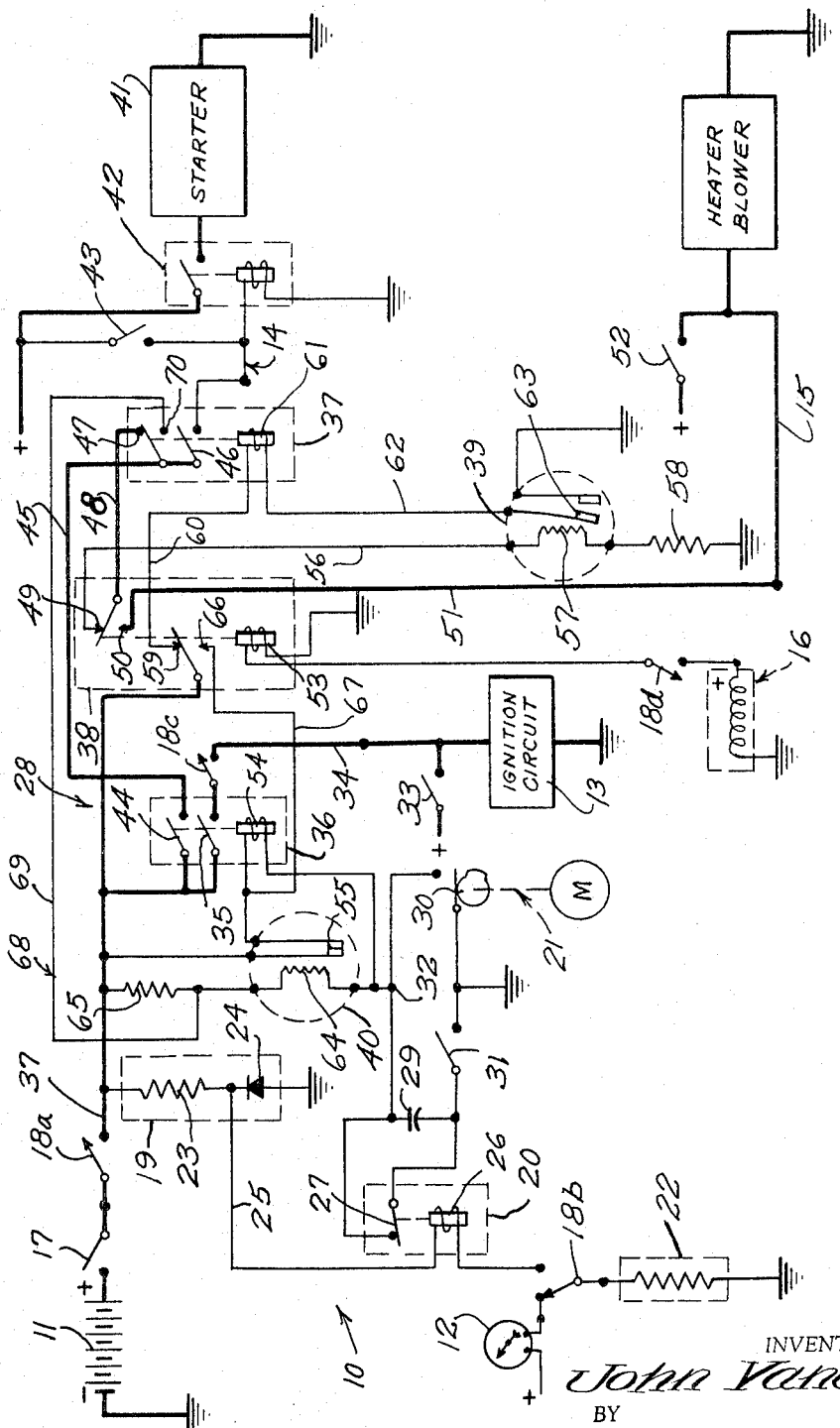
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AUTOMATIC ENGINE STARTER

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AUTOMATIC ENGINE STARTER

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This invention relates generally to an automatic starting system for engines, and more specifically to an automatic electrical control system for starting internal combustion engines on motor vehicles.

Although the principles of the present invention may be included in various devices employing internal combustion engines, a particularly useful application is made in motor vehicles. The system may be constructed in a manner in which it is fully integrated into the known types of electrical systems now employed, or it may be constructed as a separate device having appropriate adaptation as by terminals for installation in or attachment to the electrical system of such an engine.

It has been previously suggested that a system should be provided to start an engine automatically as a function of a predetermined temperature or as a function of the elapse of a predetermined period of time. In such systems, the ignition has been turned on automatically, the starting circuit has been energized, engine operation has been sensed to terminate operation of the starting circuit, the vehicle heater has been energized, and the system has been shut down upon the attainment of a predetermined temperature or time. Prior systems have been characterized by excessive complexity in that they have involved a large number of components, many of which have been of a mechanical nature, usually requiring lubrication, and hence not suitable for extreme low-temperature starting. It has also been considered impractical previously to employ as a thermal sensing element any component which changes its resistance as a function of temperature since battery voltage varies widely depending upon its state of charge, its temperature, and on whether the engine is running. Further, in prior systems, there has usually been a considerable reaction time required in the automatic sensing of whether the engine has started, and it has been impractical previously to provide a system which would automatically attempt a restart of the engine in the event that it dies soon after starting.

In accordance with the principles of the present invention, I have provided a structure which employs a minimum of parts, which is all-electrical in operation, and which overcomes all of the aforementioned difficulties.

Accordingly, it is an object of the present invention to provide an improved automatic starting control system for an internal combustion engine.

Another object of the present invention is to provide a control system of the type described in which all of the components are electrically operated devices.

A further object of the present invention is to provide a system of the type described in which battery voltage variations will have a minimum effect on the control of starting.

Another object of the present invention is to provide a system of the type described which avoids all of the problems and failures incidental to the use of mechanical components, including lubrication, so that the system will be operative at extremely low temperatures.

Yet another object of the present invention is to provide a structure in which any manual reset is unnecessary, even if there has been a failure in starting.

Yet another object of the present invention is to provide a system of the type described in which the response to a stalled engine and restarting thereof is substantially instantaneous, particularly during the first few minutes of operation.

A still further object of the present invention is to provide a system of the type described in which operation of the starting circuit is terminated as soon as the engine starts.

Many other advantages, features and additional objects of the present invention will become manifest to those versed in the art upon making reference to the detailed description and the accompanying sheet of drawings in which a preferred structural embodiment incorporating the principles of the present invention is shown by way of illustrative example.

On the drawing:

The drawing shows diagrammatically and schematically an automatic starting control system constructed in accordance with the principles of the present invention.

As shown on the drawing:

The priciples of this invention are particularly useful when embodied in an automatic starting control system for an internal combustion engine, such system being illustrated by the drawing, and being generally indicated by the numeral **10**. The control system **10** is constructed to be employed with the electrical system of a motor vehicle, operating parts of which are shown to the extent necessary to illustrate the connections and relationships between the automatic starting control system and the elecrical system generally. The electrical system of a motor vehicle is known to include components such as a battery **11**, an electrical termperature-indicating gage **12**, an ignition circuit **13**, a starting circuit generally indicated at **14**, a heater blower circuit **15**, and a means generally indicated at **16** described more fully below and which may comprise a portion of the generator armature winding or a portion of the voltage regulator.

For purposes of illustration, the battery **11** comprises a 12-volt battery, the negative side of which is grounded. (The battery may be reversed if suitable attention is paid to polarity elsewhere). The normal battery voltage when the engine is operating may vary considerably due to the effect of the voltage regulator, and due to differences between voltage regulators. Further, the temperature and state of charge of the battery also affect the voltage available therefrom. The battery **11** is connected through a switch **17** which is so mounted that it is closed whenever the transmission shift lever is either in a neutral or in a parking position. Conversely, the switch **17** is open for safety reasons whenever the shift lever is in any driving position. The shift lever switch **17** is connected in series with a switch **18*a*** which forms one section of a multipole switch or which is ganged to operate with other switches identified below by the numeral **18**, but having different suffix letters. The on-off switch **18** is connected to a constant voltage supply circuit **19** which is connected to a current-sensitive relay **20**, which is connected through a selector switch **18*b*** to a thermal or temperature-sensing element **22**. To this end, the constant voltage circuit **19** includes a resistor **23** connected in series with one side of a Zener diode **24**, the other side of which is grounded. A line **25** connects a point between the resistor **23** and

the diode 24 to one side of a coil 26 of the current-sensitive relay 20, the other side of such coil being connected to one of the terminals of the selector switch 18*b* as shown. The constant voltage circuit 19 provides a potential which remains within one percent of ten volts which is thus applied across the coil 26 and the temperature-sensing element 22. The temperature-sensing element 22 comprises an electrical resistance which has a negative coefficient of thermal resistivity so that its resistance is inversely proportional to temperature. The sensing element 22 is the one which may be normally used for operating the temperature-indicating gage 12 when the selector switch 18*b* is in the position drawn. However, when the switch 18*b* is moved to its other position, the sensing element 22 is connected in series with the coil 26. Under normal conditions, when power is applied through the switches 17, 18*a*, constant voltage circuit 19, line 25, coil 26, selector switch 18*b*, and sensing element 22, sufficient current will flow therethrough to operate the relay 20, thereby opening its set of normally closed contacts 27. When the temperature drops to a predetermined level, the electrical resistance of the sensing element 22 increases until a predetermined value is reached at which value, the relay 20 drops out, thereby closing the normally closed contacts 27. The contact voltage in the line 25, the current-sensitive relay 20, and the sensing element 22 are so selected that the temperature of the sensing element 22 causes the relay 20 to close when desired. Closing of the normally closed contact 27 controls operation of a relay circuit generally indicated at 28 which is connected as described below to deliver power to the starting circuit 14.

It is preferred that a capacitor 29 be connected across the normally closed contacts 27 to protect the same against damage due to arcing.

Under certain circumstances, rather than use a predetermined condition of temperature, it will be advantageous to use a predetermined condition of time. To this end, there is provided a motor-driven switch 21 having a normally open set of contacts 30 connected in parallel with the normally closed contacts 27. A manual switch 31 may be used to isolate the contacts 27 from ground by opening the same, as drawn. A terminal 32 is grounded in response to closing of the normally closed contacts 27 of the current-sensitive relay 20 whenever the switch 31 is closed. The same terminal 32 is grounded whenever the motor-operated switch or timer 21 closes its contacts 30. The motor-operated switch or timer 21 may be constructed so as to close its contacts 30 periodically, for example at intervals of fifteen minutes, or the same may be constructed to close the contacts 30 steadily after elapse of a preset time interval. If the switch 31 be open, there can be no intervening starting of the engine, while if the switch 31 is closed, the attainment of a predetermined temperature will effect intervening operation of the engine.

In normal operation, the ignition circuit 13 is controlled by a key-governed switch 33. The regular ignition switch 33 is shunted or bypassed by a line 34 leading through a switch 18*c* to a set of normally open contacts 35 forming a part of an ignition relay 36. One of the contacts 35 is connected to a buss line 37 leading from the on-off switch 18*a* to various elements as shown. With the relay 36 not energized, power thus cannot be brought to the ignition circuit 13, but upon closing of the relay 36, the ignition circuit 13 is energized.

The relay circuit 28 includes the ignition relay 36, a starter relay 37, a cutout relay 38, a thermal cycling switch 39, a second thermal switch 40, and such interconnections and wiring as is shown and described.

The starting circuit 14 includes a conventional starter or starting motor 41 which is under the control of a starter solenoid 42 which is normally operated by the usual starter switch 43. The power buss or line 37 is connected through a pair of normally open contacts 44 in the ignition relay 36, through a line 45, to a pair of normally open contacts 46 in the starter relay 37. When both the ignition relay 36 and the starter relay 37 are in an energized position, then both the contacts 44 and the contacts 46 are closed so that power is delivered in bypassing relation to the starter switch 43 to the starter circuit 14 to energize the starter solenoid and to operate the starter motor 41. Upon opening either of the ignition relay 36 or the starter relay 37, power to the starter is interrupted.

Whenever power is interrupted to the starting circuit 14 by the relay 37, a further normally closed set of contacts 47 conducts power through a line 48 to a normally closed set of contacts 49 in the cutout relay 38.

Whenever the cutout relay 38 has been energized as described below, due to starting of the engine, power from the line 48 passes to a set of normally open contacts 50 and thence through a line 51 leading to the heater blower motor circuit 15 in bypassing relation to a switch 52 which is normally used for manual control of the heater motor.

The cutout relay 38 has a coil 53 which is connected through a switch 18*d* across the coil or portion 16 of the electrical system of the engine. The portion or means 16 may comprise a generator armature coil or a voltage regulator coil such as is a part of contemporary electrical systems of motor vehicles. The switch 18*d* is thus merely connected to such portion thereof as develops a sufficient potential in response to starting of the engine to operate the cutout relay 38. The potential across the means 16 during cranking of the engine is insufficient, if any, to operate the cutout relay 38.

The ignition relay 36 has a coil 54, one side of which is connected to the terminal 32 for grounding by the contacts 27 or 30, and the other side of which coil 54 is connected through a pair of normally closed contacts 55 forming a part of the thermal switch 40, to the power line 37. Thus, with the switches 17, 18*a*, and 31 closed, when the relay contacts 27 close, they effect grounding of the terminal 32 and hence the closing of the circuit through the coil of the ignition relay 36 to energize the ignition circuit 13 and to bring power to the line 45. This also brings power through the normally closed contacts 47, the line 48, and the normally closed contacts 49 through a line 56, through an electrical heater 57 forming a part of the thermal cycling switch 39, and through a resistor 58 to complete a circuit through the heater 57.

Energizing of the line 37 also brings power through a pair of normally closed contacts 59 in the unenergized cutout relay 38 which are connected by a line 60 to one side of a coil 61 of the starter relay 37. The other side of the coil 61 is connected through a line 62 to a pair of normally open contacts 63 in the thermal cycling switch 39, for completing the circuit. Thus, the open contacts 63 prevent initial operation of the starter relay 37. However, as heat is given off by the heater 57, the contacts 63 are caused to close in response thereto, thereby closing the starter relay 37. Doing so brings power through the normally open contacts 46 to the starting circuit 14 as described above. This also opens the normally closed contacts 47, thereby interrupting current through the heater 57 of the thermal switch 39. Upon cooling, the thermal switch 39 opens its contacts 63, thereby opening the coil circuit of the starter relay 37, to thereby terminate cranking. However, this recloses the normally closed contacts 47 to cause reheating of the heater 57 and subsequent reclosing of the contacts 63 of the thermal switch 39, and energization of the coil of the starter relay 37, which thus provides a second or next attempt to start the engine by energizing the starting circuit 14. Such cycling continues periodically until interrupted. The initial closing of the contacts 63 typically may take one minute. They typically remain closed about five seconds and open for five seconds, thus going through a ten-second cycle with about 50% on time.

As soon as the engine starts, a potential from the means **16** is applied to the coil **53** of the cutout relay **38** as described which causes opening of the normally closed contacts **59** to terminate instantly the closed condition of the starter relay **37** if it then be energized. The energizing of the cutout relay **38** also opens the normally closed contacts **49** to prevent further heating of the heater **57** in response to the closing of the contacts **47** when the starter relay **37** is deenergized.

The cycling of the thermal switch **39** may also be terminated by the second thermal relay **40** which serves as a fail-safe device to shut the system down, namely to terminate cranking, in the event that the engine fails to start within a reasonable time. To this end, the thermal switch **40** includes an electrical heater **64** which is connected to the power line **37** through a resistor **65** arranged in series therewith, the other side of the serially connected heater **64** and resistor **65** being connected to the terminal **32** for grounding as described. When the normally closed contacts **27** are closed by dropping out of the current-sensitive relay **20**, or when the contacts **30** are closed by the timer **21**, heater current passes through the resistor **65** and the heater **64** continually for a predetermined period of time, such as 180 seconds, to heat the thermal elements which thus ultimately open the normally closed contacts **55**. When these contacts open, the cutout relay **38** being deenergized, power is disconnected from the coil **54** of the ignition relay **36** to open the line **34** leading to the ignition circuit **13** and to deenergize the line **45** and hence both the heater **57** of the thermal switch **39** if the starter relay **37** is deenergized and the starting circuit **14** if the starter relay **37** is then energized. In the example given, thus there will be approximately 12 five-second attempts made to start the engine, after which further attempts to start the engine are discontinued to protect the battery **11**. Once the switch **17** of **18***a* has been opened, the heater **64** will cool and be ready to function once more. When the engine starts, and through the means **16** effects energizing of the cutout relay **38**, a pair of normally open contacts **66** leading to a line **67** are closed, the line **67** thus comprising a holding circuit connected to one side of the coil **54** of the ignition relay **36** to hold the same energized, even though the contacts **55** may open. In the event that the engine dies before the contacts **55** have opened, the cutout relay **38** will drop out, and the cycling of the starter relay **37** by the thermal switch **39** will continue. Thus, attmepts will be made automatically to restart a stalled engine during the predetermined period of time controlled by the thermal switch **40** for opening the contacts **55**.

When the starting solenoid **42** is not energized so that the starter motor **41** is not drawing current from the battery **11**, the voltage on the line **37** will ordinarily be about 12 volts. However, when the starter **41** is energized, this voltage drops to about half that value. The thermal switch **40** is preferably selected so that the heater **64** thereof should normally be provided with about six volts. The resistor **65** thus serves as a voltage-dropping resistor to maintain the proper potential on the heater **64** when the starter **41** is not energized. There is provided a shunt circuit **68** connected across the resistor **65**, the shunt circuit **68** including a line **69** and a pair of normally open contacts **70** in the starter relay **37**. Whenever the starter relay **37** is closed to operate the starting circuit **14**, the shunt circuit **68** is also close-circuited, thereby shunting or shorting out the resistor **65** so that the voltage then present on the line **37** appears at the heater **64** in the thermal switch **40**. Thus, the potential applied to the heater **64** remains relatively constant, even though cycling of the starting circuit **14** may be taking place.

While the switches **18***a*, **18***b*, and **18***d* provide the necessary isolation between the system **10** and the electrical system of the engine, the switch **18***c* serves to prevent an unwanted feedback therethruogh so as to prevent energization of the line **37** through the switch **33** if the switch **33**, in the absence of a switch **18***c*, were moved to a closed circuit position when the engine was running with control power received through the switches **17** and **18***a*.

The following represent typical values or components which may be employed in the practice of this invention:

R23	120 ohm, 1 watt
R58	10 ohm, 20 watt
R65	10 ohm, 20 watt
Diode **24**	Zener, 10 volt, 1 watt
Relay **20**	Sigma 11 F550
Relays **36, 37, 38, 42**	12 volt coils
C29	1–100 mfd.
Thermal Switch **39**	Amperite 6NO60T
Thermal Switch **40**	Amperite 6C180T

From the foregoing it should now be understood that the constant voltage circuit **19** maintains a substantially constant voltage across the serially connected coil **26** and sensing element **22** so that when the thermal element **22** is subjected to a temperature decrease to a predetermined value, the current flow in the relay coil **26** will lessen to effect self closing of the contacts **27** for operating the relay circuit **28**. By this structure, all-electrical means are provided in a simple and facile manner. Moreover, the thermal sensing element **22** may be employed both for the temperature gage **12** on the instrument panel of the vehicle, and as the condition-responsive means for controlling starting. Such shared usage of this element contributes to the structural economy thereof. Further, the thermal relays **39** and **40** thus provide cycling of the starter relay **37** for a predetermined period of time which cycling is resumed during such period of time in the event that the engine should stall. Such resumption of cycling is aided by the use of a portion of the vehicle's electrical system which is responsive to engine operation, and to that end provides a potential for energizing the cutout relay instantaneously in the event of engine starting, such means **16** further providing for the instantaneous dropout of such cutout relay in the event of engine stalling during such predetermined period. Further, the shunt circuit **68** connected in parallel with the resistor **65**, which is in series with the heater **64** insures a substantially constant voltage on the heater **64** thus facilitating predetermination or selection in a facile manner of a suitable component in a particular installation.

Although various minor modifications might be suggested by those versed in the art, it should be understood that I wish to embody within the scope of the patent warranted hereon all such embodiments as reasonably and properly come within the scope of my contribution to the art.

I claim as my invention:

1. In an automatic starting control system for an internal combustion engine having a battery and a starting circuit powered thereby, the combination comprising:

(a) a thermal sensing element having an electrical resistance responsive to temperature, and adapted to sense engine temperature;

(b) a current-sensitive relay having a coil connected in series with said thermal sensing element, and a set of contacts;

(c) a constant voltage circuit adapted to be powered by the battery, and connected in series with said coil and said thermal sensing element; and

(d) a relay circuit under the control of said contacts and adapted to be connected to the engine starting circuit for controlling application of power thereto.

2. In an automatic starting control system for an internal combustion engine having a battery and a starting

circuit powered thereby, the combination comprising:

(a) a thermal sensing element having an electrical resistance inversely proportional to temperature, and adapted to sense engine temperature;

(b) a current-sensitive relay having a coil connected in series with said thermal sensing element, and a normally closed set of contacts;

(c) a constant voltage circuit adapted to be powered by the battery, and connected in series with said coil and said thermal sensing element; and

(d) a relay circuit under the control of said contacts and adapted to be connected to the engine starting circuit for controlling application of power thereto;

whereby a temperature decrease of said thermal element to a predetermined value lessens the current flow in said relay coil to effect self closing of said contacts for operating the relay circuit.

3. In an automatic starting control system for an internal combustion engine having a battery, an engine starting circuit powered thereby, and electrical temperature-indicating gage means, the combination comprising:

(a) a thermal sensing element having an electrical resistance responsive to temperature, and adapted to sense engine temperature;

(b) a current-sensitive relay having a coil and a set of contacts;

(c) a selector switch which, in one position, connects said coil in series with said thermal sensing element, and in a second position is adapted to connect the gage means to said thermal sensing element;

(d) a constant voltage circuit adapted to be powered by the battery, and connected for applying a constant voltage across said coil and said thermal sensing element; and

(e) a relay circuit under the control of said contacts and adapted to be connected to the engine starting circuit for controlling application of power thereto.

4. In an automatic starting control system for an internal combustion engine having a battery and a starting circuit powered thereby, the combination comprising:

(a) means responsive to a predetermined condition and having a set of contacts;

(b) a relay circuit under the control of said contacts, and including

(1) a starter relay having a coil adapted to be connected at one side thereof to the battery, a set of normally open contacts operative when closed to apply power to the engine starting circuit and a set of normally closed contacts,

(2) a first thermal switch for cycling said starter relay periodically, said thermal switch including an electrical heater connected to said normally closed contacts of said starter relay to receive power therefrom, and a pair of normally open contacts responsive to heat emitted by said heater and connected in series with the other side of said starter relay coil for completing the circuit to the battery, and

(3) a second thermal switch for limiting the duration of such cycling, and including an electrical heater connected in series with said first named set of contacts and adapted therewith to be connected across the battery, and a pair of normally closed contacts responsive to heat emitted by said last named heater, and connected in said relay circuit to control delivery of power from the battery to said sets of starter relay contacts.

5. In an automatic starting control system for an internal combustion engine having a battery and a starting circuit powered thereby, the combination comprising:

(a) means responsive to a predetermined condition and having a set of contacts;

(b) a relay circuit under the control of said contacts, and including

(1) a starter relay connected to control application of power from the battery to the starting circuit,

(2) means operative to cycle said starter relay periodically,

(3) a thermal switch connected in said relay circuit to terminate the cycling of said starter relay, said thermal switch including an electrical heater connected in series with a resistor and adapted therewith to be connected across the battery, and

(4) a shunt circuit connected across said resistor and including a set of normally open contacts in said starter relay.

6. In an automatic starting control system for an internal combustion engine having an electrical system including a battery, an engine starting circuit powered thereby, and electrical temperature-indicating gage means, the combination comprising:

(a) a thermal sensing element having an electrical resistance inversely proportional to temperature, and adapted to sense engine temperature;

(b) a current-sensitive relay having a coil, and a normally closed set of contacts;

(c) a selector switch which, in one position, connects said coil in series with said thermal sensing element, and in a second position is adapted to connect the gage means to said thermal sensing element;

(d) a constant voltage circuit adapted to be powered by the battery, and connected for applying a constant voltage across said coil and said thermal sensing element;

(e) a relay circuit under the control of said normally closed contacts, and including

(1) a starter relay having a coil adapted to be connected at one side thereof to the battery, a set of normally open contacts operative when closed to apply power to the engine starting circuit, and a set of normally closed contacts,

(2) a first thermal switch for cycling said starter relay periodically, said thermal switch including an electrical heater connected to said normally closed contacts of said starter relay to receive power therefrom, and a pair of normally open contacts responsive to heat emitted by said heater and connected in series with the other side of said starter relay coil for completing the circuit to the battery,

(3) a second thermal switch for limiting the duration of such cycling, and including an electrical heater connected in series with a resistor and with said first named set of contacts and adapted therewith to be connected across the battery, and a pair of normally cloced contacts responsive to heat emited by said last named heater, and connected in said relay circuit to control delivery of power from the battery to said sets of starter relay contacts,

(4) a shunt circuit connected across said resistor and including a set of normally open contacts in said starter relay, and

(5) a cutout relay having contacts operative on energization of the relay to terminate operation of the starting circuit, said cutout relay having a coil for being connected across a portion of the electrical system of the engine in which portion a relay-operating potential is developed in response to starting of the engine.

References Cited by the Examiner

UNITED STATES PATENTS

2,975,296	3/1961	Dominquez-Rego.	
3,009,067	11/1961	Janeczko et al.	290—38
3,130,318	4/1964	Curtis	290—38
3,154,689	10/1964	Bubbenmoyer	290—38

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