

[54] **LOW IMPEDANCE CAPACITOR DISCHARGE SYSTEM AND METHOD**

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[75] Inventor: **Harold E. Anderson**, Los Angeles, Calif.

*Primary Examiner*—Laurence M. Goodridge

*Assistant Examiner*—Ronald B. Cox

[73] Assignee: **McCulloch Corporation**, Los Angeles, Calif.

*Attorney, Agent, or Firm*—Burns, Doane, Swecker & Mathis

[22] Filed: **Nov. 10, 1972**

[21] Appl. No.: **305,308**

[52] U.S. Cl. **123/148 E, 123/148 AC, 123/148 DC**

[51] Int. Cl. .... **F02p 1/00**

[58] Field of Search.... 123/148 E, 148 DC, 148 AC

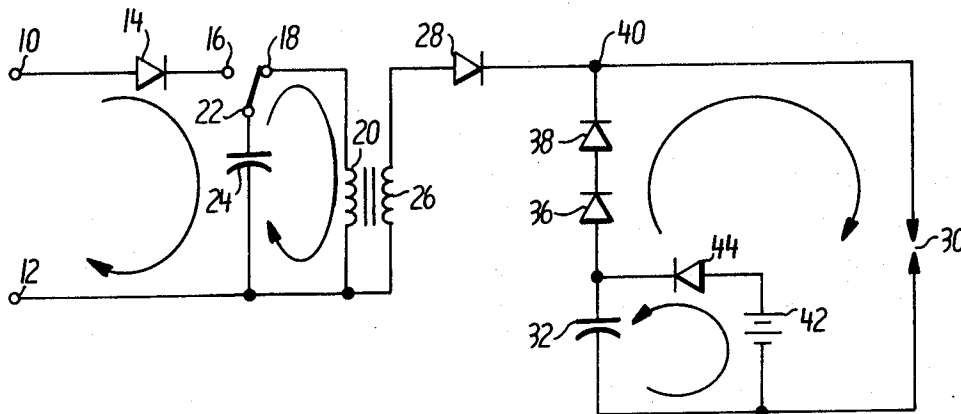
[57] **ABSTRACT**

A low impedance capacitor discharge ignition system and method in which a supplemental capacitor is utilized on the secondary winding side of the high voltage transformer to avoid the impedance of the transformer in sustaining the gap ionization potential of the ignition device.

[56] **References Cited**  
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**22 Claims, 3 Drawing Figures**



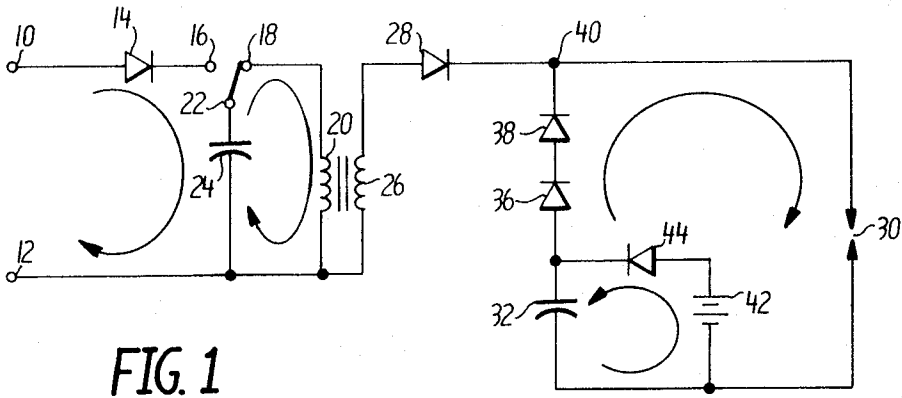


FIG. 1

FIG. 2

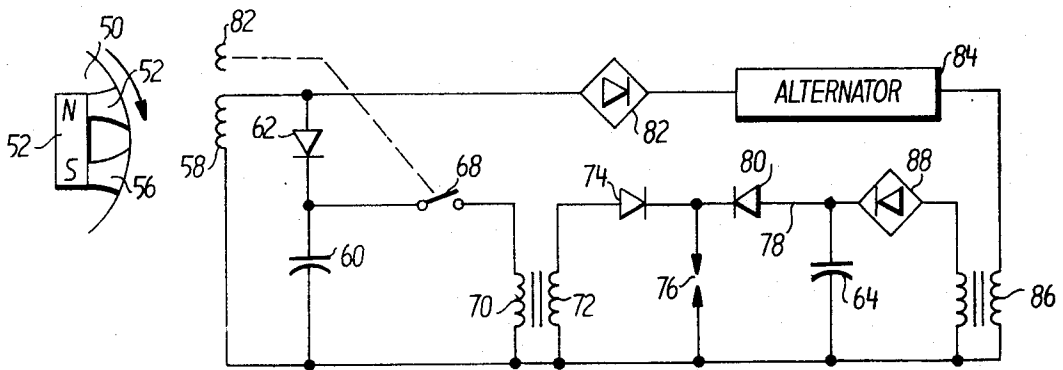
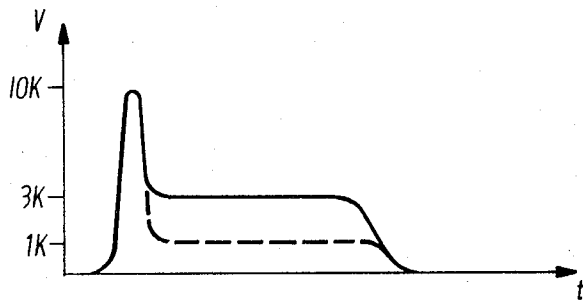


FIG. 3

## LOW IMPEDANCE CAPACITOR DISCHARGE SYSTEM AND METHOD

### BACKGROUND OF THE INVENTION

Capacitor discharge ignition systems in common use generally employ a discharge capacitor which is alternatively connected between a source of direct current and the primary winding of a high voltage transformer having its secondary winding connected to the ignition device. The capacitor in such systems may receive direct current from a storage device or from a coil disposed in flux cutting proximity to a magnetic element movable in response to rotation of the engine. The switch means customarily employed to alternatively connect the capacitor to the source of direct current and to the primary winding of the high voltage transformer may be of the solid state type, e.g., a silicon controlled rectifier, and operable in response to engine rotation by means of a trigger coil disposed in flux cutting proximity to the same magnetic element as the current source. Alternatively, the switch may be breaker points mechanically operable in response to engine rotation in a conventional manner.

Capacitor discharge ignition systems of the type above described suffer from the disadvantage that the charge in the capacitor is applied to the ignition device through the high voltage transformer. While the impedance of the high voltage transformer is generally quite small upon the initial application of the discharge pulse, the impedance of the high voltage transformer becomes quite large as the passage of current through the windings of the transformer is sustained. The impedance of the high voltage transformer thus significantly reduces the potential applied to the ignition device.

The reduction in the potential applied to the ignition device due to the high voltage transformer impedance is not nearly so significant at very high engine speeds or under the circumstances where atomized fuel is in immediate proximity to the electrode of the ignition device at the time that the arc is initiated. However, and as is well known, the likelihood that sufficient atomized fuel will be in such proximity is significantly reduced at low engine speeds and as a result, the potential applied to the ignition device may be insufficient to ignite the fuel when the fuel does become present. Even where the fuel does ignite late in the cycle, the efficiency of the fuel combustion is severely reduced. This reduction in efficiency adds significantly to the unburned hydrocarbons and thus the pollution problem plaguing many parts of the country.

In addition, the increased potential permits the combustion of leaner mixtures and the present invention has been successfully utilized with air/fuel ratios of about 30 to 1. This excessive air serves to cool the combustion below the knee in the emission/temperature curve, i.e., about 3,200° F, as a result of which the presence of unburned hydrocarbons is significantly reduced.

It is accordingly an object of the present invention to obviate many of the problems associated with generally known capacitor discharge ignition devices and to provide a novel method and system for sustaining the gap ionization potential of an ignition device in a capacitor discharge ignition system.

It is another object of the present invention to provide a novel method and system for combating pollu-

tion by increasing the efficiency of fuel combustion in internal combustion engines.

It is still another object of the present invention to provide a novel method and system for supplementing the gap ionization potential applied to the ignition device of an internal combustion engine in which the impedance of the high voltage transformer may be avoided.

These and many other objects and advantages of the present invention will be readily apparent to one skilled in the art to which the invention pertains from the claims and from a perusal of the following detailed description when read in conjunction with the appended drawings.

### THE DRAWINGS

FIG. 1 is a schematic circuit diagram of one embodiment of the present invention;

FIG. 2 is a graph of the potential applied to the ignition device with respect to time; and,

FIG. 3 is a schematic circuit diagram of the second embodiment of the present invention.

### THE DETAILED DESCRIPTION

With reference now to FIG. 1, a source of direct current (not shown) may be applied to the input terminals 10 and 12 and the input terminal 10 connected through a diode 14 to one terminal 16 of a single pole, double throw switch schematically illustrated. The other terminal 18 of the switch is connected to one end of the primary winding 20 of a high voltage transformer and the other end thereof is connected to the terminal 12. The switch arm 22 is operable to connect the primary capacitor 24 across the input terminals 10 and 12.

One end of the secondary winding 26 of the high voltage transformer is grounded and the other end thereof may be connected through a diode 28 to the ignition device 30. The ignition device 30 may be paralleled by a supplemental capacitor 32 connected through diodes 36 and 38 to a terminal 40 intermediate the diode 28 and the ignition device 30. The supplemental capacitor 32 may in turn be paralleled by a suitable conventional source of direct current such as a battery 42 and a diode 44.

In operation with the switch arm 22 in contact with the terminal 16, the direct current applied to the input terminal 10 may be applied through the diode 14 to the capacitor 24 to charge the capacitor 24. Once the capacitor 24 has been charged, the movement of the switch arm 22 to the terminal 18 provides a discharge path for the capacitor 24 through the primary winding 20 of the high voltage transformer. The current pulse thus generated in the secondary winding 26 of the high voltage transformer is supplied through the diode 28 to the ignition device 30 and is of sufficient magnitude to ionize the gap thereof.

The operation of the circuit thus far described is conventional. In such circuits, the diode 14 may be eliminated by the use of the switch as described or alternatively the capacitor 24 may be directly connected to the terminal 16 and the switch disposed between the illustrated terminal 18 and the primary winding 20 of the high voltage transformer. In a typical embodiment having values hereinafter set forth, the potential applied to the ignition device by the circuit of FIG. 1 thus operated may take the shape of the waveform illustrated in dashed lines in FIG. 2. With reference to FIG.

2, the waveform includes a brief initial portion having an amplitude approximately one order of magnitude higher than the amplitude of the remainder of the waveform due to the impedance of the high voltage transformer.

With continued reference to FIG. 1, the supplemental capacitor 32 may be charged from the battery 42 through the diode 44. Once charged, the supplemental capacitor 32 may be discharged through the diodes 36 and 38 and the ignition device 30. The charge on the supplemental capacitor 32 may thus be dissipated through the ignition device 30 while avoiding the impedance of the high voltage transformer.

It is necessary that the discharge of the primary capacitor 24 and the supplemental capacitor 32 be synchronized so that the discharge impulses are superimposed on the ignition device 30. The operation of the switch 22 may be controlled in any suitable conventional manner in timed relationship to engine rotation. The simultaneous discharge of the capacitor 32 has been found for the circuit values hereinafter set forth to provide a threefold increase in the amplitude of the ignition device potential as shown in FIG. 2.

Simultaneous discharge of the capacitors 24 and 32 is assured by the impedance of the ignition device 30 which acts as an open circuit during the charging of the capacitor 32 from the battery 42. Once the ignition device has received an ionizing potential, the impedance of the spark gap drops sufficiently to provide a discharge path for the capacitor 32 through the diodes 36 and 38. The voltage drop across the diodes 36 and 38 is, moreover, sufficient to insure the effective disconnecting of the capacitor 32 from the ignition device 30 once the capacitor 32 has been discharged.

With continued reference to FIG. 1, the diodes 28, 36 and 38 may have a 10 Kv. 2.5 amp rating for use with a 3 Kv. 100 watt source 42 and a 1 microfarad capacitor 32. By means of the discharge of the supplemental capacitor, the normal 0.321 Kv. ionization sustaining potential applied to the ignition device 30 may be increased to approximately 3 Kv.

With reference now to FIG. 3, a flywheel 50 is schematically illustrated having a permanent magnet 52 and pole pieces 54 and 56 for rotation in response to engine rotation. A current coil 58 may be disposed in flux cutting proximity to the flywheel 50 and may be connected across a primary capacitor 60 by way of a diode 62. The diode 62-capacitor 60 interconnection may be connected through a switch 68 to the primary winding 70 of a high voltage transformer to provide a discharge path for the capacitor 60 through the primary winding 70. The secondary winding 72 of the high voltage transformer may be connected through a diode 74 across the ignition device.

The switch 68 may be any suitable conventional switch and may, for example, be a silicon controlled rectifier having a gate electrode connected to a trigger coil 82 also disposed in flux cutting relationship to the flywheel 50. The switch 68 may alternatively be a mechanical switch operable by a trigger coil 82 or any suitable conventional cam mechanism to provide the desired synchronization with engine rotation.

With continued reference to FIG. 3, the current coil 58 may also be connected through a full wave rectifier 82 to the alternator 84 of the vehicle to provide a 12v. a.c. signal to a transformer 86 where the signal is increased to about 1 Kv. a.c. This high voltage signal may

be applied through a full wave rectifier 88 to the supplemental capacitor 64 to effect the charging thereof. As earlier explained in connection with the circuit of FIG. 1, the ionization of the spark gap of the ignition device 76 provides a discharge path for the capacitor 64 through a diode 80 and the ignition device 30.

In operation, the rotation of the flywheel 50 and the magnetic elements contained therein past the stationary current coil 58 will generate a current pulse therein and this current pulse will be applied through the diode 62 to charge the primary capacitor 60. Operation of the switch 68 will provide, by the ionization of the spark gap, a discharge path for the supplemental capacitor 64 through the diode 80 to the ignition device 76. As is readily apparent, this latter discharge path does not include the impedance of the high voltage transformer and the gap ionization sustaining potential may be appreciably increased.

While only one discharge device has been illustrated and described, it is to be understood that the present invention contemplates the utilization of rotor and multiple ignition devices such as commonly found in multiple cylinder internal combustion engines.

#### ADVANTAGES AND SCOPE OF THE INVENTION

As is readily apparent from the foregoing description, the novel method and system of the present invention significantly increases the ignition device gap ionization sustaining potential by means of a supplemental capacitor and a discharge path therefore excluding the impedance of the high voltage transformer through which the gap ionization potential is initially applied. By means of the present invention, the efficiency of an internal combustion engine may be significantly increased, particularly at low engine speeds, and the emission of unburned hydrocarbons significantly reduced. By avoiding the impedance of the high voltage transformer for the gap ionization sustaining potential, the size of the primary capacitor may be significantly reduced for any predetermined gap ionization sustaining potential.

The present invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The presently disclosed embodiments are therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

What is claimed is:

1. A method of sustaining the duration of the gap ionization potential applied to an ignition device in a capacitor ignition system comprising the steps of:

- a. alternately charging a primary capacitor from a first current source and discharging the primary capacitor through a high voltage transformer and an ignition device to initiate the application of a gap ionization potential to the ignition device; and,
- b. alternately charging a supplemental capacitor from a second current source and discharging the supplemental capacitor through the ignition device but not through the high voltage transformer in timed relation to the charging and discharging of the primary capacitor, whereby the impedance of the high voltage transformer is avoided in discharg-

ing the supplemental capacitor through the ignition device and sustaining the duration of the gap ionization potential thereof.

2. The method of claim 1 wherein the discharge of the supplemental capacitor is initiated before the discharge of the primary capacitor is terminated.

3. The method of claim 2 wherein the primary and secondary capacitors are charged from different sources.

4. The method of claim 3 wherein the peak amplitude of the gap ionization potential applied to the ignition device from the supplemental capacitor is greater than about fifteen percent of the peak amplitude of the gap ionization potential applied to the ignition device from the primary capacitor.

5. The method of claim 4 wherein the duration of the discharge of the primary and supplemental capacitors is substantially equal.

6. The method of claim 1 wherein the peak amplitude of the gap ionization potential applied to the ignition device from the supplemental capacitor is greater than about twenty-five percent of the peak amplitude of the gap ionization potential applied to the ignition device from the primary capacitor.

7. The method of claim 6 wherein the discharge of the supplemental capacitor is initiated before the discharge of the primary capacitor is terminated.

8. A low impedance capacitor discharge ignition system comprising:

a primary capacitor;

a first source of direct current;

a high voltage transformer;

first switch means operable to connect said primary capacitor to said first source of direct current to charge said primary capacitor therefrom and to connect said primary capacitor to said high voltage transformer to discharge said primary capacitor through the primary winding thereof;

a supplemental capacitor;

a second source of direct current;

an ignition device connected in series with the secondary winding of said transformer to receive a gap ionizing potential upon the discharge of said primary capacitor; and,

circuit means operable to connect said supplemental capacitor to said second source of direct current to charge said supplemental capacitor therefrom and to connect said supplemental capacitor to said ignition device to discharge said supplemental capacitor through said ignition device in timed relation to the discharge of said primary capacitor.

9. The system of claim 8 wherein said switch means include mechanically actuable breaker points.

10. The system of claim 8 wherein said switch means include coils and a permanent magnet movable with respect to each other.

11. The system of claim 8 wherein first switch means and said circuit means are operable to initiate the discharge of said primary and supplemental capacitors at substantially the same time.

12. The system of claim 11 wherein the duration of the discharge of said primary and supplemental capacitors is substantially equal.

13. The system of claim 8 wherein the duration of the discharge of said primary and supplemental capacitors is substantially equal.

14. A method of reducing the emission of hydrocarbons from an internal combustion engine having an ignition device by increasing the power applied to the ignition device comprising the steps of:

a. discharging a first capacitor through a high voltage transformer to apply a gap ionization potential to the ignition device; and,

b. discharging a second capacitor to apply a gap ionization sustaining potential to the ignition device through a circuit excluding the impedance of the high voltage transformer whereby the power applied to the ignition device may be increased.

15. The method of claim 14 wherein the discharge of the primary and supplemental capacitors is substantially simultaneous.

16. The method of claim 15 wherein the gap ionization potential applied by the primary capacitor to the ignition device is substantially in excess of the gap ionization sustaining potential applied by the supplemental capacitor to the ignition device.

17. The method of claim 14 wherein the gap ionization potential applied by the primary capacitor to the ignition device is substantially in excess of the gap ionization sustaining potential applied by the supplemental capacitor to the ignition device.

18. A low impedance capacitor discharge system comprising:

an ignition device;

a high voltage transformer;

means for applying a gap ionizing potential to said ignition device through a circuit including said high voltage transformer; and,

means for applying a gap ionization sustaining potential to said ignition device through a circuit excluding said high voltage transformer whereby the impedance to the application of power to said ignition device may be reduced.

19. The system of claim 18 wherein the gap ionizing potential and the gap ionization sustaining potential are substantially coextensive.

20. The system of claim 19 wherein the average gap ionizing potential is significantly greater than the average gap ionization sustaining potential.

21. The system of claim 18 wherein said means for applying a gap ionizing potential and for applying a gap ionization sustaining potential to said ignition device comprises:

first and second capacitors;

movable magnetic means

a coil disposed in flux cutting proximity to the path in which said magnetic means moves;

unidirectional current means for connecting said coil to said first and second capacitors;

first switch means operable in synchronism with movement of said magnetic means for connecting said first capacitors to said discharge device through said transformer; and,

second unidirectional current means for connecting said second capacitor to said discharge device in synchronism with the discharge of said first capacitor.

22. The system of claim 18 wherein said means for applying a gap ionizing potential to said ignition device includes a first capacitor, movable magnetic means, a coil disposed in flux cutting proximity to the path in which said magnetic means moves, and first switch means operable in synchronism with movement of said

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magnetic means for connecting said first capacitor to said ignition device through said transformer; and, wherein said means for applying a gap ionization sustaining potential to said ignition device includes a second capacitor, a source of direct current, and 5

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diode means for connecting said second capacitor to said ignition device in synchronism with the discharge of said first capacitor.

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