excess voltage across the transistor Q3 from damaging the transistor.

The three transistors are supplied with electrical energy via the terminal B1, the circuit being completed to the negative battery terminal by means of the emitter connection of each transistor to ground. The ignition coil T1, battery, distributor, and breaker points P are standard automobile equipment; the remaining components forming the described embodiment of the circuit according to the invention could be packaged as a unit with appropriate lead wires for connection to the aforesaid standard equipment.

The operation of the circuit is as follows:

When the points P open, the transistor Q2 conducts and the transistor Q1 is cut off. When the points P close a negative pulse is applied to the base of the transistor Q2, thereby turning if off, and a simultaneous positive pulse applied to the base of transistor Q1 turns on transistor Q1. When the points P once again open, a negative pulse at the base of transistor Q1 cuts off the transistor Q1, and Q2 is turned on by a positive pulse at its base. Because of the described flip-flop connections, described above, between the transistors Q1 and Q2, each transistor is held in an OFF condition or an ON condition by means of the condition of the other transistor.

Thus, when the transistor Q2 is ON, the transistor Q1 is OFF, and vice versa. The application of a negative pulse to the base of the ON transistor switches the conducting state of the circuit, while the application of a positive pulse to the base of the OFF transistor causes it to conduct, and this state is then maintained until the next pulse triggers the circuit back to the original state.

The foregoing operation of the flip-flop circuit is conventional and is well understood to those skilled in the art.

The base of transistor Q3 is directly coupled to the collector of transistor Q2 so that when transistor Q2 is turned OFF, the transistor Q3 will be ON and vice versa. In the ON condition, transistor Q3 is saturated.

Thus, when the points are closed, transistor Q2 is turned OFF, and therefore the transistor Q3 conducts. When the points open, transistor Q2 turns ON, turning transistor Q3 OFF, and the collapse of the current through the primary winding of the ignition coil T1 generates an impulse in the coil secondary winding which is fed to the spark plug via the distributor to create a spark in the spark plug at that time fed by the distributor. The points themselves need carry only a low triggering current (say 100 ma.) and thus do not tend to burn.

The above description of the structure and operation of the circuit is of course predicated on the assumption that the automobile has a negative ground system and a 12 volt battery. It will be obvious to those skilled in the art that appropriate modifications of the circuit could be made if the automobile had a 6 volt battery or if the automobile had a positive ground system. It will be equally obvious to those skilled in the art that the particular design of DC-coupled flip-flop circuit illustrated need not be adopted; the flip-flop unit shown in the drawing does have the advantage that only resistors are used in addition to the two active circuit elements, thus enabling production costs to be kept down.

A satisfactory prototype of the circuit shown in the drawing uses the following circuit components:

R1: 500Ω, 10 watts
R2: 150Ω, ½ watt
R3: 500KΩ, ½ watt
R4: 500KΩ, ½ watt
R5: 150Ω, ½ watt
R6: 100Ω, 25 watt
R7: 150Ω, ½ watt
Q1: 2N3054
Q2: 2N3054
Q3: 2N4348
Z1: 120 v, 1w.

In another satisfactory prototype, it was possible to eliminate resistors R3 and R4 altogether and replace each by an open circuit.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. In an internal combustion engine ignition circuit having a direct current source, an ignition coil with primary and secondary windings and breaker points adapted to provide positive and negative pulses, the improvement comprising a flip-flop circuit responsive to said positive and negative pulses and having first and second states, said first state being stable during positive pulses, said second state being stable during said negative pulses, one of said first and second states being adapted to provide a constant drive signal, a means responsive to said drive signal adapted to connect said direct current source to
the primary winding of said ignition coil, whereby the constant drive signal has a magnitude independent of said triggering signal.

2. The improvement of claim 1, wherein said means is a power transistor and is driven by the flip-flop circuit so that when the flip-flop circuit is in one of said states the power transistor conducts and is saturated and when the flip-flop circuit is in the other of said states the power transistor is turned off.

3. The improvement of claim 2 wherein the power transistor does not conduct when the points are open and conducts when the points are closed.

4. The improvement of claim 2 wherein a Zener diode is operably connected in parallel with emitter and collector electrodes of the power transistor to limit the voltage drop across the power transistor.