

July 26, 1966

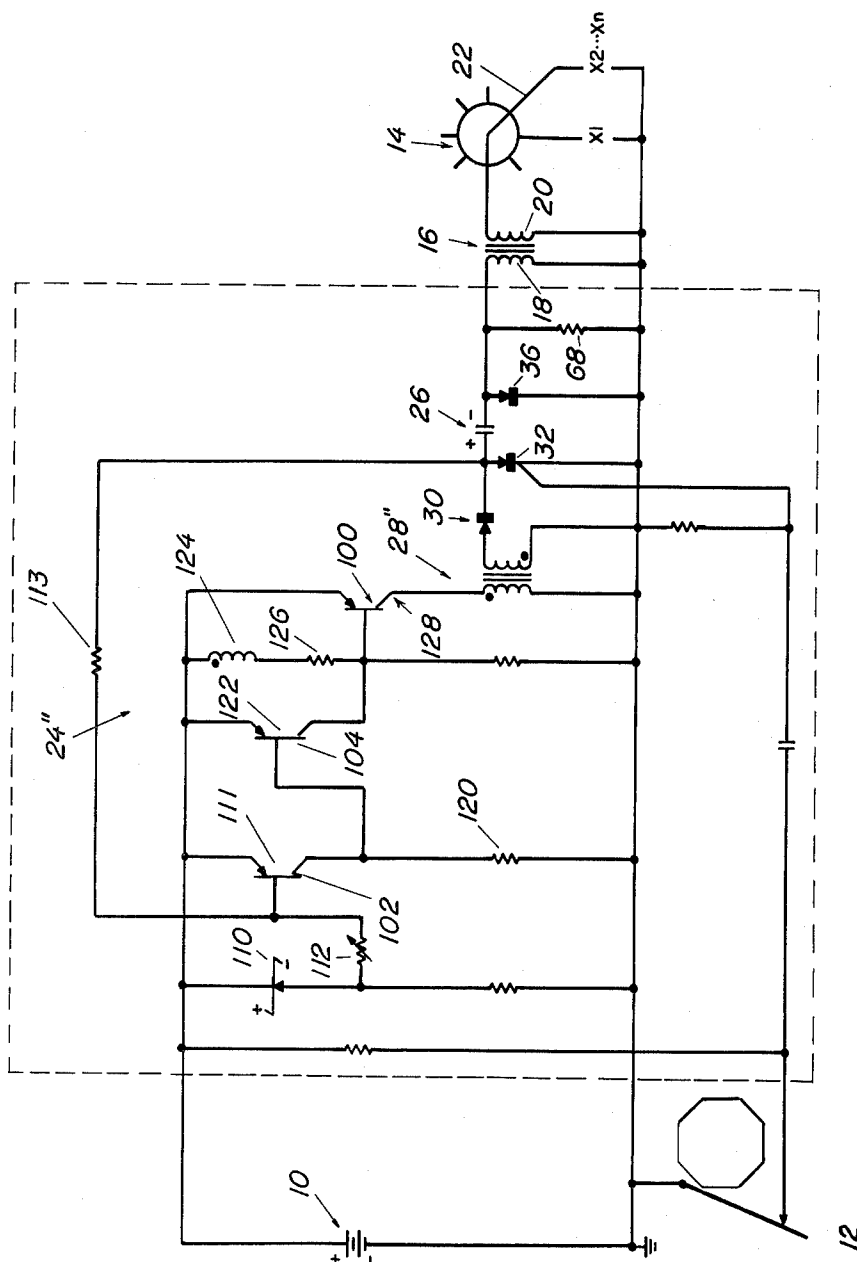
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SOLID STATE CAPACITOR DISCHARGE IGNITION SYSTEM

Filed Aug. 14, 1963

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SOLID STATE CAPACITOR DISCHARGE IGNITION SYSTEM

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Filed Aug. 14, 1963, Ser. No. 302,048

3 Claims. (Cl. 315-212)

This invention relates generally to ignition systems, and is particularly concerned with the provision of a transistorized semi-conductor, or solid-state ignition system which can be easily used with conventional and available automobile ignition components to increase the efficiency, and decrease the wear thereof.

There have been various prior suggestions concerning supposedly improved solid-state ignition systems. For example, with some systems, an attempt is made to achieve better ignition by supplying higher sparking voltages to the spark plugs. With other systems, an attempt is made to supply the sparking voltages at a faster rate, or with increased rise times. In still further systems, a combination of higher voltage and faster feed or rise time is contemplated. With each of the systems presently available, however, there is a requirement for the use of a special high voltage transformer or ignition coil which must be substituted for the conventional ignition coil now commonly employed in automobile ignition systems. Still further, with other solid-state ignition systems previously suggested, there is normally a substantial, and in certain instances even a constant, drain of current from the battery to operate the system. Additionally, with previously available solid-state ignition systems, the so-called "breaker point current" is limited due to the operating characteristics of the particular network employed.

In contrast to prior ignition circuits which have been suggested, the present invention is directed to the provision of a solid-state ignition system which is free of all of the aforesaid disadvantages, namely; a solid-state ignition system (a) which is designed to operate in conjunction with the standard types of ignition coils commonly employed on automobiles today; (b) which permits the achieving of a minimum breaker point current during operation of the system; (c) which requires but a minimum of electrical energy from the power supply or battery during operation; (d) which increases the life of spark plugs associated therewith by eliminating the supply of undesired portions of voltage waves supplied thereto; (e) which is efficiently operable even with partially worn or otherwise "fouled" spark plugs; and (f) which is extremely simple to install on available automobiles.

From the preceding paragraph, it will be understood that the primary object of the present invention is to provide an ignition system which incorporates the listed advantages. More specifically, the primary object hereof is to provide an ignition system which utilizes only semiconductor type electronic valves in association with standard resistors, condensers, and the like to yield an overall arrangement which can be easily coupled between a conventional automobile distributor and a conventional automobile induction coil, and which operates to increase spark plug life and ignition efficiency.

Within the above primary object of the invention, there are certain specific objects that relate particularly to the new and improved result obtained with the invention. Among such specific objects are the following: (1) the provision of a solid-state ignition system conforming with the above objects, and incorporating an oscillator means adapted to be battery powered, condenser storage means for receiving voltages, as amplified, from the oscillator means, control means for selectively discharging the condenser storage means through the system ignition coil, means for limiting shock excited oscillation within the induction coil, and means for preventing the drain of un-

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necessary energy from a battery by an oscillator means connected therewith; (2) the provision of such an ignition system wherein the condenser storage means is charged to a pre-determined level during each cycle of operation of the system, and wherein once the charge on the condenser means reaches such level, the voltage supply components are either shut off, or so operated that they essentially recharge the battery; (3) the provision of such an ignition system which incorporates a silicon controlled rectifier coupled with the condenser means and with the low voltage switch of a conventional distributor to effect control over the discharge of the condenser means through the primary winding of the system induction coil, and in turn, to sequentially effect proper timed control over the supply of "sparking voltages" through the high voltage contact of the distributor; (4) the provision of such an ignition system which includes clamping means for limiting shock excited oscillation in the primary winding of the induction coil to a single half cycle of voltage during discharge of the condenser means therethrough whereby the so-called "voltage tail" which commonly appears on sparking voltage waves is eliminated; (5) the provision of such an ignition system which is trouble-free with continued operation and which can be inexpensively produced so as to be commercially available for use commonly by members of the purchasing public.

The above-stated objects are generic to various embodiments of the present invention. However, with respect to specific embodiments of the present invention, there are certain more detailed objects of importance. For example, in connection with one embodiment of the invention, it is an object to provide an ignition system conforming with the preceding objects, but wherein the voltage generating means comprises a blocking oscillator adapted to supply but a single pulse during each cycle of operation thereof, which single pulse is sufficient to charge the condenser means whereby the same may in turn supply a sparking voltage through the induction coil.

Consistent with a further embodiment of the invention, it is an object to provide such an ignition system wherein the voltage generator means comprises a free-running oscillator, and means associated therewith for returning at least a part of the effective output thereof to the power supply or battery once the generator means has operated to itself supply sufficient voltage for charging the condenser means of the system to the desired level.

In accordance with a still further embodiment of the present invention, the voltage generator means essentially takes the form of a free-running blocking oscillator. Consistent with this embodiment, it is an object hereof, to provide a sensing network and a shunting network which cooperate with a basic oscillator network to shut off the basic oscillator network when the series of voltage pulses produced thereby have resulted in charging the condenser means of the system associated therewith to the desired level.

In essence, and consistent with all of the embodiments of the invention, the system hereof operates through an oscillator means and a transformer means to supply voltages to a storage condenser means. Once the voltage on the condenser means has reached a pre-determined level, the supply of voltage thereto is stopped. Moreover, means are incorporated for blocking of the condenser the voltages fed thereto, until it is desired to discharge the same. At least one of the means which blocks the charge on the condenser means is controllable to permit a discharge from the condenser means through an associated induction coil. In accordance with preferred embodiments hereof, additional means are incorporated to limit unnecessary current drain on the power supply associated with the system, and to prevent ringing oscillations of the induction coil.

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The invention itself, and other specific aspects which are particularly important, will become more readily understandable after consideration is given to the following detailed description. Such description refers to the annexed drawings presenting preferred and illustrative embodiments of the invention.

In the drawings:

FIGURE 1 is a schematic circuit diagram illustratively presenting one embodiment of the present invention wherein a single pulse blocking oscillator is utilized;

FIGURE 2 is a schematic circuit diagram illustratively presenting another embodiment of the present invention wherein a free-running oscillator is utilized as a voltage source; and

FIGURE 3 is a schematic circuit diagram illustratively presenting still a further embodiment of the present invention wherein a combined free-running and blocking oscillator is used as a voltage source.

Referring first to FIGURE 1, the ignition system shown therein includes a power supply in the form of a battery 10, a distributor including a first switching means 12 and a second multiple contact switching means 14, and induction coil 16 having a primary winding 18 and a secondary winding 20 and a plurality of spark producing means (not shown) but designated as X1, X2, etc. The spark producing means, take the form of conventional spark plugs and the battery, the distributor, and the induction coil also are of conventional design. Moreover, as in the case of the usual ignition circuit, the secondary winding 20 of the induction coil 16 is connected to the multiple contact distributor switch 14 whereby voltages induced in the secondary winding 20 are fed to the switching means 14 and then, with movement of the wiper arm 22 of such switching means, to the spark plug in desired sequence. Operation of the switching means 12 and of the switching means 14 results from the conventional coupling of the distributor with an associated motor or engine.

It should be here understood that the present invention is not concerned with the exact form of distributor used, with the exact form of battery used, with the exact form of induction coil used, or with the exact form of spark plugs used. Instead, it is contemplated that the invention is applicable for use with these components as conventionally designed and commonly employed in existing automobiles. The particular form of any given component may vary. For example, the battery 10 may be replaced by an alternator and rectifier arrangement, if desired. Notwithstanding the considerations of this paragraph, it will be remembered, however, that one of the advantages of the present invention is that it can be employed with a conventional induction coil.

The invention, as used in combination with the standard components discussed above, includes an oscillator means generally designated by the numeral 24, a condenser means generally designated by the numeral 26 for storing a voltage thereon, a transformer means generally designated by the numeral 28 for amplifying voltage pulses produced by the oscillator means, a transferring and blocking means generally designated by the numeral 30 for transferring amplified voltages from the transformer means 28 to the condenser means 26 and for blocking such voltages thereon, a gate means generally designated by the numeral 32 which is connected between the condenser means and the primary winding 18 of the induction coil 16 for preventing discharge of the condenser means 26 through the primary winding 18 until the gate means is activated to permit such discharge, and coupling means generally designated by the numeral 34 for connecting the gate means 32 with the first switching means 12 for activation of the gate means in response to operation of the first switching means.

In addition, the arrangement of FIGURE 1 preferably includes a clamping means generally designated by the numeral 36 for limiting shock excited oscillation of the

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primary winding 18 to a single half cycle of voltage during discharge of the condenser means 26 therethrough. Moreover, the oscillator means 24 preferably includes a blocking loop generally designated by the numeral 38, which blocking loop, as explained more fully below, serves as a means for preventing unnecessary operating current drains on the power supply or battery 10 by the oscillator means so long as the voltage stored on the condenser means 26 is above a pre-determined desired minimum level.

The oscillator means 24, as indicated, is a blocking oscillator circuit, and this circuit is connected with the first switching means 12 so that the circuit produces a single voltage pulse in response to each like operation of the first switching means, namely, each opening operation thereof.

For convenience, and to illustrate the components with which the invention is particularly concerned, a phantom box has been drawn in FIGURE 1 and designated by the letter A. The components which fall within this box are those which are arranged in accordance with the present invention to cooperate with the standard components discussed so as to yield the desired result.

The blocking oscillator circuit or means 24 includes a transistor 50 and a bias resistor 51 therefor. Certain windings of the transformer means 28 also form part of the oscillator means. Thus, the transformer means 28 includes a trigger-winding 52, an input winding 54, and a feed-back winding 56. The trigger winding 52 is coupled between the switch 12 and the positive side of battery 10 by a resistor 58. Moreover, connected between the positive side of the battery and the emitter of the transistor 50 is a rectifier or semi-conductor diode 60. The feed-back winding 56, on the other hand, is coupled to the positive side of battery 10 through the resistor 62. The input winding 54, in contrast, is coupled between the collector of the transistor 50 and ground.

With such an arrangement, the trigger-winding 52 serves to render the transistor 50 conductive, the input winding 54 serves to feed the pulse produced by the transistor to the secondary winding 64 of the transformer 28, and in turn to the transfer and blocking means 30. The feed-back winding is coupled to the transistor and the diode 60 so as to render the transistor non-conductive in response to a pulse produced by the transistor 50.

More specifically, transformer 28 has four windings, an input winding 54, a secondary winding 64, a feed-back winding 56, and a trigger-winding 52. The relative polarities of these windings are indicated by the dot at the ends of the respective windings, in accordance with conventional practice.

By virtue of the couplings recited, the oscillator circuit 24 is a blocking oscillator normally biased in an off or non-conducting state by the forward voltage drop across the diode 60 which itself is preferably a silicon diode. The resistance 51 serves to permit enough current flow through the diode 60 to provide such bias. When the switch 12 closes for the first time, the voltage of the battery 10 is suddenly applied across the trigger winding 52. This voltage is reflected by transformer action in the other windings, specifically the feed-back winding 56. The polarity of the induced voltage is such as to make the base of the transistor 50 more negative than it was initially. This induced voltage accordingly overcomes the bias of the voltage drop across the diode 60 and allows the transistor 50 to conduct from emitter to collector. Current then starts to build linearly with time in the primary winding 54 of transformer 28 under the influence of the inductance of such winding.

The induced voltage in the feed-back winding 56 which results from this current build-up is such as to keep the base of the transistor biased in "on" condition. Thus, the current buildup is permitted to continue for a given period of time. However, when the current in the primary winding 54 has built up to a pre-determined level,

the core of the transformer 28 begins to saturate and the induced voltage in the feed-back winding 56 drops in magnitude.

The reduction in magnitude of the induced voltage in the feed-back winding 56 reduces the forward bias on the transistor base, and in turn causes the collector current to drop, reducing the induced bias voltage still further. This action is cumulative, and very rapidly "blocks" or turns off the transistor 50.

The extremely rapid reduction of current in the primary winding 54 of transformer 28 induces a voltage in the secondary winding 64 of several hundred volts magnitude. The polarity of this voltage pulse is such as to make the upper end of the secondary winding 64, as shown, positive with respect to the lower end thereof. This voltage pulse serves to charge the condenser means 26 through the transfer and blocking means 30 to the peak value of the voltage pulse. The transfer and blocking means in this instance preferably comprises a silicon diode.

From the preceding paragraph, it will be appreciated that the rapid collapse of transformer saturation results in having the transformer means supply, through its secondary winding, an amplified voltage which is produced in response to the pulse generated by the oscillator means. In this instance, the transformer means thus supplies an amplified voltage pulse in response to each pulse produced by the oscillator means.

The transformer means 28 is preferably chosen such that the current buildup described above, the turn-off of the blocking oscillator, and the charging of the condenser means 30 all occur in about one millisecond. Once the condenser means 26 has been charged, the circuit is essentially dormant insofar as operation is concerned until the switching means 12 is open. Only one charging cycle as described above occurs each time the switching means 12 closes, and hence the system takes only as much energy from the battery as is required to charge the condenser means 26 for each spark plug firing.

When the switching means 12 opens, the upper end of the trigger winding 52, as shown in FIGURE 1 is suddenly raised to a potential above ground level. This positive potential rise or voltage pulse is fed to the gate means 32 which preferably comprises a silicon controlled rectifier. The feeding in this instance is through the condenser 66.

By virtue of the feed through the condenser 66, the gate means 32 is triggered so that the same conducts. Accordingly, the voltage across the condenser means 26 which has been stored thereon, becomes suddenly impressed upon the primary winding 18 of the ignition coil 16, and the condenser means discharges rapidly through this primary winding.

The voltage application and discharge described immediately above results in a voltage pulse preferably of the order of 28,000 volts at the secondary winding 20. Such voltage fires the spark plug X1 through the high voltage multiple contact switching means 14.

It should be noted that the condenser means 26 cannot discharge through the clamping means 36 which itself comprises a silicon rectifier, because such rectifier blocks concurrent flow in the discharge direction. The clamping means is included, as indicated above, to effectively clamp the normal ringing or shock excited oscillation of the primary winding 18 of the ignition coil 16 on the opposite half cycle. This clamping action is particularly important because it greatly reduces spark plug wear.

In addition to the components described above, the circuit of FIGURE 1 preferably further includes a resistor means, generally designated by the numeral 68, which resistor means has a resistance value that is substantially greater than the impedance value of the primary winding 18 during operation of the ignition system. The resistance means 68 provides a discharge path for the condenser means 26 in the event the ignition coil is not

connected when the system is operated. In other words, the resistor means 68 prevents excessively high voltages being reflected onto the transistor 50 if the ignition coil is disconnected.

The only component not described specifically above, but of some importance in the arrangement of FIGURE 1, is the resistor 69 connected between the condenser 66, the silicon controlled rectifier which provides the gate means 32, and electrical ground. This resistor operates to permit a current path for the desired voltage control of the gate means 32. The arrangement of FIGURE 2 is in many basic respects the same as the arrangement of FIGURE 1. The difference resides in the construction and operation of the oscillator means 24' of FIGURE 2 in contrast with the construction and operation of the oscillator means 24 in the arrangement of FIGURE 1. By referring to FIGURE 2, it will be noted that the induction coil 16 is again shown, that the multiple contact switching means 14 is again shown, that the spark producing means X1, X2, X3 are similarly indicated, that the first switching means 12 is again presented, and that the power supply 10 is also again presented. These particular components which are designated by the same numerals in FIGURES 1 and 2 can be inter-changeably used in either of the circuit arrangements.

The oscillating means 24' of FIGURE 2 comprises a free-running oscillator as opposed to a blocking oscillator. However, in this instance, the means incorporated for preventing current drain on the power supply comprises a means for coupling at least a part of the output produced by the oscillator means in feedback relation to the power supply, as explained more fully below.

To understand the above, it is first necessary to consider the transformer means 28' and oscillator means 24' in some detail. The transformer means 28' includes a secondary winding 64' and a plurality of series coupled further windings 70, 72 and 74. The winding 70 serves as a primary or input winding, whereas the winding 72 serves as a feed-back winding, and the winding 74 serves as a control winding.

The oscillator means 24' includes the winding 70 and 72, the transistor 50', and bias resistors 76 and 78. The two resistors 76 and 78 serve to bias the base of the transistor 50' such that the transistor is saturated, and collector current increases until the core of the transformer 28' saturates, and the induced voltage in the feed-back winding 72 starts to decrease. The decrease in induced voltage in the feed-back winding 72 reduces the forward bias on the transistor 50', thus reducing the collector current in a cumulative action which produces a "fly-back" or collapse of the magnetic field. The components are selected to have a magnitude whereby the whole process repeats itself several hundred times per second.

The control winding 74 of the transformer 28' serves a very important function in the arrangement of FIGURE 2. When the fly-back voltage in this winding exceeds the voltage of the power supply 10, current is permitted to flow through the diode 80 which is connected between ground and the upper end of the control winding 74. The diode 80, preferably a silicon diode, effectively clips the fly-back voltage in the control winding 74 in the battery voltage level. This clipping serves two purposes. First, it limits the fly-back voltage of all of the windings of transformer 28' and hence automatically fixes the voltage magnitude to which the condenser means 26 is charged. Secondly, this clipping action results in pumping the excess energy generated by the oscillator pulses back to the battery, after a sufficient quantity of such pulses have occurred to sufficiently charge the condenser means 26.

It should be noted with respect to FIGURE 2, that only the opening of the switching means 12 is utilized for control. By virtue of such factor, the dwell angle of the points of the switching means 12 becomes immaterial

for all practical considerations, and any dwell from a few degrees to almost continuous closure will operate satisfactorily as long as the opening operation occurs in proper time sequence.

With the arrangement of FIGURE 2, it is not necessary to incorporate a resistor such as the resistor 68 used in the arrangement of FIGURE 1. No damage due to excessive voltage build-up can occur if the ignition coil primary winding 18 is disconnected. Every fly-back pulse will be clipped at the appropriate level if the condenser means 26 is fully charged, and the excess energy will be pumped back to the battery as previously explained.

Aside from operation, as noted above, the general operation of the system of FIGURE 2 corresponds quite closely with the operation of the system of FIGURE 1. The discharging of the condenser is controlled in virtually an identical manner. For simplicity, coupling components interposed in the connection between the switching means 12 and the gate means 32 have been eliminated, but this should not affect an understanding of the invention.

With the arrangement of FIGURE 3, the basic operation is again similar to the operation described in connection with FIGURE 1, the switching means 12 and 14 of the distributor remain the same, the spark producing means or spark plugs X1, X2, etc. remain the same, the induction coil 16 remains the same, and the battery 10 remains the same. Moreover, certain of the components associated with the standard components in accordance with the invention remain the same. For example, a corresponding transfer and blocking means 30 is utilized, a corresponding condenser means 26 is utilized, a corresponding gate means 32 is utilized, a corresponding clamping means 36 is utilized, and a corresponding resistor means 68 is incorporated. Here again, the difference between the arrangement of FIGURE 3 and the arrangement of FIGURE 1 resides in the particular construction of the oscillator means.

As suggested in preceding sections of this specification, the oscillator means 24' of the circuit of FIGURE 3 is in a sense a combined free-running and blocking oscillator.

In its most basic nature, the oscillator means or circuit 24' of FIGURE 3 includes a main electronic oscillating valve network generally designated by the numeral 100, a sensing electronic valve network generally designated by the numeral 102, and a shunting electronic valve network generally designated by the numeral 104. The shunting electronic valve network is activatable to shunt the main electronic oscillating valve network 100. The main oscillating valve network is connected to the transformer means 28'' to feed pulses produced thereby to and through the transformer means.

On the other hand, the sensing electronic valve network is connected to the condenser means 26 for sensing when the voltage level on the condenser means reaches the desired predetermined upper value. The sensing valve network, moreover, is connected with the shunting valve network 104 to activate the shunting network and render the same effective as a shunt across the main oscillating valve network 100.

The sensing electronic network 102 comprises a zener diode 110, a transistor 111, and a voltage dividing resistance network including the resistors 112 and 113. The resistors 112 and 113 are connected between the zener diode 112, the transistor 111, and the condenser means 26 to change a current characteristic of the transistor 111 when the level of voltage on the condenser means 26 reaches the desired value. The shunting valve network 104 is activated in response to the change in such current characteristics.

The preceding general description will be better understood by reference to the following detailed description of the operation of the arrangement of FIGURE 3.

So long as the ratio of the voltage across the condenser

means 26 to the regulator voltage of the zener diode 110 is less than the ratio of the value of resistance 113 to resistance 112, the base of the transistor 111 is appreciably lower in potential than its emitter, and collector current flows therethrough. In fact, transistor 111 is saturated until the voltage across condenser means 26 approaches the pre-determined desired storage level. While the transistor 111 is saturated, the top of resistance 120 is almost at the maximum positive potential of the power supply or battery 10. This fact is true due to the low voltage drop across the collector emitter of transistor 111, and the fact that resistance 120 is coupled between the collector of such transistor and electrical ground. During this time, the transistor 122 which forms part of the shunting network, it cut off. Its base to emitter voltage is almost zero. The collector emitter current of transistor 122 constitutes a shunt around the feed-back winding of the transformer 28'', which feed-back winding in this instance, is generally designated by the numeral 124. Such shunt, as should be apparent, actually exists not only across the feed-back winding 124, but actually across the series connection of such winding with the limiting resistor 126.

When the shunt has a sufficiently low resistance value, the base of the transistor 128 forming part of the main oscillating network 100, will be essentially connected to its emitter, and no collector current can flow therethrough. In other words, at this time, no oscillating action can be sustained.

If the resistance value of the shunting action of the transistor 122 is high, as is the case if the voltage across condenser means 26 is less than the set value, then transistor 122 has no effect on the blocking oscillator operation of transistor 128. However, as the voltage on the condenser means approaches the critical set value, the transistor 128 begins to conduct less and less, thus permitting the transistor 122 to conduct more and more, until the transistor 122 clamps the base emitter circuit of the transistor 128, and prevents further pulses—i.e., blocks oscillation.

In operation, as soon as an ignition pulse has occurred, the voltage on the condenser 26 has dropped to essentially zero, and the transistor 128 is unblocked for a few pulses so that the condenser means again charges. With a stalled engine, a single blocking oscillator pulse occurs periodically as the voltage of the condenser means 26 gradually drops due to the drain of the feed-back resistor 113, or other linkages.

Preferably, the resistor 112 is made variable so that the charging voltage across condenser means 26 may be set accurately at a desired level. It will be remembered that it is the ratio of this resistance with the resistance 113, and with the ratio of the condenser means voltage and the zener diode regulating voltage, which sets the critical level.

To clarify an understanding of the invention, the transistors 128, 122, and 102 may be considered as a three-stage direct coupled amplifier with an error signal input consisting of the difference between the zener voltage of diode 110 and set fraction of the voltage across the condenser 26. As this error signal approaches zero, the last stage of the amplifier, namely, transistor stage 128, is shut-off, and can no longer conduct.

With the arrangement of FIGURE 3, and proper selection of the components, input current with stalled or stopped engines is extremely low, e.g., of the order of 50 milliamperes. Accordingly, this system is particularly efficient. Because of the gain of the transistors, the voltage of condenser means 26 which is desired to be set, can be held within 3% of the pre-determined value for battery voltages between 8 and 15 volts.

Although certain of the resistance components and condenser components included in the arrangement of FIGURE 3 have not been described in particular detail, it should be readily apparent to those of ordinary skill

in the art that such components are used for coupling and bias purposes in accordance with conventional techniques. Thus, further discussion of these remaining components appears unnecessary.

Having now described illustrative and preferred embodiments of the invention in considerable detail, it should be apparent that the objects set forth at the outset of the present specification have been successfully achieved.

Accordingly, what is claimed is:

1. In combination with an ignition system including:

- (a) a power supply;
- (b) distributor means having a first switching means and a multiple contact second switching means;
- (c) induction coil means having primary and secondary windings with the secondary winding connected to said multiple contact second switching means to feed voltages induced in said secondary winding to said second switching means; and,
- (d) a plurality of spark-producing means connected to respective contacts of said second multiple contact switching means to sequentially receive voltages fed thereto;

the improvements comprising:

- (e) oscillator means connected to said power supply for producing at least one voltage pulse in response to operation of said first switching means;
- (f) condenser means for storing a voltage thereon;
- (g) transformer means for supplying amplified voltage pulses in response to pulses produced by said oscillator means;
- (h) transfer and blocking means for transferring amplified voltages from said transformer means to said condenser means and for blocking such voltages thereon;
- (i) gate means connected between said condenser means and said primary winding of said induction coil, said gate means normally preventing discharge of said condenser means through said primary winding but being activatable to permit discharge of said condenser means through said primary winding;
- (j) means connecting said gate means with said first switching means for activation of said gate means in response to operation of said first switching means; and,
- (k) clamping means for limiting shock excited oscillation of said primary winding to a single half cycle of voltage during discharge of said condenser means therethrough, said clamping means being coupled in parallel with said induction coil means and in series with said condenser means;

wherein said oscillator means comprises a free-running oscillation circuit, and wherein said means for preventing current drain on said power supply comprises means for coupling at least part of the output produced by said oscillator means in feed-back relation to said power supply.

2. In combination with an ignition system including:

- (a) a power supply;
- (b) distributor means having a first switching means and a multiple contact second switching means;
- (c) induction coil means having primary and secondary windings with the secondary winding connected to said multiple contact second switching means to feed voltages induced in said secondary winding to said second switching means; and,
- (d) a plurality of spark-producing means connected to respective contacts of said second multiple contact switching means to sequentially receive voltages fed thereto;

the improvements comprising:

- (e) oscillator means connected to said power supply

for producing at least one voltage pulse in response to operation of said first switching means;

- (f) condenser means for storing a voltage thereon;
- (g) transformer means for supplying amplified voltage pulses in response to pulses produced by said oscillator means;
- (h) transfer and blocking means for transferring amplified voltages from said transformer means to said condenser means and for blocking such voltages thereon;
- (i) gate means connected between said condenser means and said primary winding of said induction coil, said gate means normally preventing discharge of said condenser means through said primary winding but being activatable to permit discharge of said condenser means through said primary winding;
- (j) means connecting said gate means with said first switching means for activation of said gate means in response to operation of said first switching means; and,
- (k) clamping means for limiting shock excited oscillation of said primary winding to a single half cycle of voltage during discharge of said condenser means therethrough, said clamping means being coupled in parallel with said induction coil means and in series with said condenser means;

wherein said oscillator means comprises a blocking oscillator circuit for producing a series of voltage pulses only until the voltage stored on said condenser means reaches a predetermined level; wherein said blocking oscillator circuit comprises a main electronic oscillating valve network, a sensing electronic valve network and a shunting electronic valve network activatable to shunt said main electronic oscillating valve network, said main oscillating valve network being connected with said transformer means to feed pulses produced thereby to and through said transformer means, said sensing electronic valve network being connected to said condenser means for sensing when the voltage level on said condenser means reaches a predetermined value, said sensing electronic valve network being connected with said shunting electronic valve network to activate the same and render said shunting electronic valve network effective as a shunt across said main electronic valve network whereby said main electronic valve network ceases to oscillate when the level of voltage on said condenser means reaches said predetermined level.

3. The combination defined in claim 2 wherein said sensing electronic network comprises a zener diode, a transistor, and a voltage dividing resistance network connected between said zener diode, said transistor and said condenser means to change a current characteristic of said transistor when the level of voltage on said condenser means reaches said predetermined level and wherein said shunting electronic valve network is activatable in response to the change in said current characteristic.

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