

[54] **ALTERNATING CURRENT CAPACITOR DISCHARGE IGNITION SYSTEM**

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[58] Field of Search **123/148 E**

[56] **References Cited**

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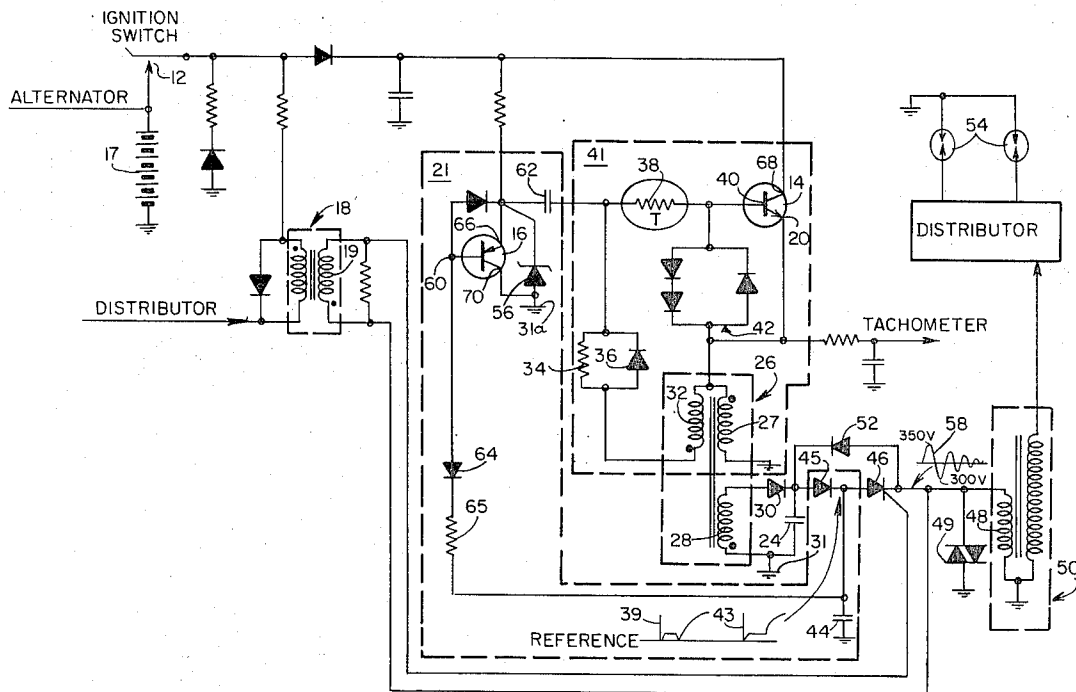
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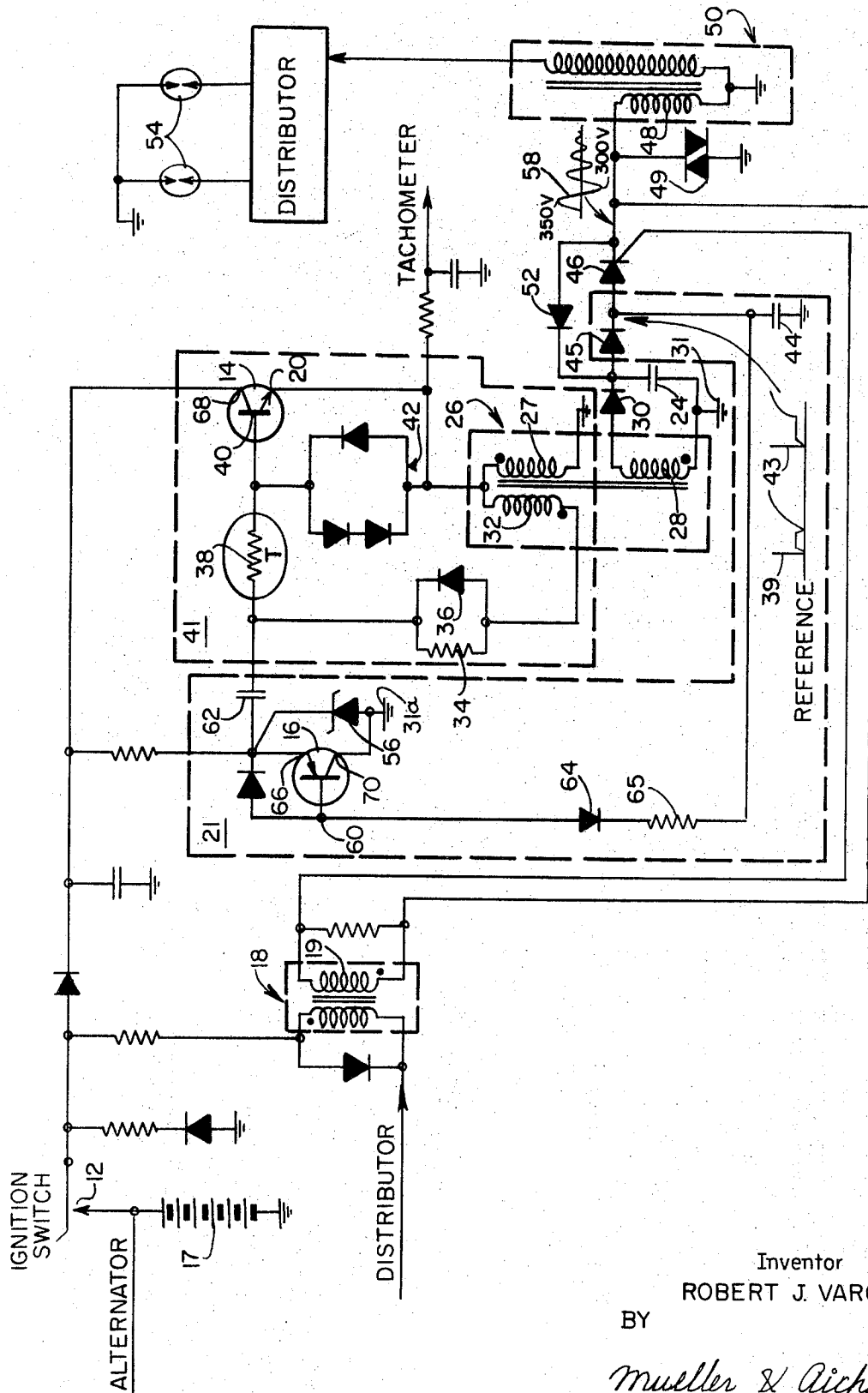
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ABSTRACT

An alternating current capacitor discharge ignition system includes a diode connected in a feedback path between the primary of the ignition transformer connected to the output of a semiconductor triggering device used to discharge the ignition capacitor and the ignition capacitor itself. The diode provides a return path for creating a ring-out oscillation between the ignition transformer and ignition capacitor to produce an alternating current ignition pulse.

1 Claim, 1 Drawing Figure





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ALTERNATING CURRENT CAPACITOR DISCHARGE IGNITION SYSTEM

CROSS REFERENCE TO RELATED APPLICATION

A related application discloses the present invention.

BACKGROUND OF THE INVENTION

Capacitor discharge ignition systems are well-known in the art. However, in two and four cylinder internal combustion engines which have been used in outboard boat motors, spark plug fouling has been a severe problem. In particular, oil and gas mixtures used in outboard motors for combustion have resulted in a short life for the spark gap of the spark plug. With conventional ignition systems, whether they be of breaker point operation or of timing sensor operation, the gap eventually closes due to deposits of carbon on one side of the gap or the other.

SUMMARY OF THE INVENTION

It is an object of this invention to provide an improved capacitor discharge ignition system.

It is another object of this invention to provide a capacitor discharge ignition system wherein fouling of the spark plugs is greatly reduced.

With the closing of the ignition switch a bias potential is applied to the power output transistor, an enabling transistor and trigger transformer of the initiation and discharge ignition system. Ignition does not instantaneously occur, however, because the ignition capacitor is not charged. The power transistor of the saturable oscillator operates to charge the ignition capacitor through one secondary winding of a tertiary transformer and also operates through the other secondary winding to increase the input of the power transistor through a temperature responsive element connected to the control electrode for controlling the saturability of the transistor. Pulses picked up from the distributor and applied to the gate of the semiconductor controlled rectifier through the trigger transformer operate to discharge the ignition capacitor through the semiconductor controlled rectifier to the ignition transformer. A diode in a feedback circuit between the cathode of the semiconductor controlled rectifier and ignition capacitor is poled to cause a ringout oscillation between the ignition capacitor and the primary winding of the ignition transformer thus resulting in an alternating current output pulse. This alternating current output pulse is effective in reducing fouling of the spark plugs.

The enabling transistor, being turned on with the discharge of the ignition capacitor, operates to actuate the saturable oscillator for recharging the ignition capacitor and preparing the circuit for another cycle.

BRIEF DESCRIPTION OF THE DRAWING

The drawing is a circuit diagram of the capacitor discharge ignition system in accordance with this invention.

DETAILED DESCRIPTION

Referring to the drawing, with the ignition switch 12 being closed, the PNP enabling transistor 16 of the enabling circuit 21 and the NPN power transistor of the oscillating charging circuit, and the trigger transformer 18 are energized from a 12 volt wet cell battery 17

which acts as a supply potential of the kind generally found in vehicles or used with outboard motors. The output or emitter electrode 20 of power transistor 14 immediately conducts because of the signal applied to the base 40 through capacitor 62 and the temperature responsive element, thermistor 38. The secondary winding 19 of the trigger transformer 18 produces a voltage on the order of 1 volt in response for instance to the opening of the points in the distributor for activating a semiconductor controlled rectifier 46 to which it is connected. However, no ignition pulse is applied to the ignition transformer 50 because the ignition capacitor 24 is not initially charged with the ignition switch being closed. The ignition capacitor 24 must be charged to about 350 volts before it will operate the ignition transformer 50.

Charging the ignition capacitor 24 is accomplished with the saturable oscillator 41. The oscillator comprises the NPN transistor 14 having its emitter electrode 20 connected to the grounded primary winding 27 and one termination of secondary winding 32 of the tertiary transformer 26. The output potential at the emitter electrode 20 is fed back to the control, or base, electrode 40, of transistor 14 for increasing the output current to drive the transistor 14 into saturation. The feedback through secondary winding 32 of the tertiary transformer 26, the parallel combination of resistor 34 and diode 36, and temperature responsive element 38 increases the signal at the control electrode 40 and consequently increases the output at electrode 20. Once the power transistor 14 is driven into saturation, the oscillator 41 shuts off and capacitor 24, having been charged through secondary winding 28 is ready for discharge through the ignition circuit. The secondary winding 28 of the tertiary transformer 26 is grounded and connected in series with a diode 30 to the ignition capacitor 24 poled to conduct only for the positive half cycle of the output signal from the oscillator 41 with respect to ground 31 to charge the ignition capacitor 24.

Capacitor 44, a component of the control circuit of the transistor 16 of enabling circuit 21 and connected between the anode of the semiconductor controlled rectifier 46 and the reference potential 31, acts as a voltage spike suppressor filtering out the high speed turnoff voltage spikes from the secondary winding 28 when the power transistor 14 turns off. With capacitor 44 disconnected and the discharge of the capacitor 24, the anode voltage drops to approximately 0, the reference potential, and rapidly rises to approximately 12 volts as illustrated in waveform 39, where it remains while the winding 28 becomes energized. When the oscillator 41 goes into saturation and transistor 14 turns off, a high speed turnoff voltage spike from the transistor 14 through secondary winding 28 appears at the anode of semiconductor controlled rectifier. This spike which is the second spike shown in waveform 39 acts to shorten the life of the semiconductor controlled rectifier 46. After the turnoff of transistor 14 simultaneously with the second spike, the capacitor 24 begins to charge again to approximately 350 volts which is also shown in that waveform. Waveform 43, in contrast, displays the voltage at the anode with capacitor 44 in circuit and the second spike, or turnoff voltage, suppressed. The use of the spike suppressor capacitor 44 has greatly enhanced the useful life of the semicon-

ductor controlled rectifier on the order of 350 hours.

The trigger transformer 18 has heretofore mentioned is periodically energized in timed relation to the engine speed by pulses from the distributor which may function in either breaker point operation or timing sensor operation as is wellknown in the art. When triggered, the semiconductor controlled rectifier 46 discharges capacitor 24 through diode 45 to the primary winding 48 of the high voltage ignition transformer 50. Diode 52 provides a feedback circuit means which conducts with the ignition capacitor potential being less than the potential of the ignition transformer primary resulting in a ring-out oscillation between the ignition capacitor 24 and the ignition transformer primary 48. Variable resistance 49 limits the peak voltage and operates similarly to a zener diode.

The ring-out oscillation is very rapidly damped. When utilized in a conventional outboard motor the ignition transformer voltage, as illustrated in waveform 58 will be damped below the minimum spark gap arcing voltage level in approximately 190 microseconds, as illustrated by oscillating voltage wave 58. An alternating current spark is effected at spark gap 54 as activated by the high voltage ignition transformer 50. The alternating current spark at spark gap 54 prevents the hot oil and gas mixture in the cylinder from depositing in the spark gap. This invention thus prevents spark gap fouling and reduces the frequency of spark plug replacement.

With each pulse from the trigger transformer 18 the semiconductor controlled rectifier 46 is turned on permitting the discharge of capacitor 24. Capacitor 44 charges to the same potential as capacitor 24. Consequently when the semiconductor controlled rectifier 46 is gated on, the potential at the anode of the semiconductor controlled rectifier will drop with respect to the voltage across capacitor 44 and diode 64 will conduct thus turning on the enabling transistor 16 by applying a pulse to control electrode 60. Diode 45 isolates capacitor 24 from the anode of the semiconductor controlled rectifier 46. Consequently, with the semiconductor controlled rectifier turned on and conduction occurring, the response time of the enabling transistor 16 is rapid. Without diode 45, capacitor 24, because of its size and resultant time constant, would have an adverse effect on the speed with which charging would proceed. The control, or base, electrode 60 has a change in voltage and voltage across transistor 16 drops sharply as the semiconductor controlled rectifier 46 is turned on. The voltage then returns to its original value with the semiconductor controlled rectifier 46 being turned off, thereby creating a pulse. The pulse driving through capacitor 62 then actuates the saturable oscillator 41 by turning on transistor 14.

Zener diode 56 clamps the output of the enabling transistor 16 at a lower voltage than the supply potential so a rippling supply voltage generally resulting from a permanent magnet alternator will not actuate the saturable oscillator. Overcharging the ignition capacitor is

thus prevented. The capacitor 24 dielectric is protected from breaking down and its useful life lengthened along with that of the semiconductor controlled rectifier 46.

What we have therefore is an alternating current capacitor discharge ignition system for preventing spark gap fouling of spark plugs.

I claim:

1. In a capacitor discharge ignition system for an internal combustion engine having an ignition capacitor, trigger means for discharging said ignition capacitor in synchronism with the engine to produce ignition pulses, a semiconductor controlled rectifier having a gate, an anode and a cathode, a power transistor for charging said ignition capacitor, said power transistor having control and output electrodes, a transformer having first, second and third inductively coupled windings with the output electrode of said power transistor being coupled to said first winding, circuit means for connecting said second winding to said control electrode of said power transistor with increasing current in said first winding increasing current in said second winding and driving said power transistor into saturation with said ignition capacitor being charged, a first diode and said third winding connected in series and coupled across said ignition capacitor with pulses of one polarity induced in said third winding charging said ignition capacitor, an enabling transistor having control and output electrodes with said control electrode being coupled to said anode of said semiconductor controlled rectifier for activating said transistor, a high voltage transformer having primary and secondary windings and being connected to said cathode of said semiconductor controlled rectifier, a capacitor coupled between said output of said enabling transistor and said control electrode of said power transistor for initiating said power transistor with said enabling transistor being activated, a supply potential coupled to said power and enabling transistors, a zener diode connected between said output electrode of said enabling transistor and a reference potential and poled to prevent changes in magnitude of said supply potential from initiating said power transistor, first diode means coupled between said ignition capacitor and said anode of said semiconductor controlled rectifier for preventing said ignition capacitor from delaying the activation of said power transistor, a capacitor connected between said input of said semiconductor controlled rectifier and said reference potential to filter out turnoff spikes resulting from said power transistor becoming saturated, said filter preventing damage to said semiconductor controlled rectifier, the combination including second diode means coupled between said output of said semiconductor controlled rectifier and said ignition capacitor and poled to create a ringout oscillation between said ignition capacitor and said high voltage transformer thereby causing an alternating current to appear across the spark gap.

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