H. H. CUTLER.

CONTROLLER FOR ELECTRIC MOTORS.

APPLICATION FILED FEB. 10, 1902. RENEWED JUNE 15, 1907.

1,154,976.

Patented Sept. 28, 1915.

3 SHEETS—SHEET 1.

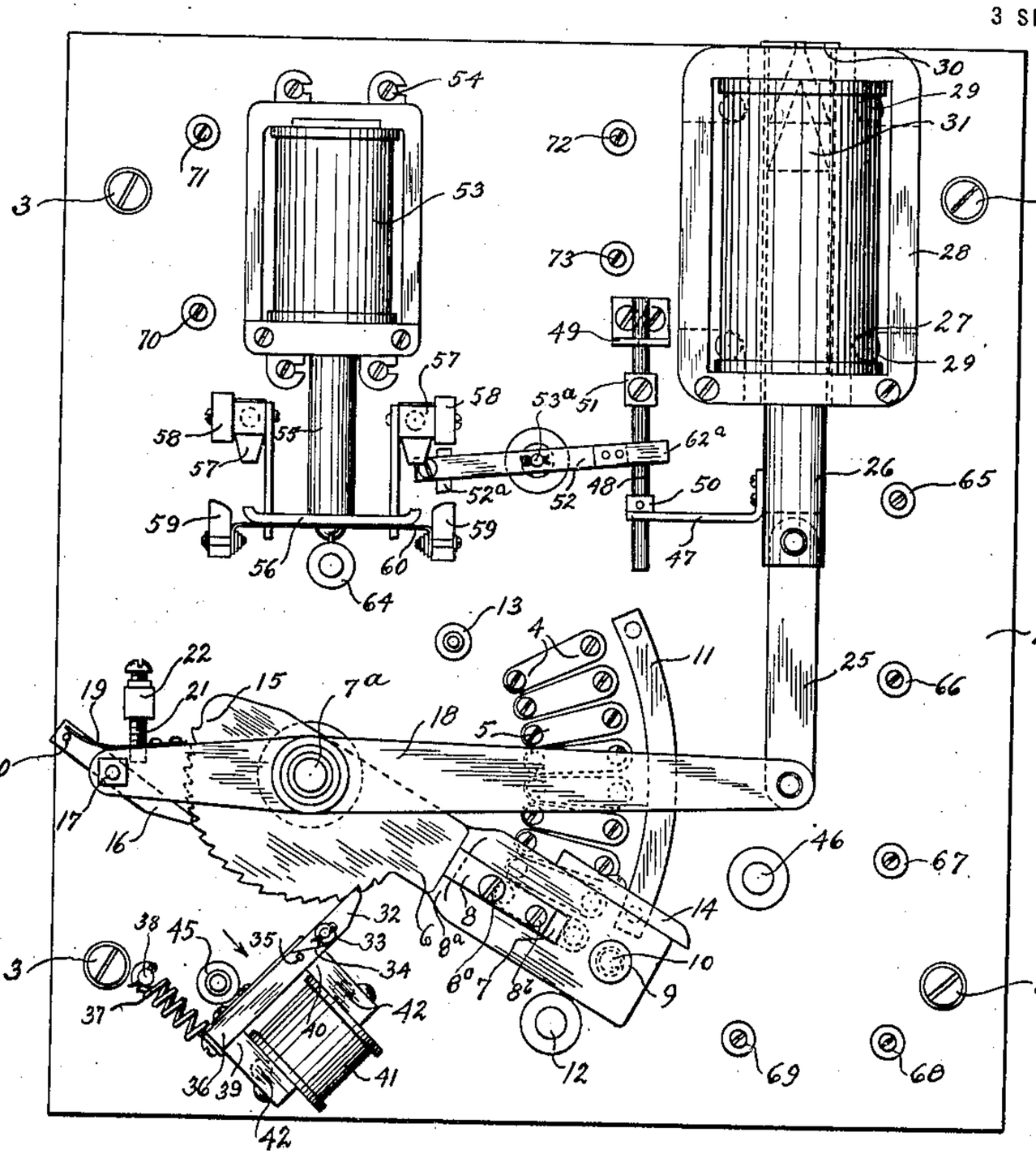


Fig. 1.

Fig. 2.

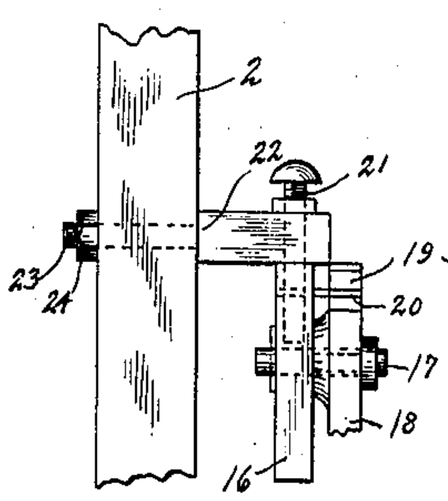


Fig. 3.

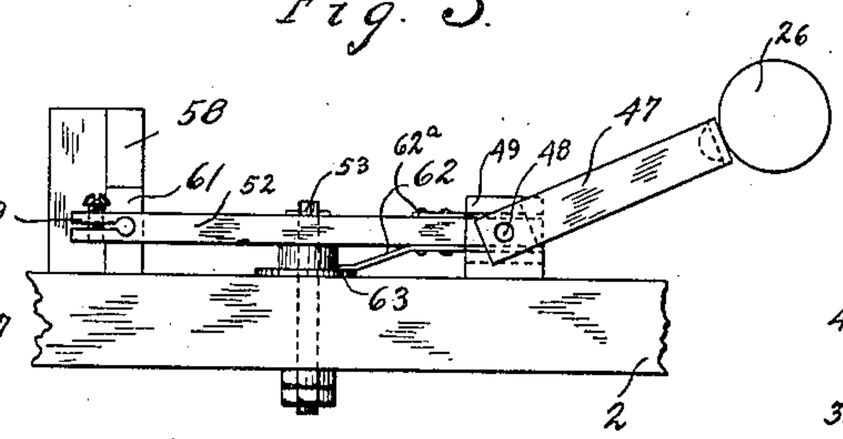
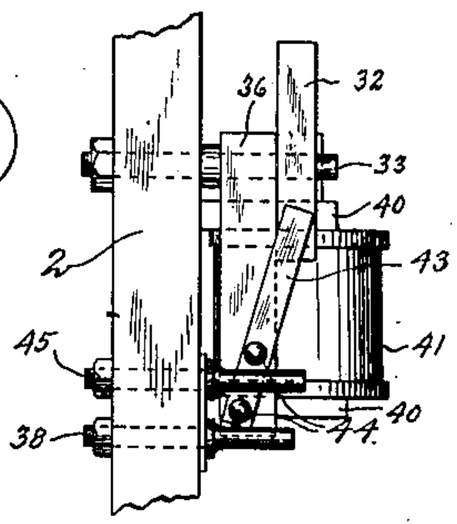


Fig. 4.



Witnesses.

Otto E. Johnson.

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3 SHEETS—SHEET 2.

Fig. 5

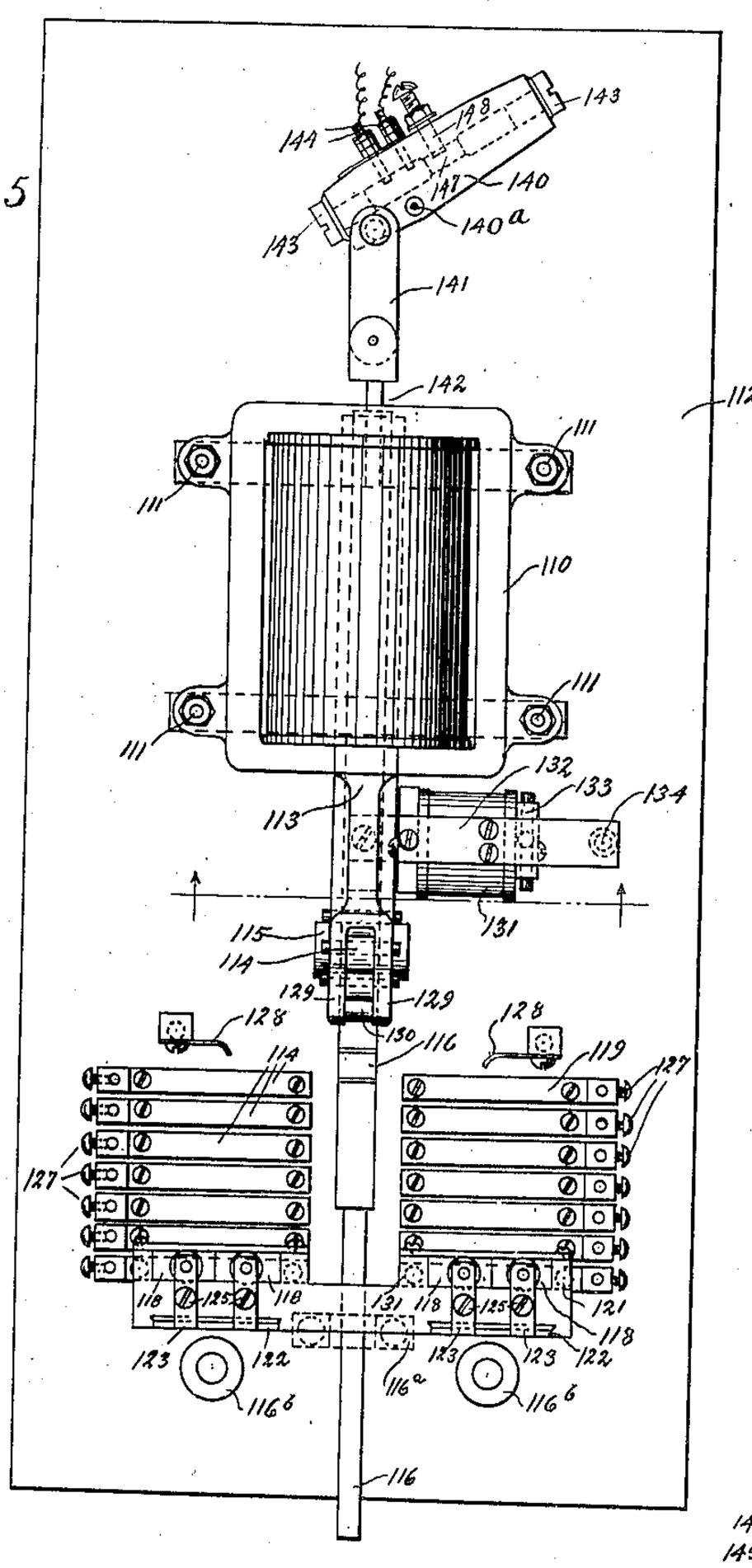


Fig. 6

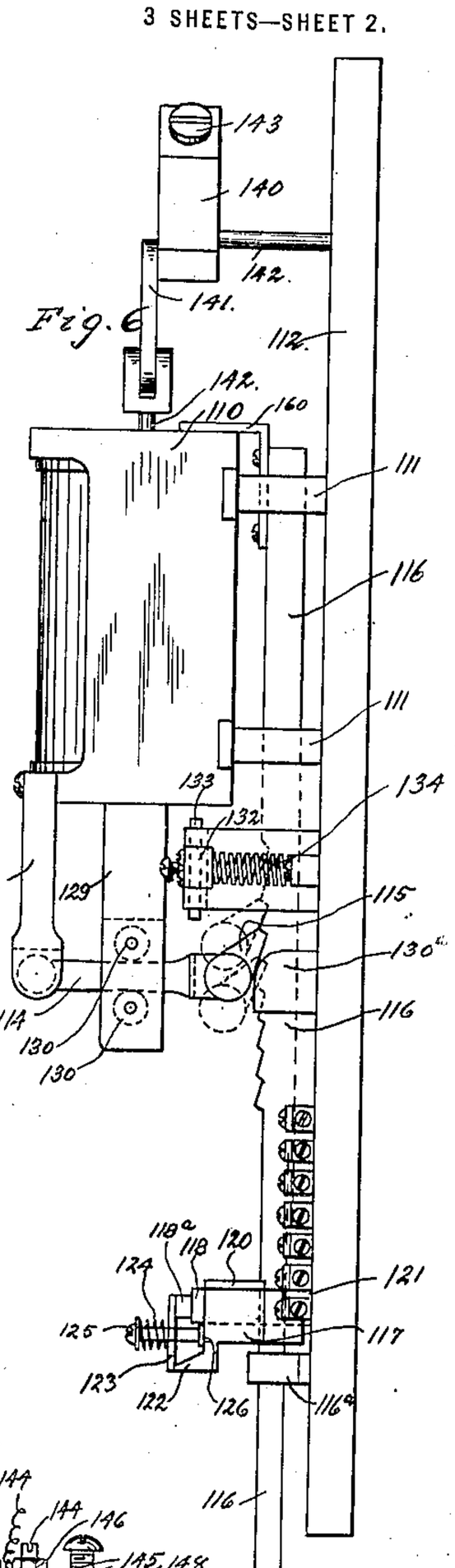


Fig. 7.

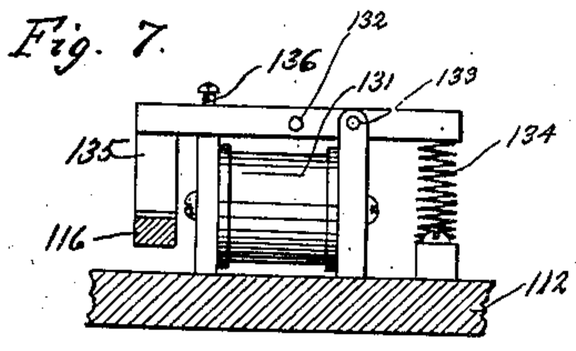


Fig. 8.

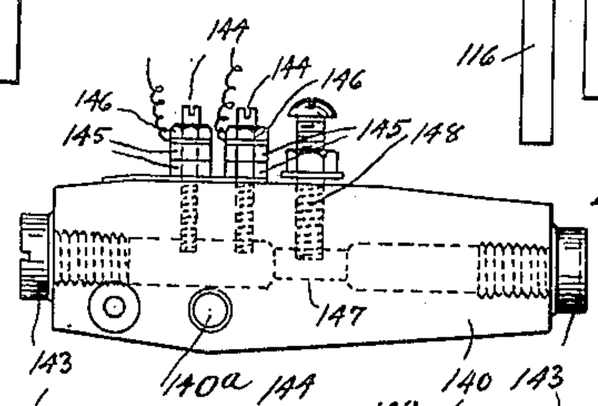
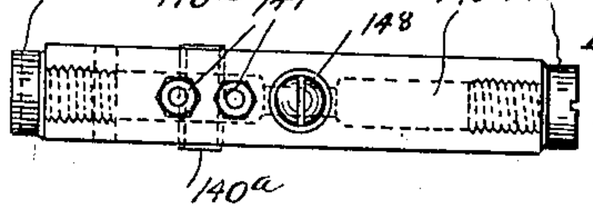


Fig. 9.



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3 SHEETS—SHEET 3.

Fig. 10.

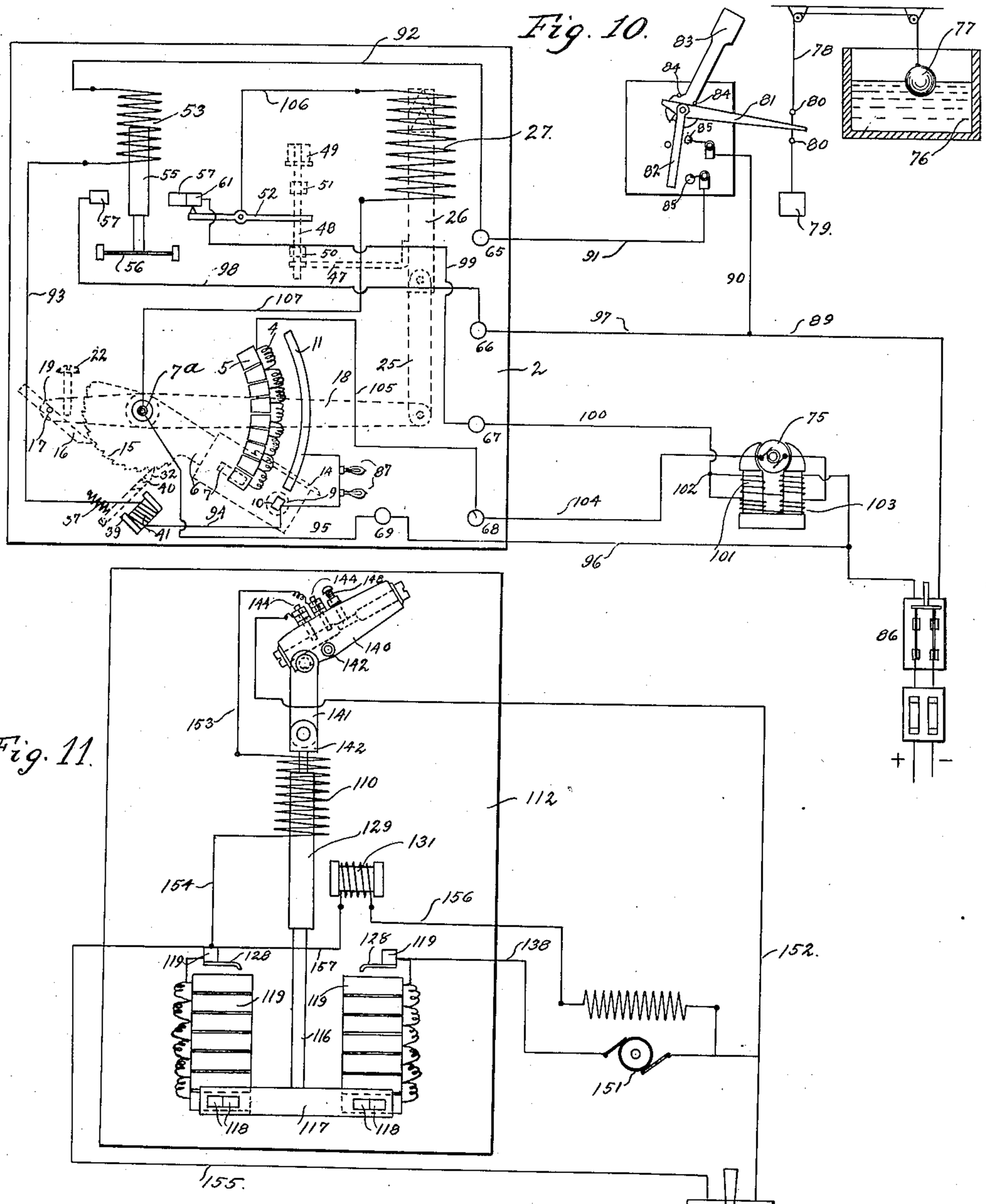

Fig. 11.

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UNITED STATES PATENT OFFICE.

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CONTROLLER FOR ELECTRIC MOTORS.

Specification of Letters Patent. **Patented Sept. 28, 1915.**

1,154,976.

Application filed February 10, 1902, Serial No. 93,387. Renewed June 15, 1907. Serial No. 379,178.

To all whom it may concern:

Be it known that I, HENRY H. CUTLER, citizen of the United States, residing at Milwaukee, in the county of Milwaukee and State of Wisconsin, have invented a certain new and useful Improvement in Controllers for Electric Motors, 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 has for its objects the provision of means for automatically controlling a variable resistance adapted to be included in a motor circuit.

My invention is illustrated in the accompanying drawing in which:

Figure 1 is a face view of one form of the controller mechanism; Fig. 2 is a detail view of the releasing stop of the pawl carried by the operating lever; Fig. 3 is a bottom plan view of the circuit breaker and arm connected with the core of the master solenoid; Fig. 4 is a detail view of the retaining magnet looking in the direction of the arrow in Fig. 1; Fig. 5 is a front view of a different form of the apparatus; Fig. 6 is an edge view of the same; Fig. 7 is a detail view of the retaining or releasing magnet; Fig. 8 is a side view of the mercury "tilt" or switch connected by the solenoid; Fig. 9 is a plan view of the same; Fig. 10 is a diagram of circuits employed in connection with the device shown in Fig. 1; and, Fig. 11 is a diagram of the circuits of the device shown in Fig. 5.

Like letters refer to like parts in the several views.

The several parts of the apparatus are mounted upon a suitable slate or insulating base, 2, which is adapted to be secured against a wall or other support by means of suitable screws, 3. This apparatus includes a starting or regulating resistance, 4, consisting of several sections connected between the contacts, 5, arranged circular upon said base. An arm, 6, is pivoted at 7^a, upon said base and carries a suitable brush 7, adapted to coöperate with the contacts, 5, in the movement of the arm, 6, to cut out or cut in the resistance 4. The brush 7 is of any suitable kind to make electrical contact with the contacts, 5, and is preferably yieldingly supported in said arm as by means of the leaf spring, 8, resting at one end upon the raised rib 8^a, formed upon the arm 6, and carrying at the other a small block secured by screw 8^b adapted to bear upon the upper end of the brush, 7. A coil spring is placed between the head of a screw 8^c and the upper face of the said leaf spring. This construction is usual and well understood. An additional brush, 9, is carried by said arm, and is adapted normally to rest upon a suitable contact, 10, shown in Fig. 10, and to make connection with the contact strip, 11, when it is out of normal position, said brush 9, being of any suitable construction to accomplish the desired results. Suitable buffers 12 and 13 are provided for said arm, to limit its movement in either direction. The upper edge of the front end of the arm is provided with an insulating block, or plate, 14, for a purpose hereinafter explained. The pivoted end of the arm is provided with a series of ratchet teeth, 15, as shown, which are adapted to be engaged by a dog, 16, pivoted at 17, upon a vibrating lever or arm, 18, a spring, 19, fixedly secured to the arm, 18, and pressing against a pin, 20, upon the dog, 16, tending to hold the forward end of said dog against or in engagement with the ratchet teeth, 15. A suitable stop, 21, which in the present instance is in the form of a set screw, threading into a bar or post, 22, secured to the base, 2, by means of the threaded extension, 23, and nut, 24, strikes against the dog, 16, when the arm, 18, is in its normal position to force the said dog away and out of the line of the ratchet teeth, 15. The forward end of the arm is connected by a link, 25, with the core, 26, as shown, of a solenoid, 27, the frame, 28, of which is suitably secured as by means of screw-bolts, 29, shown in dotted lines to the insulating base, 2. This solenoid is preferably provided with a soft iron cap, 30, having a conical cavity on its lower face adapted to accommodate the corresponding end, 31, of the core, 26, which thus strengthens the action of the solenoid. When the solenoid is energized, the core, 26, is lifted and the arm, 18, drawn up to cause the dog, 16, to engage the ratchet teeth, 15, and thereby move the arm, 6, about its pivot to cause the brush, 7, to successively engage the resistance contacts 5, and the brush 9, to move from contact 10 to contact 11.

In order to retain the arm, 6, in the position to which it is moved by the arm, 18, a pawl, 32, is provided, the free end of

which is adapted to engage with the ratchet teeth, 15. This pawl is pivoted upon a pin, 33, and is provided with a beveled rearwardly extending end, 34, the said end being adapted to normally rest against the pin, 35, carried by the armature, 36, which is also pivoted upon the pin, 33, at its upper end. A coiled spring, 37, extending between the pin, 38, and the end of the armature tends to withdraw the same from the magnet poles, 39, and 40. A magnet coil, 41, is provided upon a suitable core, the ends of which are extended by the pole pieces 39 and 40, in proximity to the armature, 36. This magnet may be secured to the base, 2, by means of screw-bolts, 42 or other suitable devices. A leaf spring, 43, is secured at its rear end to the armature by screws 44, and its free end is adapted to bear against the rear end of the pawl, 32, thus tending to force it against the pin, 35, as shown in Fig. 1. A suitable buffer or stop, 45, is provided for said armature and a like stop 46, is furnished for the arm, 18.

A bracket or laterally extending arm, 47, is secured to and carried by the solenoid core 26. This arm is not parallel with the face of the base, 2, but its free end, as shown in Fig. 3, is located closer the face of the base, 2, than the opposite end. A reciprocating rod, 48, passes through an aperture in the free end of the bracket or arm, 47, and is guided at its upper end by a suitable bracket, 49. A block or stop, 50, is secured to said rod and normally rests upon the arm, 47, and a suitable adjustable stop, 51, is carried upon the upper end of the rod, 48.

A lever, 52, is pivoted at 53^a, upon the base and is provided with a strip of metal, 62 and 62^a upon each side of one end, said strips passing upon either side of the rod, 48. The lever is split at its opposite end and clamps therein a suitable contact, 52^a, which may be a carbon contact. A suitable solenoid, 53, is provided upon the base and is secured in any desired way as by means of the clips, 54, secured to the frame of the solenoid, the core, 55, thereof carries at its lower end a bridge contact, 56, which is adapted in its upper position to engage suitable terminals, 57. At the side of these terminals, 57, carbon contacts or terminals, 58, are mounted, and are adapted to be engaged by coöperating contacts, 59, carried upon the ends of a leaf spring, 60, which is secured to the bridge contact, 56, and is carried likewise by the core, 55. As shown in Fig. 3, the carbon contacts, 58, are located some distance in front of the face of the base, 2, and in the rear of the same as shown at 61 is another contact against which the contact, 52^a, carried by the lever 52 strikes. The strip, 62, upon the lever, 52 is extended as shown in Fig. 3 and engages a washer, 63 with its free end; whereby the lever will stay in its upper or lower position until positively moved by extraneous means. A suitable buffer, 64, is provided for the lower end of the core, 55. Binding posts, 65, 66, 67, 68, 69, 70, and 71, as well as 72, and 73, are provided upon the base, 2, to suitably connect the apparatus in circuit. Connecting wires between the several parts and binding posts are extended preferably upon the rear of the base in suitable slots or grooves which may be then filled with insulating compound in the usual manner.

It will be apparent from the above description that when the solenoid, 27, is operated, the arm, 18, is lifted and the arm, 6, is rotated. The pawl, 32, serving to prevent the same from returning to normal position as long as the magnet, 41, is energized. When the core, 26, lifts the arm, 47, it carries the stop 50, against the end of the lever, 52, which moves the contact, 52^a, away from the coöperating contact 61. In the opposite movement of the core, the contacts, 52^a and 61 remain apart until the stop, 51, upon the rod, 48, in its downward movement strikes the end of the lever, 52, and causes them to engage. It will also be seen that when the arm, 6, reaches the highest point, the insulating block 14 carried thereby will be placed in the path of the lower end of the rod, 48, and prevent it falling to again operate lever, 52 and thereby close contacts, 52^a, and 61 together. The object of this will be explained in connection with the diagram. The ratchet teeth and retaining pawl are preferably so formed that when the magnet is deënergized, the teeth themselves will tend to disengage the pawl.

The circuit arrangement of the apparatus is shown in Fig. 10, in which a motor, 75, is adapted to be controlled thereby. As shown, this motor may be employed for pumping water and is automatically started and stopped by a float, 77, in the tank, 76, a rope 78, passing therefrom over suitable pulleys and supporting the weight, 79. By means of suitable stops, 80, upon the rope, upon opposite sides of the lever, 81, a weighted lever, 83 is actuated to quickly open and close a switch 82. This switch is of ordinary well known construction and is therefore not shown in detail. By means of the weighted arm, 83, which carries suitable stops, 84, to engage the arm, 81, the switch arm, 82, is quickly thrown into engagement with the switch contacts, 85, when the float falls a predetermined distance, and is disengaged therefrom when it rises to a certain height. A knife switch, 86, is placed in the main circuit.

The operation is as follows: The switch, 86, being closed, and with the switch 82, open in the position shown, the circuits are

open and all parts are in normal position. When the liquid in the tank, 76, falls, the stops, 80, lift the arm, 81, and cause it to engage one of the stops, 84, upon the weighted arm, 83; this moves the arm to the other side of the vertical line through its pivot, when it acts by gravity and quickly throws the switch arm, 82, into engagement with the contacts, 85. This serves to close a circuit from one side of the main line through conductors 89 and 90, the contacts, 85, and arm, 82, of the switch, conductors, 91 and 92, to the winding of the solenoid 53, thence through conductor, 93, to the retaining magnet 41, over conductor, 94, contact 10, through the rheostat arm, 6, to conductors 95 and 96, to the opposite side of the main circuit. This has the effect of operating solenoid, 53, thereby bridging together contacts 57 by means of the contact, 56, and operating the retaining magnet, 41, to cause the pawl, 32, to engage with the ratchet teeth upon the switch arm, 6. The closing of the contact, 56, with contacts, 57, by the solenoid, 53, serves to close a circuit through the shunt coil of the motor over the following path. From conductor, 89, over conductors 97 and 98, contacts, 57 and 56, conductor, 99, 100, to and through the shunt coils, 101, of the motor, 75, to the opposite side, 96, of the circuit. From the point, 102, upon this same circuit an additional path for current is completed through the series coil, 103, of the motor, 75, thence through its armature and by way of conductors 104 and 105, to the resistance 4. From this point the circuit is completed through the resistance, 4, through the rheostat arm, 6, conductors, 95 and 96, to the opposite side of the circuit. The motor is thus permitted to start but has included in its circuit the whole of the resistance, 4. At the same time a path for current is completed from the contacts 56 and 57 and 61 through the lever, 52, conductor, 106, to the solenoid, 27, thence by way of conductor, 107, to the arm, 6, and over wires, 95 and 96 to the opposite side of the circuit. The solenoid 27, which may be termed the master solenoid is thus energized and lifts its core and by means of the connecting link, 25, arm, 18, and pawl, 16, moves the rheostat arm, 6, upward so that its brush 7 engages the succeeding contact of the series to cut out a portion of the resistance 4. In this movement of the arm, 6, the brush, 9, leaves the contact, 10, and comes into engagement with contact, 11, with which it continuously engages when out of normal position. This has the effect of cutting lamps, 87 into the circuit of the magnet, 41, and solenoid, 53, to cut down the consumption of current therein and still permit enough to flow to maintain them actuated until their circuit is opened when they cannot be again energized until arm, 6, returns to normal position. The contacts 10, and 11, are close enough to prevent de-energizing the coils as the brush, 9, passes from one to the other. As the solenoid core rises, the arm, 47, affixed thereto, and carrying the reciprocating rod, 48, causes the stop, 50, to engage the end of the lever, 52, and open the circuit between the contact, 61 and the opposite end of the lever. This opens the circuit of the solenoid 27 causing the same to be deënergized and permitting its core, 26 as well as the arm, 18, to fall; the pawl, 32, being held against the ratchet teeth, 15, by the magnet, 41, prevents the arm, 6, from returning to normal position. As the core, 26, falls, the reciprocating rod, 48, travels downwardly and the stop, 51, thereon engages the end of the lever, 52, and closes the contact at 61. The said lever is frictionally sustained as before explained so that it will remain in the upper or lower position until positively moved therefrom by one of the stops on the rod. The solenoid, 27, is again actuated as before, and the rheostat arm, 6, is again moved to cut out more of the resistance, 4. This operation is continued until the whole of the resistance is cut out at which time the motor will have developed sufficient speed to prevent injury thereto by the cutting out of the whole of the resistance. At the last movement of the arm, 6, the insulating plate or block, 14, carried thereby is disposed in the path of the downwardly reciprocating rod, 48, carried by the solenoid core, which prevents it from falling and again closing the circuit of the solenoid, 27, through the lever 52, and contact 57. The motor is operated under these conditions as long as necessary or until the float, 77, rises to the desired height when the arm, 81, throws the weighted lever, 83, to the opposite side of its pivot thereby quickly opening the switch arm, 82. The opening of this circuit has the effect of deënergizing solenoid, 53, thereby opening the circuit through the motor and resistance and at the same time deënergizing magnet, 41, thus releasing the rheostat arm, 6, which descends by gravity to its normal position, thus cutting in again the whole of the resistance 4. Whenever lever, 18, is in normal position the screw, 22, forces pawl, 16, away from teeth 15, whereby when the arm is released by magnet 41, the said arm, 6, readily returns to normal position. Of course, the retaining magnet 41 may be connected in circuit in other ways. For instance, it may be connected in the field circuit of the motor as hereinafter described.

Fig. 5 shows a different form of the invention in which a vertically movable arm or frame, is employed for cutting out the resistance in the motor circuit. In this construction the solenoid, which may be termed

a master solenoid, is mounted upon a base 112 of slate or other material, in any suitable way, as by the bolts, 111, passing through suitable clips formed upon the frame of the solenoid. As shown in Fig. 6, this solenoid is supported at some distance from the face of the base 112, to provide room for the reciprocation beneath it of the resistance controlling arm, 116. An arm or bracket, 113, extends downwardly from the frame of the solenoid, 110, and in its lower end is pivoted a lever, 114, carrying a suitable pawl, 115, on its free end, which is adapted to engage ratchet teeth, in the front edge of the vertical rod, 116; this rod is adapted to reciprocate vertically and carries at its lower end a cross bar or frame, 117. Suitable brushes, 118, are carried by this frame or cross bar, and are adapted to engage with the contacts, 119, associated with the several sections of the resistance in the usual way. These brushes, 118, are secured in position by means of a plate, 120, secured to the upper edge of projections, 121, formed on the upper edge of the cross arm, 117. These parts together with the upper edge of the bar form a rectangular frame in which the brushes, 118, which may be of carbon or other suitable material slide. The two brushes 118, in each such frame are pressed down against the contacts, 119, by suitable plates or strips, 123. The cross bar, 117, has a raised rib 122, along the lower side at each end opposite the frames carrying the brushes, 118 and the plates or strips, 123, rest at their lower ends upon these ribs and at their upper ends upon the brushes, 118, these brushes being formed with cylindrical extensions, 118[a], or these extensions may be blocks secured to the ends of the strips. Coil springs, 124, are then placed between the outer faces of these strips, 123, and the heads, of suitable screw-bolts, 125, which are threaded into the cross bar, 117, and locked in place by suitable lock nuts, 126. A guide 116[a] is provided for the lower end of the rod, 116, and buffers, 116[b] are provided for the bar 117. Binding screws, 127, may be employed to secure the sections of the resistance to the contacts, 119. Additional contacts, 128 are provided to engage the cross arm in its upper position and assist in completing the circuit through the motor. These contacts are suitably connected in the circuit. The solenoid core, 129, is extended beneath the frame of the solenoid and is provided with a slot at its lower end in which the lever, 114 works. Rollers 130, are placed above and below the said lever, 114, in the slot and are designed to relieve the parts of friction. The pawl 115 is considerably wider than the bar, 116, and in normal position rests against a suitable stop, 130[a] which extends upon both sides of the strip, 116, and forms a guide therefor; the pawl is thus held out of the path of the ratchet teeth on the bar, 116 when in normal position. A retaining magnet, 131, is suitably mounted upon the base, 112, and is provided with an armature 132, pivoted at 133 at one end of the magnet and is normally held away from the other pole of the magnet by means of a coiled spring, 134, suitably arranged for the purpose. At its opposite end, the armature, carries a pawl, or dog, 135, adapted to engage the ratchet teeth upon the bar, 116, when the magnet is energized. A suitable adjusting screw, 136, is provided to adjust the movement of the armature.

In order to open and close the circuits through the solenoid by its own action, a mercury switch, 140, is provided. This switch is connected with the core of the solenoid by means of the connecting link, 141, and a forked extension, 142, from the core, passing upwardly through the upper end of the frame of the solenoid. The switch is preferably composed of a block of fiber, pivoted at 140[a] upon the base, 112, and having an aperture extending longitudinally therethrough. Suitable screw-bolts, 143, are placed in the ends of the aperture to close them. Contact terminals, in the form of screws, 144, project into one end of the opening and are adapted in the position shown in Fig. 5 of the drawing to be connected together by the mercury within the switch. These screws are provided with adjusting and locking nuts, 145, and with binding nuts, 146, to secure the circuit wires thereto. The central aperture, through the block has preferably a central restricted portion, 147, which is adapted to be further closed by a screw, 148. By this means it is possible to adjust the passage way between the end portions of the chambered block and thus vary the time required for the mercury to flow from one end to the other.

In Fig. 11, the diagram of circuits employed with this last form of the invention is shown. A switch, 150, closes circuit from the power circuit to the apparatus, a motor, 151, being controlled thereby. It is apparent that the apparatus shown in this figure may be employed with the automatically controlled switch of Fig. 10, or in other desired relations, but it is ample for the purpose of describing the operation to merely show the closing of the circuit by the switch, 150. When no current is flowing the parts are shown in the position in the diagram. When the switch, 150, is closed, however, a path for current from the conductor, 152, is completed, through the contacts of the mercury switch, 140, over conductor, 153, through the winding of solenoid, 110, conductors, 154 and 155, to the opposite side of the circuit. At the same time a parallel path is completed from the conductor, 152,

through the shunt coil of the motor, conductor, 156, retaining magnet, 131, conductors, 157 and 155, to the opposite side of the circuit. A third path for current is also provided, through the armature of the motor, 151, conductor, 158, the resistance controlled by the contacts, 119, and the cross arm, or frame, 117, and conductor, 155, to the opposite side of the circuit. This motor is thus permitted to start but with all of the resistance, 119, in its armature circuit. The closing of the circuit through the mercury switch causes the solenoid, 110, to operate thus lifting the cross bar, 117, and cutting out a portion of the resistance, 119. When the switch is tilted upon its pivot, 142, the mercury flows to the opposite end thus breaking contact with the screws, 144, and opening the circuit through the winding of the solenoid. This causes the solenoid core to fall. The traveling bar, 117, is maintained lifted by the pawl of the retaining magnet, 131, engaging the rack 116. The falling of the core, 129, serves to tilt the mercury switch into its first position and the operation is repeated until all the resistance is cut out of the motor circuit. At the last operation of the solenoid the stop 160 (see Fig. 6), secured to the bar, 116, in any desired way is lifted into the path of the mercury switch and prevents it from tilting again to allow the mercury therein to close together the contacts 144, whereby the solenoid circuit remains open as long as the magnet 131 is energized. The stop, 160, may be adjustably secured to the said rod, 116, and it may be given a slight longitudinal play or lost motion, as by means of slots therein, to accomplish the desired operation. By adjusting the screw, 148, of the mercury "tilt" the speed of operation of the solenoid and the cutting out of the resistance, 119, from the motor circuit may be varied as desired to suit different conditions of use. The bar of frame, 117, in its raised position engages contacts, 128, which carry the bulk of the current and thus save the other contacts from deterioration.

When the switch, 150, is open, the retaining magnet, 131 is deënergized and the bar, 117, is permitted to fall by gravity, thus cutting in the resistance as in the first position, and returning all parts to normal position.

Having described my invention what I claim as new and desire to secure by Letters Patent is:

1. In an electric controller in combination, a resistance controlling member, an operating member therefor, said resistance controlling member being released from said operating member when the latter is in normal position, means for holding said resistance controlling member against return movement after operation by said operating member, and a single electroresponsive winding for successively moving said operating member in the same direction to cause it to connect with and operate said resistance controlling member in a step by step manner.

2. In an automatic accelerating device for electric motors, in combination, a resistance varying element, means operable to impart a step by step movement thereto, a solenoid having a movable plunger for operating said means, a switch operated by a moving part to energize and deënergize said solenoid at intervals and means automatically locking said switch against further operation upon movement of said resistance varying element to a predetermined position.

3. In an automatic accelerating device for electric motors, in combination, a resistance varying element biased toward initial position, said element being provided with a series of ratchet teeth, means for imparting a step by step movement to said element including a pawl adapted to engage the ratchet teeth of said element, means for disengaging said pawl from said ratchet teeth after each step of operation of said element and an electromagnet for holding said element against return movement.

4. In a controller for electric motors, in combination, a supporting base, a rectilinearly movable contact member mounted thereon, a solenoid mounted upon said base and having a movable plunger, a member pivoted to a fixed part and operatively connected to said solenoid plunger and a pivoted pawl carried by said pivoted member to coöperate with said ratchet teeth on said contact member, said solenoid plunger upon successive reciprocations thereof operating said pivoted member to impart a step by step movement to said contact member.

5. In a controller for electric motors, in combination, a supporting base, a rectilinearly movable contact-carrying member mounted thereon, a solenoid mounted upon said base and having a movable plunger, a member pivoted to a fixed part and operatively connected to said solenoid plunger, a pivoted pawl carried by said pivoted member to coöperate with said ratchet teeth, said solenoid plunger upon successive reciprocations thereof operating said pivoted member to impart a step by step movement to said contact carrying member and means for disengaging said pawl from said ratchet teeth when said pivoted member is in normal position.

6. In a controller for electric motors, in combination, a vertical supporting base, a vertically disposed longitudinally movable bar mounted thereon and provided with a series of ratchet teeth, a magnet frame mounted upon said base, a member pivoted to a portion of said magnet frame and pro-

vided with a pawl adapted to engage said ratchet teeth and said bar and an electromagnetic winding mounted in said magnet frame and having a movable plunger operatively connected to said pivoted member to actuate the same to impart a step by step movement to said bar.

7. In an automatic starting device for electric motors, in combination, a solenoid having a reciprocating core, a rectilinearly movable bar, a contact member carried by said bar, a plurality of resistance contacts arranged to be successively engaged by said contact member, connections for causing said bar to move with the core of said solenoid in one direction and permitting the core of said solenoid to move independently of said bar in an opposite direction, an automatically operated switch for intermittently energizing and deënergizing said solenoid to cause the same to impart, through said connections, a step-by-step movement to said bar, and a retaining magnet adapted to hold the bar in the positions to which it is moved by said solenoid.

8. In an automatic starting device for electric motors, in combination, a solenoid having a reciprocating core, a rectilinearly movable bar, a contact member carried by said bar, a plurality of resistance contacts adapted to be successively engaged by said contact member, a pivoted pawl actuated by the core of said solenoid, a toothed rack portion on said bar arranged to be engaged by said pivoted pawl to cause said bar to move with the core of said solenoid in one direction, said pawl being movable out of engagement with the rack portion of said bar when the core of said solenoid moves in the opposite direction, a switch actuated by the core of said solenoid for intermittently energizing and deënergizing said solenoid to cause the same to impart, through said pawl, a step-by-step movement to said bar, and a retaining magnet for holding said bar in the successive position to which it is moved by said solenoid.

9. In combination, a slidingly mounted contact member, a reciprocating operating member therefor, means for inherently connecting said contact member to and releasing the same from said operating member upon reciprocations of said operating member in opposite directions, said operating member upon successive reciprocations in the same direction moving said contact member in a step by step manner, and a magnet for holding said contact member against return movement.

10. In combination, a slidingly mounted contact member, a reciprocating operating member therefor, means for inherently connecting said contact member to and releasing the same from said operating member upon reciprocations of said operating member in opposite directions, said operating member upon successive reciprocations in the same direction moving said operating member in a step by step manner, a magnet for holding said contact member against return movement, a solenoid for operating said reciprocating member, and means for automatically energizing and deënergizing said solenoid upon movement of said reciprocating member in opposite directions.

11. In combination, a rectilinearly moving contact carrying member, a member adapted upon movement in one direction to inherently connect with and move said contact carrying member, and when moved in the opposite direction to inherently release said contact carrying member, a retaining magnet for holding said contact carrying member against return movement, and an operating solenoid for said second mentioned member alternately energized and deënergized upon reversals of the movement of said member to cause successive movements thereof in the same direction to impart a step by step movement to said contact carrying member.

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

HENRY H. CUTLER.

Witnesses:
W. CLYDE JONES,
M. R. ROCKFORD.