March 31, 1936. P. H. MAURER 2,035,820

AUTOMATIC STARTER CONTROL

Filed April 26, 1934 2 Sheets-Sheet 1

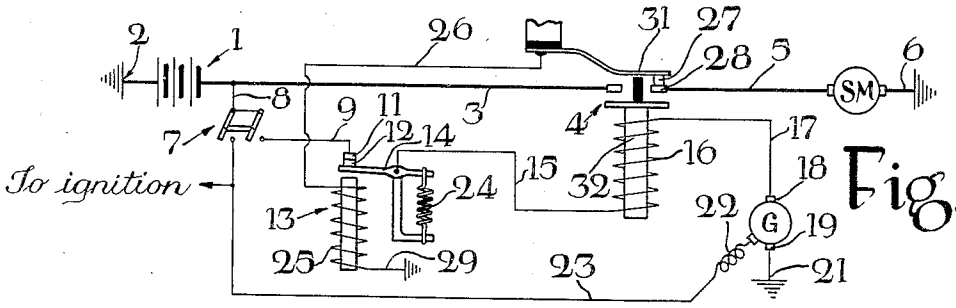


Fig. 1

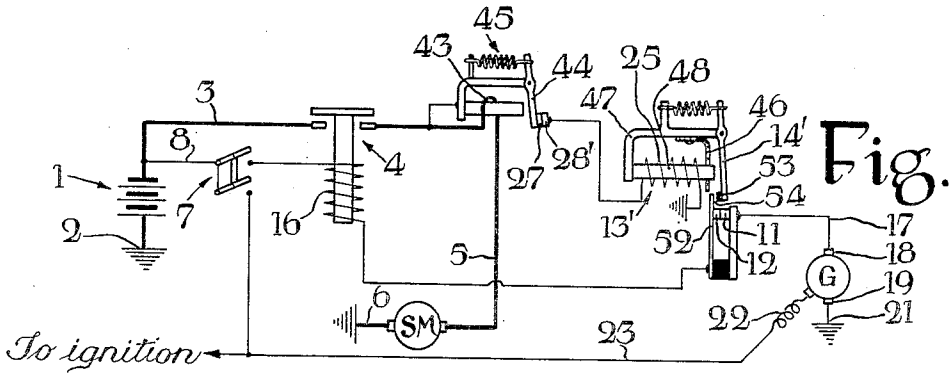


Fig. 2

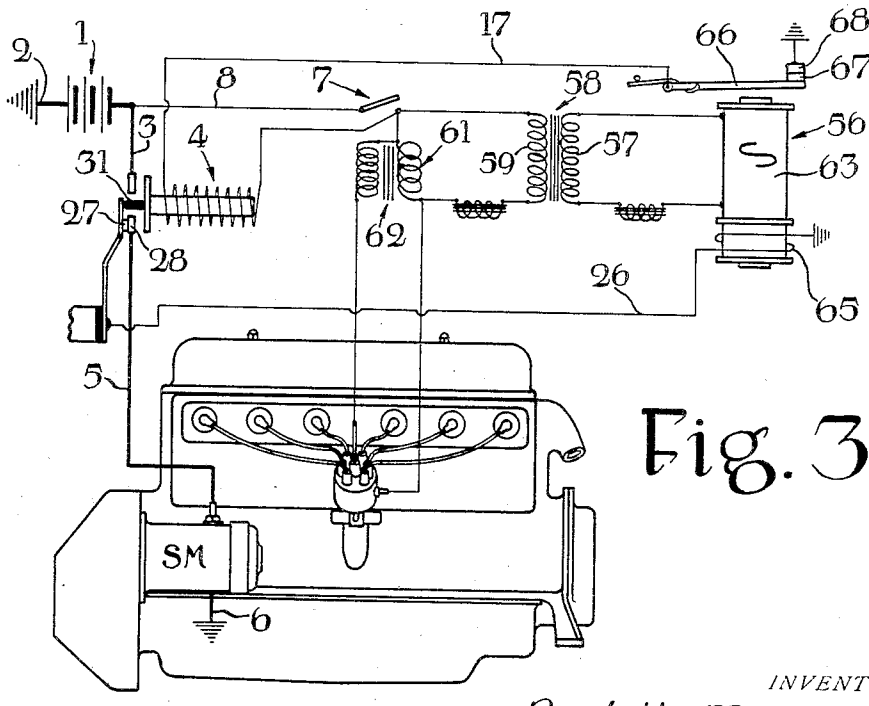


Fig. 3

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AUTOMATIC STARTER CONTROL

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Fig. 4

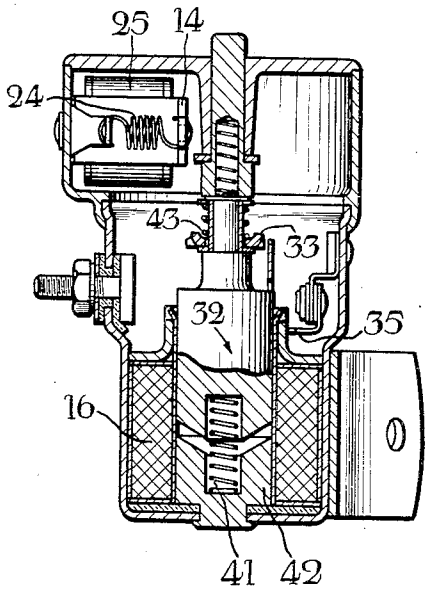


Fig. 5

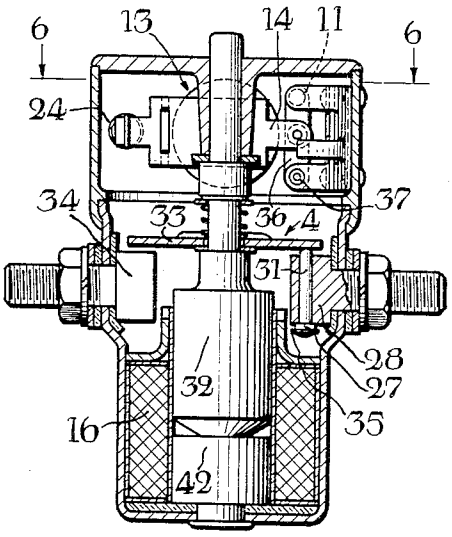


Fig. 7

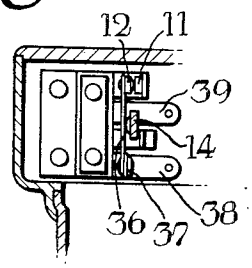


Fig. 6

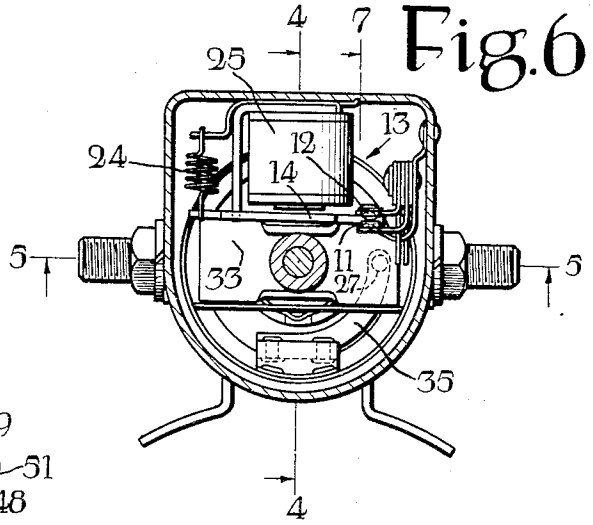
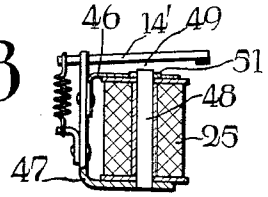


Fig. 8



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UNITED STATES PATENT OFFICE

2,035,820

AUTOMATIC STARTER CONTROL

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8 Claims. (Cl. 290—37)

This invention relates to an automatic starter control for internal combustion engines and more particularly to a device for actuating the starting mechanism upon closure of the ignition switch of the engine and for automatically reactuating the same in case of engine stall.

In devices of this character of the type in which the starter gearing is automatically disconnected when the engine starts, it has been found desirable to provide some form of time delay to prevent immediate reactuation of the starting mechanism in case of a false start in order to permit the starting motor to come substantially to rest before reclosure of the starting switch.

It is an object of the present invention to provide a novel automatic starter control which is effective and reliable in operation and simple and economical in construction.

It is another object to provide such a device which incorporates a time delay to retard the reactuation of the starting mechanism.

It is a further object to provide such a device which in case of a false start of the engine prevents reclosure of the starting switch while the starting motor is spinning.

It is another object to provide such a device which embodies a relay actuated by the counter E. M. F. of the spinning starting motor to hold open the starting switch.

It is a further object to provide such a device in which the motor spin hold-out relay is protected from overloading by battery voltage.

Further objects and advantages will be apparent from the following description taken in connection with the accompanying drawings in which:

Fig. 1 is a diagrammatic illustration of one preferred embodiment of the invention;

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

Fig. 3 is a semi-diagrammatic illustration of a third embodiment of the invention;

Fig. 4 is substantially a mid-sectional view of a preferred form of magnetic starting switch and control relay especially adapted for use in the embodiment of the invention illustrated in Fig. 1, the section being taken substantially on the line 4—4 of Fig. 6;

Fig. 5 is a similar view, the section taken on the line 5—5 of Fig. 6;

Fig. 6 is a horizontal section taken substantially on the line 6—6 of Fig. 5;

Fig. 7 is a detail partly in section taken substantially on the line 7—7 of Fig. 6; and

Fig. 8 is a detail partly in section of one preferred form of relay especially adapted for use in that embodiment of the invention illustrated in Fig. 2.

Referring first to Fig. 1 of the drawings there is illustrated a starting mechanism for an internal combustion engine, not illustrated, comprising a starting circuit including a battery 1 grounded at 2 and connected by a lead 3 to a magnetic starting switch 4 which in turn is connected by a lead 5 to the starting motor SM which is grounded at 6. A control circuit for the magnetic starting switch 4 is provided comprising a manual switch 7, which is preferably the ignition switch of the engine, connected by a lead 8 to the battery lead 3 and by a lead 9 to circuit controlling means in the form of contacts 11, 12 of a control relay 13. Contact 12 is mounted on a swinging armature 14 which is connected by a lead 15 to the solenoid 16 of the magnetic starting switch 4, which solenoid is in turn connected by a lead 17 to one brush 18 of engine driven generator G, the opposite brush of which 19 is grounded as indicated at 21.

The field 22 of the generator is preferably separately excited from the battery 1 by means of a lead 23 connecting the same to the manual switch 7.

Armature 14 is normally biased in position to close contacts 11, 12 by suitable means such as a spring 24, and actuating means in the form of a solenoid 25 is provided for opening contacts 11, 12 responsive to current generated by the starting motor SM when the armature thereof is idly spinning. For this purpose the solenoid 25 is connected by a lead 26 to a spring mounted contact 27 which normally engages the contact 28 of the starting switch 4 which is connected by the lead 5 to the starting motor, the opposite end of the solenoid 25 being grounded at 29 to complete the circuit of relay 13.

Means energized by closure of the starting switch 4 are provided for disconnecting the solenoid 25 from the starting circuit. As here shown this disconnecting means is in the form of a plunger 31 of insulating material resting on the plunger 32 of the starting switch in such position that closure of the starting switch causes the plunger 31 to move contact 27 out of engagement with the switch contact 28.

In the operation of this embodiment of the invention starting with the parts in the positions illustrated, closure of the ignition switch 7 completes the control circuit through solenoid 16 of the magnetic starting switch 4 and at the same

time causes excitation of the field 22 of generator G. Since the armature of generator G is at this time stationary, the generator forms a good ground connection for the control circuit causing the magnetic starting switch to close and initiate cranking. During the closing movement of the starting switch, the plunger 31 moves contact 27 away from contact 28 thus breaking the circuit of relay 13 whereby contacts 11, 12 remain closed.

When the engine starts, the consequent acceleration of the generator G causes it to generate a voltage opposing the flow of current through the control circuit thereby deenergizing the control circuit including the magnetic starting switch and permitting the same to open. It will be understood that the engine speed at which this action takes place may readily be determined by proper adjustment of the starting switch, this regulation being greatly facilitated by the fact that since the generator is separately excited, the voltage produced thereby is substantially directly proportional to the rotational speed of the generator until such time as the voltage of the generator approaches that of the battery.

When the starting switch 4 opens in response to self-operation of the engine, contacts 27, 28 are permitted to close and the current generated by the starting motor while its armature is spinning by momentum is conducted by lead 26 to the relay 13 whereby contacts 11, 12 are opened and are held open to maintain the control circuit inoperative until the starting motor comes substantially to rest. If the engine should give one or two explosions sufficient to cause the starting switch to open and then should stall, it will be appreciated that the relay 13 functions to delay reclosure of the starting switch until the starting motor has decelerated. It will be understood that this time delay insures reengagement of the starter gearing upon reactuation of the starting motor, and also allows the engine flywheel to come completely to rest before reengagement of the starter gearing.

One preferred form of starting switch 4 and control relay 13 built up as a unit is illustrated in Figures 4, 5, 6 and 7. As there shown the starting switch comprises solenoid 16 and plunger 32 carrying contactor 33 which is movable thereby into engagement with the switch elements 28 and 34.

Contact 27 (Fig. 5) is mounted on a spring strip 35 (Fig. 6) in position to normally engage the switch element 28 and is moved out of engagement therewith by the plunger 31 (Fig. 5) when said plunger is pushed down by the contactor 33.

Coil 25 (Fig. 6) of relay 13 is here shown as actuating an armature 14 which as shown more particularly in Figs. 5 and 7 is arranged to engage a leaf spring 36 anchored at 37 to a connector 38 adapted to receive the end of the control circuit lead 15. Contact 12 is mounted on the free end of the spring 36 normally in engagement with contact 11 which is mounted on a fixed bracket providing a connector 39 adapted to receive the end of the control circuit lead 9.

Plunger 32 of the starting switch is normally maintained in its upper position by suitable means such as a spring 41 and is moved into engagement with a fixed pole piece 42 upon energization of solenoid 16. Contactor 33 is preferably connected to plunger 32 by yieldable means such as a spring 43 and in its downward movement engages plunger 31 which is slidably mounted in the switch element 28, thus opening contacts 27, 28 as above set forth.

In Fig. 2 a second embodiment of the invention is illustrated which is similar to that shown in Fig. 1 except that electrical means are provided in the form of a current controlled relay for opening the circuit of the relay 13' instead of the mechanical connection to the starting switch illustrated in Fig. 1. As here shown this starting current relay comprises a single turn coil 43 arranged to attract an armature 44 which carries the contact 27 and which is normally held by means such as a spring 45 in position to cause contact 27 to engage fixed contact 28'. The strength of the spring 45 is so related to the magnetic effect of the single turn coil 43 that armature 44 will be attracted by the heavy current traversing the coil 43 during cranking whereby contacts 27, 28' are held open. The relay 13' is thus disconnected from the starting motor during the cranking operation and is protected from overloading by battery voltage as in the embodiment previously described.

When the engine starts, the release of the cranking load on the starting motor causes a reduction in current traversing the relay coil 43 which becomes sufficiently weakened to permit contacts 27, 28' to close. If for any reason the generator should not cause the starting switch 4 to open prior to closure of the contacts 27, 28', the momentary flow of battery current through the relay coil 25 instantly opens contacts 11, 12 whereby the control circuit is broken and the starting switch caused to open. The relay 13' is then connected to the starting motor but not to the battery and performs its time delay function in the manner previously described.

Since in this embodiment of the invention closure of the starting switch 4 connects the coil 25 of relay 13' to the battery 1 at the time that cranking is initiated, it is desirable that contacts 27, 28' be opened by the cranking current traversing the single turn coil 43 prior to the opening of contacts 11, 12 of relay 13', since otherwise a chattering of the starting switch would result. Obviously the inherent characteristics of the coils 43 and 25 are such that the self-inductance of the coil 25 is greater than that of the coil 43 and the coil 25 is therefore less rapid in its action. In order to insure that the relay 13' does not act too quickly, however, it has been found desirable to provide means for delaying the action thereof.

As here illustrated this means is in the form of a member 46 of magnetic material attached to the frame 47 of the relay 13' and extending into proximity to the free end of the core 48 of said relay, thus forming a magnetic shunt for the flux traversing said core.

Referring more particularly to Fig. 8 of the drawings, it will be seen that the magnetic shunt member 46 is arranged to surround the end of the core 48 with a space therebetween somewhat less than the air gap 49 between the armature 14' of the relay and the end of the pole piece. This space between the magnetic shunt member and the pole piece is preferably filled by a spacing element 51 of suitable nonmagnetic material such as brass.

In the operation of this relay, the flux caused by the initial energization of the coil 25 traverses the path of least reluctance constituted by the magnetic shunt 46 since the space 51 has less reluctance than the air gap 49. The arma-

ture 14' is therefore not strongly attracted until the flux in the core 48 has built up sufficiently to saturate the magnetic shunt, whereafter the flux traverses the air gap 49 and causes the armature 14' to be pulled down against the end of the core 48. After this occurs, the magnetic circuit through the armature 14' has much less reluctance than the magnetic shunt circuit so that substantially all the flux traverses the armature 14' whereby said armature will be held against the core 48 until said core is completely deenergized.

In order to permit a slight closing motion of the armature 14' without opening contacts 11, 12, contact 12 is in this embodiment of the invention preferably mounted on a leaf spring 52 (Fig. 2) which extends into the path of a block of insulation 53 mounted on the end of the armature 14', the spring 52 being normally separated from the end of said armature by a space 54 permitting initial movement of the armature without engaging the spring 52.

In Fig. 3 the invention is illustrated as applied to a starter control utilizing the functioning of the ignition mechanism of the engine to control the starting operation. As here shown the starting circuit is the same as illustrated in Figs. 1 and 2 and the elements are similarly numbered. The control relay 56 for the magnetic starting switch 4, however, is an alternating current relay actuated by current from the secondary 57 of a transformer 58, the primary 59 of which is supplied with pulsating current during the operation of the engine by virtue of being connected in parallel with the primary 61 of the ignition coil 62.

Relay 56 in addition to its alternating current coil 63 is provided with a solenoid 65 corresponding to the coil 25 of relay 13 in Figs. 1 and 2 and connected by the lead 26 to the contact 27 as described in Fig. 1.

Either or both of the coils 63 and 65, when sufficiently energized, are arranged to attract an armature 66 carrying a contact 67 which is normally in engagement with a grounded contact 68 thus forming the ground connection for the lead 17 of the control circuit. When the ground connection is thus broken by the energization of relay 56, the control circuit is deenergized and the starting switch 4 permitted to open.

In the operation of this embodiment of the invention closure of the ignition switch 7 completes the control circuit through the starting switch 4 thus closing the starting switch and initiating the cranking operation. Closure of the starting switch causes plunger 31 to open contacts 27, 28 as above set forth thus breaking the circuit through the relay coil 65. When the engine becomes self-operative, the pulsations of current through the primary 59 of transformer 58 caused by the operation of the breaker points of the ignition mechanism attains sufficient speed to induce an alternating current in the secondary 57 of said transformer powerful enough to energize the alternating current coil 63 of relay 56 and open contacts 67, 68. The starting switch 4 is thus permitted to open and contacts 27, 28 to close.

Should the engine immediately stall, reclosure of contacts 67, 68 is prevented by the coil 65 which is energized by the counter E. M. F. of the starting motor SM until the starting motor comes substantially to rest.

Although certain embodiments of the invention have 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 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 an automatic starter control for internal combustion engines a starting circuit including a battery, a starting motor and a magnetic starting switch, a control circuit for said starting switch including said battery, an electromagnet for operating said starting switch, a relay having normally closed contacts and a coil normally connected to the starting circuit on the starting motor side of the starting switch, and means for disconnecting said relay coil from the starting circuit when the starting motor is connected to the battery whereby the relay contacts remain closed during cranking, said relay coil being actuated to open said contacts by current generated by the starting motor when spinning idly.

2. In automatic starting mechanism for internal combustion engines, a starting circuit including a starting motor and a magnetic starting switch, a control circuit for said starting switch, means for deenergizing the control circuit when the engine starts and a relay having a pair of contacts in said control circuit and a coil, and means rendered operative by the opening of the starting switch for energizing said coil from current generated by the starting motor when spinning idly, to open said contacts and thereby break the control circuit and hold it open until the starting motor comes substantially to rest.

3. In automatic starting mechanism for internal combustion engines a starting circuit including a motor and a magnetic starting switch, a control circuit for the starting switch including normally closed circuit controlling means, means for holding open said circuit controlling means during idle spinning of the starting motor, and means operated by closure of the starting switch for deenergizing said holding means and thereby maintaining the controlling means closed during the cranking operation.

4. In automatic starting mechanism for internal combustion engines a starting circuit including a motor and a starting switch, a control circuit including circuit controlling means, electromagnetic means for holding open said circuit controlling means during idle spinning of the starting motor and a relay operated by cranking current for open-circuiting said electromagnetic holding means.

5. In automatic starting mechanism for internal combustion engines a starting circuit including a motor and a starting switch, a control circuit including circuit controlling means, electromagnetic means for holding open said circuit controlling means during idle spinning of the starting motor, a relay operated by cranking current for open-circuiting said electromagnetic holding means, and means for retarding the action of said electromagnetic means.

6. In automatic starting mechanism for internal combustion engines a starting circuit including a motor and a starting switch, a control circuit including circuit controlling means, electromagnetic means energized from the starting circuit for opening said circuit controlling means, a relay operated by cranking current for open-circuiting said electromagnetic holding

means, and means for delaying the opening action of the electromagnetic means.

7. An automatic starting mechanism for internal combustion engines including a battery, a motor and a magnetic starting switch, a control circuit for the starting switch including normally closed contacts and an engine driven generator arranged to oppose the flow of battery current through the control circuit and thereby cause the starting switch to open when the engine starts, and means actuated by the starting motor for opening said contacts when the starting switch opens and for holding open said contacts during idle spinning of the starting motor.

8. An automatic starting mechanism for internal combustion engines including a battery, a motor and a magnetic starting switch, a control circuit for the starting switch including normally closed contacts and an engine driven generator arranged to oppose the flow of battery current through the control circuit and thereby cause the starting switch to open when the engine starts, electromagnetic means actuated by the starting motor for holding open said contacts, and means actuated by closure of the starting switch for rendering said electromagnetic means inoperative.

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