A. SUNDH.

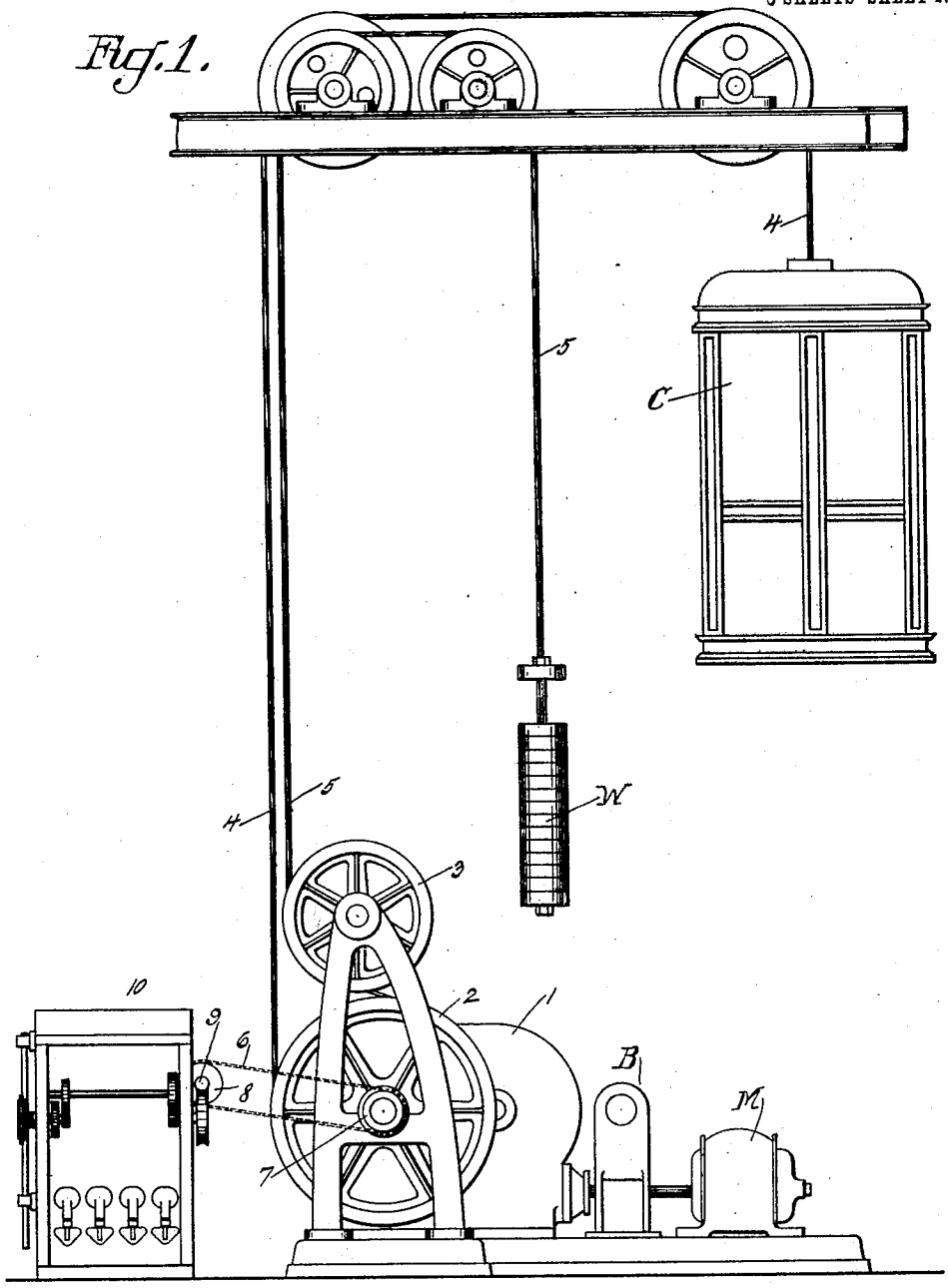
ALTERNATING CURRENT ELECTROMECHANICAL CONTROLLER.

APPLICATION FILED MAY 7, 1908. RENEWED MAY 27, 1912.

1,055,570. Patented Mar. 11, 1913.

5 SHEETS—SHEET 1.

Fig. 1.



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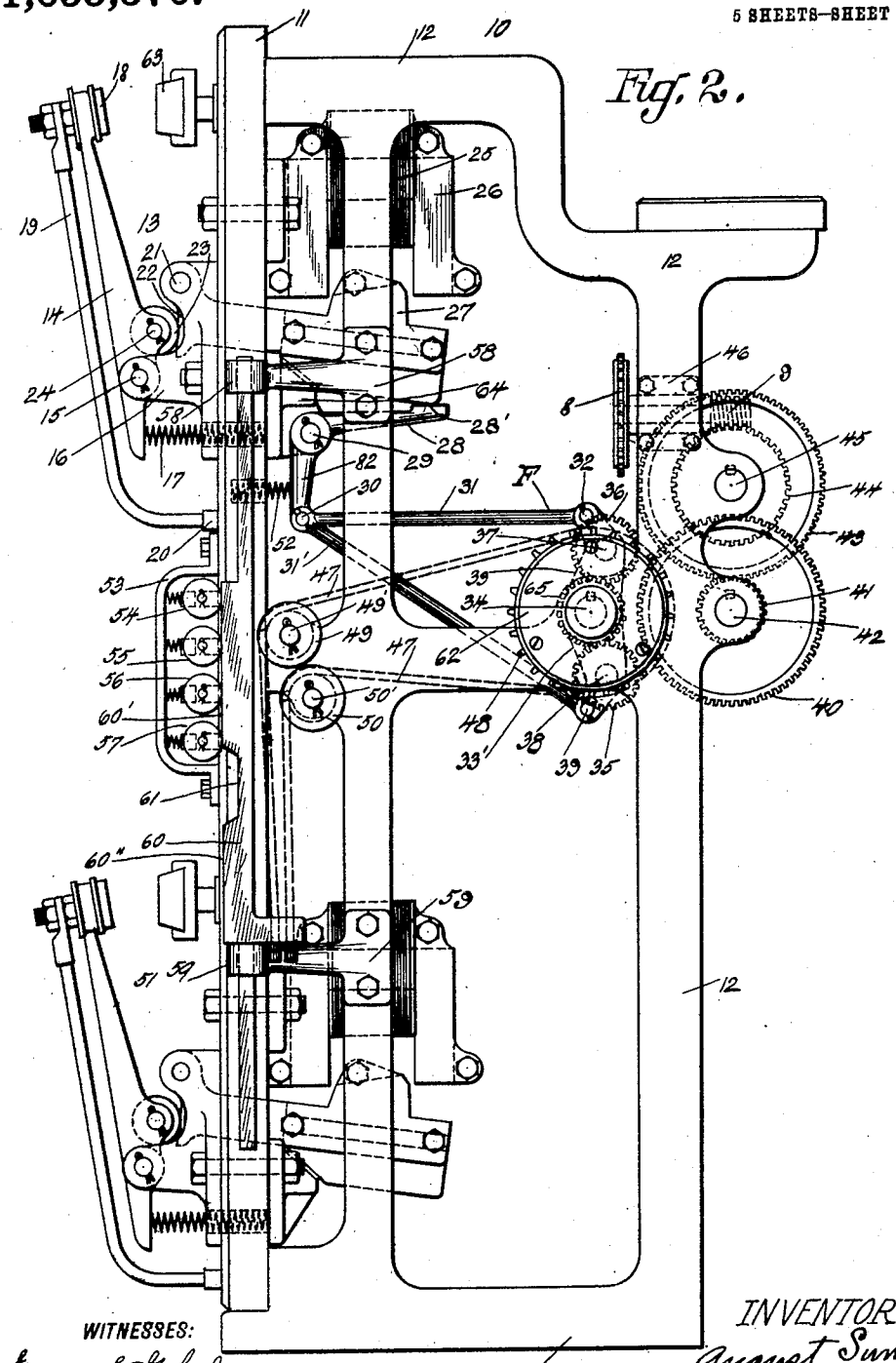
5 SHEETS—SHEET 2.

Fig. 2.



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5 SHEETS—SHEET 3.

Fig. 3.

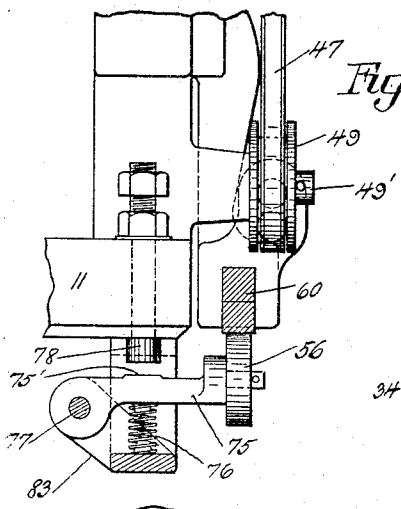


Fig. 5.

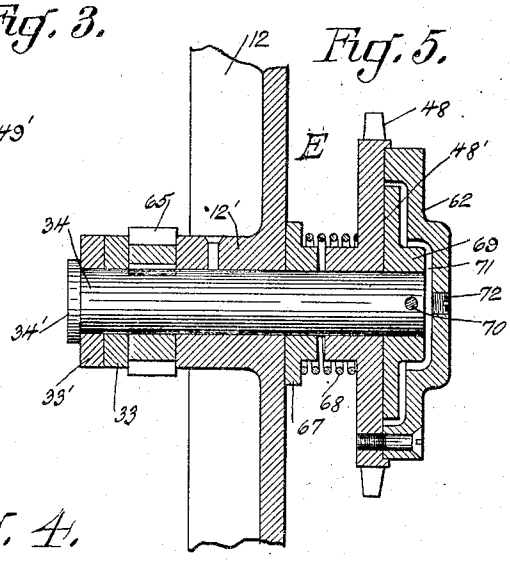


Fig. 4.

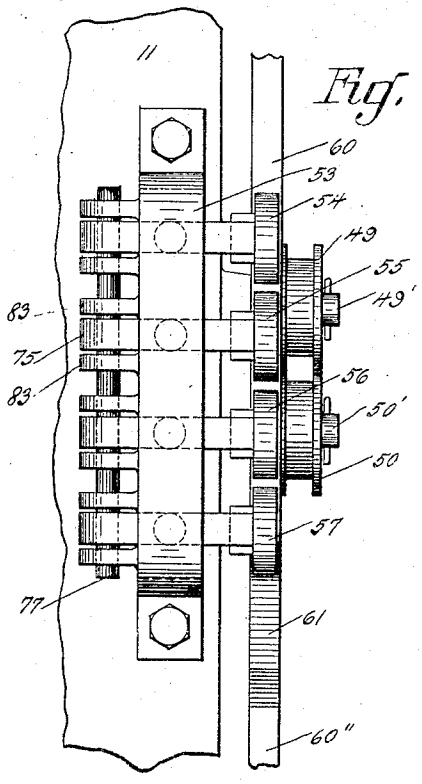
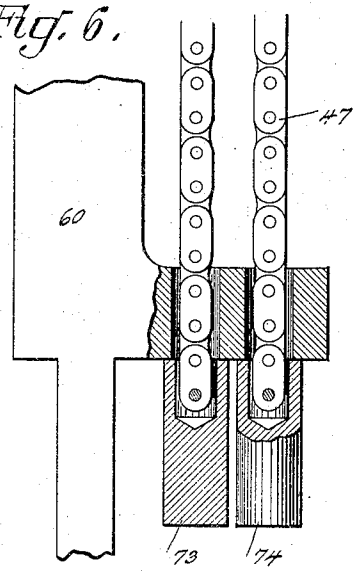


Fig. 6.



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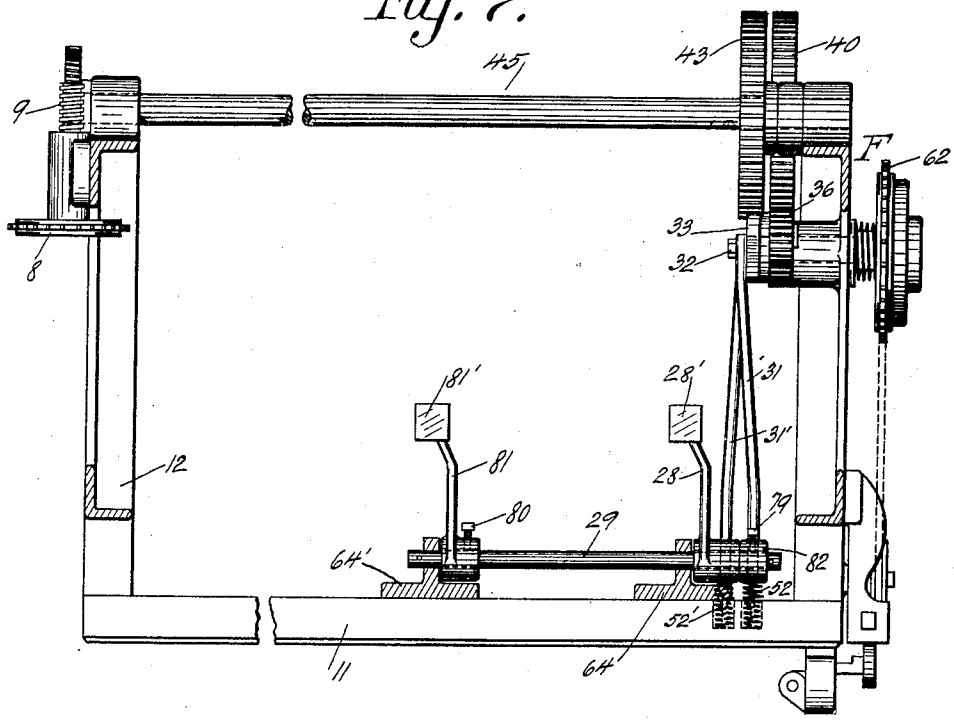
5 SHEETS—SHEET 4.

Fig. 7.



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5 SHEETS—SHEET 5.

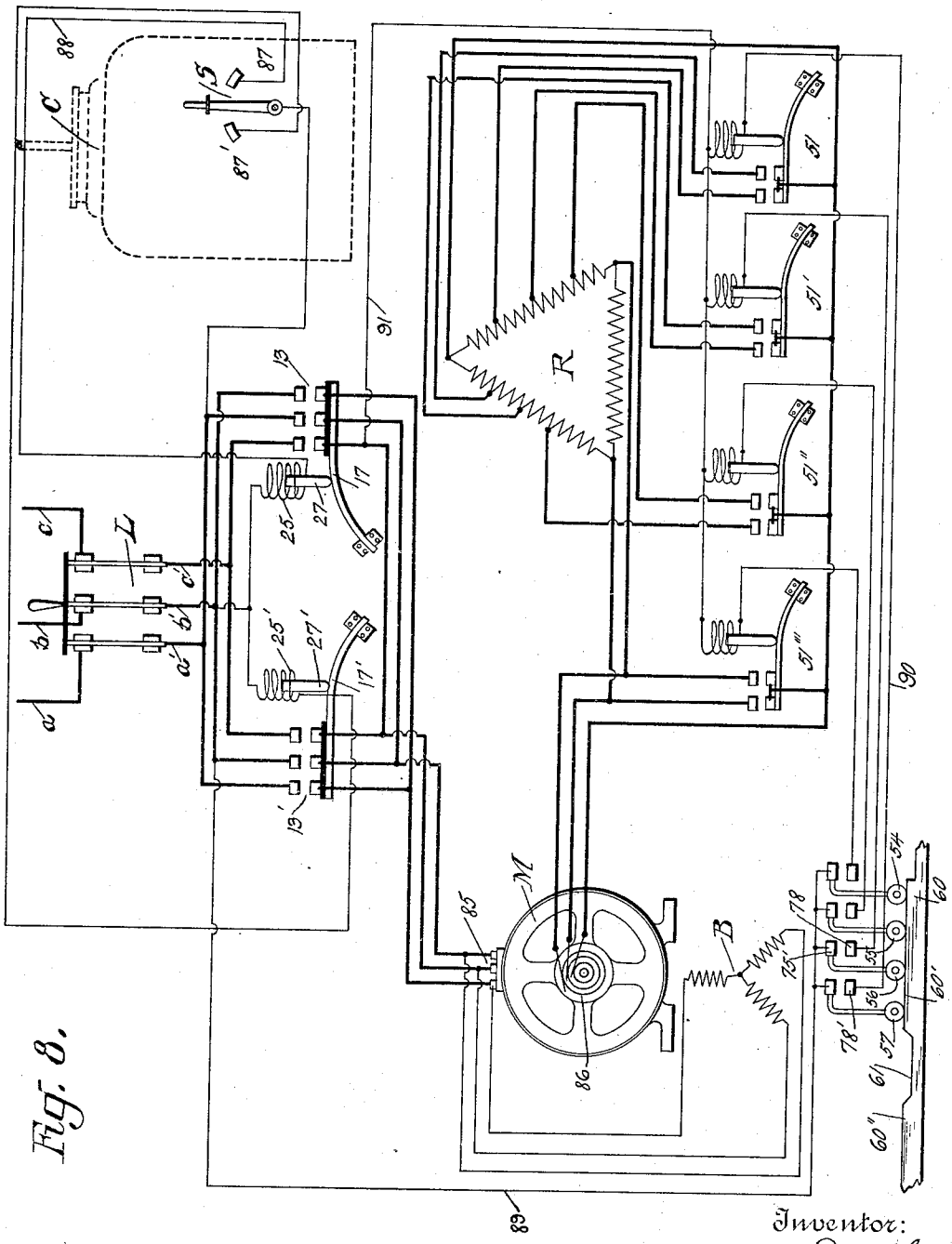

Fig. 8.

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UNITED STATES PATENT OFFICE.

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ALTERNATING-CURRENT ELECTROMECHANICAL CONTROLLER.

1,055,570. Specification of Letters Patent. Patented Mar. 11, 1913.

Application filed May 7, 1908, Serial No. 431,493. Renewed May 27, 1912. Serial No. 700,081.

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.

Generally speaking, my invention comprises means whereby a motor is started, stopped and reversed 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 construction embodying my invention; Figs. 3, 4, 5, 6 and 7 are detail views of various portions of my apparatus; and Fig. 8 is a wiring diagram of the electrical circuits.

Referring to Fig. 1, M designates the hoisting motor, herein shown as an alternating current motor, which 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 extended up over suitable guide pulleys located at the upper part of the hatchway and then 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-mechanical controlling device which is preferably connected to some movable part of the hoisting apparatus, such as the drum shaft, by a sprocket wheel 7 and chain 6.

Referring now to Fig. 2, 12 designates a metal framework to which is attached an insulating base 11, preferably of slate or marble, upon which the various electrical parts are mounted. At the upper part of the insulating base 11 are mounted two similar reversing switches 13 and 13′ (Fig. 8), only one of which is shown in Fig. 2, as 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 (Fig. 8). 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 tends to swing the arm 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 co-act with a magnet armature 27 carried by a lever 22. The latter is pivoted at 21 to the bracket 16 and is adapted to engage the 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 to Figs. 2, 3, 4, 5, 6 and 7, it will be seen that the sprocket wheel 8, which is preferably connected by a sprocket chain to the drum shaft of the hoisting apparatus, as before pointed out in connection with Fig. 1, 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 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 the 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, and the other end of the rod is connected by a pin 30 to a lever 82. This latter is secured by a set screw 79 (Fig. 7) to the rod 29, which is free to rotate in the brackets 64 and 64′ mounted upon the back of the insulated base 11. Directly back of the lever 82 as seen in Fig. 2, is a bell crank lever 28 (Fig. 7) 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′. 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 flat portion 28′ in close engagement with the pivoted magnet armature 27. Secured to the rod 29 by a set screw 80 is a lever 81 having a flat portion 81′ which is arranged in vertical alinement with the pivoted magnet armature 27′ of the reversing switch 13′. A compression spring 52 bears against the lever 82 and tends to rotate the rod 29 and thereby hold the flat portion 81′ against the magnet armature 27′.

The gear 65 is connected through a clutch device F (Fig. 5) 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 65. This shaft is arranged to rotate freely in a bearing 12′ which may be formed integral with the frame 12, as shown, or, if desired, may be a separate piece connected to the frame. 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 which is loosely mounted the sprocket wheel 48 having a friction surface 48′ on one face. A corresponding friction element 69 is securely fastened to the shaft 34 by a pin 70 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 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 cover 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 thereby and the sprocket wheel 48 will also be driven because of the frictional engagement between the two, owing to the pressure produced by the spring 68. The sprocket wheel 48 is provided with a sprocket chain 47 which passes over two guide pulleys 49 and 50 pivoted to the frame 12 at 49′ and 50′, respectively, and the ends of this chain are connected to similar weights 73 and 74.

60 designates a vertically movable cam which is connected to the guides 58 and 59. The lower guide 59 serves as a support for the cam. The portions of the cam 60 which pass through these guides are reduced in size and are preferably square or rectangular in section so as to prevent any turning movement of the cam. The cam 60 comprises two cam faces 60′ and 60″ lying in the same vertical plane, and an intermediate cut-away portion 61. The cam face 60′ is long enough to span the four rollers 54, 55, 56 and 57. The cut-away portion 61 is made long enough to span any two adjacent rollers, while the cam face 60″ is of sufficient length to span but three of the rollers before mentioned. The rear of the cam 60 adjacent the support 59 is extended as shown (see Fig. 6) and is provided with holes through which both ends of the sprocket chain 47 freely pass. The weights 73 and 74 are of somewhat larger diameter than the holes in the cam extension, and the chain 47 is of such length that the weights 73 and 74 are held substantially in contact with the lower side of the cam extension when said extension rests on the support 59.

The cam 60 is arranged to operate a series of similar circuit closing switches which are clearly illustrated in Figs. 3 and 4. In the present instance I show but four of these switches, although any desired number may be used, each switch being adapted to close a circuit to the magnet of a corresponding electrically operated switch which will be described hereinafter. Each of the switches adjacent the cam 60 comprises an insulated roller, such as 56, which may be constructed of wood, fiber, or other suitable material, and is arranged to rotate freely at one end of a switch lever 75. This lever is pivoted on a rod 77 supported by brackets 83 which are formed integral with a supporting frame 53 attached to the insulated base 11. The switch lever 75 has a flattened

contact face 75′ adjacent to which is a fixed contact 78 mounted upon the insulated base 11. A compression spring 76 tends to move the switch lever 75 inwardly and bring the contacts 75′ and 78 together, but the contacts are normally held apart by the cam 60 engaging the roller 56.

The switch 51 (Fig. 8) is one of four similarly electrically operated switches substantially like the reversing switches 13, 13′ mounted upon the upper part of the base 11 excepting as to the number of electrical contacts included. Each switch 51 has by preference but two movable contacts and two corresponding fixed contacts coöperating therewith. The number of electrical contacts may be more or less than two if desired.

The operation of the apparatus above described is as follows: Upon closing a circuit to the magnet winding 25 of the reversing switch 13, the magnet is energized to lift the armature 27 and move the lever 22 away from the roller 23, thereby enabling the spring 17 to close the switch 13. 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 center until the gear 35 meshes with the large gear 40. Upon closing the reversing switch 13, the motor and hoisting apparatus are set in motion and the sprocket 8 connected thereto will slowly rotate. 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 hoisting motor. We will assume that the sprocket 48 is frictionally driven in a clockwise direction as viewed in Fig. 2, in which case the weight 73 will be lifted, carrying with it the cam 60 while the weight 74 will descend, the chain 47 passing freely through the hole in the extension of the cam. As the cam 60 rises, the roller 57 will move off of the cam face 60′, thereby causing the contacts of the connected spring-pressed switch to electrically engage each other and thus effect the energization and operation of the corresponding switch 51. As the cam continues to move upwardly, the next roller 56 passes off of the cam face 60′ and the spring-pressed lever connected thereto is enabled to effect the connection of its contacts, thus effecting the operation of the magnet switch coöperating therewith. Directly after the roller 56 passes off of the cam face 60′, the roller 57 rides up onto the cam face 60″ and the contacts controlled by this roller become separated, thereby breaking the circuit to the magnet winding of the switch 51 and the same becomes deënergized. In this manner each roller of the series is operated successively, the cut-away portion 61 of the cam being of such length that after one roller switch has been closed it is not opened again until after the next roller switch has operated to connect its contacts. The cam reaches its limit of upward movement when the cam proper meets the supporting bracket 58, in which position the rollers 57, 56 and 55 rest on the cam face 60″, the uppermost roller 54 being in the cut-away cam portion 61 so that the switch contacts operated by this roller are the only ones of the series in electrical engagement when the cam is in this position. The cam, having now reached its upper limit of movement, forms a positive stop for the chain 47 and gear wheel 48, so that as the positively driven shaft 34 continues to rotate slipping will take place at the friction surfaces 48′ of the clutch F. This slipping continues so long as the reversing switch 13 remains closed and the hoisting apparatus is in operation. Upon deënergizing the magnet of the reversing switch 13, however, the armature 27 and lever 22 swing downwardly, forcing the roller 23 and connected switch arm 14 outwardly, thus opening the switch and bringing the motor and connected hoisting apparatus to rest. The armature 27 as it falls depresses the bell crank lever 28 against the action of its spring 52′, thereby drawing the gear 35 out of mesh with the gear 40, whereupon the cam 60, due to its weight, will fall, pulling the chain back to the position shown in Fig. 2, with all parts at rest and the switch rollers 57, 56, 55 and 54 once more resting upon the cam face 60′. When it is desired to operate the hoisting motor in a reverse direction, the reversing switch 13′ is energized, in which case its armature upon being lifted out of engagement with the rock arm 81 enables the spring 52 to rock the rod 29 and rigidly connected lever 82 so that the connecting rod 31 will swing the gear 36 into mesh with the gear 40. The subsequent operations will be 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 47 pulling the weight 74 and connected cam upwardly. The roller switches will operate in succession as before to close circuits to the corresponding electrically-operated switches 51, etc.

Referring to the wiring diagram shown in Fig. 8, *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 manually-operated switch in the car C, by means of which either of the reversing switches 13 or 13′ may be operated. A magnet winding 25 or 25′ is adapted to lift a heavy free core or plunger 27 or

27′, thereby allowing a leaf spring under tension to lift a series of contacts carried thereon into electrical engagement with corresponding fixed contacts arranged to cooperate therewith. The motor M is shown as a three-phase motor with stator windings connected to the terminals 85, the rotor windings being connected through the slip rings 86 to a delta-connected motor starting resistance R. 51, 51′, 51″ and 51‴ are electrically-operated switches which serve to short-circuit the starting resistance in consecutive steps.

Assuming the lever of the car switch S to be moved to the right until it electrically engages the contact 87, a circuit is established from the main *a′* to contact 87 of the car switch S, wire 88, magnet winding 25 to the main *b′*. The core 27 is thereupon lifted out of engagement with the leaf spring 17 and the latter lifts the insulated contacts carried thereon into electrical engagement with corresponding fixed contacts directly above and in alinement therewith. A circuit is closed by the switch 13 to the stator winding terminals 85 of the motor M at the same time the brake magnet B is energized and the brake released allowing the motor 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 60 is slowly lifted until the cut-away portion 61 of the cam reaches the roller 57, when the contact connected to said roller engages the fixed contact 78′. This closes a circuit to the winding of switch 51 from the main *b′*, through wires 89 and 90, magnet winding of switch 51, wire 91, and reversing switch 13, to the main *c′*. The switch 51 is thereupon closed to short-circuit a portion of the starting resistance R and allow the motor to run at an increased speed. The roller 56 next permits its switch to close as the cam 60 continues to move, thereby closing a circuit to the magnet winding of switch 51′ which will operate to short-circuit an additional portion of the resistance R, followed by a further increase in motor speed. At about this time the roller 57 rides up onto the cam face 60″ and the circuit to the magnet of switch 51 is opened at the contact 78′. The roller 55 next operates to short-circuit an additional portion of the starting resistance R by energizing the magnet of switch 51″, the magnet switch 51′ being shortly after deënergized. The cam 60 finally reaches its limit of travel with the rollers 57, 56 and 55 resting upon the cam face 60″, the roller 54 alone being in the cut-away cam portion 61 and having its switch closed and the corresponding magnet switch 51‴ energized. This last switch short-circuits the entire starting resistance R so that the motor M runs at full normal speed with short-circuited rotor winding. Upon bringing the car switch lever back to central position, the motor and brake circuits are both interrupted at the contacts of switch 13, the brake is applied and the motor comes to rest, all parts returning to their initial positions. If the car switch lever is moved onto contact 87′ the reversing switch magnet 25′ will be energized and the reversing switch 13′ 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.

The system of electrical circuits herein shown, while particularly adapted to a three-phase alternating current, could readily be changed to suit a direct or intermittent current, or an alternating current of any desired phase, the manner of making such changes to suit different conditions being well known to those skilled in the art, and for this reason does not require any further description.

It is obvious that various modifications could readily be made in the apparatus herein illustrated 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 shown.

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

1. The combination with an electric motor, of starting resistance therefor, electromagnetic switches controlling the circuits of said resistance, and cam mechanism operated by the motor for controlling the operation of said switches.

2. The combination with an electric motor, of a resistance in a circuit of the motor, electro-responsive devices controlling said resistance, and cam mechanism connected for operation to the motor to effect the operation of said devices and thereby effect the control of said resistance.

3. The combination with an electric motor, of a sectional starting resistance therefor, electromagnetic switches in the circuits of said resistance, switches in the circuits of the electromagnets, and a mechanical device geared to the motor for operating said last-named switches.

4. The combination with an electric motor, of a starting resistance therefor, electromagnetic switches controlling said resistance, switches in the circuits of the electromagnets, a device for operating the last-named switches, and mechanical operating connections between said device and the motor.

5. The combination with an electric motor, of a sectional starting resistance therefor, electromagnetic switches controlling the circuits of the starting resistance, switches

in the circuits of the electromagnets, and a device mechanically operated by the motor for successively closing the switches and opening each switch after the succeeding one has been closed.

6. The combination with an electric motor, of starting resistance therefor, switches associated with said resistance, a device for operating the switches, gearing connecting said device and the motor, a reversing switch, and means controlled thereby for connecting and disconnecting said gearing.

7. The combination with a motor, of accelerating mechanism operated by the motor, an electro-magnetic reversing switch, and means mechanically controlled by the reversing switch for effecting the operation of the accelerating mechanism.

8. The combination with a series of electric switches, of a cam movable in contact with the switches and shaped to effect the closing of the switches successively and the opening of each switch after the succeeding switch is closed, means for operating the cam, means for stopping the cam with the last switch of the series in a closed position, and mechanism controlled by the switches.

9. The combination with a plurality of switches, of a cam, a rotatable member, a flexible power-transmitting device passing over said member and having its ends connected to the cam, means for rotating said member, and mechanism controlled by said switches.

10. The combination with a switch, of a cam for operating the switch, a rotatable member, means for rotating said member in either direction, and flexible power-transmitting connections between said rotatable member and said cam device.

11. The combination with a support, of a series of switches mounted thereon, a vertically disposed cam rod, a sprocket wheel, a sprocket chain engaging said wheel and having its ends connected to the cam rod, means for operating the sprocket wheel, and mechanism controlled by the switches.

12. The combination with a series of switches, of a support therefor, a cam rod, guides for limiting the rod to a vertical movement, a sprocket wheel, a sprocket chain passing over said wheel and having its leads slidably connected to the cam rod, stops connected to the chain, means for rotating the sprocket wheel, and mechanism controlled by the switches.

13. The combination with a motor, of a controller board, controlling mechanism mounted thereon, mechanical power-transmitting mechanism extending from the motor to the controlling mechanism, reversing switches, and mechanical means operated by the reversing switch mechanism for connecting or disconnecting said power-transmitting mechanism.

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.

Copies of this patent may be obtained for five cents each, by addressing the "Commissioner of Patents, Washington, D. C."