

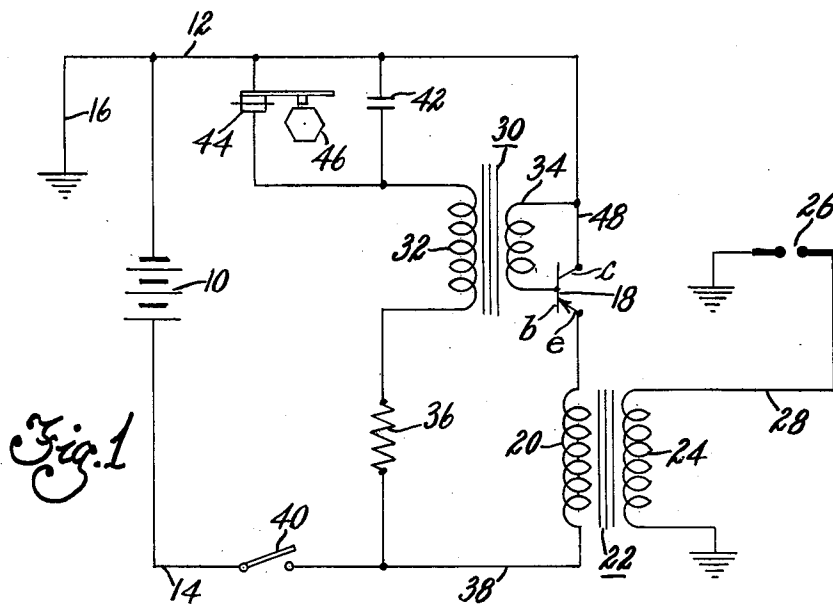
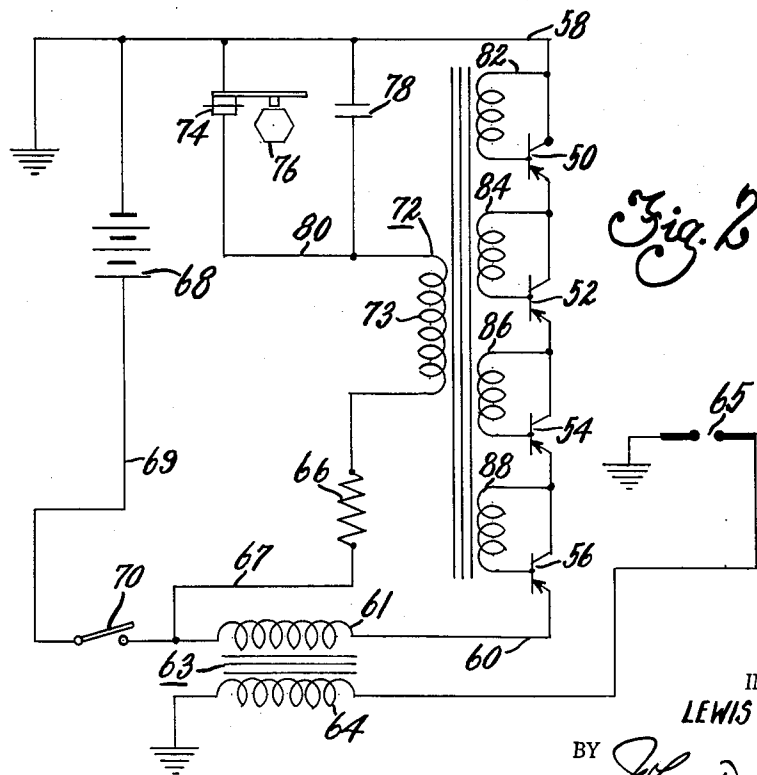
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ELECTRONIC IGNITION CIRCUIT

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ELECTRONIC IGNITION CIRCUIT

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This invention relates to an electronic ignition system for an internal combustion engine and is an improvement of the system disclosed and claimed in co-pending application S.N. 719,661, filed March 6, 1958, now U.S. Patent No. 2,941,119, and assigned to the assignee of this invention.

In the above mentioned co-pending application, a circuit is illustrated and claimed that includes an ignition coil, a transformer, a voltage source, a plurality of transistors and a pair of breaker contacts. The transistors are all connected in series with the voltage source and primary winding of the ignition coil with the secondaries of the transformer being connected across the base and emitter circuit of the transistors. The primary winding of the transformer is connected in series with the voltage source and the breaker contacts. When the breaker contacts are closed, a high power pulse is passed by the transformer to render the transistors conductive and thus build up current in the primary winding of the ignition coil. When the breaker points open, the transistors become non-conductive and a high voltage is induced in the secondary winding of the ignition coil to fire a spark plug. It will be appreciated that in this circuit of the co-pending application, the transistors are normally non-conductive and become conductive when the breaker points are closed.

Although the circuit disclosed and claimed in the above identified co-pending application has worked effectively, it is necessary that the transformer be capable of passing a high power pulse of voltage with a time duration equal to the time that the breaker points are closed which is commonly termed the breaker point dwell angle. At low speeds this creates a problem and the transformer becomes very large.

In contrast to the circuit of the above identified co-pending application, it is an object of this invention to provide a transistorized ignition circuit for an internal combustion engine that includes one or more transistors connected in series with a voltage source and the primary winding of an ignition coil and wherein the transistors are rendered normally conductive to permit current to build up in the primary winding and are rendered non-conductive only during the time that a blocking pulse is applied to the base-collector diode of the transistor. This object is accomplished by providing a transformer that has a primary winding connected in circuit with the voltage source and breaker contacts of a motor vehicle ignition system. The secondary of the transformer is connected across the base-collector diode of the transistor and when a blocking pulse is applied by the secondary of the transformer, the voltage cuts off conduction of the transistor, but only for the duration of the blocking pulse.

In the circuit of this invention, the duration of the blocking pulse is designed to be long enough to permit the ignition pulse to take place and this is a very short portion of the total time between spark impulses. The total balance of time is available for dwell time during which the current in the ignition coil primary is permitted to increase toward its maximum value. This is an outstanding feature of this invention since an increase of 30 to 40% in dwell time over the circuit of the co-pending application is readily achieved. It is accordingly another object of this invention to provide an electronic ignition circuit wherein the dwell time or the time when the breaker points of the distributor are closed is increased.

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Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings, wherein a preferred embodiment of the present invention is clearly shown.

In the drawings:

FIGURE 1 is a circuit diagram of an ignition circuit made in accordance with this invention.

FIGURE 2 is a circuit diagram of a modified motor vehicle ignition circuit that includes a plurality of transistors connected in series.

Referring now to the drawings and more particularly to FIGURE 1, the ignition circuit includes a voltage source 10, which is illustrated as a storage battery, and which is connected with leads 12 and 14. One end of the lead 12 is connected directly to ground via lead 16 while the opposite end of lead 12 is connected with the collector electrode *c* of a P-N-P transistor designated by reference numeral 18. Transistor 18 has a base electrode *b* and an emitter electrode *e*. The emitter electrode of the transistor is connected with the primary winding 20 of an ignition coil designated by reference numeral 22. The secondary winding 24 of the ignition coil is connected with a spark plug or spark discharge device 26 through a lead 28. One side of the secondary winding 24 is grounded while the opposite side of the spark plug 26 is connected to ground so that the spark plug is connected in the usual manner directly across the secondary of the ignition coil. It will be appreciated that in actual practice the connection between the spark plug 26 and the secondary winding of the ignition coil will be made through the usual distributor contacts (not shown).

The electronic ignition circuit further includes a transformer generally designated by reference numeral 30 and having a primary winding 32 and a secondary winding 34. The primary winding 32 of the transformer has one side thereof connected with a resistor 36 which is in turn connected with lead 38. The lead 38 is connected to lead 14 whenever the ignition switch 40 is closed. One side of the primary winding 32 is also connected with one side of a condenser 42 and to one side of a pair of distributor breaker contacts 44. The breaker contacts are opened and closed by an cam 46 that is driven in synchronism with the internal combustion engine in the usual manner. The breaker contacts as shown are thus connected directly between lead 12 and the primary winding 32 of transformer 30.

The secondary winding 34 of the transformer 30 is connected between the base electrode of transistor 18 and lead 48 which is connected with the collector electrode of the transistor. It thus is apparent that the secondary winding 34 is connected directly across the base and collector electrodes of the transistor. It will be appreciated that the primary winding 20 of the ignition transformer is connected in series with the emitter and collector circuit of the transistor and the current flowing through the primary winding from the voltage source 10 will therefore be controlled as a function of the conductance of the transistor 18.

The operation of the circuit illustrated in FIGURE 1 will now be described. With the ignition switch 40 in a closed position, the secondary of the ignition coil will fire a plug at the instant the breaker contacts 44 open. Since ignition switch 40 is closed, current will then flow from the battery 10, through the primary winding 20 of transformer 22 and thence back to the opposite side of the battery. During this time, current is permitted to flow through the primary winding 20 of the ignition coil due to the fact that the transistor 18 at this time is conductive. The transistor 18 is conductive because of the fact that the emitter is connected to the positive side of the battery 10 and is at a positive potential with respect to the base and

further because there is a path for base current to flow through the secondary winding 34 of the transformer 30. When the breaker points 44 close, the conductance of the transistor is increased even more due to the fact that a voltage is applied by the secondary winding 34 to the transistor base-collector diode that is in such a direction as to turn on the transistor even more effectively than before. At this stage of operation, it can be seen that the transistor is conductive so that current is readily supplied to the primary winding 20 of the ignition coil.

When the breaker points 44 open, a pulse of voltage is induced in the secondary winding 34 of transformer 30 due to the change in current through the primary winding 32. This voltage is applied across the base-collector diode of the transistor so that the base is driven positive with respect to the emitter. This will, of course, turn off the transistor so that the circuit between the primary winding 20 of the ignition coil and the battery is effectively opened and at this time a high voltage is induced in the secondary winding 24 of the ignition coil to fire the spark plug 26. The duration of the pulse applied to the base-collector diode of transistor 18 is determined by the characteristics of the transformer 30 and by the capacitance of the condenser 42. This duration is designed to be long enough to permit the ignition pulse to take place. This is a very short portion of the total time between spark impulses; hence, the total balance of time is available for dwell time during which the current in the ignition coil primary winding 20 is permitted to increase toward its maximum value. In the circuit described, it is, of course, necessary that the secondary voltage applied across the base and collector electrodes of transistor 18 be equal to or exceed the total voltage that appears across the transistor. The transformer is designed to supply this value of voltage.

It will be readily apparent that the circuit just described operates in such a fashion that the transistor 18 is normally conductive to permit current flow between the battery 10 and primary winding 20 and further, that this normal conduction is only interrupted during the time the voltage pulse is applied across the base and collector electrodes of the transistor.

In the circuit illustrated in FIGURE 1, only a single transistor is shown connected between the voltage source and the primary winding of the ignition coil. In order to handle increased power and voltage, it may be desirable in certain installations to connect a plurality of transistors in series in a manner illustrated in FIGURE 2. The number of transistors employed is a function of their own voltage rating and the characteristics of the ignition coil which is used with the transistors.

In a circuit of FIGURE 2, a plurality of transistors 50, 52, 54 and 56 are connected in series between leads 58 and 60. The lead 60 is connected with one side of the primary winding 61 of an ignition coil 63. The secondary winding 64 of the ignition coil is connected directly across a spark plug 65. The opposite side of primary winding 61 is connected with resistor 66 through a lead 67 and is connected with one side of battery 68 through lead 69 and ignition switch 70. One side of battery 68 is connected with lead 58 while the lead 58 is connected between ground and the collector electrode of transistor 50.

A transformer generally designated by reference numeral 72 has a primary winding 73 connected in series with resistor 66 and in series with breaker contacts 74 that are operated by a cam 76. The cam 76 is driven in synchronism with the internal combustion engine in a conventional fashion and forms a portion of the well-known motor vehicle distributor. A condenser 78 is connected between lead 58 and a lead 80 which is connected to one side of the primary winding 73 of the transformer. The secondary windings 82, 84, 86 and 88 of the transformer 72 are connected respectively across the base and collector of the transistors 50, 52, 54 and 56.

The circuit of FIGURE 2 operates in a manner substantially identical to the operation of the circuit of FIGURE 1 in that the transistors are normally rendered conductive except when a voltage pulse is applied to the secondaries of transformer 72 to cut off conduction of the transistors. In the circuit of FIGURE 2, it is necessary that the voltages appearing in each secondary winding equal or exceed the portion of the total voltage that appears across each transistor, in order to cut off the conduction of the transistors when the blocking pulse is applied to the base-collector diode of the transistors. As has been noted above the circuit of FIGURE 2 operates in a manner substantially identical with the circuit of FIGURE 1, the transistors being turned on to a greater extent when the breaker points are closed and being rendered non-conductive only for a short duration of time after the breaker points open by the application of a high voltage of the base-collector circuit of the transistors.

While the embodiments of the invention as herein disclosed constitute preferred forms, it is to be understood that other forms might be adopted.

What is claimed is as follows:

1. An ignition circuit for an internal combustion engine comprising, an ignition coil having a primary winding and a secondary winding, a spark discharge device connected across said secondary winding, a voltage source, a transistor having base, collector and emitter electrodes, means connecting the emitter to collector circuit of said transistor between said voltage source and the primary winding of said ignition coil whereby said transistor controls current flow to said primary winding, means constantly connecting said voltage source across the emitter and base electrodes of said transistor whereby said transistor is rendered normally conductive, and means energized from said voltage source for applying pulses of voltage periodically across said base and collector of said transistor for rendering said transistor periodically non-conductive.

2. An ignition circuit for an internal combustion engine comprising, an ignition coil having a primary winding and a secondary winding, a spark discharge device connected across said secondary winding, a voltage source, a transistor having base, emitter and collector electrodes, means connecting the emitter to collector circuit of said transistor between said voltage source and said primary winding of said ignition coil whereby the current in said primary is controlled as a function of conductance of said transistor, a transformer, a pair of breaker contacts, means connecting the primary winding of said transformer in series with said breaker contacts and across said voltage source, and means connecting the secondary of said transformer across the base and collector electrodes of said transistor, said secondary winding forming part of a circuit that constantly connects the emitter and base electrodes of said transistor across said voltage source whereby said transistor is normally conductive between its emitter and collector electrodes.

3. An ignition circuit for an internal combustion engine comprising, an ignition coil having a primary winding and a secondary winding, a voltage source, a plurality of transistors connected in series with each other and between said voltage source and said primary winding of said ignition coil for controlling the current flow through said primary winding, means energized from said voltage source constantly biasing said transistors to a state of conduction including a circuit constantly connecting the emitter and base electrodes of said transistors across said voltage source, and means including said voltage source for periodically rendering all of said transistors non-conductive for short periods of time in synchronism with the operation of said engine.

4. An ignition circuit for an internal combustion engine comprising, an ignition coil having a primary winding and a secondary winding that is adapted to be connected across a spark discharge device, a voltage source,

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a plurality of transistors each having base, emitter and collector electrodes, means connecting the emitter to collector circuits of said transistors in series with each other and between said voltage source and primary winding whereby the current flow through said primary winding is a function of the conductance of said transistors, a transformer having a primary winding and a plurality of secondary windings, means connecting a respective secondary winding across the base and collector electrode of a respective transistor, a pair of breaker contacts that are opened and closed in synchronism with the operation of said engine, and means connecting said breaker contacts and the primary winding of said transformer in series with each other and across said voltage source.

5. An ignition circuit for an internal combustion engine comprising, an ignition coil having a primary winding and a secondary winding, a spark discharge device connected across said secondary winding, a transistor having base, collector and emitter electrodes, a voltage source, means connecting the emitter to collector circuit of said transistor in series with said voltage source and primary winding of said ignition coil, means constantly connecting said voltage source across the emitter and base electrodes of said transistor when said ignition circuit is energized, said voltage source being poled in such a direction with respect to said emitter and base electrodes that said transistor is rendered normally conductive, a set of breaker contacts, and electric circuitry connected with said breaker contacts and voltage source

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and energized solely from said voltage source for applying a bias voltage to said transistor to render it temporarily non-conductive when said breaker contacts open.

6. An ignition circuit for an internal combustion engine comprising, an ignition coil having a primary winding and a secondary winding, a spark discharge device for igniting a combustible mixture connected across said secondary winding, a voltage source, a three terminal semi-conductor having a pair of current carrying terminals and a control terminal, means connecting the current carrying terminals of said semi-conductor in series with said primary winding and across said voltage source, means constantly connecting one of said current carrying terminals and said control terminal across said voltage source when said ignition circuit is energized whereby said semi-conductor is normally biased to a state of conduction, and means energized from said voltage source for applying a biasing voltage to the other current carrying terminal and said control terminal at a periodic rate for periodically rendering said semi-conductor non-conductive.

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