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OSCILLATOR IGNITION SYSTEM

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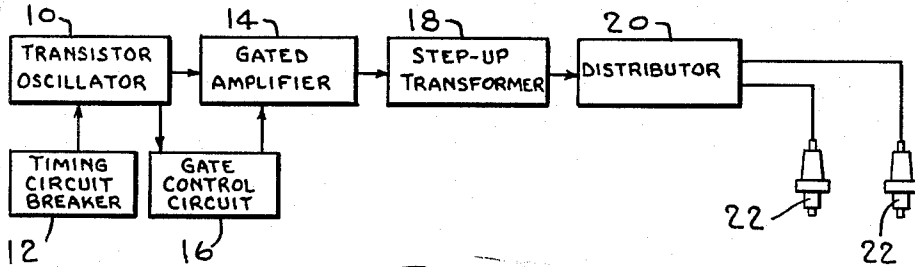


FIG. 1

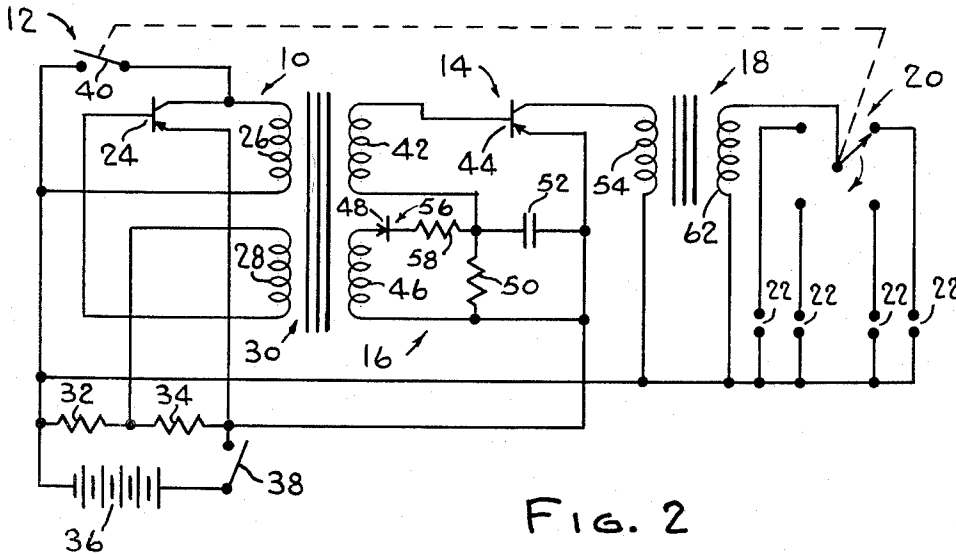


FIG. 2

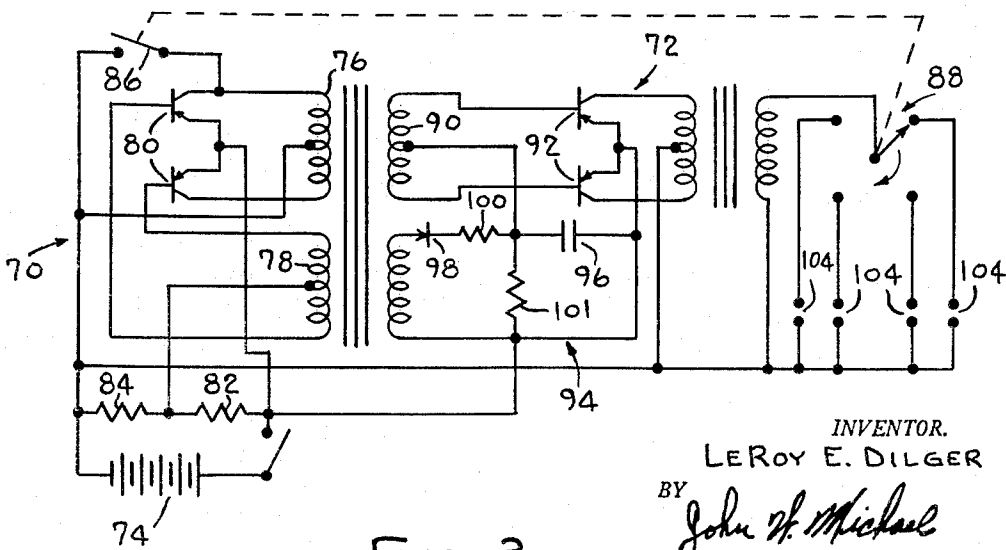


FIG. 3

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OSCILLATOR IGNITION SYSTEM

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This invention relates to ignition systems for internal combustion engines.

Ignition systems as used on present day internal combustion engines utilize the energy stored in the magnetic field of a coil to generate the sparking voltage. This is a high impedance device and when a low impedance spark plug, such as a surface gap plug, is used with it, the terminal voltage drops to a low value and only a weak spark or no spark is produced. At high engine speeds, this problem is further increased because the high inductance of the ignition coil prevents the primary current from reaching its maximum value in the short period of time that the breaker points are closed. Where a train of sparks is applied to the spark plug, the spark plugs have a tendency to erode at an unusually fast rate. Since a high current is switched by the breaker points in order to effect sufficient coil output for ignition, the breaker point life is reduced to a minimum because of burning and pitting.

The primary object of this invention is to provide an ignition system for internal combustion engines which overcomes all of the above shortcomings.

This object is accomplished by combining the characteristics of a transistorized blocking-oscillator, a gated amplifier including a gate control circuit to deliver a limited number of full amplitude oscillator pulses to a step-up coil or transformer and a spark gap. With this arrangement, a conventional circuit breaker or a commutator can be used to control the operation of the oscillator without any arcing. By suppressing all but a few of the full amplitude pulses, spark plug erosion is minimized. This step-up transformer has a very low inductance in comparison with a standard ignition coil and thus is capable of producing constant amplitude sparks over a wide speed range.

Other objects and advantages will be pointed out in, or be apparent from, the specification and claims, as will obvious modifications of the single embodiment shown in the drawings, in which:

FIG. 1 shows the relationship between the various elements of the system;

FIG. 2 is a circuit diagram of the transistorized ignition system; and

FIG. 3 is a circuit diagram of the transistorized ignition system using a push-pull oscillator and a push-pull class "B" amplifier.

Referring to the drawings, a transistorized blocking oscillator 10 is shown which is periodically de-energized by closing timing circuit breaker 12. When the timing circuit breaker is open, a near square wave alternating current will be delivered to gated amplifier 14 which is controlled by gate control circuit 16. The gated amplifier will deliver the first cycle at full amplitude to step-up transformer 18 and successive cycles at exponentially decreasing amplitudes until an equilibrium condition is reached in the gate control circuit. Distributor 20 will deliver the pulses received from the step-up transformer to the proper plug 22.

The oscillator includes a transistor 24 connected to windings 26, 28 in transformer 30 to bias resistors 32 and 34 to form a common emitter type of blocking-oscillator well known to the art. Current is supplied to the circuit from a battery 36 by closing switch 38 producing a near square-wave alternating current in the transformer.

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A circuit breaker switch 40 which may be either cam operated or of a commutator type of suitable design is connected to the emitter of the transistor and when closed will shunt winding 26 so that no voltage will be induced in the transformer. The oscillator will then be quiescent and draw only a small bias current through resistors 32 and 34. This mode of switching, in which the contacts carry minute amounts of current, is covered in copending patent application, Serial Number 791,562, filed February 6, 1959, now Patent 2,976,461.

The wave form produced by this type of switching is picked-up by winding 42 of the transformer and applied to base 44 of the gated amplifier transistor and by winding 46 and applied to the anode 48 of rectifier 56 in the gate control circuit. The gated amplifier is biased to collector current cut-off by having the lower end of winding 42 returned to the positive side of battery 36 through resistor 50. The negative swing of the wave form applied to the transistor will drive the gated amplifier transistor into full conduction. Base current will be drawn through the transistor, winding 42 and resistor 50. The voltage will rise across the resistor at an exponential rate determined by the resistance of the emitter-base circuit of the transistor and the capacitance of capacitor 52. The voltage rise across resistor 50 and capacitor 52 will reduce the gain of the amplifier transistor and tend to reduce the current through resistor 50. Ultimately, after several cycles, a condition of equilibrium will be reached when the voltage across the resistor-capacitor circuit reaches a steady value that is added to the fixed cut-off bias of the base of the transistor. This additional bias causes the amplifier to run at reduced gain. The wave-form across winding 54 in the step-up transformer will consist of a cycle of full amplitude followed by successive cycles decreasing at an exponential rate, determined by the values of resistor 50 and capacitor 52, until an amplitude is reached, at equilibrium, that is a fraction of full output.

In order to minimize spark plug erosion by reducing the number of sparks in each firing cycle, the wave form applied to the step-up transformer is limited to one or only a few cycles at full amplitude by suppressing all subsequent cycles. This is accomplished by rectifier 56 and resistor 58 forming a bias power supply deriving its power from winding 46 in the blocking oscillator. The direct current output of this bias supply flows in the same direction through resistor 50 as does the base current, further increasing the voltage drop across resistor 50 to an amount sufficient to cut-off the gated transistor. Series resistor 58 limits the bias supply current and, along with resistor 50, capacitor 52 and the base resistance of the transistor, controls the number of full amplitude cycles that are passed by the transistor. The amount of voltage available from winding 46, the capacitance of capacitor 52 and the resistance of resistors 50 and 58 are all chosen normally to allow passage of one or two cycles at full amplitude and to suppress all others. The amount of time that the amplifier will pass signals is determined by how long it takes the voltage across resistor 50 and capacitor 52 to reach a value sufficient to cut-off the amplifier transistor while a signal is applied to its base winding.

The amplified pulses that have been passed by the gated amplifier transistor develop a voltage across winding 54 of step-up transformer 18. A wave form consisting of a single impulse or several impulses, depending upon the design of the gate control circuit will appear across the winding and this pulse will then be stepped-up by the transformer in winding 62 to a suitable level for ignition and will be distributed by the distributor 20 to the proper spark plug. Closing the circuit breaker causes capacitor 52

to discharge because of the lack of signal of the oscillator to supply charging voltage.

It can be seen from the above description that the problems inherent with breaker points, such as burning, pitting, erosion, mechanical wear, bouncing, and frequent adjustment can be eliminated by use of a commutator switching a very minute amount of current as it does in this system. The step-up transformer is of very low inductance in comparison with the standard ignition, and thus it is capable of producing a constant amplitude spark at any speed obtainable with modern engines. The output from this system is being actively driven from the amplifier, thus it has a much lower impedance than a standard system. This means that it is capable of driving substantial power into the spark using a surface gap plug for the production of ample heat to insure good ignition. An inherent feature of surface gap plugs is that they have a universal heat range, therefore, they operate satisfactorily in any type of engine under all operating conditions. For applications requiring a hotter spark, the power output of this system can be increased or modified. One way to do this is to adjust the gate control circuit to allow several cycles instead of one. This would allow a greater average spark temperature by having a train of sparks and would enhance the possibility of ignition.

Another method for increasing power is to use the push-pull configuration of the circuit shown in FIG. 3. This circuit operates identically to the circuit shown in FIG. 2, except that it will provide power on both the positive and negative swings of the wave form because it is a balanced circuit. Examination will show it to be nothing more than a push-pull blocking oscillator 70 followed by a push-pull class "B" amplifier 72. The oscillator has a source of unidirectional power 74, an oscillator or primary winding 76, a feed-back winding 78 and a pair of transistors 80. The positive terminal of this power supply is connected to the emitters of the transistors and through a resistor 82 of suitable value to the center tap of the feed back winding. The ends of the feed back winding are connected to the bases of the transistors. The negative terminal of the power supply is connected to the center tap of the primary winding and through a suitable resistor 84 to the center tap of the feed back winding. The ends of the oscillator winding are connected to the collectors of the transistors.

The switching of the oscillator in time with the engine speed is accomplished by a circuit breaker 86 connected to the collector of one of the transistors to shunt the primary winding. This is timed in a well known manner so that during the "off" position of the distributor 88, the circuit breaker will be closed.

The wave form in the primary winding is picked up by the class "B" amplifier which includes secondary winding 90 having its ends connected to the bases of transistors 92 in the gated amplifier. The center tap of the secondary winding is connected to the positive terminal of the power source 74 to provide a cut-off bias as above. Gate control circuit 94 which includes capacitor 96, rectifier 98 and resistors 100 and 101 operates as above to exponentially suppress the subsequent cycles transmitted to the transistors 92 from the oscillator. Distributor 88 directs the stepped-up current to the proper spark plug 104 in the internal combustion engine.

A somewhat different output wave form is obtained from this system since both halves of the first cycle are present when the push-pull arrangement is used. Common-base or common-collector oscillators would serve equally well; therefore, while a common collector is described, it is to be understood that the oscillator may take either of the other forms.

Although two embodiments of the present invention have been illustrated and described, it will be apparent to those skilled in the art that various changes and modifications may be made therein without departing from the

spirit of the invention or from the scope of the appended claims.

I claim:

1. An ignition system for an internal combustion engine comprising, a first circuit, a transistorized blocking oscillator in said primary circuit, a unidirectional voltage power supply connected to said oscillator, and means for shunting the oscillator to cut-off, a second circuit including a first winding in inductive relation with the primary circuit, a transistor having its base connected to one end of the first winding, and the emitter connected to the other end of said winding, said other end of said winding being connected to the positive side of the unidirectional power source, distribution means and sparking means connected in inductive relation with the transistor collector, and gate control circuit means connected to the said other end of the winding and the emitter to control the bias current to the base whereby the amplitude of the cycles passed by the transistor to the distribution means are suppressed at an exponential rate.

2. An ignition system according to claim 1 which includes a second winding providing said inductive relationship with the primary circuit and a rectifier and resistor connected in series with the second winding.

3. An ignition system according to claim 2 in which the means for shunting the oscillator and the distribution means are timed so that when the distribution means is not delivering current to the spark plug, the oscillator will be shunted to cut-off.

4. A simplified ignition system for internal combustion engines utilizing spark plugs and adapted to supply metered constant energy to the plugs at low and high engine speeds comprising:

a first circuit having a transistorized blocking oscillator, a unidirectional voltage power supply, and means for periodically shunting said oscillator in timed relation to engine speeds;

a second circuit in inductive relation to said first circuit having a base current controlled transistorized amplifier, and a gate control responsive to the output signal of said oscillator and base current control of said amplifier to cut off after a predetermined interval the output pulses from said amplifier during a period of operation of said oscillator;

a low inductance output transformer inductively connected to said second circuit to step-up pulses from said amplifier to a voltage level sufficient for firing the spark plugs; and

a distributor for applying the amplified pulse in proper sequence to the spark plugs.

5. An ignition system as claimed in claim 4 in which: said gate control includes a first resistor and a capacitor connected to reduce the gain of said amplifier at an exponential rate until an equilibrium is reached at which said amplifier, if then operating, operates at a non-effective output level.

6. An ignition system as claimed in claim 5 in which: said gate includes a rectifier and a second resistor combined with said first resistor and said capacitor to form a bias power supply for said amplifier whereby the values of said inductive relation of said gate control to said first circuit, and the values of said capacitor and first and second resistors may be chosen to allow said amplifier to provide only one cycle at full amplitude to said low inductance transformer.

7. In an ignition system in which a source of unidirectional current is transformed to alternating current by oscillating means, the improvement for supplying from said alternating current to a spark gap needed increments of metered constant energy which comprises:

oscillator means;

base current controlled transistorized amplifier means inductively coupled to the oscillating means;

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a gate control circuit responsive both to the oscillating means and the amplifier base current to control the cut-off of said amplifier during the operation of the oscillating means whereby said amplifier delivers a required limited number of full amplitude pulses; and step-up means of low inductance output for transmitting said pulses to the spark gap.

8. In an ignition system according to claim 7 wherein said transistorized amplifier means includes a transistor having its emitter connected to the unidirectional power source, its base connected to the power source through the gate control circuit and its collector connected to the step-up means.

9. In an ignition system according to claim 7 wherein said gate control circuit is connected in inductive relation with the oscillating means, whereby said gate control circuit biases the base of the transistor to collector current cut-off after the first full amplitude oscillator pulse has been delivered to the amplifier means.

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10. In an ignition system according to claim 9 wherein said gate control circuit includes a rectifier, a first resistor, a capacitor and a second resistor.

11. An ignition system as claimed in claim 4 in which: the oscillator of said first circuit is a push-pull oscillator; and

the amplifier of said second circuit is a push-pull class "B" amplifier.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,175,123

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Le Roy E. Dilger

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 4, line 73, for "oscillator" read -- oscillating --.

Signed and sealed this 27th day of July 1965.

(SEAL)

Attest:

ERNEST W. SWIDER
Attesting Officer

EDWARD J. BRENNER
Commissioner of Patents

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