F. R. BACON.

MULTIPLE SWITCH STARTER.

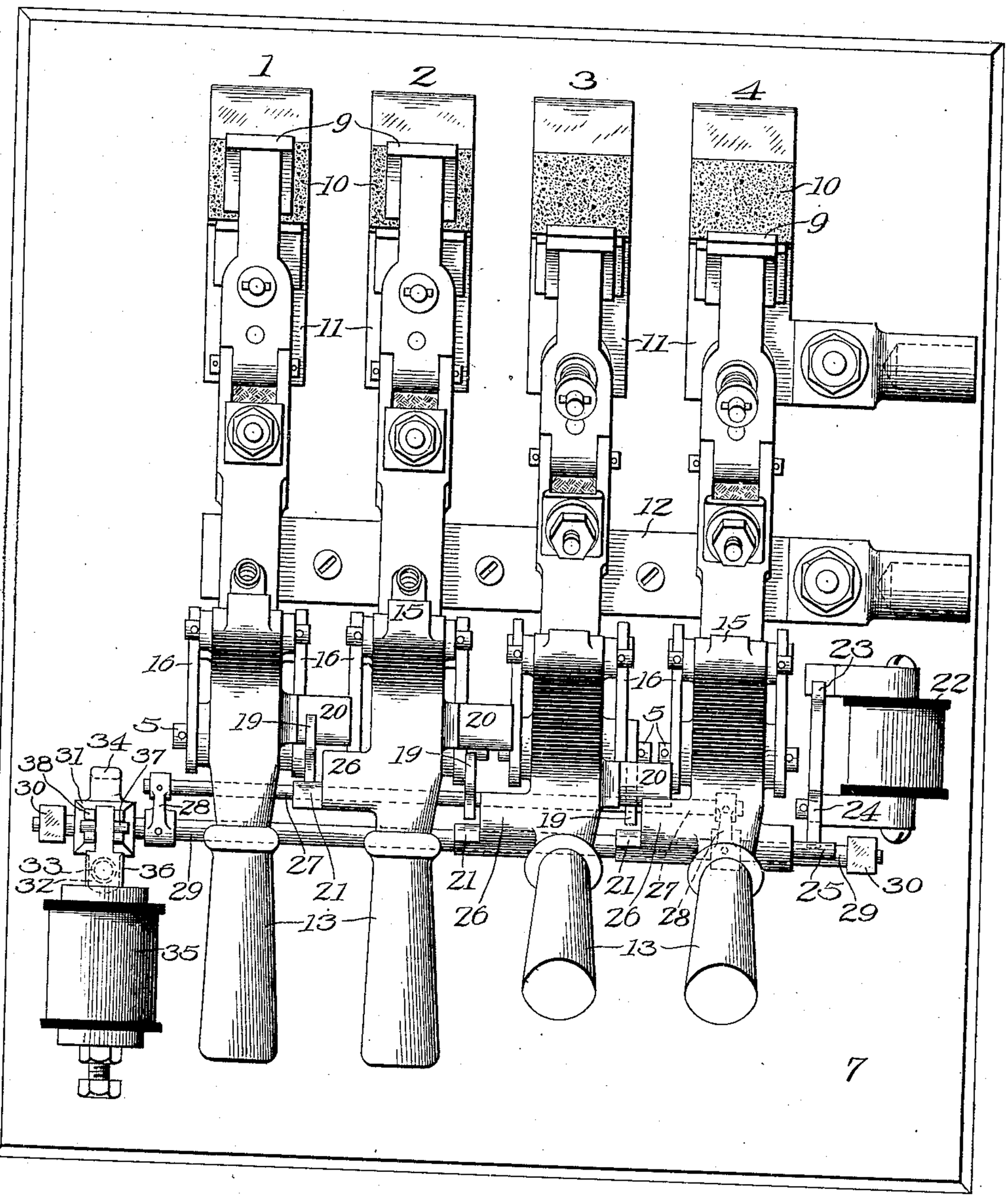
APPLICATION FILED AUG. 2, 1909.

993,434.

Patented May 30, 1911.

3 SHEETS—SHEET 1.

Fig. 1.



Witnesses:
George Haynes
~~Swift~~ Fitzgerald

Inventor:
Frank R. Bacon.
By Edwin B. Tower, Jr.
atty.

F. R. BACON.

MULTIPLE SWITCH STARTER.

APPLICATION FILED AUG. 2, 1909.

993,434.

Patented May 30, 1911.

3 SHEETS—SHEET 2.

Fig. 2.

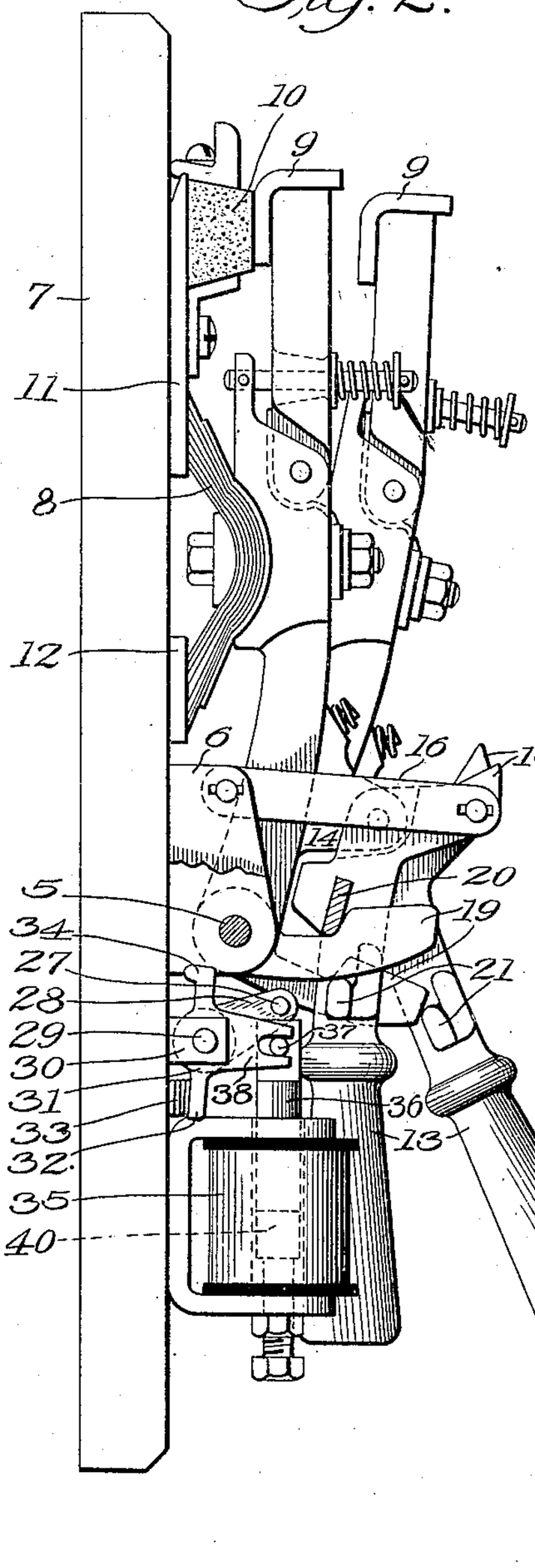
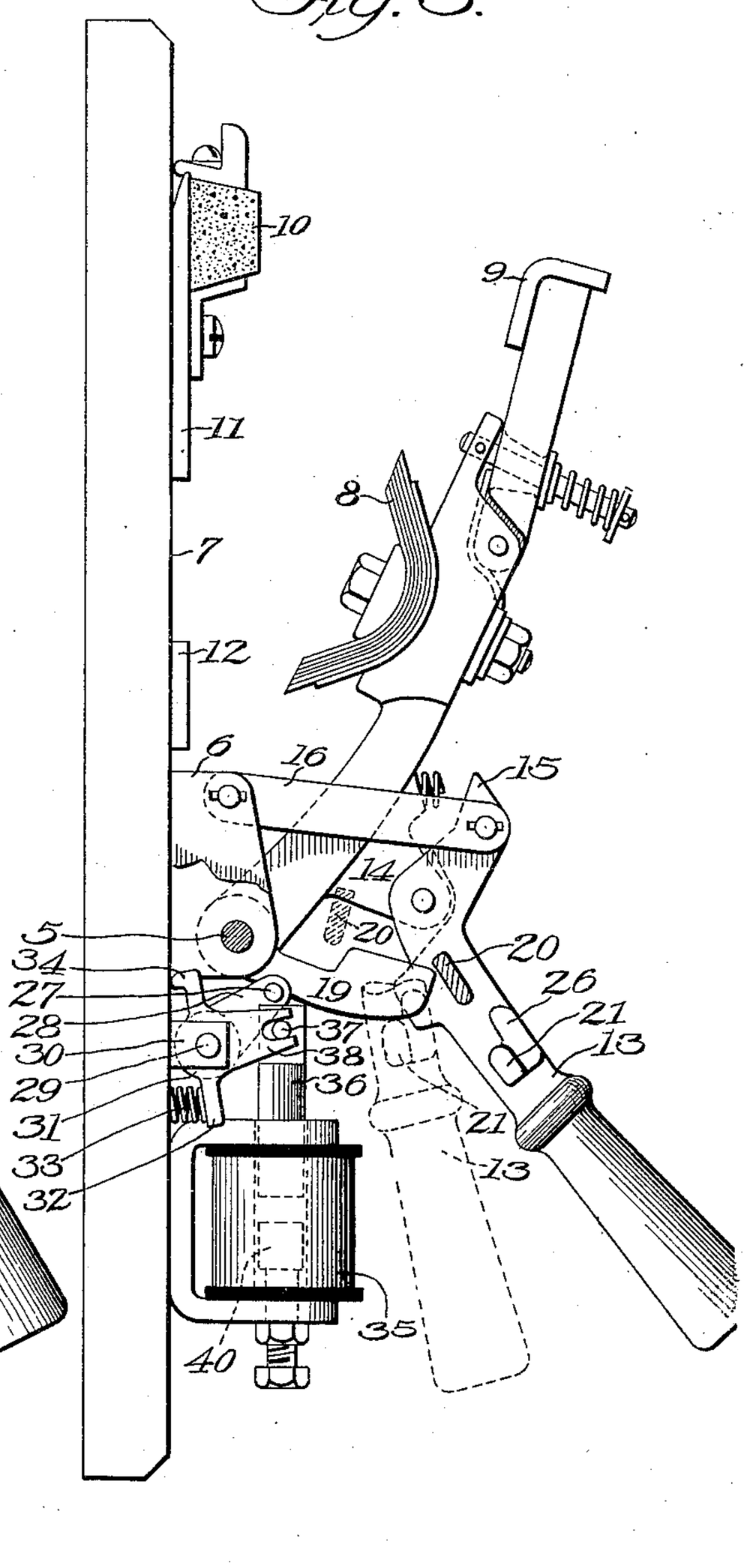


Fig. 3.



Witnesses:

George Hayner

~~W. F. Fitzgerald~~

Inventor:

Frank R. Bacon.

By Edwin B. A. Tower, Jr.

Atty.

F. R. BACON.

MULTIPLE SWITCH STARTER.

APPLICATION FILED AUG. 2, 1909.

993,434.

Patented May 30, 1911.

3 SHEETS—SHEET 3.

Fig. 4.

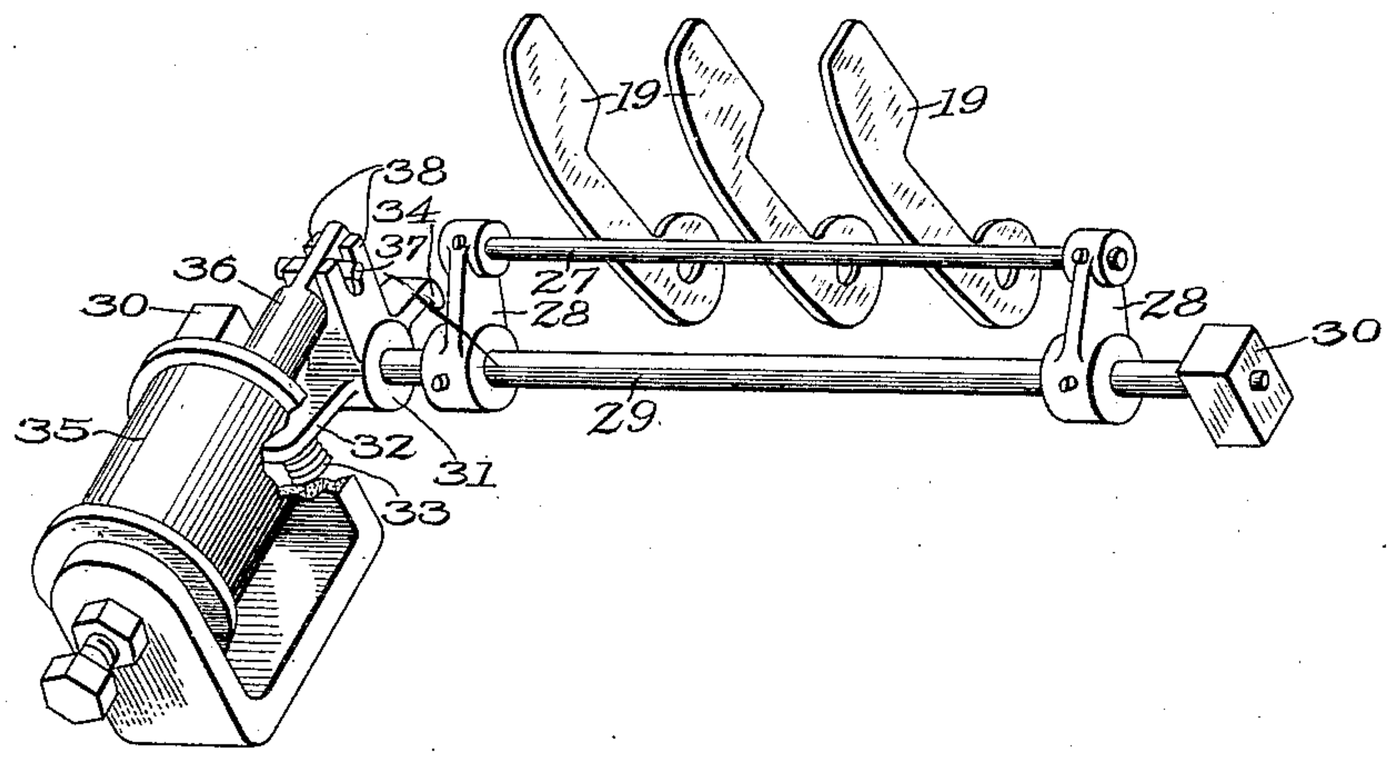
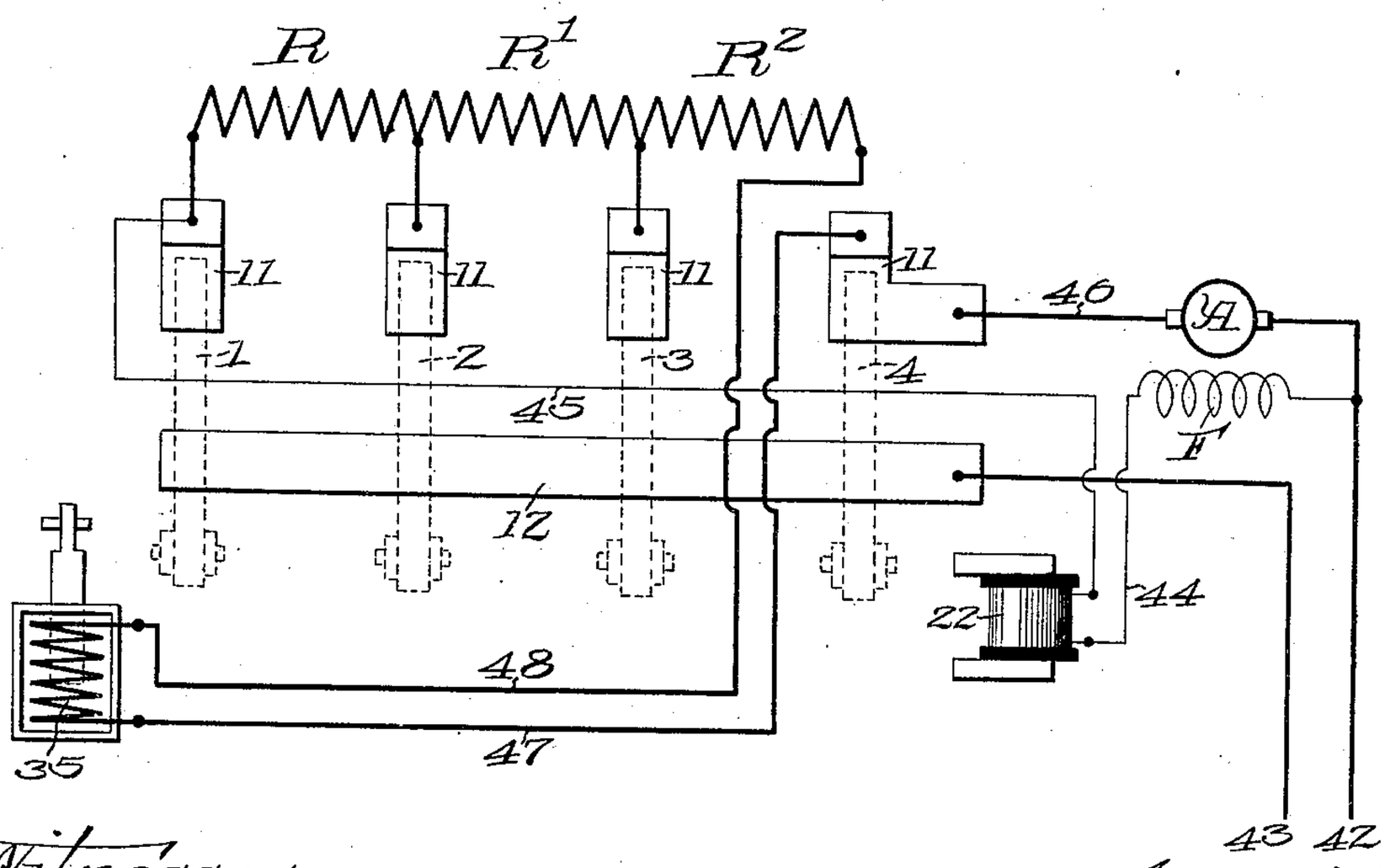


Fig. 5.



Witnesses.

George D. Haynes

W. F. Fitzgerald

Inventor:

Frank R. Bacon.

By Edwin B. H. Tower Jr.

Atty.

UNITED STATES PATENT OFFICE.

FRANK R. BACON, OF MILWAUKEE, WISCONSIN, ASSIGNOR TO THE CUTLER-HAMMER MFG. CO., OF MILWAUKEE, WISCONSIN, A CORPORATION OF WISCONSIN.

MULTIPLE-SWITCH STARTER.

993,434. Specification of Letters Patent. **Patented May 30, 1911.**

Application filed August 2, 1909. Serial No. 510,721.

To all whom it may concern:

Be it known that I, FRANK R. BACON, a citizen of the United States, residing at Milwaukee, in the county of Milwaukee and State of Wisconsin, have invented new and useful Improvements in Multiple-Switch Starters, of which the following is a full, clear, concise, and exact description, reference being had to the accompanying drawing, forming a part of this specification.

My invention relates to improvements in starters for electric motors, and more particularly to those comprising a plurality of manually operated switches for removing the starting resistance from the motor circuit. With such devices it is possible to close the switches so rapidly that the starting resistance is removed from circuit before the motor has accelerated to a sufficient extent to protect itself against the increased surges of current.

The principal object of my invention is to provide means responsive to abnormal conditions in the motor circuit for checking the progressive operation of the several switches until normal conditions are restored.

Various other objects and advantages of my invention will hereinafter be clearly and fully set forth.

For the purpose of disclosing the characteristic features of my invention, I shall describe the embodiment thereof illustrated in the accompanying drawing.

Of course, my invention is susceptible of various modifications.

The several views in the drawings are as follows:

Figure 1 is a front elevation of a device constructed in accordance with the preferred form of my invention; Fig. 2 is an end elevation of Fig. 1 with parts of the first switch removed; Fig. 3 is a view similar to Fig. 2, showing the switches in different positions; Fig. 4 is a detailed perspective view of a portion of the device; and, Fig. 5 illustrates diagrammatically one circuit arrangement for the device.

The device which I have shown, for the purpose of illustration, includes a plurality of switches 1, 2, 3 and 4, each of which is pivotally mounted upon a pin 5 carried by a supporting bracket 6. The several supporting brackets may be secured in any preferred manner to a suitable insulating base 7. Each of the switches carries a laminated brush 8 and a yielding arcing contact 9. The arcing contact 9 of each switch is arranged to engage a carbon contact 10, while the laminated brush 8 is adapted to electrically connect a contact 11 with a contact strip 12, said contacts 10, 11 and 12 being mounted on the insulating base. Each of the switches has an operating lever 13, which is pivotally connected to a lug 14 projecting from said switch. Each of the levers 13 has a projection 15 which is connected by links 16 to the supporting bracket 6, the links being pivotally connected to both the projection and the bracket. This arrangement provides a toggle connection between each switch and its operating lever, whereby, when the operating lever is thrown inwardly, the switch is thrown into closed position. In practice, it is preferable to have each switch biased to open position. This may be accomplished in any desired manner; but, with the particular arrangement shown, it is unnecessary to provide any special means for this purpose as each switch will readily fall open by gravity when released. The outward movement of each switch is limited by the projection 15 of its operating lever.

The switches are arranged to be held in closed position by latches 19. Each latch is adapted to be moved into engagement with a lug 20 carried on the right hand side of its corresponding switch lever to hold the switch in closed position. For the purpose hereinafter set forth, I prefer to provide the latches with blunt ends. In addition to the lugs 20 each of the levers 13 carries on its left hand side a lug 21 adapted to engage the lower edge of the latch of the next preceding switch to move the same into holding position. With such an arrangement each switch serves to hold a preceding switch in closed position, thereby enabling the several switches to be closed by a hand-over-hand movement. The last switch of the series may be retained in closed position by any preferred means. However, I preferably provide a retaining magnet 22 for this purpose. The retaining magnet illustrated is provided with a pivoted armature 23 having a hook portion 24 arranged to engage a pin 25 carried by the operating lever of the last switch.

In devices of this character it is desirable

to provide means for insuring the closure of the switches in definite sequence. This may be accomplished in any preferred manner. The means which I have illustrated for this purpose comprises an enlargement 26 on the lug 21 arranged to function with the lug 20 of the next preceding switch in the manner hereinafter set forth.

When released, the latches 19 are adapted to rest upon a rod 27 which extends transversely of the switches. The rod 27 is supported by a pair of arms 28 which are rigidly secured to a rod 29. The rod 29 is revolubly mounted in bearings 30, suitably secured to the insulating base. Also rigidly mounted on the rod 29 is a member 31 having a depending portion 32. Interposed between the portion 32 of the member 31 and the insulating base is a coil spring 33 tending to rock the member 31 in a direction to cause the arms 28 and the rod 27, carried thereby, to move upwardly. The upward movement of the arms 28 and the rod 27 is limited by a lug 34 carried by the member 31, which is arranged to engage the insulating base. Under the influence of the spring 33, the rod 27 is normally maintained in the position illustrated in Fig. 3, thus normally maintaining the latches 19 in the position illustrated in the same figure. For rocking the member 31, and consequently lowering the arms 28 and the rod 27 against the action of the spring 33, I have provided an electromagnet 35 arranged to be connected in circuit in the manner hereinafter set forth. The magnet 35 is provided with a movable core 36 carrying a transversely extending pin 37, arranged to fit into slots in a bifurcated extension 38 provided on the member 31. With this arrangement, when the magnet 35 is sufficiently energized to rock the member 31 against the action of the spring 33, the rod 27 supporting the latches 19 is drawn downwardly, thereby permitting the latches 19, resting thereon, to drop into the position of the lowermost latch illustrated in Fig. 2. In practice, I preferably provide the magnet 35 with an adjustable stationary core 40 for varying the air gap between the same and the movable core 36. This enables me to vary the conditions under which the magnet responds.

I shall now describe the operation of the device illustrated, referring first to Fig. 3. In this figure, as well as in Fig. 2, I have omitted switch 1 and its operating lever and have merely shown its latch 19 and the lug 20 of its operating lever. This view shows the switches in open position and the latches 19 maintained in normal position under the influence of the spring 33. Under these conditions, the lug 20 of the first switch, which is shown in full line section, lies adjacent to the upper edge of its locking latch 19. Upon closure of the first switch, the lug 20 thereof is carried upwardly into the position illustrated in dotted lines, but is not engaged by its latch 19. Consequently, until the latch 19 is moved into engagement with the lug 20, the first switch must be manually maintained closed. Upon closure of the second switch, however, the lug 21, carried thereby, is first moved into the position illustrated in dotted lines, in which position it engages the lower edge of the latch 19 of the first switch. Continued inward movement of the operating lever 13 of the second switch causes the lug 21, carried thereby, to force the latch 19 upwardly into holding position. That is to say, it forces the latch 19 into engagement with the lug 20 of the first switch as clearly shown in Fig. 2. This effectually locks the first switch in closed position, whereupon the same may be released by the operator. Upon closure of the second switch, the lug 20 thereof is also moved into the position shown in dotted lines, Fig. 3. Closure of the third switch moves the latch of the second switch into holding postion in the manner just described.

The operation of the remaining switches is the same as switches 1 and 2. With this arrangement, it will be seen that each switch serves to hold the preceding switch in closed position. Upon closure of the last switch, the pin 25, carried thereby, engages the armature of the retaining magnet and forces the same against the pole pieces of said magnet. Hence, if the magnet is energized, it will effectually hold the last switch in closed position. With the latches 19 in the position illustrated, it will thus be seen that all of the switches are free to close in the manner described. It is impossible, however, to close the same in any other sequence for the reason which I shall now describe.

As previously set forth, when the several switches are in open position, the lugs 20 thereof will be disposed adjacent to the forward and upper edge of the latches 19 as illustrated in full lines, Fig. 3. Consequently, if an attempt is made to close the second switch before the first switch is closed, the portion 26 of the lug 21 of the second switch will be thrown into engagement with the lug 20 of the first switch. Continued inward movement of the operating lever of the second switch will merely tend to jam the portion 26 of the lug 21 of the second switch against the lug 20 of the first switch, which will, in turn, be jammed against the edge of the latch 19 of the first switch, thereby blocking further operation of the second switch. It will thus be obvious that in order to close the second switch, the lug 20 of the first switch must be moved out of the path of the portion 26 of the lug 21 of the second switch. The lugs of the remaining switches coöperate in a similar manner to that just described, thereby insuring

the closure of the switches in the order previously set forth.

It has been previously seen that when the latches 19 are in normal position and the switches are closed in the proper sequence, the lug 21 of each switch is free to engage the lower edge of the latch of the preceding switch. Assuming, now, that the magnet 35 is sufficiently energized to rock the member 31, thereby turning the rod 29, the latches 19 will fall by gravity into the position of the lowermost latch illustrated in Fig. 2. In this position of the latches, if any one of the operating levers 13 is thrown inwardly, the lug 21 provided thereon will engage the blunt outer end of the latch of the next preceding switch. It will thus be seen that in its lowermost position, the latch of each switch blocks the inward movement of the next succeeding switch, thereby preventing closure of the same. However, inasmuch as the latches of the closed switches are positively retained in holding position by the lugs of the succeeding switches, it will be seen that upon lowering of the supporting rod 27 only the latches, which have not been locked in holding position, will drop. Consequently, the magnet 35, when responding, will not affect the switches that have already been closed, but will merely check the operation of the unclosed switches. Of course, the last switch closed must be manually maintained closed until its latch is returned to normal position, thereby permitting closure of the next succeeding switch.

I shall now more fully describe the function of the magnet 35 in connection with Fig. 5, which diagrammatically illustrates one circuit arrangement for the device described. As illustrated in this figure, the device is arranged to control an electric motor having an armature A and a shunt field winding F. The several switches are arranged to control resistance sections R, R′ and R^2 arranged in the motor circuit. The sections of resistance are electrically connected to the contacts 11 of the several switches. The contact 11 of the last switch is connected to one terminal of the motor armature. The opposite terminal of the motor armature is connected to main line 42. The other main line 43 is connected to contact strip 12. The retaining magnet 22 for the last switch is connected in series with the shunt field winding, while the magnet 35 is connected between the resistance section R^2 and the contact 11 of the last switch 4, and is, consequently, connected in series with the motor armature.

I shall now describe the operation of the controller, at the same time more specifically setting forth the circuit connections. With the several switches in open position, no current will flow through the motor. To start the motor, it is necessary to close switch 1. This completes a circuit for the shunt field winding F from main line 42, by conductor 44, through the retaining magnet 22, by conductor 45, to contact 11 of switch 1, across the laminated brush thereof to contact strip 12, and thence to main line 43. Circuit is also closed from main line 42 through the motor armature A, by conductor 46 to contact 11 of switch 4, by conductor 47 through the winding of magnet 35, by conductor 48 through the resistances R^2, R′ and R to contact 11 of switch 1, and thence to main line 43 as already traced. The motor is thus started with all of the resistance included in its armature circuit. Closure of the switch 2 shortcircuits resistance section R, while closure of the switch 3 shortcircuits resistance section R′. Closure of the switch 4 shortcircuits resistance section R^2 and also the magnet 35. As is well understood, when the switch 1 is closed, a heavy surge of current is sent through the motor. Consequently, if switch 2 should immediately be closed, an excessive surge of current would pass through the motor armature. It is for avoiding such heavy surges of current that I have provided the electromagnet 35 which may be set to respond when the current through the motor armature attains any predetermined value. As has already been set forth, when the magnet 35 responds, it causes the latches of the several switches to be dropped into checking position. Consequently, if upon closure of switch 1 the electromagnet 35 responds, switch 2 cannot be closed until the current through the motor armature is reduced to a predetermined value, thereby permitting the magnet 35 to release its plunger. Upon return of the latches to normal position, the switch 2 may be closed, thereby removing the resistance R from circuit. Again, an increased surge of current passes through the motor armature, and, if the magnet 35 responds, the operation of switch 3 will be checked until normal conditions are restored. This continues throughout the operation of the several switches, further operation of the switches being always checked upon the occurrence of abnormal conditions in the motor circuit. Of course, when the last switch of the sequence is closed, there is no further use for the magnet 35, and I have, therefore, arranged the same in such a manner that it will be shortcircuited upon closure of the last switch. Upon closure of switch 4, the circuit of the motor armature may be traced, as already described, to contact 11 of switch 4, thence through said switch directly to contact 12 and back to the main line 43.

Having thus described my invention, what I claim and desire to secure by Letters Patent, is:—

1. In combination, a plurality of sepa-

rately actuated manual switches normally free to be closed, and automatic means for checking the closure of said switches.

2. In combination, a plurality of manually operated switches mechanically interlocked to close in a definite sequence, and automatic means for checking the progressive operation of said switches.

3. In combination, a plurality of manually operated switches tending to stand in open position, and means for holding said switches closed and automatically checking the closure thereof.

4. In combination, a plurality of manually operated switches tending to stand in open position, a plurality of latches for holding said switches in closed position, and automatic means for causing said latches to check the closure of said switches.

5. In combination, a plurality of manually operated switches tending to stand in open position, a plurality of latches for holding said switches closed and insuring closure of said switches in a definite sequence, and automatic means for causing said latches to check the progressive operation of said switches.

6. In combination, a plurality of manually operated switches tending to stand in open position, means for causing each switch to hold a preceding switch closed, and automatic means for checking the closure of said switches.

7. In combination, a plurality of manually operated switches tending to stand in open position, means insuring the closure of said switches in a definite sequence, and electroresponsive means for causing said first mentioned means to arrest the progressive operation of said switches.

8. In combination, a plurality of manually operated switches, a plurality of devices necessitating closure of said switches in a definite sequence, said devices tending to stand in position to permit closure of said switches, and automatic means for causing said devices to move into position to arrest the progressive operation of said switches.

9. In a starting device for electric motors, in combination, a plurality of separately actuated manual switches normally free to be closed, and means responsive to abnormal conditions for checking the closure of said switches until normal conditions are restored.

10. In a starting device for electric motors, in combination, a plurality of manually operated switches mechanically interlocked to close in a definite sequence, and means responsive to abnormal conditions in the motor circuit for arresting the progressive operation of said switches until normal conditions are restored.

11. In a starting device for electric motors, in combination, a plurality of manually operated switches tending to stand in open position, means for holding said switches in closed position and insuring closure thereof in a definite sequence, and means responsive to abnormal conditions in the motor circuit for arresting the progressive operation of said switches until normal conditions are restored.

12. In a starting device for electric motors, in combination, a plurality of switches tending to stand in open position, a plurality of latches for holding said switches in closed position, and means responsive to abnormal conditions in the motor circuit for causing said latches to check the closure of said switches until normal conditions are restored.

13. In a starting device for electric motors, in combination, a plurality of manually operated switches tending to stand in open position, said switches having lugs thereon, a plurality of latches arranged to coöperate with said lugs to hold said switches in closed position and to insure closure of said switches in a definite sequence, and means responsive to abnormal conditions in the motor circuit for causing said latches to check the progressive operation of said switches until normal conditions are restored.

14. In a starting device for electric motors, in combination, a plurality of manually operated switches tending to stand in open position, each of said switches being adapted, when closed, to hold another switch closed, and electroresponsive means for causing the closure of said switches to be checked.

15. In a starting device for electric motors, in combination, a plurality of manually operated switches tending to stand in open position, means insuring the closure of said switches in a definite sequence, and for causing each switch to hold a preceding switch closed, and electroresponsive means responsive to abnormal conditions in the motor circuit for causing the progressive operation of said switches to be checked until normal conditions are restored.

16. In a starting device for electric motors, in combination, a plurality of separately actuated manual switches, and electromagnetically controlled means for checking the operation of said switches, said means normally being adapted to permit closure of said switches.

17. In a starting device for electric motors, in combination, a plurality of manually operated switches tending to stand in open position, a plurality of latches adapted to hold said switches in closed position, said latches being automatically controlled to

check the closure of said switches upon the occurrence of abnormal conditions in the motor circuit.

18. In a starting device for electric motors, in combination, a plurality of manually operated resistance switches tending to stand in open position, a plurality of latches for holding said switches in closed position and tending to stand in position to release said switches and necessitate closure thereof in a definite sequence, said latches being arranged to successively move into holding position upon closure of said switches, and electroresponsive means for causing said latches to check the operation of unclosed switches upon the occurrence of abnormal conditions in the motor circuit.

19. In a starting device for electric motors, in combination, a switch, a device associated therewith tending to move to a position to prevent closure of said switch, means tending to hold said device in a position to permit closure of said switch while normal conditions prevail in the motor circuit and to permit said device to move to said first mentioned position upon abnormal conditions in the motor circuit.

20. In a starting device for electric motors, in combination, a switch, a device associated therewith tending to move to a position to prevent closure of said switch, means tending to hold said device in a position to permit closure of said switch while normal conditions prevail in the motor circuit and to permit said device to move to said first mentioned position upon abnormal conditions in the motor circuit, said device being movable to another position to retain said switch in closed position.

In witness whereof, I have hereunto subscribed my name in the presence of two witnesses.

FRANK R. BACON.

Witnesses:
HENRY F. VOGT,
A. H. BARNICKEL.