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CAPACITOR DISCHARGE IGNITION SYSTEM

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1 Claim

ABSTRACT OF THE DISCLOSURE

A capacitor ignition system which utilizes a silicon controlled rectifier (SCR) that is triggered by the opening of the ignition points to discharge the capacitor through an ignition coil to produce firing pulses. A transistor switch is energized by the triggering of the SCR to operate a saturable oscillator for recharging the ignition capacitor. A temperature sensitive resistor is positioned in the positive feedback path of the oscillator and controls the degree of saturation of the same in accordance with the ambient temperature.

CROSS REFERENCE TO RELATED APPLICATIONS

Related capacitor discharge ignition systems are disclosed in application Ser. No. 615,987, filed Feb. 14, 1967 and Patent No. 3,318,296, issued May 9, 1967, both of which are assigned to the assignee of this application.

BACKGROUND OF THE INVENTION

This invention pertains to a capacitor discharge ignition system and more particularly to a capacitor discharge ignition system which is temperature compensated to control the current for charging the ignition capacitor.

Capacitor discharge ignition systems using a saturable oscillator for charging the ignition capacitor are known. In some instances, however, at high speeds the saturable oscillator can draw so much current that it is permanently damaged. In other instances, especially during cold weather when battery voltage is low, there has been a problem with the saturable oscillator providing enough current to charge the ignition capacitor.

SUMMARY OF THE INVENTION

It is an object of this invention to provide a capacitor discharge ignition system using a saturable oscillator which provides sufficient current during low battery voltage to charge the ignition capacitor.

It is another object of this invention to provide a capacitor discharge ignition system using a saturable oscillator for charging the ignition capacitor in which the current through the oscillator during high speed operation is limited to protect the oscillator.

In one embodiment of this invention, a silicon controlled rectifier (SCR) is operated by the closing and opening of the ignition points in synchronism with the engine to produce ignition pulses. A saturable oscillator is coupled to the ignition capacitor for charging the same. The oscillator includes a power transistor the output of which is connected to the first winding of a transformer. The second winding of the transformer is connected through a temperature responsive resistor to the control electrode of the transistor and provides a positive feedback path. Triggering of the SCR to discharge the capacitor operates a semiconductor switch which energizes the transistor of the saturable oscillator. Increased current in the first winding of the oscillator due to conduction of the transistor induces current in the second winding to sustain conduction of the transistor to saturation. The temperature sensitive resistor is responsive to the ambient temperature to control the degree of saturation of the transistor. For instance, at low temperatures and battery

voltage, the resistance of the temperature sensitive resistor is a minimum so that the bias applied to the control electrode of the transistor is relatively large thereby driving the transistor into a high degree of saturation and providing sufficient current during engine cranking to charge the ignition capacitor. At high speeds, when the ambient temperature is high, the resistance of the temperature sensitive resistor is high so that the bias on the control electrode of the transistor is kept at a reduced value thereby limiting the current through the transistor when it is saturated to protect the transistor from high current breakdown.

In the drawing:

The drawing is a schematic wiring diagram of an ignition circuit in accordance with this invention.

DETAILED DESCRIPTION

Referring to the drawing, the ignition system includes an ignition coil 10 having a primary winding 12 and a secondary winding 14. Secondary winding 14 may be coupled to the center post of the distributor as is well known in the art. A silicon controlled rectifier (SCR) 16 is connected in series with an ignition capacitor 18, which is across the primary winding 12 of the ignition coil 10. The diode 20 protects the SCR 16 from back swing voltages produced in the ignition coil 10. The diode 22 is connected across primary winding 12 and serves to reduce the amplitude of current reversals in the ignition coil secondary winding 14. This reduces the amount of electromagnetic radiation produced by the ignition coil and results in a corresponding reduction in radio interference noise.

SCR 16 is triggered in synchronism with the internal combustion engine by pulses applied to the gate 16a of the SCR 16. These pulses are coupled to the gate 16a by means of a transformer 21 having a secondary winding 24 coupled between the gate 16a and the cathode of rectifier 16. Transformer 21 has a primary winding 26 which is connected through resistor 28 and ignition switch 30 to the battery 32. The opposite end of the primary winding 26 is connected to ground by intermittently operable breaker points 34. Breaker points 34 may be the well known mechanical type breaker points synchronized with engine operation. A diode 36 connected across primary winding 26 of transformer 21 damps out reverse current transients.

When capacitor 18 is charged to the desired firing potential and SCR 16 is fired by a pulse applied to the gate 16a, capacitor 18 discharges through primary winding 12 of ignition coil 10. This produces a high voltage pulse in secondary winding 14, which is applied to the distributor for firing the fuel in the cylinders of the internal combustion engine. Transients which would possibly fire the SCR 16 at the wrong time are damped out by the diode 36.

A saturable oscillator 40 is used to charge the ignition capacitor 18 after it has been discharged. Saturable oscillator 40 includes an NPN type power transistor 42 having a collector electrode 44 that is coupled by diode 46 and ignition switch 30 to the B+ potential of battery 32. Resistor 45 and series connected diode 47 provide a path to ground reference potential for negative transients, and capacitor 43 connected across the two elements removes any ripple from the power supply. The emitter 48 of transistor 42 is connected in series to primary winding 49 of transformer 50. A positive feedback path for the oscillator 40 includes secondary winding 52 of the transformer 50, which is coupled by the thermistor or temperature sensitive resistor 55 through the parallel combination of diode 57 and resistor 58 to the base or control electrode 59 of the transistor 42. A Zener diode 60 is connected between the collector 44 and the base electrode 59 of the transistor 42 to limit the voltage between these two electrodes for protective purposes.

An enabling or semiconductor switching circuit 65 is provided for initiating operation of the saturation oscillator 40 to recharge the ignition capacitor 18 after each discharge of the capacitor by the triggering of SCR 16. The semiconductor switching circuit 65 includes a transistor 67 having an emitter 70 that is connected to the source of direct current 32 by diode 46 and ignition switch 30. The collector 72 of the transistor 67 is coupled by blocking diode 74 and the temperature sensitive resistor 55 to the control electrode 59 of the transistor 42. The base or control electrode 76 of the transistor 67 is coupled by resistor 78 and blocking diode 80 to point 82 which is the junction between the capacitor 18 and SCR 16.

In operation, when initially cranking the engine during starting, the point 34 close grounding the primary 26 of transformer 21. Subsequent opening of the points generate a pulse in secondary winding 24 of the transformer to trigger SCR 16. The triggering of SCR 16 grounds the control electrode 76 of transistor 67 through the primary winding 12 of transformer 10. This causes transistor 67 to conduct applying a pulse to the base 59 of transistor 42 thereby causing that transistor to conduct. Increasing current in primary winding 49 of transformer 50, induces a current in the secondary winding 52. The positive feedback network of the saturation oscillator 42 couples the current back to the control electrode 59 to drive the transistor 42 to saturation. When the transistor 42 reaches saturation, the steady state current through winding 49 no longer induces a current in winding 52. Since the pulse caused by the opening of the points which fires the SCR is very short, the SCR 16 is off, and the steady state condition of current through the winding 49 no longer induces a current in winding 52, the potential is removed from control electrode 59 and transistor 42 is rendered non-conductive. This causes the field in transformer 50 to collapse inducing a current in winding 84 of the transformer 50 which is coupled by resistor 86 to charge the ignition capacitor 18. Subsequently, the next time the points 34 are cycled the SCR 16 will be triggered to discharge the charge capacitor 18 through the primary winding 12 of ignition coil 10 to produce a firing pulse in the secondary winding 14 of the transformer 10. The diode 83 prevents ringing in the circuit when capacitor 18 discharges.

When the field collapses in the ignition coil 10 after producing a firing pulse, a potential is developed across winding 12 which charges the ignition capacitor 18 in the opposite direction. Subsequent discharge of the capacitor 18 will induce a current in winding 52 of transformer 50 to energize the saturation oscillator 40. The importance of the enabling circuit 65 is that at high speeds it will initiate operation of the saturation oscillator sooner than the collapsing field in the ignition coil 10 can induce a pulse in the winding 84 to initiate operation of the oscillator thereby insuring sufficient charging of ignition capacitor 18 prior to the next discharge thereof.

Problems in ignition systems of this type have often made it difficult to start an engine during cold winter months when the battery voltage is low. In addition, during hot weather and/or high speed operation of the engine, heavy current through the transistor 42 of the saturation oscillator 40 has caused permanent damage to the transistor resulting in ignition system failure.

The new concept of this invention, including the insertion of the thermistor 55 in the positive feedback circuit of the oscillator 59, has alleviated these problems. The thermistor 55 in this particular embodiment is a PTC-type thermistor, i.e., the resistance of the thermistor increases as the temperature increases. Consider, for example, cranking of the engine during cold weather with low battery voltage. During cold weather the thermistor 55 would have its minimum values of resistance, for ex-

ample, from 3.5 to 4 ohms. Therefore, for low battery voltage, the current coupled to the control electrode 59 of the transistor 42 from the enabling circuit 65 and from winding 52 will be the maximum value available to the system so that the transistor 42 will be driven into heavy saturation increasing the voltage output and providing sufficient voltage to readily charge the ignition capacitor 18. However, after the engine has warmed up and is running, for instance, at high speed, the ambient temperature surrounding the thermistor 55 will rise accordingly. This increase in temperature will cause the resistance of the thermistor 55 to increase, for example, to 10 to 12 ohms. This increased resistance reduces the bias coupled to the control electrode 59 from the winding 52 and from the enabling circuit 65 thereby reducing the degree of saturation of transistor 42 and limiting the current therethrough to protect that transistor from high current breakdown.

The circuit of this invention also has an added feature of a tachometer 87 which can be conveniently coupled to the transistor 42 of the saturable oscillator 40 to indicate engine r.p.m. Each time the transistor 42 is switched on following the triggering of an ignition pulse by the opening of points 34, a positive pulse is developed across resistor 88 to trigger the tachometer 87, which can be any standard tachometer operable by pulses being applied thereto. The capacitor 90 in the tachometer circuit is used to short stray signals to ground to prevent false triggering of the transistor 42.

What has been described, therefore, is a capacitor discharge ignition system which is temperature compensated to control the current for charging the ignition capacitor.

What is claimed is:

1. In a capacitor discharge ignition system for an internal combustion engine including trigger means for discharging the capacitor in synchronism with the engine to produce ignition pulses, saturable oscillator means coupled to the ignition capacitor for charging the same comprising a transistor having control and output electrodes and a transformer having first and second inductively coupled windings with the output electrode of the transistor being coupled to said first winding, circuit means for connecting said second winding to said control electrode so that increased current in said first winding due to conduction of said transistor induces current in said second winding to sustain conduction of said transistor into saturation, and enabling means including a transistor having a control electrode connected to the triggering means and an output electrode, said enabling means being responsive to the operation of the triggering means to couple a current to the control electrode of the transistor, the improvement characterized by, temperature responsive circuit means including a temperature responsive resistor connecting the output electrode of the enabling transistor and said second winding of the saturable oscillator to the control electrode of said transistor, said temperature response circuit means reacting to the ambient temperature to increase or decrease the current to said control electrode to control the degree of saturation of the transistor.

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