March 16, 1937. P. H. MAURER 2,073,645

ENGINE STARTER CONTROL

Filed April 16, 1935

Fig. 1

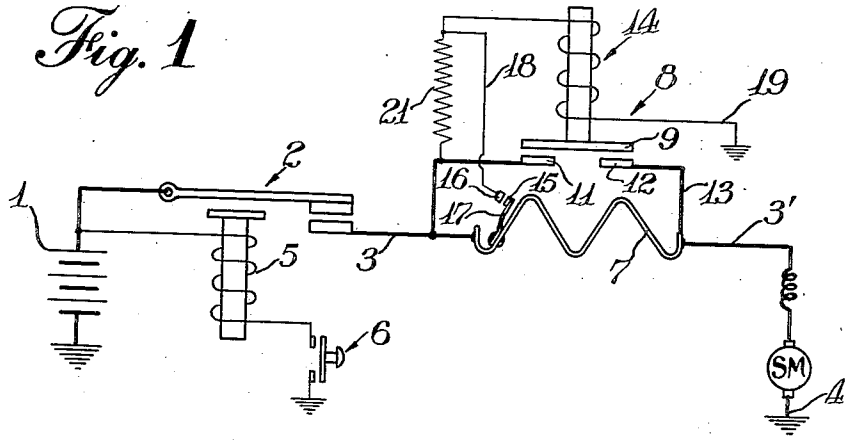


Fig. 2

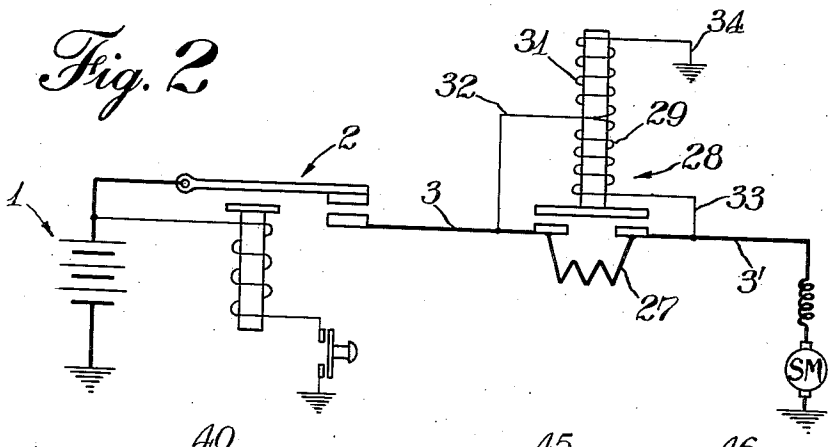
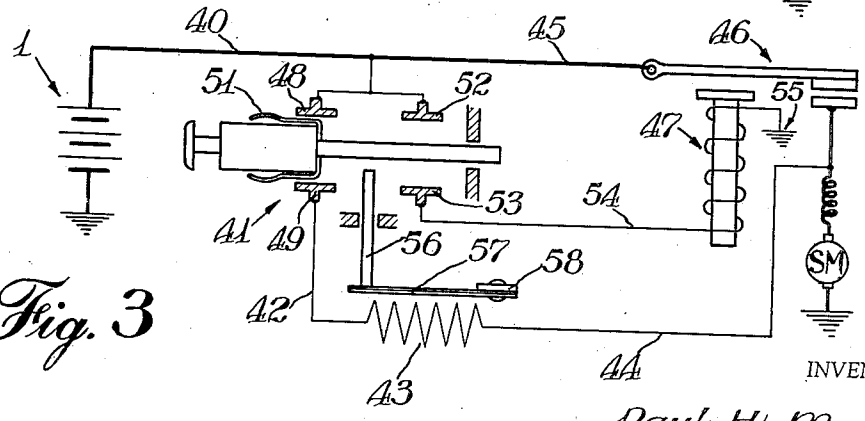


Fig. 3



INVENTOR.

Witness:
Burr W. Jones

BY Paul H. Maurer
Clinton L. Jones
ATTORNEY.

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ENGINE STARTER CONTROL

Paul H. Maurer, Elmira, N. Y., assignor to Eclipse Machine Company, Elmira, N. Y., a corporation of New York

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7 Claims. (Cl. 290—38)

The present invention relates to engine starter controls and more particularly to a device for energizing by progressive steps an engine starter of the automatic mesh and demesh type so as to secure engagement of the starting mechanism prior to the full energization of the starting motor.

An application claiming intensively the subject-matter illustrated in Fig. 3 of the present application was filed December 24, 1936, Serial Number 117,547.

In starting devices of the automatically meshing and demeshing type, energization of thestarting motor is caused to move a pinion into engagement with an engine gear and thus establish a driving connection between the starting motor and engine, which driving connection is automatically interrupted when the engine starts, by the overrunning action of the engine gear which returns the starting pinion to idle position. It will be readily understood that the running start of the motor prior to the engagement of the pinion with the engine gear permits considerable kinetic energy to be stored up in the starting motor and connected parts, which kinetic energy is applied to initiate the rotation of the engine gear.

In certain very heavy duty installations such as large Diesel engine units, where powerful starting motors are energized from batteries of comparatively high voltage with very large current consumption, it has been found that the amount of kinetic energy so stored up by the running start is so large that the parts of the drive when properly designed for the most efficient cranking operation may be seriously overloaded when the starter gearing is initially engaged.

It has therefore been suggested to energize the starting motor with less than the full battery voltage during the meshing operation and then to apply the full battery voltage to the motor after the driving connection has been established, the initial energization being merely sufficient to secure the proper automatic engagement of the drive without storing up unnecessarily large amounts of kinetic energy in the motor armature and its associated parts.

It is an object of the present invention to provide a novel starter control of the type stated which is simple and economical in construction and reliable and efficient in operation.

It is another object to provide such a starter control which positively prevents premature energization of the starting motor to its full capacity.

It is a further object to provide such a device which is entirely automatic insofar as the full energization of the starting motor is concerned.

It is another object to provide such a device in which the parts reset themselves during cranking so that a restart is controlled similarly to an original start.

It is another object to provide such a device in which a resistor is used to modify the initial actuation of the starting motor, and the same element functions to control the time delay prior to full energization thereof.

Further objects and advantages will be apparent from the following description taken in connection with the accompanying drawing in which:

Fig. 1 is a semi-diagrammatic illustration of one preferred embodiment of the invention showing the parts in normal or idle position;

Fig. 2 is a similar view of a second embodiment of the invention; and

Fig. 3 is a similar view of a third embodiment thereof.

Referring first to Fig. 1 of the drawing, there is illustrated an electrical starting system for internal combustion engines comprising a battery 1, a starting switch 2 which is preferably though not necessarily of the magnetic type, conductors 3 and 3', and a starting motor SM grounded at 4 to complete the starting circuit. The starting switch 2 is preferably actuated by a solenoid 5 controlled from a manual push button 6.

The starting motor SM is employed to crank an engine to be started by means of the usual automatically meshing and demeshing gearing which, being conventional in construction, is not illustrated.

According to the present invention, means are provided for preventing full energization of the starting motor immediately upon closure of the starting switch 2, such means being here shown in the form of a suitable resistor 7 inserted between the conductors 3 and 3', said resistor having such value as to cause the energization of the starting motor sufficiently to effect the engagement of the starter gearing actuated thereby without causing excessive stresses to be applied to the starter gearing due to the free running start of the motor. Means are further provided for short-circuiting the resistor 7 after a predetermined time and thus fully energizing the starting motor, this means being here shown in the form of a magnetic switch 8 comprising a movable contact 9 and fixed contacts 11, 12 in a bridging circuit 13. Means for causing closure of the switch 9 after a predetermined time interval is provided in the form of a solenoid 14 controlled by a pair of contacts 15, 16, contact

15 being mounted on a strip of bi-metal 17 attached to the resistor 7, and contact 16 being connected by a lead 18 to the solenoid 14 which is grounded at 19 to complete a control circuit for the switch 8. It will be understood that the bi-metal 17 is arranged to close contacts 15, 16 when the resistor 7 has been heated to a predetermined temperature by the current passing therethrough.

Means are provided for preventing the interruption of cranking by maintaining the switch 8 closed irrespective of the opening of contacts 15, 16, in the form of a resistance element 21 bridged across the contacts 15, 16 and having a holding value for the solenoid 14 whereby the switch 8 is maintained closed after initial closure thereof until the main starting switch 2 is released.

In operation, closure of the push button 6 causes energization of solenoid 5 which closes the starting switch 2 and completes the starting circuit from battery 1 to the starting motor SM through the resistor 7. The starting motor is accordingly energized at a suitably reduced voltage whereby the pinion actuated thereby is caused to engage and mesh with the gear of the engine to be started.

At this time the solenoid 14 of magnetic switch 8 is partially energized by current traversing the resistance element 21, but the value of this resistance element is such that the solenoid is not sufficiently energized to close the switch.

After a suitable time interval, the resistor 7, being heated by the current passing therethrough, raises the temperature of the bi-metal 17 sufficiently to close contacts 15, 16 and thereby bridge out the resistance element 21 and fully energize solenoid 14 to cause closure of the magnetic switch 8. The resistor 7 is thereby short-circuited and the starting motor energized by the full battery voltage to crank the engine.

As soon as the resistor 7 is short-circuited, it begins to cool off, and contacts 15, 16 open. However, the cranking is not interrupted thereby since sufficient current traverses the resistance element 21 to hold the magnetic switch 8 closed and maintain cranking so long as the starting switch 2 is held closed. When the engine starts, release of the push button 6 permits the starting switch 2 to open whereupon the parts return to their normal positions as illustrated.

In the embodiment of the invention illustrated in Fig. 2, the battery 1, starting switch 2 and starting motor SM are constructed and arranged as previously described, but a resistor 27 is employed for initially reducing the battery voltage supplied to the starting motor, which resistor is constructed of material such as iron wire which has a high positive temperature co-efficient of resistance so that its resistance increases rapidly with a rise in temperature. The magnetic bridging switch 28 is in this instance provided with a solenoid having two windings, a closing winding 29 and a holding winding 31. Both windings are connected by a lead 32 to the battery lead 3, but the closing winding is connected at its other end by a lead 33 to the starting motor lead 3', while the other end of the holding winding 31 is grounded by a lead 34.

The holding winding 31 is designed to provide only sufficient flux to hold the switch 28 closed, but not enough to cause closure thereof, while the closing winding 29 is designed to provide sufficient additional flux to cause closure of the switch 28 when the resistor 27 has reached a predetermined temperature and thereby increased its resistance sufficiently to provide a predetermined voltage drop through the coil 29.

In the operation of this embodiment of the invention, closure of the starting button 6 causes closure of the starting switch 2 which causes the motor SM to be energized from battery 1 by a suitable voltage limited by the resistor 27 to cause proper engagement of the starter gearing. The current traversing the resistor 27 raises its temperature in a predetermined time to the point where the voltage drop therethrough is sufficient to energize the closing coil 29. The combined flux of coils 31 and 29 thus becomes sufficient to cause closure of magnetic switch 28 whereupon the resistor 27 is short-circuited and the starting motor SM is fully energized and cranking takes place as usual.

When the resistor 27 is short-circuited, the closing coil 29 is also short-circuited and deenergized, but the switch 28 is held closed by the holding coil 31. Resistor 27 at the same time cools off and is thereby prepared for the next starting operation.

When the engine starts, release of the starting button 6 permits the starting switch 2 to open whereupon the holding coil 31 is deenergized and magnetic switch 28 is opened.

In the embodiment of the invention illustrated in Fig. 3, a two-stage manually operated switch is employed for controlling the starting operation. As here illustrated, the starting circuit includes battery 1, lead 40, manual switch 41, lead 42, resistor 43, lead 44 and starting motor SM, resistor 43 being of such value as to cause energization of the starting motor to a suitable degree for engaging the starting gearing. There is also provided a bridging circuit 45 for short-circuiting the resistor 43, which bridging circuit is controlled by a magnetic switch 46 comprising a solenoid 47.

Manual switch 41 comprises fixed contacts 48 and 49 and a bridging contact 51 for completing the initial starting circuit. This switch also includes a second pair of fixed contacts 52 and 53 which are closed by final movement of the bridging contact 51 to thereby complete a circuit from battery lead 40 through lead 54 to solenoid 47 which is grounded as indicated at 55.

Means are provided for initially preventing movement of the manual switch 41 sufficient to close the circuit of solenoid 47, here illustrated in the form of a latch member 56 movable into and out of the path of bridging contact 51 by means of a bi-metal strip 57 suitably anchored at 58 and arranged to be heated by the resistor 43 when current is passed therethrough. The latch 56 is in the path of the bridging contact 51 when the bi-metal is at normal temperatures, and is moved out of the path of said contact to permit full traversal thereof when the bi-metal is heated to a predetermined temperature.

In the operation of this embodiment of the invention, actuation by the operator of the manual switch 41 causes contact 51 to connect fixed contacts 48 and 49, thus completing the initial starting circuit through resistor 43 to the starting motor SM whereby the latter is energized to cause engagement of the starting gearing. Further travel of contact 51 is initially prevented by latch 56. After a predetermined time interval, resistor 43 heats up the bi-metal 57 sufficiently to withdraw the latch 56 from the path of contact 51 whereupon further actuation of the manual switch causes bridging of contacts 52, 53 by contact 51, thereby energizing solenoid 47 and caus-

ing closure of magnetic switch 46. The resistor 43 is thereby short-circuited and the starting motor fully energized to crank the engine. Resistor 43 and bi-metal 57 are thereby permitted to cool off, and when the manual switch 41 is released as the engine starts, the parts return to their normal positions as illustrated.

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

What is claimed is:

1. An electrical starting system for internal combustion engines including a battery, a starting motor, means including a resistor and a manually operable switch for partially energizing said motor, means including a magnetic switch for short-circuiting the resistor, and a control circuit for said magnetic switch including contacts, and means for closing said contacts responsive to a predetermined rise in temperature of the resistor.

2. An electrical starting system for internal combustion engines including a battery, a starting motor, means including a resistor and a manually operable switch for partially energizing said motor, means including a magnetic switch for short-circuiting the resistor, a control circuit for said magnetic switch including contacts, means for closing said contacts responsive to a predetermined rise in temperature of the resistor, said control circuit also including said manual switch, and a resistance having a holding value for said magnetic switch bridging said contacts.

3. An electrical system for internal combustion engines including a battery, a starting motor, a circuit including a manually controlled switch and a resistor for partially energizing said starting motor, a magnetic switch for short-circuiting said resistor to fully energize the starting motor, and a control circuit for said magnetic switch including a switch-closing winding bridged across the resistor, said resistor having a positive temperature co-efficient such that when heated to a predetermined degree the voltage drop therethrough will be sufficient to energize said winding to close the magnetic switch.

4. An electrical system for internal combustion engines including a battery, a starting motor, a circuit including a manually controlled switch and a resistor for partially energizing said starting motor, a magnetic switch for short-circuiting said resistor to fully energize the starting motor, and a control circuit for said magnetic switch including a switch-closing winding bridged across the resistor, said resistor having a positive temperature co-efficient such that when heated to a predetermined degree the voltage drop therethrough will be sufficient to energize said winding to close the magnetic switch, said magnetic switch also having a holding winding for maintaining the switch closed so long as the manually controlled switch is closed.

5. In an electrical starting system for internal combustion engines, a starting circuit including a resistor, means for short-circuiting said resistor responsive to a predetermined rise in temperature thereof including a magnetic switch and means for strongly energizing said switch to cause closure thereof, such closure operating to permit the resistor to cool off and to cause weakening of the switch-closing means; and manually controllable means for maintaining said switch sufficiently energized to remain closed.

6. In an electrical starting system for internal combustion engines, a starting circuit including a battery, a starting motor, and connections therebetween including two electromagnetic switches in series, manually controlled means for operating one of said switches, a resistor in shunt with the second of said switches having a value such as to suitably limit the flow of current through the starting circuit for initiation of the starting operation, means controlled by said first switch for energizing the electromagnet of the second switch sufficiently to hold it closed but insufficiently to cause closure thereof, and means whereby heating of said resistor to a predetermined temperature causes additional energization of said electromagnet sufficient to cause closure of said second switch.

7. In an electrical starting system for internal combustion engines, a starting circuit including a battery, a starting motor, and connections therebetween including two electromagnetic switches in series, manually controlled means for operating one of said switches, a resistor in shunt with the second of said switches having a value such as to suitably limit the flow of current through the starting circuit for initiation of the starting operation, means controlled by said first switch for energizing the electromagnet of the second switch sufficiently to hold it closed but insufficiently to cause closure thereof, and means whereby heating of said resistor to a predetermined temperature causes additional energization of said electromagnet sufficient to cause closure of said second switch, said last means being so constructed and arranged that closure of the shunt around the resistor by said second switch causes reduction of the energization of said electromagnet to a holding value.

PAUL H. MAURER.