Dec. 1, 1936. J. B. DYER 2,062,970

CONTROL APPARATUS FOR ENGINE STARTERS

Original Filed Aug. 5, 1933 2 Sheets-Sheet 1

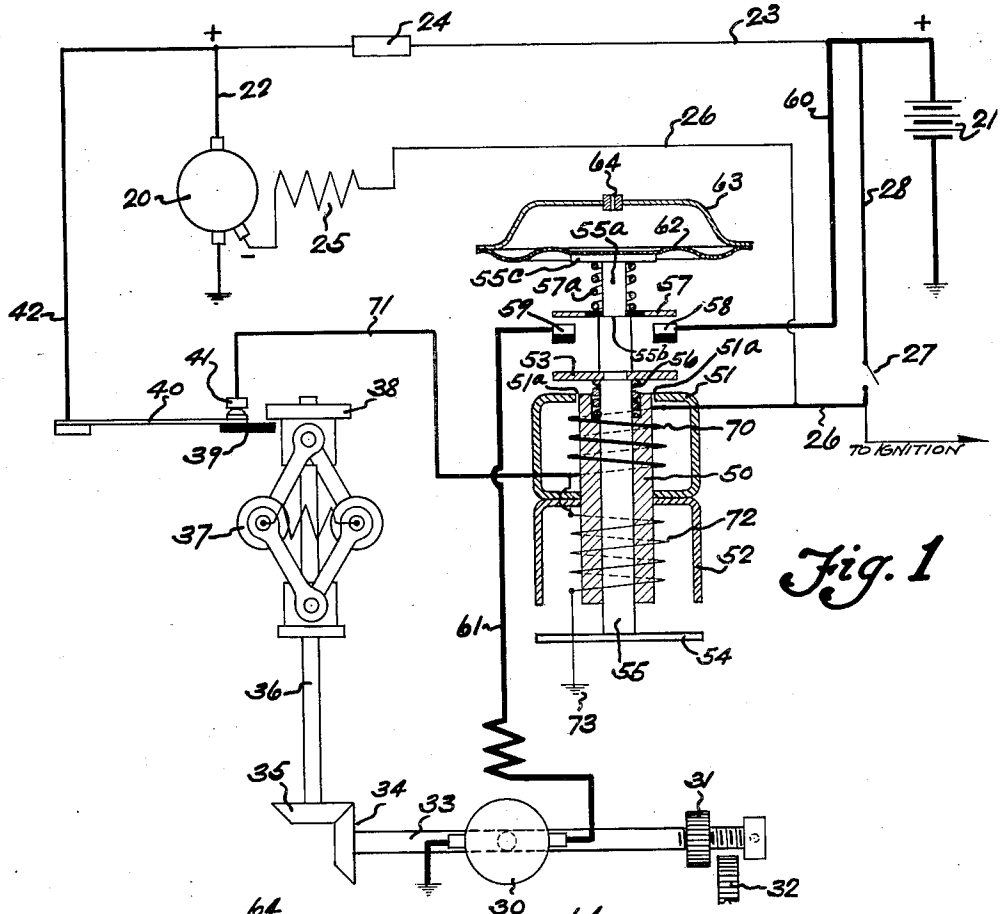


Fig. 1

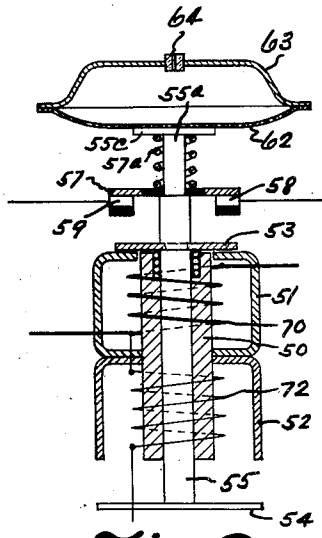


Fig. 2

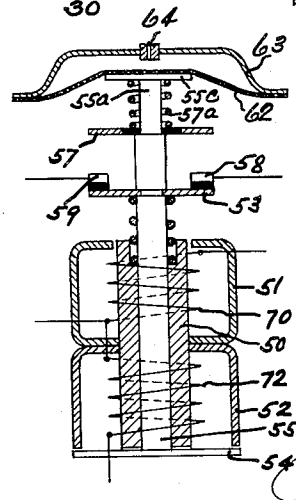


Fig. 3

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CONTROL APPARATUS FOR ENGINE STARTERS

Original Filed Aug. 5, 1933 2 Sheets-Sheet 2

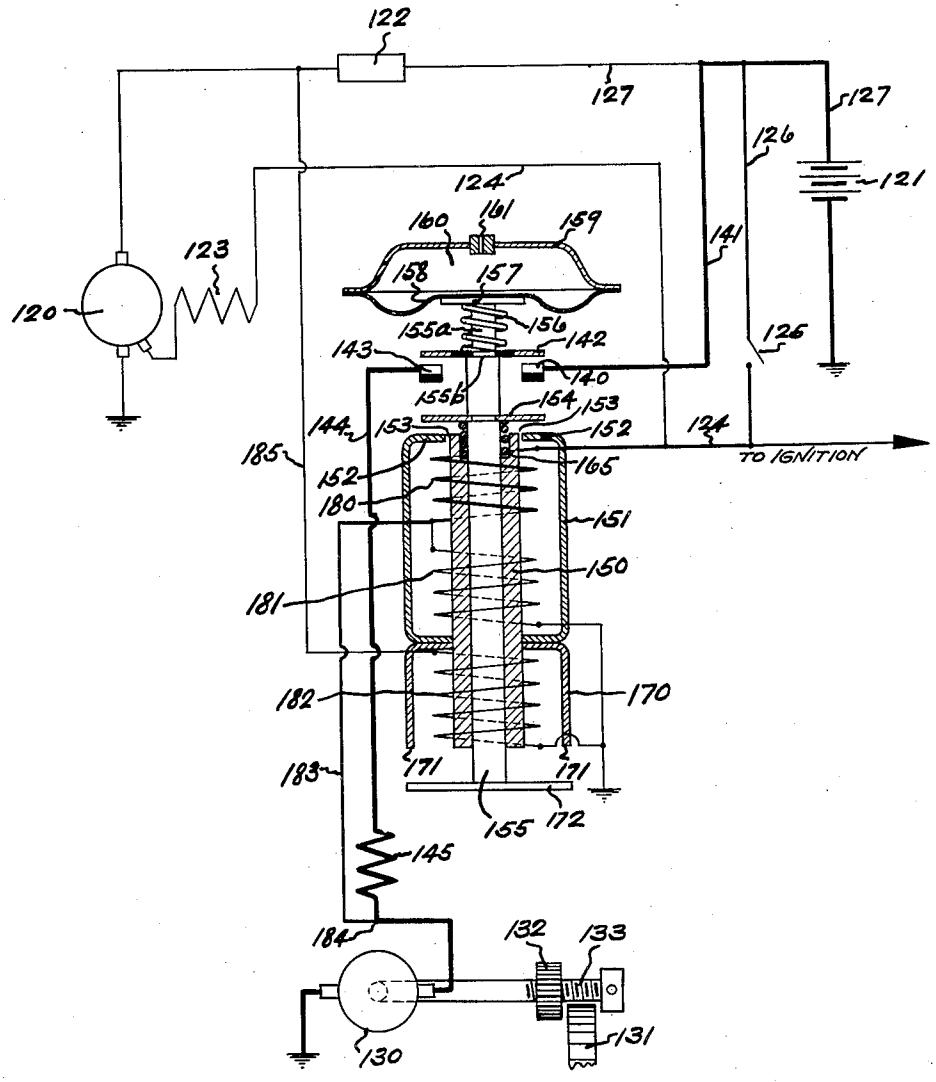


Fig. 4

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CONTROL APPARATUS FOR ENGINE STARTERS

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Application August 5, 1933, Serial No. 683,748
Renewed August 8, 1935

32 Claims. (Cl. 290—37)

This invention relates to engine starter control devices of the type in which the starter is rendered operative by the closing of the ignition switch, is prevented from operating while the engine is running, and is automatically rendered operative again in case the engine stops with the ignition switch closed.

It is among the objects of the invention to provide a controller of this type which is simple in construction and reliable in operation. This object is accomplished in the disclosed embodiments thereof by an electromagnetic device which will cause the starting motor switch to be closed in response to closing the ignition switch and which is rendered ineffective to hold the switch closed in response to the over-speeding of the starting motor after completing the starting operation, and which is positively prevented from becoming effective again to close the switch by a device which is operative until the engine stops.

In one form of my invention, I employ a centrifugal switch responsive to the over-speeding of the starting motor to control the circuit of the winding of the electromagnetic device which operates to close the starter switch when the ignition switch is closed, thereby permitting the starter switch to open and thereafter to be positively held open until the engine stops. In another form of my invention, the electromagnetic device includes a winding acting differentially with respect to the main exciting winding, said differential winding, during the starting operation, being insufficiently effective to prevent operation of said device to close the starter switch. When the starting motor overspeeds, this differential winding operates to cancel the effect of the main winding, and the starter switch is permitted to open.

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

In the drawings:

Fig. 1 is a diagram illustrating one form of the present invention.

Fig. 2 is a fragment of the diagram shown in Figure 1, and shows the status of a portion of the apparatus during the engine cranking operation.

Fig. 3 is a view similar to Figure 1 showing the status of a portion of the apparatus during the running of the engine.

Fig. 4 is a wiring diagram illustrating a modified form of the invention.

Referring to Figure 1, 20 designates an engine-driven generator connectible with a battery 21 through wires 22 and 23, and a connecting cut-out relay 24. The shunt field winding 25 of the generator 20 is connected by a wire 26, ignition switch 27 and wire 28 with the battery 21. Hence, the shunt field 25 is initially separately excited by the battery 21 in order to obtain the relatively rapid increase of the voltage as the speed of the generator is increased after the engine fires. The engine is cranked by starting motor 30 having a Bendix or inertia pinion 31 automatically engageable with, and disengageable from the flywheel gear 32 of the engine to be started. The shaft 33 of the motor 30 is connected by gears 34 and 35 with a shaft 36 carrying a centrifugal device 37 which includes a sliding member 38 adapted to engage a non-conducting block 39 attached to a blade spring contact 40 normally engaging a contact 41. The contact 40 is connected by wires 42 and 22 with the generator 20. In order that the engine starting motor 30 will operate automatically to crank the engine whenever the ignition switch 27 is closed there is provided an electromagnetic device which comprises a central magnetizable core 50 cooperating with two external magnetizable members 51 and 52 providing pole pieces which respectively cooperate with armatures 53 and 54 attached to a rod 55, which is slidably supported by the core 50. The member 51 provides leakage gaps at 51*a*. A spring 56, interposed between the armature 53 and the core 50, normally supports the rod 55 in the position shown in Figure 1, wherein the armature 53 is held away from the magnetizable member 51 and armature 54 is held away from the magnetizable member 52 but within range of their influence. In this position of the rod 55 a movable switch contact 57 is held out of engagement with stationary contacts 58 and 59, connected respectively by wires 60 and 61 with wire 23 and starting motor 30. The contact 57 is insulatingly carried by the rod 55 and is slidable along a reduced portion 55*a* thereof, and is maintained against the shoulder 55*b* thereof by a spring 57*a* interposed between the contact 57 and a plate 55*a* attached to the rod 55. The plate 55*a* is attached to the diaphragm 62 of a delayed action device which includes the diaphragm 62 and a chamber member 63 having a restricted vent 64. The magnetizable member 51 is magnetized by a winding 70 of relatively few turns of relatively heavy wire connected with the wire 26, and by wire 71 with the contact 41. The magnetizable member 52 is magnetized by a magnet coil 72 of relatively fine

wire and having a greater number of turns than the winding 70. The winding 72 is connected with the wire 71 and with ground at 73.

The operation of the device is as follows: The operator closes the switch 27, thereby causing current to flow from the battery 21 to the ignition apparatus (not shown) and also to flow through the magnet coil 70, the circuit of which includes the wire 26, wire 71, switch contacts 40 and 41, wire 42, wire 22, the armature of generator 20 and thence through ground to the battery 21. The magnetism induced in the magnetic circuit including the parts 50 and 51 will be sufficient to attract the armature 53 against the action of the spring 56, thereby causing the contact 57 to engage the contacts 58 and 59, as shown in Fig. 2. When this occurs current will flow from the battery 21 to the motor 30 through the circuit including the wire 60, contact 58, contact 57, contact 59 and wire 61. The rotation of the motor shaft 33 causes the pinion 31 to be automatically connected with the engine gear 32 to crank the engine. When the engine fires the pinion will be automatically demeshed from the engine gear so that the starting motor may rotate free of the load of cranking the engine. The starting motor will therefore over-speed, thereby causing the centrifugal device to move the sliding member 38 against the block 39 and to separate the contact 40 from contact 41 thereby interrupting the path of low resistance from the battery 21 to the coil 70. Since the switch 40, 41 is opened the only way in which the circuit through the winding 70 can be completed is through the winding 72 which is of much higher resistance. Therefore the current flowing through the coil 70 is decreased to such extent that coil 70 is no longer effective to hold the switch 57 closed against the action of spring 56. Due to breaking its short-circuit, coil 72 becomes effective to move the armature 54 to the position shown in Fig. 3 and to hold the armature 53 substantially out of the field of influence of the magnetizable member 51. During the operation of the engine coil 72, which is then responsive to generator voltage, will hold the rod 55 in such position that the contact 57 can never be closed with the contacts 58 and 59. The engine must come to rest before the coil 72 will release the armature 54 to permit the rod 55 to descend by gravity to normal position shown in Fig. 1. If the ignition switch 27 is still closed, the operation of the starting of the engine will be repeated, since the switch contact 40 is then in engagement with the contact 41, the starting motor being at rest.

Reference is now made to Fig. 4 disclosing a modified form of the invention. An engine driven generator 120, which charges the storage battery 121 and is connected therewith through a cut-out relay 122, is provided with a shunt field winding 123 which is connected by wire 124, switch 125 and wire 126 with a wire 127 connecting the relay 122 with the battery 121. Hence when the switch 125 is closed the field winding 123 is excited by the battery 121. Hence, the generator voltage will rise more rapidly at the start than would be the case if the field 123 were connected between the generator and relay 122. The switch 125 also controls the ignition apparatus (not shown) connected with the wire 124.

The vehicle engine which drives the generator 120 is started by means of an electric motor 130 which is connected with the fly wheel gear 131 of the engine to be started through a Bendix or inertia pinion drive including a pinion 132 which is meshable with the engine gear 131 and is threadedly connected to a shaft 133 driven by the motor. The switch for connecting the battery 121 with the motor 130 includes a stationary contact 140 connected by wire 141 with wire 127, a movable contact 142 and a stationary contact 143 connected by wire 144 with the series field winding 145 of the motor and thence through the motor armature.

The device for automatically closing the starter switch when the ignition switch 125 is closed in order to start the engine and for automatically opening the starter switch when the engine starts comprises an electromagnetic structure including a central tubular core 150 associated with a magnetizable member 151 providing pole pieces 152 and having leakage gaps 153 at the upper end of the core 150. The pole pieces 153 cooperate with an armature 154 mounted on a rod 155, the reduced upper end 155*a* of which provides a support upon which the contact 142 is relatively slidable but is insulated therefrom. The rod 155 provides a shoulder 155*b* against which the contact 142 is normally urged by spring 156 confined between the contact 142 and a disc 157 secured to the upper end of the rod 155 and also secured to a flexible diaphragm 158 which cooperates with a cup-shaped member 159 to provide a motion retarding chamber 160 vented by a restricted orifice 161. The armature 154 is held in a normal position shown in the drawings by spring 165 confined by the armature 154 and the core 150. The core 150 is associated also with an external magnetizable body 170 providing pole pieces 171 which cooperate with an armature 172 mounted on the lower end of the rod 155.

The magnetic structure including the core 150, the magnetizable member 151 and the armature 154 is influenced by two magnet coils 180 and 181, the former being of relatively few turns of relatively coarse wire and the latter of a larger number of turns of relatively fine wire. The electromagnet structure comprising the core 150, the magnetizable member 170 and the armature 172 and is influenced by a magnet coil 182. The magnet coil 180 is connected with the wire 124 and by wire 183 with a connection 184 between the series field winding 145 of the motor and its armature. The coil 181 is connected between coil 180 and ground. The magnet coil 182 is connected by wire 185 with the generator at a point between the generator and cutout relay 122 and the winding 182 is grounded.

The operation of the form of the invention shown in Fig. 4 is as follows: When the switch 125 is closed to connect the ignition with the battery 121, current will flow from the battery through wire 126, switch 125, wire 124, coil 180, wire 183 through the armature of motor 130. Part of the current flowing through the coil 180 will also flow through the coil 181 which is wound differentially with respect to the coil 180. But, since the resistance of the path through wire 183 and the armature of motor 130 is much less than the resistance of the coil 181, coil 181 will receive a relatively small amount of current; and, though the coil 181 opposes the magnetizing effect of the coil 180, the opposition will not be sufficient to prevent the coil 180 from energizing its associated magnetic structure sufficiently to attract the armature 154 downwardly to cause the contact 142 to engage the contacts 140 and 143. Then current will flow from battery 121, wire 127, wire 141, contact 140, contact 142, con-

tact 143, wire 144, series field winding 145 and the armature of the motor 130. The motor will operate automatically to connect the pinion 132 with the fly wheel gear 131 of the engine to be started and thereafter to crank the engine. When the engine becomes self-operative the pinion 132 will be automatically demeshed from the engine gear 131. The motor 130, being then freed of its load of cranking the engine, will speed up very rapidly thereby causing the motor to generate in its armature an E. M. F. which will cause the ampere turns of the coil 180 to diminish and the ampere turns of the coil 181 to increase. This results in the magnetizing effect of the coil 181 substantially balancing the magnetizing effect of the coil 180, sufficiently, at least, to permit the spring 165 to move the armature 154 away from the poles 152 thereby causing the switch contact 142 to be separated from the contacts 140 and 143 thereby interrupting the circuit through the starting motor.

The generator being initially excited by the battery, the voltage of the generator will rapidly increase as the engine picks up speed after becoming self-operative. Therefore, the coil 182 will receive sufficient current to energize its associated magnetic structure and cause the armature 172 to move toward the poles 171 thereby positively holding the armature 154 away from the field of influence of its associated electromagnet and hence positively holding the motor switch in open position so that during the running of the engine it cannot be closed again. Even at a very low speed there will be sufficient current flowing through the coil 182 to seal the armature 172 in the upper position, thereby preventing any possibility of closing the starting motor circuit.

In both forms of the invention the delayed action device, provided by a diaphragm and chamber having a restricted vent 161, prevents too rapid descent of the movable contact of the starter switch so that, in the event the engine turns momentarily at a speed approximating zero speed, the starter will not be brought into action. The delayed action device functions, in case the engine fails to remain operative after having been started, to permit the starting motor to come substantially to rest before the starting operation is repeated.

It is therefore apparent from the foregoing description of the construction and mode of operation of two forms of my invention, that said invention embraces an electromagnet for drawing the movable contact of the starter switch into engagement with stationary contacts, an instrument responsive to the overspeeding of the motor for rendering said electromagnet inoperative to maintain said movable contact in circuit-closing position, and means responsive to engine operation for positively maintaining the movable contact in circuit-open position. More specifically my invention embraces a second electromagnet responsive to generator voltage for positively maintaining the armature of the first electromagnet out of the field of influence thereof so long as the engine is operating. In the first form of my invention the ampere turns of the coil of the first magnet are reduced by a centrifugal switch operated in response to the overspeeding of the motor. In the second form the ampere-turns of the coil of said first magnet are cancelled by the ampere-turns of a second coil responsive to an E. M. F. of the motor armature when over-speeding.

While the form of 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. An engine starter control system comprising, in combination, a battery, a starting motor, a starter switch, an electromagnet for closing the starter switch and including a coil and a movable armature for actuating the movable contact of the starter switch, a switch for connecting said coil with the battery, means responsive to over-speeding the starting motor for weakening the influence of said coil to permit opening of starter switch and means responsive to engine operation for positively holding the starter switch in open position.

2. An engine starter control system comprising, in combination, a battery, a starting motor, a starter switch, an electromagnet for closing the starter switch and including a coil and a movable armature for actuating the movable contact of the starter switch, a switch for connecting said coil with the battery, means including a centrifugal switch responsive to over-speeding the starting motor for reducing the ampere turns of said coil to permit opening of the starter switch, and means responsive to engine operation for positively holding the starter switch in open position.

3. An engine starter control system comprising, in combination, a battery, a starting motor, a starter switch, an electromagnet for closing the starter switch and including a coil and a movable armature for actuating the movable contact of the starter switch, a switch for connecting said coil with the battery, means including a second electromagnet coil responsive to E. M. F. of the armature of the starting motor when over-speeding for cancelling the ampere-turn effect of the first coil to permit opening of the starter switch, and means responsive to engine operation for positively holding the starter switch in open position.

4. An engine starter control system comprising, in combination, a battery, a starting motor, a starter switch, an electromagnet for closing the starter switch and including a coil and a movable armature for actuating the movable contact of the starter switch, a switch for connecting said coil with the battery, means including a centrifugal switch responsive to over-speeding the starting motor for reducing the ampere-turns of said coil to permit opening of the starter switch, a generator for charging the battery and means responsive to generator voltage for positively holding the starter switch in open position.

5. An engine starter control system comprising, in combination, a battery, a starting motor, a starter switch, an electromagnet for closing the starter switch and including a coil and a movable armature for actuating the movable contact of the starter switch, a switch for connecting said coil with the battery, means including a second electromagnet coil responsive to E. M. F. of the armature of the starting motor when over-speeding for cancelling the ampere-turn effect of the first coil to permit opening of the starter switch, a generator for charging the battery and means responsive to generator voltage for positively holding the starter switch in open position.

6. An engine starter control system comprising, in combination, a battery, a starting motor, a

starter switch, an electromagnet for closing the starter switch and including a coil and a movable armature for actuating the movable contact of the starter switch, a switch for connecting said coil with the battery, means responsive to over-speeding the starting motor for weakening the influence of said coil to permit opening of starter switch, a generator for charging the battery and means responsive to generator voltage for positively holding the starter switch in open position.

7. An engine starter control system comprising, in combination, a battery, a starting motor, a starter switch having a movable contact, an electromagnet for closing the starter switch and including a coil and a movable armature connected with the movable contact of the switch, a switch for connecting the coil with the battery, means responsive to over-speeding the starting motor for weakening the influence of said coil thereby permitting said armature to be retracted from its electromagnet and the switch to open, and means responsive to engine operation for positively retracting said armature still further from its electromagnet and for maintaining said armature in retracted position while the engine is running.

8. An engine starter control system comprising, in combination, a battery, a starting motor, a starter switch having a movable contact, an electromagnet for closing the starter switch and including a coil and a movable armature connected with the movable contact of the switch, a switch for connecting the coil with the battery, means including a centrifugal switch responsive to over-speeding the starting motor for weakening the influence of said coil thereby permitting said armature to be retracted from its electromagnet and the switch to open, and means responsive to engine operation for positively retracting said armature still further from its electromagnet and for maintaining said armature in retracted position while the engine is running.

9. An engine starter control system comprising, in combination, a battery, a starting motor, a starter switch having a movable contact, an electromagnet for closing the starter switch and including a coil and a movable armature connected with the movable contact of the switch, a switch for connecting the coil with the battery, means including a second electromagnet coil responsive to E. M. F. of the armature of the starting motor when over-speeding for cancelling the ampere-turn effect of the first coil thereby permitting said armature to be retracted from its electromagnet and the switch to open, and means responsive to engine operation for positively retracting said armature still further from its electromagnet and for maintaining said armature in retracted position while the engine is running.

10. An engine starter control system comprising, in combination, a battery, a starting motor, a starter switch having a movable contact, an electromagnet for closing the starter switch and including a coil and a movable armature connected with the movable contact of the switch, a switch for connecting the coil with the battery, means including a centrifugal switch responsive to over-speeding the starting motor for weakening the influence of said coil thereby permitting said armature to be retracted from its electromagnet and the switch to open, a generator for charging the battery and means responsive to generator voltage for positively retracting said armature still further from its electromagnet and for maintaining said armature in retracted position while the engine is running.

11. An engine starter control system comprising, in combination, a battery, a starting motor, a starter switch having a movable contact an electromagnet for closing the starter switch and including a coil and a movable armature connected with the movable contact of the switch, a switch for connecting the coil with the battery, means including a second electromagnet coil responsive to E. M. F. of the armature of the starting motor when over-speeding for cancelling the ampere-turn effect of the first coil thereby permitting said armature to be retracted from its electromagnet and the switch to open, a generator for charging the battery and means responsive to generator voltage for positively retracting said armature still further from its electromagnet and for maintaining said armature in retracted position while the engine is running.

12. An engine starter control system comprising, in combination, a battery, a starting motor, a starter switch having a movable contact, an electromagnet for closing the starter switch and including a coil and a movable armature connected with the movable contact of the switch, a switch for connecting the coil with the battery, means responsive to over-speeding the starting motor for weakening the influence of said coil thereby permitting said armature to be retracted from its electromagnet and the switch to open, a generator for charging the battery and means responsive to generator voltage for positively retracting said armature still further from its electromagnet and for maintaining said armature in retracted position while the engine is running.

13. An engine starter control system comprising, in combination, a battery, a starting motor, a starter switch including a movable contact, an electromagnet for closing the starter switch and including a coil and a movable armature, an endwise movable rod connecting the armature and movable contact, a spring normally holding the armature in a position retracted from its electromagnet, a switch for connecting said coil with the battery, means responsive to over-speeding the starting motor for weakening the influence of said coil thereby permitting said armature to be retracted by said spring from its electromagnet and the switch to open, and means acting directly upon said rod in response to engine operation for positively retracting said armature still farther from its electromagnet and for maintaining said armature in retracted position while the engine is running.

14. An engine starter control system comprising, in combination, a battery, a starting motor, a starter switch including a movable contact, an electromagnet for closing the starter switch and including a coil and a movable armature, an endwise movable rod connecting the armature and movable contact, a spring normally holding the armature in a position retracted from its electromagnet, a switch for connecting said coil with the battery, means including a centrifugal switch responsive to over-speeding the starting motor for weakening the influence of said coil thereby permitting said armature to be retracted by said spring from its electromagnet and the switch to open, and means acting directly upon said rod in response to engine operation for positively retracting said armature still further from its electromagnet and for maintaining said armature in retracted position while the engine is running.

15. An engine starter control system comprising, in combination, a battery, a starting motor, a starter switch including a movable contact, an electromagnet for closing the starter switch and including a coil and a movable armature, an endwise movable rod connecting the armature and movable contact, a spring normally holding the armature in a position retracted from its electromagnet, a switch for connecting said coil with the battery, means including a second electromagnet coil responsive to E. M. F. of the armature of the starting motor when over-speeding for cancelling the ampere-turn effect of the first coil thereby permitting said armature to be retracted by said spring from its electromagnet and the switch to open, and means acting directly upon said rod in response to engine operation for positively retracting said armature still farther from its electromagnet and for maintaining said armature in retracted position while the engine is running.

16. An engine starter control system comprising, in combination, a battery, a starting motor, a starter switch including a movable contact, an electromagnet for closing the starter switch and including a coil and a movable armature, an endwise movable rod connecting the armature and movable contact, a spring normally holding the armature in a position retracted from its electromagnet, a switch for connecting said coil with the battery, means including a centrifugal switch responsive to over-speeding the starting motor for weakening the influence of said coil thereby permitting said armature to be retracted by said spring from its electromagnet and the switch to open, a generator for charging the battery and an electromagnet responsive to generator voltage and having an armature attached to said rod and operable to move said rod in a direction to retract said first mentioned armature still farther from its electromagnet and to maintain said first mentioned armature in retracted position while the engine is running.

17. An engine starter control system comprising, in combination, a battery, a starting motor, a starter switch including a movable contact, an electromagnet for closing the starter switch and including a coil and a movable armature, an endwise movable rod connecting the armature and movable contact, a spring normally holding the armature in a position retracted from its electromagnet, a switch for connecting said coil with the battery, means including a second electromagnet coil responsive to E. M. F. of the armature of the starting motor when over-speeding for cancelling the ampere-turn effect of the first coil thereby permitting said armature to be retracted by said spring from its electromagnet and the switch to open, a generator for charging the battery and an electromagnet responsive to generator voltage and having an armature attached to said rod and operable to move said rod in a direction to retract said first mentioned armature still farther from its electromagnet and to maintain said first mentioned armature in retracted position while the engine is running.

18. An engine starter control system comprising, in combination, a battery, a starting motor, a starter switch including a movable contact, an electromagnet for closing the starter switch and including a coil and a movable armature, an endwise movable rod connecting the armature and movable contact, a spring normally holding the armature in a position retracted from its electromagnet, a switch for connecting said coil with the battery, means responsive to over-speeding the starting motor for weakening the influence of said coil thereby permitting said armature to be retracted by said spring from its electromagnet and the switch to open, a generator for charging the battery and an electromagnet responsive to generator voltage and having an armature attached to said rod and operable to move said rod in a direction to retract said first mentioned armature still farther from its electromagnet and to maintain said first mentioned armature in retracted position while the engine is running.

19. An engine starter control system comprising, in combination, a battery, a starting motor, a starter switch, an electromagnet for closing the starter switch and inculding a coil and a movable armature for actuating the movable contact of the starter switch, a switch for connecting said coil with the battery, means responsive to over-speeding the starting motor for weakening the influence of said coil to permit opening of starter switch, means responsive to engine operation for positively holding the starter switch in open position, and means for retarding movement of the armature.

20. An engine starter control system comprising, in combination, a battery, a starting motor, a starter switch, an electromagnet for closing the starter switch and including a coil and a movable armature for actuating the movable contact of the starter switch, a switch for connecting said coil with the battery, means responsive to over-speeding the starting motor for weakening the influence of said coil to permit opening of starter switch, a generator having a shunt field directly excited by the battery and means responsive to generator voltage for positively holding the starter switch in open position.

21. An engine starter control system comprising, in combination, a battery, a starting motor, a starter switch for controlling the connection of the starting motor with the battery, means for holding said switch closed, a control switch for regulating the force exerted by said means on said switch, means controlled by the speed of the starting motor itself for operating said control switch, and means operated by the engine for holding the starter switch open when the engine is running under its own power.

22. An engine starter control system comprising, in combination, a battery, a starting motor, a starter switch for controlling the connection of the starting motor with the battery, means for holding said switch closed, a control switch for regulating the force exerted by said means on said switch, means controlled by the speed of the starting motor for operating said control switch to decrease the force exerted by said holding means on said starter switch as the starting motor speed increases to permit opening of the starter switch, and means operable by the engine for holding the starter switch open during operation of the engine.

23. An engine starter control system comprising, in combination, a battery, a starting motor, a starter switch for controlling the connection of the starting motor with the battery, means for holding said switch closed, a control switch for regulating the force exerted by said means on said switch, means controlled by the speed of the starting motor for operating said control switch to decrease the force exerted by said holding means on said starter switch as the starting motor speed increases to permit opening of the starter switch,

and means responsive to operation of the generator for holding said starter switch open while the engine is running.

24. An engine starter control system comprising, in combination, a battery, a starting motor, a starter switch for controlling the connection of the starting motor with the battery, means for holding said switch closed, a control switch for regulating the force exerted by said means on said switch, means controlled by the starting motor and operable when said motor reaches a predetermined speed for reducing the force exerted by said holding means to permit opening of the starter switch, and means operable by the engine for holding the switch open when the engine is in operation.

25. An engine starter control system comprising, in combination, a battery, a starting motor, a starter switch for controlling the connection of the starting motor with the battery, a magnet for holding said switch closed, a control switch for regulating the force exerted by said magnet to hold said starter switch closed, means controlled by the speed of the starting motor for operating said control switch to decrease the force exerted by said magnet on said starter switch to permit opening of said switch, and means operable by the engine for holding said starter switch open during operation of the engine.

26. An engine starter control system comprising, in combination, a battery, a starting motor, a starter switch for controlling the connection of the starting motor with the battery, a magnet for holding said switch closed, a control switch for regulating the force exerted by said magnet to hold said starter switch closed, means controlled by the speed of the starting motor and operable when the starting motor reaches a predetermined speed for operating said control switch to decrease the force exerted by said magnet on said starter switch to permit opening of said switch and means operable by the engine for holding said starter switch open during operation of the engine.

27. An engine starter control system comprising, in combination, a battery, a starting motor, a starter switch for controlling the connection of the starting motor with the battery, a magnet for holding said switch closed, a control switch for regulating the force exerted by said magnet to hold said starter switch closed, means controlled by the speed of the starting motor for operating said control switch to decrease the force exerted by said magnet on said starter switch to permit opening of said switch, and means responsive to operation of the generator for holding said starter switch open during engine operation.

28. An engine starter control system comprising, in combination, a battery, a starting motor, a starter switch for controlling the connection of the starting motor with the battery, means for holding said switch closed, a control switch for regulating the operation of said holding means on said switch, means controlled by the speed of the starting motor itself for operating said control switch, and means operated by the engine for holding the starter switch open when the engine is running under its own power.

29. An engine starter control system comprising, in combination, a battery, a starting motor, a starter switch for controlling the connection of the starting motor with the battery, means for holding said switch closed, a control switch for regulating the operation of said holding means on said switch, means controlled by the speed of the starting motor for operating said control switch to effect opening of the starter switch on increase in speed of the starting motor, and means operable by the engine for holding the starter switch open during operation of the engine.

30. An engine starter control system comprising, in combination, a battery, a starting motor, a starter switch for controlling the connection of the starting motor with the battery, means for holding said switch closed, a control switch for regulating the operation of said holding means on said switch, means controlled by the speed of the starting motor for operating said control switch to effect opening of the starter switch, and means responsive to operation of the generator for holding said starter switch open while the engine is running.

31. An engine starter control system comprising, in combination, a current source, a starting motor and means for controlling the operation of said starting motor comprising a main starter switch for directly controlling the connection of the starting motor with the current source, a control switch for controlling the operation of said main switch, means operable upon increase of speed of the starting motor for operating said control switch, a generator, and means whereby operation of the generator directly controls the operation of said main switch.

32. An engine starter control system comprising, in combination, a current source, a starting motor and means for controlling the operation of said starting motor comprising a main starter switch for directly controlling the connection of the starting motor with the current source, a control switch for controlling the operation of said main switch, means operable upon increase of speed of the starting motor for operating said control switch, a generator, means whereby operation of the generator directly controls the operation of said main switch, and means whereby the opening of the control switch causes the generator to become effective to open the main switch.

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