United States Patent [19]

Hufton

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[45] **May 27, 1975**

[54] **DUAL IGNITION COIL FOR INTERNAL COMBUSTION ENGINE**

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[73] Assignee: **Teledyne Industries, Inc.,** Los Angeles, Calif.

[22] Filed: **July 23, 1973**

[21] Appl. No.: **381,989**

[52] **U.S. Cl.** ..... **123/148 E;** 123/148 DS

[51] **Int. Cl.** **F02p 9/00**

[58] **Field of Search** ..... 123/148 E, 148 DS, 149 R, 123/149 D

[56] **References Cited**

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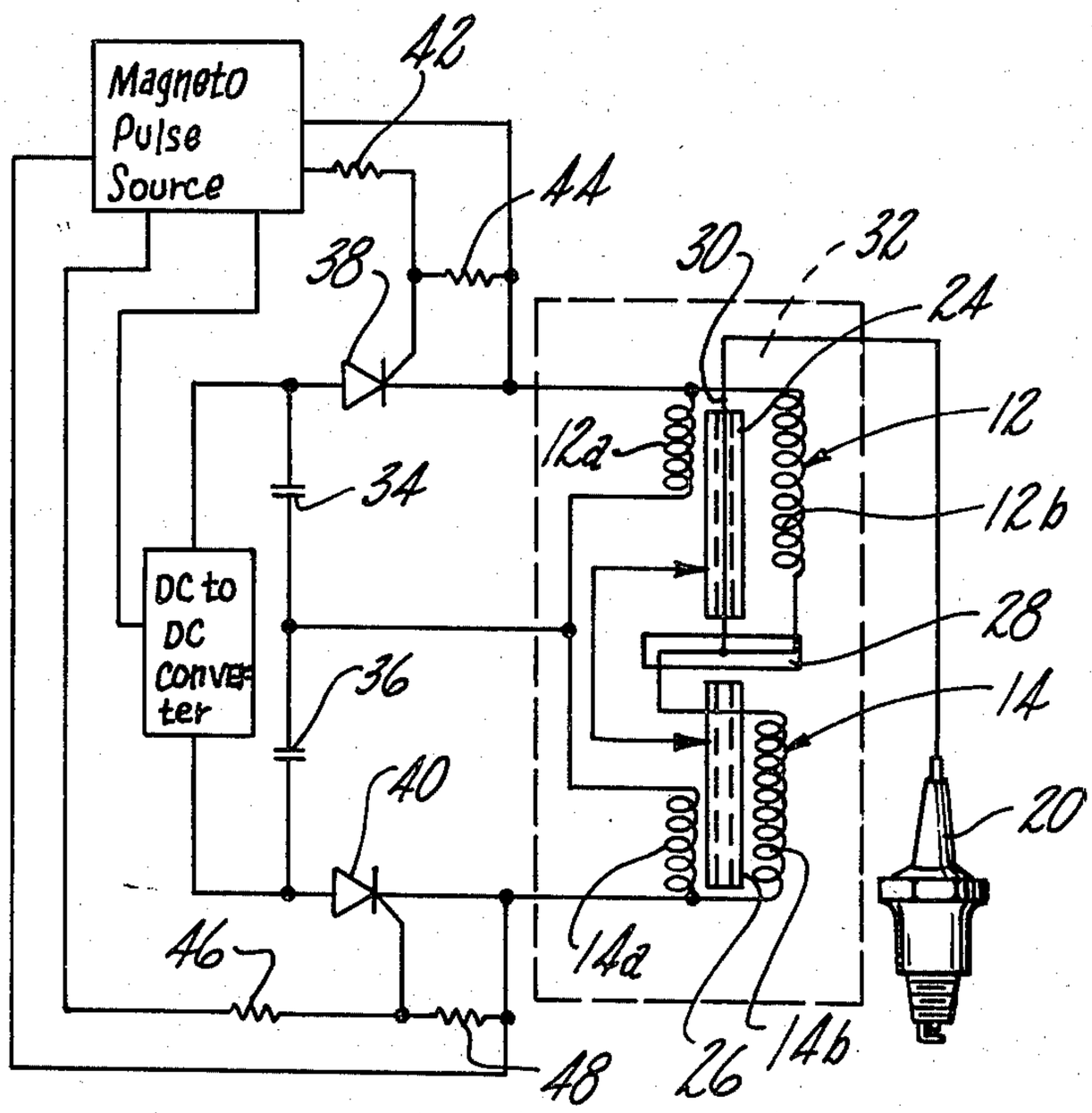
Primary Examiner—Charles J. Myhre
Assistant Examiner—Paul Devinsky
Attorney, Agent, or Firm—Hauke, Gifford, Patalidis & Dumont

[57] **ABSTRACT**

A stored energy ignition system of the capacitor discharge type in which the spark plugs of the engine are fired twice during each combustion interval. To provide ignition of the spark plugs, one of which is provided for each cylinder, a magneto type system driven from the engine crankshaft is used to charge a pair of capacitors used in the system. Electronic triggering devices or electronic switches, such as silicon controlled rectifiers, are used to discharge each respective capacitor. The dual coils are separated one from the other magnetically, physically and electrically through insulating intermediate discs, such as for example a carbon disc. The arrangement of the coils in the single casing is such that should one of the coils fail the other will have a sufficient voltage output to fire the associated spark plug. During the normal double firing of the system, the secondary combustion occurring results in a substantial reduction of unburnt gases being passed to the atmosphere.

13 Claims, 3 Drawing Figures



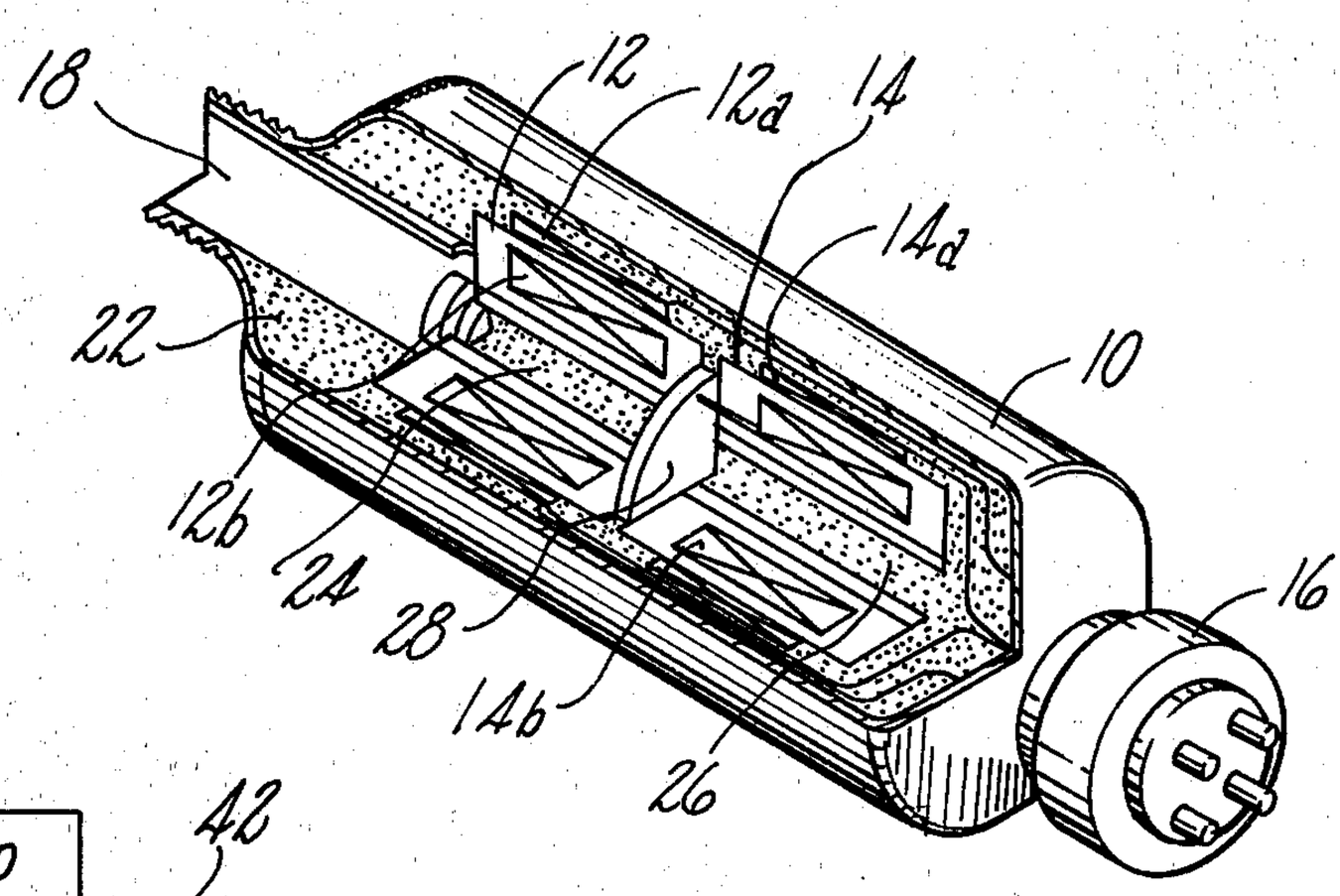


Fig - 1

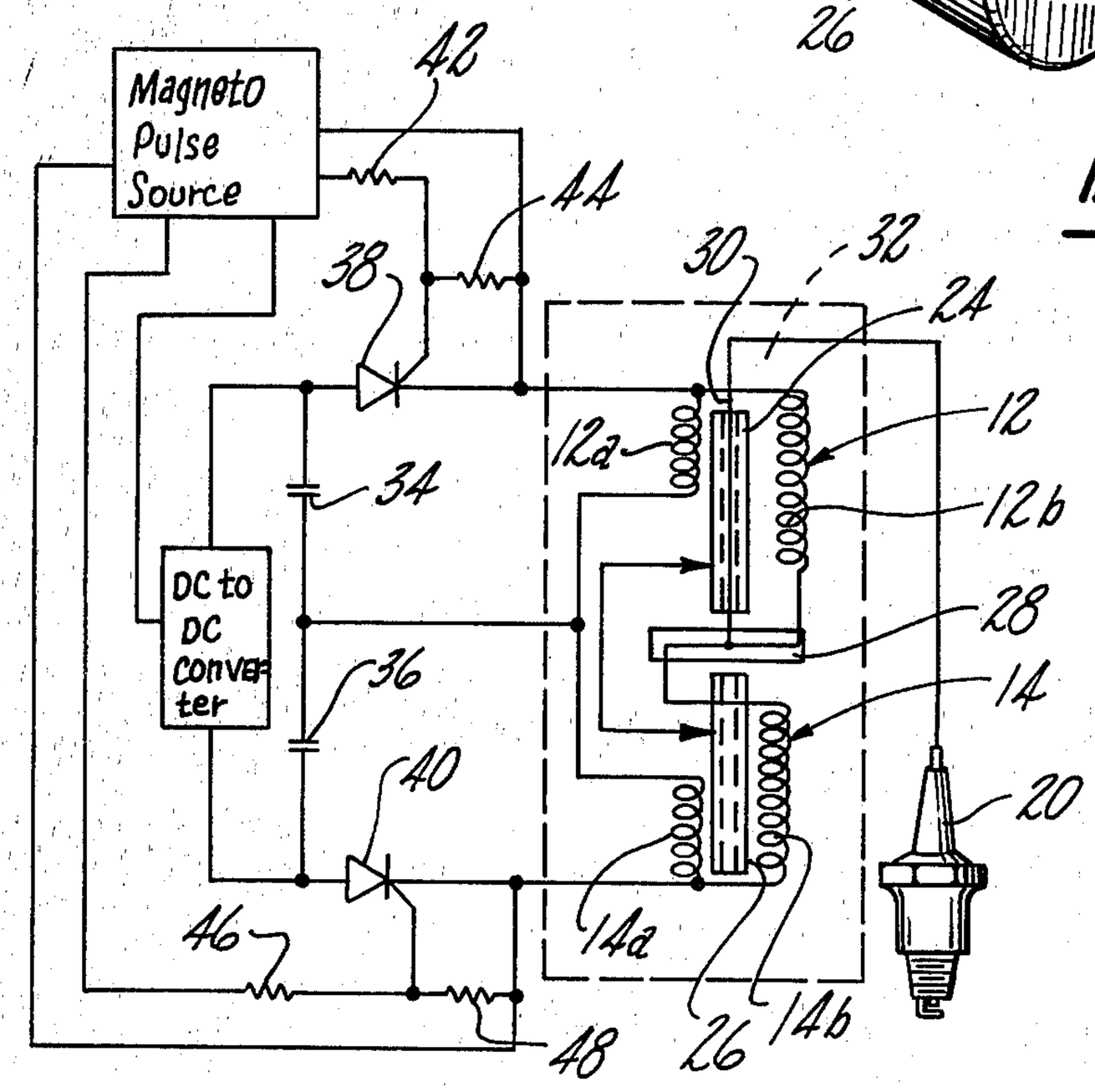


Fig - 2

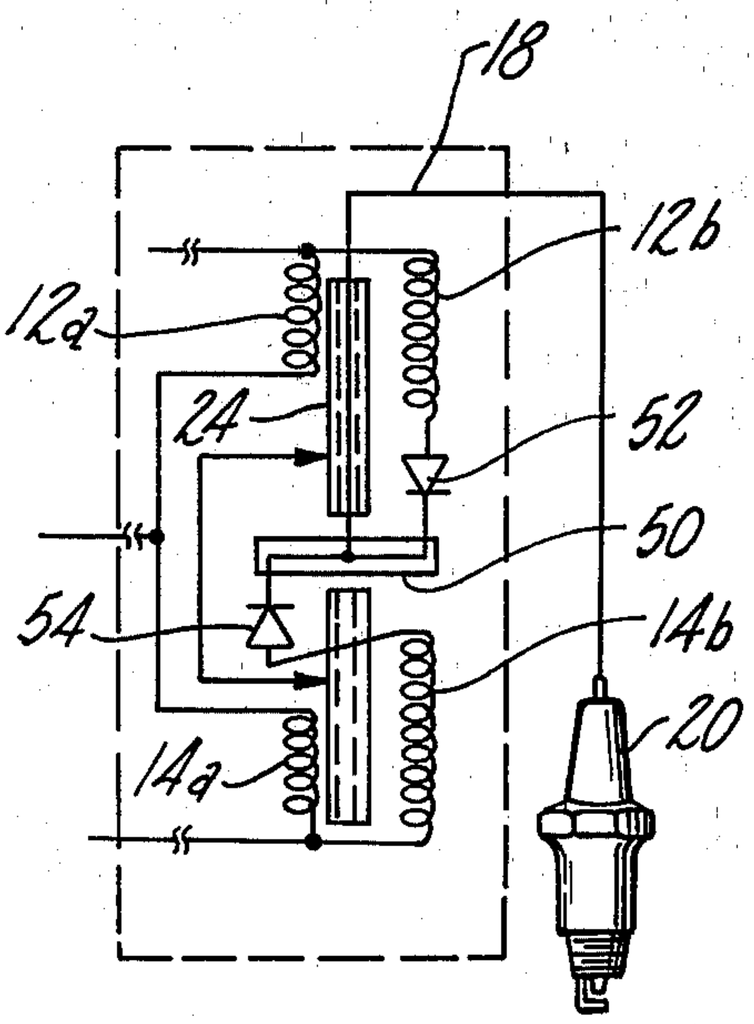


Fig - 3

DUAL IGNITION COIL FOR INTERNAL COMBUSTION ENGINE

BACKGROUND OF THE INVENTION

The present invention relates to internal combustion engine ignition systems, particularly of the magneto type, which require no auxiliary source of electrical power, in which generation of an appropriate electrical pulse for firing the spark plugs and the appropriate timing of the firing may be provided in a single unit driven by the internal combustion engine. A suitable magneto for such operation is shown and described in my co-pending application Ser. No. 367,067 entitled "Capacitor Discharge Ignition System for Internal Combustion Engine" filed on June 3, 1973. That application is of common ownership with the present application.

The present invention more particularly relates to a dual coil unit in which the two windings are wound about two ferrite tubular cores with the dual coil apparatus housed in a single metallic casing in such manner that there is a low voltage input terminal at one end and a single high voltage output at the other with the two coils magnetically and electrically separated one from the other. The timing of the firing of the spark plugs is controlled through firing pulses derived from the magneto which serves both to furnish charging voltage for the capacitors used and spaced triggering pulses for firing the switches in timed relationship. The two electronic switches are embodied as silicon controlled rectifiers, sometimes hereinafter referred to as SCRs.

It is known with respect to internal combustion engines that unburnt gases can be reburnt with the introduction of additional air to form another combustible mixture. It is likewise known that during the controlled combustion cycle of a piston engine the flame front will generally extinguish before all of the fuel in the cylinder is fully burnt. There are indications that following the initial combustion there are left pockets of air and pockets of fuel. After a brief interval of time, these elements become regrouped, or mixed, due to the turbulence of the descending piston and once again there is formed a combustible mixture which is relatively small in amount. If another spark is applied at this point, a secondary combustion will occur which serves to substantially reduce the amount of unburnt gases being passed to the atmosphere.

To provide this controlled secondary combustion, a dual firing is attained by discharging the two capacitors according to the present invention at different times to each primary coil winding. With the use of the dual coil apparatus, the time interval between sparks can be readily adjusted to any desired engine operating condition. In the interest of brevity and simplification, the detail of the magneto and of the firing pulse system for the two SCRs, which is fully explained in the aforesaid application, will not be repeated. It will be understood that the firing pulses applied to the SCRs are applied at brief timed spaced intervals, which intervals are readily adjustable through the use of the magneto and its associated control circuitry. Other circuits and arrangements for providing spaced triggering pulses to fire a pair of SCRs are well known to those skilled in the electronic arts.

SUMMARY OF THE INVENTION

The present invention thus provides an ignition system for internal combustion engines which requires no moving parts with the exception of a rotating magnet means and which further requires no rotating switch or distributor means. Even more importantly, the present invention provides a dual ignition coil for firing a spark plug twice during each combustion cycle thus largely eliminating the problems arising from incomplete fuel burning.

By reason of the construction of the dual coil the two coils are connected for timed relationship firing of the single spark plug associated with each cylinder, and in such manner that failure of one will not affect the continued operation of the other and the continued operation of the internal combustion engine. The dual ignition coil thus will be seen to provide an ignition system with insurance against failure of either one of the ignition coils, and further providing the advantage during normal operation of dual firing and timing for greatly improved emission control.

BRIEF DESCRIPTION OF THE DRAWINGS

The several objects and advantages of the present invention thus will become apparent to those skilled in the art when the following description of a preferred and alternate embodiment for practicing the invention is read in conjunction with the accompanying drawings, wherein like numerals refer to like parts, and in which:

FIG. 1 is a perspective view of the dual ignition coil with parts broken away to better reveal the internal construction and arrangement of the parts;

FIG. 2 is a combined schematic and block diagrammatic drawing of the ignition system illustrating one preferred embodiment of the disc for separating the two coils electrically and physically; and

FIG. 3 is a partial schematic having the capacitor and electronic switch firing portion of the circuit deleted, but showing an alternate embodiment of the means for electrically, magnetically and physically separating the dual ignition coils.

DETAILED DESCRIPTION OF THE PREFERRED AND ALTERNATE EMBODIMENTS

As best shown in FIG. 1, the structural embodiment of the present invention takes the form of a single container and casing **10**, preferably formed of a metal such as aluminum. Included in the container **10** are a pair of coils, indicated generally by the numerals **12** and **14.** Extending from the right hand end of the container **10** is a low voltage input connector **16.** Extending from the opposite end of the container **10** is a high voltage output lead **18** adapted to be connected to the terminal of a spark plug **20.** The two coils **12** and **14** are encapsulated within the container **10** in an epoxy type filling material **22.** The left hand winding **12** includes a primary winding **12***a* and a high voltage secondary winding **12***b*. The coil **14** includes a primary winding **14***a* and a high voltage secondary winding **14***b*. Each of the two windings **12** and **14** further includes a ferrite tubular core **24** and **26,** respectively. The dual coil apparatus further includes a carbon disc positioned transversely within the container **10** and identified by the numeral **28.** It is the function of the carbon disc **28** to operate as a separating means to isolate the ignition coil **12** from the ignition coil **14** magnetically and physically by spacing and electrically by potential dividing as will be further clarified in the schematic drawing of FIG. 2 hereinafter. An alternate embodiment for the carbon disc **28** is shown in FIG. **3** described hereinaf-

ter. The high voltage output to the spark plug **20** is taken through a central opening **32** of the ferrite core **24** through a lead **30** in the ferrite core **24,** as better shown in FIG. **2.**

FIG. **2** shows the electrical control system used to fire the two coils and the spark plug **20.** The circuit of FIG. **2** includes an upper capacitor **34** and a lower capacitor **36.** The discharge of the upper capacitor **34** is controlled through an SCR **38,** while the discharge of the capacitor **36** is controlled by the firing of an SCR **40.**

Included in the firing circuit for the SCR **38** is a series limiting resistor **42** and a bias resistor **44** connected across its gate cathode circuit. Included in the firing circuit for the SCR **40** is a series limiting resistor **46** and a bias resistor **48** connected across its gate cathode circuit. The present invention is illustrated for use in conjunction with a magneto type pulse generating system in which pulses are provided in timed relationship one to the other for charging the capacitors **34** and **36** and then firing in each SCR to discharge its associated capacitor. Each spark plug **20** is therefore fired twice for each compression stroke of the associated piston. The present invention is disclosed in connection with a magneto of the type shown in my above referred to patent application. It will be understood that the present invention is suitable for connection with any ignition system using stored electrical energy whether capacitive or inductive in type.

It will be understood that the capacitors **34** and **36** may be charged preparatory to the spark plug **20** firing through any of a number of suitable alternative circuits and likewise that the firing of the SCRs **38** and **40** may be provided by any source of separately operated trigger pulse generators, the only requirement being that time-spaced pulses sufficient to fire the two SCRs **38** and **40** are provided to their gate circuits.

The carbon disc **28** is shown as it is positioned between the opposed ends of the ferrite cores **24** and **26.** The lower terminal of the secondary winding **12***b* is preferably attached to the upper surface of the carbon disc **28** near its perimeter. The high voltage winding **14***b* is similarly connected to the lower surface of the carbon disc **28,** but at a position substantially 180° apart from the point of connection of the upper high voltage coil **12***b*. In this manner, the two ignition coils **12** and **14** are isolated magnetically by spacing and electrically by potential dividing. In the event of the failure of either of the two coils **12** or **14,** the carbon disc **28** will act as a potential divider. While the output of one coil would be slightly reduced by a failure of the other, this could be compensated for by increasing the available voltage from the voltage source to the spark plugs **20.**

FIG. **3** similarly shows the right hand portion of the dual coil arrangement, with the two SCRs and their firing cirucits omitted in the interest of brevity. The embodiment of FIG. **3** differs from that of FIG. **2** by reason of the substitution of a disc **50** fabricated from an epoxy or other suitable insulation material in place of the carbon disc **28** of the FIG. **2** embodiment. The disc **50** further has associated with it a pair of high voltage diodes **52** and **54,** each diode having its cathode connected to a conductor passing through the disc **50** to the common high voltage output lead **18.** It will thus be seen that the high voltage output from the upper secondary winding **12***b* and from the lower secondary winding **14***b* is connected to the anode of the associated diode. Thus, if either of the two coils **12** or **14** fails in operation, the diode attached in series with the secondary of the faulty coil will effectively block the output of the other coil. In this manner, the output of either coil will not be appreciably reduced by the failure of the other.

It will be understood that while the present invention has been shown and embodied in a capacitive stored energy system such as is incorporated through capacitors **34** and **36,** it could likewise be used with an inductively stored energy system or with a battery DC source system in which the impulses to the two coils **12** and **14** are precisely controlled through the firing of electronic switching devices.

It will further be apparent that the present invention through redesign and substitution of parts could be adapted for use with different electronic switches in place of the SCRs used. The only requirement would be that the switches have the capability to carry relatively high voltage impulses sufficient to fire the spark plugs.

It will thus be seen that the present invention affords a substantial advancement with respect to ignition systems for internal combustion engines with the advantages being particularly directed to more complete emission control and more complete combustion in each cylinder through the double-firing feature. The additional advantage provided by the present invention is that of insuring continued operation of the ignition system even in the event one of the two dual coil elements fails.

What is claimed is:

1. A capacitor discharge ignition system for an internal combustion engine for firing each of the engine spark plugs twice during each combustion interval comprising:

a dual ignition coil apparatus;

means for physically and electrically separating the high voltage winding of each of said coils, one from the other;

a single high voltage output lead coupled between said separating means and a terminal of said spark plug;

a pair of electronic switching means operable in timed relationship one to the other to provide ignition impulses to the primaries of said coils at slightly spaced time intervals;

said means for separating the high voltage windings of the coils comprising a carbon material disc, each of said high voltage coils fixed to an opposite surface of the disc at points spaced one from the other, said disc further having connected to its central portion a high voltage output lead.

2. The combination as set forth in claim **1** in which the ignition system is of the capacitor discharge type and in which a magneto coupled to the engine crankshaft is used to provide appropriately spaced capacitor charging pulses and triggering pulses coupled to the control electrodes of said electronic switches for providing the discharge of the capacitors in timed relationship.

3. The combination as set forth in claim **2** wherein said electronic switches are of the semi-conductor controlled rectifier type and wherein said triggering pulses are applied across their gate and cathode terminals.

4. The combination as set forth in claim **1** wherein said internal combustion engine includes one spark plug corresponding to each engine cylinder and

wherein said dual coils are incorporated within a single casing.

5. The combination as set forth in claim 4 wherein said windings of each of said coils are wound about two spaced ferrite tubular cores, said dual coils further housed in a substantially cylindrical shaped casing having a low voltage input terminal at one end and said high voltage output lead proximate the other.

6. A capacitor discharge ignition system for an internal combustion engine for firing each of the engine spark plugs twice during each combustion interval comprising:

a dual ignition coil apparatus;

means for physically and electrically separating the high voltage winding of each of said coils, one from the other;

a single high voltage output lead coupled between said separating means and a terminal of said spark plug;

a pair of electronic switching means operable in timed relationship one to the other to provide ignition impulses to the primaries of said coils at slightly spaced time intervals;

said means for separating the two high voltage coils comprising a disc of high electrical insulating quality and a pair of high voltage diodes each connected between a terminal of a different one of said high voltage windings and the terminal of said lead to provide the electrical separation of the two coils.

7. An ignition system for an internal combustion engine having one spark plug for each cylinder and having the capability of firing each of the engine's spark plugs twice during each combustion interval, comprising:

a dual ignition coil apparatus;

means for physically and electrically separating the high voltage windings of each of said coils one from the other;

a pair of electronic switching means, each connected to a different one of said coils for providing a pulse thereto in timed relationship thus to provide ignition pulses at slightly spaced time intervals;

said electronic switching means comprising in each case a semi-conductor controlled rectifier having its principal electrodes coupled between an electrical energy storage device and an associated coil primary;

said separating means comprising a disc of carbon material, each of said high voltage coils fixed at spaced points on opposite surfaces of said disc, said disc further having a single output high voltage lead connected between its central portion and the spark plug terminal.

8. The combination as set forth in claim 7 wherein the ignition system is of the capacitor discharge type and in which a magneto operatively connected to a rotary part of the engine is used to provide the timed spaced triggering pulses to the control electrodes of said electronic switching means.

9. An ignition system for an internal combustion engine having one spark plug for each cylinder and having the capability of firing each of the engine's spark plugs twice during each combustion interval, comprising:

a dual ignition coil apparatus;

means for physically and electrically separating the high voltage windings of each of said coils one from the other;

a pair of electronic switching means, each connected to a different one of said coils for providing a pulse thereto in timed relationship thus to provide ignition pulses at slightly spaced time intervals;

said electronic switching means comprising in each case a semi-conductor controlled rectifier having its principal electrodes coupled between an electrical energy storage device and an associated coil primary;

said separating means comprising a disc of electrically insulating material and a pair of opposed polarity high voltage diodes connected to said disc through a common conductor, said high voltage windings being connected between said common conductor and the spark plug terminal.

10. The combination as set forth in claim 9 wherein each of said coils comprises a ferrite core of a tubular configuration and wherein a common high voltage output lead is passed between said separating means and the terminal of the spark plug.

11. An energy storage ignition system for an internal combustion engine for firing each individual one of the engine's spark plugs twice during each combustion interval, including a pair of separately and sequentially triggered electronic switches, each providing a discharge path from an associated storage element comprising:

a dual ignition coil arrangement;

means for physically and electrically separating the high voltage winding of each of said coils, one from the other;

a single high voltage output lead coupled between the separating means and a terminal of each spark plug for providing a pair of time-spaced output firing pulses to the spark plug responsive to passage of a pulse through each of said coils;

said separating means comprising a carbon disc having a high voltage winding of each of said coils coupled to an opposite face of said disc, said disc further having connected to a central portion of one of its faces a single output high voltage lead, said lead connected to the spark plug.

12. An energy storage ignition system for an internal combustion engine for firing each individual one of the engine's spark plugs twice during each combustion interval, including a pair of separately and sequentially triggered electronic switches, each providing a discharge path from an associated storage element comprising:

a dual ignition coil arrangement;

means for physically and electrically separating the high voltage winding of each of said coils, one from the other;

a single high voltage output lead coupled between the separating means and a terminal of each spark plug for providing a pair of time-spaced output firing pulses to the spark plug responsive to passage of a pulse through each of said coils;

said separating means comprising an element of high electrical insulating characteristic and wherein a high voltage blocking diode is coupled intermediate each of said high voltage coil windings and said output lead.

13. An energy storage ignition system for an internal combustion engine for firing each individual one of the engine's spark plugs twice during each combustion interval, including a pair of separately and sequentially

triggered electronic switches, each providing a discharge path from an associated storage element comprising:

a dual ignition coil arrangement;

means for physically and electrically separating the high voltage winding of each of said coils, one from the other;

a single high voltage output lead coupled between the separating means and a terminal of each spark plug for providing a pair of time-spaced output firing pulses to the spark plug responsive to passage of a pulse through each of

said disc having a high voltage winding of each of said coils coupled to an opposite face of said disc, said disc further having connected to a central portion of one of its faces a single output high voltage lead, said lead connected to the spark plug.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 3,885,541
DATED : May 27, 1975
INVENTOR(S) : Arthur G. Hufton

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Col. 8, line 3, after "of" insert
--said coils--.

Signed and Sealed this

twenty-eight Day of *October 1975*

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks