

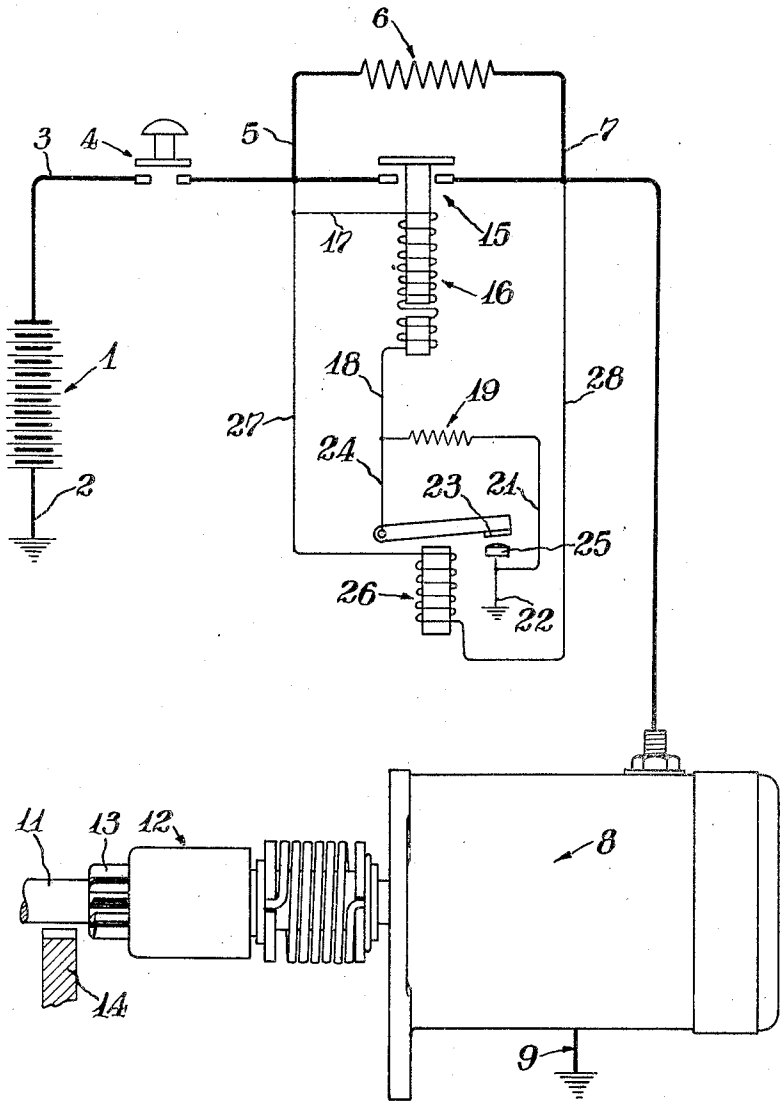
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TWO-STAGE ENGINE STARTER CONTROL

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TWO-STAGE ENGINE STARTER CONTROL

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The present invention relates to a two-stage engine starter control and more particularly to a device for initially energizing a starting system with reduced power to secure engagement of the gearing, and for causing full energization of the starting system after the gearing is completely engaged.

In starting systems which are used for cranking heavy duty power plants such as Diesel engines, it is customary to use quite powerful starting motors energized by batteries of comparatively high voltage. If gearing of the automatically engaging type is employed and the full voltage of the battery is initially applied to the starting motor, the acceleration of the armature thereof is so energetic that a large amount of kinetic energy is built up in the rotating parts during the engaging movement of the pinion, so that a yielding connection of large torque capacity is necessary to properly cushion the engagement of the pinion and the initiation of the cranking operation. Since such cushioning devices are comparatively expensive, it is customary to energize the starting motor with a reduced voltage to secure engagement of the starter gearing, the application of the full voltage of the battery being delayed until after the gearing is fully engaged.

It is an object of the present invention to provide a novel two-stage starter control which is reliable and efficient in operation while being simple and economical in construction.

It is another object to provide such a device which is not critical of adjustment nor liable to get out of adjustment due to variable operating conditions of the starter.

It is another object to provide such a device which is arranged to maintain energization of the starting motor without interruption irrespective of the functional condition of the engine.

It is another object to provide such a device which interposes only such time delay of the full energization of the starting motor as is necessary to proper operation of the starter.

Further objects and advantages will be apparent from the following description taken in connection with the accompanying drawing which illustrates semi-diagrammatically a starting system incorporating a preferred embodiment of the present invention.

In the drawing there is illustrated a starting system including a source of electrical energy such as a battery 1 which is grounded at 2 and connected by a lead 3 to a starting switch 4 of any suitable character. A conductor 5 connects

the starting switch 4 to a resistor 6 which in turn is connected by a lead 7 to a starting motor 8 which is grounded at 9 to complete the starting circuit.

The starting motor 8 is provided with an extended armature shaft 11 on which is mounted a starter drive 12 of conventional character which includes a pinion 13 adapted to be moved by acceleration of the motor shaft into engagement with a member such as a flywheel gear 14 of an engine to be started.

The resistor 6 is of such value as to suitably reduce the voltage initially applied to the starting motor, and means are provided in the form of a bridging switch 15 for short-circuiting said resistance and applying the full battery voltage to the starting motor after engagement of the gearing. Means for closing the bridging switch 15 is illustrated in the form of an electromagnet 16 connected by a lead 17 to the starting circuit lead 5, and through a lead 18, a holding resistance 19 and a lead 21 to the ground at 22. The holding resistance 19 is of such value as to reduce the current flow through the electromagnet 16 to a value merely sufficient to hold the switch 15 closed, but insufficient to cause closure thereof.

Means for short-circuiting the resistance 19 to effect closure of the bridging switch 15 is provided in the form of a movable contact 23 connected by a lead 24 to the control circuit lead 18 and a stationary contact 25 connected to the control circuit lead 21. Means for closing contacts 23, 25 is provided in the form of a coil 26 connected by leads 27 and 28 to the starting circuit leads 5 and 7 respectively whereby said coil is bridged across the resistor 6 and is accordingly energized by the voltage drop across said resistor.

In the operation of this device, closure of the starting switch 4 completes the starting circuit through the resistor 6 whereby the starting motor is energized at reduced voltage to secure engagement of the starting pinion 13 with the engine gear 14. At the same time, the electromagnet 16 of the bridging switch 15 is energized by current passing through the resistance 19, but such energization is insufficient to cause closure of said switch. Coil 26 is also at this time energized by virtue of its parallel relation with the resistor 6, but as long as the starting motor is free to revolve, the counter E. M. F. generated by such rotation prevents the voltage drop across the resistor 6 from assuming a value sufficient to cause the coil 26 to close contacts 23, 25.

When the starting pinion 13 is fully meshed with the engine gear, further rotation of the starting motor is prevented by the resistance to rotation of the engine gear. This stalling of the starting motor reduces its counter E. M. F. to zero, whereupon the voltage drop across the resistor 6 rises to a maximum value which is sufficient to energize the coil 26 to close contacts 23, 25. Closure of these contacts causes full energization of electromagnet 16 whereby the bridging switch 15 is closed, short-circuiting the resistor 6 and applying the full battery voltage to the starting motor. Contacts 23, 25 are opened by the short-circuiting of the coil 26 by the switch 15, but the current traversing the electromagnet 16 as limited by the resistance 19 is sufficient to maintain the bridging switch closed.

When the engine starts, the acceleration of the engine gear 14 demeshes the pinion 13 in the usual manner, and opening of the starting switch 4 by the operator permits the parts to return to their idle positions as illustrated.

It will be seen that there is here provided a device which positively prevents application of the full battery voltage to the starting motor until full engagement of the gearing is effected, while introducing no unnecessary time delay since the full voltage is applied to the motor immediately upon the stalling thereof caused by completion of the engagement of the starter gearing.

Although but one embodiment of the invention has been shown and described in detail, it will be understood that other embodiments are possible and various changes may be made in the design and arrangement of the parts without departing from the spirit of the invention as defined in the claims appended hereto.

What is claimed is:

1. In a starting system for internal combustion engines, a source of electrical energy, a starting motor, a circuit connecting the same including a switch and a starting resistor, and means for short-circuiting the resistor including a magnetic switch, a control circuit for the magnetic switch including a holding resistance and a pair of bridging contacts in parallel therewith, and means responsive to a predetermined voltage drop across the starting resistor to close said contacts.

2. In a starting system for internal combustion engines, a source of electrical energy, a starting motor, a circuit connecting the same including a switch and a starting resistor, and means for short-circuiting the resistor including a magnetic switch, a control circuit for the magnetic switch including a holding resistance and a pair of bridging contacts in parallel therewith, and an electromagnet connected in shunt with the starting resistor operative to close said contacts re-

sponsive to a predetermined energization thereof.

3. A starting system for internal combustion engines including a source of electrical energy, a starting motor, a resistor and a starting switch, a bridging switch in parallel with the resistor, means including an electromagnet energized by closure of the starting switch to hold the bridging switch closed, and means including an electromagnet responsive to a predetermined voltage drop across the resistor for closing the bridging switch.

4. A starting system for internal combustion engines including a source of electrical energy, a starting motor, a resistor and a starting switch, a bridging switch in parallel with the resistor, electromagnetic means actuated by stalling of the starting motor for closing the bridging switch, and manually controllable means for energizing the closing means sufficiently to hold the bridging switch closed.

5. In a starting circuit for internal combustion engines, a battery, a starting motor, a resistor for reducing the flow of current from the battery to the starting motor, and a starting switch for completing said circuit, an electromagnetic switch for bridging the resistor including a coil in circuit with said battery and starting switch, a resistance in series with the coil for reducing the flow of current therein to a holding value, and means responsive to stalling of the starting motor for short-circuiting said holding resistance.

6. In combination with a starting circuit for internal combustion engines including a battery, a starting motor, a resistor for reducing the flow of current from the battery to the starting motor, and a starting switch for completing said circuit, an electromagnetic switch for bridging the resistor, a control circuit for the bridging switch including a pair of contacts, and an electromagnet having a coil energized by the voltage drop across the resistor to close the contacts responsive to stalling of the starting motor.

7. In a two-stage starter control for internal combustion engines, a starting system including a manual switch and a starting resistor, an electromagnetic switch in parallel with the resistor, a control circuit for the magnetic switch including a resistance arranged to reduce the current in the control circuit to a holding value for the magnetic switch, a pair of normally open contacts connected in shunt with the holding resistance, and means for closing said contacts in response to stalling of the starting motor.

8. A two-stage starter control as set forth in claim 7 in which the means for closing the contacts includes a solenoid connected in shunt with the starting resistor.

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