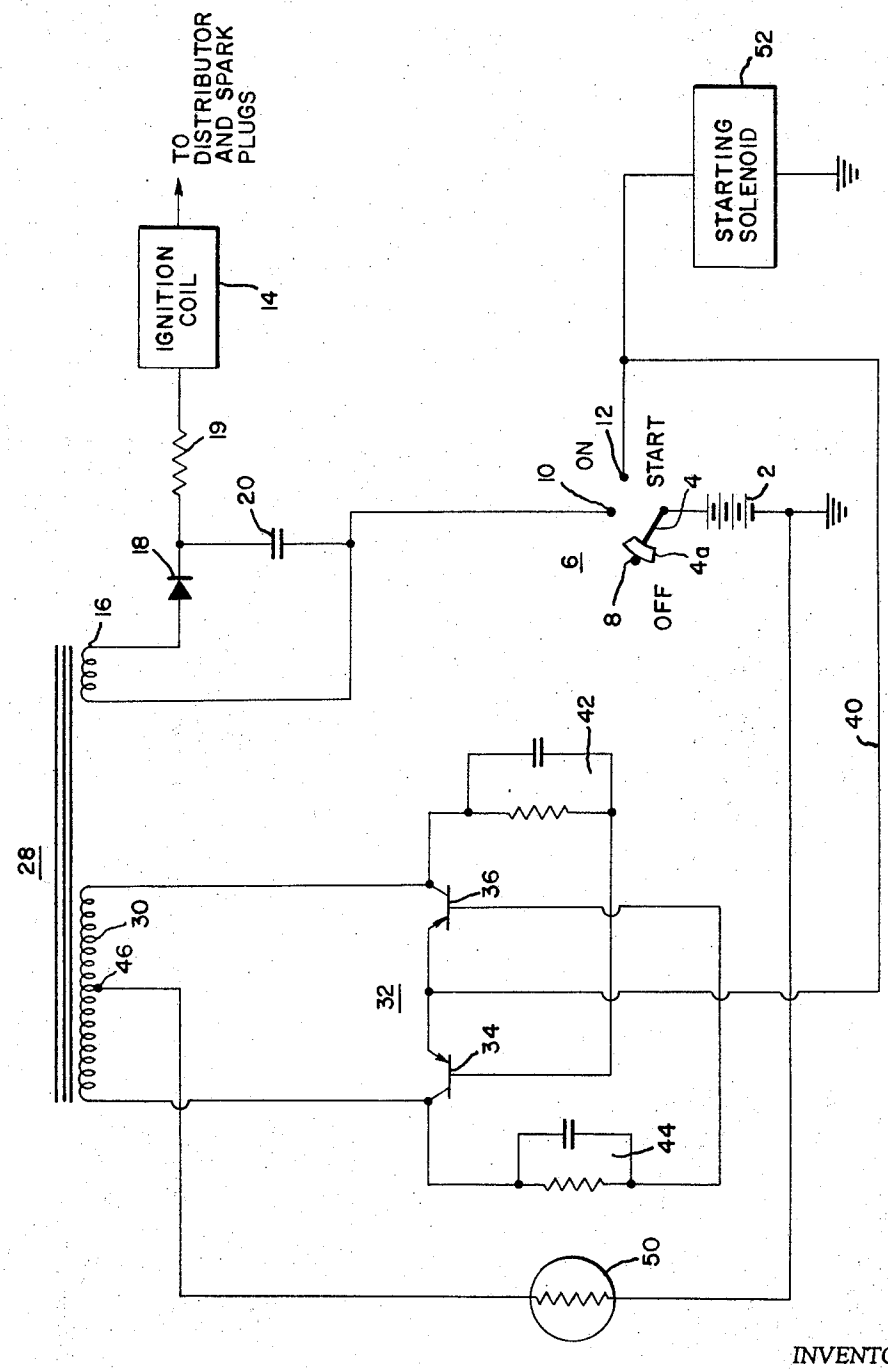
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ELECTRONIC IGNITION COMPENSATION

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ELECTRONIC IGNITION COMPENSATION

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This invention relates generally to an ignition system for internal combustion engines, and more particularly to an ignition system including means operable during the starting of an engine for applying upon the high tension ignition circuitry a temperature-compensated auxiliary power input.

In the prior art, ignition systems for internal combustion engines have been proposed that includes a ballast resistor connected in series with the ignition coil primary winding to maintain a safe continuous primary current. This resistor, which is shunted during the starting period only, is generally incapable of sensing changes in starting load that occur with variations in ambient temperature. Thus, the starting load at low ambient temperature may reduce the available high tension voltage below the point at which the normally combustible mixture may be ignited. More particularly, since the flash point of the fuel mixture increases and battery voltage decreases as ambient temperature decreases, the starting of internal combustion engines is rendered difficult under cold weather conditions.

The present invention was developed to provide an improved temperature-responsive voltage compensator for providing additional power to the high tension ignition circuitry of an internal combustion engine during the starting period. The compensating circuit is designed to provide only that energy necessary to maintain the high tension voltage at an optimum value.

The primary object of the present invention is to provide an improved ignition system including means operable during the engine starting period for introducing a temperature-compensated auxiliary current into the ignition coil circuit. The invention is characterized in that voltage compensation is generated during the starting period as a function of ambient temperature. According to the preferred embodiment of the invention, use is made of a temperature-responsive resistor having a positive temperature coefficient for controlling the magnitude of the voltage induced in a secondary winding connected in series with the ignition coil and the supply battery. The resistor is preferably connected in series with free-running oscillator means which include a primary winding inductively coupled to the aforementioned secondary winding. The improved compensation means may be installed either as a permanent part of the ignition system or is an auxiliary system that may be by-passed to permit conventional engine operation during warm weather.

A more specific object of the invention is to provide an ignition system of the type described above including transformer means having primary and secondary windings, said primary winding comprising an inductive component of oscillator means that are energized by the battery through the START contact of an ignition switch. According to the preferred embodiment of the invention, a temperature-responsive resistor is connected in series with the battery and the oscillator. The secondary winding is connected to the ignition coil and is energized, during engine starting, by induction as a function of the operation of the temperature compensated oscillator means. During the engine running period, the oscillator means are deactivated; the secondary winding and rectifier form a low impedance path to the normal current flow and offer an insignificant voltage drop which can be ignored.

The present invention offers the advantage that the output of the compensating voltage generator means increases as the ambient temperature decreases, as effected by the use of a biasing resistor having a positive temperature coefficient. Moreover, as a consequence of the invention, the starting efficiency achieved by the additive energy compensation is relatively high and the demand on the prime power source is insignificant.

Other objects and advantages of the invention will become apparent from a study of the accompanying drawing, the single figure of which is an electrical schematic diagram of the ignition system of the present invention.

Referring to the drawing, the ignition system includes a battery **2** having a grounded negative terminal, and a positive terminal connected to the movable contact **4** of a three-position ignition switch **6**. The switch contact **4**, which carries a bridging head portion **4***a*, is movable between positions in electrical engagement with the stationary OFF, ON, and START contacts **8**, **10** and **12**, respectively. The configuration of the bridging portion **4***a* is such that it bridges both contacts **10** and **12** when contact **4** is pivoted to the START position. The ON contact **10** is connected with one terminal of ignition coil **14** via winding **16**, diode **18**, and a conventional ballast resistor **19**. Connected across the series branch including winding **16** and diode **18** is a filter capacitor **20**.

Winding **16** comprises the secondary winding of a transformer **28** having a primary winding **30** which forms an inductive component of conventional oscillator means **32**. More particularly, the oscillator means **32** includes a pair of transistors **34**, **36** the emitters of which are connected with the START contact **12** via conductor **40**. The collector electrodes of the transistors are connected with opposite ends of the primary winding **30**, respectively. The base electrodes of transistors **34**, **36** are connected with the collectors of transistors **36**, **34** via resistance-capacitance biasing networks **42**, **44**, respectively. The center tap **46** of primary winding **30** is connected with the grounded negative terminal of battery **2** by conductor **48** which contains in series with the oscillator **32** an ambient temperature-responsive resistor **50**. In the illustrated embodiment, the resistor **50** has a positive temperature coefficient. The conventional starting solenoid **52** is connected between START contact **12** and ground.

Operation

When movable ignition switch contact **4** is pivoted to the START position, contacts **10** and **12** are bridged by bridging portion **4***a*, and starting solenoid **52** is energized to effect driving of the crank shaft of the internal combustion engine by starter motor means, not shown. Positive battery voltage is applied to the emitter electrodes of transistors **34**, **36** via conductor **40**, and since the center tap **46** of winding **30** is connected with ground via temperature-responsive resistor **50**, the oscillator **32** is activated and commences oscillation at a frequency dependent upon the time constants of resistance-capacitance branches **42**, **44**, and the characteristics of the transformer windings and core material. Owing to transformer action, an alternating current voltage is induced in secondary winding **16** that is rectified by diode **18**, filtered by capacitor **20**, and is added to the normal direct current that is supplied from the battery **2** to one terminal of coil **14** via switch **6**, contact **10**, coil **16**, diode **18** and ballast resistor **19**. Current is then supplied to the spark plugs via the distributor to effect ignition of the fuel and starting of the internal combustion engine.

In accordance with the present invention, the additive (i.e., auxiliary) voltage applied to the high tension circuit is controlled as a function of ambient temperature to compensate for the variations in battery voltage and in the ignition flash point of the fuel that result from variations in temperature. To this end, the resistor **50**

has such a positive temperature coefficient that as the ambient temperature increases, the resistance of resistor **50** increases to reduce the current flowing from the positive terminal, through the oscillator **32** and resistor **50**, and back to the battery negative terminal and ground. Since the current flowing through (i.e., the voltage applied across) the oscillator is reduced, the voltage induced in secondary winding **16** and the current supplied to ignition coil **14** is reduced correspondingly. Since the flash point of the fuel decreases with the increase in temperature, the spark plug cylinders are efficiently fired through the use of only that energy necessary to maintain the high tension system level at an optimum value.

In the event that ambient temperature decreases, the battery potential falls and the flash point of the fuel increases. Since the resistance of resistor **50** decreases, the potential applied across oscillator **32** increases, whereby the voltage induced in secondary winding **16** and the corresponding level of the current supplied to ignition coil **14** are increased.

When the engine has been started, the ignition switch contact **4** is pivoted to the ON position (in which bridging portion **4***a* merely engages the contact **10**), and battery current continues to be supplied to the ignition coil **14** via secondary winding **16** and diode **18**. Since the open-circuited oscillator **32** is de-activated, no auxiliary voltage is induced in the secondary winding **16**.

While the invention has been described in connection with an ignition system including an oscillator of the solid state, free-running type, it is apparent that energy generation might be accomplished by vibrating reeds, silicon controlled rectifier switches, mechanical breakers, and associated voltage transforming and rectifying devices. It will also be apparent to those skilled in the art that other changes and modifications may be made in the apparatus described without deviating from the invention set forth in the following claims.

What is claimed is:

1. In an internal combustion engine ignition system, the combination which comprises,

a battery including a positive terminal and a grounded negative terminal;

an ignition coil having an output end adapted for connection with the spark plug of the engine, and an input end;

ignition switch means including START and RUN positions;

first means operable when said switch means is in the RUN position for connecting said positive battery terminal with the input end of said ignition coil;

second means operable when said switch means is in the START position for supplying a starting current to the input end of said ignition coil; and

temperature-responsive means operable when said switch means is in the START position for controlling as a function of ambient temperature the magnitude of the starting current supplied to said ignition coil,

said first means including a secondary winding and a rectifier means connected in series between said ignition switch means and the input end of said ignition coil and a filter capacitor connected in parallel with said secondary winding and said rectifier,

said second means including a primary winding inductively coupled with said secondary winding and circuit means including an oscillator means,

said temperature responsive means including a temperature-responsive resistor, wherein said oscillator means comprises a pair of electronic devices each having a pair of power circuit electrodes and a control electrode, the ends of said primary winding being connected with corresponding first power circuit electrodes of said electronic devices, respectively, the other power circuit electrodes of said devices being connected with the START contact of said ignition switch, said temperature-responsive resistor being connected at one end with the center of said primary winding and at the other end with said grounded negative terminal, and a pair of resistance-capacitance biasing networks each connecting the control electrode of one device with the first power circuit electrode of the other device, respectively.

2. Apparatus as defined in claim **1** wherein said temperature-responsive resistor has a positive temperature coefficient.

3. Apparatus as defined in claim **1**, and further wherein said switch means includes a conductive bridging portion carried by said movable contact for electrically connecting said START and RUN contacts only when said movable contact is in the START position, whereby rectified temperature-compensated auxiliary power is added to the normal battery supply during the engine starting period.

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