

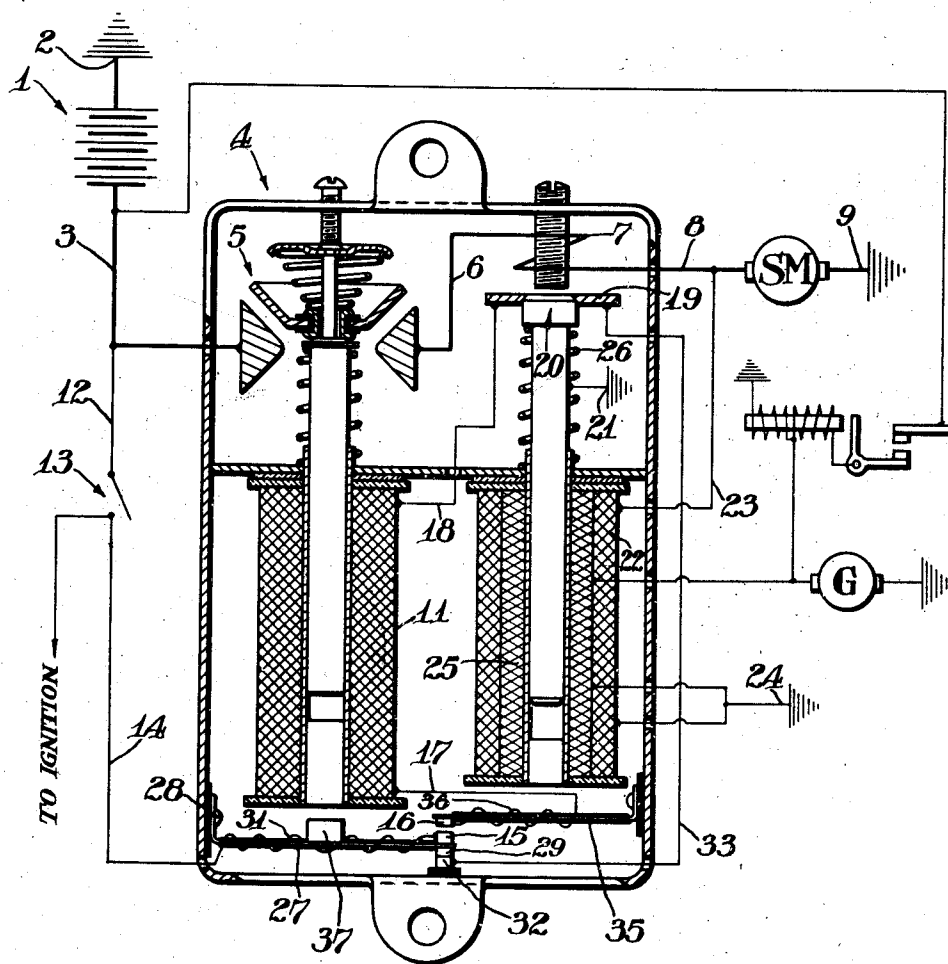
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AUTOMATIC STARTING MECHANISM

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AUTOMATIC STARTING MECHANISM

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This invention relates to automatic starting mechanism for internal combustion engines, and more particularly to a time delay for preventing actuation of the starting mechanism until a predetermined time after the engine has come substantially to rest.

In certain forms of automatic starting mechanism as heretofore designed, the engagement of the starting mechanism has been allowed to take place as soon as forward rotation of the engine stopped without waiting for the rocking of the flywheel to cease. Under these circumstances it is possible for the starting mechanism to engage during a back rock of the flywheel, which would cause unnecessary and undesirable stresses on the starting mechanism.

It is an object of the present invention to provide a novel automatic starting mechanism in which means are provided for preventing actuation of the starting mechanism until a predetermined time after the engine has come to rest.

It is another object to provide such a device which is operated electrically and does not depend on mechanical retarding elements.

A further object is to provide such a device which is simple and economical in construction and reliable and efficient in operation over long periods of use.

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.

Referring to the drawing, there is illustrated a starting system comprising a battery 1 grounded at 2 and connected by a lead 3 to an automatic starting mechanism indicated generally by the numeral 4. The automatic starting mechanism comprises a magnetic starting switch 5 connected to the lead 3, and connected by a lead 6 to a single turn coil 7 which in turn is connected by a lead 8 to a starting motor SM which is grounded at 9 to complete the starting circuit.

The starting switch 5 is adapted to be operated by means of a solenoid 11 which is included in a control circuit comprising a battery 1, lead 3, lead 12, manual switch 13, lead 14, normally open thermostatic contacts 15, 16, leads 17 and 18 and normally closed relay contacts comprising fixed contact 19 and relay plunger 20 which is grounded as indicated at 21 to complete the control circuit.

Means are provided for breaking the ground connection in order to open the control circuit when the engine starts, retaining the circuit open

as long as the engine is running under its own power, and for closing the control circuit in case of engine stall. The means for opening the control circuit when the engine starts comprises a solenoid coil 22 connected by a lead 23 to the motor lead 8 and grounded as indicated at 24. This coil is energized when the starting switch 5 is closed but its action is opposed by the single turn coil 7 which, while traversed by the heavy cranking current, retains the plunger 20 in its closed position. When the engine starts, however, the single turn coil 7 is weakened by the reduction in cranking current so that coil 22 is enabled to withdraw the plunger 20 and open the control circuit.

The plunger 20 is retained in its retracted position while the starting motor is decelerating by reason of a small amount of current which is generated by the starting motor while spinning by momentum. When the engine becomes self-operative, the generator driven thereby actuates a coil 25 to retain the plunger in its retracted position as long as the engine is self-operative. Should the engine stall for any reason, the coil 22 becomes deenergized and the plunger 20 is raised to its normal or closed position by suitable means such as a spring 26.

According to the present invention means are provided for normally maintaining the control circuit open, and for closing said circuit a predetermined time after closure of both the manual switch 13 and contacts 19, 20. As here shown, this means takes the form of a thermostatic element 27 fixed at one end as indicated at 28 and carrying at its free end the contact 15 and a twin contact 29. A heating coil 31 is mounted on said thermostatic element and is connected at one end to the lead 14 of the control circuit and at its other end to the contacts 15 and 29. Contact 29 is normally in engagement with a fixed contact 32 which is connected by a lead 33 to the fixed relay contact member 19. A heating circuit is thus established by closure of the manual switch 13, whereby the thermostatic element 27 may be heated and thereby be bent upward.

A second thermostatic element 35 is arranged opposite the element 27 and carries at its free end the contact 16 in juxtaposition to contact 15 and adapted to be engaged thereby when the first thermostatic element 27 is heated. Contact 16 is connected to a heating coil 36 which in turn is connected to the lead 17 of the control circuit whereby closure of the control circuit causes the second thermostatic element 35 to be

heated and contact 16 moved thereby away from contact 15.

Means are provided for holding contacts 15, 16 closed during the cranking operation, such means being illustrated as an armature 37 of magnetic material fixed in any suitable way to the thermostatic element 27 adjacent the lower end of solenoid 11 so as to be in the magnetic field thereof. Energization of said solenoid will thus attract the armature 37 and hold the contact 15 against the contact 16 in spite of any upward motion of the latter due to the heating effect of the coil 36 on the thermostatic element 35. It will be noted that since the heating coil 31 of the thermostatic element 27 is in the control circuit when the latter is closed, said thermostatic element will continue to be heated thereby during the cranking of the engine so that when the control circuit is broken by the starting of the engine, and the armature 37 is released by the deenergization of the solenoid 11, the thermostatic element 27 will not at once resume its normal position but will merely spring back part way, and the heating circuit through contacts 29, 32 will not be reclosed until the thermostatic element 27 has cooled off. The springing back of said element upon release of the armature 37, however, is sufficient to open the thermostatic contacts 15, 16 which remain open until both thermostatic elements 27 and 35 have cooled off.

In the operation of the device and starting with the parts in their normal or idle positions as illustrated, closure of the manual switch 13 closes the heating circuit from the battery 1 through leads 3, 12 and 14 to the heating coil 34, and through contacts 29, 32 and lead 33 to the fixed relay contact 19 which is grounded by the relay plunger 20. The coil 31 immediately becomes heated and imparts this heat to the thermostatic element 27 which thereupon is deflected upward, opening contacts 29, 32 and closing contacts 15, 16. It will be understood that the initial heating effect of the coil 31 while contacts 29, 32 are closed, is not transmitted instantaneously to the thermostatic element 27 but that there is a time lag in the transmission of heat from the coil to the thermostatic element whereby the heating effect on the element persists and the temperature of the element continues to rise for an appreciable interval after contacts 29, 32 are opened. This interval has been found to be ample to secure effective closure of contacts 15, 16.

Closure of contacts 15, 16 completes the control circuit through heating coil 36, lead 17, solenoid 11, lead 18 and contacts 19, 20 to the ground at 21. Solenoid 11 is thereby energized to close the starting switch for cranking the engine. Energization of the heating coil 36 by closure of the control circuit causes the thermostatic element 35 to be deflected to move contact 16 away from contact 15, but the attraction of armature 37 by solenoid 11 holds these contacts closed as long as the control circuit is completed. Heating coil 31 is also kept warm by the flow of current through the control circuit, but as above explained, the thermostatic element 27 is not heated sufficiently to cause the contact 15 to follow the contact 16 without the assistance of the armature 37.

When the engine starts, relay plunger 20 is retracted by the coil 22, thus breaking the ground connection 19, 20 and opening the control circuit. The solenoid 11 is thus deenergized, allowing the

starting switch 5 to open and releasing the armature 37 whereby contact 15 springs away from contact 16.

In case of a false start, as when the engine stops after an initial explosion or two, the relay plunger 20 closes as soon as the starting motor has come to rest, but the control circuit is not completed thereby since the contacts 15, 16 are now open; and the heating circuit for the coil 31 is not completed since contacts 29, 32 are still open. Cooling off of the thermostatic element 27 after a predetermined time closes contacts 29, 32 completing the heating circuit and causing the contacts 15, 16 to be closed again as above described.

When the engine becomes properly self-operative, the relay plunger 20 is maintained in its open position by means of the generator coil 25, so that cooling off of the thermostatic elements to their normal positions does not close either the heating circuit or the control circuit. Thereafter, in case of engine stall, the starting operation is repeated after a predetermined time as measured by the heating period of the coil 31, which is arranged to be sufficient to allow the engine to come completely to rest.

Although but one embodiment of the invention has been shown and described in detail, it will be understood that other embodiments are possible and changes may be made in the structural details 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 magnetic starting switch, a control circuit for said starting switch including two automatic switches in series, closure of both being necessary to complete the control circuit and thereby close the starting switch, means responsive to self-operation of the engine for opening one of said automatic switches, and means for closing the other automatic switch a predetermined time after reclosure of said first switch.

2. In automatic starting mechanism for internal combustion engines, a starting circuit including a magnetic starting switch, a control circuit for said starting switch including two automatic switches in series, closure of both being necessary to complete the control circuit and thereby close the starting switch, one of said switches being normally closed, means responsive to self-operation of the engine for opening said switch; and the other switch being normally open, and means for closing the latter switch a predetermined time after reclosure of the first switch responsive to engine stall.

3. In automatic starting mechanism for internal combustion engines, a starting circuit including a magnetic starting switch, a control circuit for said starting switch including three switches in series, closure of all three being necessary to complete the control circuit and thereby close the starting switch, one of said switches being manually controlled, means responsive to self-operation of the engine for opening another of said switches, and means for closing the third switch a predetermined time after the closure of both the first mentioned switches.

4. Automatic starting mechanism for internal combustion engines including a starting circuit having a magnetic starting switch, a control circuit for said starting switch including therein a manual switch, a normally open switch and a

normally closed switch, closure of all said switches being necessary to complete the control circuit; means whereby closure of the manual switch causes closure of the normally open switch after a predetermined time delay and means responsive to self-operation of the engine for opening said normally closed switch.

5. Automatic starting mechanism for internal combustion engines including a starting circuit having a magnetic starting switch, a control circuit for said starting switch including a manual switch, a normally open switch and a normally closed switch, closure of all said switches being necessary to complete the control circuit; means whereby closure of the manual switch causes closure of the normally open switch after a predetermined time, and means responsive to self-operation of the engine for opening said normally closed switch and thereby opening said normally open switch, said closure means for the normally open switch being arranged to operate a predetermined time after reclosure of the normally closed switch.

6. Automatic starting mechanism for internal combustion engines including a starting circuit having a magnetic starting switch, a control circuit for said starting switch including a manual switch, a normally open switch and a normally closed switch, closure of all said switches being necessary to complete the control circuit; means whereby closure of the manual switch causes closure of the normally open switch after a predetermined time, means responsive to self-operation of the engine for opening said normally closed switch and thereby opening said normally open switch, said closure means for the normally open switch being arranged to operate a predetermined time after reclosure of the normally closed switch and means for preventing immediate reclosure of the normally open switch in case the normally closed switch opens and immediately recloses due to a false start of the engine.

7. In an automatic starting mechanism for internal combustion engines, a magnetic starting switch having an actuating electromagnet, a circuit for controlling said switch including in series a manual switch, a set of normally open contacts and said electromagnet, means energized by closure of the manual switch for closing said contacts to thereby complete the control circuit, and means for opening said control circuit and deenergizing said closing means responsive to the self-operation of the engine.

8. In an automatic starting mechanism for internal combustion engines, a magnetic starting switch having an actuating electromagnet, a circuit for controlling said switch, including in series a manual switch, a set of normally open contacts and said electromagnet, means energized by closure of the manual switch for closing said contacts to thereby complete the control circuit, auxiliary means energized by the control circuit for holding said contacts closed during cranking, and means for opening said control circuit and deenergizing said closing means responsive to the self-operation of the engine.

9. In an automatic starting mechanism for internal combustion engines, a magnetic starting switch, a control circuit therefor including a manual switch and a pair of normally open contacts, thermostatic means energized by closure of the manual switch for closing said contacts, means energized by completion of the control circuit for holding said contacts closed during cranking and thermostatic means energized by

closure of said contacts for opening said contacts when said holding means is deenergized and preventing reclosure thereof for a predetermined time.

10. Automatic starting mechanism for internal combustion engines including a magnetic starting switch, a control circuit therefor, a manual switch, a pair of normally open contacts, a thermostatic element for closing said contacts, and a pair of normally closed contacts all included in said control circuit; and an auxiliary heating circuit for said thermostatic element including said manual switch and said normally closed contacts.

11. Automatic starting mechanism for internal combustion engines including a magnetic starting switch, a control circuit therefor, a manual switch, a pair of normally open contacts, a thermostatic element for closing said contacts, and a pair of normally closed contacts all included in said control circuit; an auxiliary heating circuit for said thermostatic element including said manual switch and said normally closed contacts, and means for opening said normally closed contacts to break both the control circuit and the auxiliary heating circuit when the engine starts.

12. Automatic starting mechanism for internal combustion engines including a magnetic starting switch, a control circuit therefor including a manual switch, a pair of normally open contacts, a thermostatic element for closing said contacts and a pair of normally closed contacts; a heating circuit for said thermostatic element including said manual switch and said normally closed contacts, and means for opening said normally closed contacts when the engine starts, said control circuit also including a thermostatic element for preventing reclosure of the normally open contacts for a predetermined time after closure of said normally closed contacts.

13. Automatic starting mechanism for internal combustion engines including a magnetic starting switch, a control circuit therefor including a manual switch, a pair of normally open contacts, a thermostatic element for closing said contacts, and a pair of normally closed contacts, a heating circuit for said thermostatic element including said manual switch and said normally closed contacts, means for opening said normally closed contacts when the engine starts, said control circuit also including a thermostatic element for preventing reclosure of the normally open contacts for a predetermined time after closure of said normally closed contacts, and magnetic means responsive to closure of the control circuit for holding said normally open contacts closed during cranking.

14. Automatic starting mechanism for internal combustion engines, including a magnetic starting switch, a control circuit therefor including a manual switch, a pair of normally closed contacts, a thermostatic contact member having a heating element normally grounded through said normally closed contacts to form a heating circuit, and a second thermostatic element having a heating element in said control circuit and having a contact adjacent the first thermostatic contact adapted to be engaged thereby to complete the control circuit when said first thermostatic element is heated.

15. Automatic starting mechanism for internal combustion engines, including a magnetic starting switch, a control circuit therefor including a manual switch, a pair of normally closed contacts,

a thermostatic contact member having a heating element normally grounded through said normally closed contacts to form a heating circuit, a second thermostatic element having a heating element in said control circuit and having a contact adjacent the first thermostatic contact adapted to be engaged thereby to complete the control circuit when said first thermostatic element is heated, means energized from the control circuit for holding the thermostatic contacts closed during cranking of the engine, and means for opening said normally closed contacts when the engine starts.

16. Automatic starting mechanism for internal combustion engines, including a magnetic starting switch, a control circuit therefor including a manual switch, a pair of normally closed contacts, a thermostatic contact member having a heating element normally grounded through said normally closed contacts to form a heating circuit, a second thermostatic element having a heating element in said control circuit and having a contact adjacent the first thermostatic contact adapted to be engaged thereby to complete the control circuit when said first thermostatic element

is heated, means energized from the control circuit for holding the thermostatic contacts closed during cranking of the engine, and means for opening said normally closed contacts when the engine starts, said second thermostatic element being arranged when heated to move its contact away from the first thermostatic contact to prevent reclosure of the thermostatic contacts until said second thermostatic element has cooled off.

17. In automatic starting mechanism for internal combustion engines, a starting circuit, including a starting switch, a control circuit including a manual switch, a set of normally open contacts and a set of normally closed contacts; means responsive to closure of the manual switch for closing said normally open contacts after a predetermined time interval, means responsive to self-operation of the engine for opening said normally closed contacts, means for thereupon opening said normally open contacts, and means for preventing reclosure of the normally open contacts for a predetermined time after reclosure of the normally closed contacts.

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