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STARTING MOTOR CONTROL SYSTEM

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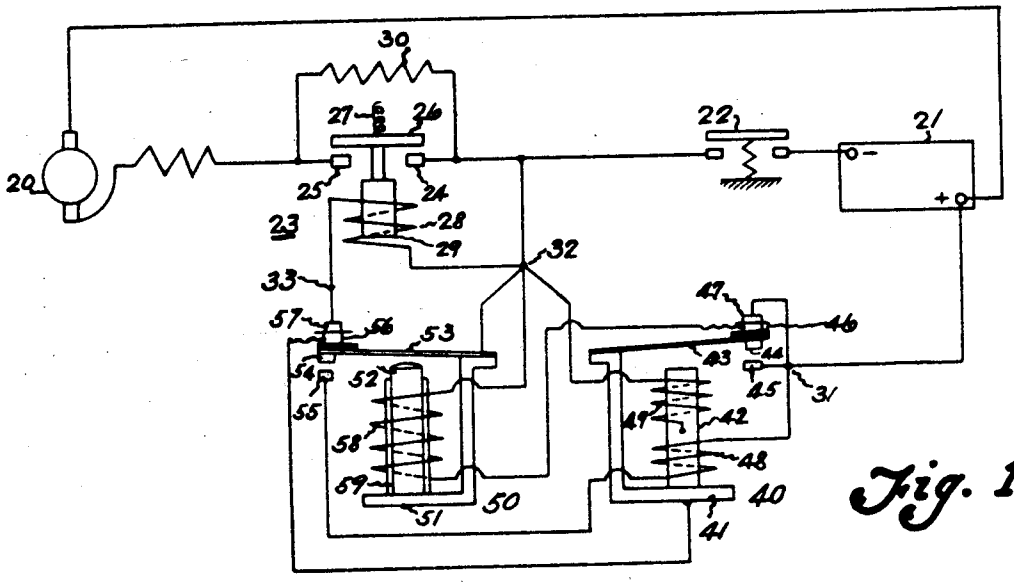


Fig. 1

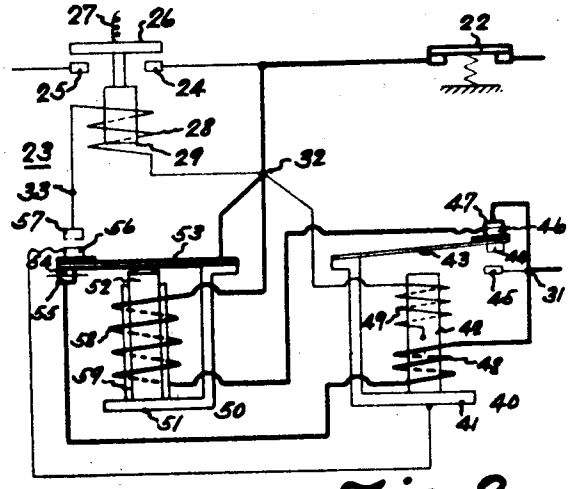


Fig. 2

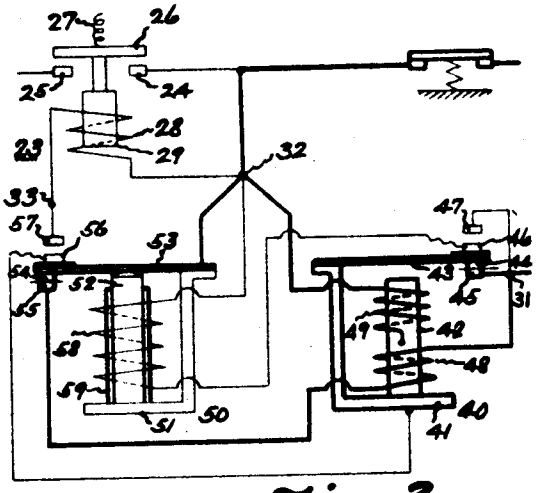


Fig. 3

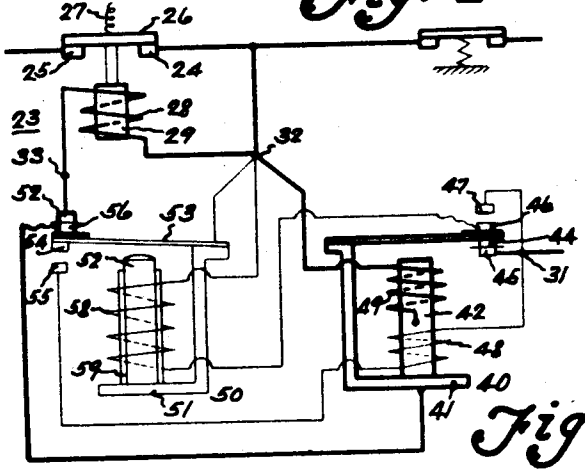


Fig. 4

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STARTING MOTOR CONTROL SYSTEM

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3 Claims. (Cl. 290—38)

This invention relates to a system of control for engine starting motors and aims to delay the application of the full amount of current to the motor for a predetermined time interval following the closing of a manually operated switch, said time-interval being determined by a system of relays whose cycle of operation is initiated by said manual switch. During this time-interval the starter gears are brought into full mesh before the full current is applied to the starting motor. A system of control, such as the present invention provides, is particularly useful when cranking an engine, such as a Diesel, which requires a relatively high-power cranking motor operating at relatively high cranking speed.

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 of an embodiment of the present invention.

Figs. 2, 3 and 4 are fragmentary diagrams showing stages in the cycle of operations of the relay system.

According to Fig. 1, a starting motor 20 is supplied with current from a storage battery 21 through a manually operated switch 22 and a solenoid switch 23 having fixed contacts 24 and 25 bridged by a contact 26 held normally up by a spring 27. Switch 23 is closed electro-magnetically by the energization of a coil 28 for attracting a plunger 29 attached to contact 26. A resistance 30 by-passes switch 23.

The time-delay relay system includes a terminal 31 connected with battery 21, a terminal connected to the line between switches 22 and 23 and a terminal 33 connected to solenoid coil 28 the other end of which is connected to terminal 32. Relay 40 which has a slight lag comprises a magnet frame 41 supporting a core 42 and an armature 43 carrying and electrically connected with a contact 44 for energizing a contact 45 connected with terminal 31. Armature 43 supports an insulated contact 46 normally engaging a contact 47 connected with terminal 31. Surrounding core 42 are two coils, namely: an armature attracting coil 48 connected between terminal 31 and a contact 55 of a relay 50, and an armature holding coil 49 grounded on core 42 and connected with terminal 32.

Relay 50, which has a substantial time-lag, comprises a frame 51 supporting a core 52 and an armature 53 carrying and electrically connected with a contact 54 for engaging a contact 55 connected with coil 48 of relay 40. Armature supports an insulated contact 56 connected with frame 41 of relay 40 and normally engaging a contact 57 connected with terminal 33. The core 52 is surrounded by an armature attracting coil 58 connected between terminal 32 and contact 46 of relay 40, and by a copper sleeve 59 which provides the time-lag of the relay 50.

Fig. 1 shows the system in its normal or non-operating condition. To start the engine the operator closes switch 22 and the system begins its cycle of operations. The first stages are shown in Fig. 2 in which the heavy lines denote the energized circuits. The coil 58 of relay 50 has been energized to effect the attraction of armature 53 which has closed contacts 54, 55 and has separated contacts 56, 57. Solenoid coil 28 is open-circuited but attracting coil 48 of relay 40 receives current. This results in the movement of armature 43 of relay 40 toward the core 42 to separate contacts 46, 47 and to close contacts 44, 45 as shown in Fig. 3.

The separation of contacts 46, 47 open-circuits coil 58 of relay 50, but the contacts 54, 55 do not immediately separate because the delay of flux of relay 50 is retarded by the current induced in copper sleeve 59 which is shown heavy in Fig. 3 since it is active to retard flux decay. The heavy lines in Fig. 3 show that there are two energized branch circuits between terminals 32 and 31, namely: a branch including armature 53 and contacts 54, 55 of relay 50 and coil 48 of relay 40, and a branch including coil 49, core 42, frame 41, armature 43 and contacts 44, 45 of relay 40. Thus the relay 40 remains energized by both coils 48 and 49 while the flux in relay 50 is decaying. For a time, contacts 44, 45 of relay 40 and 54, 55 of relay 50 are closed concurrently.

Finally the flux of relay 50 dies away and armature 53 springs upwardly to separate contacts 54, 55 and to close contacts 56, 57 as shown in Fig. 4.

Due to the slight lag of relay 40, contacts 56, 57 of relay 50 close before contacts 44, 45 of relay 40 have a chance to open. The energized circuits are shown in Fig. 4 in heavy lines and comprise two branch circuits between terminal 32 and the frame 41 of relay 40. One branch includes solenoid coil 28, contacts 56, 57 and frame 41; and the other branch includes armature holding coil 49 of relay 40 grounded on core 42. Holding coil 49 keeps relay 40 closed to maintain the circuit between the battery 21 and solenoid

coil 28, although attracting coil 48 is open-circuited.

The solenoid switch 23 then closes to short-out resistance 30 so that full current is applied to the motor.

Briefly the operation of the system is as follows:— (1) Switch 22 is closed and reduced current passes to motor 20 so that it operates with low power. If it is connected with the engine through a Bendix or other form of automatic gear shifting device responsive to motor rotation, the act meshing starter gears is started. If the motor 20 is connected with the engine through gear meshed by an electro-magnetic shift, the act meshing gears through the operation of an electromagnet will start upon the closing of switch 22. As the present invention is applicable to any form of power-shift for meshing the starter gears, these forms are not shown in the drawing.

(2) Armature 53 of relay 50 is attracted.

(3) Armature 43 of relay 40 is attracted while armature 53 of relay 50 remains attracted.

(4) Flux in relay 50 decays and armature 53 is released. While armature 43 of relay 40 remains attracted due to holding coil 49.

(5) Solenoid coil 48 is energized and solenoid switch 23 closes.

(6) By this time the starter gears will have been fully meshed, and the motor operates with full power to crank the engine.

Therefore I have provided a system of relays giving a measured time of delay between the closing of manual switch 22 and the closing of solenoid switch 23 sufficient to insure the complete meshing of starter gears before full current is applied to the motor. Therefore I provide against breakage of starter gears which would likely occur if the motor operates with full power before the starter gears are fully meshed.

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. A system of control for engine starting motors comprising a battery, a motor, a resistance unit, and a manually operated switch for initially connecting the motor and battery through the resistance in order to reduce the power of the motor, a normally open resistance-short-circuiting switch operated electromagnetically, two relays respectively for controlling two pairs of contacts in the circuit of the battery and the coil of the resistance short-circuiting switch, one of said relays having a substantial time lag and normally closing said circuit at one point and the other relay normally interrupting said circuit, normally closed contacts provided by the second relay for controlling the armature attracting coil of the first or time-delay relay, normally open contacts provided by the time-delay relay for controlling the armature attracting coil of the second relay, and an armature holding coil provided by the second relay and controlled by the normally open contacts of the second relay.

2. A system of control for engine starting motors comprising a battery, a motor, a resistance unit, and a manually operated switch for initially connecting the motor and battery through the resistance in order to reduce the power of the motor, a normally open resistance-short-circuiting switch operated electromagnetically, and means for delaying the application of current to the coil of the resistance-short-circuiting switch, said means comprising a system of relays whose cycle of operation is initiated by the closing of the manual switch, one of the relays having a substantial time lag and the other relay having an armature holding coil in addition to an armature attracting coil, the first relay operating first to effect energization of the armature attracting coil of the second relay, the second relay then acting to open-circuit the coil of the first relay while establishing a circuit connection for the coil of the resistance-short-circuiting switch, and while completing a circuit for its armature holding coil, the first relay then acting to complete the circuit of the coil of the resistance-short-circuiting switch while the circuit connection just made by the second relay is maintained.

3. In a system of control for engine starters, the sub-combination of a means for withholding the application of current from an electromagnetically operated device for causing the motor to receive full current from a source, said sub-combination comprising two inter-dependent relays, one having a substantial time lag and the other having an armature holding coil as well as an armature attracting coil, said first relay, when energized, operating to open-circuit the device at one point and to effect energization of the armature attracting coil of the second relay, the second relay, when energized, operating to open-circuit the coil of the first relay and to close circuit for the device at another point and to effect energization of the armature holding coil of said second relay, said first relay, after its flux decay, operating to complete the circuit of the device and to open circuit the armature attracting coil of the second relay, said second relay then remaining energized due to its armature holding coil.

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