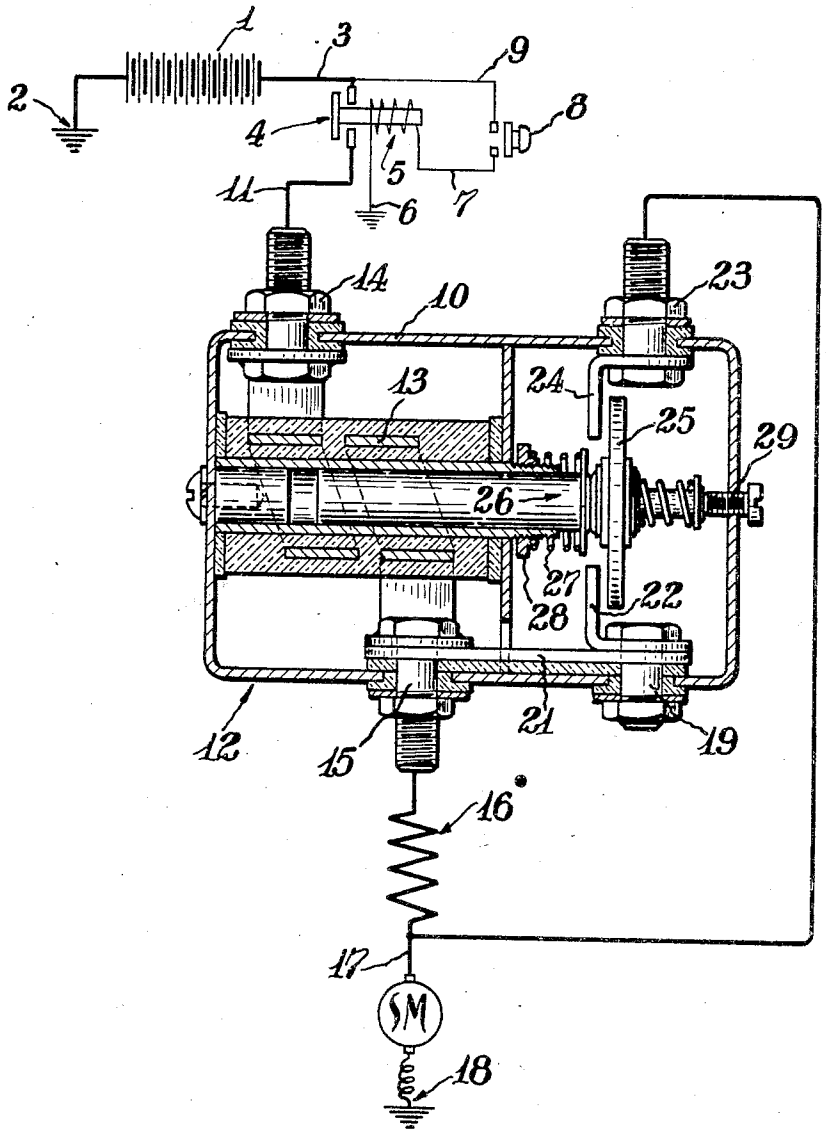
Aug. 27, 1940. J. E. BUXTON 2,213,158

TWO-STAGE ENGINE STARTER CONTROL

Filed May 10, 1939



Witness:
Burr W. Jones

INVENTOR.
BY James E. Buxton
Clinton L. Jones
ATTORNEY.

Patented Aug. 27, 1940

2,213,158

UNITED STATES PATENT OFFICE

2,213,158

TWO-STAGE ENGINE STARTER CONTROL

James E. Buxton, Elmira Heights, N. Y., assignor to Bendix Aviation Corporation, South Bend, Ind., a corporation of Delaware

Application May 10, 1939, Serial No. 272,875

5 Claims. (Cl. 290—38)

The present invention relates to a two-stage engine starter control and more particularly to a device for initially energizing an engine starter at less than full battery voltage and for automatically applying the full voltage of the battery to the starter after engagement of the starter gearing.

In heavy duty starter installations such as starters for Diesel engines in which the gearing is automatically engaged by the operation of the motor, it is desirable to delay the full energization of the starting motor until after the gearing is engaged, in order to avoid unnecessary shock loads on the gearing. Various forms of control for effecting this purpose have been utilized, but in general they have been subject to disadvantages because of complication in structure, the necessity of installing special fixtures on the starting motor, the requirement of a resistor capable of handling heavy loads for considerable periods of time, and/or other undesirable features.

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

It is another object to provide such a device which is a self-contained unit and necessitates no changes or special attachments to the starting motor or any other part of the starting system.

It is a further object to provide such a device which is arranged to apply the full battery voltage immediately upon assumption of the cranking load by the starting motor whereby there is only a short time interval during which the voltage of the battery is reduced, and consequently only a small amount of energy so dissipated.

It is another object of the invention to provide such a device incorporating a resistor for initially reducing the battery voltage, and a switch for bridging the resistor which is automatically closed as soon as the starting motor assumes the cranking load.

It is another object to provide such a device in which the control of the switch is electrical in character and accordingly requires no mechanical connections of any kind.

Further objects and advantages will be apparent from the following description taken in connection with the accompanying drawing in which there is illustrated semi-diagrammatically a preferred form of the present invention.

In the drawing there is illustrated a starting system for an internal combustion engine comprising a battery 1 grounded at 2 and connected by a lead 3 to a starting switch 4 which may be operated magnetically by means of a solenoid 5, one terminal of which is grounded at 6 and the opposite terminal of which is connected by a lead 7 to a push button switch 8 which is connected by a lead 9 to the battery lead 3.

Starting switch 4 is connected by a lead 11 to a magnetically operated control switch indicated generally by numeral 12. As here illustrated, the control switch 12 is actuated by a series coil 13, one end of which is attached to a binding post 14 mounted in the casing 10 of the switch and connected to lead 11, and the other end of which is attached to a second binding post 15 mounted in the opposite side of the casing. A resistor 16 of suitable resistance and load capacity is connected to the binding post 15 and to a lead 17 which is connected to the starting motor SM. The starting motor is grounded as indicated at 18 to complete the starting circuit.

The control switch 12 is arranged to bridge and short-circuit the resistor 16 during the cranking operation. For this purpose a binding post 19 is connected by a bus bar 21 to the binding post 15 and carries a stationary switch contact 22. A binding post 23 carries a second stationary switch contact 24, and a movable insulated bridging contact 25 is mounted on a magnetic plunger 26, which plunger is arranged to reciprocate within the coil 13 to thereby open and close the bridging switch.

The bridging contact 25 is normally maintained in open position by means of a spring 27, the pressure of which is preferably adjustable as by means of a threaded abutment 28. The idle or open position of the plunger 26 and bridging contact 25 is defined by an adjustable stop member 29 threaded within the switch casing 10 and adjustable to vary the gap between the bridging contact 25 and the fixed contacts 22 and 24.

In operation, starting with the parts in the positions illustrated, closure of the push button 8 causes energization of the solenoid 5 to close the starting switch 4. Current from battery 1 then traverses lead 3, switch 4, lead 11, coil 13, resistor 16 and lead 17 whereby the starting motor is energized by a current, the voltage of which is reduced by the resistor 16 to a value suitable for causing initial engagement of the starter gearing with the engine, not illustrated. When switch 4 is first closed, the coil 13 of the bridging switch 12 is partially energized, but the inertia of the plunger 26 and its associated parts, aided by the self-inductance of the elements of the starting circuit prevents the switch 12 from clos-

ing for an appreciable time interval. This time interval is sufficient for the counter E. M. F. of the starting motor to build up consequent to its initial energization and rotation to secure the meshing action and thereby prevent the coil 13 from causing closure of the bridging switch at this time.

When the starter gearing is engaged with the engine, the starting motor becomes stalled since it is not sufficiently energized by the reduced voltage of the battery to crank the engine. When the starting motor is thus stalled it becomes in effect a pure resistance of very low value so that sufficient current is permitted to flow through the starting circuit including the resistor 16 to cause the coil 13 to attract the plunger 26 and cause closure of the bridging switch. The full battery voltage is thus applied to the starting motor which thereupon proceeds to crank the engine in the usual manner. During the cranking operation, the coil 13 is energized by the full cranking current, thus holding the switch 12 firmly closed.

When the engine starts, release of the push button 8 causes all the parts to return to their normal positions, as illustrated.

It will be understood that the compression of the spring 27, and the adjustment of the stop 29 will be so coordinated as to prevent the bridging switch from closing in response to the initial flow of current through the starting circuit, but to insure such closure in response to stalling the starting motor. It has been found in practice that this adjustment is not at all critical but that considerable latitude of adjustment is possible without sacrificing satisfactory performance of the switch.

Although but one embodiment of the invention has been shown and described in detail, it will be understood that other embodiments are possible and that 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 an engine starting system, a battery, a starting motor, connecting means including a resistor for reducing the initial application of voltage from the battery to the starting motor, and a magnetic switch for bridging the resistor having an energizing coil in series with the battery, the resistor and the starting motor.

2. In an engine starting system, a battery, a starting motor, connecting means including a resistor for reducing the initial application of voltage from the battery to the starting motor, a magnetic switch for bridging the resistor having an energizing coil in series with the battery, the resistor and the starting motor, and means for adjusting the sensitivity of the switch to cause closure thereof in response to stalling of the starting motor.

3. In a two-stage starter control for internal combustion engines, a starting circuit including a resistor normally in series therein to limit the flow of current therethrough to a predetermined maximum, and a magnetic switch for bridging said resistor having an energizing coil in series with the resistor in the starting circuit.

4. In a two-stage starter control for internal combustion engines, a starting circuit including a resistor normally in series therein to limit the flow of current therethrough to a predetermined maximum, and a magnetic switch for bridging said resistor having an energizing coil in series with the resistor in the starting circuit and calibrating means for adjusting the switch to close responsive to a predetermined current flow in the starting circuit.

5. In a two-stage starter control for internal combustion engines, a starting circuit including a resistor normally in series therein to limit the flow of current therethrough to a predetermined maximum, and a magnetic switch having an energizing coil in series with the resistor in the starting circuit and a bridging member adapted when the switch is closed, to short-circuit the resistor; yielding means holding the starting switch open, and an adjustable stop for defining the open position of the bridging member to calibrate the sensitivity of the switch.

JAMES E. BUXTON.