Oct. 31, 1950 D. L. MILLER 2,528,160

BACKFIRE PROTECTIVE DEVICE

Filed Sept. 23, 1946 3 Sheets-Sheet 1

Fig. 1

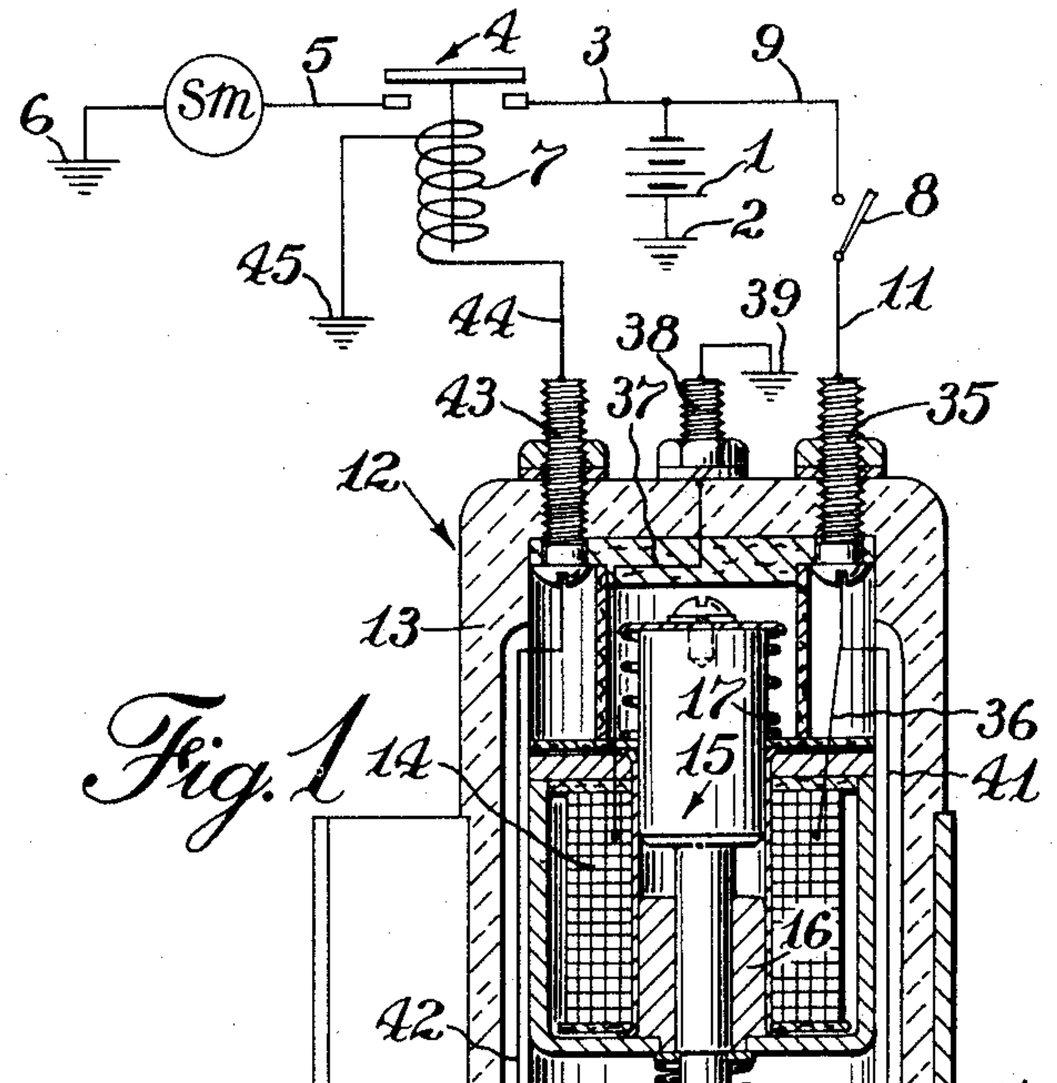


Fig. 2

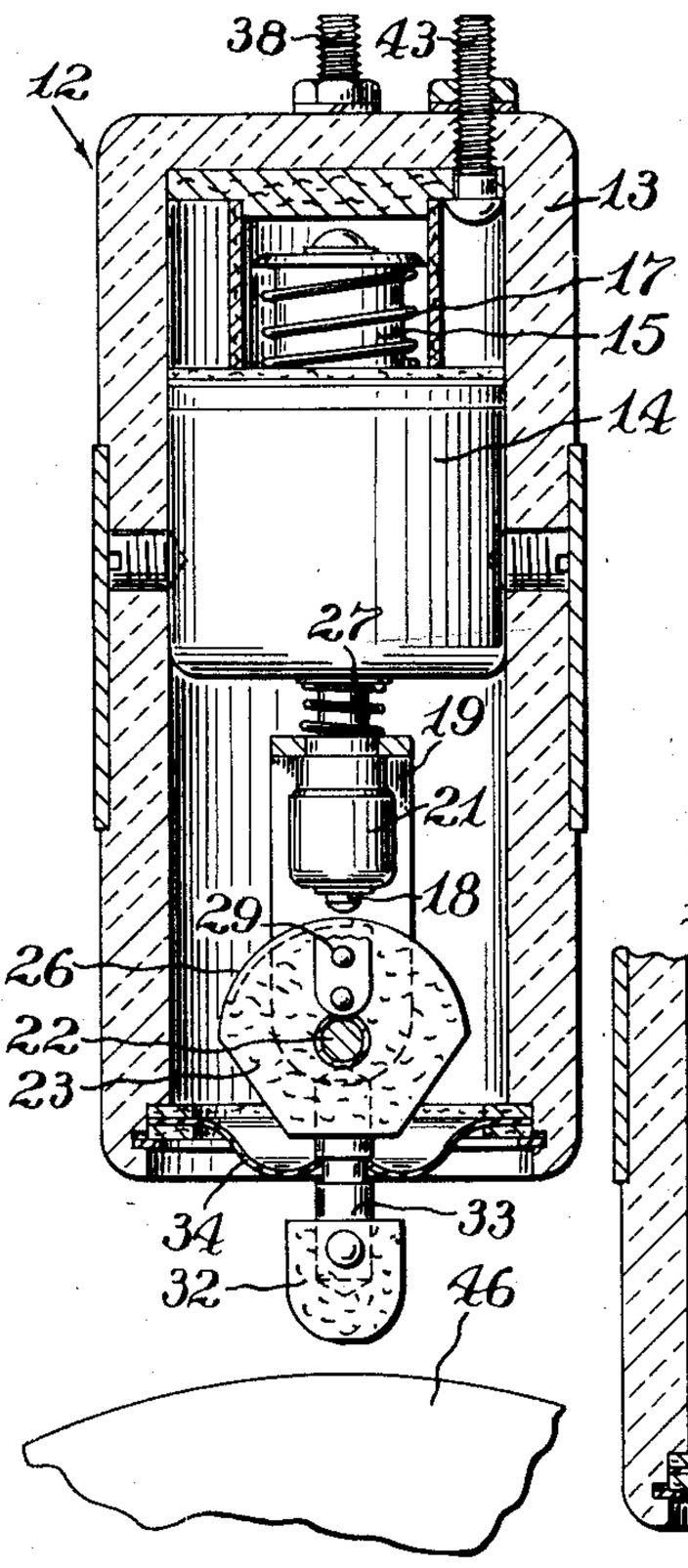
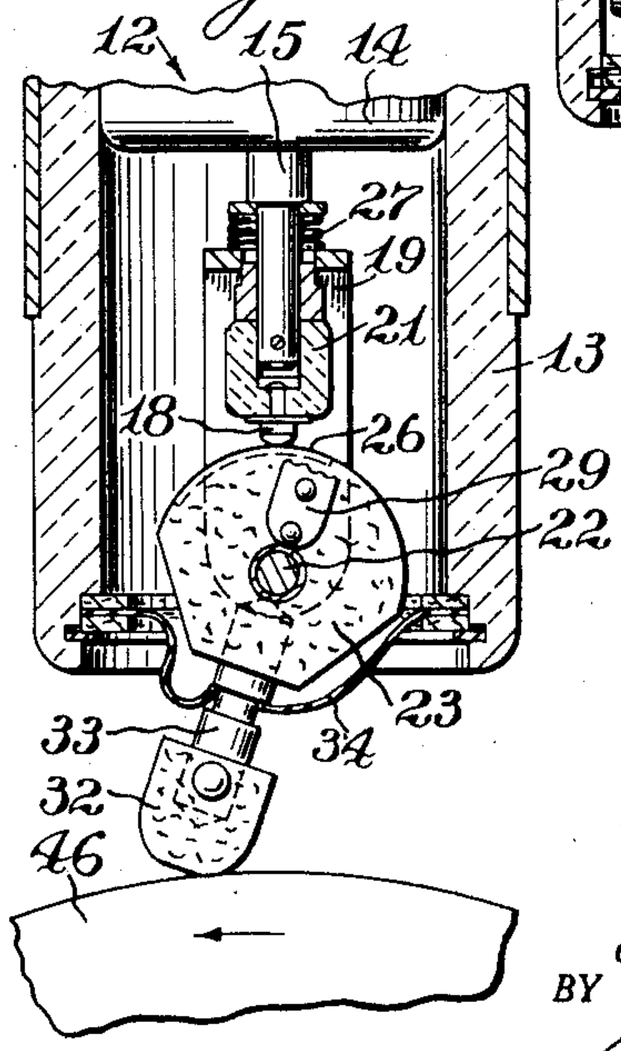


Fig. 3



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BACKFIRE PROTECTIVE DEVICE

Filed Sept. 23, 1946 3 Sheets-Sheet 2

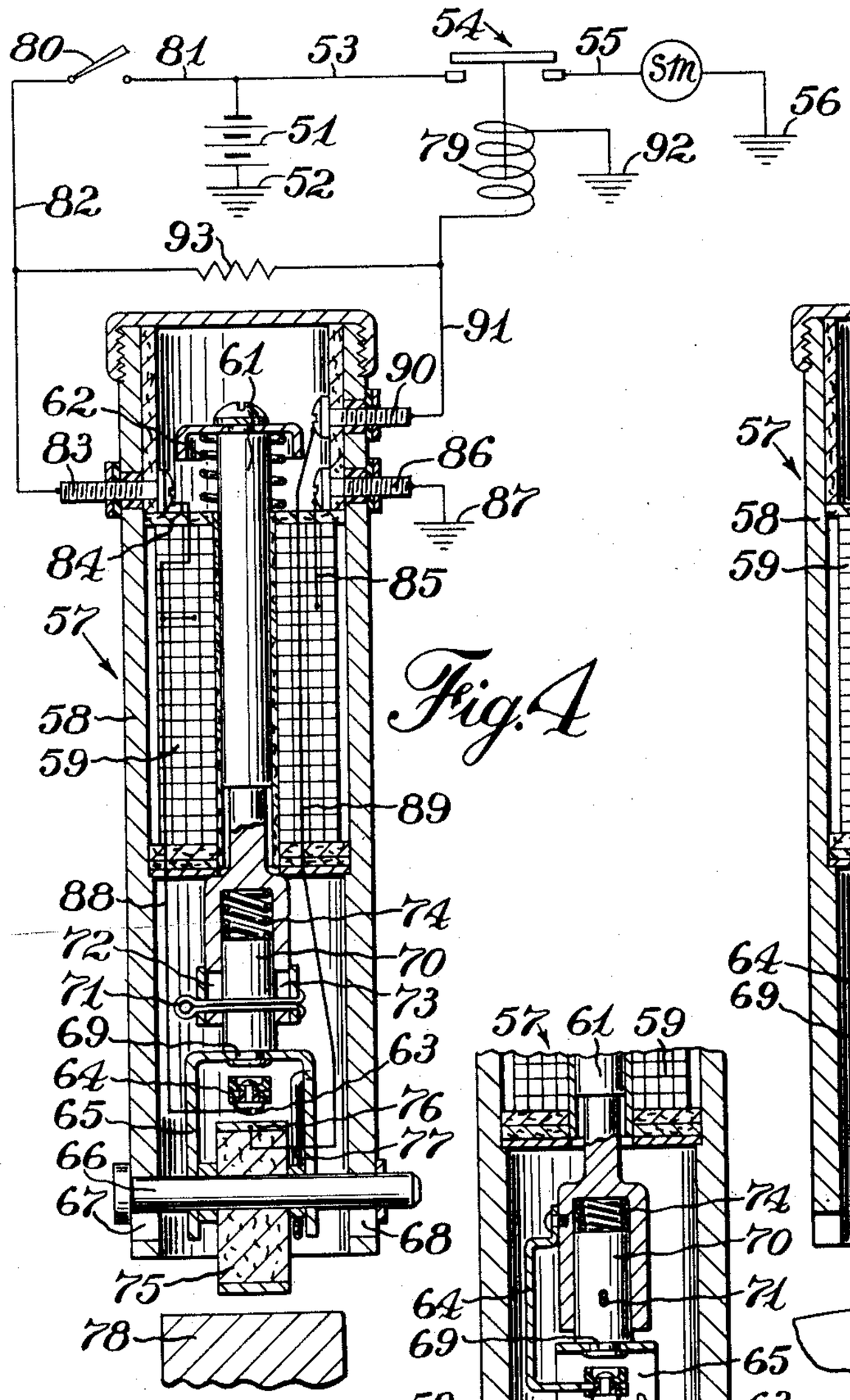

Fig. 4

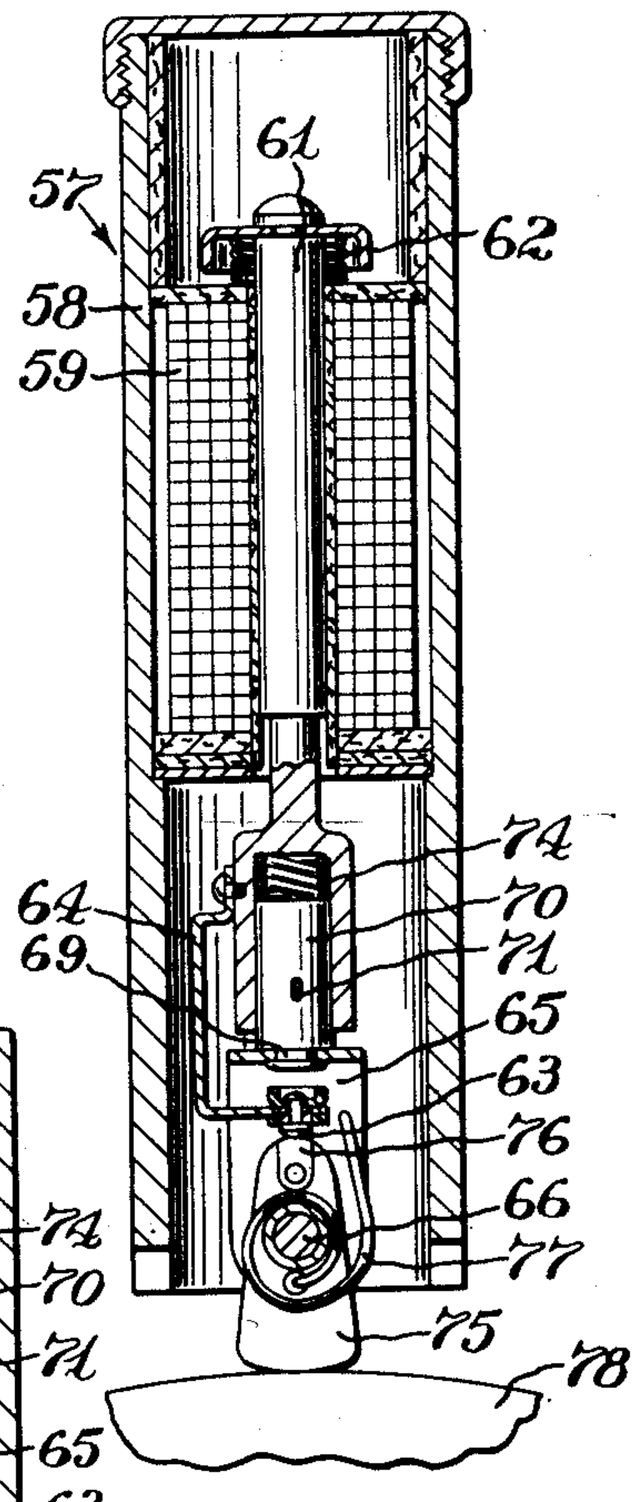

Fig. 5

Fig. 6

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Filed Sept. 23, 1946 3 Sheets-Sheet 3

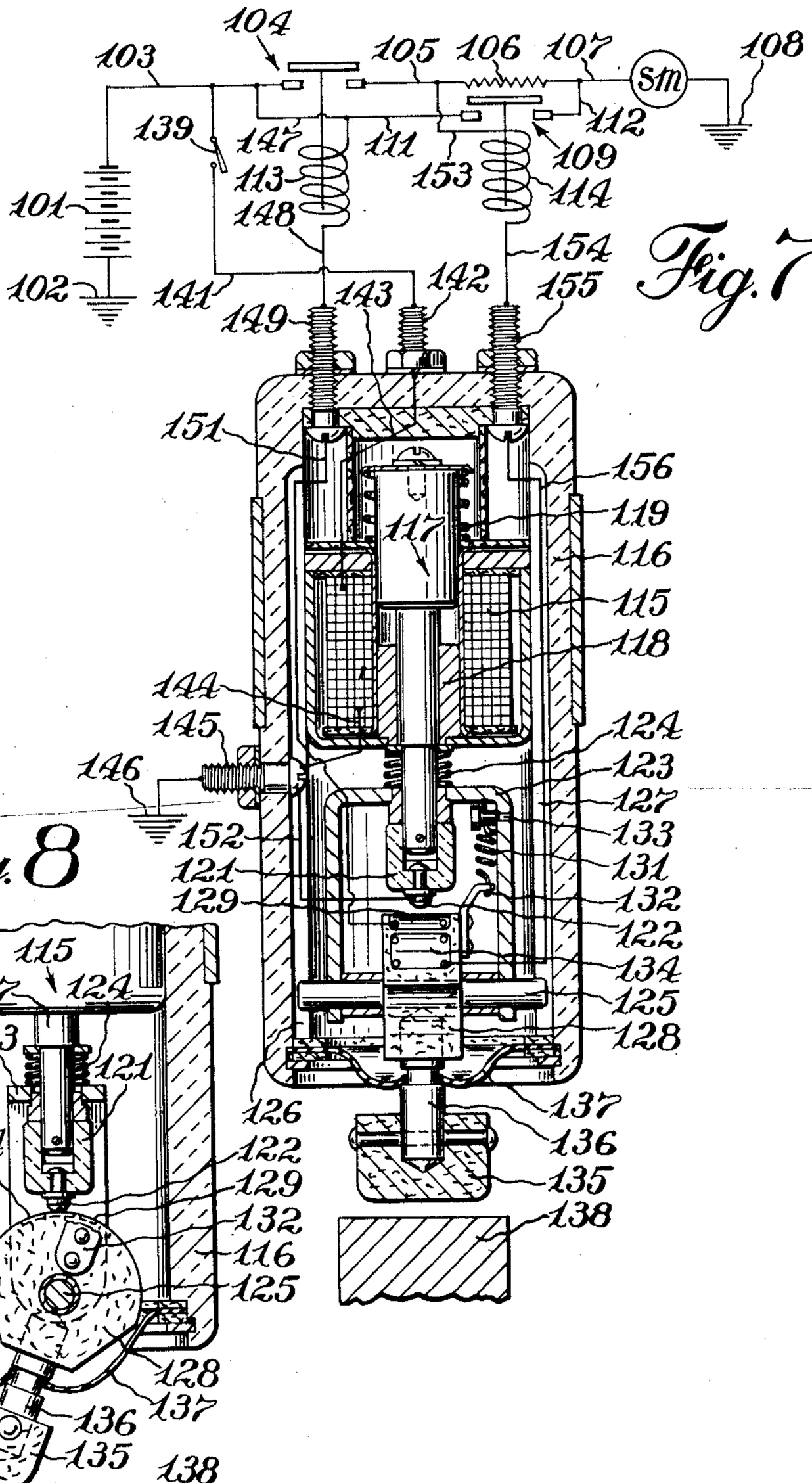

Fig. 7

Fig. 8

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2,528,160

BACKFIRE PROTECTIVE DEVICE

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9 Claims. (Cl. 290—38)

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The present invention relates to a backfire protective device for engine starters, and more particularly to a mechanically actuated switch mechanism for preventing actuation of the starting mechanism while the engine is rotating backward.

It is an object of the present invention to provide a novel mechanism for preventing actuation of an engine starter while the engine is rotating or rocking backward.

It is another object to provide such a device which may be arranged to prevent actuation of the starter whether the engine is rotating backward or forward.

It is another object to provide such a device which, after cranking has commenced, will not interrupt the cranking operation.

It is another object to provide such a device which may be actuated by any exposed moving part of the engine or its auxiliaries.

It is another object to provide such a device incorporating a two-stage starter control.

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 a preferred embodiment of the invention, the starting switch and control mechanism being shown partly broken away and in section;

Fig. 2 is a side view of the starting switch and control mechanism partly broken away and in section, showing the parts in idle position;

Fig. 3 is a detail of the control mechanism showing the parts in cranking position;

Fig. 4 is a view similar to Fig. 1 showing a second embodiment of the invention;

Fig. 5 is a side view of the starting switch and control mechanism shown in Fig. 4, the parts being shown in the positions assumed when the control switch is initially closed while the engine member is stationary;

Fig. 6 is a detail similar to Fig. 5 showing the parts in the positions assumed when the control switch is actuated during backward rotation of the engine part;

Fig. 7 is a view similar to Fig. 1 of a third embodiment of the invention; and

Fig. 8 is a detail in side elevation, partly broken away and in section, of the contact mechanism of Fig. 7 in cranking position.

In Fig. 1 of the drawing, there is illustrated a starting system comprising a battery 1 grounded at 2 and connected by a lead 3 to a magnetic starting switch indicated generally by numeral 4. A lead 5 connects the starting switch with the starting motor SM which is grounded at 6 to complete the starting circuit.

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The starting switch 4 is provided with a solenoid 7, energization of which is controlled primarily by the operator, and secondarily by an automatic means for preventing such energization when the engine to be started is rotating backward. As here shown, this is accomplished by means comprising a manual switch 8 connected to battery 1 by a lead 9, and connected by a lead 11 to a backfire protective device indicated generally by numeral 12. This device comprises a casing 13 containing a solenoid 14, with a magnetic plunger 15 slidably mounted therein within a bearing member 16. The plunger 15 is normally maintained in its upper position as shown in Fig. 1 by means of a spring 17, and carries on its lower end an insulated contact 18. A yoke member 19 is slidably mounted on the magnetic plunger 15 adjacent its lower end, being retained thereon by a cap 21 which serves as the mount for the contact 18. A pin 22 is arranged to traverse the yoke 19 and is slidably mounted at its ends in guideways 24, 25 formed in the lower end of the casing 13.

An arcuate contact carrying member 23 of suitable insulating material such as fiber is pivotally mounted on the pin 22 and carries on its arcuate surface a curved contact element 26 which is normally spaced slightly from the contact 18, but may be engaged thereby when the plunger moves downward through the yoke 19. The yoke is normally held in extended relation to the plunger by means of a spring 27 located on the plunger above the yoke 19, so as to maintain contacts 18, 26 disengaged.

Means for normally maintaining the contact carrying member 23 in alignment with the plunger 15 is provided in the form of a tension spring 28 attached as indicated at 29 and 31 to the contact carrying member and the yoke 19 respectively.

The lower end of the contact carrying member 23 has a block 32 of suitable frictional material such as fiber fixed thereto as by means of a coupling member 33. The block 32 is arranged to project beyond the housing 13 and a flexible diaphragm or boot 34 is preferably employed to close the lower end of the casing while permitting longitudinal and pivotal movement of the coupling member 33.

The casing 13 is provided with a binding post 35 to which the lead 11 of the control circuit

is attached, and this binding post is connected by a lead 36 to one end of the solenoid 14. The opposite end of the solenoid is connected by a lead 37 to a binding post 38 which is grounded as indicated at 39 to complete the circuit for energizing solenoid 14. Binding post 35 is also connected by a lead 41 to the contact 18, and the arcuate contact 26 is connected by a lead 42 to a binding post 43 which is connected by a lead 44 to one end of solenoid 7 of the magnetic starting switch 4, the opposite end of which is grounded as indicated at 45 to complete the control circuit for the starting switch.

The backfire protective device 12 is mounted as illustrated adjacent a moving part 46 of the engine to be started or of an auxiliary mechanism actuated thereby, so that the fiber block 32 will engage the moving part 46 when the magnetic plunger 15 is actuated. The device 12 is so mounted that the axis of the pin 22 forming the pivotal mount for the fiber block 32 is parallel to the axis of the engine part 46, and rotation of the engine part in a forward direction as indicated by the arrow in Fig. 3 thus causes the contact carrying member 23 to be rotated in a clockwise direction as there shown. The contact 26 is arranged to extend from the upper portion of the contact carrying member 23 a sufficient distance to maintain its engagement with the contact 18 during such clockwise movement of the contact carrying member. Counterclockwise movement of the member 23 due to backward rotation of the engine part moves the contact 26 out of the path of contact 18, however, so as to hold open the control circuit for the magnetic starting switch 4.

In the operation of this embodiment of the invention, starting with the parts in the positions illustrated in Fig. 1, closure of the manual switch 8 causes energization of the solenoid 14 which pulls the plunger 15 downward. This motion is transmitted through the spring 27 to the yoke member 19, thus moving the fiber block 32 into engagement with the engine part 46. If the engine is stationary at the time, the upright position of the contact carrying member 23 is maintained and further downward movement of the plunger 15, after the movement of the contact carrying member 23 is thus arrested, causes the contact 18 to engage the contact 26, thus completing the control circuit for the starting switch 4, causing closure thereof to actuate the starting motor. The consequent rotation of the engine part 46 causes the contact carrying member 23 to swing around its pivot pin 22 in a clockwise direction as shown in Fig. 3 but this pivotal movement does not interrupt the control circuit, so that the cranking operation is continued. When the engine starts, opening of the control switch by the operator causes the parts to return to normal position.

If, when the control swtich 8 is closed, the engine part 46 is rotating backward due to a backfire or for any other reason, when the fiber block 32 engages said part, the contact carrying member 23 is rotated in a counterclockwise direction thus moving the contact 26 out of the path of contact 18 whereby the control circuit for the starting switch is held open. As soon as the backward movement of the engine parts ceases, a reactuation of the starter control will cause energization of the starting mechanism in the usual manner.

In the embodiment of the invention illustrated in Figs. 4, 5 and 6, means are provided for preventing actuation of the starting mechanism while the engine to be started is rotating or rocking in either direction, and additional means are incorporated to prevent interruption of the cranking operation after it has commenced.

As shown in Fig. 4, the starting system comprises a battery 51 grounded at 52 and connected by a lead 53 to a magnetic starting switch 54 which in turn is connected by a lead 55 to the starting motor SM which is grounded at 56 to complete the starting circuit. The backfire protective device indicated generally by numeral 57 comprises a casing 58 containing a solenoid 59 and a magnetic plunger 61 slidably mounted therein. The plunger is normally maintained in its upper position as shown in Fig. 1 by a spring 62 and carries on its lower end an insulated contact 63 by means of a spring arm 64. A yoke 65 is pivoted on a pin 66 which is slidably mounted in slots 67, 68 in the lower end of the casing 58. The upper portion of the yoke 65 is attached as indicated at 69 to a pin 70 slidably mounted in the lower end of the plunger 61 and retained therein by suitable means such as a cotter pin 71 traversing slots 72, 73 therein. The pin 70 is normally held in extended relation to the plunger 61 by means of a spring 74.

A contact carrying member 75 is pivotally mounted on the pin 66 within the yoke 65 and has on its upper end a contact 76 which is in the path of movement of the contact 63 when the member 75 is in upright position as shown in Figs. 4 and 5. Means for normally holding the member 75 in such upright position is provided in the form of a coil spring 77 anchored at its ends to the member 75 and the yoke 65 respectively.

The backfire protective device 57 is mounted adjacent a moving part 78 of the engine in such manner that when the solenoid 59 is energized the movement of the plunger 61 causes the contact carrying element 75 to engage said moving part, and to be rotated thereby, if the engine is in motion at that time, so as to move the contact 76 out of the path of contact 63.

The starting switch 54 is arranged to be actuated by an electromagnet 79, and a control circuit therefor is provided comprising a manual switch 80 connected by a lead 81 to the battery 51 and by a lead 82 to a binding post 83 mounted on the casing 58. A lead 84 connects the binding post 83 to one end of the solenoid 59, the opposite end of the solenoid being connected by a lead 85 to a binding post 86 which is grounded at 87. Lead 84 is also connected by a lead 88 to the contact 63, and the contact 76 is connected by a lead 89 to a binding post 90 which is connected by a lead 91 to one end of electromagnet 79, the opposite end of which is grounded as indicated at 92 to complete the control circuit for the starting switch.

In order to prevent interruption of cranking due to the forward rotation of the engine part 78 by the starting motor, a holding resistor 93 is bridged across the leads 82, 91 of the control circuit, the value of the resistor being such as to pass sufficient current to hold the starting switch closed, such current being insufficient however to effect initial closure thereof.

In the operation of this embodiment of the invention, closure of the manual switch 80 effects energization of the solenoid 59, causing the plunger 61 to move downward, bringing the contact carrying member 75 into engagement with the engine part 78. If the engine is stationary at

the time, the upright position of the contact carrying member 75 is maintained, and further movement of the plunger 61 causes the contact 63 to be brought into engagement with the contact 76, thus completing the control circuit for the starting switch which is thus actuated to energize the starting motor. The consequent rotation of the engine part 78 by the starting motor causes the contact carrying element 75 to be rotated on the pin 66 so as to disengage the contact 76 from the contact 63. Energization of the electromagnet 79 is, however, maintained sufficiently by the current flowing through resistor 93 to hold the starting switch 54 closed and prevent interruption of the cranking operation. When the engine starts, opening of the control switch 80 by the operator causes the parts to return to idle position.

If, when the control switch 80 is initially closed, the engine is rotating or rocking in either direction, such motion of the engine part 78 will cause pivotal movement of the contact carrying member 75 as soon as it engages said part, thereby moving the contact 76 out of the path of contact 63 so as to hold open the control circuit and prevent actuation of the starting mechanism.

The contact carrying element 75 is preferably shaped as illustrated so that when it has been swung out of its upright position by motion of the engine part 78 in either direction, it will maintain its displaced position irrespective of reversals of movement of the engine part 78, so that actuation of the starting mechanism cannot take place until the operator has deenergized the solenoid 59 and then caused reenergization thereof. This is desirable since it prevents the possibility of the actuation of the starting mechanism during a back-rock of the engine after forward rotation thereof has ceased.

In Fig. 7 of the drawing, there is illustrated an embodiment of the invention incorporating a two-stage starter control, that is, one in which the starting motor is initially energized by a reduced voltage from the battery, the full voltage of the battery being applied to the starting motor after such initial energization thereof. As illustrated, the starting circuit comprises a battery 101 grounded at 102 and connected by a lead 103 to a magnetic starting switch 104. Switch 104 is connected by a lead 105 to a resistor 106 having such a value as to reduce the voltage of the battery sufficiently to properly control the initial actuation of the starting motor. Resistor 106 is connected by a lead 107 to the starting motor SM which is grounded at 108 to complete the starting circuit.

A second electromagnetic switch 109 is provided for short-circuiting the resistor 106 as well as the starting switch 104, and for this purpose is connected by a lead 111 to the battery lead 103, and by a lead 112 to the starting motor lead 107.

Starting switch 104 is arranged to be actuated by a solenoid 113, and the second magnetic switch 109 is similarly provided with a solenoid 114. Means are provided for controlling both these solenoids so as to prevent energization of the starting circuit when the engine is rotating in either direction, and further to secure closure of the second magnetic switch by the initial rotation of the engine after closure of the starting switch 104. For this purpose, a solenoid 115 is mounted in a casing 116, and a magnetic plunger 117 is slidably mounted in the solenoid by means of a bearing 118 in position to be drawn downward into the solenoid against the pressure of a

spring 119. The lower end of the plunger 117 has fixed thereon a cup member 121 carrying an insulated contact 122. A yoke member 123 is slidably mounted on the plunger 117 and is normally pressed against the contact carrying cup 121 by a compression spring 124. A pin 125 traverses the lower ends of the yoke arms and is slidably mounted at its ends in guideways 126, 127 formed in the interior of the casing 116.

A movable contact carrying member 128 is pivotally mounted on the pin 125 and carries on its upper end a contact 129 which is normally maintained in the path of the contact 122 by means of a tension spring 131 attached at its ends to the contact carrying member 128 and the yoke 123 as indicated at 132 and 133 respectively. The contact carrying member 128 also carries adjacent its upper end a second contact 134 which is movable into the path of the contact 122 when the contact carrying member is rotated in a clockwise direction as shown in Fig. 8.

A friction block 135 of suitable material such as fiber is mounted on the lower end of the contact carrying member 128 as by means of a connector 136 in position to project out of the casing 116, and the lower end of the casing is preferably closed by means of a flexible boot 137. The casing 116 is mounted adjacent a movable part 138 of the engine to be started, in such position that the friction block 135 will be moved into engagement with the engine member by the initial movement of the plunger 117 when the solenoid 115 is energized, whereby the contact carrying member 128 will be moved about its pivot 125 in a clockwise direction when the engine is rotating forwardly as indicated by the arrow in Fig. 8.

Means under the control of the operator for energizing the solenoid 115 is provided comprising a manual switch 139 connected to the battery lead 103, and by a lead 141 to a binding post 142 on the casing 116. Binding post 142 is connected by a lead 143 to one end of the solenoid 115, the opposite end of which is connected by a lead 144 to a binding post 145 which is grounded as indicated at 146.

In order to provide a control circuit for solenoid 113 of the starting switch 104, one end of the solenoid is connected by a lead 147 to the battery lead 103, and the opposite end is connected by a lead 148 to a binding post 149 on the casing 116. Binding post 149 is connected by a lead 151 to the contact 129. Contact 122 is connected by a lead 152 to the grounded binding post 145 to complete said control circuit.

Similarly, solenoid 114 for the second magnetic switch 109 is connected by a lead 153 to the starting circuit lead 105, and by a lead 154 to a binding post 155 on the casing 116, which binding post is connected by a lead 156 to the contact 134 on the contact carrying member 128.

In operation, closure of the manual switch 139 completes the circuit through the solenoid 115 whereby the plunger 117 is drawn downwardly, the yoke 123 with the contact carrying member 128 being connected to move with the plunger by the spring 124. When the friction block 135 engages the engine member 138, the downward movement of the contact carrying member 128 and the yoke 123 is arrested whereby the further downward movement of plunger 117 brings the contact 122 into engagement with the contact carrying member 128. If at this time the engine member is stationary, the contact 129 is in the path of contact 122, and the control circuit for the solenoid 113 of the starting switch is com-

pleted through contacts 129, 122 to the ground whereby the starting switch 104 is caused to close and energize the starting motor from the battery 101 at a reduced voltage by virtue of the resistor 106. Initial rotation of the engine member 138 by the starting motor causes the friction block 135 to swing the contact carrying member 128 in a clockwise direction as shown in Fig. 8 thereby bringing the contact 134 into engagement with contact 122 thus completing the control circuit for the second magnetic switch 109 which thereupon closes and connects the starting motor directly to the battery thus utilizing the full battery voltage to crank the engine. It will be understood that the space between the contacts 129 and 134 is less than the width of the cooperating contact 122 whereby the latter bridges said space and causes closure of magnetic switch 109 prior to the opening of the starting switch 104. After the starting switch opens, the control circuit for the magnetic switch 109 is maintained fully energized by current supplied to the starting motor lead 105 through the magnetic switch 109 and resistor 106. Since the current drain through this control circuit is very small compared to the cranking current, the voltage drop through the resistor 106 under these circumstances is negligible, and the solenoid 114 is maintained fully energized as long as the manual switch 139 is held closed. When the engine starts, the manual switch 139 is opened and the parts returned to their idle positions as illustrated in Fig. 7.

If, when the manual switch 139 is first closed, the engine is rotating rearwardly because of a previous backfire, or for any other reason, when the friction block 135 engages the moving engine member 138, it will cause the contact carrying member 128 to swing in a counterclockwise direction, thereby moving the contact 129 out of the path of contact 122. The further movement of contact 122 thus causes it to engage the contact carrying member 128 without completing the control circuit for solenoid 113 through contact 129, whereby the starting mechanism is prevented from being energized. Likewise, if when the manual switch 139 is closed, the engine is rotating in a forward direction, the block 135 will swing the contact carrying member 128 in a clockwise direction so that when the contact 122 engages the contact carrying member, it makes connection with the contact 134 instead of the contact 129. Inasmuch as contact 134 is at this time dead, since the starting switch 104 has not closed, the starting mechanism is again prevented from being energized.

Although certain embodiments of the invention have been shown and described in detail, it will be understood that other embodiments are possible and that various changes can be made in the design and arrangement of the parts illustrated 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, an electrical circuit, closure of which causes actuation of the starting mechanism, said circuit comprising a pair of normally open contacts, means under the control of the operator for moving one of the contacts toward the other and means actuated by a moving part of the engine for displacing the second mentioned contact from the path of the movable contact.

2. In an engine starting system, a starting circuit including a magnetic starting switch, a control circuit for the starting switch including a pair of normally open contacts, means under the control of the operator for moving one of the contacts into engagement with the other to close the control circuit, means responsive to movement of a member of the engine to be started for moving the second contact out of the path of the first contact, and means for preventing the automatic deenergization of the starting switch by forward movement of the engine member.

3. In an engine starter, a starting circuit including a battery, a starting motor, manually controllable means for applying part of the voltage of the battery to the motor, and means responsive to initial forward rotation of the engine for applying the full voltage of the battery to the motor.

4. In an engine starter, a starting circuit, a battery, a starting motor, manually controllable means for applying a part of the voltage of the battery to the motor, and unitary means responsive to backward rotation of the engine to prevent energization of the starting motor, and responsive to forward rotation of the engine for applying the full voltage of the battery to the starting motor.

5. An engine starter as set forth in claim 4 including further, means responsive to forward rotation of the engine, for preventing initial energization of the starting motor.

6. In an engine starter, a starting circuit including a battery, a starting motor, a starting switch, and a resistor for reducing the voltage from the battery applied to the starting motor upon closure of the starting switch, and means responsive to initial forward rotation of the engine after closure of the starting switch for short-circuiting said resistor.

7. An engine starter as set forth in claim 6 including further, means responsive to rotation of the engine in either direction for preventing closure of the starting switch.

8. In an engine starter, a starting circuit including a battery, a starting motor and electromagnetic starting switch, and a resistor for reducing the voltage from the battery applied to the starting motor by closure of the starting switch, a control circuit for the starting switch, a second electromagnetic switch for connecting the starting motor directly to the battery, a control circuit for the second electromagnetic switch including said starting switch, means responsive to rotation of the engine in either direction for preventing closure of the control circuit for the starting switch and means responsive to forward rotation of the engine for completing the control circuit for the second electromagnetic switch through the starting switch.

9. An engine starter as set forth in claim 8 comprising further, means including a manual switch for controlling the energization of both control circuits.

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