

1,060,299.

Patented Apr. 29, 1913.

2 SHEETS-SHEET 1.

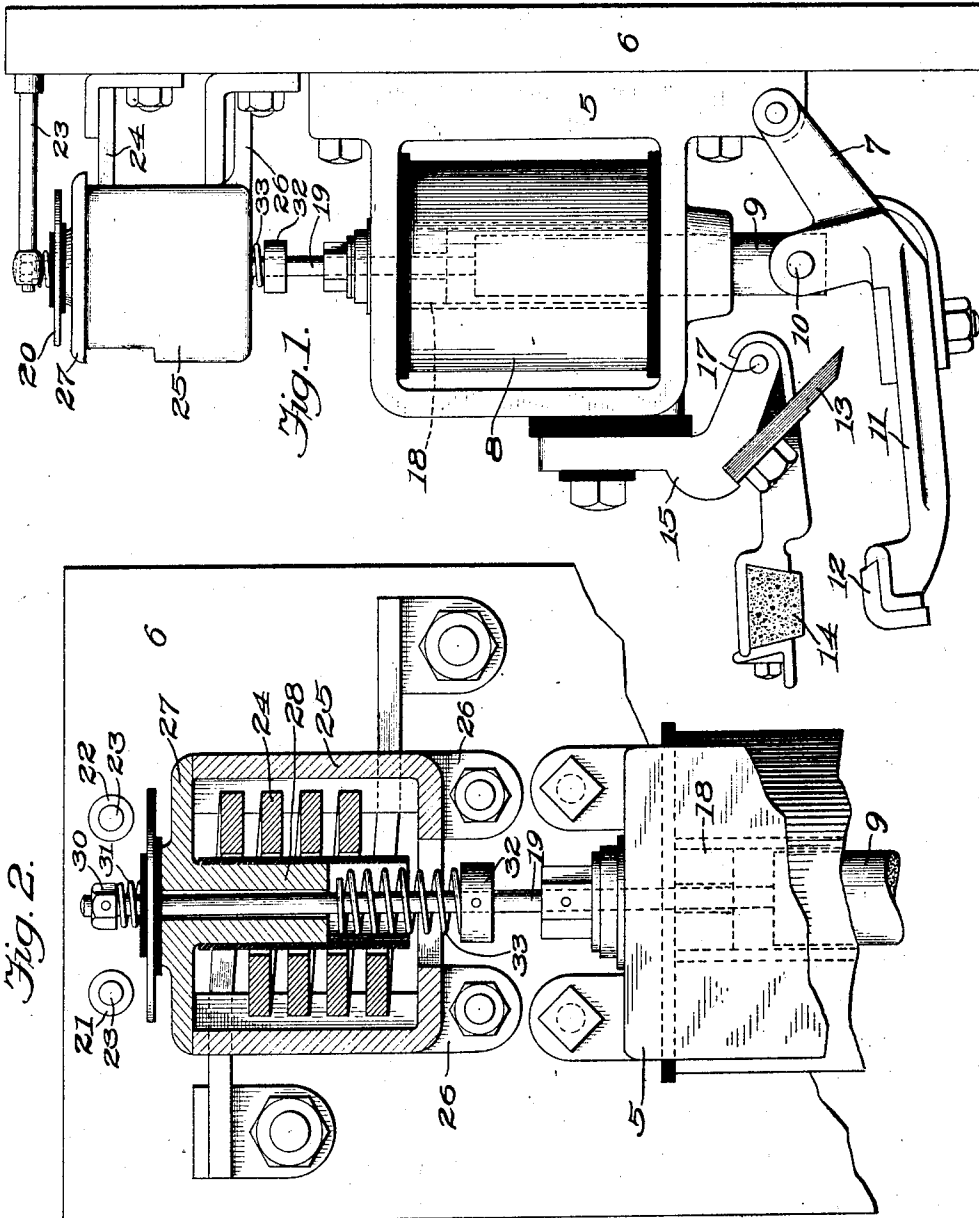


Fig. 2.

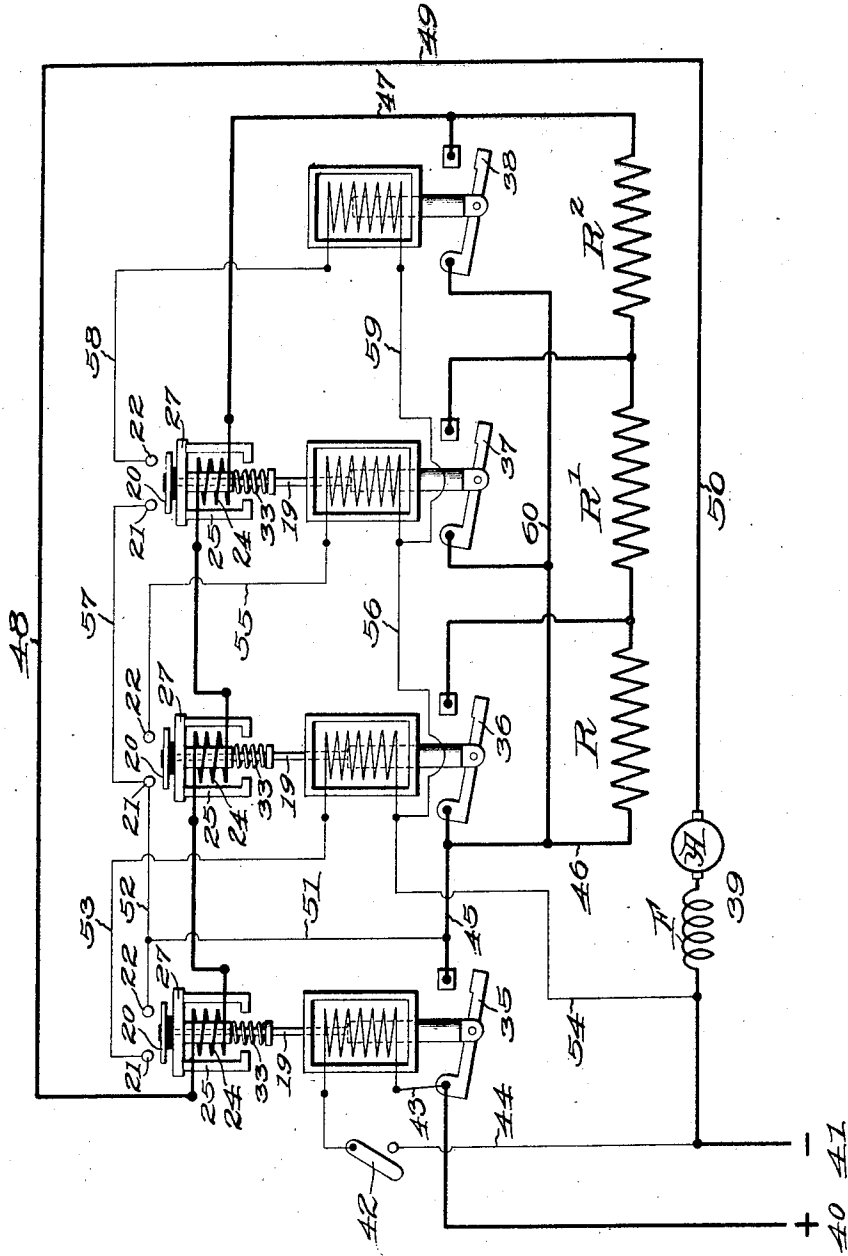
Witnesses:
George Haynes
L. S. Arnold

Inventor:
Edwin B. H. Tower, Jr.

1,060,299.

Patented Apr. 29, 1913.
2 SHEETS-SHEET 2.

Fig. 3.



Witnesses:
George Haynes
W. F. Gerald

Inventor:
Edwin B. H. Tower, Jr.

UNITED STATES PATENT OFFICE.

EDWIN B. H. TOWER, JR., OF MILWAUKEE, WISCONSIN, ASSIGNOR TO THE CUTLER-HAMMER MFG. CO., OF MILWAUKEE, WISCONSIN, A CORPORATION OF WISCONSIN.

MOTOR-CONTROLLER.

1,060,299.

Specification of Letters Patent.

Patented Apr. 29, 1913.

Application filed November 26, 1909. Serial No. 529,909.

To all whom it may concern:

Be it known that I, EDWIN B. H. TOWER, Jr., 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 Motor-Controllers, 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 controllers for electric motors, and more particularly to controllers including a plurality of successively operating switches for accelerating the motor.

One of the objects of my invention is to provide means for temporarily checking the successive operation of the accelerating switches upon the occurrence of abnormal conditions in the motor circuit, or, in other words, to prevent the resistance from being removed from circuit too rapidly.

Another object of my invention is to provide each or any desired number of the accelerating switches with an auxiliary contact, tending to move therewith to cause energization of a succeeding switch and having a controlling winding for arresting its operation so long as abnormal conditions prevail in the motor circuit.

A further object of my invention is to provide means whereby the auxiliary contact of each switch, when operated, will remain in the same position, regardless of any subsequent surges of current through its controlling winding.

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

For the purpose of more clearly disclosing the nature and characteristic features of my invention, I shall describe the embodiment thereof illustrated in the accompanying drawings. It should, of course, be understood that my invention is not limited to the particular embodiment thereof illustrated, but is capable of various modifications.

The views in the accompanying drawing are as follows:

Figure 1 is a side elevation of a switch embodying certain features of my invention; Fig. 2 is an enlarged view of the upper portion of Fig. 1, showing parts thereof in section; and Fig. 3 diagrammatically illus-

trates a system of control employing switches similar to the one illustrated in Figs. 1 and 2.

The general structure of the switch illustrated is of conventional form. Briefly described, this switch comprises a magnet frame 5 secured to a suitable insulating base 6 and having pivoted thereto a contact arm 7. Mounted within the magnet frame 5 is a solenoid winding 8 having a plunger 9 connected by a pin 10 to the switch arm 7. The switch arm 7 has a main contact 11 and an arcing contact 12 arranged to engage relatively stationary contacts 13 and 14. The contact 13 comprises a laminated brush rigidly secured to a support 15 which is mounted upon the front of the magnet frame and insulated therefrom. The contact 14 comprises a carbon block carried by an arm 16 which is fulcrumed at 17 to the contact support 15. The solenoid winding 8 has a stationary core 18 with which the plunger is adapted to seal when moved upwardly.

Secured to the plunger 9 of the solenoid 8 is an upwardly extending tail rod 19, having loosely mounted thereon a contact disk 20. The contact disk 20 is adapted to bridge contacts 21 and 22 which are mounted upon posts 23 secured to and projecting forwardly from the insulating base 6. Surrounding the tail rod 19 is a coil 24 which is mounted within a magnet frame 25. The magnet frame may be of any preferred construction and supported in any suitable manner. As illustrated, the magnet frame is substantially cylindrical and is provided with rearwardly extending lugs 26 secured to the insulating base 6 to form a support therefor. The top 27 of the magnet frame is preferably formed separate from the main portion thereof and provided with a cylindrical portion 28, projecting into the coil 24. Surrounding the portion 28 is a nonmagnetic bushing 29, preferably extending entirely through the coil 24. The portion 28 forms a core for the coil 24, or, in other words, the top 27, as a whole forms an armature for the coil. The core 28 has a central aperture therein for permitting the tail rod 19 to pass therethrough. The contact disk 20 is mounted on the upper end of the tail rod so as to rest upon the top of the magnet frame, and said disk is preferably insulated from both the tail rod and magnet frame. Upon the upper end of the tail rod is a nut 30, and

surrounding the tail rod between said nut and the contact disk 20 is a coil spring 31. The spring 31 bears against the contact disk 20 and acts as a buffer to check the downward movement of the plunger 9 of the solenoid 8.

Fixed to the tail rod 19 below the core 28 is a collar 32. Surrounding the tail rod 19 and interposed between the collar 32 and the core 28 is a coil spring 33. With this arrangement, upon movement of the solenoid plunger to actuate the contact arm 7, the tail rod 19 will be raised, thereby exerting a pressure through the spring 33 against the core 28 of the winding 24. This, of course, tends to raise the top of the magnet frame, and, consequently, tends to move the contact disk 20 into engagement with contacts 21 and 22. If, however, the winding 24 be sufficiently energized to hold its core 28 against the pressure of the spring 33, said spring will compress or yield to permit continued operation of the contact arm 7. This compression of the spring 33 results in storing up energy, which will cause the core 28 to be raised as soon as the magnetic pull of the winding 24 decreases to a predetermined degree. As soon as the magnetic pull of the coil decreases to such an extent, the contact disk 20 will be moved into engagement with contacts 21 and 22. It will be apparent that as the top of the magnet frame is raised, air gaps will be inserted in the magnetic path of the coil 24, thereby further decreasing the magnetic pull of said coil. It will, therefore, readily be seen that the coil spring 33 may be so designed as to predominate the magnetic pull of the coil 24 upon subsequent surges of current therethrough, thereby insuring the retention of the armature 27 and contact disk 20 in raised position until the solenoid 8 is deenergized.

I shall now describe the controller diagrammatically illustrated in Fig. 3. This controller includes switches 35, 36, 37 and 38 arranged to control an electric motor 39, having an armature A and a series field winding F. Each of the switches 35, 36 and 37 is of substantially the same construction as the switch illustrated in Figs. 1 and 2, and the parts thereof will, therefore, be designated by the same reference numerals. The switch 38 is similar to the remaining switches, except that it is not provided with an auxiliary contact disk. The switches 36, 37 and 38 are arranged to control resistances R, R' and R² respectively connected in the motor circuit. While I have shown series resistances, it should be understood that parallel resistances might be used if preferred.

I shall now describe the operation of the controller, at the same time clearly setting forth the circuit connections therefor, assuming that current is supplied from main lines 40 and 41. For initially controlling

the operation of the several switches, I have shown a manually operated switch 42 adapted, when closed, to complete a circuit through the operating winding of switch 35. This circuit may be traced from main line 40 by conductor 43 through the operating winding of switch 35, thence through switch 42, by conductor 44 to main line 41. Thereupon the switch 35 responds and closes the motor circuit which may be traced from main line 40, through said switch 35, by conductors 45 and 46, through the resistances R, R' and R² in series, by conductor 47 through the controlling coils 24 of the auxiliary contacts of switches 35, 36 and 37, by conductors 48, 49 and 50, through the motor armature A and series field winding F to main line 41. The motor is thus started with all of the resistance in circuit therewith. The coils 24 of the switches 35, 36 and 37 being connected in series with the motor, will, of course, vary in strength in accordance with the flow of current to the motor. Hence, these coils may be so designed as to hold their armatures against the pressure of the springs 33 only when there is an abnormal flow of current in the motor circuit. Furthermore, these coils may be adjusted to hold and release their armatures at different current values. Hence, if an abnormal flow of current occurs in the motor circuit upon closure of switch 35, the coil 24 thereof will hold its armature 27 and auxiliary contact 20 against the pressure of the spring 33 until the flow of current decreases to the predetermined value. Thereupon the spring 33 will overcome the magnetism of the coil 24 and raise the armature 27, thereby causing the auxiliary contact 20 to engage the stationary contacts 21 and 22. Of course, if there is no abnormal surge of current upon closure of the switch 35, the auxiliary contact 20 thereof will be immediately moved into engagement with the stationary contacts. Upon operation of the auxiliary switch 20, circuit will be closed from conductor 45 by conductors 51 and 52, through said auxiliary switch, by conductor 53, through the operating winding of switch 36, by conductor 54 to main line 41. Thereupon the switch 36 will respond and shortcircuit the resistance R from the motor circuit. Again, if an excessive surge of current occurs upon shortcircuiting the resistance R, the coil 24 of switch 36 will prevent operation of the auxiliary switch 20 thereof until the flow of current is reduced to the desired value. Thereupon the auxiliary switch 20 of switch 36 will operate and close a circuit from conductor 52 to conductor 55, thence through the operating winding of switch 37, by conductor 56 to conductor 54. Thereupon the switch 37 will respond and shortcircuit resistance R'. Again, if an abnormal surge of current occurs upon shortcircuiting the resistance

R', the auxiliary switch 20 of switch 37 will be maintained open until the current in the motor circuit is reduced to the desired value. Thereupon the auxiliary contact 20 of switch 37 will be moved into engagement with its contacts, thereby completing a circuit from conductor 52, by conductor 57, to conductor 58, and thence through the operating winding of switch 38, by conductor 59 to conductor 56. The switch 38 will thereupon respond and shortcircuit resistance R². The motor circuit may then be traced from main line 40, through switch 35, by conductors 45, 46 and 60, through switch 38, and thence through the motor as already traced. All resistance is thus removed from the motor circuit and the motor will be brought up to normal speed.

As previously set forth, the springs 33 of the several switches may be so designed as to prevent the attraction of any of the armatures 27 by the coils 24 after they have once been released. Consequently, each of the accelerating switches, after having once responded, will be unaffected by any subsequent surges of current in the motor circuit.

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

1. In a controller for electric motors, in combination, a plurality of automatic switches for accelerating the motor, means actuated by said switches for causing successive operation thereof, and electroresponsive means for arresting the operation of said first mentioned means while abnormal conditions prevail in the motor circuit, said first mentioned means being adapted to be arrested independently of the switches actuating the same.

2. In a controller for electric motors, in combination, a plurality of automatic switches for accelerating the motor, a plurality of devices, each adapted to be actuated by one of said switches to cause the operation of another switch, and electroresponsive means for arresting the successive operation of said devices while abnormal conditions prevail in the motor circuit, said devices being adapted to be arrested independently of the switches actuating the same.

3. In a controller for electric motors, in combination, a plurality of automatic switches for accelerating the motor, a plurality of devices each adapted to be actuated by one of said switches to cause the operation of another switch, a resilient connection between each of said devices and its actuating switch, and electroresponsive means for arresting the successive operation of said devices while abnormal conditions prevail in the motor circuit.

4. In a controller for electric motors, in combination, a plurality of automatic switches for accelerating the motor, a plurality of devices each adapted to be actuated

by one of said switches to cause the operation of another switch, a resilient connection between each of said devices and its operating switch, and a plurality of controlling windings, one for each of said devices, each of said controlling windings being adapted to check the operation of its corresponding device while abnormal conditions prevail in the motor circuit.

5. In a controller for electric motors, in combination, a plurality of automatic switches, a plurality of devices each tending to operate upon closure of one of said switches to cause the operation of another of said switches, a plurality of controlling windings, one for each of said devices, each of said windings being adapted to arrest operation of its corresponding device while abnormal conditions prevail in the motor circuit, and means for retaining each of said devices in the position to which it is moved regardless of subsequent surges of current through its controlling winding.

6. In a controller for electric motors, a plurality of electroresponsive accelerating switches, a plurality of relay switches each operatively connected to one of said accelerating switches and tending to operate therewith to energize another of said accelerating switches, and electroresponsive means for arresting the operation of said relay switches upon the occurrence of abnormal conditions in the motor circuit, the connection between each relay switch and its corresponding accelerating switch permitting operation of the latter, while the former is arrested and positively operating the former upon restoration of normal conditions.

7. In a motor controller in combination, a plurality of electroresponsive accelerating switches, a plurality of relay switches each operatively connected to one of said accelerating switches and tending to operate therewith to energize another of said accelerating switches, and electroresponsive means for arresting the operation of said relay switches upon the occurrence of abnormal conditions in the motor circuit independently of their corresponding accelerating switches, the connection between each relay switch and its corresponding accelerating switch insuring operation of the former upon restoration of normal conditions, and further insuring the retention thereof in the position to which it is moved regardless of subsequent surges of current in the motor circuit.

8. In a controller for electric motors in combination, a plurality of electroresponsive accelerating switches, a plurality of relay switches, an operative connection between each of said relay switches and one of said accelerating switches tending to cause the former to move with the latter, but permitting the latter to move inde-

pendently of the former, and a plurality of controlling windings one for each of said relay switches, each of said windings being adapted to arrest the operation of its corresponding relay switch upon the occurrence of abnormal conditions in the motor circuit.

9. In a controller for electric motors in combination, a plurality of electroresponsive accelerating switches, a plurality of relay switches, an operative connection between each of said relay switches and one of said accelerating switches, tending to cause the former to move with the latter but permitting the latter to move independently of the former, and a plurality of controlling windings one for each of said relay switches, each of said windings being adapted to arrest the operation of its corresponding relay switch upon the occurrence of abnormal conditions in the motor circuit, the connection between each relay switch and its corresponding accelerating switch insuring operation of the former upon restoration of normal conditions in the motor circuit and further insuring the retention of its relay switch in the position to which it is moved regardless of subsequent occurrences of abnormal conditions of the motor circuit.

10. In a controller for electric motors, in combination, a plurality of electroresponsive accelerating switches, a plurality of relay switches, each having a resilient connection with one of said accelerating switches and tending to operate therewith to cause another accelerating switch to respond, and a controlling winding for each of said relay switches adapted to arrest the operation thereof upon the occurrence of abnormal conditions in the motor circuit.

11. In a controller for electric motors, in combination, a plurality of electroresponsive accelerating switches each being provided with an auxiliary contact adapted to cause the energization of another accelerating switch, a controlling winding for each of said auxiliary contacts adapted to prevent operation thereof while abnormal conditions prevail in the motor circuit, and resilient connections between each accelerating switch and its auxiliary contact adapted to have energy stored therein for operating its auxiliary contact immediately upon restoration of normal conditions in the motor circuit.

12. In a controller for electric motors, in combination, a plurality of electroresponsive accelerating switches, each being provided with an auxiliary contact adapted to cause the energization of another accelerating switch, a controlling winding for each of said auxiliary contacts adapted to prevent operation thereof while abnormal conditions prevail in the motor circuit, and re-

silient connections between each accelerating switch and its auxiliary contact adapted to have energy stored therein for operating its auxiliary contact immediately upon restoration of normal conditions in the motor circuit, and for insuring the retention of its auxiliary switch in the position to which it is moved, regardless of subsequent surges of current through its controlling winding.

13. The combination with an electric switch, of a device associated with said switch, an operative connection between said device and said switch tending to positively actuate said device upon operation of said switch and electroresponsive means for temporarily checking the operation of said device independently of said switch.

14. The combination with an electric switch, of an auxiliary switch, an operative connection between said switches tending to positively operate the latter upon operation of the former, and an electroresponsive winding for holding said auxiliary switch against movement upon operation of said first mentioned switch.

15. The combination with an electric switch of an auxiliary switch, a resilient connection between said switches capable of having energy stored therein, and an electroresponsive winding for arresting the operation of said auxiliary switch upon operation of said first mentioned switch.

16. The combination with an electric switch, of an auxiliary switch, a resilient connection between said switches capable of having energy stored therein, an electroresponsive winding for arresting the operation of said auxiliary switch upon operation of said first mentioned switch, said connection adapted to insure the retention of said auxiliary switch in the position to which it is moved, regardless of subsequent energization of said winding.

17. The combination with an electroresponsive switch, of an auxiliary contact therefor resiliently connected therewith, and an electromagnet for holding said auxiliary switch stationary upon operation of said first mentioned switch, said resilient connection being adapted to have energy stored therein to prevent attraction of said auxiliary switch by said magnet after the same has been released.

18. In combination with a power circuit, a plurality of contactors intended for operation in succession to effect certain connections in said power circuit, auxiliary switches coöperating with certain of said contactors, each arranged to control the operation of a succeeding contactor, means for positively holding each auxiliary switch open while its coöperating contactor is open, said means permitting each contactor to close independently of its auxiliary switch, but tending to positively move each aux-

iliary switch to closed position upon closure of its cooperating contactor, and electrical means for controlling the closing of said auxiliary switches.

19. In combination with a power circuit, a plurality of contactors intended for operation in succession to effect certain connections in said power circuit, auxiliary switches cooperating with certain of said contactors, each arranged to control the operation of a succeeding contactor, a mechanical connection between each contactor and its auxiliary switch for positively holding the latter open when the former is open, and an electroresponsive controlling winding for each auxiliary switch adapted to hold the same in open position under predetermined conditions, said connections being arranged to permit closure of each contactor while its auxiliary switch is held in open position and to positively move the latter to closed position when released by its controlling winding.

20. In a motor controller in combination,

a plurality of electroresponsive accelerating switches, auxiliary switches associated with certain of said accelerating switches, each arranged to control the circuit of a succeeding switch, a mechanical connection between each of said switches and its auxiliary switch tending to positively close the latter upon closure of the former, and an electroresponsive winding associated with each auxiliary switch for preventing closure thereof while abnormal conditions prevail in the motor circuit, said connections being adapted to permit closure of each accelerating switch independently of its auxiliary switch when the latter is held open by its controlling winding.

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

EDWIN B. H. TOWER, Jr.

Witnesses:

FRANK H. HUBBARD,
S. W. FITZ GERALD.