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ENGINE STARTER CONTROL APPARATUS

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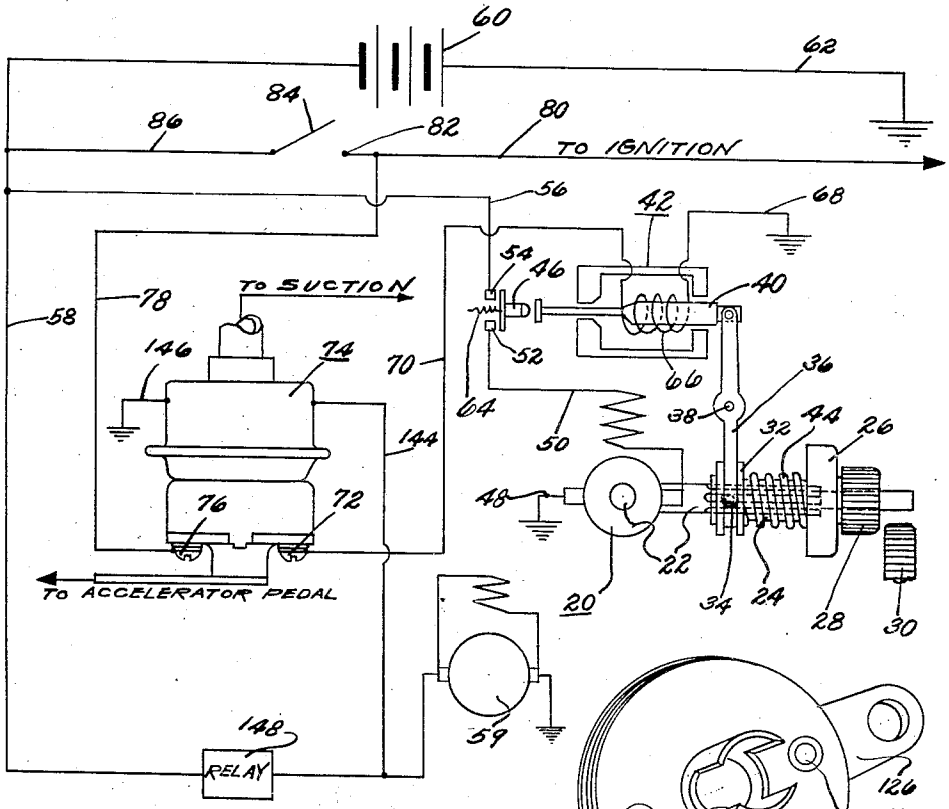


Fig. 1

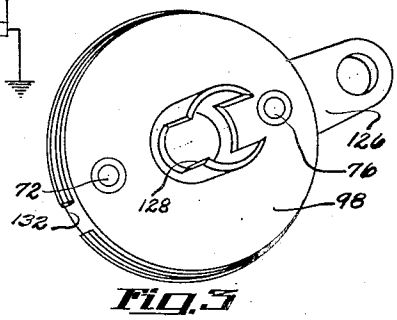


Fig. 3

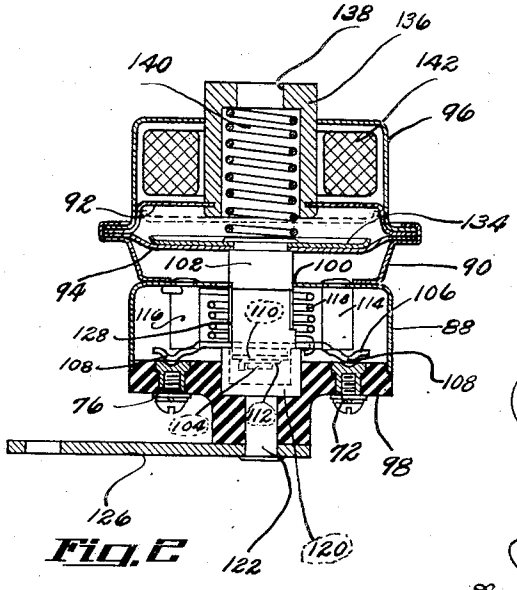


Fig. C

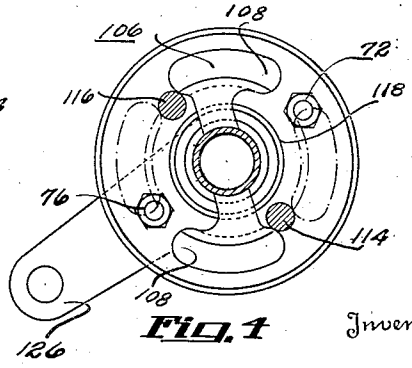


Fig. 4

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ENGINE STARTER CONTROL APPARATUS

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Application September 11, 1933, Serial No. 688,887

20 Claims. (Cl. 290—37)

This invention relates to apparatus for controlling engine starting devices and more particularly to that form of engine starting device which is controlled automatically or semi-automatically.

Starting devices of the semi-automatic type which include a starting motor designed to be rendered operative upon the closing of the ignition switch and a second switch operable by some of the ordinary control devices of the vehicle, such for instance, as the accelerator pedal, or clutch pedal, and rendered inoperative by engine suction when the engine is running under its own power, are old and an example of such devices is disclosed in applicant's copending application Serial No. 594,553, filed February 23, 1932. In this form of the device either the switch which is closed by the fuel control member, or a separate switch in the starting motor circuit are adapted to be opened by engine suction.

In devices of this character which have been already designed, it has been found difficult to provide a suction-operated switch which is sufficiently sensitive to remain open under all operating conditions when the engine is running under its own power and which is not sensitive enough to be opened during the cranking of the engine by the starting motor. For instance, when the engine is operating under very heavy load with wide open throttle, as when an automotive vehicle is ascending a steep incline, the suction on the switch is very low, approaching the suction which is effective during the cranking of the engine by the starting motor and it has been found difficult to design a suction-controlled switch which will remain in open position when the engine is operating under heavy load as described and which will not open during engine cranking.

It is the principal object of the present invention to provide a suction-operated switch which will remain closed at all times during the cranking of the engine by the starting motor, but which will be held open under all conditions of speed and load when the engine is operating under its own power.

According to the present invention, this object is accomplished by the provision of a diaphragm which is controlled by the joint engine suction and a small electromagnet so that the switch is opened and held open during such time as the engine is operating under its own power, under any operating conditions, said electromagnet being energized by the generator when the engine is running. It will be understood that during the cranking of the engine by the starting motor, the speed of the generator is insufficient to energize the electromagnet and under such circumstances the suction effective on the diaphragm is insufficient to open the switch.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawing wherein a preferred embodiment of the present invention is clearly shown.

In the drawing:

Fig. 1 is a wiring diagram disclosing a preferred form of the present invention.

Figs. 2, 3 and 4 are detailed views showing the specific construction of the switch.

Referring to Fig. 1, the starting motor is indicated at **20** and has an armature shaft **22** on which is splined a sleeve **24** which is secured to one member of an overrunning clutch **26**, the other member of which is secured to or integral with a pinion **28** driven by the starting motor and adapted to be moved into engagement with a gear **30** formed on the engine flywheel in order to turn said gear and start the engine whenever the starting motor is operated. The sleeve **24** is moved to the right in Fig. 1 in order to effect engagement of the pinion **28** with the gear **30** and when this takes place the circuit between the starting motor and the battery is closed by means which will now be described, so as to render the starting motor effective.

To this end the sleeve **24** is provided with a grooved collar **32** which is slidable on the sleeve and said collar is engaged by pins **34** projecting from the bifurcated lower end of a lever **36** suitably pivoted at **38** and pivotally connected at its upper end with an armature **40** of an electromagnet indicated in its entirety by the reference character **42**. When the electromagnet is energized, the lever **36** is moved in a counterclockwise direction and through the medium of the collar **32**, compresses a spring **44** which surrounds the sleeve **24** between the collar **32** and clutch **26** to move the pinion **28** into engagement with the flywheel gear, as previously described, and at the same time the left end of the armature **40** operates the movable contact member **46** of the main starting motor circuit and causes the motor to become operative.

The starting motor is grounded through the connection **48** while a wire **50** leads from the starting motor to a fixed contact **52** and a second fixed contact **54** is connected by a wire **56** with a wire **58** which leads from the generator **59** hereinafter described, to a battery **60**, grounded through the connection **62**. The movable contact **46** is normally held out of engagement with

the contacts 52 and 54 by a compression spring 64, but upon energization of the electromagnet 42 the contact 46 is moved so as to engage both of the contacts 52 and 54, thus closing the circuit of the starting motor. When this takes place, current will flow from the battery 60 through wires 58 and 56, contacts 54, 46 and 52 and wire 50 to the starting motor, thence through the connection 48 to ground and from ground through the connection 62 to the battery.

The starting motor will cause the engine to start and when running under its own power, the starting motor is rendered inoperative by means later described, at which time the lever 36 and the parts operated thereby will be moved to normal position with the pinion 28 out of engagement with the gear 30.

The operation of the electromagnet is both manually and automatically controlled, the magnet being caused to become energized upon closing of certain manually operated switches but is de-energized by the action of engine suction and by the action of another electromagnet which assists tne suction of the engine, said magnet being energized by the action of the generator when the latter is operating at a predetermined speed after the engine is operating under its own power.

In order to control the operation of the electromagnet 42 in this manner, it is provided with a winding 66, one end of which is grounded at 68 and the other end of which is connected by a wire 70 with one fixed contact 72 of a switch indicated in its entirety by the reference numeral 74 and provided with a second fixed contact 76 connected by a wire 78 with a wire 80 which leads to the ignition system of the engine (not shown) from the fixed contact 82 of the ignition switch, the latter being provided with a movable contact 84 which is adapted to be moved into engagement with contact 82 manually and is connected by a wire 86 with the wire 58 leading from the generator to the battery as previously described.

The switch 74 is adapted to be closed by operation of the accelerator pedal as will be hereinafter more specifically set forth and when the ignition switch and the switch 74 are both closed, the current will flow from the battery through the wires 58 and 86, the ignition switch, wire 78, the switch 74 and wire 70 to the winding 66 and through the connection 68 to ground, thence through connection 62 back to the battery, thus energizing the magnet and causing the operation of the lever 36 and the closing of the starting motor switch as previously described. The switch 74 is operated automatically by the combined action of engine suction and a magnet energized when the generator is charging as will be more specifically set forth hereinafter.

The switch 74 comprises a sheet metal housing 88 which may be supported adjacent the engine in any desirable way. Riveted or secured in any other desirable manner to this housing is a diaphragm chamber formed by two cup-shaped metal shells 90 and 92 suitably flanged and joined together so as to form a fluid tight joint with the diaphragm 94 secured between the flanges. A third cup-shaped shell 96 is provided which is also suitably flanged and is secured between the flange of shell 92 and the bent-over flanged portion of shell 90, as indicated in the drawing. The shell 96 forms a housing for the electromagnet. The housing 88 is closed at one end by a circular block of insulating material 98 supporting the fixed contacts 72 and 76 hereinbefore referred to. Secured to and supported at one end by the diaphragm 94 in any suitable manner and extending through an opening 100 in the housing 88 is a cylindrical element 102 having a stud 104 which projects from and is integral with the opposite end of said cylindrical member.

Pivotally mounted on this stud is a movable contact member 106 having arcuate contact surfaces 108 which are adapted to be moved into contact with the fixed contacts 72 and 76 when the member 102 is rotated by means which will be later described. The contact member 106 is held flat against the closed end of the cylindrical member 102 by washers 110 and a locking clip 112 which engages a groove (not shown) in the stud 104. Posts 114 and 116 are secured in the housing 88 on opposite sides of the member 102 and act as stops to limit the rotary movement of the contact member 106 while a helical spring 118 is connected at one end to the post 116 and at its other end to the contact member 106 so that the spring tends to rotate the contact member toward its normal open position under all circumstances.

In order to move the contact member 106 into engagement with the fixed contacts 72 and 76, there is provided a sleeve 120 which is closed at one end, the closed end fitting within a suitable recess in the insulating material 98, and projecting therefrom is a stud 122 journalled in said insulating material and having secured thereto in any desirable way at its outer end, an arm 126 which is adapted to be connected in any suitable way to the accelerator pedal or some member operated thereby. This sleeve is provided with slots 128 which embrace the movable contact member 106 so that rotation of the sleeve in the manner hereinafter described rotates the movable contact member. The member 98 may be held in place in any suitable manner and may have notches 132 formed in its periphery which receive suitable tangs (not shown) projecting from the housing 71 and adapted to be bent over the face of the member 98.

Secured on the upper side of the diaphragm 94 is a disk 134 which has a diameter almost as great as that of the interior of the shell 92. This disk is slightly cup-shaped in form and is held against the diaphragm by the end of the cylindrical element 102 which extends through an opening in the disk and is riveted or spun over the edge of the opening to form a rigid assembly. This disk forms the armature of the electromagnet, the winding of which is received within the housing 96. Extending through an opening in the shell 92 is a nipple 136, the lower end of which is riveted or spun over the edge of the opening in said shell so that the shell and nipple are rigidly secured together. This nipple, at its upper end, has a bore of reduced size which is threaded as indicated at 138 and is adapted to be connected to a suitable suction conduit extending to some suitable port on the intake manifold, or the suction conduit may be connected to the nipple in any other suitable way. Received within the nipple 136 is a coil spring 140, one end of which engages the armature disk 134 and the other end of which engages the end of the nipple in which the bore 138 is formed. This spring acts to normally hold the parts in the position shown in Fig. 2, with the contact member 106 in engagement with the face of the insulating material 98.

The above described nipple extends through an opening within the shell 96 and received within the shell outside the nipple is the winding 142 of

an electromagnet, one end of the magnet being connected to a wire 144 as indicated in Fig. 1 and the other end of the magnet being grounded through the connection 146, as shown in Fig. 1. It will be noted that the wire 144 is connected to the wire 58 which leads to the generator at a point between the generator and the usual cutout relay 148 so that when the generator is running at sufficient speed to charge the battery, current will flow from the generator through the wire 58, wire 144, the winding 142 and the ground connection 146 to ground, energizing the magnet. When this takes place the magnet exerts an upward pull on the armature disk 134 and aids the engine suction which is communicated through the previously described suction conduit and the nipple 136 to the upper side of the diaphragm, in overcoming the pressure of spring 140.

The operation of this switch is substantially as follows. When the engine is at rest the parts are in the position shown in Fig. 2, the contact member 106 occupying the position shown in full lines in Fig. 3 with the contact surface 180 out of engagement with the fixed contacts 72 and 76 but in engagement with the surface of the insulating material 98. Upon movement of the operating arm 126 in a counterclockwise direction from the full line to the dotted line position in Fig. 3, the contact 108 will be moved into engagement with contacts 72 and 76. If the ignition switch has been previously closed, current will then flow through the path previously described from the battery to the electromagnet 42, the magnet being thus energized to effect the starting of the engine. During the entire movement of the accelerator pedal from the closed to full open throttle position, as indicated by the full and dotted line positions of the arm in Fig. 3, the contacts 108 would remain in engagement with the contacts 72 and 76 unless the contact member 106 were pulled away from the face of the insulating material 98 in a direction substantially normal to the surfaces of such material. The engine suction and the electromagnet which forms part of this switch are both utilized to move the contact member 106 in the manner described. The pressure of the spring 140 is so great that the engine suction is insufficient during the operation of the starting motor while cranking the engine to overcome the effect of this spring and the generator is not running at sufficient speed at this time to cause the electromagnet 142 to aid the action of engine suction to perform this function. Therefore, during all the time the engine is being operated by the starting motor, the switch contacts 108 would be in engagement with the contacts 72 and 76.

When the engine starts running under its own power, however, the speed of the generator is increased and the suction of the engine is also increased so that the winding 142 is energized and the combined effect of the electromagnet and the suction on the diaphragm 94 is always sufficient to overcome the pressure of the spring and the contact member 106 is moved away from the face of the insulating material 98 and is no longer in contact with the fixed contacts 72 and 76. This will, of course, break the circuit through the magnet 42 and cause such magnet to become de-energized. The magnet may or may not be operative to aid the suction in opening. For instance, if the carburetor throttle is substantially closed when the engine is running under its own power, the suction will be so great that the switch will be opened before the generator is operating at sufficient speed for the pull of the magnet to be material. If, however, the throttle be partially open, the suction will not be sufficient to open the switch and the latter will remain closed until the pull of the magnet becomes considerable and aids the suction in opening the switch.

It will be understood that after the armature 134 has been moved upwardly, the edge of the disk which forms such armature will engage the shell 92 thus forming a magnetic seal between these parts and eliminating the air gap which normally exists so that after the magnet has become effective it will require much less pull of the magnet to hold the armature in its upward position than would be required to move it to such position initially. Therefore, after the switch has already been opened, the speed of the engine when operating under load may be reduced to substantially the cranking speed without permitting the spring 140 to overcome the effect of the suction and magnet, because the effect of the magnet is greater in proportion to the generator speed at such time than before the switch is opened. In fact, the engine must substantially stop before the spring 140 can move the movable contact toward the fixed contacts.

While the embodiment of the present invention as herein disclosed, constitutes a preferred form, it is to be understood that other forms might be adopted, all coming within the scope of the claims which follow.

What is claimed is as follows:

1. Control apparatus for engine starting devices comprising a current source, a starting motor adapted to be operated by current from said source, a control switch for controlling the operation of said starting motor having fixed and movable contacts, manually operable means for operating said movable contact to close said switch to cause said starting motor to become operative, and a plurality of means operable by the engine for holding said movable contact in position to maintain said switch open during the operation of the engine under its own power, said means being operable irrespective of the position of the switch closing means.

2. Control apparatus for engine starting devices comprising a current source, a starting motor adapted to be operated by current from said source, a control switch for controlling the operation of said starting motor comprising fixed and movable contacts, means for controlling the supply of fuel mixture to the engine, means operable by said mixture controlling means for moving said movable contact to position to close the control switch, means operable by engine suction to move said movable contact to position to open the switch when the engine begins to operate under its own power, and another means operable by the engine to hold the movable contact in position to maintain said switch open as long as the engine continues to run, and effective only after the switch is opened.

3. Control apparatus for engine starting devices comprising a current source, a starting motor adapted to be operated by current from said source, a control switch for controlling the operation of said starting motor comprising fixed and movable contacts, means for controlling the supply of fuel mixture to the engine, means operable by said mixture controlling means for moving said movable contact to position to close the control switch, means operable by the engine suction to move said movable contact to position to open the switch when the engine be-

gins to operate under its own power, and a magnet energized when the engine is running and adapted to hold said movable contact in position to maintain the switch open as long as the engine continues to run.

4. Control apparatus for engine starting devices comprising a current source, a starting motor adapted to be operated by current from said source, a control switch for controlling the operation of said starting motor comprising fixed and movable contacts, manually operable means for moving said movable contact to close the switch, means operated by engine suction for moving said movable contact to position to open the switch when the engine begins to run under its own power, and means also operated by the engine for holding the movable contact in position to maintain the switch open as long as the engine continues to run, said last named means being effective only after the switch is opened.

5. Control apparatus for engine starting devices comprising a current source, a starting motor adapted to be operated by current from said source, a control switch for controlling the operation of said starting motor having fixed and movable contacts, manually operable means for moving said movable contact to position to close the switch, means operated by engine suction for moving said movable contact to position to open the switch when the engine begins to run under its own power, and a magnet adapted to be energized when the engine is running under its own power for holding said movable contact in position to maintain the switch open as long as the engine continues to run.

6. Control apparatus for engine starting devices comprising a current source, a starting motor adapted to be operated by current from said source, a control switch for controlling the operation of said starting motor, comprising fixed and movable contacts, manually operable means for moving said movable contact to close said switch to cause said starting motor to become operative, means operable by the engine for moving said movable contact to position to open the switch when the engine begins to run under its own power, a generator, an electromagnet in circuit with the generator and adapted to be energized by the generator when the engine is operating under its own power and positioned to hold the switch open as long as the engine continues to run, said magnet being effective on said switch only after the latter is open.

7. Control apparatus for engine starting devices comprising a current source, a starting motor adapted to be operated by current from said source, a control switch for controlling the operation of said starting motor, comprising fixed and movable contacts, manually operable means for moving said movable contact to close said switch to cause said starting motor to become operative, means operable by the engine suction for moving said movable contact to position to open the switch when the engine begins to run under its own power, a generator, an electromagnet in circuit with the generator and adapted to be energized by the generator when the engine is operating under its own power and positioned to hold the switch open as long as the engine continues to run, said magnet being effective on said switch only after the latter is open.

8. Control apparatus for engine starting devices comprising a current source, a starting motor adapted to be operated by current from said source, a control switch for controlling the operation of said starting motor having fixed and movable contacts, means for controlling the supply of fuel mixture to the engine, means operable by said mixture controlling means for moving said movable contacts to position to close the control switch, means operable by the engine suction to move said movable contact to position to open the switch when the engine begins to operate under its own power, a generator, and an electromagnet in circuit with the generator and adapted to be energized by the generator when the engine is operating under its own power to hold said movable contact in position to maintain the switch open as long as the engine continues to run.

9. Control apparatus for engine starting devices comprising a current source, a starting motor adapted to be operated by current from said source, a control switch for controlling the operation of said starting motor, said switch comprising fixed and movable contacts, a suction operated member directly carrying said movable contact, manually operable means for causing said movable contact to be moved to switch closing position, means for communicating the engine suction to said member when the engine is operating under its own power to move said movable contact out of engagement with the fixed contact and a magnet for holding the switch open, said magnet including an armature also carried by said suction operated member whereby when the magnet is energized the movable contact is held out of engagement with the fixed contact, said magnet being effective on said switch only after the switch is opened.

10. Control apparatus for engine starting devices comprising a current source, a starting motor adapted to be operated by current from said source, a control switch for controlling the operation of said starting motor, said switch comprising fixed and movable contacts, a suction operated member directly carrying said movable contact, manually operable means for causing said movable contact to be moved to switch closing position, means for communicating the engine suction to said member when the engine is operating under its own power to move said movable contact out of engagement with the fixed contact, a magnet for holding the switch open, said magnet including an armature also carried by said suction operated member whereby when the magnet is energized the movable contact is held out of engagement with the fixed contact and means whereby the magnet is energized at all times when the engine is operating under its own power, said magnet being effective on said switch only after the switch is opened.

11. In control apparatus for engine starting devices having a current source and a starting motor adapted to be operated by current from said source, a control switch for controlling the connection of the starting motor with said current source, said control switch having a fixed contact, a movable contact manually movable to switch closing position, a suction operated member operable by engine suction to move the movable contact to switch open position, and an electromagnet energizable by the engine to hold the movable contact in switch open position during all operation of the engine under its own power, said means being operable irrespective of the position of the switch closing means.

12. In control apparatus for engine starting devices having a current source and a starting motor adapted to be operated by current from

said source, a control switch for controlling the connection of the starting motor with said current source, said control switch having a fixed contact, a movable contact manually movable to switch closing position, a suction operated member supporting the movable contact and operable by engine suction to move said movable contact out of engagement with said fixed contact, an electromagnet having an armature supported by said suction operated member and energizable by the engine to hold said movable contact out of engagement with the fixed contact during all operation of the engine under its own power, said means being operable irrespective of the position of the switch closing means.

13. Control apparatus for engine starting devices comprising a current source, a starting motor adapted to be operated by current from said source, a control switch for controlling the operation of said motor having fixed and movable contacts, manually operable means for causing the movable contact to be moved to a position to close said switch, engine operated means for moving said movable contact to effect opening of the switch, said means being constructed to exert a force on said movable contact either in its open or closed position, a second engine operated means also exerting a force on said movable contact tending to move said contact to position to open the switch and operative to hold said contact in open position during operation of the engine under its own power, said last named means being so constructed that it exerts insufficient force to move the contact to switch open position, and sufficient force to hold the switch open only after said movable contact is moved to open position.

14. Control apparatus for engine starting devices comprising a current source, a starting motor adapted to be operated by current from said source, a control switch for controlling the operation of said motor having fixed and movable contacts, manually operable means for causing the movable contact to be moved to a position to close said switch, means for holding the movable contact in closed position, engine operated means for moving said movable contact to effect opening of the switch, said means being constructed to exert a force on said movable contact either in its open or closed position, a second engine operated means also exerting a force on said movable contact tending to pull it toward open position and adapted to hold it in open position while the engine runs under its own power, said last named means being ineffective to overcome the force holding the switch closed until the movable contact has been moved to open position.

15. Control apparatus for engine starting devices comprising a current source, a starting motor adapted to be operated by current from said source, a control switch for controlling the operation of said motor having fixed and movable contacts, manually operable means for causing the movable contact to be moved to a position to close said switch, means operable by engine suction for moving said movable contact to open position and operable to exert substantially the same force on said contact whether the latter is open or closed, a generator and means operated by the generator exerting a force on said movable contact tending to move said contact to position to open the switch and operative to hold said contact in open position during operation of the engine under its own power, said last named means being so constructed that it exerts insufficient force to move the contact to switch open position, and sufficient force to hold the switch open only after said movable contact is moved to open position.

16. Control apparatus for engine starting devices comprising a current source, a starting motor adapted to be operated from current from said source, a control switch having fixed and movable contacts for controlling the operation of said starting motor, manually operable means for causing the movable contact to be moved to a position to close said switch, means operable by the engine to exert a force on the movable contact to move said contact to switch open position, and a second means also operable by the engine exerting a force tending to move said movable contact to open position and effective to exert a sufficient force on said movable contact to hold said contact in switch open position during operation of the engine under its own power, said last named means being ineffective until the first named means has moved the switch contact to open position.

17. Control apparatus for engine starting devices comprising a current source, a starting motor adapted to be operated from current from said source, a control switch having fixed and movable contacts for controlling the operation of said starting motor, manually operable means for causing the movable contact to be moved to a position to close said switch, suction operated means exerting a force on the movable contact to move said contact to switch open position, and a magnet energized during operation of the engine exerting a force tending to move said movable contact to open position and effective to exert sufficient force on the movable contact to hold said contact in switch open position, said magnet being ineffective until the switch contact is moved to open position.

18. Control apparatus for engine starting devices comprising a current source, a starting motor adapted to be operated from current from said source, a control switch having fixed and movable contacts for controlling the operation of said starting motor, manually operable means for causing the movable contact to be moved to a position to close said switch, a plurality of means exerting a force on said movable contact tending to move it toward switch open position, one of said means exerting insufficient force to move said contact independently of the other means and operative to hold said contact in its open position only after said contact has been moved to such position.

19. Control apparatus for engine starting devices comprising a current source, a starting motor adapted to be operated from current from said source, a control switch having fixed and movable contacts for controlling the operation of said starting motor, manually operable means for causing the movable contact to be moved to a position to close said switch, means operable by engine suction and a magnet exerting a force on said movable contact tending to move said contact to switch open position, said magnet being so constructed that the force exerted thereby is insufficient to move the movable contact to open position independently of the suction operated means, but is sufficient to hold said movable contact in position only after the said movable contact has been moved to such position.

20. Control apparatus for engine starting devices comprising a current source, a starting mo-

tor adapted to be operated by current from said source, a magnetic switch for connecting the starting motor with the current source and for establishing driving connection between the starting motor and the engine, a control switch for controlling the operation of said magnetic switch having fixed and movable contacts, manually operable means for causing said movable contact to be moved to position to close the switch in order to cause the starting motor to become operative, means operable by the engine when it begins to run under its own power for moving said movable contact to position to open said control switch in order to render the starting motor inoperative, and another means also operable by the engine tending to move the movable contact to open the control switch and adapted to hold said control switch open independently of the first mentioned means, said last named means being effective on said movable contact only after said control switch is opened.

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