Oct. 5, 1954 C. E. LINCOLN 2,691,110

INTERNAL-COMBUSTION ENGINE STARTER

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Fig. 1

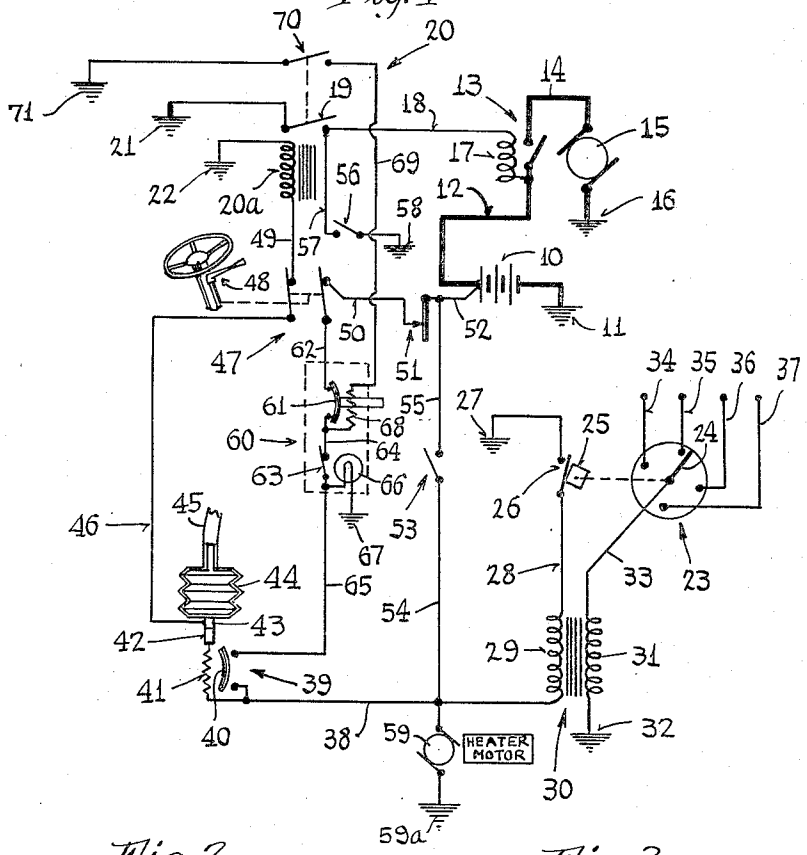


Fig. 2

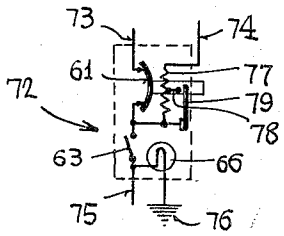


Fig. 3

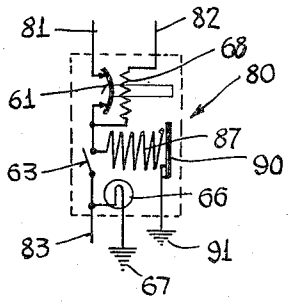
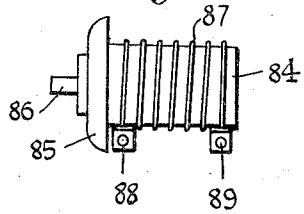


Fig. 4



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Fig. 5

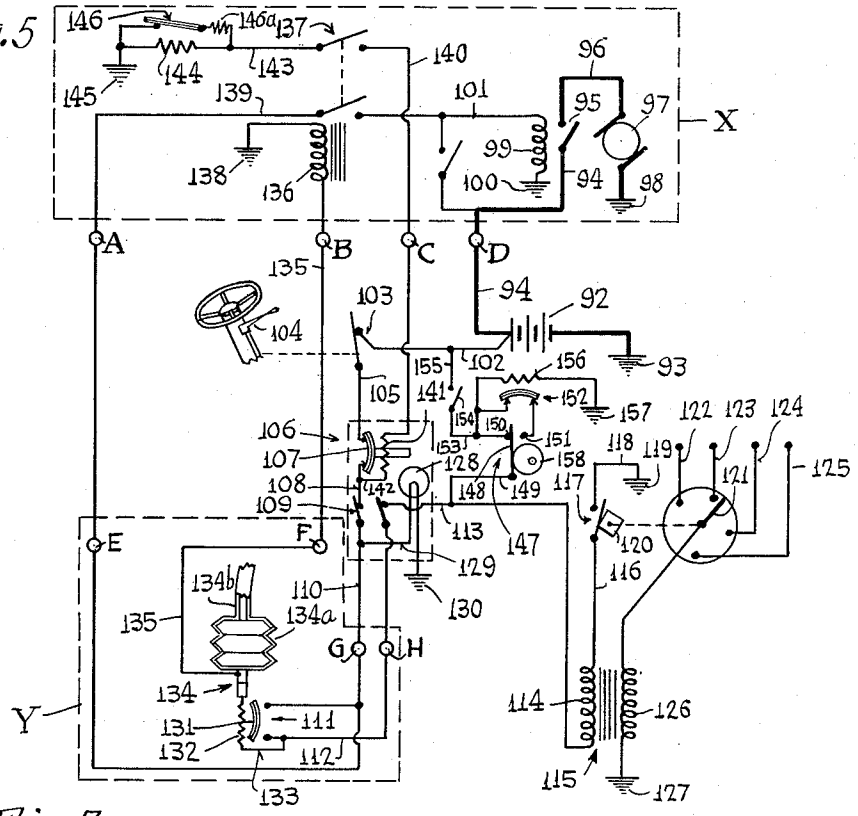


Fig. 7

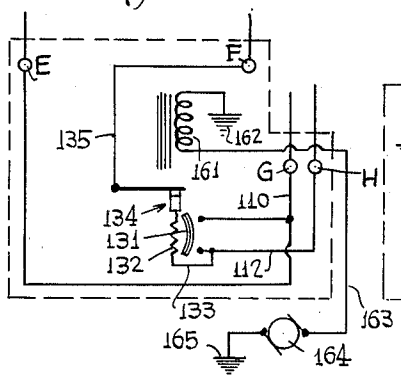


Fig. 6

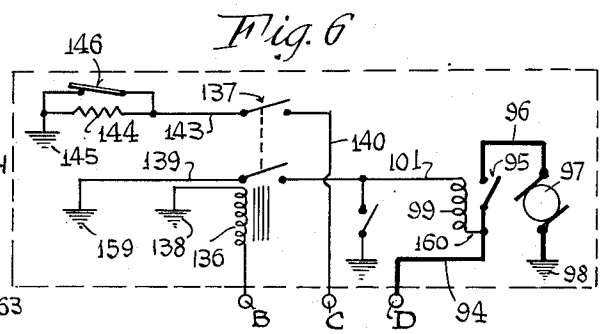
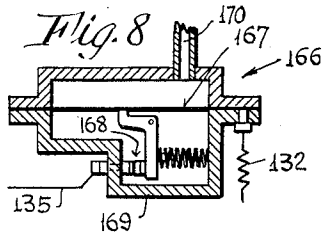


Fig. 8



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Fig. 9

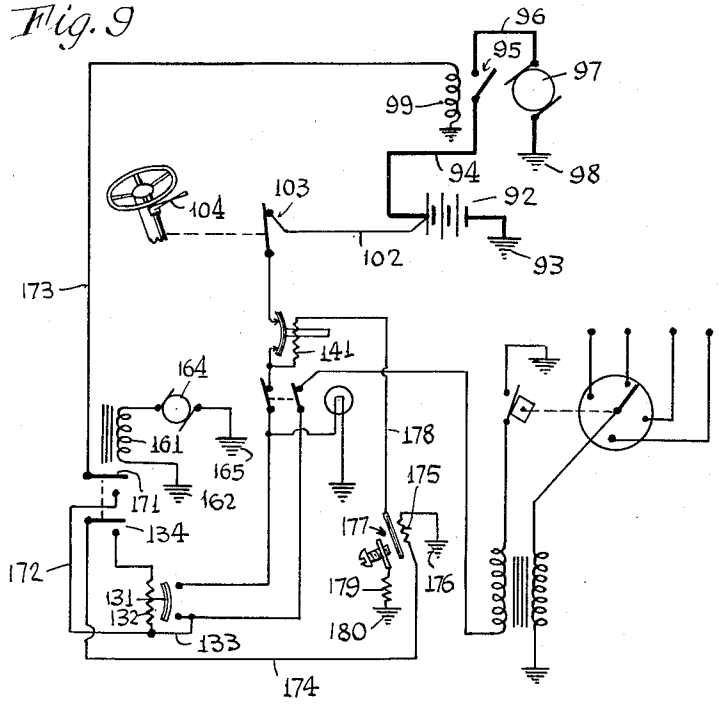
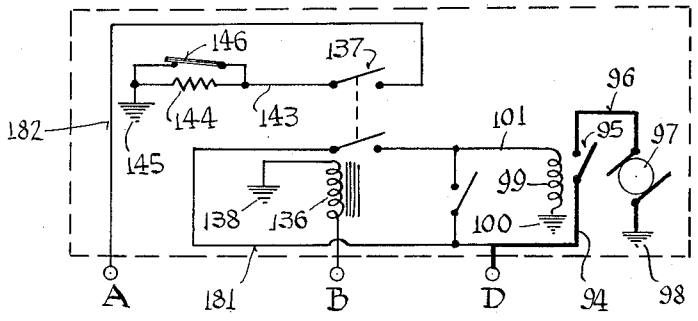


Fig. 10



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Patented Oct. 5, 1954

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UNITED STATES PATENT OFFICE

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INTERNAL-COMBUSTION ENGINE STARTER

Carl E. Lincoln, Marlboro, Vt.

Application September 14, 1951, Serial No. 246,658

3 Claims. (Cl. 290—38)

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This invention relates to powered outdoor equipment driven by internal combustion engines, as for example automobiles and the like, and more particularly to a mechanism for automatically controlling the engine. In several embodiments of the invention the mechanism periodically operates the engine when the equipment is idle in cold weather, to maintain engine temperatures above a predetermined value. In another embodiment of the invention the mechanism shuts off the engine after it has idled a predetermined time. The present invention is a continuation in part of my copending application, Serial No. 193,985, filed November 3, 1950, entitled Automatic Control for Internal Combustion Engine.

In this copending application there is described and claimed an automatic control employing a thermal cutout to render the control inoperative in the event that the internal combustion engine should fail to start after a number of attempts, for example three or four. This cutout is of the manually resettable type, and after functioning maintains the control inoperative until such time as the cutout is reset.

While the cutout of my application above referred to operated satisfactorily where temperatures were not extremely low, it sometimes did not function in sub-zero weather where temperatures dropped considerably below freezing. In other words, the effect of sub-zero ambient temperature at times prevented the cutout from operating to render the control inoperative, and in such event the control did continue to function and ultimately drained the battery or other source of power.

Also, in the control of my copending application the thermal cutout was warmed or actuated by a resistor placed in series with the feed circuit for the ignition coil, starter relay and other apparatus such as the heater motor, etc. Such series connection resulted in a voltage drop which therefore decreased the voltage available for the coil, relay, heater motor, etc., and while this voltage drop was of small magnitude it is nevertheless considered undesirable because of the reduced efficiency of storage batteries when subjected to low temperatures.

The above disadvantages of my prior control are overcome by the present invention, which has for its object the provision of an improved control of the type described which is reliably operative over a wide range of ambient temperatures including sub-zero, and the provision of a control which will not reduce the voltage available for the ignition coil, etc.

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Another object of the invention is to provide an improved control as above set forth, which is simple and economical to produce, and which is reliable in its operation.

In accomplishing the above objects I provide a control with thermal cutout wherein the heating current for the cutout is obtained through a shunt path, being different from the series current which passes through the cutout and which supplies the ignition coil and other equipment. Thus there is eliminated the objectionable voltage drop which characterized my prior construction and which served to decrease the voltage available for the electrical components required in starting the engine. The heating current in the shunt path required to energize the heater for the thermal cutout is relatively small and therefore does not appreciably affect the voltage of the supply or battery.

In the specific embodiments of the invention illustrated herein the shunt path in which the heater is connected includes a pair of auxiliary contacts on a relay forming part of the control, and by this organization energization of the heater for the thermal cutout can be effected only during the intervals when the engine is being cranked by the starter.

In one illustrated form of the invention the heater for the thermal cutout is provided with a tap connected in circuit with a bimetallic switch whereby a portion of the heater will be cut out automatically when the ambient temperature reaches a predetermined low value. With this construction the heater will draw higher current and provide more heat when the ambient temperature drops.

In another illustrated form of the invention a casing is provided around the thermal cutout, having a heating coil controlled by a bimetallic switch whereby the casing is electrically heated when the ambient temperature drops below a predetermined low value.

In accordance with this invention auxiliary equipment such as a car heater may be operated by the engine control, thereby to heat the interior of the car at the same time that the engine is being warmed up. The additional electrical load imposed by the heater motor will not appreciably detract from the voltage available for the ignition coil because of the elimination of the drop resistance in the thermal cutout.

A further object of the invention is to provide, in conjunction with the cold weather engine control, an improved and simplified automatic

engine shutoff means for an automobile which is used for delivery or pick-up service, such shutoff functioning in the event that the time of a call exceeds a predetermined duration, to shut off the idling engine and thereby save gasoline.

Still another object of the invention is to provide an improved delayed-action cutout to render the system inoperative in the event of repeated unsuccessful attempts to start, said cutout being reliable and at the same time simple and economical to fabricate.

Yet another object of the invention is to provide a greatly simplified engine control coordinated with the generator of the engine to effect deenergization of the starter motor.

Other features and advantages will hereinafter appear:

In the accompanying drawings:

Figure 1 is a schematic diagram of one form of improved engine control of the present invention, applied to an automobile.

Fig. 2 is a schematic diagram of a modified form of thermal cutout, for use with the circuit diagram of Fig. 1.

Fig. 3 is a schematic diagram of still another form of thermal cutout for use with the circuit of Fig. 1.

Fig. 4 is a side elevational view of the thermal cutout unit shown in Fig. 3.

Fig. 5 is a schematic diagram of an engine control illustrating another form of the invention, characterized by a single-pole shift-controlled switch and a double-pole manual on-and-off switch, together with automatic engine shutoff means for use where the vehicle is employed for delivery service.

Fig. 6 is a schematic diagram of a starter circuit and part of a control circuit, illustrating an insulated type of starter relay to replace part of the circuit of Fig. 5.

Fig. 7 is a schematic diagram illustrating a generator-controlled cutout switch to replace the vacuum control of Fig. 5.

Fig. 8 is a schematic diagram illustrating an oil pressure type of cutout, to replace the vacuum control of Fig. 5.

Fig. 9 is a schematic diagram of another form of improved engine control having a generator cutout and a simplified relay means.

Fig. 10 is a schematic diagram of a starter circuit and control circuit to replace part of the circuit of Fig. 5.

Referring to Fig. 1 there is shown an automobile engine control comprising a source of electricity such as a battery 10, having one side or terminal connected to a ground 11. The other side of the battery is connected with the starter circuit for the engine, comprising a wire 12 connected to a relay starting switch 13 which is in turn connected by a wire 14 with a starting motor 15 having a ground connection 16.

The relay switch 13 is actuated by the coil 17 having one end connected to the wire 12 and the other end connected to a wire 18 in turn connected to switch contacts 19 of a relay 20. The switch 19 is grounded at 21, and is actuated by a coil 20*a* connected to a ground 22.

Energization of the coil 20*a* closes the switch 19, effecting energization of the coil 17 which will in turn close the switch 13 and energize the starting motor 15 to crank the engine.

The engine has the usual ignition distributor 23 with rotor 24 joined to a cam 25 actuating breaker points 26 which are connected to a

ground 27 and a wire 28 joined to the primary 29 of an ignition coil 30. The coil 30 has a secondary 31 connected to a ground 32 and by means of a wire 33 to the rotor 24 of the distributor. The distributor has high tension leads 34, 35, 36 and 37 which are to be connected with spark plugs (not shown) all in the well known manner.

As in my copending application above referred to, the ignition coil primary 29 is connected through a wire, indicated as 38, to a heat responsive switch 39 arranged to close when the engine temperature drops below a predetermined value. The switch 39 may have a bimetallic actuator 40 and a heating element 41, the latter being connected to the wire 38 and to a contact 42 cooperable with a movable contact 43 which is actuated by a bellows 44 operated by vacuum introduced through a pipe line 45.

The pipe line 45 is to be connected to the intake manifold (not shown) of the automobile engine whereby operation of the engine will separate the contacts 42 and 43 as a consequence of the vacuum existing in the intake manifold.

The contact 43 is connected through a wire 46 to a double-pole single-throw switch 47 which is actuated by the shifting mechanism 48 of the automobile. Details of the shift-actuated switch may be found in my copending application above referred to. The organization is such that the switch 47 is closed only when the shifting mechanism is in neutral position, and is open at all times that the shifting mechanism is in any gear, either forward or reverse. The switch 47 is connected by a wire 49 with the relay coil 20*a*, and by a wire 50 with an ambient-temperature controlled switch 51, preferably bimetallic, said switch being connected by a wire 52 to the battery 10.

An ignition switch 53 is shown, connected by wires 54 and 55 respectively to the wires 38 and 52.

A manually operable starter switch 56 is connected by a wire 57 to the wire 18 and also connected to a ground 58, the switch 56 thus controlling the energization of the starter relay 13. Also, a heater motor 59 is connected with the wire 38 and with a ground 59*a* as shown, to be automatically controlled by the ignition switch 53.

In accordance with the present invention a novel and improved thermal cutout 60 is provided whereby the control system will be rendered inoperative whenever the engine fails to start after several unsuccessful attempts, as for instance three or four, said cutout being characterized by a heating means which is independent of current supplied to the equipment of the automobile such as the ignition coil 30, heater motor 59, relays 13 and 21, etc. By this organization there is obviated any undesired and disadvantageous voltage drop in the cutout 60, such as characterized the thermal cutout of my copending application above referred to. The present improved thermal cutout, instead of using a heater in series with the circuit supplying the electrical equipment of the car, utilizes a heater having a shunt connection with respect to said equipment. Accordingly, this equipment will have available the full voltage of the battery 10, without having detracted from it any voltage drop through a heater.

The present improved cutout comprises a bimetallic manually resettable switch 61 connected by a wire 62 to the shift controlled switch 47. The cutout 60 also includes a manually operable

on-off switch 63 connected by wires 64 and 65 respectively to the switches 61 and 39. A pilot light 66 is provided, connected to the wire 65 and to a ground 67.

Automatic actuation of the bimetallic switch 61 is accomplished by means of a heating coil 68 connected to the wire 64, and connected through a wire 69 to auxiliary contacts 70 on the relay 20, which are also connected to a ground 71.

Operation of the improved control shown in Fig. 1 is as follows: When the driver leaves the vehicle after operating it, the engine will be warm and the bimetallic switch 39 will be open as shown. If the driver desires the control to be operative, he closes the manual switch 63, and places the car in neutral, this latter closing the double-pole single-throw switch 47. These switch positions are indicated in Fig. 1.

The ambient temperature controlled switch 51 is normally closed in cold weather, being open only when the weather is so warm that a driver would not desire the control to be operative.

After the engine has been shut off and its temperature drops, a point will be reached where the bimetallic switch 39 closes. Upon this occurring, the ignition coil 30 will be energized, as will the heater motor 59 and the relay coil 20*a*. The latter will close the relay switches 19 and 70, resulting in energization of the starter relay 17, and energization of the starting motor 15. The engine will thus be cranked.

Upon the engine starting, the bellows 44 will be immediately actuated to separate the contacts 42 and 43, thereby de-energizing the relay coils 20*a* and 17 and de-energizing the starter motor 15. The engine will now continue to operate until its temperature rises to the point where the bimetallic switch 39 functions to open the circuit. This will disconnect the ignition coil 30 and result in the engine ceasing to operate.

If, after an initial cranking of the engine it should fail to start, the current passing through the heater 41 will create sufficient heat to open the bimetallic switch 39 without benefit of heat from the engine. Such action will disconnect the ignition coil 30, heater motor 59 and starting motor 15, together with the relay coils 20*a* and 17.

Upon this occurring a second attempt to start the engine will be automatically made as soon as the bimetallic switch 39 cools sufficiently in consequence of the heater 41 being de-energized.

The above cranking cycle will now be repeated when the switch 39 closes, and such repetition may occur several times until the engine starts.

If, after several attempts to start the engine it still does not start, the heat produced by the heater 68 will accumulate in the thermal cutout 60 and will actuate the switch 61 to permanently open the circuit. The switch 61 is of the type which requires being manually reset after it has once been actuated to open position. Thus there will be prevented further operation of the control, to unnecessarily drain the battery 10.

It will be observed that none of the current required by the ignition coil 30, heater motor 59, heater 41, or relay coil 20*a* passes through the heater 68. In other words, the heater 58 is not in series with the circuit supplying such equipment with current. Accordingly there is no voltage drop in said circuit due to the heater 68, and such equipment will be provided with the full voltage supplied by the battery 10. The heater 68 is instead connected in a shunt circuit comprising the wire 69, relay switch 70 and ground 71, said circuit being in shunt with the ignition coil 30, heater motor 59, etc. The said shunt circuit does not therefore reduce the voltage available for the ignition coil and other equipment, and this is an important advantage when it is considered that the efficiency of the battery 10 is materially decreased when it is subjected to very low temperatures, as for example sub-zero temperatures.

In Fig. 2 there is shown a novel, improved thermal cutout unit provided by the present invention, which is so arranged and constituted that it will operate with reliability even though subjected to sub-zero ambient temperatures.

The thermal cutout unit 72 shown in Fig. 2 has connecting wires 73, 74 and 75, and a ground connection 76 which may be respectively substituted for the wires 62, 69, 65 and the ground 67, with the cutout 72 substituted for the cutout 60 shown in Fig. 1.

The cutout unit 72 includes the manually operable switch 63 and the bimetallic switch 61. It also includes the pilot light 66. For the purpose of actuating the bimetallic switch 61 a heater 77 is provided, connected with the switch 63 and with the wire 74. The heater 77 has a tap 78 intermediate its ends, adapted to be engaged by a bimetallic switch arm 79 connected with one end of the heater 77 as shown. The bimetallic arm 79 is arranged to be normally open when ambient temperatures are not extremely low. However, when the ambient temperature falls to sub-zero values, the arm 79 will be actuated to engage the tap 78, thereby short circuiting part of the heater 77. Accordingly the heater will draw more current from the battery 10 and will produce a greater amount of heat to actuate the bimetallic switch 61. Thus the effect of the sub-zero ambient temperature is counteracted or compensated for, and such low temperatures will not result in the thermal cutout 72 being rendered inoperative. This is an important advantage in the device of the present invention in that it insures the control being rendered inoperative after several unsuccessful attempts to start the engine have been made, and thereby protects the battery 10 from being unnecessarily drained of energy.

Another cutout unit of the invention is illustrated in Figs. 3 and 4. The thermal cutout 80 in these figures has lead wires 81, 82 and 83 adapted to replace respectively the wires 62, 69 and 65 to enable the cutout 80 to be substituted for the cutout 60.

The thermal cutout unit 80 includes the manually operable switch 63, thermostatic switch 61 and heater 68. Also, it includes the pilot light 66 and ground connection 67.

Referring to Fig. 4, the thermal cutout 80 is provided with a casing 84 having a face plate 85 through which a reset button 86 for the switch 61 extends.

By the present invention the casing 84 is provided with a heating coil 87 having its ends connected with terminals 88 and 89. Within the casing 84 a second bimetallic switch 90 is located, connected in series with the heating element 87 and also connected with a ground 91.

The bimetallic switch 90 is so adjusted that it will remain open during cold weather which does not have abnormally low temperatures. If, however, the temperature becomes abnormally low, as for example sub-zero, the switch 90 will automatically close, connecting the heating coil 87 for energization. This will heat the casing 84 and

warm the air inside the casing, which surrounds the bimetallic switch 61. Accordingly, the switch 61 will operate in a normal manner in response to heat from the heater 63, and will not fail to function to render inoperative the control in the event that the engine fails to start after several tries.

An automobile engine control having a single-pole shift-controlled switch, and having a double-pole manual on-and-off switch, is shown in Fig. 5. The circuit of Fig. 5 includes a battery 92 connected with a ground 93, and by means of a wire 94 with a non-insulated type relay starting switch 95. The switch 95 is connected through a wire 96 with a starting motor 97 which is in turn grounded at 98. The relay starting switch 95 is controlled by a coil 99 having a ground 100 and having a lead 101 through which it is energized.

The battery 92 is connected by a wire 102 to a single-pole shift-controlled switch 103 actuated by the shift mechanism 104 of the vehicle. As in the circuit of Fig. 1, the switch 103 is open for all running positions of the shift mechanism 104, the exception being the neutral position for which the switch 103 is closed. A wire 105 connects the switch 103 with a thermal cutout unit 106 having a bimetallic, manually resettable switch 107 controlling the circuit of the wire 105. From the switch 107 a wire 108 connects to one pole of a double-pole manual on-and-off switch 109 connected by a wire 110 with a heat-responsive switch 111. From the switch 111 a wire 112 leads to the other pole of the manually operable switch 109, said other pole being connected through a wire 113 to the primary 114 of an ignition coil 115. The primary of the coil 115 also connects through the wire 116 with distributor points 117 connected by wire 118 with a ground 119. The distributor points 117 are actuated by a cam 120 coupled to a distributor rotor 121 arranged to feed spark plug wires 122, 123, 124 and 125. The rotor 121 is energized from the secondary 126 of the spark coil 115, said secondary being grounded at 127.

In the thermal cutout unit 106 a pilot light 128 is provided, connected by a wire 129 with the wire 110, the pilot light being grounded at 130.

The heat-responsive switch 111 has a bimetallic actuator 131 responding to a heating coil 132 connected by a wire 133 with the wire 112. The coil 132 is also connected with a cutout switch 134 in turn connected by a wire 135 with a magnet coil 136 of a double-pole relay 137, said coil being grounded at 138.

Automatic control of the switch 134 is effected by a bellows 134*a* connected with a vacuum line 134*b* of the car. The establishing of a vacuum in the line 134*b* will compress the bellows and open the switch 134. One pole of the relay 137 is connected with the wire 101 and also with a wire 139 which in turn connects with the wire 110. The other pole of the relay 137 is connected by a wire 140 with a heater coil 141 in the thermal cutout unit 106, said coil having its other end connected by a wire 142 to the wire 108. The said other pole of the relay switch 137 is also connected by a wire 143 to a heater coil 144 grounded at 145, and the coil 144 is bridged by a short-circuiting bimetallic switch 146 responding to heat from the coil by closing. If desired, a current-limiting resistor 146*a* may be connected in series with the switch 146.

In accordance with this invention, in conjunction with the above circuit novel and simplefied means are provided, to be made operative by the driver, for automatically shutting off the engine if it should be left idling for more than a predetermined length of time. This means is of advantage in certain circumstances, such as where the car is used for delivery service and the like, since an unexpectedly long call could result in the engine running uselessly for an extended period of time, wasting gasoline.

As shown, this shutoff comprises a single-pole double-throw switch 147 having its blade 148 connected by a wire 149 with the wire 113. The two contacts 150 and 151 of the switch 147 are bridged by a bimetallic heat-responsive switch 152 one terminal of which is connected by a wire 153 with the ignition switch 154, the latter being in turn connected by a wire 155 with the battery lead 102. The wire 153 is connected to a heater 156 which is grounded at 157. The blade 148 of the switch 147 may be manually actuated in any suitable manner, as by means of a cam or eccentric 158.

Operation of the improved control device shown in Fig. 5 is as follows: If in cold weather the operator intends to leave the car for any length of time and desires to have the engine temperature maintained above a point where starting is difficult, he closes the double-pole manually operable switch 109 and places the gear shift lever 104 in neutral position before leaving. Shifting the lever 104 to neutral closes the switch 103. The heat-responsive cutout 106 is normally closed. When the temperature of the engine falls below a predetermined value, the heat-responsive switch 111 will close, energizing the ignition coil 115 through the wires 102, 105, 108, 110, 112 and 113. At the same time the heater 132 and relay 137 will be energized through the circuit including the wires 133 and 135. The contacts of the relay 137 will thus be closed, energizing the starter relay switch 95 through the wires 139 and 101 and energizing the heaters 141 and 144 through the wires 142, 140 and 143.

Energization of the starter switch 95 will cause the engine to be turned over with the ignition on, and normally this will start the engine. Upon the engine starting, the bellows 134*a* will be immediately actuated by the vacuum in the line 134*b*, opening the switch 134 so as to de-energize the relay 137 and open the starting switch 95. The engine will now run at idling speed, or slightly faster depending on the throttle setting. After the engine has run for a predetermined length of time to raise its temperature, the bimetallic arm 131 will be actuated to open the switch 111, disconnecting the ignition coil 115 and stopping the engine. The cycle will then be repeated when the engine temperature again falls sufficiently to close the switch 111.

If, when the engine is initially turned over several times it will not immediately start, the circuit through the starter switch 95 will be opened as follows: Of the three heat-responsive switches 106, 146 and 111, the latter is made the quickest to react to its associated heater. Thus, if the engine does not start after a predetermined cranking, the circuit controlled by the switch 111 will be opened, disconnecting the ignition coil, the relay 137 and the starter switch 95. Another attempt to start the engine will be made when the bimetallic arm 131 cools as a consequence of disconnection of the heater 132. After several unsuccessful attempts to start the engine have been made, the heater 144 will have produced sufficient heat to close the bimetallic switch 146, and this will in turn cause a greater energization of

the heater 141 when the next try to start the engine is made. Such greater energization of the heater 141 will actuate the cutout 106 to permanently open the circuit until it is subsequently manually reset by the operator. Thus unnecessary drainage of energy from the battery 95 is prevented. Overload protection for the resistor 141 and cutout 106 is provided by the resistor 146a.

If the vehicle is to be used for delivery service where the driver lets the engine idle while making a call, the automatic engine cutoff feature of the invention may be brought into use. To do this, the driver actuates the eccentric 158 to bring the switch blade 148 into engagement with the contact 151. Normally the heat-responsive switch 152 is closed so that such actuation of the eccentric will connect the wire 153 through the switches 152 and 147 with the wire 113. When the vehicle if left with its engine idling the ignition switch 154 will normally be closed. This will cause current to flow through the heater 156 and after a predetermined interval of idling the heat generated will actuate the bimetallic switch 152 to open the circuit through the ignition coil 115 and thereby stop the engine. Upon the driver returning to the vehicle he can throw the switch 147 to the left and again start the engine.

It will be noted that in the circuit of Fig. 5 I have eliminated the double-pole shift-controlled switch shown in Fig. 1, and utilize instead a simple single-pole switch controlled by the shift lever more readily available on the market. Also the circuit of Fig. 5 utilizes an easily obtainable double-pole manually operable on-off switch in place of the single-pole on-off switch shown in Fig. 1, and incorporates the novel time delay for the thermal cutout 106, in the form of the heat-responsive switch 146 and heater 144 therefor

In Fig. 6 there is shown a circuit diagram incorporating an insulated type of starter switch, which may be replaced for the non-insulated starter switch 95 shown in Fig. 5. The circuit of Fig. 6 may be substituted for that portion of the circuit of Fig. 5 included in the rectangular broken outline X, and for convenience in making the substitution the wires 139, 135, 140 and 94 have been provided respectively with terminals A, B, C and D indicating where the separation and substitution of the circuit may be made.

Components illustrated in Fig. 6 which are similar to those of Fig. 5 have been given identical characters. The differences which characterize Fig. 6 are as follows: The wire 139 which in Fig. 5 has the terminal A is not brought out to such terminal in Fig. 6, but instead is grounded at 159. The end of the starter switch coil 99 which in Fig. 5 is grounded is not grounded in Fig. 6, but instead is connected by a wire 160 with the wire 94. Operation of the control with the circuit of Fig. 6 substituted for the corresponding portion in Fig. 5 is identical to that already described with the exception that the starter switch coil 99 has its polarity changed by virtue of the shifting of the ground, whereby the coil is grounded through a contact of the relay 137 instead of being permanently grounded (as shown in Fig 5) and energized through the contact of the relay 137.

In Fig. 7 a schematic diagram is shown, illustrating a generator controlled circuit breaker to be substituted for the pneumatic or vacuum-operated circuit breaker of Fig. 5. The circuit of Fig. 7 may be substituted for that portion of the circuit of Fig. 5 enclosed in the broken outline labelled Y, and for convenience in making the substitution the wires 139, 135, 110 and 112 have been provided respectively with terminals E, F, G and H. In Fig. 7 components which are identical to those found in Fig. 5 have been given like characters.

The cutout switch 134 in Fig. 7 is actuated by a magnet coil 161 grounded at 162 and connected by a wire 163 with the car generator 164 which is grounded at 165. Operation of the control apparatus with the circuit of Fig. 7 substituted for the corresponding portion of the circuit of Fig. 5 is similar in most respects, with the exception that when the engine starts up the current provided by the generator 164 will energize the coil 161 to open the switch 134, as distinguished from said switch being opened by the bellows 134a of Fig. 5.

In Fig. 8 there is shown a schematic diagram illustrating a cutout switch actuated in response to liquid pressure, such as oil pressure of a vehicle engine. The circuit of Fig. 8 may be substituted for the portion of the circuit of Fig. 5 enclosed in the broken outline Y, having the terminals E, F, G and H. Components of the circuit of Fig. 8 which are identical with those of Fig. 5 have been given like characters.

In Fig. 8 a pressure-responsive switch 166 is provided, having a movable diaphragm 167 controlling switch contacts 168 one of which is connected with the heater 132 and the other with the wire 135. The switch 166 has a casing 169 connected to an oil pressure line 170 of the vehicle engine. When the engine starts up, the oil pressure in the line 170 will separate the contacts of the switch 168, de-energizing the wire 135. This operation replaces the vacuum actuation of the switch 134 described previously in connection with Fig. 5.

Another embodiment of the invention is illustrated in Fig. 9. Components of the apparatus shown in this figure which are identical to those of Figs. 5 and 7 have been given like characters.

Considering the difference of the circuits, in Fig. 9 the magnet coil 161 controls not only the cutout switch 134 but also a second cutout switch 171 having one terminal connected by a wire 172 with the wire 133 and having its other terminal connected by a wire 173 with the starter switch coil 99. The cutout switch 134 is connected by a wire 174 with a heater 175 grounded at 176, said heater controlling a bimetallic switch 177 connected by a wire 178 with the thermal cutout heater 141. The switch 177 is connected to a resistor 179 which is grounded at 180.

In the operation of the control illustrated in Fig. 9, starting of the automobile engine will open the switches 134 and 171, de-energizing respectively the heater 175 and the coil 99 of the starter switch 95. If the automobile engine should not start after several repeated trials, the heat accumulated at the heater 175 will actuate the bimetallic switch 177 and close the latter, connecting the heater 141 in the circuit so that at the next unsuccessful attempt to start the engine, the thermal cutout 106 will be actuated to permanently open the circuit until it is again manually reset.

Fig. 10 shows a circuit diagram which may be substituted for the blocked portion X of Fig. 5 to effect several advantages. For example, in Fig. 5 four terminals A, B, C and D are utilized whereas with the circuit of Fig. 10 substituted, only the terminals A, B and D would be utilized, eliminating one lead wire. In addition to eliminating the lead connected with the terminal C,

there would also be eliminated the resistors 141 and 146a, thereby reducing the number of components required.

Another advantage provided by the circuit of Fig. 10 is that, where the starter relay 99 draws a very heavy current this will not affect the reset breaker 106, since the current for the starter relay will now be provided through the lead 94 from the battery 92 and not through the switch 106.

Parts in Fig. 10 which are similar to those of Fig. 5 have been given like characters. New parts or connections are as follows: A wire 181 connects the lower pair of contacts of the relay 137 with the wire 94. The current limiting resistor 146a is omitted from the circuit of the bimetallic switch 146. The upper pair of the relay contacts 137 is connected by a wire 182 to the terminal A, and said terminal is not now connected through wire 139 to the lower pair of contacts. Other connections are as previously described.

Operation of the apparatus incorporating the circuit of Fig. 10 is in general similar to that already described above, with the exception that the starter relay coil 99 receives its energization from the wire 181 connected to the cable 94, instead of being energized through the switches 109 and 106. Accordingly the switch 106 is independent of the current drawn by the relay coil 99, which varies with different cars and may in some instances be quite substantial.

It will be noted that, with the circuit of Fig. 10 substituted for the corresponding circuit in Fig. 5, the heating effect of current passing through the switch 106 is depended on to open the switch, rather than any transfer of heat from the heater 141 which is now omitted.

Variations and modifications may be made within the scope of the claims and portions of the improvements may be used without others.

I claim:

1. A control for an internal combustion engine having an electrical ignition circuit, comprising a single-pole double-throw manually operable switch having its blade and one contact connected in said ignition circuit; a heat-responsive switch connected across the contacts of the first-named switch; and a heater for said heat-responsive switch, having one end connected to the heat-responsive switch and having its other end grounded.

2. A control for an internal combustion engine having a starter circuit and a source of electricity, comprising means for connecting said circuit to said source when the engine is not running, in response to the engine temperature dropping below a predetermined value; and means for disconnecting said circuit and said source whenever said first connection persists beyond a predetermined time, including a thermostatic switch in said circuit and a heater for said switch, and including a second thermostatic switch series connected to said heater and a second heater bridged across the second thermostatic switch.

3. A control for an internal combustion engine having a starter circuit and a source of electricity, comprising means including a control circuit for connecting said starter circuit to said source when the engine is not running, in response to the engine temperature dropping below a predetermined value; and means for disconnecting said starter circuit and said source whenever said first connection persists beyond a predetermined time, including a thermostatic switch in said starter circuit and a heater for said switch, and including a second thermostatic switch series connected to said heater and a second heater for said switch, connected to said control circuit.

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