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DUAL SPARK CAPACITOR DISCHARGE IGNITION SYSTEM
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ABSTRACT OF THE DISCLOSURE

A capacitor discharge ignition system which produces two sparks per cylinder per compression stroke. The ignition signals are applied across a circuit which produces two like polarity signal pulses per ignition input signal. To produce the two like polarity signal pulses, the primary winding of a transformer is connected in series with the current carrying electrodes of a normally conducting transistor across a direct current potential source. The primary winding of the transformer is connected across the output circuit therein and the secondary winding of the transformer is also connected across the output circuitry thereof in a polarity relationship opposite that of the primary winding. A switching and timing circuit responsive to each input ignition signal extinguishes the transistor and maintains it non-conducting for a predetermined time delay which is less than the time between ignition signal pulses. The output of this circuit is applied to a connector circuit which provides the potential for charging the ignition capacitor. An output circuit which discharges the ignition capacitor through the primary winding of the ignition coil is coupled to the converter circuit.

This invention is directed to a dual spark capacitor discharge ignition system and, more specifically, to the circuitry included therein which produces two like polarity signal pulses in response to a single ignition input signal. It has been found that the fuel ignition spark produced by a capacitor discharge ignition system is of insufficient duration to provide complete fuel combustion at intermediate and low engine speeds. Consequently, a capacitor discharge ignition system which provides two firing sparks per cylinder per compression stroke to improve the performance of capacitor discharge ignition systems at these engine speeds, is desirable.

It is, therefore, an object of this invention to provide an improved capacitor discharge ignition system.

It is another object of this invention to provide an improved capacitor discharge ignition system which produces two firing sparks per cylinder per compression stroke.

It is a further object of this invention to provide a circuit which is responsive to each ignition input signal to produce two like polarity output signals which are employed by the converter and output circuits of a capacitor discharge ignition system to supply two firing sparks per cylinder per compression stroke.

In accordance with this invention, a dual spark capacitor discharge ignition system is provided wherein a circuit responsive to each ignition input signal to produce two like polarity output signals is combined with a converter circuit and an output circuit to produce two firing sparks per cylinder per compression stroke.

For a better understanding of the present invention, together with additional objects, advantages and features thereof, reference is made to the following description and accompanying drawings wherein:

FIG. 1 schematically sets forth the dual spark capacitor discharge ignition system of this invention suitable for use with a conventional breaker contact type ignition distributor, and,

FIG. 2 schematically sets forth the dual spark capacitor discharge ignition system of this invention suitable for use with a magnetic type ignition distributor.

In the two figures of the drawings, like elements have been given like characters of reference.

As the point of reference or ground potential is the same point electrically throughout the system, it has been represented by the accepted schematic symbol and referenced by the numeral 5 throughout the drawings.

Referring to the figures, the capacitor discharge system of this invention is shown to include the combination of a source of ignition signals produced in timed relationship with the internal combustion engine with which the ignition system is being used, a circuit responsive to each ignition input signal to produce two like polarity output signal pulses, a converter circuit responsive to each output signal pulse for producing the potential which provides the charge upon the ignition capacitor and a system output circuit which provides for the discharge of the ignition capacitor through the primary winding of the ignition coil with each output signal from the converter circuit. A source of direct current potential, which may be a conventional storage battery 8, is provided to supply the operating potential for the circuits of FIGS. 1 and 2.

In FIG. 1, the source of ignition signal pulses is schematically illustrated as a pair of conventional automotive ignition breaker points 10 and 10a, which are located within the ignition distributor and are opened and closed in timed relationship with the internal combustion engine with which the ignition system is being used by a rotating lobed cam in a manner well known in the automotive art, and the associated circuitry. In FIG. 2 the source of ignition signal pulses is schematically illustrated as a magnetic type distributor having a field pole piece 12 with a pick-up coil 14 wound thereon and a lobed armature 15 which is driven in timed relationship with the internal combustion engine with which the ignition system is being used in a manner well known in the automotive art. An example of a distributor of this type is disclosed and described in U.S. Pat. No. 3,254,247 which issued May 31, 1966 and is assigned to the same assignee as the present invention. The operation of the respective sources of ignition signals will be described in detail later in this specification.

The current responsive converter circuit of this invention includes a converter transformer 24 having a primary winding 25 and a secondary output winding 26, across which external utilization circuitry may be connected, a parallel control resistor pair 30 and 31 and a normally not conducting type NPN transistor 40, having a control electrode and two current carrying electrodes connected in series with primary winding 25 of converter transformer 24 and the parallel combination of control resistors 30 and 31 across direct current potential source 8, a trigger circuit for producing a trigger signal in response to each input signal pulse, shown in the figures as a normally not conducting type NPN transistor 50.
and the associated circuitry, a control circuit responsive to the potential drop across the parallel combination of control resistors 33, 34, and 35 for disabling the trigger circuit through the potential drop through the predetermined magnitude, shown in the figures as two normally conducting type NPN transistors 60 and 70 connected in a Darlington pair and the associated circuitry, and a circuit for applying the potential drop which appears across the control resistors 33 and 34 to the control circuit, shown in the figure as series resistors 33, 34 and 35.

The system output circuit includes an ignition capacitor 18 and a charging circuit therefor, the primary winding 20 of a conventional ignition coil 19, which also has a secondary winding 21, and a silicon controlled rectifier ignition capacitor switch 22, for connecting the ignition capacitor 18 across the ignition coil primary winding 20.

The circuit for producing two like polarity output signal pulses in response to each input signal includes an input circuit across which the input signals may be applied, which may be terminals 16 and 17 or other electrical devices suitable for connection to external circuitry, an output circuit which may be terminal 28 and point of reference or ground potential 5, a transformer 36 having a primary winding 37 connected across the output circuit and a secondary winding 38 connected across the output circuit in a polarity relationship opposite in phase to that of the primary winding 37, an energizing circuit for primary winding 37 of transformer 36 including a first controllable switching device operable to a circuit completing and a circuit interrupting or operating condition connected across the direct current potential source and circuitry including a timing circuit interconnected with the input circuit and the controllable switching device in a manner to operate the controllable switching device to the opposite operating condition in response to each input signal applied across the input circuit and to operate the controllable switching device to the original operating condition at the conclusion of a predetermined time delay.

Primary winding 37 of transformer 36 is connected across output circuit terminal 28 through capacitor 44 and diode 45, at terminal end 46, and point of reference or ground potential 5 through positive polarity lead 48, movable contact 57 of switch 56, resistor 67 and minimal end 47. The secondary winding 38 of transformer 36 is also connected across the output circuit terminal 28 and point of reference or ground potential 5 through capacitor 54 and diode 55 at terminal end 58, and through lead 64 at terminal end 59, in a polarity relationship opposite to that of primary winding 37. That is, the terminal end of primary winding 37 which is of a positive polarity potential upon the interruption of the energizing circuit therefor is connected to output circuit terminal 28 and the other terminal end is connected to point of reference or ground potential 5 while the terminal end of secondary winding 38 which is of a positive polarity upon the establishment of the energizing circuit for primary winding 37 is connected to output circuit terminal 28 and the other terminal end thereof is connected to point of reference or ground potential 5.

The circuitry including a timing circuit interconnected with input circuit terminals 16 and 17 via capacitor 68 and transistor 80 in a manner to operate transistor 80 to the opposite operating condition in response to each input signal applied across input terminals 16 and 17 and to operate transistor 80 to the original operating condition at the conclusion of a predetermined time delay, in a manner to be later explained, is shown in Fig. 7. Similarly, Figs. 8 and 9 show the control circuitry including a voltage limiter in a circuit including a trigger circuit, having one end connected to the collector-emitter electrodes of transistor 80 and an emitter electrode 83. The primary winding 37 of transformer 36 and the current carrying electrodes, collector-emitter electrodes, of transistor 80 are connected in series across battery 8 upon the closure of movable contact 57 of switch 56 through resistor 74 and positive polarity line 48, and movable contact 57 of switch 56 and point of reference or ground potential 5.

A charging circuit for capacitor 69 which includes resistor 67, capacitor 69 and the base-emitter electrodes of transistor 80 are also connected across the direct current potential source through positive polarity line 48 and movable contact 57 of switch 56 and point of reference or ground potential 5.

The collector-emitter electrodes of transistor 90 are connected at junction 75 between capacitor 69 and resistor 67 and the emitter electrode 83 of transistor 80, through point of reference or ground potential 5.

Resistor 68 is connected across the base electrode 81 of transistor 80 and the emitter electrode 93 of transistor 90 through positive polarity line 48, movable contact 57 of switch 56, battery 8 and point of reference or ground potential 5.

The base-emitter electrodes of transistor 90 are connected across input terminals 16 and 17 through diode 76 and resistor 77 and through point of reference or ground potential 5.

As the collector-emitter electrodes of each of transistors 80 and 90 are connected across the positive and negative polarity terminals of battery 8, respectively, the correct collector-emitter potential for type NPN transistors is impressed across the collector-emitter electrodes of both of these devices upon the closure of movable contact 57 of switch 56, which may be a pole of a conventional ignition switch.

Upon the closure of movable contact 57 of switch 56, a circuit is established for base-emitter current flow through type NPN transistor 80 which may be traced from the positive polarity terminal of battery 8 through movable contact 57 of switch 56, positive polarity line 48, resistor 67, base-emitter 81 of transistor 80 and through point of reference or ground potential 5 to the negative polarity terminal of battery 8. Consequently, transistor 80 is normally closed or conducting to complete the energizing circuit for primary winding 37 of transformer 56.

A charging circuit for capacitor 69 is also established and may be traced from the positive polarity terminal of battery 8 through movable contact 57 of switch 56, positive polarity line 48, resistor 67, capacitor 69, the base-emitter electrodes of transistor 80 and through point of reference or ground potential 5 to the negative polarity terminal of battery 8. Consequently, capacitor 69 charges, the plate thereof connected to junction 75 being of a positive polarity.

As the base electrode 91 of transistor 90 is connected to point of reference or ground potential 5 with ignition breaker contacts 10 and 10a closed, transistor 90 is not conducting during the periods of closure of these breaker contacts.

Upon each opening of breaker contacts 10 and 10a, a circuit is established for base-emitter current flow through type NPN transistor 90 which may be traced from the positive polarity terminal of battery 8 through movable contact 57 of switch 56, resistor 77, the base-emitter electrodes of transistor 90 and through point of reference or ground potential 5 to the negative polarity terminal of battery 8. In this manner, the input ignition signals are applied across input circuit terminals 16 and 17.

Consequently, transistor 90 conducts through the collector-emitter electrodes thereof to connect capacitor 69
in an opposite polarity relationship across the base-emitter electrodes of transistor 80 to extinguish this device to establish a discharge circuit for capacitor 69 which may be traced from junction 75, through the collector-emitter electrodes of transistor 90, point of reference or ground potential 5, battery 8, movable contact 57 of switch 56, positive polarity line 48 and resistor 68 to the other plate of capacitor 69. This circuit is the timing circuit which permits transistor 80 to return to its original operating condition of conduction through the collector-emitter electrodes thereof after a predetermined time delay as determined by the R-C time constant of capacitor 69 and resistor 68.

With transistor 80 extinguished, the energizing circuit of primary winding 20 of transformer 19 is interrupted and energizing current flow therethrough ceases. The resulting collapsing magnetic field induces a potential in primary winding 37 which is of a positive polarity at terminal end 46 with respect to point of reference or ground potential 5. This positive polarity pulse is conducted through capacitor 44 and diode 45 and appears across output circuit terminal 28 and point of reference or ground potential 5.

The collapsing magnetic field also induces a potential in secondary winding 38 which is of a positive polarity at terminals thereof through a circuit which may be traced from the positive polarity terminal of battery 8, through movable contact 57 of switch 56, positive polarity line 48, resistor 87, lead 88, the emitter-collector electrodes of transistor 100, resistor 94, resistor 95 and point of reference or ground potential 5 to the negative polarity terminal of battery 8. Conducting transistor 100 establishes a circuit for base-emitter current flow through type NPN transistor 90 to trigger this device conductive through the collector-emitter electrodes thereof. With transistor 90 triggered conductive, the sequence of events just described in regard to FIG. 1 is repeated through the remainder of the circuitry to produce two like polarity output pulses across output terminal 28 and point of reference or ground potential 5.

By carefully selecting the values of resistors 67 and 68 and capacitor 69, the time interval between the two signal pulses may be made to be a function of engine speed. The R68-C69 determines the length of time transistor 80 remains non-conductive, hence, the time between pulses. The values of the R67-C69 time constant determine the length of time required for capacitor 69 to charge. Therefore, the values of resistor 67 and capacitor 69 may be selected to provide a time constant of sufficient length to permit substantially a complete charge upon capacitor 69 at a relatively steady speed, for example, but of insufficient length to permit complete charge of capacitor 69 at high engine speed. With less than a complete charge upon capacitor 69, the time required for capacitor 69 to discharge to a value which permits transistor 80 to go into conduction is less, consequently, the time between pulses decreases as engine speed increases.

The signal pulses produced by the circuitry just described appear across output terminal 28 and point of reference or ground potential 5, are of a positive polarity at output terminal 28 with respect to point of reference or ground potential 5 and are applied across the base-emitter electrodes of trigger transistor 50 in the correct potential polarity relationship to produce base-emitter current flow and, consequently, collector-emitter current flow through a type NPN transistor. Therefore, trigger transistor 50 is triggered conductive through the collector-emitter electrodes thereof upon the application of each input signal pulse across the base-emitter electrodes thereof.

Upon the triggering of trigger transistor 50 conductive, a circuit is established across direct current potential source 8 through the collector-emitter electrodes of trigger transistor 50 and series resistor 96. The resulting current flow through resistor 96 produces a trigger signal thereacross which is of a positive polarity at junction 97 with respect to point of reference or ground potential 5. This trigger signal is applied across the base-emitter electrodes of switching transistor 40 and is of the correct polarity relationship to produce base-emitter current flow and, consequently, collector-emitter current flow through a type NPN transistor. Consequently, type NPN switching transistor is triggered conductive through the collector-emitter electrodes by the trigger signals produced by the trigger circuit.

Conducting switching transistor 40 connects the positive polarity end, junction 98, of control transistor base bias circuit series resistors 34 and 35 to point of reference or ground potential 5 through control resistors 30 and 31, a condition which results in a potential across junction 98 and point of reference or ground potential 5 which is of a positive polarity upon junction 98 with respect to point of reference or ground potential 5 and of a magnitude equal to the potential drop across control resistors 30 and 31 and the collector-emitter electrodes of switching transistor 40. Therefore, control resistors 30 and 31 are selected to have a resistance value which, upon the initial conduction of switching transistor 40, will result in a total potential drop across control
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resistors 30 and 31 and the collector-emitter electrodes of switching transistor 40 of an insufficient magnitude to maintain base drive current through the base-emitter electrodes of control transistor 70, thereby extinguishing this device and transistor 60.

With control transistors 60 and 70 extinguished upon the initial conduction of switching transistor 40, a base drive circuit for maintaining base-emitter current flow through trigger transistor 50 is established through the series combination of resistors 105 and 106, diode 107, the base-emitter electrodes of trigger transistor 50 and resistor 96 to maintain trigger transistor 50, and consequently, switching transistor 40 conductive. Conducting circuit 40 also forms a feedback circuit for the series combination of primary winding 25 of converter transformer 24 and control resistors 30 and 31 across direct current potential source 8.

With the energizing circuit completed for primary winding 25 of converter transformer 24, energizing current which increases in magnitude, flows through primary winding 25 of converter transformer 24 and produces an increasing primary winding 25 magnetic field which induces a potential in secondary winding 26 thereon of a positive polarity at terminal 108 with respect to terminal 109, and a potential in switch winding 112 of a positive polarity at terminal 110 with respect to terminal 111. Blocking diode 114 prevents the flow of current through secondary winding 26, consequently, the potential induced in secondary winding 26 is of no effect. The purpose of the potential induced in switch winding 112 will be explained in detail later in this specification.

As energizing current flows through primary winding 25 of converter transformer 24 and control resistors 30 and 31 continues to increase in magnitude, the potential upon junction 98 increases in magnitude. This positive polarity potential signal is applied across the base-emitter electrodes of control transistor 70 through series resistors 34 and 35 and point of reference or ground potential 5 in the correct polarity relationship to produce base-emitter current flow through type NPN control transistor 70. When the potential drop across control resistors 30 and 31 reaches the predetermined magnitude, this signal produces base-emitter and, consequently, collector-emitter conduction through control transistor 70 which, in turn, supplies base-emitter current for control transistor 60 to trigger this device conductive through the collector-emitter electrodes.

Conducting control transistors 60 and 70 divert base current from trigger transistor 50 to extinguish this device. With trigger transistor 50 extinguished, the trigger signal provided across resistor 96 is removed from across the base-emitter electrodes of switching transistor 40, consequently, switching transistor 40 extinguishes to interrupt the energizing circuit for primary winding 25 of converter transformer 24.

The resulting collapsing primary winding 25 magnetic field induces the ignition capacitor 18 charging potential in secondary winding 26 thereof, which is of a positive polarity at terminal 109 with respect to terminal 108, and a potential in switch winding 112, which is of a positive polarity at terminal 111 with respect to terminal 110. The ignition capacitor 18 charging potential induced in secondary winding 26 charges ignition capacitor 18 through a circuit which may be traced from terminal 109, through diode 114, ignition capacitor 18, the parallel combination of primary winding 20 of ignition coil 19, resistor 115 and diode 116, point of reference or ground potential 5 and the parallel combination of resistor 150 and the base-emitter electrodes of transistor 160 to the other terminal 108 of secondary winding 26. Ignition capacitor 18 is now charged with an ignition potential with the plate thereof connected to junction 120 being of a positive polarity with respect to the other plate. Diode 122 prevents the flow of current through switch winding 112, consequently, the potential induced in switch winding 112 is of no effect.

The charge upon ignition capacitor 18 is applied across the anode-cathode electrodes of silicon controlled rectifier ignition capacitor switch 22 through lead 124 and through the primary winding 20 of ignition coil 19 and point of reference or ground potential 5. As the polarity of the charge upon ignition capacitor 18 is positive upon the plate connected to junction 120, the polarity of the potential applied across the anode-cathode electrodes of silicon controlled rectifier ignition capacitor switch 22 is positive upon the anode electrode and negative upon the cathode electrode.

The silicon controlled rectifier is a semiconductor device having a control electrode, generally termed the gate electrode, and two current carrying electrodes, generally termed the anode and cathode electrodes, which is designed to normally block current flow in either direction. With the anode and cathode electrodes forward poled, the anode positive and cathode in the proper polarity relation, the rectifier may be triggered to conduction upon the application, to the control electrode, of a control potential signal of a polarity which is positive in respect to the potential present upon the cathode electrode and of sufficient magnitude to produce control electrode-cathode, or gate-cathode, in the conducting state, the silicon controlled rectifier will conduct current in one direction and retains the ability to block current flow in the opposite direction. In the conducting state, therefore, the silicon controlled rectifier functions as a conventional diode.

Upon being triggered to conduction, however, the control electrode is no longer capable of affecting the device which will remain in the conducting state until either the anode-cathode circuit is interrupted or the polarity of the potential applied across the anode-cathode electrodes is reversed. Of these two alternatives, the reversal of the polarity of the potential across the anode-cathode electrodes thereof is perhaps the most satisfactory.

Upon the next input signal pulse across terminal 28 and point of reference or ground potential 5, the sequence of events just described is repeated. With the next initiation of conduction of switching transistor 40, the increasing primary winding 25 magnetic field produced as a result of increasing energizing current flow therethrough induces a potential in switch winding 112 of a positive polarity at terminal 110 with respect to terminal 111. This potential produces a current flow through a circuit which may be traced from terminal 110, through diode 122, the parallel combination of resistor 125 and series connected resistor 126 and resistor 127 and point of reference or ground potential 5 to terminal 111. The capacitor 126 charging current flows through resistor 127 and produces a potential signal thereacross which is of a positive polarity at junction 130 with respect to point of reference or ground potential 5. This signal is applied across the gate-cathode electrodes of silicon controlled rectifier ignition capacitor switch 22 in the proper relationship to produce gate current through this device. As the charge on ignition capacitor 18 is applied across the anode-cathode electrodes of silicon controlled rectifier ignition capacitor switch 22 in the correct anode-cathode polarity relationship, this device conducts through the anode-cathode electrodes thereof to connect ignition capacitor 18 across the ignition coil primary winding 20. Consequently, ignition capacitor 18 discharges rapidly through primary winding 20 of ignition coil 19 and the discharge current produces a magnetic field which induces a high firing potential in secondary winding 21. The firing potential is directed to the ignition coil terminal of a conventional automotive type distributor, not shown.

With high engine speeds, the two pulses produced by transformer 36 and the associated circuitry may become so closely spaced that the second pulse occurs before ignition capacitor 18 has become completely charged. In this event, the second pulse will trigger silicon controlled rec-
tifier 22 conductive while ignition capacitor 18 is charging. That is, charging and discharging circuits for ignition capacitor 18 are established simultaneously. To prevent this undesirable situation, a pulse cancelling transistor 160 having the usual base 161, collector 162 and emitter 163 electrodes is provided. The collector electrode 162 is connected to the junction between diode 107 and the base electrode of trigger transistor 50, the emitter electrode is connected to terminal 108 of secondary winding 26 and the base electrode 161 is connected to point of reference or ground potential 5 through resistor 165. As ignition capacitor 18 charges, charging current flows through resistor 150 in a direction from point of reference or ground potential 5 toward terminal 108 of secondary winding 26. The potential drop produced by the charging current flow through resistor 150 places the emitter electrode 163 of pulse cancelling transistor 160 at a potential which is slightly less positive than the potential upon base electrode 161 thereof. Consequently, base-emitter current flows through pulse cancelling transistor 160 with each charge of ignition capacitor 18. Should a second pulse occur while ignition capacitor 18 is in the charging state, this pulse would be conducted through the collector-emitter electrodes of pulse cancelling transistor 160, which are connected in shunt with trigger transistor 50, consequently, the second pulse would be ineffective to trigger transistor 50 and, consequently, switching transistor 40 conductive at this time. As the terminal 111 of switch winding 112 is of a positive polarity with respect to terminal 110 thereof, resistor 168 is connected between terminal 110 and the collector electrode of pulse cancelling transistor 160 to provide an additional positive polarity potential upon collector electrode 162 of pulse cancelling transistor 160 to provide additional insurance that pulse cancelling transistor 160 will conduct with each second input pulse which is produced during the periods ignition capacitor 18 is charging.

With an open ignition coil secondary, the series L-C circuit comprising primary winding 20 of ignition coil 19 and ignition capacitor 18 produces a ringing action which charges ignition capacitor 18 in the reverse direction. Ignition capacitor 18 then discharges in the reverse direction through primary winding 20. The ring back of ignition capacitor 18 in a reverse direction extinguishes silicon controlled rectifier 22 and charges ignition capacitor 18 in the forward direction through diode 132 which prevents the application of the high inverse polarity potential of ignition capacitor 18 when discharging in the reverse direction across the anode-cathode electrodes of silicon controlled rectifier ignition capacitor switch 22. As ignition capacitor 18 attempts to discharge in the forward direction through silicon controlled rectifier ignition capacitor switch 22 not conducting, the potential applied across the anode-cathode electrodes thereof rise rapidly. Capacitor 134 and the parallel combination of diode 135 and resistor 136 act as a filter which reduces the potential build-up, thereby preventing the triggering of silicon controlled rectifier 22. Ignition capacitor switch 22 conductive through the anode-cathode electrodes because of the rapid \(\frac{dv}{dt}\) applied across the anode-cathode electrodes thereof.

Diode 116 is a "free wheeling" diode in parallel with ignition coil primary winding 20 to rapidly dampen the oscillations through primary winding 20 while the ignition system is firing across the spark plug gap. Resistor 138 is a "bleeder" resistor through which ignition capacitor 18 discharges when switch 57 is open; thermistor 140 is connected as shown to provide temperature compensation; capacitor 142 is a filter capacitor and Zener diode 144 is connected as shown to provide protection for switching transistor 40 in the event ignition coil 19 should become disconnected from the circuitry.

Throughout the specification, specific transistor types, electrical polarities and circuit element have been set forth. It is to be specifically understood, however, that alternate transistor types and compatible electrical polarities and alternate circuit elements possessing similar electrical characteristics may be substituted without departing from the spirit of the invention.

While a preferred embodiment of the present invention has been shown and described, it will be obvious to those skilled in the art that various modifications and substituations may be made without departing from the spirit of the invention which is to be limited only within the scope of the appended claims.

What is claimed is:

1. In a capacitor discharge ignition system of the type including a source of ignition signals produced in timed relationship with the internal combustion engine with which the ignition system is associated, said source of ignition signals being responsive to each input signal pulse for producing the potential which provides the charge upon the ignition capacitor and a system output circuit including at least the ignition capacitor and a charging circuit therefor, the primary winding of an ignition coil and an ignition capacitor switch for connecting the ignition capacitor across the ignition coil primary winding, the circuit for producing two like polarity output signal pulses in response to each input ignition signal comprising in combination with a direct current potential source, input circuit means, means for connecting said ignition signal source across said input circuit means, output circuit means, a transformer having a primary winding and a secondary winding, means for connecting said primary winding of said transformer across said output circuit means, means for connecting said secondary winding of said transformer across said output circuit means in a polarity relationship opposite that of said primary winding, a transformer having a control electrode and two current carrying electrodes, means for connecting said primary winding of said transformer and said current carrying electrodes of said transformer in series across said direct current potential source, a capacitor, first and second resistors, an R-C circuit for said capacitor including at least the series combination of said first resistor, said capacitor and said control electrode and one of said current carrying electrodes of said transformer connected across said direct current potential source and a controllable switching device responsive to each input ignition signal applied across said input circuit means for connecting said capacitor in a reverse polarity relationship across said control electrode and one of said current carrying electrodes of said transformer and for establishing a discharge circuit including said second resistor for said capacitor.

2. A circuit for producing two like polarity output signal pulses in response to each input signal comprising in combination with a direct current potential source, input circuit means across which the input signals are applied, output circuit means, a transformer having a primary winding and a secondary winding, means for connecting said primary winding of said transformer across said output circuit means, means for connecting said secondary winding of said transformer across said output circuit means in a polarity relationship opposite that of said primary winding, an energizing circuit for said primary winding of said transformer including a first controllable switching device operable to a circuit completing and a circuit interrupting operating condition connected across said direct current potential source and circuit means including a timing circuit interconnected with said input circuit means and said controllable switching device in a manner to operate said controllable switching device to the opposite operating condition in response to each input signal applied across said input circuit means and to operate said controllable switching device to the original operating condition at the conclusion of a predetermined time delay.

3. A circuit for producing two like polarity output signal pulses in response to each input signal comprising in combination with a direct current potential source, input circuit means across which the input signals are
applied, output circuit means, a transformer having a primary winding and a secondary winding, means for connecting said primary winding of said transformer across said output circuit means, means for connecting said secondary winding of said transformer across said output circuit means in a polarity relationship opposite that of said primary winding, a converter circuit responsive to each input signal pulse for producing the potential which provides the charge upon the ignition capacitor and a charging circuit therefor, means for connecting the ignition capacitor across the ignition coil primary winding, the circuit for producing two like polarity output signal pulses in response to each input ignition signal comprising in combination with a direct current potential source, a capacitor, first and second resistors, means for connecting said capacitor across the least absolute value of said primary winding, a transformer having base, emitter and collector electrodes, means for connecting said primary winding of said transformer and said collector-emitter electrodes of said transistor in series across said direct current potential source, a collector, first and second resistors, a charging circuit for said capacitor including at least the series combination of said primary winding, said transistor and said collector-emitter electrodes of said transistor across said direct current potential source and a controlling circuit responsive to each input signal pulse applied across said input circuit means for connecting said capacitor across said base-emitter electrodes of said transistor in a reverse polarity relationship to extinguish this device and for establishing a discharge circuit including said second resistor for said capacitor whereby said transistor returns to its normal operating condition at the conclusion of a predetermined time delay.

5. In a capacitor discharge ignition system of the type including a source of ignition signals produced in timed relationship with the internal combustion engine with which the ignition system is being used, a converter circuit responsive to each input signal pulse for producing the potential which provides the charge upon the ignition capacitor and a charging circuit therefor, the primary winding of an ignition coil and an ignition capacitor switch for connecting the ignition capacitor across the ignition coil primary winding, the circuit for producing two like polarity output signal pulses in response to each input ignition signal comprising in combination with a direct current potential source, a collector, first and second resistors, a charging circuit for said capacitor including at least the series combination of said primary winding, said transistor and said collector-emitter electrodes of said transistor across said direct current potential source and a controlling circuit responsive to each input signal pulse applied across said input circuit means for connecting said capacitor across said base-emitter electrodes of said transistor in a reverse polarity relationship to extinguish this device and for establishing a discharge circuit including said second resistor for said capacitor whereby said transistor returns to its normal operating condition at the conclusion of a predetermined time delay.

6. In a capacitor discharge ignition system of the type including a source of ignition signals produced in timed relationship with the internal combustion engine with which the ignition system is being used, a converter circuit responsive to each input signal pulse for producing the potential which provides the charge upon the ignition capacitor and a charging circuit therefor, the primary winding of an ignition coil and an ignition capacitor switch for connecting the ignition capacitor across the ignition coil primary winding, the circuit for producing two like polarity output signal pulses in response to each input ignition signal comprising in combination with a direct current potential source, a collector, first and second resistors, a charging circuit for said capacitor including at least the series combination of said primary winding, said transistor and said collector-emitter electrodes of said transistor across said direct current potential source and a controlling circuit responsive to each input signal pulse applied across said input circuit means for connecting said capacitor across said base-emitter electrodes of said transistor in a reverse polarity relationship to extinguish this device and for establishing a discharge circuit including said second resistor for said capacitor whereby said transistor returns to its normal operating condition at the conclusion of a predetermined time delay.
capacitor and a charging circuit therefor, the primary winding of an ignition coil and an ignition capacitor switch for connecting the ignition capacitor across the ignition coil primary winding, and a pulse cancelling circuit responsive to the charging current of said ignition capacitor for providing an electrical path in parallel with said converter circuit for said second pulse produced by said circuit for producing two like polarity output pulses at high engine speeds.