

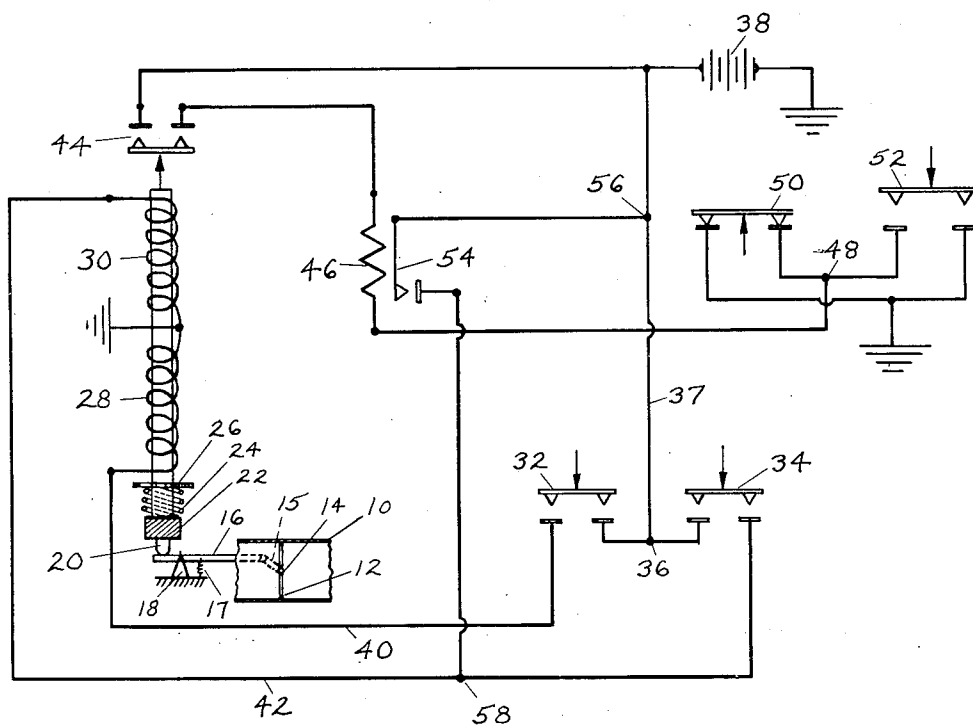
April 1, 1952

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2,591,184

CONTROL DEVICE

Filed June 24, 1949



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2,591,184

CONTROL DEVICE

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Application June 24, 1949, Serial No. 101,076

6 Claims. (Cl. 175—335)

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This invention relates to improvements in control devices. More particularly this invention relates to an improved control device that can be used to start and stop the operation of internal combustion engines.

It is therefore an object of the present invention to provide an improved control device that can be used to start and stop internal combustion engines.

In the operation of certain internal combustion engines, it is customary to stop the engines by preventing the flow of fuel to those engines. Control of the fuel flowing to a particular engine is readily effected by providing a valve in the fuel line of that engine and by providing an actuator for that valve. The actuator is preferably electrically operated, and it preferably "draws" current only when it actuates the valve. The present invention provides such an actuator by making a solenoid with a plunger of considerable magnetic retentivity and with a coil that has a magnetizing section and a de-magnetizing section. The plunger of considerable magnetic retentivity will respond to energization of the magnetizing section of the coil to move into valve-closing position, and its magnetic retentivity will enable it to coact with the residual magnetism of the coil to maintain itself in valve-closing position indefinitely. As a result, only a momentary energization of the magnetizing section of the coil is needed to move the plunger to valve-closing position and to cause it to remain in that position; and this minimizes current consumption. Return of the plunger to valve-opening position is effected by passing a current through the de-magnetizing section of the coil for a short period of time, thereby reducing the residual magnetism of the coil and plunger to values at which a spring can move the plunger. Again, current consumption is minimized since only a momentary passage of current through the de-magnetizing section of the coil is needed to reduce the residual magnetism. It is therefore an object of the present invention to provide a solenoid with a plunger having considerable magnetic retentivity and a coil having a magnetizing section and a de-magnetizing section.

The passage of current through the magnetizing and de-magnetizing sections of the coil of the solenoid is best controlled by normally-open push button switches. Where such switches are used, the current flow will cease as soon as the push buttons are released; and under such conditions the current can easily be provided by "dry" batteries. It is therefore an object of

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the present invention to provide push button switches that control the flow of current through the magnetizing and de-magnetizing sections of the solenoid coil.

5 The solenoid provided by the present invention can also protect the internal combustion engine against injury due to failure of the lubricating or cooling systems of that engine. This is done by providing a pressure-responsive switch that responds to variations in the pressure in the lubricating system of the engine, and by providing a temperature-responsive switch that responds to variations in the temperatures within the cooling system of the engine; and by having those switches energize the magnetizing section of the solenoid coil when the oil pressure decreases unduly or when the coolant temperature increases unduly. It is therefore an object of the present invention to provide a pressure-responsive switch and a temperature-responsive switch that selectively energize the magnetizing section of the coil of a solenoid.

When an internal combustion engine starts to operate, the pressure within the lubricating system of that engine will begin to rise, but that pressure may not immediately rise to normal operating levels. The engine can operate safely for short periods with less-than-normal pressures in the lubricating system, but it cannot do so indefinitely. It is therefore desirable to permit the engine to run for short periods of time even though the pressures in the lubricating system are abnormally low, but to stop the engine if the low pressure continues. The present invention makes this possible by providing a thermostatic switch in series with the magnetizing section of the solenoid coil and by providing a heating element in series with the pressure-responsive switch. The time required for the heating element to actuate the thermostatic switch will be long enough to enable the pressures in the lubricating system of the engine to rise to normal values if operating conditions are normal but will be short enough to cause energization of the magnetizing section of the coil, with consequent closing of the valve in the fuel line, if the pressure in the lubricating system of the engine continues to be abnormally low. It is therefore an object of the present invention to provide a thermostatic switch in series with the magnetizing section of a solenoid coil and to provide a heating element, adjacent that switch, in series with a pressure-responsive switch.

Other and further objects and advantages of the present invention should become apparent

from an examination of the drawing and accompanying description.

In the drawing and accompanying description a preferred embodiment of the present invention is shown and described but it is to be understood that the drawing and accompanying description are for the purposes of illustration only and do not limit the invention and that the invention will be defined by the appended claims.

The accompanying drawing is a schematic diagram of a solenoid with a plunger having considerable magnetic retentivity, and of the control circuit associated with that solenoid.

Referring to the drawing in detail, the numeral 10 denotes the fuel line of an engine which can be stopped by halting the flow of fuel to it. A valve 12 is provided in the fuel line 10, and that valve can be rotated in a counter-clockwise direction until it permits fuel to pass through line 10 to the engine; or it can be rotated to the position shown in the drawing to prevent fuel passing to that engine. The valve 12 is mounted on a shaft 14 which is pivotally supported within the fuel line 10; and a portion of that shaft extends outwardly beyond the fuel line 10 and supports a crank arm 15. A lever 16 is loosely pivoted to the end of crank arm 15, as by having an elongated hole or slot in the end of that lever; and that lever is also pivoted to a fulcrum 18. A tension spring 17 is connected to the lever 16, and that spring tends to rotate that lever in a clockwise direction. Such rotation opens the valve 12 by rotating the crank arm 15 in a counter-clockwise direction. Relative movement of lever 16 and crank arm 15 is possible, despite the fact that pivots 14 and 18 are fixed, because of the loose connection between the lever 16 and crank arm 15.

The other end of lever arm 16 projects beyond fulcrum 18, and that end will be selectively engaged by the plunger 20 of a solenoid. This plunger will preferably be made of high carbon iron or steel and will have considerable magnetic retentivity. Plunger 20 is disposed axially within de-magnetizing section 28 and magnetizing section 30 of the solenoid coil; and it will be biased for upward movement by a compression spring 24 that extends between a stationary frame element 22 and a collar 26 mounted on the plunger 20. The plunger 20 will respond to the lines of force generated in the magnetizing section 30 to move downwardly to the position shown in the drawing, thereby opening switch 44 and closing valve 12. That plunger will remain indefinitely in the position shown in the drawing because of the conjoint effect of the retentivity of the plunger and the residual magnetism in the coil. When, however, the residual magnetism in the coil is reduced, as by passing a current through the de-magnetizing section 28, the plunger 20 will move upwardly in response to spring 24 and will close switch 44 while permitting valve 12 to open.

The de-magnetizing section 28 of the solenoid coil will have fewer ampere turns than the magnetizing section 30; thus the section 28 will be unable to move the plunger 20 downwardly against the force of the spring 24. Instead the section 28 will only be able to reduce the residual magnetism in the solenoid coil to values at which the spring 24 can move the plunger 20.

The adjacent ends of the sections 28 and 30 of the solenoid coil are connected together and are connected to ground. The outer end of section 28 is connected to one terminal of a battery

38 by conductor 40, push button 32, junction 36, conductor 37, and junction 56. The outer end of section 30 is connected to that terminal of the battery 38 by conductor 42, junction 58, push button 34, junction 36, conductor 37, and junction 56. The other terminal of the battery 38 is connected to ground, and thus when one or the other of the push buttons 32 and 34 is pressed, a circuit is completed through one or the other of the sections of the solenoid coil; the section 28 being energized when push button 32 is pressed, and the section 30 being energized when push button 34 is pressed. The circuits through the sections 28 and 30 will be completed only as long as the push buttons 32 and 34 are pressed down, and as soon as the forces on those push buttons are released, those circuits will be opened.

The armature of the switch 44 is secured to the upper end of the plunger 20, and that armature spans the two spaced contacts of that switch. The switch 44 is disposed between the battery 38 and a heating element 46; and that heating element is selectively connected to ground by a pressure-responsive switch 50 or a temperature-responsive switch 52. The pressure-responsive switch 50 is closed whenever the pressure in the lubricating system of the engine is below a predetermined value, but that switch will open whenever that pressure reaches that value. The predetermined value is set so the switch 50 will be held open when the engine is operating normally, but will be closed when that engine is not operating or is not operating properly. The switch 52 is a temperature-responsive switch that responds to the temperature of the coolant in the engine, or to the temperature of the engine itself; and it is normally in open position. When the temperature of the coolant or of the engine itself rises above a predetermined level, the switch 52 will close.

When either of the switches 50 or 52 closes, at a time when the switch 44 is closed, a circuit will be completed from battery 38, through switch 44, through heating element 46, and through one of those switches to ground. As a result, current will flow through the heating element 46, and that current will generate heat in the heating element 46. That heat will affect the thermostatic switch 54; and if the current through the heating element 46 continues for an appreciable period of time, as for example sixty (60) seconds, the thermostatic switch 54 will close. The closing of the switch 54 will complete a circuit from the battery 38, through junction 58, through switch 54, through junction 56, through conductor 42, and through the magnetizing section 30 of the solenoid coil to ground; and this will cause the plunger 20 to move downwardly and open the switch 44 while closing the valve 12. If the current through the heating element 46 continues only for a shorter period, as when the oil pressure is below the predetermined value for a few seconds or when the temperature of the coolant or the engine itself rises above the predetermined level for a few seconds, the heat from the heating element 46 will be insufficient to close the thermostatic switch 54. In the latter cases, the engine can continue to operate without interruption. As a result, the control device provided by the present invention avoids needless interruptions due to harmless, short-duration transitory changes in oil pressure and coolant temperature, but will halt the engine long before any injury could occur.

It is important to note that the present inven-

tion does this without imposing a steady drain on the battery 38; current being drawn from that battery only when the engine is started and stopped, when the oil pressure is too low, or when the coolant temperature is too high. This is accomplished by having the push buttons 32 and 34 biased to open position, and by having the thermostatic switch 54 open except when the oil pressure is too low or the coolant temperature is too high.

The normal position of the plunger 20 is shown in the drawing; and that plunger is held in that position, against the biasing force of spring 24, by the coaction of the magnetic retentivity of that plunger and the residual magnetism of the coil. In that position, the plunger 20 holds valve 12 closed and holds switch 44 open; and no current will be drawn from the battery 38 since push buttons 32 and 34, as well as switch 44, are open. The plunger 20 can remain in this position indefinitely, thus avoiding all current drain from the battery during "off" periods of the engine. When the engine is to be started, the "start" push button 32 is momentarily pressed; and this completes a circuit from battery 38, through junction 56, junction 36, switch 32, conductor 40, and de-magnetizing section 28 to ground. Although this circuit will only be completed momentarily, the push button 32 opening that circuit as soon as it is released, sufficient current will flow through the de-magnetizing section 28 to reduce the residual magnetism of the solenoid coil to a value at which it cannot overcome the force of spring 24. Thereupon the plunger will move upwardly to close switch 44 and to permit spring 17 to open valve 12.

The opening of valve 12 will permit fuel to flow through the fuel line 10 to the engine, and the closing of switch 44 will permit current to flow through the heating element 46 because the pressure-responsive switch 50 will be closed. The heat from the heating element 46 will cause the thermostatic switch 54 to tend to move to closed position; but under normal operating conditions the pressure in the lubricating system of the engine will quickly rise to the value at which the switch 50 opens, and it will usually reach that value and open switch 50 before thermostatic switch 54 closes. Opening of the switch 50 will halt further flow of current through the heating element 46, and the thermostatic switch 54 will cool down and remain open.

The plunger 20 will remain in its upper position, under the action of spring 24, as long as the engine operates normally or as long as the "stop" push button 34 is not pressed; and it will remain in that position even if the pressure-responsive switch 50 or the temperature-responsive switch 52 closes for short periods of time. When, however, the engine fails to operate properly and the pressure-responsive switch 50 or the temperature-responsive switch 52 closes for more than a minute, or when the "stop" push button 34 is pressed, the plunger 20 will be actuated by the magnetizing section 30 of the solenoid coil. In case the pressure-responsive switch 50 closes, a circuit will be completed from battery 38, through switch 44, heating element 46, junction 48, and switch 50 to ground. The closing of that circuit will cause thermostatic switch 54 to close; and that will complete a circuit from battery 38, through junction 56, switch 54, junction 58, conductor 42 and magnetizing section 30 to ground. The closing of this latter circuit energizes the magnetizing section 30 of the coil; and the consequent move-

ment of plunger 20 will open switch 44 while closing valve 12. The engine will continue to run for a few minutes but will soon stop for lack of fuel. In case the temperature-responsive switch 52 closes, the circuit through the heating element 46 will be completed through switch 52 rather than switch 50, but the circuit through the thermostatic switch 54 will be completed in the same way. In case the "stop" push button 34 is pressed, a circuit will be completed from the battery 38, through junction 56, conductor 37, switch 34, junction 58, conductor 42, and section 30 to ground.

In each case, the plunger 20 will move to the position shown in the drawing and will be held there by the coaction of its magnetic retentivity and the residual magnetism of the solenoid coil. In that position of plunger 20, the switch 44 will be open and it will open the circuit through the heating element 46; and this permits the thermostatic switch 54 to cool and open the circuit through the section 30 of the solenoid coil. From this it is apparent that in either of the two positions to which plunger 20 can move, no current is drawn from battery 38 until one of the switches 32, 34, 50, or 52 is closed.

The de-magnetizing section 28 of the solenoid coil is wound in such a manner that it draws considerably more current than the heating element 46 or the magnetizing section 30 draw. This is a very important safety feature since it guarantees that if the battery 38 has enough electrical capacity to open valve 12, as by de-magnetizing the coil to permit the plunger 20 to move upwardly, that battery will have enough capacity to heat the heating element 46 and close thermostatic switch 54, and then to energize section 30 of the solenoid coil.

Whereas a preferred embodiment of the present invention has been shown and described in the drawing and accompanying description it should be obvious to those skilled in the art that various changes may be made in the form of the invention without affecting the scope thereof.

What I claim is:

1. A control device that comprises a solenoid coil, a solenoid plunger, said solenoid coil having a magnetizing section which can respond to momentary energization to move said solenoid plunger to energized position and to create a residual magnetism within said solenoid coil and a de-magnetizing section which can respond to momentary energization to reduce the residual magnetism within said solenoid coil, said solenoid plunger having sufficient magnetic retentivity to coact with residual magnetism in said coil to hold itself in magnetized position, a spring biasing said plunger out of magnetized position, a switch that is operated by said plunger and is in series relation with a heating element and with a condition-responsive switch, a normally open thermostatic switch that is adjacent said heating element and is in series relation with said magnetizing section of said coil, a normally open starting switch in series with said de-magnetizing section of said coil, and a normally-open stopping switch in series with said magnetizing section of said coil, said starting switch being closable to momentarily energize said de-magnetizing section of said coil so said spring can move said plunger to de-magnetized position and close said plunger-operated switch, said condition-responsive switch normally being open when said plunger is in de-magnetized position but being

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closable to energize said heating element and cause said thermostatic switch to close the circuit of said magnetizing section of said solenoid coil, said stopping switch being closable to momentarily energize said magnetizing section of said coil and move said plunger to magnetized position and open said plunger switch.

2. A control device that comprises a solenoid coil with two sections, a solenoid plunger selectively movable in response to energization of said sections, and a heating coil controlling a thermostatic switch, said thermostatic switch being in series with one of said sections of said solenoid coil, said one section of said solenoid coil and said heating coil having less resistance than the other section of said solenoid coil whereby a source of electricity having sufficient capacity to energize the other of said sections of said solenoid coil will have sufficient capacity to energize said one section of said solenoid coil and said heating coil.

3. A control device that comprises a solenoid plunger, a solenoid coil, a switch that is in series relation with said coil, a second switch that is in series with said coil but is in parallel relation with said first switch, said first switch being a manual switch, said second switch being a thermostatic switch, and a condition-responsive switch that is in series with a heating element, said heating element being adjacent to and in heat-transferring relation with said second switch, said condition-responding switch responding to a predetermined condition to energize said heating element and thereby cause heating of said second switch, said second switch responding to said heating to close the circuit to said coil.

4. A control device that comprises a solenoid plunger, a solenoid coil, a switch that is in series relation with said coil, a second switch that is in series with said coil but is in parallel relation with said first switch, said first switch being a manual switch, said second switch being a thermostatic switch, a switch that is actuated by said plunger, and a condition-responsive switch that is in series with said plunger-actuated switch and with a heating element, said heating element being adjacent to and in heat-transferring relation with said second switch, said plunger acting in a predetermined position to close said plunger-actuated switch so closure of said condi-

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tion responsive switch can energize said heating element.

5. A control device that comprises a solenoid coil, a solenoid plunger with sufficient magnetic retentivity to coast with residual magnetism in said coil to hold itself in magnetized position, a plunger-operated switch, a heating element, a condition-responsive switch, said plunger-operated switch and said heating element and said condition-responsive switch being in series, and a thermostatic switch that is in series with said solenoid coil and responds to changes in the heat from said heating element to energize said solenoid coil, said plunger-operated switch permitting energization of said solenoid coil when said condition-responsive switch is closed for a time sufficient to cause the heating element to actuate said thermostatic switch, said condition-responsive switch and said heating element and said thermostatic switch energizing said solenoid coil whenever a dangerous condition continues for an undue period of time.

6. Control apparatus that comprises a solenoid coil with a magnetizing section and a de-magnetizing section, and a plunger movable in response to energization of said sections, a thermostatic switch in series with said magnetizing section of said coil, a heating element adjacent to and in heat-transferring relation with said thermostatic switch, and a switch in series with said heating element to selectively initiate energization of said heating element, and thereby cause heating of said thermostatic switch, said thermostatic switch responding to said heating to close the circuit to said magnetizing section of said coil, said de-magnetizing section of said coil requiring more current than said magnetizing section and said heating element "draw."

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