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AUTOMATIC STARTER CONTROL

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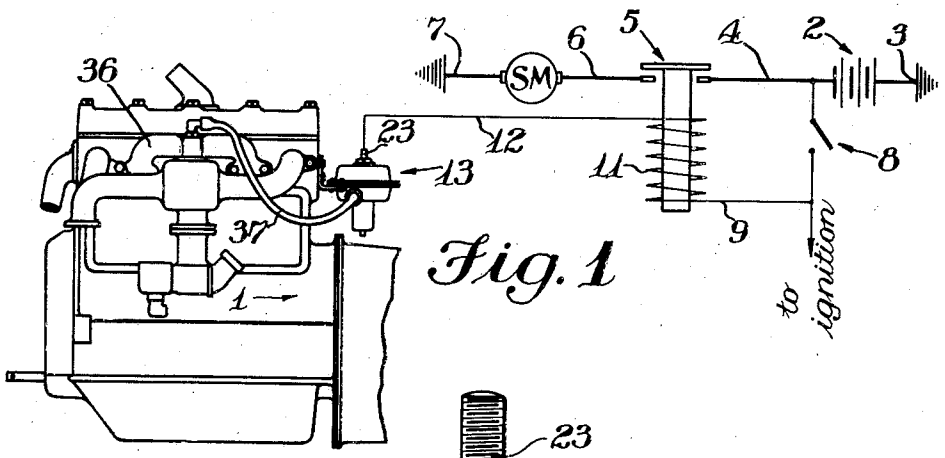


Fig. 1

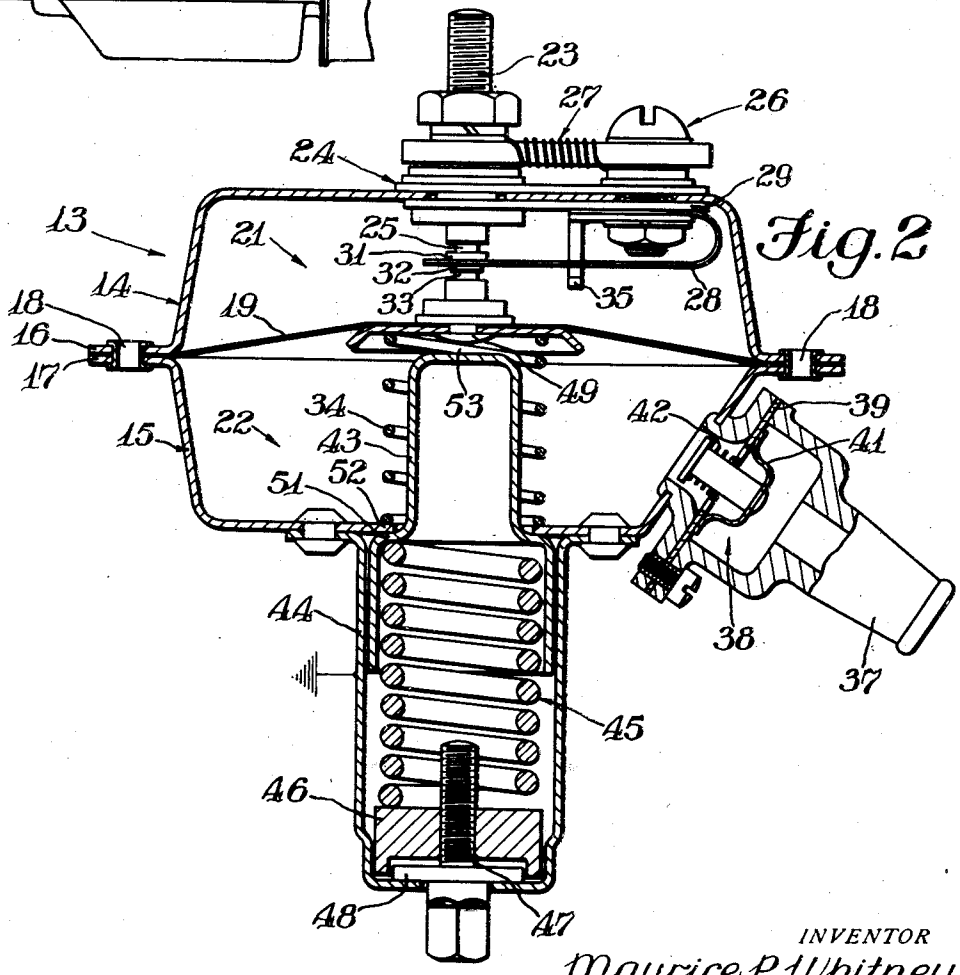


Fig. 2

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AUTOMATIC STARTER CONTROL

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This invention relates to an automatic starter control for internal combustion engines and more particularly a device for causing operation of the starting mechanism upon closure of the manual switch such as the ignition switch of the engine, and for automatically causing re-operation thereof in case of engine stall.

It is an object of the present invention to provide an automatic starter control which is efficient and reliable, but of simple construction and readily installed.

It is another object to provide such a device which provides for all normal conditions of operation without complication of structure.

It is another object to provide such a device which utilizes a single running function of the engine for the entire control of the operation.

It is another object to provide such a device which incorporates a single simple adjustment for adaptation to various installations.

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:

Fig. 1 is a semi-diagrammatic illustration of a preferred form of the invention; and

Fig. 2 is an enlarged view, partly in section, of the circuit controlling elements thereof.

Referring to Fig. 1, there is illustrated a starting system for an internal combustion engine 1 comprising a battery 2 grounded at 3 and connected by a lead 4 to an electromagnetic starting switch indicated generally at 5, which is connected by a lead 6 to a starting motor SM grounded at 7 to complete the starting circuit. A control circuit for the electromagnetic starting switch 5 is provided which includes battery 2, lead 4, manual switch 8, which is preferably the ignition switch of the engine, lead 9, solenoid 11 of the starting switch, lead 12, and a pressure-responsive circuit controlling device 13 which is grounded on the engine 1 to complete the control circuit.

Referring now to Fig. 2, it will be seen that the circuit controlling device 13 comprises a casing made of two cup-shaped halves 14 and 15 having peripheral flanges 16 and 17 suitably connected as by means of rivets 18. A flexible diaphragm 19 is located between the flanges 16 and 17 and forms a partition separating the casing into two chambers 21 and 22 and further constitutes an actuating element for a plurality of circuit controlling devices.

The casing element 14 has centrally mounted therein a binding post 23 forming the terminal connection of the lead 12 as illustrated in Fig. 1. The binding post 23 is insulated from the casing as indicated at 24 and terminates in a fixed contact 25 which projects within the chamber 21. A connecting post 26 is also mounted in the top of the casing element 14 insulated therefrom, and is connected to the binding post 23 by a resistance element 27. The inner end of the connecting post 26 serves to mount a spring strip 28 which is also insulated from the casing as indicated at 29 and the free end of which carries a contact member 31 arranged normally to engage the contact 25. A second contact 32, which may be integral with contact 31 is mounted on the opposite side of strip 28 in position to be engaged by a contact 33 carried by the diaphragm 19.

Diaphragm 19 is yieldably maintained in its upper position as illustrated by suitable means such as a spring 34 having a comparatively slight compressive force whereby contacts 25, 31, 32 and 33 are normally maintained in engagement. Contact 33 is grounded to the casing 14, 15 through the diaphragm 19 if the latter is made of conducting material, and in any case through the spring 34. It will thus be seen that under normal conditions the lead 12 is grounded through the controlling device 13 to the engine 1, but upon opening of contacts 25, 31, the resistance 27 will be introduced into the control circuit and upon opening of contacts 32, 33 the control circuit will be broken. A stop member 35 for the spring strip 28 is provided in order to cause contacts 32, 33 to open after the diaphragm 19 has been flexed downwardly a predetermined amount. It will be understood that the spring strip 28 is so tensioned as to cause the contact 32 to follow the contact 33 until it is stopped by the abutment 35.

Means responsive to a running function of the engine is provided for causing the diaphragm 19 to flex downwardly and open the circuit controlling devices formed by the sets of contacts 25, 31 and 32, 33 in sequence. As here shown, this means comprises a connection from chamber 22 to the intake manifold 36 of the engine to be started, in the form of a conduit 37. Means are preferably employed to delay the return of the diaphragm 19 to its normal position, such means being here shown as a check valve 38 located in the conduit 37 permitting rapid evacuation of chamber 22 but restricting the return of air thereto. The check valve herein illustrated comprises a perforated plate 39 and a cup-shaped valve member 41 having a radial flange arranged

to seat on said plate and being yieldably maintained thereagainst as by means of a spring 42. It has been found in practice that the seepage of air through the restricted passage formed between the plate 39 and valve member 41 as commercially produced without being ground together forms a very satisfactory time delay for this device.

According to the present invention, the resistance 27 is made sufficient to limit the current traversing the control circuit when contacts 25, 31 are open, to a mere holding value for the solenoid 11. That is, the current under these circumstances will be sufficient to hold the starting switch 5 closed but will be inadequate to effect closure thereof. Means are further provided for causing the pressure responsive diaphragm to operate the sets of contacts selectively by loading the diaphragm in corresponding stages. As here illustrated, this is accomplished by opposing the opening of contacts 32, 33 by a comparatively heavy resistance whereby an increased effect of the running function of the engine, namely a predetermined substantially higher vacuum is required to open said contacts. This means comprises a thimble 43 slidably mounted in a cylindrical extension 44 of the casing element 15, and maintained in its upper position by a comparatively heavy compression spring 45, the pressure of which may be adjusted by means of a nut 46 threaded on a stud 47 the head of which projects from the casing to permit easy adjustment thereof. The stud 47 is provided with packing means such as a flange 48 in order to prevent substantial leakage of air into the chamber 22. The upper end of the thimble 43 extends into proximity with an abutment on the diaphragm 19 such as the rivet head 49, the normal position of the thimble being determined by the engagement of a shoulder 51 thereon with the flange 52 of the casing element 15. The space 53 between the thimble 43 and rivet 49 when the parts are in normal position is so arranged that the rivet will engage the thimble prior to the engagement of the spring strip 28 with the stop member 35, so that it is necessary to overcome the pressure of the spring 45 in order to open contacts 32, 33.

In operation, starting with the parts in their idle position as illustrated, closure of the ignition switch 8 completes the control circuit, both sets of contacts being closed whereby solenoid 11 is energized to close the starting switch 5 whereupon the starting motor SM is energized from the battery 2 and cranks the engine in the usual manner. During cranking, a slight amount of vacuum is generated in the engine intake manifold which is transmitted through the conduit 37 to the chamber 22 and may be sufficient to compress the spring 34 slightly and open contacts 25, 31. This introduces the resistance 27 into the control circuit, but cranking is not interrupted since sufficient current traverses the control circuit including the resistance 27 to maintain the starting switch 5 closed.

When the engine becomes self-operative, the intake vacuum immediately rises to a substantial amount, whereby the diaphragm 19 is caused to compress the spring 45, opening the contacts 32, 33, thus breaking the control circuit and causing the starting switch 5 to open. This opening of contacts 32, 33 may be merely momentary, but when reclosure of these contacts takes place, the starting switch 5 is not reclosed since the resistance 27 does not permit sufficient current to traverse the control circuit to cause closure of the starting switch.

During self-operation of the engine, the vacuum in the intake manifold is at all times sufficient to maintain contacts 25, 31 open whereby undesired operation of the starting mechanism is prevented.

In case of engine stall, the intake vacuum being dissipated, the vacuum in the chamber 22 is slowly lost by means of seepage through the check valve 38 and after the predetermined time delay caused thereby, the contacts 31, 25 will be permitted to close, thereby causing reoperation of the starting mechanism. It will be understood that the time delay is arranged to be sufficient to allow the engine to come completely to rest before such restarting occurs.

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

What is claimed is:

1. In combination with an internal combustion engine, an electrical starting system therefor including a magnetic starting switch, a control circuit for said starting switch including means responsive to a running function of the engine for reducing the current flow through the control circuit to a holding value for the starting switch, and means responsive to an increased effect of said running function for opening said control circuit.

2. In combination with an internal combustion engine, an electrical starting system therefor including a magnetic starting switch, a control circuit for said starting switch including means responsive to intake vacuum in said engine to introduce a predetermined resistance in said control circuit, and means responsive to a predetermined increase in the intake vacuum to open said circuit.

3. In combination with an electrical starting system for internal combustion engines including a magnetic starting switch, a control circuit for said switch, a fluid-pressure operated mechanism actuated from a running function of the engine for causing the energization and deenergization of the control circuit in accordance with operating conditions of the engine including a pressure responsive device, a plurality of circuit controlling elements operated thereby to govern the energization of the control circuit, and means for operating said controlling elements selectively from the pressure responsive device including means for loading said device in a corresponding plurality of stages.

4. In combination with an electrical starting system for internal combustion engines including a magnetic starting switch, a control circuit for said switch, a fluid-pressure operated mechanism actuated from a running function of the engine for causing the energization and deenergization of the control circuit in accordance with operating conditions of the engine including an actuating element movable in response to intake vacuum of the engine, a plurality of circuit controlling elements arranged to be actuated thereby to govern the energization of the control circuit, means for offering a comparatively slight resistance to movement of the actuating element to operate one of said controlling elements, and means for offering a comparative-

ly heavy resistance to movement of the actuating element to operate another of said controlling elements.

5. In a starter control for internal combustion engines, a starting switch, an actuating element movable in response to intake vacuum of the engine, a control circuit for said starting switch including a plurality of circuit closing means arranged to be actuated by said movable element in sequence, means for offering a comparatively slight resistance to movement of the actuating element to open one of said circuit closing means, and means for offering a comparatively heavy resistance to movement of the actuating element to open another of said circuit closing means.

6. In a starter control for internal combustion engines, a starting switch and a control therefor responsive to the intake vacuum of the engine to be started including means for causing closure of said switch responsive to dissipation of the intake vacuum, means for causing a mere holding effect on said switch responsive to a predetermined minimum value of intake vacuum, and means for causing opening of the switch responsive to a predetermined higher value of intake vacuum.

7. In an automatic starter control for internal combustion engines, a starting circuit including an electromagnetic starting switch, a control circuit therefor including a set of normally closed contacts, means responsive to a predetermined minimum intake vacuum in the engine for introducing a resistance in the control circuit to reduce the current through the switch magnet to a mere holding value, and means responsive to a predetermined increase in intake vacuum to open said contacts and break the control circuit.

8. In an automatic starter control for internal combustion engines, a starting circuit including an electromagnetic starting switch, a control circuit therefor including two sets of normally closed contacts, a conductor bridging one set of contacts having such a resistance as to pass merely sufficient current to hold the starting switch closed, means responsive to engine rotation to open said one set of contacts, and means responsive to initial self-operation of the engine for opening the other set of contacts.

9. In an automatic starting control for internal combustion engines, a starting circuit including an electromagnetic starting switch, a control circuit therefor including two sets of normally closed contacts in series, a conductor bridging one set of contacts having such a resistance as to pass merely a holding current for the starting switch, means responsive to intake vacuum of the engine tending to open said contacts, means offering a slight resistance to the opening of said one set of contacts and means offering a comparatively heavy resistance to the opening of the other set of contacts.

10. In an automatic starting control for internal combustion engines, a starting circuit including an electromagnetic starting switch, a control circuit therefor including two sets of normally closed contacts in series, a conductor bridging one set of contacts having such a resistance as to pass merely a holding current for the starting switch, means responsive to intake vacuum of the engine tending to open said contacts, means offering a slight resistance to the opening of said one set of contacts, means offering a comparatively heavy resistance to the opening of the other set of contacts, means for adjusting said latter means, and means for delaying reclosure of the contacts for a predetermined time.

11. In an automatic starter control for internal combustion engines, a starting circuit including an electromagnetic starting switch, a control circuit therefor including two sets of contacts in series, one set being bridged by a predetermined resistance, a diaphragm arranged to open said two sets of contacts in sequence under the influence of the intake vacuum of the engine to be started, a comparatively light spring for opposing the opening of said one set of contacts and a comparatively heavy spring for opposing the opening of the other set of contacts.

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