United States Patent

Safstrom

[15] **3,658,044**

[45] **Apr. 25, 1972**

[54] CAPACITOR DISCHARGE IGNITION SYSTEM

[72] Inventor: **Alden L. Safstrom,** 1120 North Melrose Ave., Glendale, Calif. 91202

[22] Filed: **Dec. 8, 1970**

[21] Appl. No.: **96,004**

[52] **U.S. Cl.** ..... **123/148 E,** 315/209

[51] **Int. Cl.** **F02p 3/06**

[58] **Field of Search** ..... 123/148 E; 315/209 CD

[56] **References Cited**

UNITED STATES PATENTS

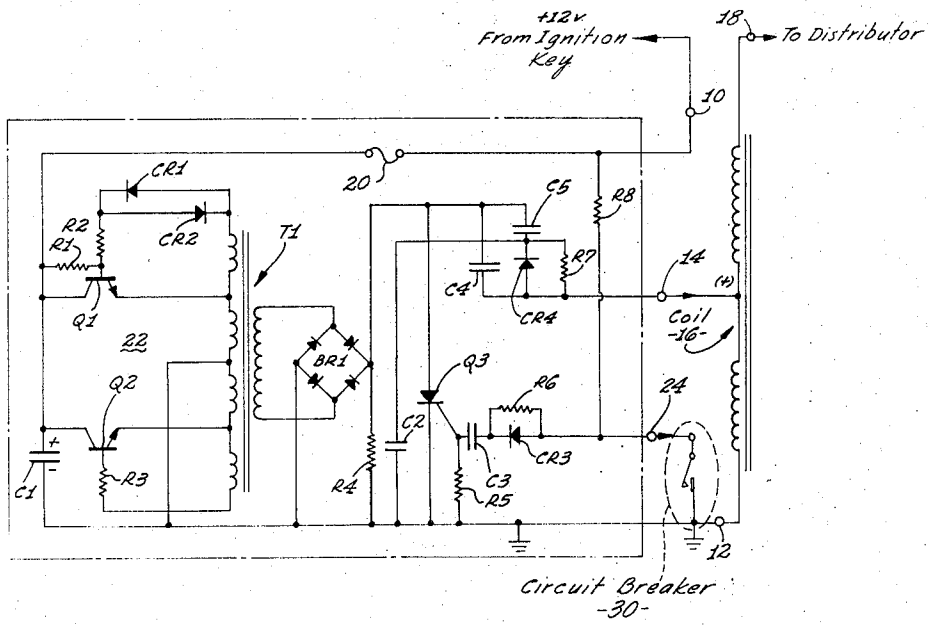
3,234,430	2/1966	Issler	123/148 E
3,267,329	8/1966	Segal	315/209 CD
3,331,986	7/1967	Hardin	123/148 E
3,376,470	4/1968	Stone et al	123/148 E
3,448,732	6/1969	Weiss	123/148 E

Primary Examiner—Laurence M. Goodridge
Assistant Examiner—Cort Flint
Attorney—Jessup & Beecher

[57] **ABSTRACT**

An improved ignition system is provided for an internal combustion engine which is of the capacitive discharge type, and which serves to maintain the engine in tune for long operational periods; and which also serves to improve combustion within the engine so as to prevent the emission of smog-forming, unburned fuel components at all operational speeds of the vehicle in which the engine is installed. The ignition system of the present invention includes a resistance-capacitance discharge circuit which exhibits a relatively high effective spark energy at low cranking speeds of the engine for cold weather starting, yet which exhibits a lower spark energy at higher engine speeds to prevent undue burning of the spark-plugs.

9 Claims, 3 Drawing Figures



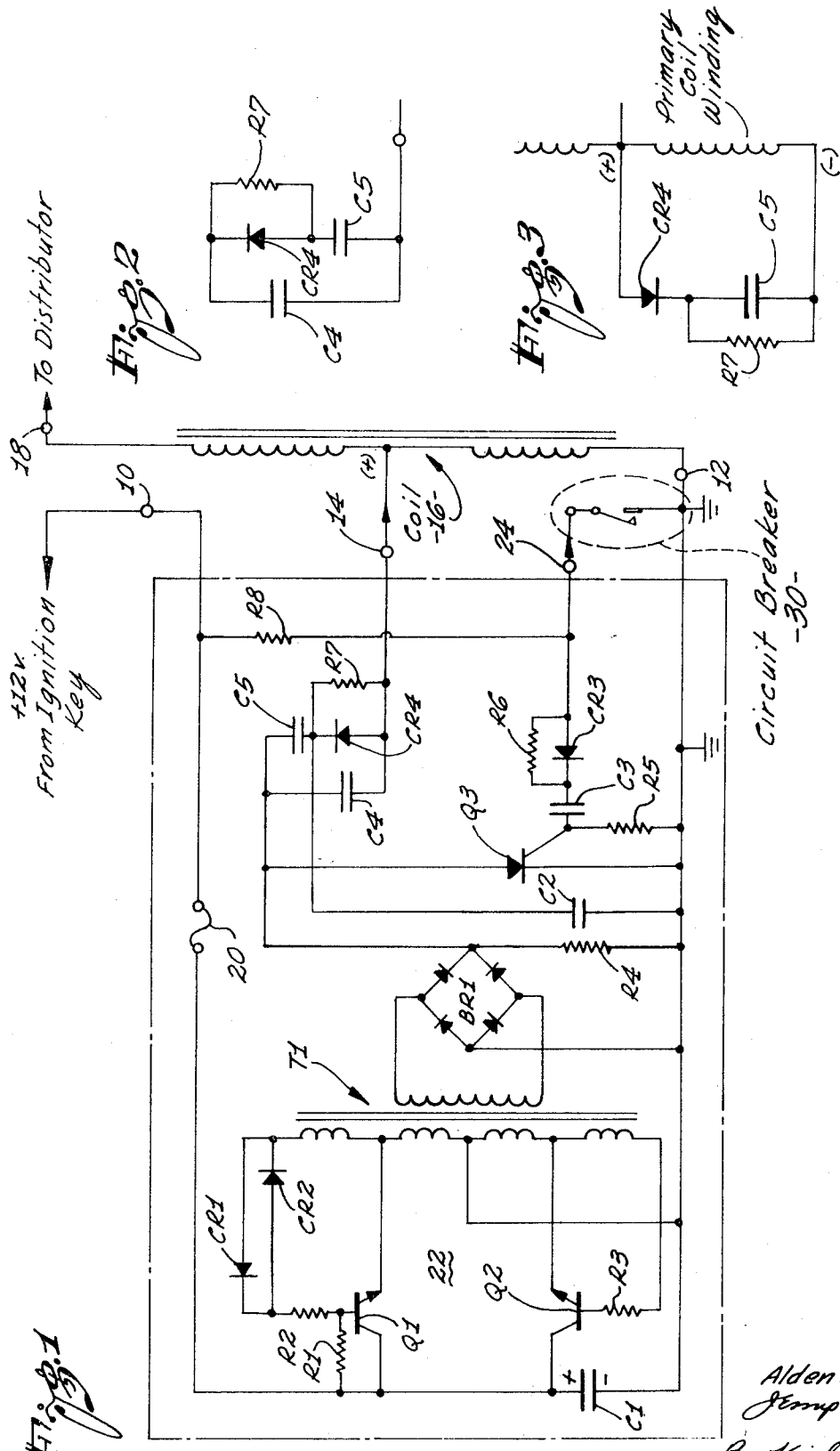


Fig. 1

Fig. 2

Fig. 3

INVENTOR:
Alden L. Safstrom
Jemp and Beecher
By Keith D. Beecher
ATTORNEYS

CAPACITOR DISCHARGE IGNITION SYSTEM

BACKGROUND OF THE INVENTION

Capacity discharge type ignition systems are known. Such systems usually incorporate, for example, an inverter section for raising the normal 12-volt direct current battery voltage to a higher direct current value. The prior art capacitor discharge ignition system also includes appropriate switching means which is controlled by the usual breaker, or its equivalent, and which serves to cause a capacitor to charge to the voltage of the inverter when the breaker points are closed, and to apply its energy to the ignition coil when the breaker points are opened. This latter action assures an extremely high voltage across the secondary of the ignition coil, and it produces clean and positive sparks across the respective spark plugs of the engine.

A problem has arisen in the prior art capacitor discharge ignition systems such as described above, in that when sufficient capacity is used to assure that sufficient energy is applied to the ignition system at low cranking speeds and especially during cold weather engine starting, the capacity is excessive for normal engine speeds, and is in fact detrimental, because excessive sparkplug erosion results.

The capacitor discharge ignition system of the present invention, however, provides sufficient capacity at the low engine cranking speeds to assure that ample energy is provided for the ignition system to start the engine even at low temperatures. However, the effective capacity of the system is decreased at the normal running speeds of the engine so that the aforementioned detrimental effects do not occur.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a schematic circuit diagram of one embodiment of the improved ignition system of the invention; and

FIGS. 2 and 3 are fragmentary circuit diagrams illustrative of possible modifications to the circuit of FIG. 1.

DETAILED DESCRIPTION OF THE ILLUSTRATED EMBODIMENT

The capacity discharge ignition system of the present invention, and as shown in the accompanying diagram, may be easily connected into the ignition systems of existing motor vehicles. This is achieved, for example, by disconnecting the lead from the ignition switch from its connection to the primary of the ignition coil, and reconnecting the lead to a terminal of the unit of the invention (terminal **10** in FIG. 1). A second lead is then connected to the ignition coil from a second terminal (terminal **14** in FIG. 1). The other lead from the primary of the ignition is disconnected from the breaker points and is connected to a third terminal of the unit (terminal **24** in FIG. 1). Finally, a fourth terminal of the unit (terminal **12** in FIG. 1) is connected to the primary of the ignition coil.

The input terminal **10** is connected through a fuse **20** to a free-running multivibrator circuit **22**. The circuit **22** may incorporate a pair of NPN-silicon transistors Q1 and Q2, which are noted for their rugged construction and stable operation. The emitters of the transistors Q1 and Q2 are connected across emitter windings of an inverter transformer designated T1, and the base electrodes of the transistors Q1 and Q2 are connected across the base windings of the transformer T1 through respective resistors R2 and R3, and through diodes CR1 and CR2. The collectors of the transistors Q1 and Q2 are connected to a grounded capacitor C1 and to a resistor R1. The resistor R1 is connected back to the base of the transistor Q1.

The circuit **22** oscillates at a predetermined frequency when the ignition key switch is turned on so as to apply the 12-volt direct current potential to the transistors Q1 and Q2. The resulting oscillation of the multivibrator **22** produces an alternating voltage of the order of 400 volts across the secondary of the transformer T1. This voltage is rectified by a full-wave rectifier designated BR1, so that a direct -current voltage of the order of 400 volts appears across the grounded resistor R4, which resistor is shunted by a capacitor C2. The capacitors C1 and C2 are useful in suppressing radio frequency interference signals.

The transistors Q1 and Q2 constitute switching transistors. The resistor R1 serves as a limiting resistor which is sufficient to start oscillation, but which restricts current to the transistor Q1 when the inverter is not oscillating. The resistors R2 and R3 are limiting resistors, and serve to limit the current flowing into the transistors Q1 and Q2 when the multivibrator **22** is oscillating. The diode CR2 functions in conjunction with the resistors R1 and R2 to provide a starting network. The diode assures that the inverter circuit will operate at low battery voltages. The diode CR1 is used in place of a capacitor and makes it unnecessary to incorporate an excessively high value capacitor into the circuit to assure oscillations at the fundamental inverter frequency.

The system of the invention is made up of two basic units, namely, a direct current to direct current inverter section and a section for converting direct current energy to a spark system.

The inverter section includes the inverter transformer T1, and the switching transistors Q1 and Q2. The transistors are biased by the starting network made up of resistor R1, diodes CR1, and CR2, and current limiting resistor R2 which limits the current to the transistor Q2 when the inverter is oscillating. In a constructed embodiment oscillation of the inverter starts at 1.5 to 2 volts. Resistor R1 has a value sufficient to start oscillation but to restrict current to the transistor Q1 when the inverter is not oscillating.

The conversion section includes the bridge BR1 and the capacitors C4 and C5. The direct current energy from the secondary of the transformer T1 and bridge BR1 charges the capacitors C4 and C5. When the breaker points open, a position signal is applied to the gate of the SCR Q3 through the resistor R8, diode CR3 and capacitor C3. This causes Q3 to be turned on and to cause the energy stored in the capacitor C4 and C5 to be "dumped" into the primary of the ignition coil **16**. The resulting step-up action of the ignition coil induces a spark in the distributor.

The diode CR3 and resistor R6 form an anti-contact bounce protection for misfire. Reset of the SCR Q3 is accomplished by the fly-back characteristics of the ignition coil **16**. Measured energy at the low cranking speeds of the engine is provided by the network of capacitor C5, diode CR4 and resistor R7. The effect of this latter network disappears above a predetermined engine speed, established by the value of the resistor R7 so as to avoid sparkplug wear at the normal and high engine speeds. The capacitors C1 and C2 suppress radio frequency interference.

The operation of the system is described in greater detail in the following paragraphs.

The voltage appearing across the secondary of the inverter transformer T1 is rectified and converted to direct current by the diode bridge BR1, as mentioned above. The silicon controlled rectifier Q3 is connected across the resistor R4, and its anode is connected to a pair of capacitors C4 and C5. The capacitor C5 is connected to diode CR4 and to resistor R7. The capacitor C4, the diode CR4 and the resistor R7 are all connected to the output terminal **14** which, as stated above, is connected to the primary of the ignition coil **16**. The gate electrode of the silicon controlled rectifier Q3 is connected to grounded resistor R5 and to capacitor C3.

The capacitor C3 is connected through diode CR3 to terminal **24** of the breaker points **30** of the ignition system, the diode CR3 being shunted by a resistor R6. The input terminal **10** is also connected to terminal **24** through resistor R8. It will be understood that the breaker **30** may be a usual type of unit incorporated in most motor vehicle ignition systems, or its equivalent. For example, the breaker **30** may be replaced by a magnetic pick-up, photoelectric transducer, or the like.

When the breaker points **30** are closed, the gate electrode of the silicon controlled rectifier Q3 is held near ground potential, so that the silicon controlled rectifier is non-con-

ductive, and the direct-current voltage across the resistor R4 charges the capacitors C4 and C5 through the primary winding of the ignition coil 16. Then, when the circuit breaker points 30 are opened, a positive voltages is applied to the gate electrode of the silicon controlled rectifier Q3 through the resistor R8, and through the diode CR3 and capacitor C3.

This positive voltage causes the silicon controlled rectifier Q3 to become conductive, so that it acts as a switch and causes the energy stored in the capacitors C4 and C5 to be transferred to the primary winding of the coil 16. Due to the step-up action of the ignition coil 16, a high voltage appears across the secondary winding at the output terminal 18 which is applied to the sparkplugs through the usual distributor.

The diode CR3 and its shunting resistor R6 form an "anti-contact bounce" protection to prevent misfires. The silicon controlled rectifier Q3 is reset by the fly-back action of the ignition coil 16, as mentioned, so that the operation may be repeated for each opening and closing of the breaker points 30.

During the low cranking speeds of the engine, of the order, for example, of 100 rpm, and which occurs when the engine is being started, both the capacitors C4 and C5 are fully charged during each cycle, so that maximum energy is transferred to the ignition coil 16 each time the breaker points 30 are opened. However, as the engine speed increases, the capacitor C5 does not have a chance to become fully charged during each cycle, this being due to the inclusion of the series resistor R7. In fact, by the proper selection of the value for the resistor R7, the effect of the capacitor C5 may be made to disappear at normal running speeds of the engine.

Therefore, the system illustrated in FIG. 1 is one in which an effectively large capacity is provided during low engine speeds, so as to assure the transfer of sufficient energy to the ignition coil for each cycle, and especially to assure starting of the engine during cold weather. However, as the engine speeds approach normal, the excessive capacity is removed, so that spark plug burning and wear is avoided during the higher engine speeds; and also so that the ignition system may operate satisfactorily at the higher engine speeds, without any tendency to cut out due to excessive loading on the inverter.

FIG. 2 is a fragmentary circuit showing a portion of the circuit of FIG. 1; and in which the same effect is achieved, merely by reversing the manner in which the capacitor C5, and the diode CR4 and resistor R7, are connected across the capacitor C4.

A further fragmentary circuit is shown in FIG. 3, in which the diode CR4 and capacitor C5 are connected across the primary winding of the ignition coil 16, with the capacitor C5 being shunted by the resistor R7, and with the other circuitry being as shown in FIG. 1. The circuit of FIG. 1 uses the stored energy in the coil to prolong spark duration at the lower cranking speeds.

The invention provides, therefore, an improved capacitive discharge ignition system for use in conjunction with motor vehicles, and for other internal combustion engine ignition systems. The improved ignition system of the present invention is advantageous in that it secures all the advantages of the capacitor discharge type ignition system, which includes efficient combustion in the engine at all operating speeds and the ability for the engine to remain in tune over long operational periods; and yet one which will operate under all conditions without deleterious effects, including cold weather starting of the engine and the running of the engine at high speeds.

While a particular embodiment of the system has been shown and described, modifications may be made. It is intended in the claims to cover all modifications which come within the spirit and scope of the invention.

What is claimed is:

1. In an ignition system for an internal combustion engine, and the like, and which includes a source of direct-current voltage, an oscillating inverter for converting the direct-current voltage from said source to a higher direct-current voltage, an ignition coil, first capacitor means connected to said coil, and switching means for alternately causing said first capacitor means to be charged by said inverter and to discharge through said ignition coil at a rate determined by the speed of said internal combustion engine, the combination of: further capacitor means connected in circuit with said first capacitor means for increasing the energy supplied to said ignition coil by said first capacitor means at low cranking engine speeds, and a resistor connected in circuit with said further capacitor means to decrease the effectiveness of said further capacitor means at increased engine speeds.

2. The combination defined in claim 1, in which said further capacitor means and said resistance means are series connected in shunt with said first capacitor means.

3. The combination defined in claim 1, and which includes diode means connected in series with said further capacitor means.

4. The combination defined in claim 2, and which includes diode means connected in shunt with said resistance means.

5. The combination defined in claim 1, in which said further capacitor means and said resistance means are connected in shunt with one another, and are connected across a portion of the aforesaid ignition coil.

6. The combination defined in claim 5, and which includes diode means in series with said capacitor means.

7. The combination defined in claim 1, in which said inverter means includes a multivibrator circuit having first and second transistors and an inverter transformer, and which includes first and second diodes connected in circuit with one of said transistors to provide low voltage operation for the multivibrator circuit.

8. The combination defined in claim 7, in which said transistors are of a silicon type.

9. The combination defined in claim 1, in which said switching means comprises a silicon controlled rectifier.

* * * * *