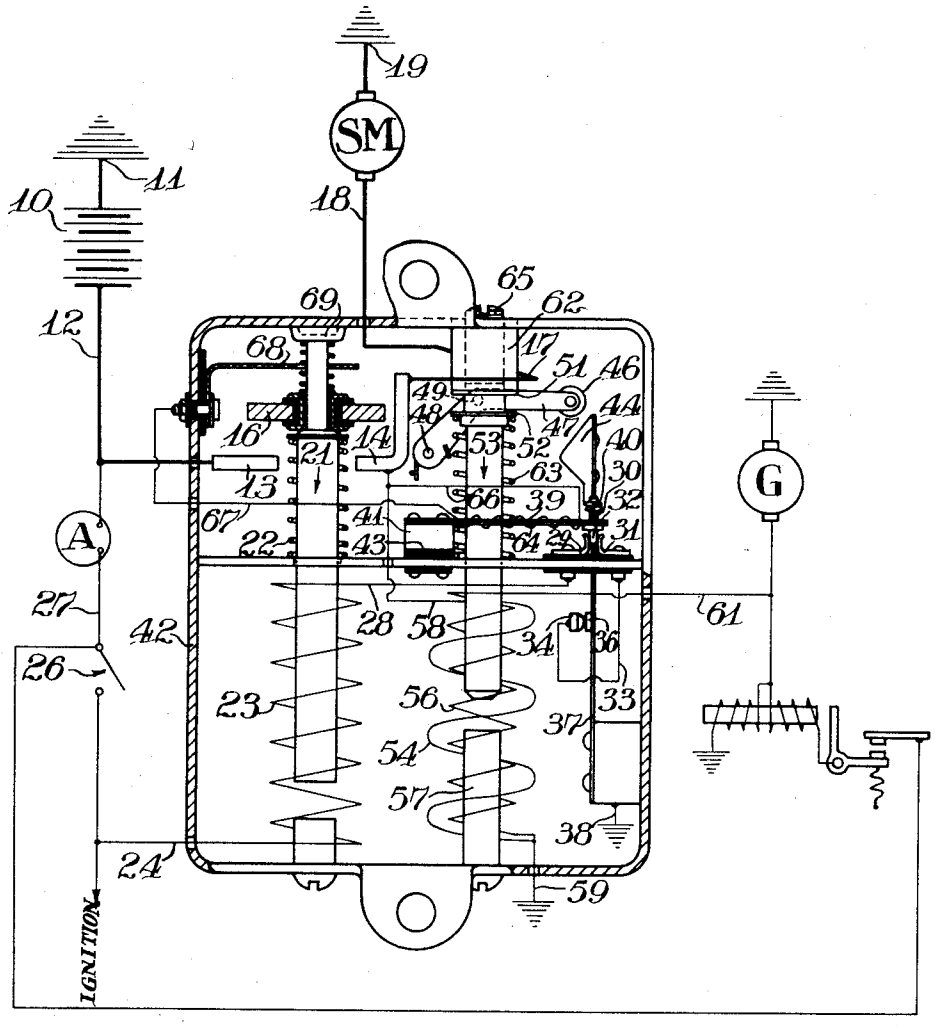
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AUTOMATIC STARTING MECHANISM FOR INTERNAL COMBUSTION ENGINES

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AUTOMATIC STARTING MECHANISM FOR INTERNAL COMBUSTION ENGINES

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This invention relates to automatic starting mechanism for internal combustion engines and more particularly to a device for protecting the starting mechanism and conserving the source of electrical energy in case the engine fails to start after a predetermined time of cranking, or in case the starting mechanism fails to crank the engine for any reason.

It is an object of the present invention to provide a novel automatic starting mechanism embodying means for opening the starting circuit after said circuit has been energized a predetermined length of time.

Another object is to provide such a device embodying means for releasing the starting switch.

Another object is to provide such a device in which said releasing means are arranged to automatically reset themselves at intervals.

A further object is to provide such a device in which the releasing means are actuated by a circuit controlled by the starting switch and therefore in shunt with the starting motor, but so arranged as not to interfere with the normal operation of the automatic starting mechanism.

Further objects and advantages will be apparent to those skilled in this art from the following description taken in connection with the accompanying drawing in which the figure is a semi-diagrammatic illustration of a preferred embodiment of the invention, the automatic starting switch elements being shown in elevation and partly in vertical section.

In the drawing there is illustrated a starting motor circuit including a battery 10 one terminal of which is grounded at 11 and the other terminal of which is connected by a lead 12 to an automatic starting mechanism comprising a starting switch having a stationary element 13 connected to the lead 12, a second stationary element 14, and a movable insulated bridging element 16. The stationary element 14 is connected through a single turn coil 17 and lead 18 to the starting motor SM which is grounded as indicated at 19 in order to complete the starting circuit.

The movable element 16 of the starter switch is mounted on a magnetic plunger 21 which is normally maintained in its upper position by suitable means such as a spring 22 but which may be drawn down to close the starting switch by a solenoid 23. Said solenoid is included in a control circuit which when closed causes said solenoid to be energized to close the starting switch. For this purpose the solenoid is connected at one end to the battery 10 by means of a lead 24, a manual switch 26, which may as indicated be the ignition switch of the internal combustion engine, and a lead 27 in which an ammeter A is inserted and which is connected to the battery lead 12. The other end of solenoid 23 is connected by a lead 28 to an insulated fixed contact 29. A corresponding insulated fixed contact 31 is mounted in spaced relation to the contact 29 and is adapted to be connected thereto by means of a movable bridging member 32. Contact 31 is connected by a lead 33 to a fixed contact 34 which is normally engaged by a movable contact 36 mounted on a spring strip 37 which is grounded as indicated at 38.

The bridging contact member 32 is formed on a bolt 30 mounted loosely in the free end of a heat responsive member 39 which is fixedly mounted at its opposite end in any suitable manner as indicated at 41, being insulated from the casing 42 of the automatic starting mechanism as shown at 43. The heat-responsive member 39 is so mounted that the bridging contact 32 is normally in engagement with the fixed contacts 29 and 31, as illustrated, but said member is adapted when heated to deflect upwardly, first engaging an adjustable stop 40 on the bolt 30 and thereafter withdrawing the contact 32 and opening the control circuit at that point.

Means are provided for automatically opening the control circuit when the engine starts, for holding said circuit open as long as the engine is self-operative, and for delaying the closing thereof until a predetermined time after the engine has come substantially to rest. As illustrated, these means include a wedge-shaped weight member 44 mounted on the free end of the spring strip 37 in the path of movement of a roller 46. Said roller is mounted on the end of a lever

47 pivoted at 48 and having a pin 49 at an intermediate point thereof projecting laterally between a pair of flanges 51 and 52 on a movable magnetic relay plunger 53. A voltage coil 54 and a generator coil 56 are arranged to surround the lower part of relay plunger 53 and, when energized, attract it downwardly into contact with a pole piece 57. The voltage coil 54 is connected at one end by a lead 58 to the stationary switch member 14 and is grounded at its other end as indicated at 59. Generator coil 56 is connected at one end by a lead 61 to the generator G and is also grounded at its other end at 59. Plunger 53 is normally retained in its upper position against a spacing sleeve 62 by means such as a spring 63 whereby the roller 46 is maintained as shown in the drawing out of contact with the weight member 44 so that contact 36 normally rests against fixed contact 34. A magnetizable core 65 is preferably adjustably mounted within the spacing sleeve 62 in order to regulate the magnetic effect of the single turn coil 17 on the plunger 53.

A heating element 64 is arranged to surround the heat-responsive member 39 and cause said member to break the control circuit at 29, 31 after the starting circuit has been closed for a predetermined time. For this purpose, said heating element is included in a releasing circuit which is adapted to be closed when the starting switch 13, 16, 14 is closed. As illustrated, this is accomplished by connecting one end of the heating element 64 to the stationary starting switch element 14 by a lead 66, and by connecting the opposite end of the heating element by a lead 67 to an insulated spring strip 68 having an aperture through which the upper end of starting switch plunger 21 is adapted to extend.

A collar 69 is fixedly mounted on the upper end of the plunger 21 in position to make contact with the spring strip 68 when the plunger is in its lower position, thus grounding said spring strip, and causing the completion of the releasing circuit through the heating element 64. It will be noted that by this arrangement, when the starting switch is open, the heating element 64 is disconnected both from the battery 10 and from the ground.

In the normal operation of the device, closure of the ignition switch 26 completes the control circuit from the battery 10 through lead 12, switch 26, lead 24, solenoid 23, lead 28, contacts 29, 32, 31, lead 33, contacts 34, 36, spring strip 37 and ground connection 38. The consequent energization of solenoid 23 causes the starting switch plunger 21 to close the starting switch, thus completing the starting circuit from battery 10, through lead 12, starting switch 13, 16, 14, single turn coil 17, lead 18, starting motor SM and ground connection 19, whereby the starting motor is caused to crank the engine. During this time the voltage coil 54 is energized by reason of its connection to the starting switch member 14 and to the ground connection 59, but the heavy current traversing the single turn coil 17 magnetizes the adjustable core 65 therein sufficiently to hold the plunger 53 in its upper position.

When the engine starts, the load on the starting motor is relieved, and the consequent reduction of the current through the single turn coil 17 together with the increase in voltage drop through the voltage coil 54 enables the latter to overcome the effect of the single turn coil 17 and draw the plunger 53 downward, causing the lever 47 to carry the roller 46 into engagement with the weight member 44 and bend the spring strip 37 backward sufficiently to open the contacts 36, 34.

The consequent opening of the control circuit causes the release of the starting switch plunger 21 whereby the spring 22 operates to open the starting switch. The relay plunger 53 is not immediately released, however, since the voltage coil 54 is traversed by a slight amount of current generated by the starting motor spinning by momentum in its residual field, this current being sufficient to hold the plunger 53 against its pole piece 57 until the starting motor has come substantially to rest. Before the voltage coil 54 becomes entirely deenergized, the generator G which is driven from the engine builds up sufficient voltage to energize the generator coil 56 and retain the relay plunger 53 in its lower position, thus holding open contacts 36, 34, as long as the engine is self-operative.

If the engine should stall for any reason, the coil 56 becomes deenergized and the spring 63 raises the relay plunger 53, releasing the weight member 44 which vibrates for a predetermined length of time due to its pendulous mounting on the spring strip 37, thus giving the engine time to come completely to rest. When the vibration ceases and the contact 36 comes to rest against the contact 34, the starting operation is repeated.

During the cranking operation, the heating element 64 is energized by the closure of the releasing circuit whereby the temperature of the heat-responsive member 39 is gradually raised, causing its free end to move upwardly away from contacts 29, 31. If the engine should fail to start after being cranked for a predetermined length of time, the heat-responsive member will be deflected sufficiently to engage the stop 40 and retract the contact 32 from its engagement with contacts 29, 31. The control circuit is thus broken and the starting switch thereby allowed to open.

It will be noted that since the releasing circuit is broken by the opening of the start-

ing switch, the heating element 64 will then be allowed to cool down and reclose the control circuit, causing a repetition of the energization of the starting circuit at increasingly frequent intervals. If the operator fails to open the ignition switch 26, the intermittent operation of the automatic switch members will make a clicking noise which will remind the operator to open the ignition switch and take the necessary steps to relieve the inoperative condition of the engine.

It will also be noted that, inasmuch as the releasing circuit is not grounded except when the starting switch is closed, this releasing circuit does not form a shunt for the voltage coil 54 at the time said coil is being energized by the spinning of the starting motor in its residual field. This is advantageous in that all of the slight amount of energy so supplied by the starting motor is utilized in energizing said voltage coil.

Although but one embodiment of the invention has been shown and described in detail, it will be understood that various other embodiments are possible, and certain changes may be made in the proportions and arrangements of the parts without departing from the spirit of the invention as defined in the claims appended hereto.

What is claimed is:

1. In automatic starting mechanism for internal combustion engines, a starting circuit including a source of electrical energy, a starting motor and a starting switch for controlling said motor, a control circuit including said source of energy and electromagnetic means for actuating said starting switch, means for opening said control circuit when the engine starts and for closing the same when the engine stalls, and a thermostatic switch energized by the closing of the starting switch for periodically interrupting said control circuit after a predetermined time.

2. In automatic starting mechanism for internal combustion engines, a starting circuit including a source of electrical energy, a starting motor and a starting switch for controlling said motor, a control circuit including said source of energy and electromagnetic means for actuating said starting switch, said control circuit including a make and break device and means for periodically operating said make and break device including a heat-responsive member and an electrical circuit established by closure of the starting switch, having a heating element for said heat-responsive member.

3. In automatic starting mechanism for internal combustion engines, a starting circuit including a source of electrical energy, a starting motor and a starting switch for controlling said motor, a control circuit including said source of energy and electromagnetic means for actuating said starting switch, said control circuit including a make and break device, a heat responsive member, a lost motion connection therebetween for operating said make and break device, and a heating element for said heat-responsive member, and means whereby closure of the starting switch energizes said heating element.

4. In automatic starting mechanism for internal combustion engines, a starting circuit including a source of electrical energy, a starting motor and a starting switch for controlling said motor, a control circuit including said source of energy and electro-magnetic means for actuating said starting switch, said control circuit including a make and break device, a heat-responsive member for operating said make and break device and a heating element therefor, means for connecting one end of said heating element to a dead element of the starting switch and means for grounding the other end of said heating element when the starting switch is closed.

5. In an automatic starting mechanism for internal combustion engines, a starting circuit, a control circuit therefor, means for closing the control circuit when the engine stalls and for opening the control circuit when the engine starts, and independent means for periodically interrupting the control circuit after the starting circuit has been closed for a predetermined length of time, said latter means including normally closed contacts in the control circuit and thermostatic means energized by closure of the starting circuit for periodically opening and closing said contacts.

6. In automatic starting mechanism for internal combustion engines, a starting circuit, a control circuit therefor including fixed and movable contacts, a thermostatic element, means for heating said element when the starting circuit is closed, a lost motion connection between the thermostatic element and the movable contact whereby heating of said element opens said contacts, said connection being adjustable whereby said contacts may be opened after the starting circuit has been closed for a predetermined length of time.

7. In an automatic starting mechanism for internal combustion engines, a starting switch including a battery, a starting motor and a switch for controlling said motor, a control circuit therefor, electro-magnetic means in shunt with said motor during cranking for opening said control circuit when the engine starts, and in series with the motor when the starting switch is open whereby it is energized by said motor to maintain said starting circuit open, and heat-responsive means energized from the starting circuit for opening said control circuit after a predetermined time of cranking.

8. In an automatic starting mechanism for internal combustion engines, a starting switch including a battery, a starting motor and a switch for controlling said motor, a control circuit therefor, electro-magnetic means in shunt with said motor during cranking for opening said control circuit when the engine starts, and in series with the motor when the starting switch is open whereby it is energized by said motor to maintain said starting circuit open, and heat-responsive means energized from the starting circuit for opening said control circuit after a predetermined time of cranking, said means including a heating element and means for connecting the same in shunt with said motor during cranking and for breaking the circuit therethrough when the starting switch is opened.

In testimony whereof I have signed this specification.

MAURICE P. WHITNEY.