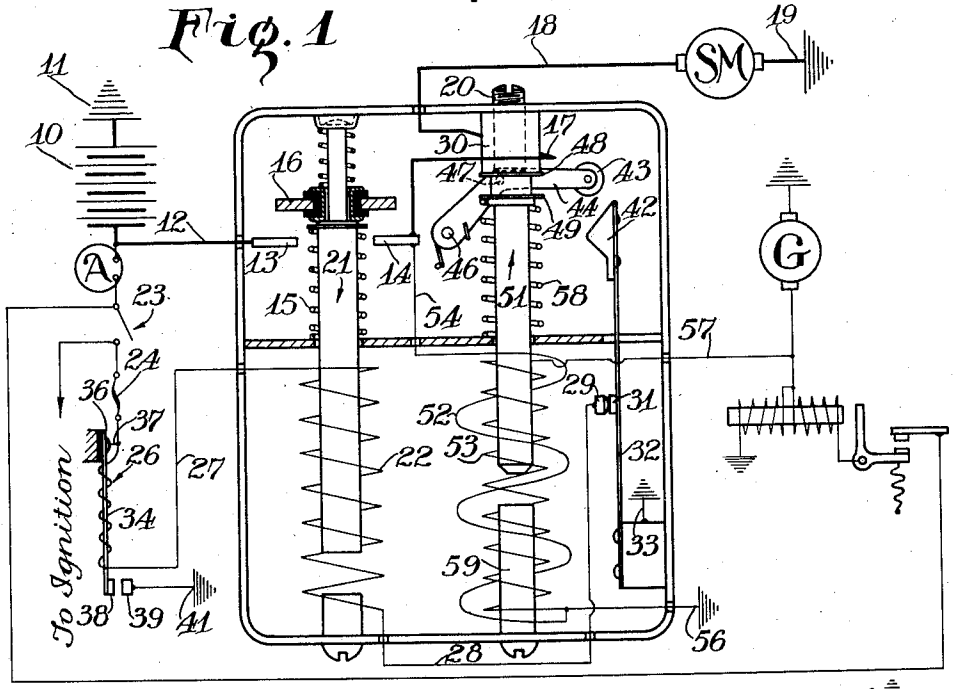
March 14, 1933. F. T. CHRISTIAN 1,901,285

AUTOMATIC STARTING MECHANISM FOR INTERNAL COMBUSTION ENGINES

Filed April 2, 1931 2 Sheets-Sheet 1

Fig. 1



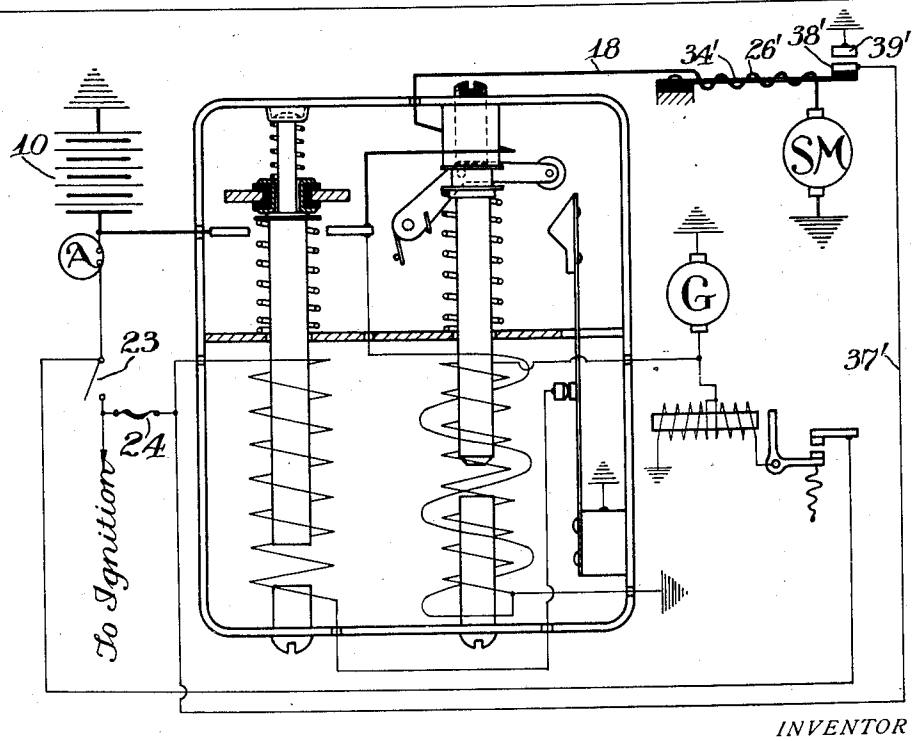


Fig. 2

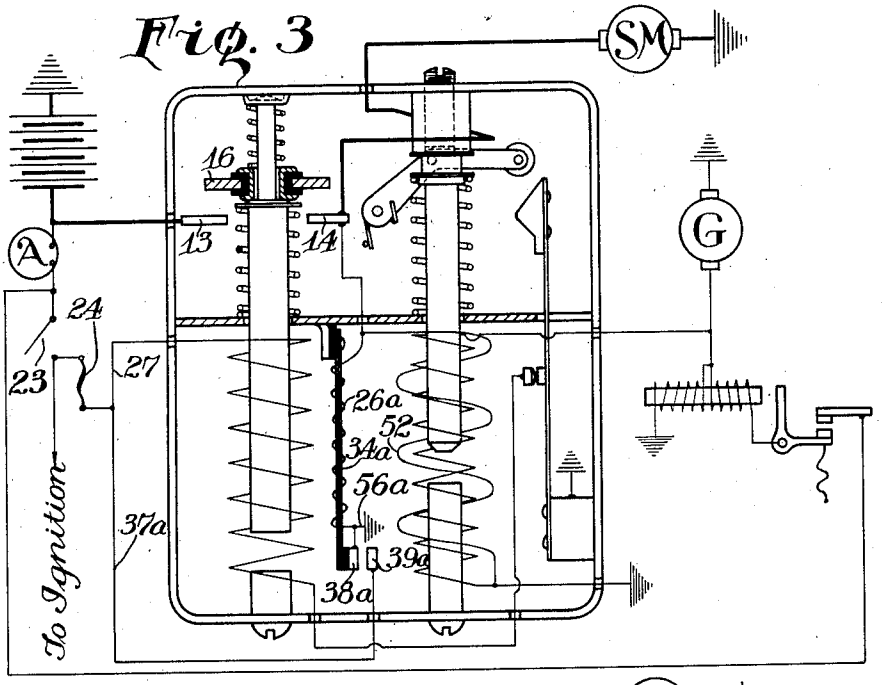
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AUTOMATIC STARTING MECHANISM FOR INTERNAL COMBUSTION ENGINES

Filed April 2, 1931 2 Sheets-Sheet 2

Fig. 3



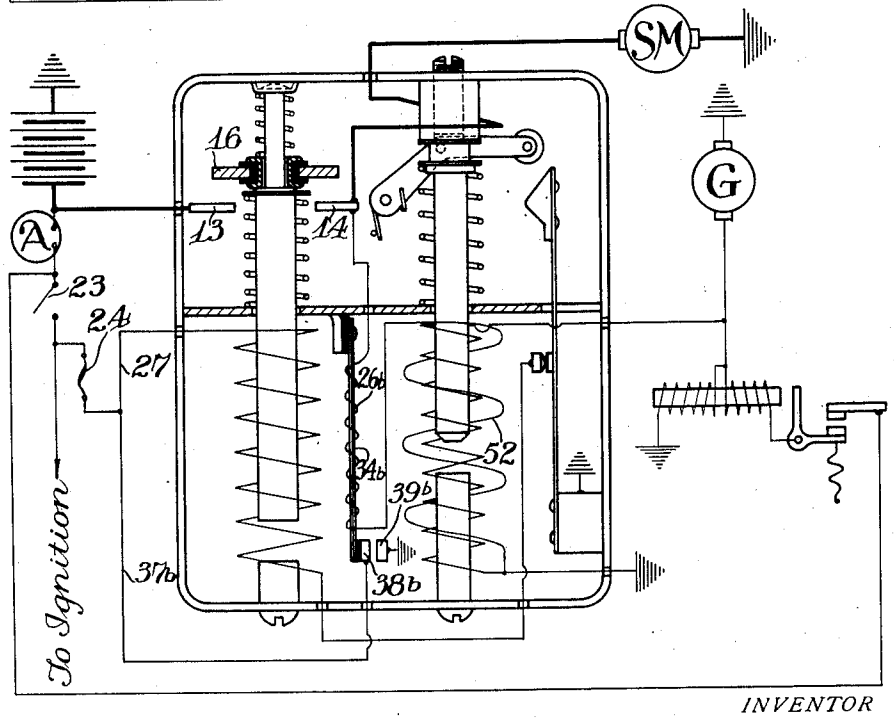


Fig. 4

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UNITED STATES PATENT OFFICE

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AUTOMATIC STARTING MECHANISM FOR INTERNAL COMBUSTION ENGINES

Application filed April 2, 1931. Serial No. 527,234.

This invention relates to automatic starting mechanism for internal combustion engines and more particularly to a device for protecting the starting mechanism and the power source thereof. In case the engine fails to start after a predetermined time of cranking or in case of sustained overloading of the starting mechanism such as would be caused for instance by an attempt to start a motor vehicle with the transmission gears engaged and the brakes set, or by jamming of the starting gearing due to failure to secure proper mesh thereof.

In automatic starting mechanism of the type in which the stalling of the engine causes automatic operation of the starting mechanism until the engine becomes once more self-operative, failure of the engine to start, either by reason of a failure of the engine to function, or by reason of locking or jamming of the starter gearing causes the starting circuit to remain closed, whereby the starting motor may become overheated and the battery charge will become rapidly depleted.

It is an object of the present invention to provide an automatic starting mechanism embodying a novel means for opening the starting circuit if the starting motor fails to start the engine within a predetermined time.

Another object is to provide such a device in which the time interval is secured by means of a heat responsive device having a heating element that is energized when the starting motor is energized.

A further object is to provide such a device in which, when the device has functioned, the starting circuit will remain open until the operator has performed some act such as replacing a fuse, to put the automatic starting mechanism once more in operative condition.

Further objects and advantages will be apparent to those skilled in this art from the following description taken in connection with the accompanying drawings in which:

Fig. 1 is a semi-diagrammatic illustration of one preferred embodiment of the invention, the automatic starting switch elements being shown in elevation and partly in section;

Fig. 2 is a similar view of a second embodiment of the invention;

Fig. 3 is a similar view of a third embodiment of the invention; and

Fig. 4 is a similar view of a fourth embodiment of the invention.

In Fig. 1 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 switch comprising stationary elements 13 and 14 and the insulated bridging element 16. The stationary switch element or conductor 14 is connected through a single turn coil 17 and lead 18 to the starting motor SM which is grounded at 19 and is adapted when energized to crank an internal combustion engine, not illustrated.

The single turn coil 17 is provided with an adjustable magnetic core 20 surrounded by a spacing sleeve 30.

The bridging switch element 16 is mounted on a movable magnetic plunger 21 which is normally maintained in its upper position by means such as a spring 15, but which may be drawn down to close the starting switch by a solenoid 22. Said solenoid is included in a control circuit which when closed causes the solenoid 22 to be energized to close the starting switch. According to this embodiment of the invention, the control circuit comprises an element adapted to rupture the control circuit in case of an overload thereon, and a heat responsive means for causing such an overload to take place after a predetermined drain on the starting battery has taken place. As illustrated, in Fig. 1, the control circuit comprises the battery 10, ammeter A, manual switch 23, which may also serve, as indicated, as the ignition switch for the internal combustion engine, fusible element 24, heating element 26, lead 27, solenoid 22, lead 28, fixed contact 29, and movable contact 31 mounted on a conducting spring strip 32 which is grounded as indicated at 33. The spring strip 32

normally holds the contact 31 against the fixed contact 29 whereby closure of the manual switch 23 by the operator will cause a current to flow through the control circuit, whereby the solenoid 22 is energized to close the starting switch, and the element 26 gradually becomes heated.

A heat responsive element 34 such as a bimetallic strip is fixedly mounted at one end as indicated at 36 and is arranged to be surrounded by the heating element 26 so as to be heated thereby while suitably electrically insulated therefrom. The fixed end of the member 34 is connected to the control circuit as indicated at 37 and the free end carries a contact 38 adapted to cooperate with a fixed contact 39 which is grounded as indicated at 41. The member 34 is arranged so that contact 38 is normally spaced from contact 39, but when the member 34 becomes sufficiently heated, it will bend to the right in Fig. 1 and cause contact 38 to engage contact 39, thus grounding the control circuit and causing the fuse 24 to blow.

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 42 mounted on the end of the spring strip 32 in the path of movement of a roller 43. Said roller is mounted on the end of a lever 44 pivoted at 46, and having a pin 47 at an intermediate point thereof projecting laterally between a pair of flanges 48 and 49 on a movable magnetic relay plunger 51. A voltage coil 52 and a generator coil 53 are arranged to surround the lower part of the relay plunger 51 and when energized attract it downwardly. The voltage coil 52 is connected at one end by a lead 54 to the stationary switch member 14 and is grounded at its other end as indicated at 56. Generator coil 53 is connected at one end by a lead 57 to the generator G and is also grounded at its other end at 56. Plunger 51 is normally retained in its upper position against the spacing sleeve 30 by means such as a spring 58 whereby the lever 44 is maintained as illustrated out of contact with the weight member 42 so that contacts 29 and 31 are normally closed.

In the normal operation of the device, closure of the ignition switch 23 causes the solenoid 22 to close the starting switch 13, 14, 16 as above stated, thus completing the starting circuit from battery 10, through lead 12, 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 52 is energized by reason of its connection to the starting switch member 14, but the heavy current traversing the single turn coil 17 magnetizes the adjustable core 20 therein sufficiently to hold the plunger 51 in its upper position.

If the engine becomes self-operative after a reasonable amount of cranking, the load on the starting motor is thereupon relieved, and the consequent reduction of the current through the single turn coil 17 together with the increase of voltage drop through the voltage coil 52 enables the latter to overcome the effect of the single turn coil 17 and draw the plunger 51 downwardly causing the lever 44 to carry the roller 43 into engagement with the weight member 42 and bend the spring strip 32 backward sufficiently to break the contacts 29, 31.

The consequent opening of the control circuit causes the deenergization of the solenoid 22, thus releasing the switch plunger 21 whereby the spring 15 operates to open the starting switch. The relay plunger 51 is not immediately released, however, since the voltage coil 52 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 51 against its pole piece 59 until the starting motor has come substantially to rest. Before the voltage coil 52 becomes entirely deenergized, the generator G which is driven from the engine builds up sufficient voltage to energize the generator coil 53 and retain the relay plunger 51 in its lower position, thus holding open the contacts 31, 29, as long as the engine is self-operative.

If the engine should stall for any reason, the coil 53 becomes deenergized and the spring 58 raises the relay plunger 51 releasing the weight member 42 which vibrates for a predetermined length of time due to its pendulous mounting on the spring strip 32, thus giving the engine time to come completely to rest. When the vibration ceases and the contact 31 comes to rest against the contact 29, the starting operation is repeated.

If, however, when the ignition switch is closed, the engine should fail to start owing to improper functional conditions or to a jamming of the starting gearing the control circuit will remain closed and the heating element 26 will continue to heat the bimetallic strip 34 until the latter flexes sufficiently to cause contact 38 to engage contact 39. The consequent grounding of the control circuit causes the fuse 24 to blow as above pointed out, thus opening the control circuit and causing it to remain open until the operator corrects the functional condition of the engine or starting gearing and replaces the fuse 24. The elements of the starting circuit are thus protected from prolonged energization such as might cause overheating thereof and the starting battery

is protected from unnecessary or unduly prolonged discharge thereof.

Figs. 2, 3 and 4 illustrate other embodiments of the invention in which the heat responsive element is located in different relations to the various circuits of the automatic starting mechanism, but in which the elements of the automatic starting mechanism are the same as illustrated in Fig. 1 and are similarly numbered. In Fig. 2, the heating element of the heat responsive means is located in the starting circuit in order to be heated by the current flowing to the starting motor. The elements of the automatic starting mechanism are the same as illustrated in Fig. 1, and are numbered in correspondence therewith. A heating element 26′ is inserted in the lead 18 of the starting motor circuit and a bi-metallic element 34′ is placed therein to be heated thereby. The bi-metallic element carries a contact 38′ which is connected by a lead 37′ to the control circuit at one terminal of the fusable member 24, the fuse being arranged between this connection and the ignition switch 23. A grounding contact 39′ is arranged adjacent the movable contact 38′ whereby heating of the bi-metallic member 34′ will cause contact 38′ to engage contact 39′, grounding the connection 37′, thus causing the fuse 24 to blow and thereby open the control circuit.

In Fig. 3 the heating element 26^a is placed in parallel with the voltage coil 52 so as to be energized when the starting switch 13, 16, 14 is closed. A bi-metallic element 34^a is mounted within the heating element 26^a and carries at its free end a contact 38^a which is connected to the end of the heating element 26^a and grounded therewith at 56^a. A fixed contact 39^a is mounted adjacent the movable contact 38^a and is connected by a lead 37^a to the lead 27 of the control circuit. It will thus be seen that closure of the starting switch 13, 16, 14, will cause the heating of the bi-metallic element 34^a, causing the contact 38^a to engage and ground the contact 39^a, thus grounding the control circuit and blowing the fuse 24.

In Fig. 4, a heating element 26^b is connected in series with the voltage coil 52 and a bi-metallic element 34^b arranged therein is provided at its free end with a contact 38^b which is connected by a lead 37^b to the lead 27 of the control circuit. A fixed grounding contact 39^b is arranged adjacent the movable contact 38^b. In this embodiment of the invention, closure of the starting switch 13, 16, 14 causes the bi-metallic element 34^b to be heated thereby causing contact 38^b to engage the grounding contact 39^b thus grounding the control circuit and blowing the fuse 24.

It will be noted that in all the embodiments of the invention illustrated, a heating element is provided which is energized concomitantly with the energization of the starting motor, which heating element causes the starting motor circuit to be opened after a predetermined length of time as determined by the thermal constants of the heat-responsive element.

Although certain embodiments of the invention have been shown and described in detail, it will be understood that various other embodiments are possible and certain changes may be made in the structure and arrangement of the parts thereof 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, electrical starting and ignition circuits therefor, said starting circuit including a battery and a motor, said ignition circuit including an ignition switch, electro-magnetic means whereby closure of the ignition switch causes closure of the starting motor circuit, means whereby said starting motor circuit is opened when the engine starts, means for limiting the time of cranking the engine by opening said starting motor circuit in case the engine fails to start after a predetermined time of cranking, means for delaying for a predetermined time the effective reclosure of the starting motor circuit in case of engine stall, said means for limiting the time of cranking being arranged to prevent reclosure of the starting motor circuit until reset by the operator.

2. In combination with an internal combustion engine, electrical starting and ignition circuits therefor, said starting circuit including a battery and a motor, said ignition circuit including an ignition switch, electro-magnetic means whereby closure of the ignition switch causes closure of the starting motor circuit, means whereby said starting motor circuit is opened when the engine starts, means for limiting the time of cranking the engine by opening said starting motor circuit in case the engine fails to start after a predetermined time of cranking, means for delaying for a predetermined time the effective reclosure of the starting motor circuit in case of engine stall and means whereby said time delaying means also delays the actuation of the means for limiting the time of cranking.

3. In combination with an internal combustion engine, electrical starting and ignition circuits therefor, said starting circuit including a battery and a motor, said ignition circuit including an ignition switch, electro-magnetic means including a control circuit whereby closure of the ignition switch causes closure of the starting motor circuit, means for opening the control circuit to cause opening of the motor circuit when

the engine starts, means for delaying effective reclosure of the control circuit for a predetermined time after engine stall, and means for limiting the time of cranking the engine in case the engine fails to start including means for breaking the control circuit responsive to excessive current flow therethrough and means for applying an overload to said control circuit after a predetermined time of cranking.

In testimony whereof I have signed this specification.

FRANK T. CHRISTIAN.