July 6, 1937. C. F. WARNER 2,086,197

ELECTRICAL CONTROLLING APPARATUS

Filed June 21, 1934

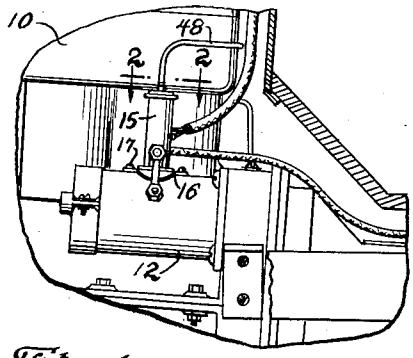


Fig. 1

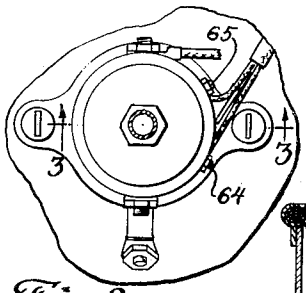


Fig. 2

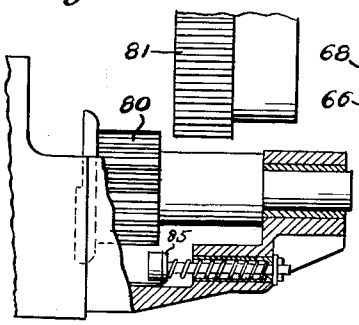


Fig. 7

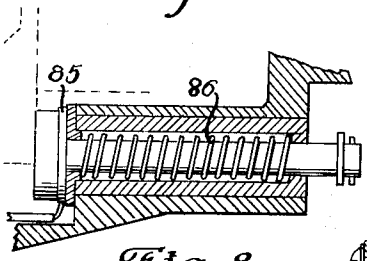


Fig. 8

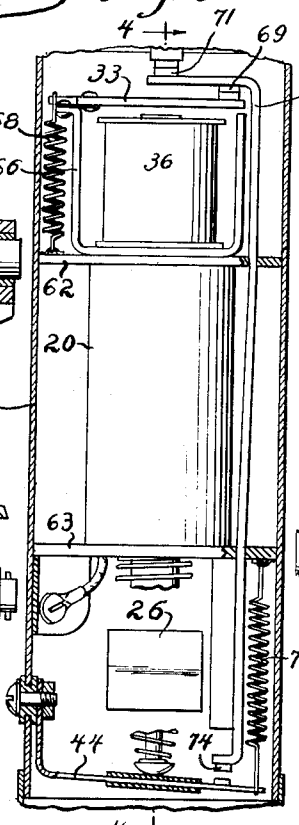


Fig. 3

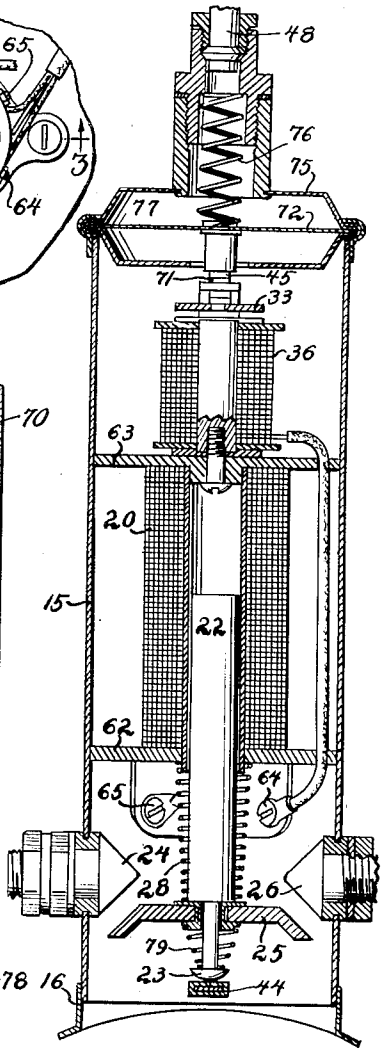
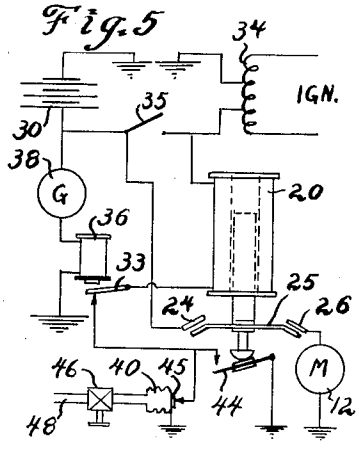


Fig. 4

Fig. 5



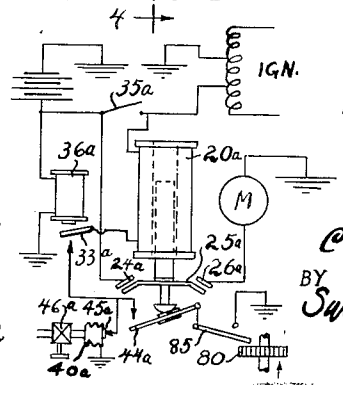


Fig. 6

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ELECTRICAL CONTROLLING APPARATUS

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Application June 21, 1934, Serial No. 731,645

1 Claim. (Cl. 200—99)

This invention relates to automatic starting devices for engines of the sort used in automotive vehicles and the like, and aims particularly to provide improved means for automatically starting an internal combustion engine upon the closing of a single switch such as that controlling an electric ignition circuit, and for immediately restarting the engine in the event it should be accidentally stopped with the ignition on.

A further object is to eliminate the dangers incident to unwanted stalling of the engine of a motor vehicle.

Another object is to provide an extremely simple and inexpensive device of the character mentioned, incorporated in a novel structural arrangement enclosed within a single casing of small size, which completely seals and protects the mechanism and enables ready installation thereof upon a motorcar, either as original or accessory equipment, with a minimum of trouble and expense.

Improvement and simplification of the mechanisms disclosed in my copending application Serial No. 664,656, filed April 5, 1933, and in my Patent No. 1,908,088, issued May 9, 1933 may be stated to constitute still further objects of the present invention.

Other objects and advantages will be apparent from the following description wherein reference is made to the accompanying drawing illustrating the preferred embodiment of my invention and wherein similar reference numerals designate similar parts throughout the several views.

Fig. 1 is a view partly in side elevation and partly in section fragmentarily showing the engine and adjacent parts of a motorcar of conventional construction, illustrating an electric starter of familiar design and the application of my invention thereto.

Fig. 2 is an enlarged detailed view partly in horizontal section and partly in plan, taken substantially on the line 2—2 of Fig. 1 and looking in the direction of the arrows.

Fig. 3 is an enlarged substantially diametrical section of the unit, taken substantially on the line 3—3 of Fig. 2 and looking in the direction of the arrows.

Fig. 4 is a view similar to Fig. 3 but taken at right angles thereto, substantially on the line 4—4 of Fig. 3.

Fig. 5 is a schematic diagram showing a preferred method of connecting the various elements of the mechanism.

Fig. 6 is a similar schematic diagram of a somewhat modified arrangement; and

Figs. 7 and 8 are fragmentary detailed sections of switching means incorporated in the modified construction.

Referring now to the drawing, in which I have shown embodiments of my invention arranged to control the starting of a motorcar engine, it will be seen that in Fig. 1 an engine is fragmentarily shown equipped with an electric starter of the so-called "Bendix" type, the motor 12 of which projects beside the engine, being supported by the flywheel housing 13. When the motor 12 is energized, the starter cranks the engine by means not necessary to be here described. Ordinarily such automotive engines are provided with electric ignition controlled by a key switch or the like, while the starter is controllable by a separate switch.

It is assumed in order to provide typical illustrative conditions that the vehicle fragmentarily shown in Fig. 1 is equipped with a battery, as 30, a generator, as 38, electric ignition energizable through an autotransformer 34 and controllable by an ignition switch 35, and that the engine 10 incorporates an intake manifold (unshown) in which a partial vacuum is formed when the engine is running.

My improved automatic starter will first be described in conjunction with Figures 1 and 5, in order that the operation of its various elements may be understood, after which mechanical features of construction will be considered. Considering first the electrical elements of my improved controlling system, it will be seen that the battery 30 is arranged to energize an ignition transformer 34 in the conventional manner when the ignition switch 35 is closed, and that the generator 38 is also arranged in series with the battery in the conventional manner. The starter motor 12 is controllable by means of a magnetically operable switch 25 arranged in series therewith and operable by means of a solenoid 20, one end of whose winding is connected to the ignition circuit on that side of the ignition switch 35 which is dead when the switch is open, while the other end of the winding is connected in series with a magnetic switch 33, which is in turn connected in series with another magnetic switch 44, operable by the same solenoid 20 which serves to operate the switch 25. From the switch 44 a circuit is completed back to the battery 30 through ground, as will be readily apparent.

Switch 44 is shunted by another switch 45, mechanically operable by means of a vacuum power unit 40. The vacuum unit is so connected

to the intake manifold (unshown) of the engine that the power unit opens the switch when the pressure in the power unit 40 is sufficiently reduced by starting of the engine, while when the engine is at a standstill and switch 45 accordingly closed, a shunt circuit to ground is provided around the switch 44. A bleeder valve 46 is arranged in the tube line 48 by which the vacuum power unit is connected to the intake manifold, and acts as a delaying agent preventing instantaneous operation of the vacuum power switch in either direction.

Switch 33 is operable by means of an electromagnet 36 arranged in series with the generator 38. The generator is of course mechanically driven by the engine 10. The electromagnet 36 is so designed that it is operative to open the switch 33 only when the current delivered by the generator 38 exceeds a predetermined potential; e. g. three-quarters volt. It goes without saying that the solenoid must be constructed to stand and operate upon any voltage up to the maximum delivered by the generator.

When the solenoid 20 is deenergized, switches 25 and 44 are yieldably held open, while switch 33 is yieldably maintained closed until a sufficient current at a potential above one volt is supplied to the magnet 36. As indicated above, vacuum power switch 45 is yieldably maintained closed until a sufficient pressure reduction takes place in vacuum unit 40 (in response to starting of the engine).

The operation of this arrangement, although doubtless readily apparent, may be summarized as follows: When the engine is at rest, turning on the ignition by closing the switch 35 results in completing a circuit through solenoid 20, as one end of its winding is connected to the high side of the battery by the closing of the switch while the other end is connected to ground through switches 33 and 45. Solenoid 20 immediately closes switch 25, which then completes a circuit to the starting motor 12 through contacts 24—26, the former of which is directly connected to the high side of the battery, while the latter is connected to the starting motor which is in turn connected to ground. Switch 44 is closed simultaneously with switch 25, and completes a shunt circuit to ground so that the opening of switch 45 which results from the starting of the engine is prevented from deenergizing the solenoid 20. Such closing of switch 44 maintains the energization of the solenoid 20 and so of the starter motor 12 until switch 33 is opened by electromagnet 36. This, as stated above, is accomplished as soon as generator 38 builds up a potential of one volt, which is in turn dependent upon the attainment of a predetermined speed by the engine 10. When the switch 33 in this fashion breaks the solenoid circuit, switches 25 and 44 are immediately opened, and it will be seen that closing of switch 45 cannot thereafter energize the solenoid and so cause cranking of the engine unless the engine speed falls away sufficiently to deenergize magnet 36 and allow switch 33 to close. By the same token any release of the switch 33 which permits it to close while the engine is running is not effective to energize the solenoid because switch 45 is held open by the vacuum unit during running of the engine, while switch 44 is of course closable only after completion of the solenoid circuit. Any accidental stopping or stalling of the engine while the ignition switch is closed, however, results in operation of the starter 12 as soon as switches 33—45 have both closed, the closing of switch 33 taking place as soon as the current in solenoid 36 drops below ¾ volt, while switch 45 closes when the engine comes to a standstill and the requisite pressure feeds into power unit 40 through the bleeder valve 46. It will be seen that the bleeder prevents fluttering or spasmodic operation of the switch 45 due to any erratic performance of the engine.

My preferred method of constructing and assembling the controlling apparatus is best shown in Figs. 3 and 4. As there indicated, a combined support and casing 15 of tubular formation and preferably magnetic metal is provided. At its base a supporting flange 16 enables its attachment to the starting motor 12 or any other suitable support. Starter motor contacts 24—26 are carried by but insulated from the casing tube and project into the interior thereof in such manner that connection between them may be established by contact element 25 when drawn into engagement therewith by the solenoid 20 acting through the slidable core 22. The insulating end plates 62—63 of the solenoid are press-fitted into the casing tube, and support the solenoid and connected elements as well as the electro-magnet 36, which is secured to the outer face of end plate 63.

One end of the winding of magnet 36 is connected to a binding post 64 from which connection to the generator may be made, while the other end of the winding is grounded. The magnet 36 acts upon the switch arm 33, which is hinged on a bracket 66 to which one end of the solenoid winding is connected. Spring 68 normally holds switch arm 33 in engagement with a contact 69 carried by a conductor and contact bar 70. Also carried by bar 70 is a contact 71 adapted to cooperate with switch contact 45 of the vacuum power unit. The contact is mounted in the center of the movable diaphragm 72 of the unit. The casing of the unit, designated 75, forms a closing head for the upper end of the main casing 15, to which it is secured in the manner best indicated in Fig. 4. A spring 76 resists the tendency of vacuum created in chamber 77 to open switch contact 75, and may also serve to connect the contact 45 to the grounded casing if the diaphragm be formed of insulating material. The bar 70 is supported by the plates 62—63, through which it extends in the manner best indicated in Fig. 3, and terminates near the bottom of the casing where it carries another switch contact 74 engageable by a contact carried by switch arm 44, which when the core is drawn into the solenoid provides the shunt ground connection described above. A spring 78, which is of course weaker than spring 28, urges the switch 44 into closed position when the head 23 of core 22 is retracted. The switch element 25 may be loosely mounted on but insulated from the reduced end portion of the core, and resiliently positioned by means of a spring 79. A binding post 65 is provided adjacent the binding post 64, to which the other end of the winding of solenoid 20 is connected, both such binding posts being insulated from the casing.

When the unit has been installed in suitable position upon the car, as in the manner indicated in Figs. 1 and 4, it is only necessary to run wires from binding posts 64—65 to the generator and to the ignition side of switch 35, respectively, from post 26 to the starter motor, and from post 24 to the high side of the battery, and then to connect the vacuum power unit to the intake manifold as by means of a tube 48, after which

the apparatus is ready to function in the manner described above.

As indicated in Figs. 6 to 8 inclusive, an additional safeguard against unwanted completion of the starter motor circuit may be provided in the form of an additional mechanically operable switch **85** arranged in series with switch **44**. In these views parts analogous to those previously described are indicated by like reference numerals distinguished by the letter "*a*". The switch **85** may be adapted to be mechanically closed by means such as the starter pinion **80**, when the pinion has moved sufficiently far in the axial direction in which it is urged by the starter motor as it begins to crank the engine. It will be understood that this is in conformity with the common method of operation of the so-called Bendix starters, and that the switch is so arranged as to be yieldably held open when the pinion is disengaged, (under the influence of a spring **86**) and thrown to closed position when the pinion has been moved into full engagement with the ring gear **81**, to close the shunt circuit to ground, provided switch **44***a* is also closed. It is characteristic of starters of the variety here under consideration that when the engine is at a standstill, the starter motor, upon commencing to turn, first throws the starting pinion into engagement with the ring gear, while when the engine takes hold and turns under its own power, it throws the pinion out of engagement when it reaches a speed which would turn the pinion faster than the starter motor. By virtue of the provision of switch **85**, when the pinion is so kicked out of engagement, the shunt ground circuit is broken, so that regardless of whether or not the generator breaks the circuit at switch **33***a*, the solenoid **20***a* is deenergized when the engine begins to fire properly. The circuit to the solenoid cannot be reestablished to again energize the starting motor until the switch **45***a* has been closed as a result of complete stopping of the motor.

While it will be apparent that the illustrated embodiments of my invention herein disclosed are calculated to adequately fulfill the objects and advantages primarily stated, it is to be understood that the invention is susceptible to variation, modification and change within the spirit and scope of the subjoined claim.

What I claim is:—

Switching apparatus for controlling electrically operable devices comprising an elongated metallic casing having mounting means at one end thereof, and open at said end, a pair of spaced laterally arranged substantially flat supports therewithin, a main solenoid arranged between said supports, a main switch actuable by said solenoid and arranged within and near one end of the casing, another switch for controlling the main solenoid arranged within and near the other end of the casing, a second solenoid for actuating said last mentioned switch carried by one of said switches on its side opposite the main solenoid, another switch in series with said second switch and arranged in the same end of the casing, pressure operable means mounted at and forming a closure for said same end of the casing for actuating said other switch, an auxiliary switch also actuable by the main solenoid and arranged at the same end of the casing as the main switch, said solenoids, switches and pressure operable means being arranged coaxially of the casing, and a contact bar carrying elements of said auxiliary switch and of a switch at the opposite end of said casing, said bar extending longitudinally of the casing through said spaced supports.

CHARLES F. WARNER.