IGNITION SYSTEM

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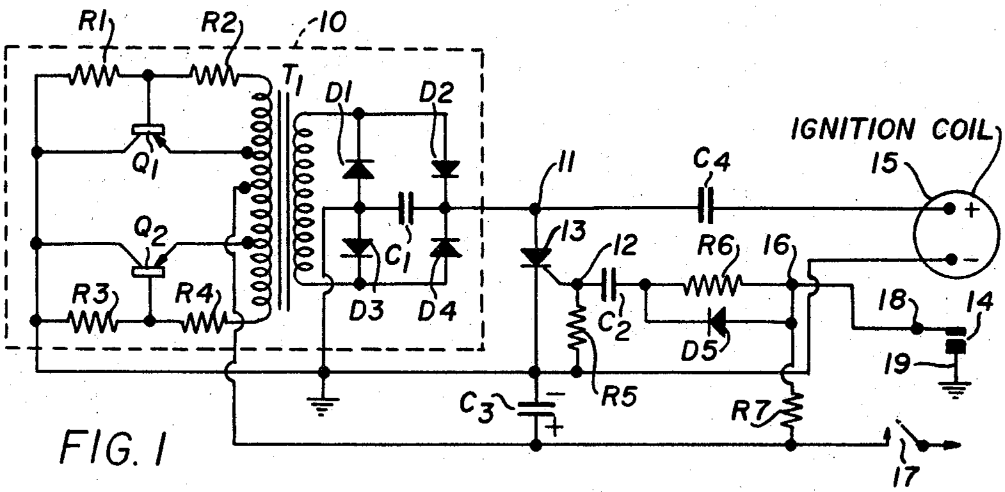

FIG. 1

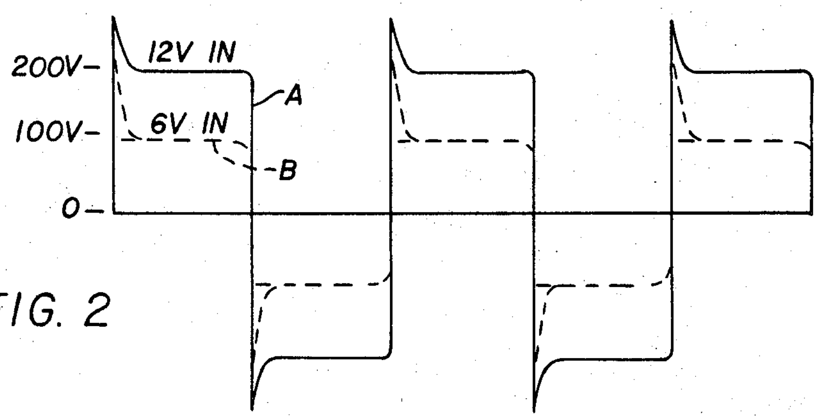

FIG. 2

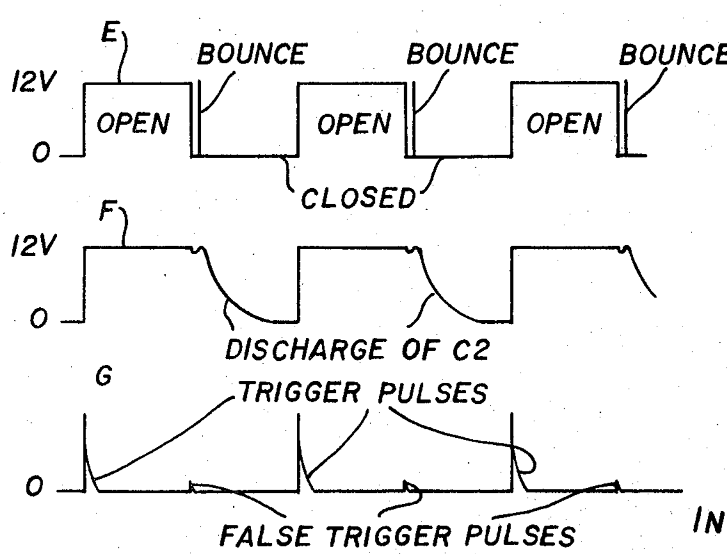

FIG. 3

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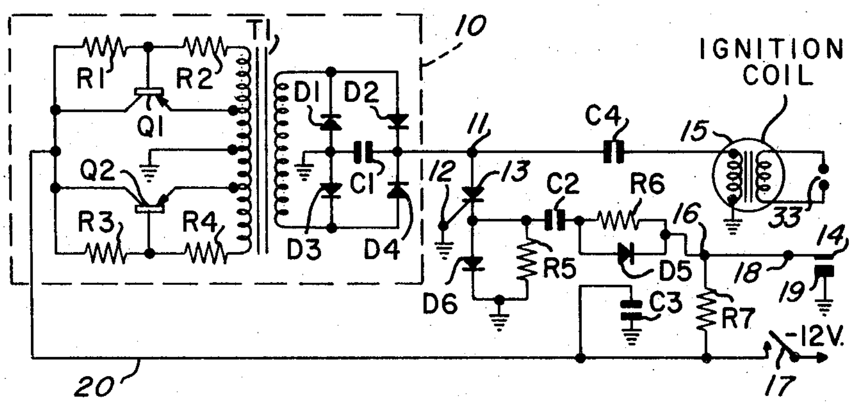

FIG. 4

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IGNITION SYSTEM

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Continuation-in-part of application Ser. No. 310,550, Sept. 23, 1963. This application Jan. 11, 1965, Ser. No. 425,686

Int. Cl. F02p 3/06

U.S. Cl. 123—148 13 Claims

ABSTRACT OF THE DISCLOSURE

A capacitor discharge type of ignition system is provided with an electronic switch triggered from the breaker points through a capacitor and diode. The capacitor discharges through a resistor in parallel with the diode on point closing to provide a time constant delay to eliminate the effect of point bounce.

The present application relates to an ignition system for internal combustion engines, and is a continuation-in-part of my application Ser. No. 310,550 filed Sept. 23, 1963, now abandoned.

The ignition system in use in most internal combustion engines for several decades has been the conventional cam-shaft-driven system having breaker points and distributor, a coil to whose primary winding the breaker points conduct pulses of battery current, and spark plugs within the cylinders of the engine which receive current pulses from the secondary winding of the coil via the distributor.

Disadvantages of such conventional ignition systems include a poor starting spark, poor high speed spark and short lifetime of breaker points, the last because of the high current carried by the points. Because of pitting and burning at the breaker points, conventional systems tend to stay perfectly timed for no more than a few operating hours following "tuning" of the ignition system used in the engine.

More recently, transistorized ignition systems have been devised in order to improve low and high speed engine performance, breaker point life, low voltage starting, and spark plug life.

Transistorized systems known in the art have generally been expensive to produce, have required critical adjustment of breaker point spacing, have been susceptible to cold weather, have tended to foul spark plugs and have not been able to maintain correct ignition timing for appreciable lengths of time.

Some of the more successful transistorized ignition systems include a capacitor which discharges through the coil primary winding. Since the capacitor, rather than the points, provides the surge of current to the coil primary winding, the wear and tear on the points is greatly reduced. However, transistorized capacitor discharged systems developed in the present state of the art have been bulky and expensive, have required a warm-up period, and have been subjected to timing difficulties.

It is therefore an object of the invention to provide an ignition system having a relatively long life and requiring relatively little attention or periodic adjustment.

It is another object of the present invention to provide an ignition system for internal combustion engines in which the peak energy content of the spark delivered to the spark plugs is greater than that of a conventional system.

It is a further object of the present invention to utilize

the distributor points to trigger the discharge of a capacitor which supplies current pulses to the primary winding of the coil, whereby a relatively small current flows through the distributor points.

It is another object of the invention to provide an ignition system in which no warm-up is required.

It is a further object of the invention to provide an ignition system in which radio ignition noise is minimal.

It is a further object of the invention to provide an ignition system which will operate in both extremely high and extremely low temperature conditions.

It is a further object of the invention to provide an ignition system in which ignition timing does not require adjustment over long periods of time.

It is a further object of the invention to provide an ignition system in which a good spark is obtained in hot and cold weather at low and normal battery voltages, at high and low engine speeds, and without fouling spark plugs.

It is a further object of the invention to provide an ignition system in which the relative times during which the breaker points are open and closed are not critical.

It is a further object of the invention to provide an ignition system which will operate almost as effectively when supply battery voltage is low as it will with rated battery voltage.

It is a further object of the present invention to provide an ignition system which operates effectively despite the bouncing of distributor points following closure of the points.

It is still a further object of the invention to provide an ignition system achieving each of the aforesaid objects at a relatively low cost. To this end, the ignition system according to the invention attempts to make as much use as possible of the conventional system components which are standard equipment on internal combustion engines.

Accordingly, the present invention provides, in an ignition system for an internal combustion engine having spark plugs, a coil whose secondary winding feed current to the spark plugs, a source of direct current, and breaker points for regularly interrupting flow of current to the primary winding of the coil; the improvement comprising a discharge capacitor charged by a power supply, preferably a rectified transistorized oscillator output, the capacitor being adapted to discharge directly through the primary winding of the coil, a gate-controlled switching means (preferably a silicon controlled rectifier) connected in series with the coil primary winding and the capacitor and causing the capacitor to discharge when the gate-controlled switching means conducts current, a trigger capacitor connected to the gate terminal of the silicon controlled rectifier and charged by the source of direct current, the trigger capacitor being connected also to the breaker points and in response to opening of the breaker points conducting a triggering impulse to the gate-controlled switching means thereby to cause it to conduct current; and means associated with said last-mentioned capacitor for preventing triggering of the gate-controlled switching means when the breaker points bounce following closure.

According to a further feature of the invention, the transistorized oscillator includes a pair of alternately-conducting transistors which operate so that a slight delay occurs between conduction periods. This delay, which increases with decreasing supply voltage, causes transient voltage peaks to occur in the output waveform of the oscillator at the beginning of each half cycle of oscillation. The amplitude of the peaks relative to the average rectified output voltage increases with increasing delay between conduction periods. This compensates for drops in supply voltage, such as occur, for example, when the engine is being cranked by the starter.

An important feature of the invention is the prevention of false triggering of the gate-controlled switching means resulting from bouncing of the points following closure. This object is achieved by the provision of a trigger circuit for the gate-controlled switching means, comprising in series: a source of pulses (e.g. the breaker points), a resistor in parallel with a diode, a trigger capacitor, and the gate of the switching means. (In one embodiment of the system, the trigger capacitor is connected to the gate through the cathode-to-gate junction of a silicon controlled rectifier.) The trigger capacitor is charged through the diode by each pulse produced by the source, thereby transmitting to the gate a trigger signal (one for each pulse) rendering the switching means conductive. The trigger capacitor discharges through the resistor in the time between successive pulses produced by the source (e.g. in the time during which the breaker points are closed). If the pulse source is the breaker points, then at the time of bouncing of the points the trigger capacitor will still be almost fully charged, not having had time to discharge through the resistor. Thus the change in voltage across the capacitor caused by the bouncing of the points is too small to trigger the gate of the silicon controlled rectifier or other gate-controlled switching means.

The invention will now be described with reference to the accompanying drawings in which:

FIG. 1 is a circuit diagram of the ignition system according to the present invention;

FIG. 2 is a graph illustrating the output waveform of the transistorized oscillator which supplies current to the periodically discharging capacitor in an ignition system constructed according to the invention;

FIG. 3 shows the voltage waveform across the distributor points, the voltage waveform at one terminal of the capacitor used to trigger the silicon controlled rectifier, and the triggering waveform appearing at the gate terminal of the silicon controlled rectifier in the ignition system of FIG. 1; and

FIG. 4 is a circuit diagram of an ignition circuit according to the invention for use in a system having a positive ground.

A circuit diagram of an embodiment of the ignition system constructed according to the invention is illustrated in FIG. 1. In this figure, conventional breaker points **19** and a coil **15** of an ordinary internal combustion engine are shown. A transistorized power suppply **10** is provided, by an oscillator circuit including transistors **Q1** and **Q2** connected via resistors **R1**, **R2**, **R3** and **R4** to one another and to the primary winding of a transformer **T1** as shown. The output current of the secondary winding of the transformer **T1** is rectified by diodes **D1**, **D2**, **D3** and **D4**, the output wave form of the rectified current being smoothed by a capacitor **C1**. The oscillator is powered via the center tap of the primary winding of transformer **T1**, which in a motor vehicle, for example, is connected to the battery of the vehicle via the ignition switch **17**. A capacitor **C3** provides an AC ground to the ignition switch lead wire.

The positive and negative terminals of the coil **15** are connected respectively to one terminal of a discharge capacitor **C4** and to ground. The other terminal of capacitor **C4** is connected to the output terminal **11** of the transistorized power supply. Also connected to the terminal **11** is the anode of a silicon controlled rectifier **13**. The cathode of the silicon controlled rectifier **13** is connected to ground. The gate terminal **12** of the silicon controlled rectifier **13** is connected to a trigger capacitor **C2**, which in turn is connected to a diode **D5** in parallel with a resistor **R6**. The other terminals of the resistor **R6** and the diode **D5** are connected to one terminal **18** of the breaker points **14**, the other terminal **19** of the points

14 being connected to ground. Connected at the junction **16** between the terminal **18** and the resistor **R6** is one terminal of a resistor **R7** whose other terminal is connected to the positive battery terminal via the ignition switch **17**. A resistor **R5** is connnected between ground and the gate terminal **12** of the silicon controller rectifier **13**.

In operation, the discharge capacitor **C4** is charged by the transistorized power supply and discharges through the silicon controlled rectifier **13** and the primary winding of the coil **15**. The silicon controlled rectifier **13** is normally non-conductive, but conducts current when an appropriate positive triggering impulse is applied to the gate terminal **12**. This trigger impulse is provided by rapid charging of the trigger capacitor **C2** from the battery through the diode **D5** in response to opening of the breaker points **14**. Once the capacitor **C2** is nearly fully charged, the trigger impulse ceases, as FIG. 3 shows. The capacitor **C2** then discharges through the resistor **R6** when the points **14** are closed. As will be described in more detail below, the resistor **R6** and the diode **D5** prevent a triggering impulse from flowing to the gate **12** following bouncing of the breaker points **14** upon closing.

Because the points are used only to initiate the triggering of the silicon controlled rectifier, point spacing is not critical and timing problems are therefore minor.

The output waveform at relatively low engine speeds (such as during starting), of the oscillator used in the power supply for the ignition system of FIG. 1, is shown in FIG. 2. In this figure, curve A represents the output waveform of the oscillator, prior to rectification, at a battery supply voltage of 12 volts. Curve B illustrates the equivalent output waveform at a battery supply voltage of 6 volts (which may occur during cranking of the engine by the starter). The power supply is preferably designed so that at an input direct voltage of 12 volts (rated voltage for most motor vehicles) the transistors **Q1** and **Q2** conduct alternately and almost exactly sequentially, the only delay between conduction of one transistor and conduction of the other transistor being as a result of the leakage inductance in the transformer **T1**. This slight delay results in a very slight transient voltage peak at the beginning of the conduction period of each transistor as curve A in FIG. 2 indicates. If the battery voltage drops below the rated voltage of 12 volts, the delay between periods of conduction of the two transistors increases, causing an increased transient voltage spike at the beginning of each oscillation period. This is indicated by curve B in FIG. 2. Accordingly, the peak voltage output of the transistorized oscillator at the beginning of each half wave of oscillator output is much higher than the average voltage output, which drops in proportion to battery supply voltage, and the voltage spike is almost as high at low battery voltage as it is at high battery voltage. A core material with a sharp "knee" in its magnetic saturation curve will tend to facilitate this result if used in the transformer **T1**. Therefore, because the capacitor **C4** is charged for the most part by the initial high voltage peaks of the transistorized oscillator output, the capacitor **C4** will receive a satisfactory charge almost as quickly at an input battery voltage of 6 volts as it will at rated battery voltage of 12 volts.

In order that satisfactory charging of the capacitor **C4** occur at high engine speeds, it is necessary that the frequency of oscillation of the power supply oscillator be high relative to the operating frequency of the system as a whole (i.e. the number of discharges per second of the capacitor **C4**). An eight-cylinder engine operating at a speed of 7,000 r.p.m. approximately represents the upper limit of conventional automobile engine speeds, and therefore an operating frequency of no more than 500 cycles per second may reasonably be expected for the system as a whole if it is to be used in conventional automobiles. Therefore, a frequency of oscillation of 5,000 cycles or more per second would be satisfactory for the transistorized oscillator. The core material of the transformer must be chosen to accommodate frequencies of this order of magnitude.

The output voltage of the power supply **10** should be much higher than the battery voltage in order to provide a high voltage discharge through the coil primary winding. Of course, a quick, high-voltage discharge produces a more efficient spark in the combustion chamber than does a low-voltage discharge of the same or longer duration. The upper limit of the coil primary voltage is usually determined by insulation problems. A voltage of the order of 200 volts is representative of a suitable output voltage from the power supply **10**.

The power supply **10** should be designed to be unaffected by shortcircuiting its output. In the circuit shown in FIG. 1, short-circuiting the output has the effect of decreasing the regenerative feedback voltage applied to the transistors Q1 and Q2; therefore the circuit shuts itself off if a short circuit occurs. In the circuit of FIG. 1, the power supply is short-circuited briefly during conduction of the silicon controlled rectifier **13**. It is therefore necessary that the oscillator recover quickly after shutting itself off, in order to be able to charge the capacitor C4 adequately prior to its discharge. To this end, the feedback windings of transformer T1, and the resistance values of the resistors R1, R2, R3, and R4 should be carefully chosen.

The power supply shown in FIG. 1 may be replaced by any other power supply meeting the requirements of the ignition circuit as a whole.

The conventional ignition coil used in most internal combustion engines will not withstand primary voltages much higher than 200 volts. This limits the choice of output voltage for the power supply **10**, assuming that the conventional coil is to be retained. In order to deliver a high-energy spark, it is therefore necessary to choose a relatively high capacitance value for the capacitor C4. However, if the capacitor C4 has a high capacitance, the power supply **10** must be able to deliver a relatively high current in order to charge the capacitor, and the silicon controlled rectifier **13** must be able to withstand high discharge currents. At high engine speeds, it will be necessary to charge the capacitor C4 within perhaps 2 milliseconds. These factors must be borne in mind when choosing the capacitance value of the capacitor C4.

In order that the silicon controlled rectifier will be shut off after discharge of the capacitor C4 and before the next cycle of operation, a very short triggering impulse must be applied to the gate terminal **12**. The silicon controlled rectifier **13** will conduct current until both its gate and anode potentials are zero or negative. Therefore, to shut off the silicon controlled rectifier **13** quickly, it is necessary that the potential at gate terminal **12** be sufficiently low when the capacitor C4 has completed its discharge. This is accomplished by selecting a low capacitance value for the capacitor C2, in order that the capacitor C2 may be completely charged by the time the capacitor C4 has discharged. For normal internal combustion engine operation the maximum time during which a triggering impulse may be applied to the silicon controlled rectifier **13** is in the order of **15** microseconds. However, the capacitor C2 must have high enough capacitance that the capacitor delivers enough current to trigger the silicon controlled rectifier **13**.

The silicon controlled rectifier has appreciable gate to anode capacity. In order to prevent accidental discharge of the silicon controlled rectifier **13** at the beginning of each half cycle of oscillator operation, the capacitor **C1** is included to take the initial surge of current from the power supply and therefore to eliminate the possibility that the current surge applied to the anode of the silicon controlled rectifier **13** will cause accidental triggering.

Prevention of accidental triggering as a result of bounce of the breaker points following their initial closing is accomplished by the resistor R6. FIG. 3 illustrates the wave forms occurring in the system as a result of bouncing of the breaker points. The uppermost curve E shows the voltage wave form across the points, the bounce occurring very shortly after the points are closed. If the resistor **R6** were replaced by a short circuit, opening of the points on the bounce would trigger the silicon controlled rectifier creating an undesired spark. But because of the presence of resistor **R6**, the capacitor **C2** cannot discharge immediately but takes an appreciable portion of the "points closed" half-cycle to discharge. The capacitor **C2** thus discharges momentarily following closure and before the bounce (curve F) but does not complete its discharge until the points are firmly closed. The resulting trigger impulse is shown in the lowermost wave form G. Because the capacitor **C2** remains almost fully charged during the bounce (because of the damping action of resistor **R6**) the "false" trigger pulses caused by bouncing of the points are insufficient to trigger the silicon controlled rectifier **13**. In contrast, the capacitor **C2** can charge almost instantaneously when the points are opened because of the conduction of diode **D5**.

The capacitor **C3** has two functions. Firstly, it compensates for line inductance in the lead wires from the ignition switch, and provides an AC ground for reflected voltage transients caused by the power supply **10**. Secondly, voltage spikes caused by transients in other devices connected to the ignition switch (for example, the starter for the engine) are directed to ground. Otherwise, such spikes might cause spurious triggering of the silicon controlled rectifier **13**.

Note that the resistance of resistor **R6** must be carefully chosen so that the capacitor **C2** may discharge sufficiently within the period during which the points are closed, at maximum engine speeds. Too high a resistance value for the resistor **R6** will have the effect of preventing the silicon controlled rectifier from being triggered at high engine speeds.

The resistance of resistor **R7** must be chosen to be great enough that excessive current will not flow through the breaker points when they are closed, and must be small enough that the capacitor **C2** acquires sufficient charging current from the battery to produce a trigger pulse when the points open. Point burning and arcing is of course to be avoided, not only because burning necessitates frequent point replacement but also because point arcing causes a great deal of radio noise. With proper choice of **R7**, these problems are not serious. It should be remembered that the low temperature requirements of the silicon controlled rectifier gate must be met. At very low temperatures perhaps six times the triggering current is required than required at normal summer temperatures.

In order to ensure that unduly large negative voltages are not applied to the gate of the silicon controlled rectifier **13** (which might damage it), the ratio of the resistance of resistor **R5** to the resistance of resistor **R6**, when multiplied by the battery voltage, must be less than about 3 volts for conventional silicon controlled rectifiers. In other words, the voltage-divider network formed by resistors **R5** and **R6** must prevent the potential at gate terminal **12** from falling too low. The resistor **R5** has the further function of preventing leakage current through the silicon controlled rectifier **13** from triggering the silicon controlled rectifier.

In general, the internal resistance of the silicon controlled rectifier will, in combination with circuit wiring resistances, be sufficiently high so that the rectifier will not be harmed by a prolonged short circuit (of the coil, for example). If this is found not be the case, a suitable current-limiting resistor may be included in series with the silicon controlled rectifier, connected, for example, to the anode of the rectifier.

When the current of FIG. 1 is mounted for use on an engine, the circuit components should be enclosed in a suitable fluid-tight container. With appropriate choice of circuit components, the circuit should operate satisfactorily in summer and winter without necessity for any warm-up.

A reasonably satisfactory prototype of a circuit constructured according to FIG. 1 used the following circuit components:

Q1 and Q2—Phillips OC22
T1—two Phillips "E" cores (K5400753A) and one bobbin(NK24605). The secondary was wound using No. 29 enameled wire, 200 turns. The primary used 30 turns of No. 24 enameled wire, center-tapped and tapped 3 turns from each end.
R1 and R3—1 kilohm, ½ watt
R2 and R4—27 ohms, ½ watt
R5—220 ohms, ½ watt
R6—33 kilohms, ½ watt
R7—47 ohms, 5 watts
C1—0.05 microfarads, 300 WVDC
C2—0.1 microfarads, 50 WVDC
C3—10 microfarads, 15 WVDC
C4—1.5 microfarads, 300 WVDC
D1, D2, D3, D4, D5—Phillips Ph 1021
Silicon controlled rectifier—General Electric C22B

The circuit shown in FIG. 1 is designed for use in systems having a negative ground, i.e. the negative terminal of the battery is grounded. In some systems, however, a positive ground is used.

FIG. 4 shows a circuit diagram of an embodiment of the ignition system for use in a system having a positive ground. The circuit includes conventional breaker points **14** and a coil **15** of an ordinary internal combustion engine. A transistorized power supply **10** is provided by an oscillator circuit including transistors Q1 and Q2 connected via resistors R1, R2, R3 and R4 to one another and to the primary winding of a transformer T1 as shown. The output current of the secondary winding of the transformer T1 is rectified by diodes D1, D2, D3 and D4, the output wave form of the rectified current being smoothed by a capacitor C1. The aforesaid components may be respectively identical to, and function in the same manner as components bearing the same reference numerals in FIG. 1.

The oscillator is powered via a lead **20** which is connected to the collectors of the transistors Q1 and Q2 and, in a motor vehicle, for example, to the negative terminal of the battery of the vehicle via the ignition switch **17**. Because the centre tap of the primary winding of the transformer T1 is grounded in FIG. 4, it will be seen that the polarity of the input direct voltage to the oscillator is the same as that in FIG. 1.

A capacitor C3 connected to the ignition switch lead wire provides and AC ground and performs the same functions as in the circuit of FIG. 1.

The negative and positive terminals of the coil **15** are connected respectively to one terminal of a capacitor C4 and to ground. The other terminal of capacitor C4 is connected to the output terminal **11** of the transistorized power supply. Also connected to the terminal **11** is the anode of a silicon controlled rectifier **13**. The gate terminal **12** of the silicon controlled rectifier **13** is connected to ground. The cathode of the silicon controlled rectifier **13** is nected to a diode D5 in parallel with a resistor R6. The diode D5 is connected so as to conduct current when the potential at its junction with capacitor C2 is higher than the potential at the point **16**. The other terminals of the resistor R6 and the diode D5 are connected to one terminal **18** of the breaker points **14**, the other terminal **19** of the points **14** being connected to ground. Connected to the junction **16** between the terminal **18** and the resistor R6 is one terminal of a resistor R7 whose other terminal is connected to the negative battery terminal via the ignition switch **17**. A resistor R5 is connected in parallel with a diode D6 between ground and the cathode terminal of the silicon controlled rectifier **13**. The diode D6 is connected so as to conduct current when the potential at the cathode of the silicon controlled rectifier **13** is higher than ground potential. The components C2, C3, C4, R5, R6, R7, D5 and **13** may be identical to those shown in FIG. 1. The resistor R6 may be of slightly lower resistance, however, in view of the slight forward voltage drop across the diode D6.

In operation, the capacitor C4 is charged by the transistorized power supply and discharges through the silicon controlled rectifier, the diode D6 and the primary winding of the coil **15**. The silicon controlled rectifier **13** is normally non-conductive, but conducts current when an appropriate positive triggering impulse is applied to the gate terminal **12**. This trigger impulse is provided by rapid charging of the capacitor C2 in response to opening of the breaker points **14**. The path of lowest impedance available for charging the capacitor C2 includes the cathode to gate junction of the silicon controlled rectifier. When the breaker points **14** open, current flows from ground to the gate terminal **12** of the silicon controlled rectifier **13** and then to the cathode of the silicon controlled rectifier **13** and through capacitor C2, diode D5 and resistor R7 to the negative terminal of the battery via switch **17**. The positive voltage pulse from gate to cathode of the silicon controlled rectifier **13**, due to this current, constitutes the trigger impulse. Once the capacitor C2 is nearly fully charged, the trigger impulse ceases. When the points **14** are closed, the capacitor C2 then discharges through the resistor R6 and the diode D6. As discussed in connection with the embodiment shown in FIG. 1, the resistor R6 prevents a triggering impulse from flowing to the gate **12** following bouncing of the breaker points **14** upon closing.

What I claim as my invention is:

1. In an ignition system for an internal combustion engine having a source of direct current, spark plugs, an ignition coil for supplying current to the spark plugs, and breaker points regularly opened and closed by the engine; the improvement comprising a discharge capacitor connected to the primary winding of the ignition coil for discharging therethrough, a silicon controlled rectifier connected in series with the capacitor and the coil and intermittently providing a discharge path for said capacitor, and means responsive to opening and closing of the breaker points for gating a trigger impulse to the silicon controlled rectifier thereby to cause said silicon controlled rectifier to conduct current from the capacitor through the primary winding of the ignition coil, wherein the means for gating the trigger impulse includes a trigger capacitor connected to the points and charged by the source of direct current when the points are open and discharging through the breaker points when the points are closed and additionally including unidirectional means connected between the breaker points and the second capacitor and preventing rapid discharge of the trigger capacitor thereby to prevent conduction of the silicon controlled rectifier in response to bouncing of the breaker points after closure.

2. A system as defined in claim **1**, wherein the trigger impulse is of shorter duration than the time taken by the discharge capacitor to discharge through the coil.

3. A system as defined in claim **2**, additionally including a second resistor connected between the gate terminal and the cathode of the silicon controlled rectifier.

4. In an ignition system for an internal combustion engine having a source of direct current, a coil, and breaker points regularly opened and closed by the engine; the improvement comprising a discharge capacitor, a silicon controlled rectifier connected in series with the capacitor and the primary winding of the coil, a power supply powered by the source of direct current and connected to the capacitor thereby to charge the capacitor, triggering means connected between the breaker points and the gate terminal of the silicon controlled rectifier, said triggering means causing the silicon controlled rectifier to conduct current intermittently in response to opening and closing of the breaker points, and false trigger prevention means connected to said triggering means for preventing the triggering means from causing the silicon controlled rectifier to conduct current in response to bouncing of the breaker points following their closure, wherein the triggering means includes a trigger capacitor one of whose terminals is connected to the gate terminal of the silicon controlled rectifier, and the false trigger prevention means includes a diode rectifier in parallel with a resistor, the anode of the diode rectifier being connected to one terminal of the breaker points and to a source of positive potential, the cathode of the diode rectifier being connected to the other terminal of the trigger capacitor.

5. An ignition system as defined in claim **4**, wherein the silicon controlled rectifier provides a short circuit across the power supply when the silicon controlled rectifier conducts current.

6. In an ignition system for an internal combustion engine having spark plugs, an ignition coil for providing current pulses to the spark plugs, a source of direct current for supplying electric power to the system, and breaker points regularly opened and closed by the engine; the improvement comprising a two-transistor oscillator powered by the source of current, rectifying means connected to the output terminal of the oscillator and rectifying the output of the oscillator, a first capacitor connected between the output terminal of the rectifying means and the primary winding of the coil; the first capacitor being charged by the rectified oscillator output and discharging intermittently through the primary winding of the coil, a silicon controlled rectifier connected in series with the primary winding of the coil and the first capacitor and providing a discharge path for the first capacitor through the primary winding of the coil when the silicon controlled rectifier conducts current, a second capacitor having one of its terminals directly connected to the gate terminal of the silicon controlled rectifier, a diode rectifier having its cathode directly connected to the other terminal of the second capacitor and having its anode connected to one terminal of the breaker points, a first resistor connected between the anode of the diode rectifier and the positive terminal of the source of current, the other terminal of the breaker points being connected to the negative terminal of the source of current, and a second resistor directly connected in parallel with the diode rectifier.

7. A system as defined in claim **6**, additionally including means for producing a slight delay between conduction periods of the two transistors thereby to produce transient voltage peaks at the beginning of each half cycle of the oscillator voltage output waveform.

8. A system as defined in claim **7**, wherein the trigger capacitor is of smaller capacitance than the discharge capacitor and intermittently provides a gate signal to the silicon controlled rectifier for a time shorter than the time required by the discharge capacitor to discharge through the coil.

9. A system as defined in claim **8**, wherein the anode of the silicon controlled rectifier is connected to the output terminal of the said rectifying means.

10. A system as defined in claim **9**, additionally including a second resistor connected between the gate terminal and the cathode of the silicon controlled rectifier.

11. A system as defined in claim **4**, wherein the source of positive potential is one terminal of a second resistor whose other terminal is connected to the positive terminal of the source of direct current, the negative terminal of the source of direct current being connected to the other terminal of the breaker points.

12. In an ignition system for an internal combustion engine having spark plugs, a coil for providing current to the spark plugs, breaker points regularly opened and closed by the engine, and a source of direct current for providing electric power for the ignition system; the improvement comprising a first capacitor connected to the primary winding of the coil and discharging periodically through the coil, means connected to the capacitor for supplying charging current to the capacitor, a silicon controlled rectifier connected in series with the primary winding of the coil and the first capacitor, a second capacitor having one of its terminals directly connected to the gate terminal of the silicon controlled rectifier, a diode rectifier having its cathode directly connected to the other terminal of the second capacitor, a first resistor connected between the anode of the diode rectifier and the positive terminal of the source of direct current, a second resistor directly connected in parallel with the diode rectifier, the anode of the diode rectifier being connected to one terminal of the breaker points, the other terminal of the breaker points being connected to the negative terminal of the source of direct current.

13. An electronic ignition circuit for an internal combustion engine comprising:

(a) a triggerable avalanche device;
(b) a capacitor;
(c) means for connecting said avalanche device and said capacitor in series with each other and with the primary winding of the ignition coil of the engine;
(d) means for charging said capacitor to a voltage less than the breakdown voltage of said avalanche device during periods when said avalanche device is in its OFF condition; and
(e) an RC circuit portion for triggering said avalanche device responsively to a signal produced by the engine, said RC circuit portion including:
(f) means for charging the capacitance thereof rapidly during firing of said avalanche device;
(g) means for discharging the capacitance thereof slowly immediately after said avalanche device cuts off; and
(h) means for applying the voltage of the discharging capacitance to said avalanche device in a direction to hold said avalanche device cut off while said capacitance discharges.

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2,980,823	4/1961	Short	123—148X
2,984,695	5/1961	Berdine et al.	123—148E
3,049,642	8/1962	Quinn	123—148E
3,051,870	8/1962	Kirk	123—148E
3,056,066	9/1962	Dozier, Jr.	123—148E
3,131,327	4/1964	Quinn	123—148E

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