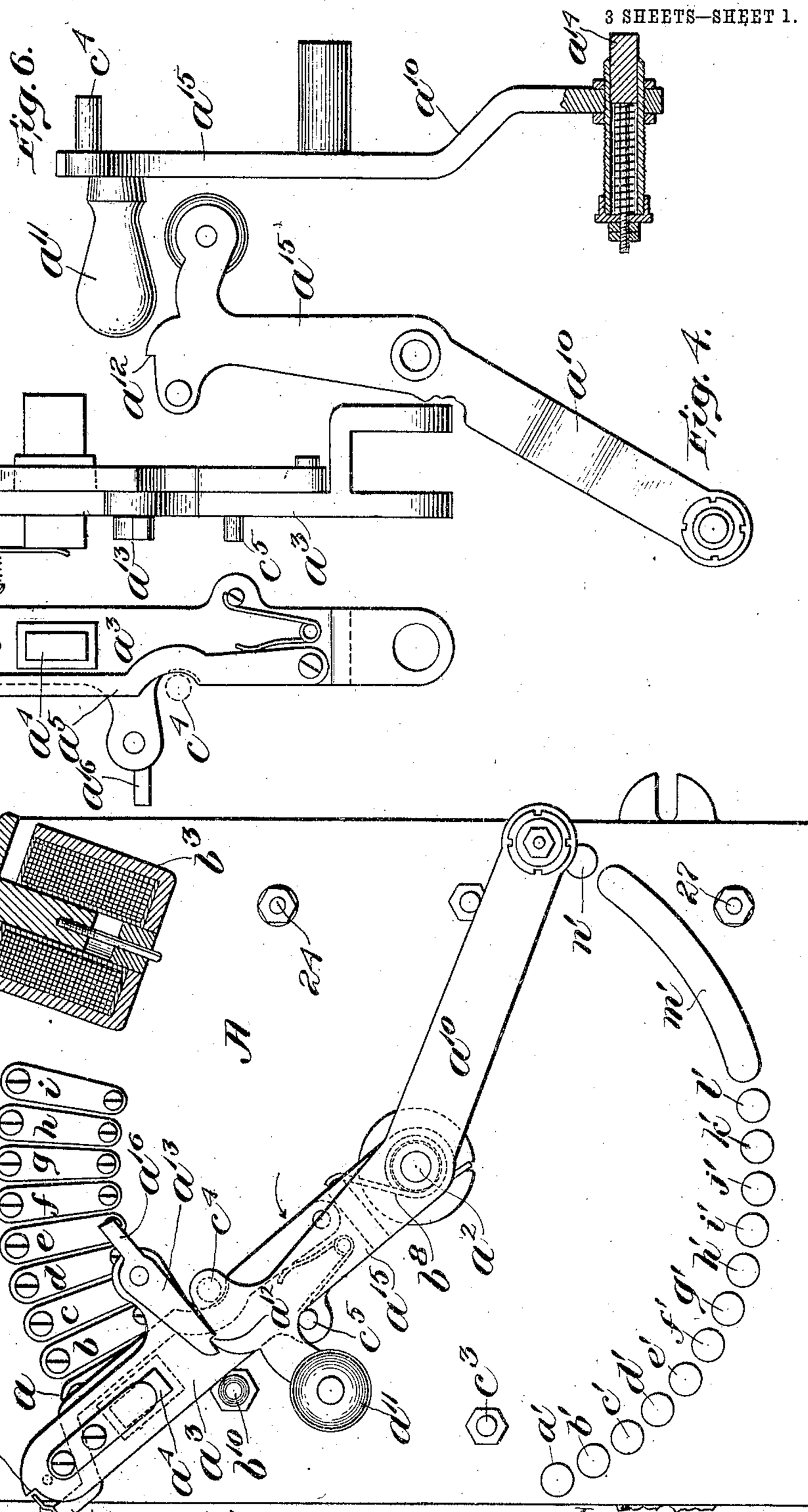
No. 828,388. PATENTED AUG. 14, 1906.

A. L. CUSHMAN.

CONTROLLER.

APPLICATION FILED MAY 3, 1905.

3 SHEETS—SHEET 1.



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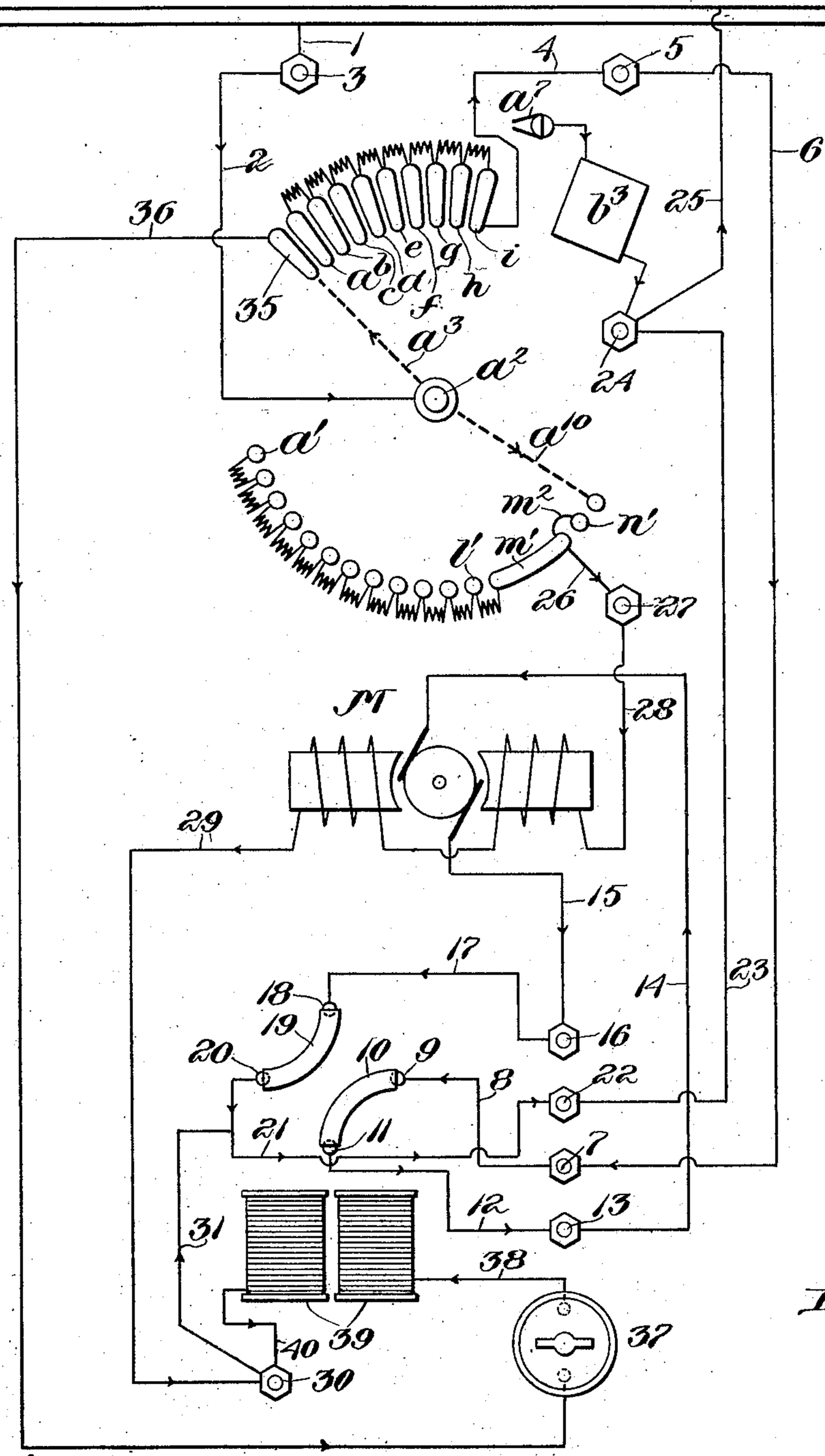

Fig. 2.

Witnesses:
Joseph L. Berman
Margaret A. Daniels.

Inventor:
Abe L. Cushman,
by Roberts & Mitchell
Attorneys.

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Fig. 8.

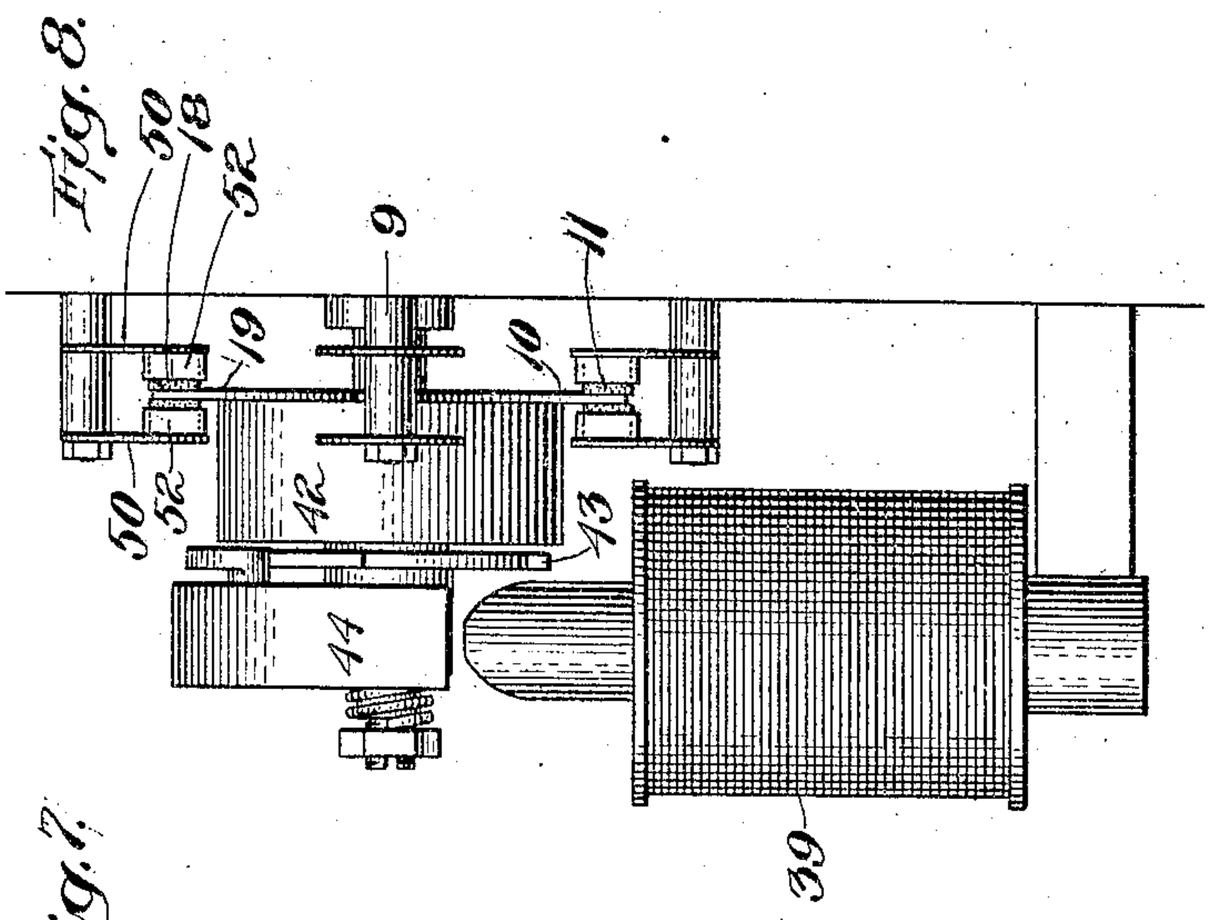
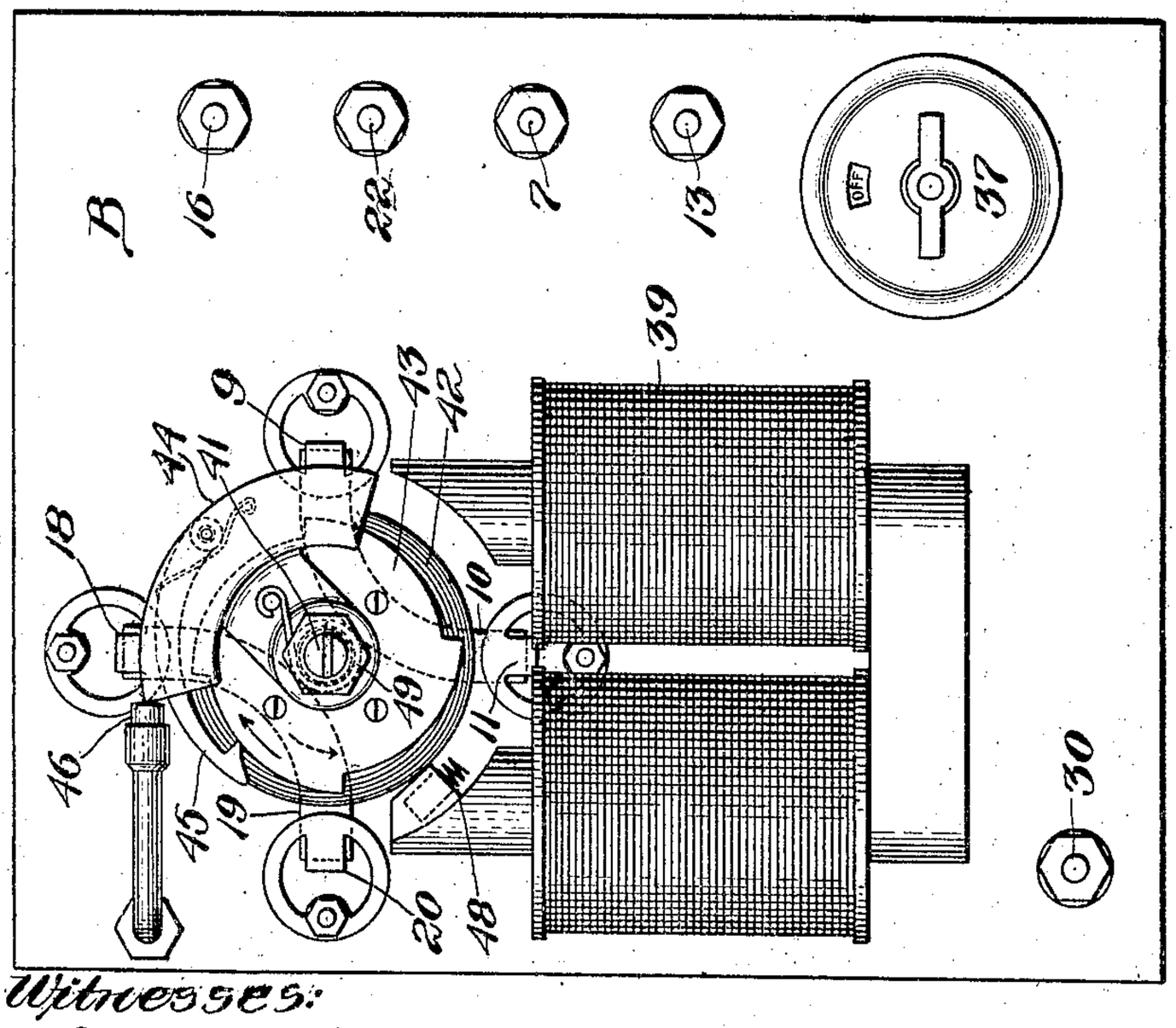


Fig. 7.



Witnesses:

Joseph T. Brennan,
Margaret N. Daniher.

Inventor:

Abe L. Cushman,

by Roberts & Mitchell,

Attorneys.

UNITED STATES PATENT OFFICE.

ABE L. CUSHMAN, OF CONCORD, NEW HAMPSHIRE.

CONTROLLER.

No. 828,388. Specification of Letters Patent. Patented Aug. 14, 1906.

Application filed May 3, 1905. Serial No. 258,677.

To all whom it may concern:

Be it known that I, ABE L. CUSHMAN, a citizen of the United States, and a resident of Concord, in the county of Merrimack and State of New Hampshire, have invented new and useful Improvements in Controllers, of which the following is a specification.

My invention relates to controllers for variable-speed motors of the kind comprising a rheostat and control-levers for successively cutting out the armature resistances and cutting in the field resistances gradually to increase the speed of the motor to its maximum and for cutting out the field resistances and cutting in the armature resistances gradually to reduce the speed. It is of highest importance in the use of variable-speed motors, particularly when employed to drive lathes, machine-tools, and the like, that the variable-speed resistances should all be operated by a single control lever or handle instead of by several handles, so that the attention and hands of the operator shall be diverted as little as possible from his work, also that in case the motor-current shall for any cause be interrupted the armature-lever shall immediately go automatically to "off" position, also that it shall be impossible to start the motor by the operation of the control-lever until the field-lever shall also have been returned to off position, which will always insure a strong field at starting; otherwise if the motor were started up with a weak field sparking would result.

To accomplish the foregoing objects and otherwise to improve and simplify the construction and operation of such rheostats or controllers, I have devised an electromechanical apparatus in which a single operating handle or lever operates both the armature-control mechanism and field-control mechanism, first to place the armature-control mechanism in cut-out or short-circuit position, where it is automatically locked, and then to operate the field-control mechanism independently. In what I believe to be the best form of my invention the single operating-lever is an extension of the field-lever, and the armature-lever is locked thereto until the armature-lever reaches the position to cut out all of the armature resistances. Thereupon means for locking the armature-lever in cut-out position and unlocking the levers from each other, consisting of an electromagnet in shunt-circuit with the motor, operates latches, so that if the motor-circuit is interrupted the electromagnet will be deenergized, releasing the latch which locks the armature-lever in cut-out position, which permits the same to fly back to off position under the influence of a spring. Furthermore, as the armature-lever is forwardly operated only by the field-lever and handle the armature-control mechanism cannot be again operated after it has gone to off position without moving the field-lever and operating-handle, so as to lock the levers together. This can be accomplished only by returning the field-lever to its off position. The motor is therefore necessarily next started up with a strong field.

Other features will hereinafter be pointed out.

As one of the most useful adaptations of my invention is in a rheostat for controlling a variable-speed motor used for driving lathes, machine-tools, and the like, which has to be frequently reversed, I will address my description to an apparatus containing the controller, motor, and pole-changer to reverse the motor. In addition to the inventions contained in the controller the pole-changer itself also contains features of novelty, all of which will hereinafter be more specifically described, and pointed out in the claims.

In the accompanying drawings, which illustrate one embodiment of my invention, Figure 1 is a plan view of the controller. Fig. 2 is a diagram showing the wiring for the controller, motor, and pole-changer. Fig. 3 is a bottom view of the armature-control lever. Fig. 4 is a bottom view of the field-control lever. Fig. 5 is a side view of the armature-control lever. Fig. 6 is a side view of the field-control lever. Fig. 7 is a plan view of the pole-changer, and Fig. 8 is a side view of the pole-changer.

Referring to the drawings, A represents a plate made of slate or other suitable material, upon which are mounted the rheostat and other controller parts.

a b c d, &c., illustrate a set of armature-contacts connected, as usual, by armature resistances, and *a' b' c' d'*, &c., illustrate field-contacts connected, as usual, by field resistances.

Fixed near the middle of the plate A is a stud a^2, upon which is mounted the arm or lever a^3, carrying the carbon block a^4, adapted to travel over the contacts *a b c d*, &c. The arm a^3, which will hereinafter be called

the "armature-lever," also carries upon its under side a supplemental arm or lever a^5, at the end of which is a contact a^6, adapted to coöperate with the contact a^7, fixed to the plate A, to make and break the electromagnet-circuit, as will presently be described. A lever a^{10} is also mounted upon the stud a^2, provided with an extension a^{15}, which is coincident with the armature-lever a^3 when the levers are locked together, as shown in Fig. 1. The lever a^{10} constitutes the field-lever and carries at its end the contact a^{14}, which travels over the field-contacts a' b' c' d', &c. Mounted upon extension-lever a^{15} is a handle a^{11}, by which the entire controller is operated. At the end of extension a^{15} is a shoulder a^{12} to coöperate with a latch a^{13}, carried by the arm a^3. The latch a^{13} is yieldingly held in operative position, as shown in Fig. 1, by a spring. (Not shown.)

Fixed to the plate A is an electromagnet b^3, whose armature b^4 is pivotally connected with the end of the arm b^5, journaled to the plate A at b^6, as shown. A spring b^7 normally holds the arm b^5 elevated against a stop b^9, whereby it is normally in inoperative position.

A spring b^8 (shown in Fig. 1) is connected at one end with the arm a^3 and at its other end with the stud a^2 and normally tends to urge arm a^3 toward its off position in the direction of the arrow in Fig. 1 and to hold the armature-lever a^3 against a stop b^{10}. The extension a^{15}, and consequently the field-lever a^{10}, is normally locked to the armature-lever a^3 by means of the latch a^{13} and the stop c^5, carried by the armature-lever a^3.

When the handle a^{11} is swung to the right in Fig. 1, it carries with it both the armature-lever a^3 and the field-lever a^{10} until the contact a^6 engages the contact a^7 and closes the circuit through the magnet b^3. At that moment the carbon contact a^4 of the armature-lever will have reached the last armature-contact i and all the armature resistances will have been cut out, the armature-lever remaining in short circuit or cut-out position. The closing of the circuit through electromagnet b^3 causes the armature thereof b^4 to descend against the tailpiece a^{16} of the latch a^{13}, thereby disengaging the latch from the shoulder a^{12} and simultaneously operating the lever b^5 until the latch or shoulder b^{12} passes into place behind a shoulder b^{13} on the end of the armature-lever, which holds the armature-lever in cut-out position and prevents it from returning to its off position under the influence of spring b^8. While the two levers are being operated together and at the moment when the armature-lever has reached said cut-out position the field-lever will be in position to close the field-circuit through contact m', all the field resistances being cut out and the field being consequently strong. When the armature-lever reaches its cut-out position, the operation of the latch a^{13} by the electromagnet, as described, unlocks the two levers from each other and frees the field-lever to be operated by the handle a^{11} independently to cut in the field resistances through contacts a' b' c' d', &c. By thus weakening the field more or less as may be desired a very wide variation of speeds may be attained. The armature-resistance contacts and the field-resistance contacts are so arranged with relation to each other and to the armature-lever and field-lever that contact a^{14} does not leave contact m' until the magnet b^3 has operated to lock the armature-lever in cut-out position and unlock the two levers from each other. c^3 represents a stop to limit the movement of the field-lever when the field resistances have all been cut in. n' is a contact through which the field-circuit is first closed and is connected with the contact m' by a fuse m^2 to guard against unnecessary shocks when the motor is started.

I will now describe the electric circuits in my apparatus. The stud a^2 is connected through wires 1 and 2 and binding-posts 3 with one line-wire. When armature-lever a^3 engages with one of contacts a b c, &c., the armature-circuit through the motor M is made as follows: from such contact through the other contacts of the armature series and the armature resistances between them by wire 4 to binding-post 5, thence by wire 6 to binding-post 7 of the pole-changer, thence by wire 8 to contact 9 of the pole-changer, thence through a bridge-piece 10, contact 11, wire 12 to binding-post 13, thence by wire 14 to the armature of the motor M, thence by wire 15 to binding-post 16 of the pole-changer, thence by wire 17 to contact 18, through bridge-piece 19 to contact 20, and through wire 21 to binding-post 22 of the pole-changer, thence by wire 23 to a binding-post 24 of the rheostat, and thence through wire 25 to the other line-wire. The field-circuit is from stud a^2, through the field-lever a^{10} to one of the field-contacts, thence by wire 26 to binding-post 27 of the rheostat, thence by wire 28 to the field of motor M, thence by wire 29 to the binding-post 30 of the pole-changer, thence by wire 31 to wire 21, and by wire 21 to line-wire by way of binding-post 24. It will thus be seen that the field is in shunt-circuit.

From the foregoing it will be clear that after the armature-lever has reached its position to cut out the armature resistances and has caused the two levers automatically to be unlocked from each other and the armature-lever to be locked in cut-out position the field-lever may be operated to cut in the field resistances, the entire operation being under the control of a single operating-handle. The return movement of the operating-handle after the field resistances have all been

again cut out automatically relocks the two levers together and unlocks the armature-lever from its cut-out position, so that the two levers may by the single handle be returned to off position. This is effected as follows: The extension a^{15} carries a stud c^4. When during the movement of the handle a^{11} to the left in Fig. 1 the extension a^{15} coincides with the armature-lever a^3, the stud c^4 strikes the supplemental lever a^5, pivoted to the armature-lever, and swings it away from contact a^7. Thereupon the circuit through the electromagnet b^3 will be broken. The armature b^4 of the electromagnet and the latch or lever b^5 are immediately lifted by spring b^7, causing the shoulder b^{12} to move out of engagement with the shoulder b^{13} and the latch a^{13} simultaneously to be moved by its spring into engagement with the shoulder a^{12}. The two levers are thereupon again locked together and free to be moved to control the armature-contacts, all under the control of the single operating-handle a^{11}.

In case the current should be interrupted while the motor is running with the armature-lever in cut-out position and the field-lever on one of the field-contacts the magnet b^3 will be deënergized, permitting the arm b^5 to be lifted by its spring, and thereby releasing the armature-lever from its cut-out position, from whence it will be automatically returned to its off position by spring b^8. Field-lever a^{10} will remain upon its field-contact with one or more of the field resistances cut in, and the field correspondingly weak; but since the armature-lever is operated by the field-lever and both by a single operating-handle before current can again be admitted to the motor the operating-handle must be moved to the left, Fig. 1, until latch a^{13} springs behind shoulder a^{12} and places the armature-lever again under the control of the operating-handle. The field-lever will then have been moved into the position shown in Fig. 1, in which all the field resistances are cut out. When the motor is next started up, therefore, it will be with a strong field and will necessarily be so, since the single operating-handle by which the armature-lever can be controlled places the field-lever in cut-out position before it can again assume control of the armature-lever.

Each time the armature-lever returns to its off position the pole-changer (shown in Figs. 7 and 8) when used is operated to reverse the direction of the current to the armature, so that when the motor is next started up it will operate in reverse direction. The principal utility of this feature, as has been indicated, is in connection with driving-motors for lathes and the like, which have to be frequently reversed. The pole-changer is mounted on a suitable plate B. Fixed to the plate B is a stud 41, upon which is rotatably mounted a wheel 42, of insulating material, and a ratchet-wheel 43, the two wheels rigidly connected together. Alongside of wheels 42 and 43 a segmental armature 44 is also rotatably mounted on stud 41. The armature carries a pawl 45, which coöperates with the ratchet 43 and is normally held elevated against the stop 46 by a spring 49, surrounding stud 41. The armature is actuated by electromagnet 39. Fixed to the plate B are the four contacts 9, 11, 18, and 20, connected with the electrical conductors, as shown in Fig. 2.

The wheel or block 42 carries two conductors in the form of bridge-pieces 10 and 19, so arranged that every quarter-turn of the wheel will change the direction of the flow of the current through the armature-circuit above described—that is, the bridge-pieces will alternately connect contacts 18 and 9 with 20 and 11, respectively, and 18 and 20 with 9 and 11, respectively. The magnet 39 is energized as follows: Each time the armature-lever a^3 is returned to its off position with respect to the motor M contact a^4 engages with contact 35, Fig. 2. A stop b^{10} is provided to limit the movement of the armature-lever and hold it at rest upon contact 35. Contact 35 is connected by wire 36 with a hand-switch 37, which is connected by wire 38 with magnet 39. Thence the circuit for magnet 39 is completed through wire 40, binding-post 30, wire 31, wire 21, binding-post 22, wire 23, binding-post 24, and wire 25 to the line-wire. Accordingly each time the foregoing circuit is closed by the engagement of the armature-lever with contact 35 the electromagnet 39 is energized and causes the segmental armature 44 to rotate a one-quarter turn in the direction indicated by the full-line arrow. A stop 48 is provided to limit the extent of such rotation. As it rotates the pawl 45 engages the ratchet-wheel 43, turning the wheel 42 and the bridge-pieces 10 and 19 a quarter-turn.

When armature-lever a^3 is again moved away from contact 35 to start up the motor, magnet 39 is deënergized and armature 44 is automatically returned to its elevated position against stop 46 by the spring 49 on stud 41.

When it is not desired to have the motor reverse after each movement of the control-lever to its off position, the hand-switch 37 is opened, and the pole-changer is thereby put out of service.

The detail construction of the contacts 9, 11, 18, and 20 of the pole-changer is best shown in Fig. 8. Each comprises two spring-jaws 50, provided with sockets 52, holding the contact-pieces proper, 18, &c. Said contact-pieces are preferably made of carbon. The ends of the metal bridge-pieces 10 and 19 pass between the carbon contacts when the pole-changer is operated.

What I claim is—

1. A controller comprising an armature-control mechanism, and a field-control mechanism; the former requiring to be placed in position to cut out the armature resistances before the latter can be placed in position to cut in the field resistances; and means electrically actuated by the motor-circuit for automatically locking the armature-control mechanism in its cut-out position.

2. A controller comprising armature resistances and field resistances; an armature-control lever and a field-control lever, adapted successively to cut out the armature resistances and to cut in the field resistances, said levers being locked together, and the field-lever controlling the armature-lever excepting when the armature-lever is in position to cut out the armature resistances; means electrically actuated by the motor-circuit automatically to lock the armature-lever when it reaches its cut-out position; and automatic means simultaneously to unlock the two levers; and means controlled by the field-lever again simultaneously to lock said levers together, and to unlock said armature-lever from cut-out position.

3. A controller comprising armature resistances and field resistances; an armature-control lever and a field-control lever, adapted successively to cut out the armature resistances and to cut in the field resistances, said levers being locked together, and the field-lever controlling the armature-lever excepting when the armature-lever is in position to cut out the armature resistances; a lock to hold the armature-lever in cut-out position; and an electromagnet in shunt with the motor and controlled by the field-lever, adapted simultaneously to actuate said lock and to unlock the levers from each other.

4. A controller comprising armature resistances and field resistances; two control-levers, one for each set of resistances, adapted successively to cut out the armature resistances and to cut in the field resistances, said levers being normally locked together excepting when the armature-lever is in position to cut out the armature resistance, and the armature-lever being operated by the field-lever; electrically-actuated means automatically to hold the armature-lever in said cut-out position and simultaneously to unlock the two levers from each other, whereby the field-lever may be operated independently to control the field resistances; and automatic means again to lock the two levers together and release the armature-lever from its cut-out position after the field-lever is returned to a position to cut out the field resistances.

5. A controller comprising armature resistances and field resistances; an armature-control lever and a field-control lever adapted successively to cut out the armature resistances and to cut in the field resistances, the field-lever controlling the armature-lever; means normally in operative position for locking the two levers together; means normally in inoperative position for locking the armature-lever in cut-out position; and means controlled by the field-lever comprising an electromagnet adapted to operate both of said locking means; a normally open circuit therefor and a switch controlled by the field-lever, whereby the forward movement of the field-lever will close said switch and cause the electromagnet to lock the armature in cut-out position and unlock said levers from each other, and the return movement of the field-lever will open said switch to permit said levers again to be locked together and the armature-lever unlocked from cut-out position.

6. A controller comprising armature resistances and field resistances; an armature-control lever and a field-control lever adapted successively to cut out the armature resistances and to cut in the field resistances; and means for automatically locking the armature-lever in its cut-out position comprising a latch, an electromagnet in shunt with the motor for operating the latch, and a supplemental switch carried by the armature-lever for controlling the electromagnet circuit, the armature-lever and the supplemental switch being controlled by the field-lever.

7. A controller comprising armature resistances and field resistances; an armature-lever and a field-lever adapted successively to cut out the armature resistances and to cut in the field resistances, said levers being locked together and the field-lever controlling the armature-lever excepting when the armature-lever is in cut-out position; a latch for locking the armature-lever in cut-out position; an electromagnet in shunt with the motor for operating the latch; and means controlled by the field-lever in its forward movement for simultaneously causing the electromagnet to close said latch and to unlock said levers from each other when the armature-lever reaches cut-out position, and means controlled by the field-lever in its return movement for opening said latch and relocking said levers with each other after the field resistance have been cut out.

8. A controller comprising armature resistances and field resistances adapted to be successively operated; an armature-lever and a field-lever normally locked together by a latch; a latch normally in inoperative position to lock the armature-lever in cut-out position; an electromagnet in a normally open circuit for operating both latches, a movable circuit-closer carried by the armature-lever adapted to close the electromagnet-circuit when the forward movement of the lever brings the armature-lever to its cut-out position, whereby the field-lever may be oper-

ated independently; the return movement of the field-lever, after the field resistances have been cut out, being adapted to actuate said movable circuit-closer again to open said electromagnet-circuit, whereby both levers may be returned to their "off" position together.

9. A controller comprising an armature-control mechanism, and a field-control mechanism; a single control-lever for operating both mechanisms; provision whereby the initial forward movement of the control-lever will cause the armature-control mechanism to be placed in cut-out position and there locked, and the continued forward movement of the control-lever will independently operate the field-control mechanism; and provision whereby the armature-control mechanism will automatically return to off position independently of the field-control mechanism when the motor-circuit is interrupted, and whereby said armature-control mechanism can again be operated only upon manually returning the field-control mechanism to off position.

10. A controller comprising an armature-control mechanism, and a field-control mechanism; a single control-lever for operating both mechanisms; provision whereby the initial forward movement of the control-lever will cause the armature-control mechanism to be placed in cut-out position and there locked, and the continued forward movement of the control-lever will independently operate the field-control mechanism to cut in the resistances thereof, and whereby the initial return movement of the control-lever will cut out the field resistances and then unlock the armature-control mechanism from cut-out position, and the continued return movement of the control-lever will carry both mechanisms together to off position; and provision whereby the armature-control mechanism will automatically return to off position independently of the field-control mechanism when the motor-circuit is interrupted, and whereby said armature-control mechanism can again be operated only upon manually returning the field-control mechanism to off position.

11. A controller comprising armature resistances and lever, and field resistances and lever, the armature-lever being movable under the control of the field-lever until the former reaches its cut-out position; means for automatically locking the armature-lever in cut-out position, the field-lever being thereafter independently operable to cut in field resistances; means controlled by the field-lever after the field resistances have been cut out for unlocking the armature-lever from its cut-out position and placing it again under the control of the field-lever; and provision whereby the armature-lever will automatically return to off position independently of the field-lever when the motor-circuit is interrupted, and whereby said armature-lever can again be operated only upon manually returning the field-lever to off position.

12. A controller comprising armature resistances and field resistances; two levers, one for each set of resistances, adapted successively to cut out the armature resistances and to cut in the field resistances, said levers being normally locked together excepting when the armature-lever is in cut-out position; a single control-handle by which both levers are operated; automatic means to lock the armature-lever in cut-out position and to unlock the two levers from each other when said cut-out position is reached, whereby the field-lever may be independently operated; automatic means controlled by said handle again to lock the two levers together and to unlock the armature-lever from its cut-out position after the field-lever has been returned to a position to cut out the field resistances; and provision whereby the armature-lever will automatically return to off position independently of the control-handle and field-lever when the motor-circuit is interrupted, and whereby said armature-lever can again be operated only upon manually returning the control-handle and field-lever to off position.

13. A controller comprising armature resistances and field resistances; an armature-control lever and a field-control lever, adapted successively to cut out the armature resistances and to cut in the field resistances, said levers being locked together, and the field-lever controlling the armature-lever excepting when the armature-lever is in position to cut out the armature resistances; means under the control of the field-lever to lock the armature-lever in cut-out position and unlock said levers from each other, whereby the field-lever may be operated independently, and means under the control of the field-lever again to unlock said armature-lever from cut-out position and relock said levers together; and provision whereby the armature-lever will automatically return to off position independently of the field-lever when the motor-circuit is interrupted, and whereby said armature-lever can again be operated only upon manually returning the field-lever to off position.

14. A controller comprising armature resistances and field resistances arranged about a common center and on different sides thereof; an armature-lever and a field-lever both journaled at said center, the field-lever having an extension normally overlying the armature-lever; a handle upon said extension for operating both levers; means normally locking the extension and the armature-lever together; and provision whereby the initial forward movement of the operat-

ing-handle will cause the armature-lever to be placed in cut-out position and there automatically locked, and automatically unlocked from the extension, and whereby the continued forward movement of the operating-handle will independently operate the field-lever.

15. A controller comprising armature resistances and field resistances arranged about a common center and on different sides thereof; an armature-lever and a field-lever both journaled at said center, the field-lever having an extension normally overlying the armature-lever; a handle upon said extension for operating both levers; means normally locking the extension and the armature-lever together; provision whereby the initial forward movement of the operating-handle will cause the armature-lever to be placed in cut-out position, there automatically locked, and automatically unlocked from the extension, and whereby the continued forward movement of the operating-handle will independently operate the field-lever; and means whereby the return movement of the operating-handle after the field resistances have been cut out will automatically relock the extension and the armature-lever together and unlock said armature-lever from cut-out position.

Signed by me at Concord, New Hampshire, this 27th day of April, 1905.

ABE L. CUSHMAN.

Witnesses:

VERA L. CATON,

ROBERT CUSHMAN.