

ALTERNATING CURRENT ELECTROMECHANICAL CONTROLLER.

Patented Dec. 12, 1911.

5 SHEETS—SHEET 1.

Arthur C. Mason
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A. SUNDH.

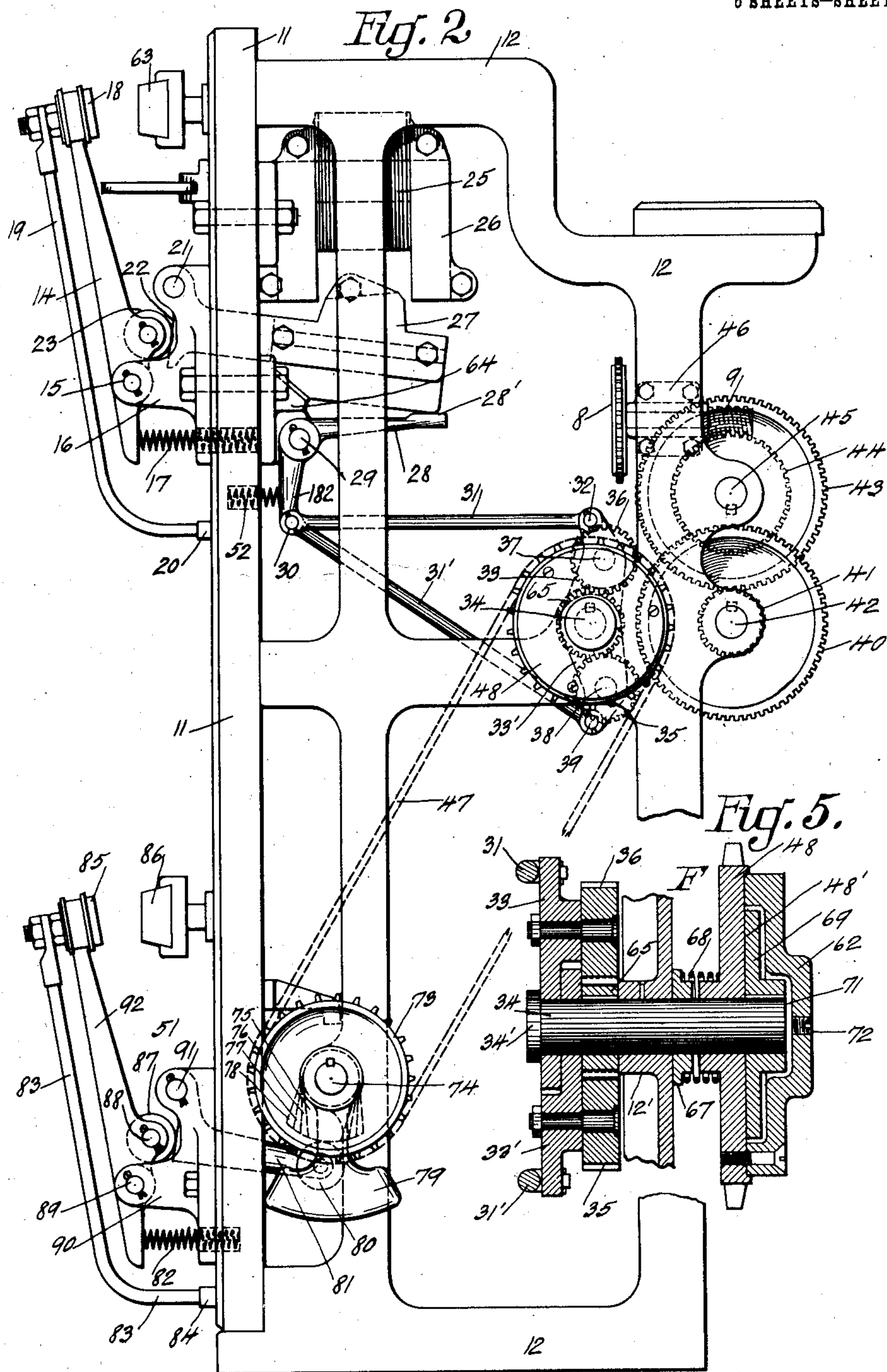
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1,011,663.

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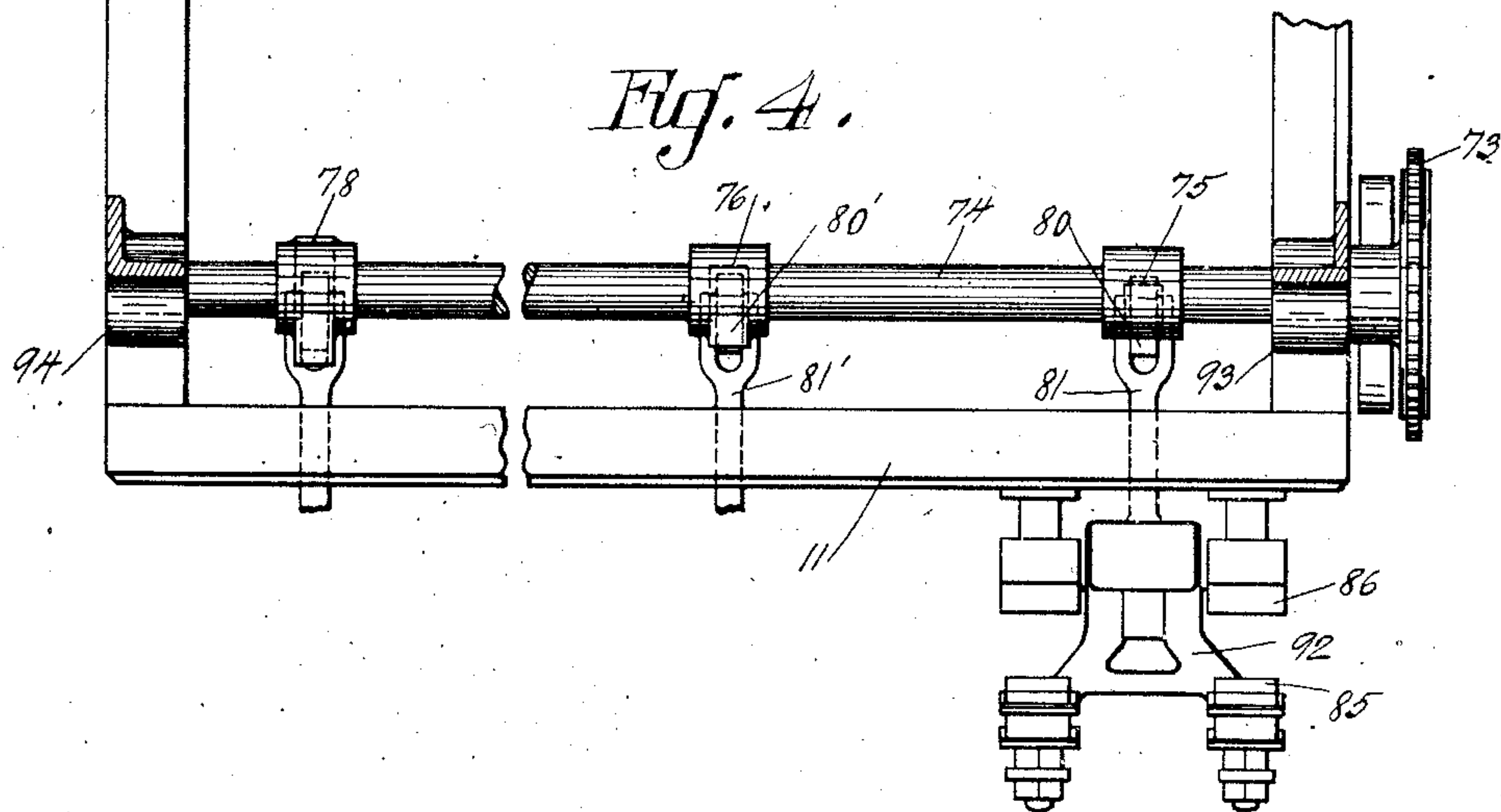
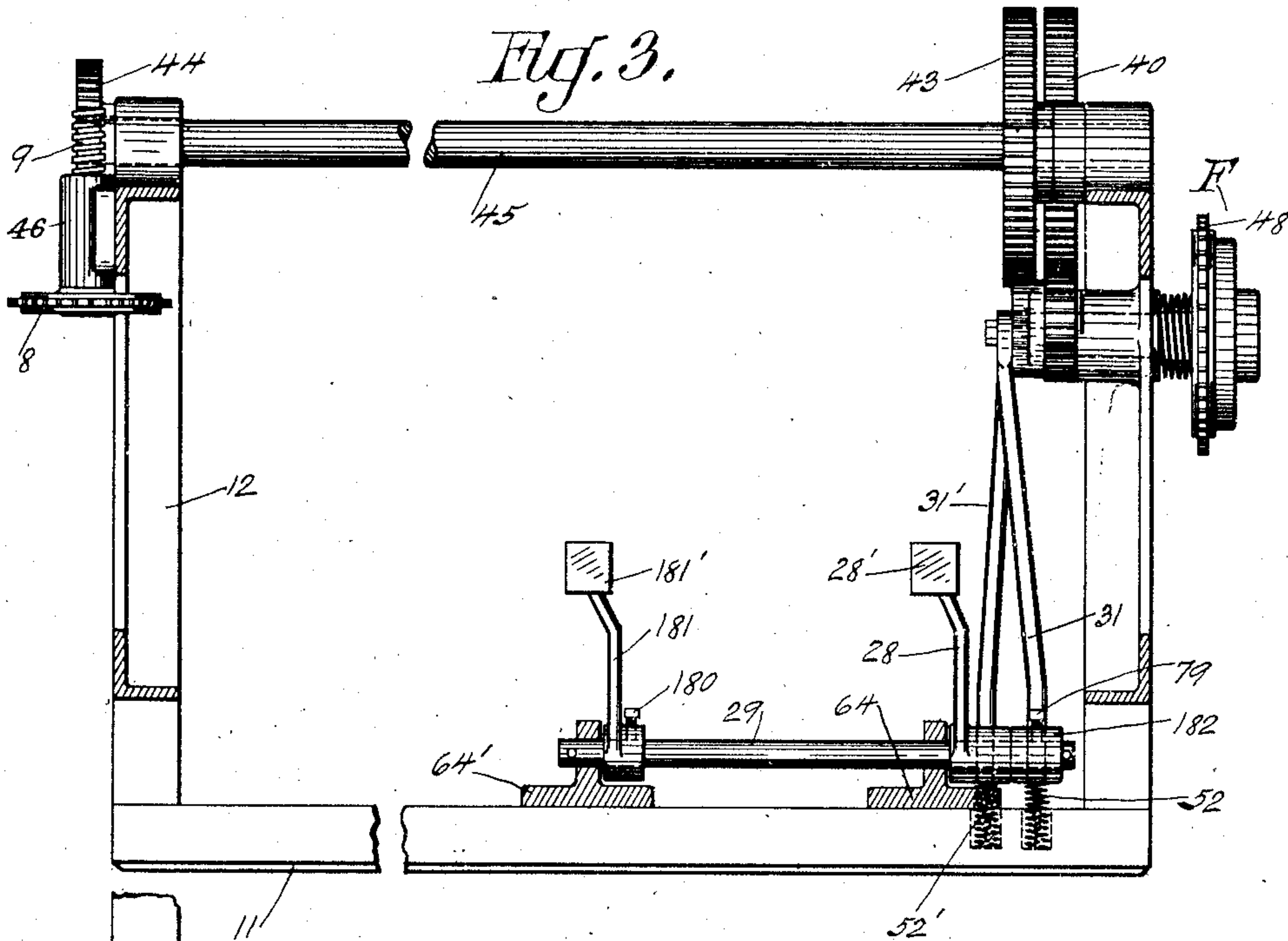
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WITNESSES:

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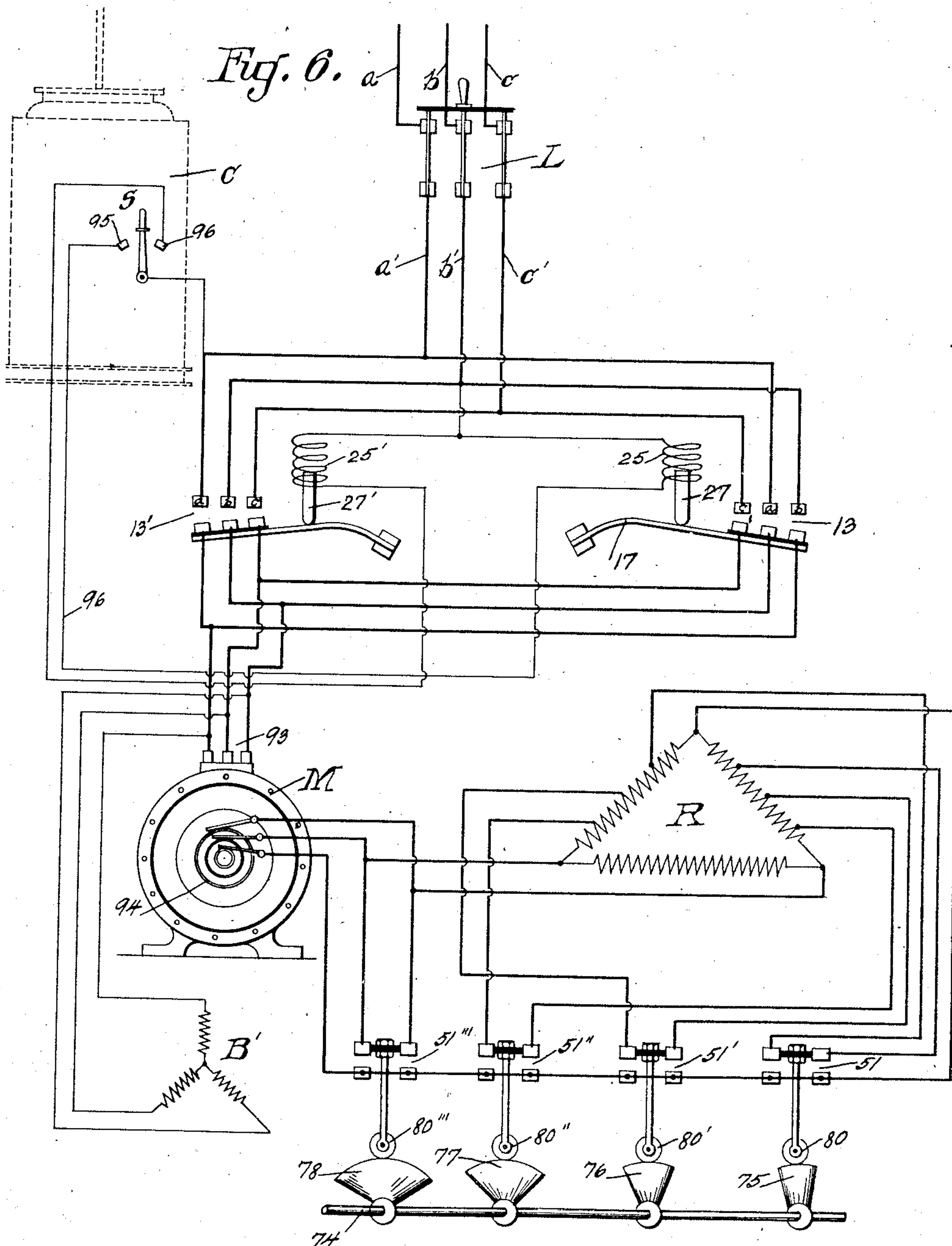
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Witnesses:

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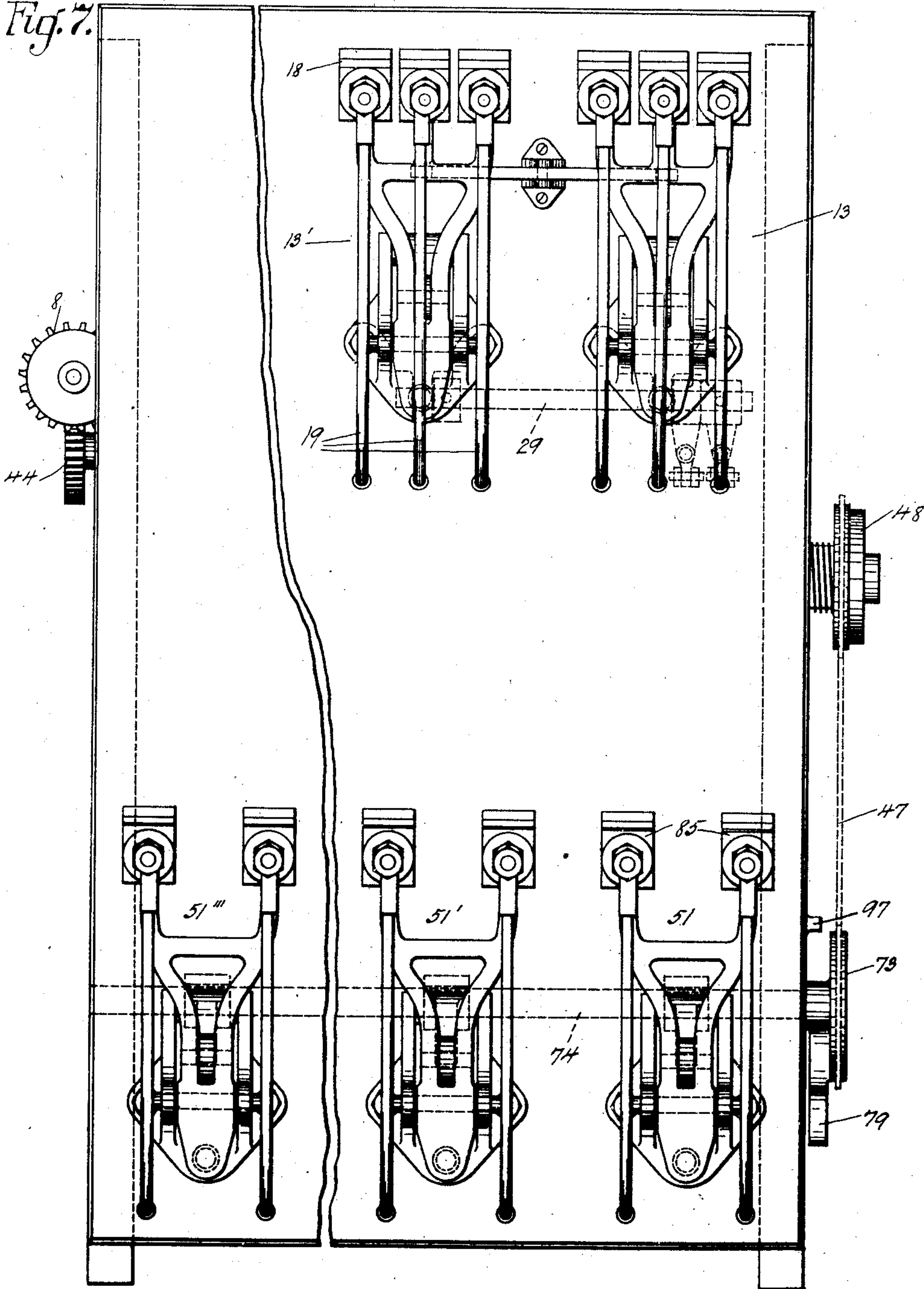
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5 SHEETS—SHEET 5.

Fig. 7.



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UNITED STATES PATENT OFFICE.

AUGUST SUNDH, OF YONKERS, NEW YORK, ASSIGNOR TO OTIS ELEVATOR COMPANY,
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ALTERNATING-CURRENT ELECTROMECHANICAL CONTROLLER.

1,011,663.

Specification of Letters Patent.

Patented Dec. 12, 1911.

Application filed August 11, 1908. Serial No. 448,016.

To all whom it may concern:

Be it known that I, AUGUST SUNDH, a citizen of the United States, residing at Yonkers, in the county of Westchester and State of New York, have invented a new and useful Improvement in Alternating-Current Electromechanical Controllers, of which the following is a specification.

My invention relates to improvements in controlling devices for alternating current motors, and one of its objects is the provision of practical and efficient means for controlling the operations of starting, stopping, reversing and accelerating alternating current motors, more particularly those used in operating electric elevators.

Broadly speaking, my invention comprises means whereby the starting, stopping and reversing of a motor is controlled by means of a manually-operated switch, the acceleration of the motor to full normal speed in either direction being effected by means of a series of mechanically operated switches which are controlled in their movements by the motor itself through the medium of a clutch device and intermediate mechanism.

In the accompanying drawings, Figure 1 illustrates a typical electric elevator system embodying my invention; Fig. 2 is a side elevation of a preferred form of my invention; Figs. 3 and 4 are sectional plan views of certain parts of my apparatus; Fig. 5 is a sectional view of a preferred form of friction clutch; Fig. 6 is a wiring diagram of the electrical circuits; and Fig. 7 is an elevation of the controller board and mechanism mounted thereon.

Referring to Fig. 1, M designates the hoisting motor herein shown as an alternating current motor of the three-phase type. This motor is connected through the usual worm and worm wheel mechanism contained in the casing 1 to a hoisting drum 2. Cables 4 are wound about this drum and pass up over suitable guide pulleys located at the upper part of the hatchway. These cables are connected to the top of the car C. Other cables 5 are wound about the hoisting drum 2 in a direction opposite to that of the cables 4 and are guided by a laterally movable guiding pulley 3. These cables lead up over suitable guide pulleys located at the upper part of the hatchway and are connected to a counterbalance weight W.

10 designates my improved electro-me-

chanical controlling apparatus which is preferably connected to some movable part of the hoisting apparatus, such as the drum shaft, by a sprocket wheel 7 and sprocket chain 6.

Referring now to Fig. 2, 12 designates a metal frame to which is attached an insulating base 11 preferably of slate or marble, upon which are mounted the various electrical parts. At the upper part of the base 11 are mounted two similar reversing switches 13 and 13', only one of which is shown in Fig. 2 since the other lies directly behind it. These switches comprise a switch arm 14 which is pivoted at 15 to a stationary bracket 16 secured to the base 11. At the upper end of the pivoted switch arm 14 is shown an insulated contact 18, and, while any desired number of such contacts may be carried by the switch arm, in the present instance there are but three. Suitable flexible conductors 19 connect these contacts to corresponding fixed studs 20 mounted upon the base 11. A compression spring 17 bears against a downwardly extending portion of the switch arm 14 and the same tends to swing the arm 14 about its pivot 15, thereby causing the contacts 18 to electrically engage corresponding fixed contacts 63 in alinement therewith.

26 and 25 designate a magnet frame and winding therefor, respectively, which are suitably mounted upon the back of the base 11 and arranged to cooperate with a magnet armature 27 carried by a pivoted lever 22. The latter is pivoted at 21 to the bracket 16 and is adapted to engage a roller 23 carried by the switch arm 14. Since the pivoted lever 22 and connected armature 27 are massive in form and have considerable weight, they will tend to swing downwardly and exert a strong pressure against the roller 23, thereby forcing the switch arm 14 outwardly against the action of the compression spring 17. A stop 64 may be provided to limit the downward movement of the armature lever 22.

Referring now also to the other views, it will be seen that the sprocket wheel 8 which is preferably connected by the sprocket chain 6 to the drum shaft of the hoisting apparatus, as before pointed out, is rigidly connected to a worm 9 and adapted to rotate in a bearing 46 attached to the frame 12. The worm 9 meshes with a worm wheel 110

44 which, together with a spur gear 43, is keyed upon a shaft 45. This gear 43 is in mesh with a smaller gear 41 which, together with a gear 40, is keyed to a shaft 42. A gear 65 is secured to a shaft 34 and is in mesh with two similar gears 36 and 35 which are carried upon pins 37 and 38 secured to the levers 33 and 33', respectively, which are adapted to freely swing about the shaft 34 as a common axis. The gears 36 and 35 are arranged in alinement with the gear 40 and are normally out of mesh therewith. A rod 31 is connected at one end to the lever 33 by a pin 32, the other end of the rod being connected by a pin 30 to a lever 182. This latter is secured by a set screw 79 (Fig. 3) to the rod 29 which is free to rotate in the brackets 64 and 64' mounted upon the back of the insulating base 11. Directly back of the lever 182, as seen in Fig. 2, is a bell crank lever 28 (Fig. 3) which is loosely mounted on the rod 29. One arm of this lever is connected through the rod 31' to the pin 39 upon the swinging lever 33', and the other arm of the lever 28 has a flattened portion 28' which is arranged in vertical alinement with the pivoted armature 27 of the reversing switch 13. A compression spring 52' lies in a recess in the base 11 and bears against the lower arm of the bell crank lever 28, thereby holding the flattened portion 28' in close engagement with the pivoted magnet armature 27. Secured to the rod 29 by a set screw 180 is a lever 181 which has a flat portion 181'. The latter is arranged in vertical alinement with the pivoted magnet armature 27' of the reversing switch 13'. A compression spring 52 bears against the lever 182 and tends to rotate the rod 29 and thereby hold the flat portion 181' against the magnet armature 27'. The gear 65 is connected through a clutch device F to a sprocket wheel 48. This clutch F is shown in section in Fig. 5 and comprises a shaft 34 upon which is keyed the gear wheel 65, and which is arranged to rotate freely in a bearing 12' which may be formed integral with the frame 12, as shown, or may be a separate piece attached thereto. One end of the shaft 34 is provided with a head 34' of larger diameter than the shaft 34 and between which and the gear 65 are located the swinging arms 33 and 33'. On the other side of the frame 12 and upon the shaft 34 is located a loose collar 67, adjacent to which is loosely mounted the sprocket wheel 48 having a friction surface 48' on one face. A corresponding friction element 69 is keyed to the shaft 34, and a compression spring 68 located between the collar 67 and sprocket wheel 48 holds the friction surface of the sprocket wheel in intimate contact with the co-acting friction element 69. A dust cap 62 is secured by screws to the sprocket

wheel 48, and this cap is so shaped with respect to the friction element 69 that it forms therewith a chamber 71 which may be filled with oil, an opening, normally closed by a plug 72, being provided for that purpose. This cap 62 also serves as a protection against the entrance of grit or other substance onto the friction surfaces 48'. Upon rotating the shaft 34 by means of the gear 65, the friction element 69 will be positively driven, while the sprocket wheel 48 will also be driven, due to the frictional engagement between the two, owing to the pressure produced by the spring 68. The sprocket wheel 48 on the clutch device is connected by a sprocket chain 47 to a sprocket wheel 73 keyed to a cam shaft 74 adapted to rotate in bearings 93 and 94. Rigidly secured to the cam shaft 74 at equally distant points are cams 75, 76, 77 and 78 of different face lengths, upon which normally rest cam rollers 80, 80', etc., which are connected to levers for operating corresponding switches 51, 51', etc. These switches are similar in construction and each comprises a switch arm 92 carrying upon its upper end insulated contacts 85 which are connected by suitable flexible cables 83 to studs 84 mounted upon the base 11. The switch arm 92 is pivoted at 89 to a bracket 90 and carries upon it a cam roller 87 pivoted at 88. A compression spring 82 lies in a recess provided in the base 11 and bears against a downwardly extending portion of the switch arm 92. The roller 87 is in contact with a swinging arm 81 pivoted at 91 to the bracket 90 and carrying a cam roller 80. The spring 82 tends to close the switch 51 and at the same time swing the pivoted lever 81 upwardly, but is prevented from doing so by reason of the cam 75 against which the cam roller 80 normally bears. The cam rollers normally bear against substantially the centers of the corresponding cam faces, being held in such position by means of a heavy centering weight 79 which is keyed to the cam shaft 74. Each switch arm such as 92, preferably carries but two movable contacts, although the number of such contacts may be more or less than two if desired.

The operation of the apparatus thus far described is as follows: Upon closing a circuit through the magnet winding 25, the armature 27 and connected lever 22 are lifted, the latter swinging about its pivot 21 and away from the roller 23 carried by the switch arm 14, thereby permitting the spring 17 to close the switch. As soon as the armature 27 is lifted, the bell crank lever 28 is rocked by the compression spring 52 about the pivot rod 29. This movement causes the connecting rod 31' to swing the lever 33' and connected gear 35 about the shaft 34 as a pivot until the gear 35 comes into mesh

with the large spur gear 40. Upon closing the switch 13, the motor and hoisting apparatus are set in motion and the sprocket 8 connected thereto will rotate slowly. This sprocket 8 is now connected through the train of gears and friction clutch F to the sprocket 48 and the same will rotate in one direction or the other, depending on the direction of rotation of the armature of the hoisting motor. Let it be assumed that the sprocket 48 is frictionally driven in a clockwise direction, thereby driving the sprocket 73 in the same direction by means of the chain 47. As the sprocket wheel 73, together with the shaft 74 and cams 75, 76, 77 and 78 carried thereon rotates, the cam 75 is first moved out of engagement with the corresponding cam roller 80. The spring 82 is now able to close the switch 51 and at the same time lift the swinging lever 81 and cam roller 80. As the cam shaft continues to rotate, the cam 76 will run off the cam roller 80' and the switch 51' cooperating therewith will be closed. In a similar manner the switches 51'' and 51''' are operated successively as the cams 77 and 78 are rotated out of engagement with their cam rollers. The sprocket wheel 73 and connected parts have at about this time rotated through an angle of substantially ninety degrees, and the cam shaft 74 has reached its limit of movement in one direction, a stop 97 (Fig. 7) being provided for this purpose. Since the sprocket 73 is now held from further movement in a clockwise direction, and since the sprocket wheel 8 continues to be driven by the hoisting apparatus, the friction clutch F allows a relative movement or slipping between the positively driven gear 65 and the sprocket wheel 48. This slipping continues just so long as the switch 13 remains in its closed position and the hoisting apparatus is in operation. Upon cutting off the current from the solenoid 25, however, the armature 27 and connected pivoted lever 22 swing downwardly, forcing the roller 23 and connected switch arm 14 outwardly against the action of the spring 17, thereby opening the switch and bringing the motor and connected hoisting apparatus to rest. The armature 27 will at the same time depress the bell crank lever 28 against the action of its spring 52', thereby drawing the gear 35 out of mesh with the gear 40, thus allowing the centering weight 79 to turn the cam shaft 74 and cams 75, 76, 77 and 78 back to their original central position as shown on the drawing. The clutch F will rotate backward freely, since it is no longer operatively connected to the hoisting apparatus through the gear 35.

When it is desired to operate the hoisting motor in a reverse direction, current is sent through the solenoid 25', whereupon its plunger 27' will be lifted out of engagement

with the lever 181 to permit the spring 52 to rock the rod 29 and rigidly connected lever 182 so that the connecting rod 31 will swing the gear 36 into mesh with the gear 40. The subsequent operations are in every way similar to those already described, the only difference being that the clutch F will in the present instance be rotated by the hoisting apparatus in a counter-clockwise direction, the chain and sprocket 73 rotating the cam shaft 74 and connected parts in a like direction, the cams operating to effect the closure of the switches 51, 51', etc., in proper order of succession.

Referring to the wiring diagram shown in Fig. 6, *a*, *b* and *c* designate conductors leading from a source of three-phase alternating current supply, and L is a main line switch.

S designates a manual switch in the car C. The reversing switches are shown diagrammatically as a leaf spring carrying a plurality of contacts adapted to engage corresponding fixed contacts arranged to cooperate therewith. The motor M is shown as a three-phase motor with stator windings connected to the terminals 93, the rotor windings being connected through the slip rings 94 to a delta-connected motor starting resistance R.

51, 51', 51'' and 51''' are the mechanically operated switches which serve to short-circuit the starting resistance R in consecutive steps.

Assuming the lever of the car switch S to be moved to the left until it electrically engages the contact 95, a circuit will be established from the main *a'* to the contact 95 of the car switch, wire 96, magnet winding 25 to the main *b'*. The core 27 is now lifted out of engagement with the leaf spring 17 and the latter lifts its insulated contacts carried thereon into electrical engagement with the corresponding fixed contacts arranged directly above. A circuit is closed by the switch 13 to the stator winding terminals 93 of the motor M. At the same time a circuit is closed to the winding B' of the brake and the same is released, thereby allowing the motor M to start at slow speed, the current induced in the rotor winding being limited by the starting resistance R. As soon as the motor starts, the cam shaft 74 begins to rotate, carrying with it the cams 75, 76, 77 and 78. The cam 75 first moves out of engagement with the cam roller 80, allowing the switch 51 to close, thereby short-circuiting a portion of the starting resistance R, followed by an increase in motor speed. As the cam shaft 74 continues to rotate, the cams 76, 77 and 78 successively move out of engagement with their respective cam rollers and leave the latter free so that the corresponding switches 51', 51'' and 51''' will close in proper order and thereby short-circuit the starting resistance R in successive steps, the switch 51''', the

last one to operate, short-circuiting the entire resistance R as well as short-circuiting the rotor winding. The motor is thus run up to full normal speed, operating as an induction motor with short-circuited rotor. Upon bringing the car switch lever back to central position, the motor and brake magnet circuits are both broken at the contacts of switch 13, the brake is applied and the motor and hoisting apparatus come to rest, all parts automatically returning to their initial in-operative positions.

If the car switch lever is moved onto contact 96, the reversing switch 13' will be closed to start the motor in a reverse direction, due to the altered connections of the motor stator, the operation of accelerating to full speed being automatically brought about as before described.

While the system of electrical circuits herein shown and described is adapted to a three-phase alternating current, the same could readily be modified to adapt it to a direct or alternating current of any desired phase. Also, while the electrically operated reversing switches herein shown are preferred over other types of switches, I do not claim as my invention this particular form of switch.

It is obvious that various modifications could readily be made in the apparatus herein shown and described without departing from the spirit and scope of my invention; and for this reason I desire not to be limited to the precise construction and arrangement of parts as shown.

What I claim as new and desire to have protected by Letters Patent of the United States is:—

1. The combination with a switchboard or support, of a series of switch levers mounted thereon, a shaft mounted at the rear of the board, cams carried by the shaft, levers extending through the switchboard and forming operating connections between the

cams and switch levers, and means for rotating the shaft.

2. The combination with a switch board or support, of a series of switches comprising switch levers mounted on the face of said switch board, cam levers extending through the switch board in position for operating the switch levers in one direction, means for operating the switch levers in the reverse direction, a rotary member located at the rear of the switch board, and means carried by said member for operating said cam levers.

3. The combination with an electric motor, of a controller board, a switch lever mounted on the face of the board, means for lifting said lever to closed position, a device for holding said lever in open position, and mechanical means extending from the motor to said device for operating the latter to position to permit the operation of the switch lever to closed position.

4. The combination with a motor, of controlling mechanism therefor, a rotatable shaft, cams carried thereby for operating the controlling mechanism, a train of gearing between the motor and said shaft, means for connecting and disconnecting said gearing, and means for automatically returning the rotatable shaft to initial position when the gearing is disconnected.

5. The combination with a motor, of accelerating means therefor comprising a series of switches, a rotatable shaft, cams carried thereby for effecting the operation of the switches, and mechanical operating connections between the motor and said shaft.

In testimony whereof, I have signed my name to this specification in the presence of two subscribing witnesses.

AUGUST SUNDH.

Witnesses:

CHAS. M. NISSEN,
JAMES D. IVERS.