No. 850,630. PATENTED APR. 16, 1907.

W. N. DICKINSON, JR.

ALTERNATING CURRENT MOTOR CONTROLLING APPARATUS.

APPLICATION FILED JULY 20, 1905.

4 SHEETS—SHEET 1.

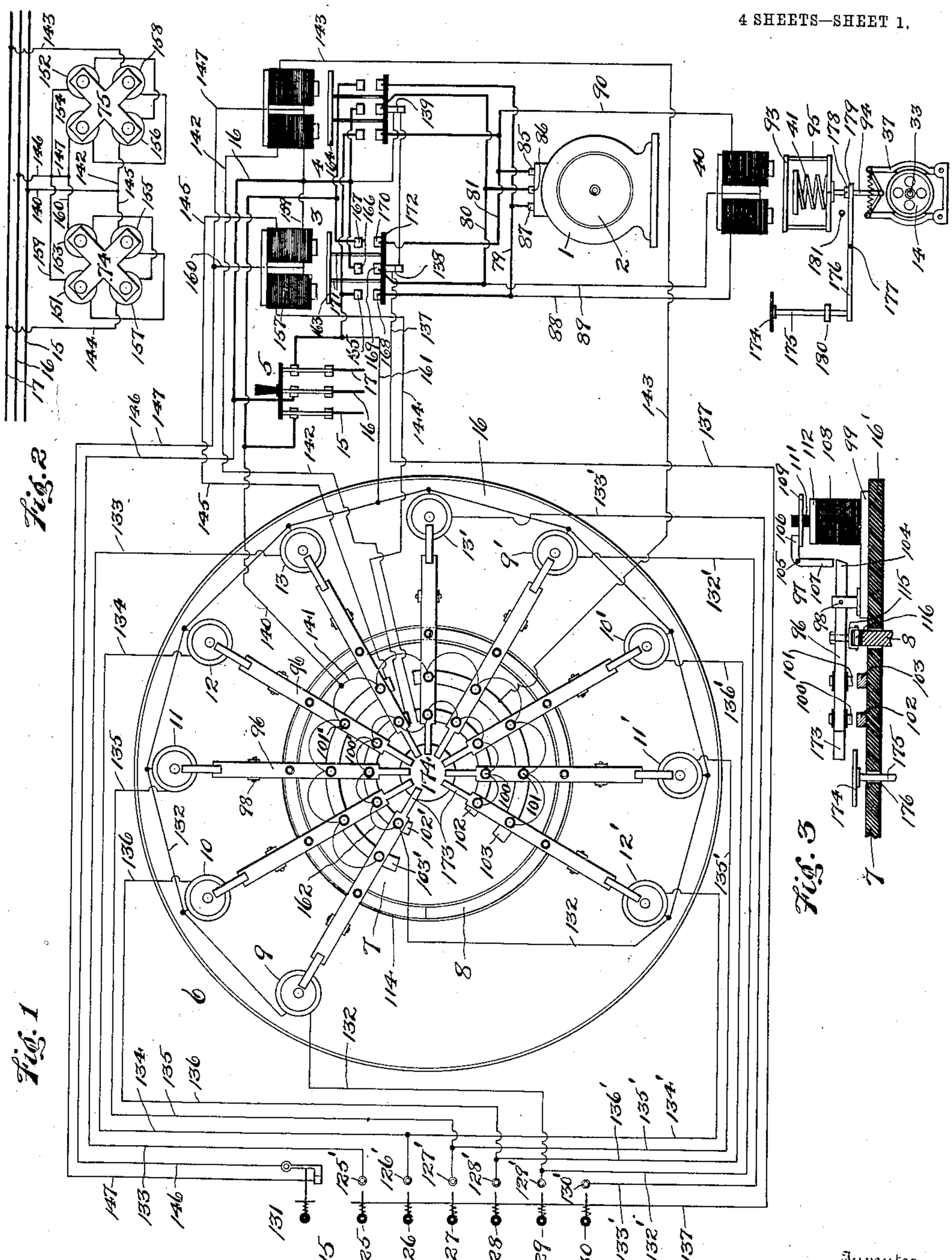

Fig. 1

Fig. 3

Witnesses

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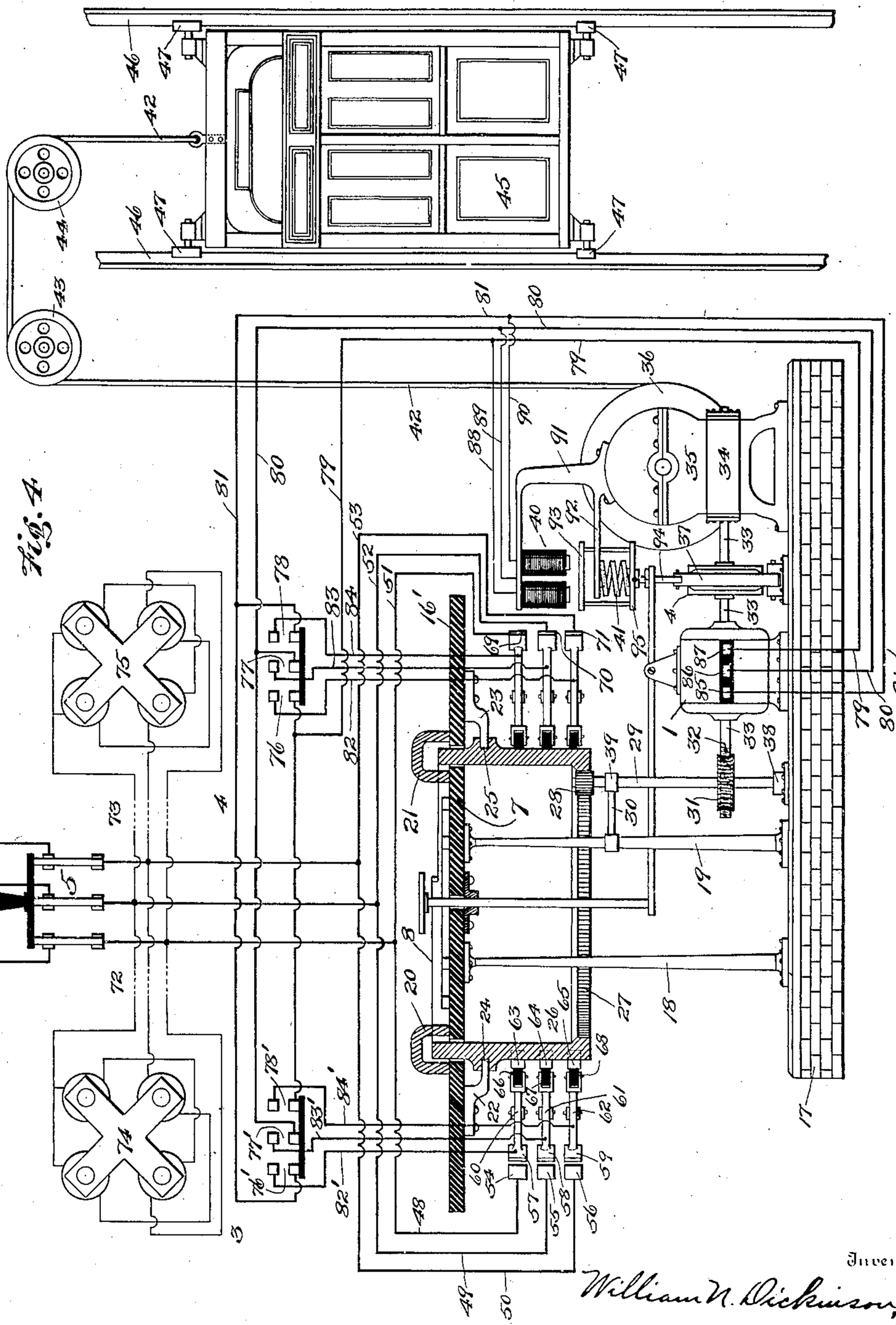

Fig. 4.

Witnesses

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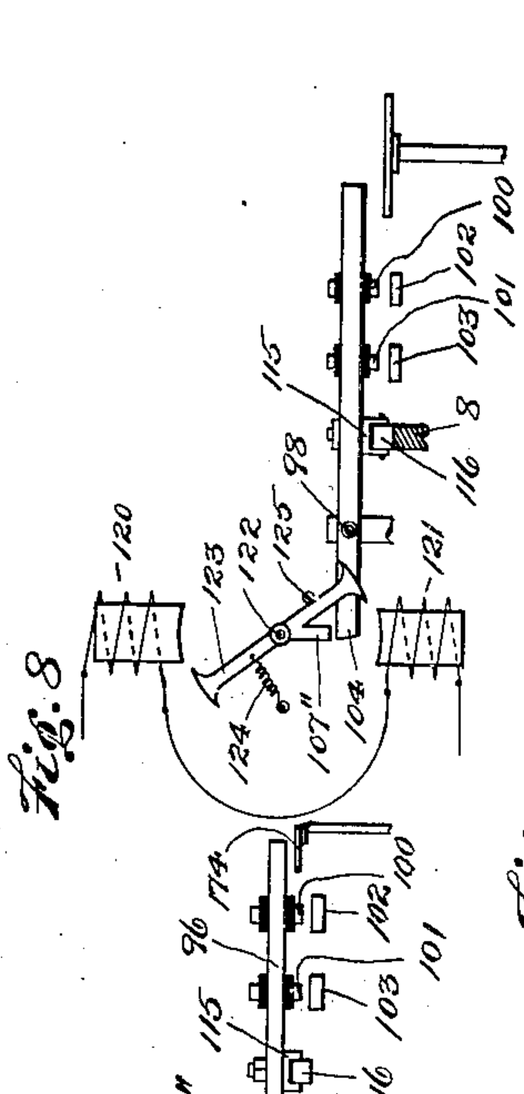

Fig. 8

Fig. 13

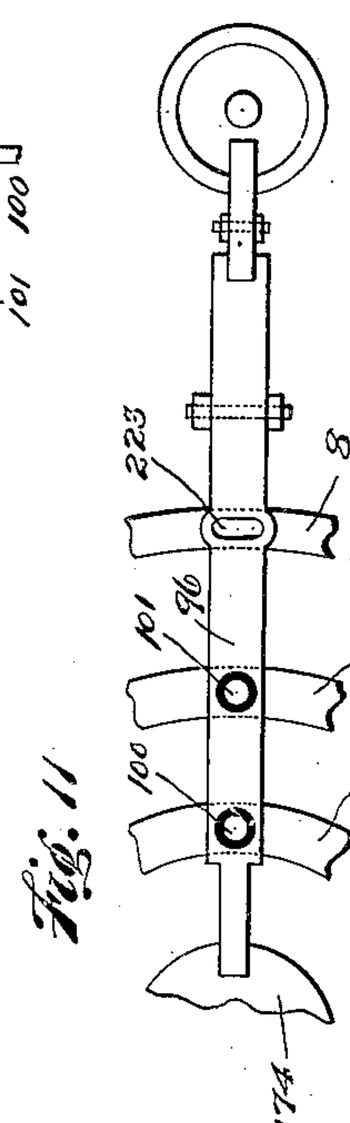

Fig. 11

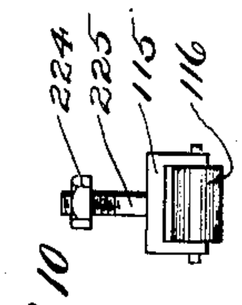

Fig. 10

Fig. 9

Fig. 7

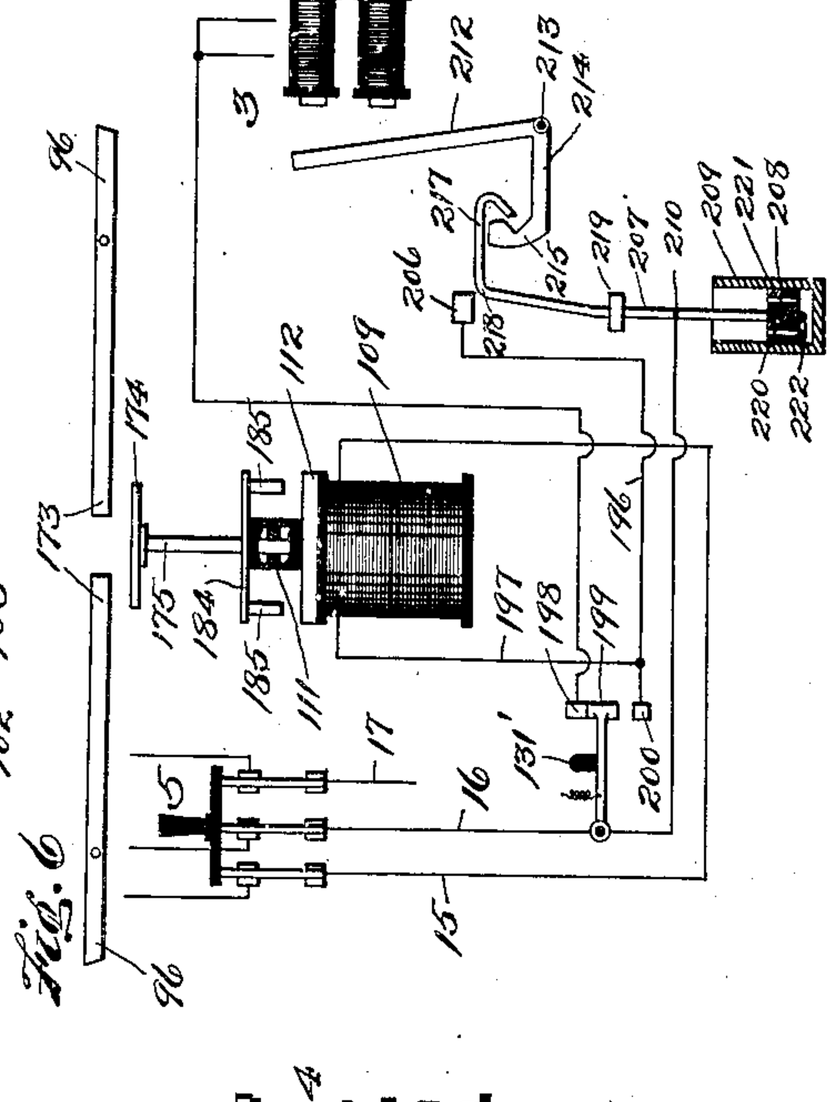

Fig. 6

Fig. 5

Witnesses

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4 SHEETS—SHEET 4.

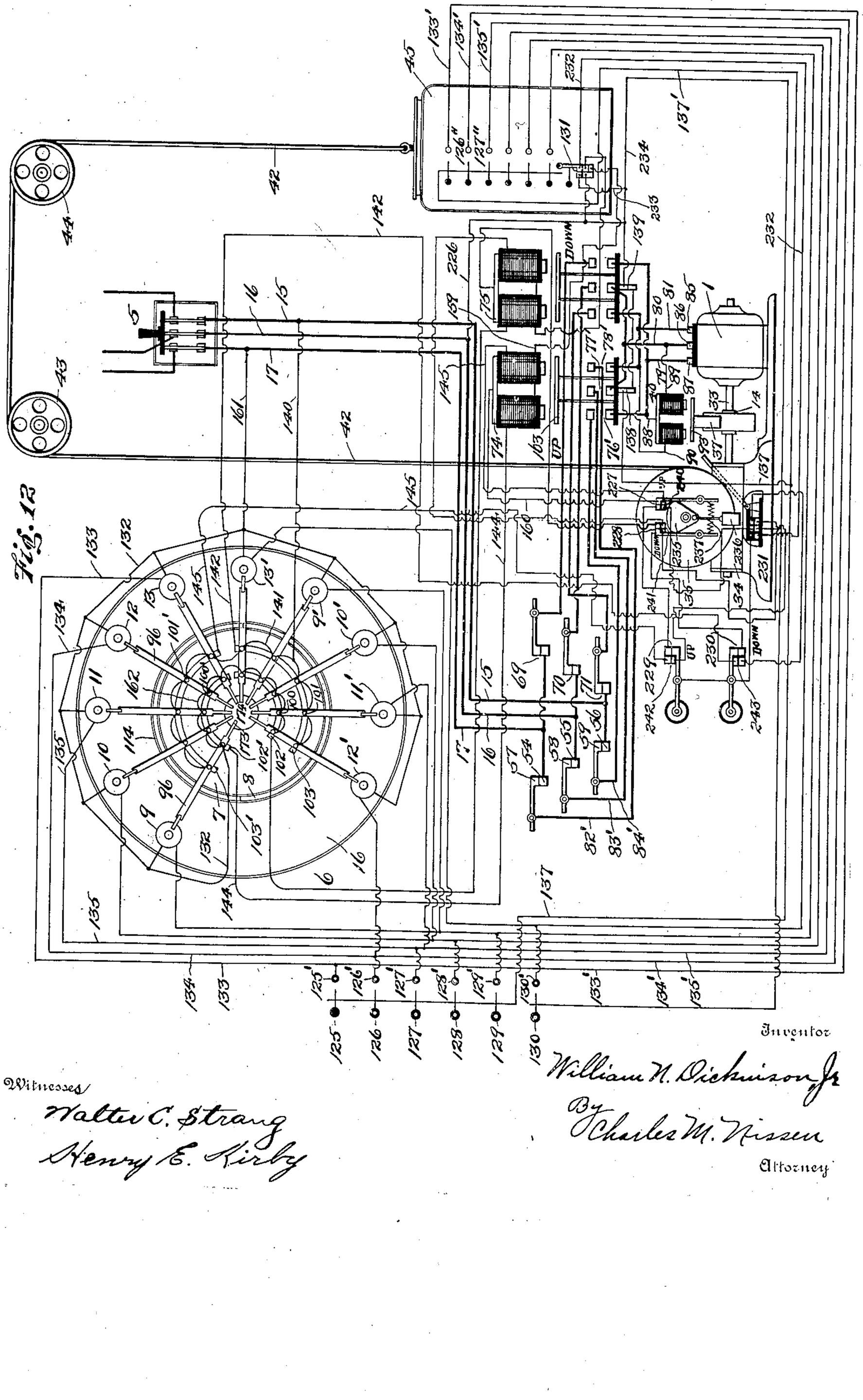

Fig. 12

Witnesses
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UNITED STATES PATENT OFFICE.

WILLIAM N. DICKINSON, JR., OF BROOKLYN, NEW YORK, ASSIGNOR TO OTIS ELEVATOR COMPANY, OF JERSEY CITY, NEW JERSEY, A CORPORATION OF NEW JERSEY.

ALTERNATING-CURRENT-MOTOR-CONTROLLING APPARATUS.

No. 850,630. Specification of Letters Patent. Patented April 16, 1907.

Application filed July 20, 1905. Serial No. 270,460.

To all whom it may concern:

Be it known that I, WILLIAM N. DICKINSON, Jr., a citizen of the United States, residing at Brooklyn, in the county of Kings and State of New York, have invented a new and useful Improvement in Alternating-Current-Motor-Controlling Apparatus, of which the following is a specification.

My invention relates to means for controlling alternating-current motors, and has for its object the provision of improved and efficient means for automatically controlling the operation of alternating-current motors.

A further object of my invention is to provide mechanism for controlling the circuits to the motor such that chattering of the parts, due to the alternating current, shall be reduced to a minimum.

To these and other ends appearing hereinafter my invention consists, substantially, of the construction, combination, location, and relative arrangement of parts, all as more fully set forth in the following description, as shown in the drawings accompanying the specification, and finally pointed out in the appended claims.

Referring to the drawings, Figure 1 represents diagrammatically and partly in plan a system of motor control with my invention included therein. Fig. 2 shows the wiring of the quarter-phase reversing-switch magnets. Fig. 3 is a sectional and elevational detail view of the controller-board shown in circular form in Fig. 1. Fig. 4 shows diagrammatically and partly in elevation my invention applied to an elevator system. Fig. 5 shows means for restoring the elements of the controller-board to normal position. Fig. 6 is a modification of Fig. 5. Fig. 7 shows a modification of the construction shown in Fig. 3. Figs. 8 and 13 are additional modifications thereof. Fig. 9 shows in detail the construction of a repulsion-magnet used on the controller-board in Fig. 1. Fig. 10 shows an antifriction-roller adapted to be engaged by a restoring-cam. Fig. 11 shows means for adjusting the controller-circuit-closing mechanism, and Fig. 12 shows my invention applied to a single-push button-controlled electric elevator system employing an alternating current to drive the hoisting mechanism.

In Fig. 1 the numeral 1 designates an alternating-current motor having a rotor 2, to the shaft of which is secured a brake-pulley 14. 3 and 4 are reversing-switches for the motor, and 5 the main-line switch. 15, 16, and 17 are main lines of a three-wire two-phase system of alternating-current supply. The supply may be two-phase or three-phase current with the system of wiring shown. 6 designates a controlling-board of insulating material. It is shown in plan in Fig. 1, but is intended to be employed in substantially a horizontal position, as shown in Figs. 1 and 4. 15 designates a bank of push-buttons for controlling the operation of the motor in a predetermined manner—as, for example, to stop a dumb-waiter or an elevator-car at predetermined points in its travel.

The controller-board and its appurtenances will now be described. Their construction is most clearly shown in Fig. 4. To the foundation 17 are secured the standards 18 and 19, which support the inner disk 7 of the horizontal controller-board 6. The outer annular part 16′ of the board may be supported in any suitable manner, but is herein shown as rigidly connected with the disk 7 by means of angle-irons 20 and 21. Three or more brackets, two of which, as 22 and 23, are shown in Fig. 4, are secured to the under side of the annular piece 16′. These brackets serve as supporting means for the cylindrical cam 26, the lower inner ends of the brackets fitting in the annular grooves 24 25 on the periphery of the cam-cylinder.

The cylinder 26 extends upwardly through the circular slot 114 in the controller-table 6 and has a portion of its upper end cut away through an arc of about one hundred and eighty degrees. The higher portion extending through this slot operates as a restoring-cam in a manner hereinafter explained. The lower inner side of the cylinder 26 is provided with an annular gear 27, with which meshes a pinion 28. This pinion is secured to the vertical shaft 29, which is supported in the bearing 38 on the foundation 17 and is prevented from moving laterally by the bearing 39 at the end of a rod 30, which is fixed to the standard 19. To the lower end of the shaft 29 is secured a worm-wheel 31, which meshes with a worm 32 on the end of the motor-armature shaft 33. The worm and worm-wheel and the pinion and

gear are so proportioned that the cylindrical cam shall move through about one hundred and eighty degrees while the motor-armature makes a predetermined number of revolutions. Also secured to the motor-armature shaft 33 are the brake-pulley 4 and the hoisting-drum worm in the housing 34. The motor 1, brake 37, housing 35 for the worm-wheel, hoisting-drum 36, brake-magnet 40, and the brake-applying spring 41 are all supported on the foundation 17 in the usual manner. The hoisting-cable 42 passes over sheaves 43 44 to the elevator-car 45 which is provided with the usual guide-shoes 47 to engage the guides 46.

Inasmuch as it is desirable to stop the car automatically if it should run beyond the limits of its travel, I have provided suitable limit-switches adjacent the cylindrical cam 26, to be operated thereby to break the main-line circuits. In Fig. 4 two sets of limit-switches, three in each set, are placed substantially diametrically opposite each other. The limit-switches at the left are designated by the reference-numbers 57, 58, and 59. These switches are suitably pivoted at 60, 61, and 62 and are adapted to engage fixed contact-blocks 54, 55, and 56 at one end and have antifriction insulation-rollers 66, 67, and 68 at the other ends which engage projections 63, 64, and 65, respectively, on the periphery of the cylinder 26. The main-line switch 5 connects the main lines 15, 16, and 17, respectively, with branch circuits 48, 49, and 50 and with the branch circuits 51, 52, and 53 in parallel.

As shown in Fig. 4, the limit-switches 57, 58, and 59 are held open by the cams 63, 64, and 65. These cams are in horizontal alinement with the switch-levers at the right as well as with those at the left, so that when the cylinder 26 has rotated through about one hundred and eighty degrees from the position shown the cams will effect the opening of the contacts 69, 70, and 71. This will cause the last-operated reversing-switch to be restored to normal, and consequently the brake-magnet applied to stop the motor, hoisting mechanism, and car.

For the sake of clearness I have omitted from Fig 4 the push-buttons, controller-board, and circuits and connections therefor shown in Fig. 1. This is indicated by the dotted lines 72 and 73. It is therefore to be understood that when the main-line switch 5 is closed neither of the magnets 74 75 of the reversing-switches 3 4 are energized. Let it be assumed, however, that the proper push-button is operated to close the contacts 76, 77, and 78 of reversing-switch 4. In such case circuits would be closed to the motor 1 as follows: from the mains 15 16 17, to and through the wires 51 52 53, contacts 69 70 71 of the closed limit-switches, wires 82 83 84, contacts 76 77 78 of reversing-switch 4, wires 79 80 81, to the motor-terminals 85 86 87. A parallel circuit is also established through the quarter-phase brake-magnet 40, whereupon the brake will be released and the motor will start. The brake-magnet 40 is shown in this instance as rigidly supported by the bracket 91, attached to the hoisting-mechanism framework. The spring 41 is secured to an extension 92 from this bracket and normally presses downwardly the connections 94 to the brake to apply the same. At the same time it moves downwardly the frame 95, which is rigidly attached to said connection 94. To the upper side of this frame is secured the armature 93 of the brake-magnet. It will now be seen that when the cams 63 64 65 strike the limit-switches at the right the contacts 69, 70, and 71 will be opened and that this operation cuts off the current to the motor and brake-magnet and causes the motor to stop. Between the limits of travel of the cams 63 64 65 both sets of reversing-switches are closed, so that the car may be operated in either direction between its limits of travel. This does not interfere in any way with the car's normal operation, as only one reversing-switch can be operated at a time. It is also to be noted that although the limit-switches are held open the car can again start, as the reversing-switch other than that last operated may be closed to automatically move the car in the opposite direction, as is desired.

In Fig. 1 are shown a series of single-phase magnets 9, 10, 11, 12, 13, 9′, 10′, 11′, 12′, and 13′, mounted on the annular piece of insulation 16 of the controller-table 6. Coacting with each of these magnets is a circuit-closing lever 96 and a tripping device, which are shown in detail in Fig. 3. In each case the lever 96 is pivoted at 98 to the strip 99, which is adjustably attached to the annulus 16′. Near the inner end of the lever 96 are mounted insulated contacts 100 and 101, which are adapted to engage the arc-shaped contact-strips 102 and 103 or 102′ and 103′, respectively, which are fixed to the inner disk 7, as shown in Fig. 1. The outer end 104 of the lever 96 engages with the vertical arm 107 of the bell-crank lever 97, which is pivotally supported at 105. The horizontal arm 106 of the bell-crank lever extends over the magnet-solenoid 108 and has fixed to it a horizontal disk 109, of fiber or other insulating material.

In Fig. 9 a sectional view of the magnet illustrates its construction in detail. A spool 110 of insulation, is provided for the solenoid 109, in the center of which is placed the laminated soft-iron core 113. The spool is extended upwardly at its central portion, so as to have a neck 111 to guide a ring or annulus of copper or other non-magnetic material, but a good conductor of electricity.

This ring 112 is so constructed that it shall have a free movement up and down on the neck 111, and is adapted to strike against the disk 109 when projected upwardly. The disk 109 has a central opening of sufficient size to allow free movement of the disk 109 and a certain tilting of the same.

On the under side of the lever 96, directly over the slot 114, is secured a frame 115, carrying an antifriction-roller 116, which is adapted to be engaged by the semicircular cam 8. When the cam 8 is in the position shown in Fig. 1, the lower five of the levers 96 will be held in the position shown in Fig. 3—that is, the toe 104 of the lever 96 is held out of engagement with the vertical arm 107 of the bell-crank lever 97.

Each of the upper five levers 96, however, are in their releasing positions, and by reason of the inner parts being heavier than the outer parts the toes 104 will be held in frictional engagement with the vertical arms 107. Now when alternating current is sent through the solenoid 108 of any magnet the ring 112, loosely carried thereby, will be suddenly projected upwardly against the disk 109 and tilt the bell-crank lever sufficiently to trip the lever 96, so that its inner end falls by gravity to bring the contacts 100 and 101 into engagement with the contact-strips 102′ and 103′, respectively. It should be particularly noted that after the magnet has once operated the tripping device to bring the circuit-closer to closed position the alternating current is no longer depended upon to maintain the circuit-closer closed. This I deem a distinct advantage of my invention, as all chattering due to pulsating attraction is avoided and the circuit-closer is not held in place by a varying force, which tends to produce sparking or at least uncertain connections.

In alternating-current push-button-controlled elevator systems difficulty has heretofore been experienced in providing a firm contact for the completion of the circuit through the reversing and brake magnets owing to the nature of the alternating current. In this device, however, an absolutely firm contact is obtained, as the contacts completing the circuit are held together by gravity or other means entirely independent of the alternating current itself.

As the cam rotates to the lever which is in its lowermost position it strikes against the roller 116, lifts the lever 96 to open the circuit-closer and restore the parts to normal. The lever 97 is so balanced that when the toe slips under the arm 107 the said lever will swing to its normal position. (Shown in Fig. 3.) In this position of the parts a certain clearance is left between the lower end of the arm 107 and the toe 104 to allow free movement of the arm 107 in swinging back to its normal position and also to allow the same to swing freely when one of the lower magnets is operated and the cam is in the position shown in Fig. 1.

In Fig. 7 I have shown a modification of the tripping mechanism. Instead of a repulsion-magnet, as illustrated in Fig. 3, I employ here an alternating-current attraction-magnet, but still depend upon gravity or other force for maintaining the circuit-closers in closed position. The solenoid 108′ has a laminated or longitudinally-slotted core 113′ and is supported on the base 99′, which is to be secured to annulus 16 of the controller-table. The lever 96 is pivoted at 98′, its outer end or toe 104 being arranged adjacent the lower end of the vertical arm 107′ of the bell-crank lever 97′, which is pivoted at 105′ to a frame 117, preferably of laminated iron. The horizontal arm 106′ is constructed of laminated soft iron and constitutes an armature for the magnet. The vertical arm 107′ may be of non-magnetic material and rigidly fastened to the arm 106′ at 119. The armature 106′ is normally held away from the pole of the magnet by means of the spring 118, the inward movement of the vertical arm 107′ being limited by the stop 119, which in this instance is an extension of the frame 117. In this position of the lever 96 (shown in Fig. 7) the operation of the electromagnetic mechanism has no effect; but when the cam 8 is moved away the toe 104 engages the arm 107′, and then when the armature is attracted the tripping device acts to release the lever 96 and allow the contacts 100 101 to engage the strips 102 103.

Another modification of the tripping mechanism is shown in Fig. 8. Here I employ the principle of the rotary motor. The fields 120 and 121, connected in series, take the place of the solenoids in Figs. 3 and 7. Between the fields and normally out of alinement therewith is a soft-iron armature 123, pivoted at 122, and held by a spring 124 against a stop 125. When the cam 8 is out of engagement with the roller 116, the toe 104 engages the normally vertical arm 107″, which is rigid with the armature 123. Now when alternating current is passed through the field-coils the armature is drawn into alinement with them against the action of the spring 124. This effects a tripping of the lever as the arm 107″ is moved over the toe 104, and consequently the contacts 100 and 101 drop into engagement with the strips 102 and 103, respectively. In Fig. 13 a movable core 238 of a solenoid 108″, resting in the recess 239 of an extension of the base-piece 99″, is adapted to strike against the arm 106″ to trip the lever 96 to circuit-closing position.

The system of circuits connecting the bank of push-buttons 15 with the controlling-magnets will now be described. The number of push-buttons 125 to 130, inclusive, in Fig. 1

is proportional to the number of levers 96, and the push-buttons correspond to the various floors at which a car or carrier hoisted by the motor, as shown in Fig. 4, is desired to be automatically stopped. A safety push-button 131 is also provided. The push-buttons may be arranged, if desired, so that one push-button be placed at each floor.

It will be noticed that the solenoids are electrically connected by means of the wire 132, which is connected to the push-button 129 at one end and to all the insulated contacts 100 at its other end. The push-button contact 129′ is also connected by wire 132′ with the magnet 9′, which is diametrically opposite the magnet 9. The other intermediate push-button contacts are in a similar manner connected to diametrically opposite magnets. The uppermost push-button contact 125′ is, however, connected by wire 133 only to the magnet 13, and the magnet 13′ is connected by wire 133′ with the lowermost push-button contact 130′. The push-button contact 126′ is connected by wire 134 with magnet 12 and by wire 134′ with magnet 12′. The push-button contact 127′ is connected to magnet 11 by wire 135 and to magnet 11′ by wire 135′. So, also, the push-button contact 128′ is connected to magnet 10 by wire 136 and to magnet 10′ by wire 136′. The wire 137 is common to the push-buttons and leads to the normally closed contacts 138 and 139 of the reversing-switches 3 and 4 and thence to the main 16 of the source of alternating-current supply.

From the main 15 a wire 140 leads to a wire 141, which connects together all the insulated contacts 101 on the levers 96. The wires 146 and 147 connect the safety-button 131 with the reversing-switch magnets 74 and 75, herein shown as quarter-phase magnets. Single-phase or three-phase magnets could be used, if desired.

With the aid of Fig. 2 the circuits for the reversing-switch magnets (shown in Fig. 1) may be easily traced. The magnets are shown connected in parallel, as they would be if a push-button were operated and the cam 8 did not keep half of the number of levers 96 from falling. Assuming the push-button 126 to have been operated, a single-phase circuit would be established from main 17 to and through wire 161, wire 132, magnet 12, wire 134, push-button 126, wire 137, contacts 138 and 139, to the main 16. The ring 112 is thereupon thrown upwardly against the disk 109 to effect a tripping of the lever 96. A branch circuit may now be traced from main 17 to and through wires 132 162, contacts 100, strip 102′, wire 144, coil 157, Fig. 2, coil 153, wires 160, 147, and 146, to the main 16. Also a circuit is established from the main 15 through the wires 140 141, contact 101, contact-strip 103′, wire 145, magnet-coils 155 and 151, wire 159, to the main 16. It is therefore seen that the coils 153 157 are connected in a different phase than the coils 155 and 151, and the current in one set lags ninety degrees behind that of the other if the current-supply is two-phase. If the cam 8 were in its opposite position, then the reversing-switch magnet 75 would be energized upon operating push-button 126.

When the magnet 74 is energized, as explained, it will attract its armature 163 and carry the contacts 168, 169, and 170, mounted on the strips of insulation 172, up against the fixed contacts 165 166 167, the said strip being secured to said armature by means of the rods 171. Circuits to the motor will then be established as follows: from main 15 to and through contacts 167 170, wire 81, to motor-terminal 85, from main 16 through contacts 166 169, wire 80, to terminal 86, and from main 17 through contacts 165 168, wire 79, to terminal 87. At the same time the brake-magent 40 is energized by a shunt-circuit comprising the wires 88, 89, and 90, whereupon the brake 37 is released and the current in the motor is free to cause the latter to rotate. At a predetermined point in the travel of the motor, however, as was explained in connection with Fig. 4, the motor is automatically brought to a stop. Wherever the elevator-car happens to be it will be automatically sent to the floor corresponding to the push-button 126 and stop at that floor. In this instance the push-button 126 corresponds to the fifth floor, and the cam 8 is shown in such a position that shows that the car is at its lowermost limit of travel. When the car reaches the second landing, the cam 8 strikes against the roller 116 and lifts the lever 96 corresponding to the magnet 9; but just after it leaves the lowermost landing it releases the lever 96 corresponding to the magnet 13′. When the car leaves the second landing, it releases the lever 96 in alinement with the one it has just lifted. This operation is continued at each floor, but has no effect until the cam 8 strikes the lever which has been dropped by operating the push-button 126. This lever 96 corresponds to that of magnet 12 and when lifted opens the circuits to the reversing-switch magnet 74 at the contacts 100 101 and contact-strips 102 103. The reversing-switch 3 will thereupon be opened to break the main-line circuits to the motor 1 and also to the brake-magnet 40. The brake will therefore be applied and the motor stopped with the car at or near the fifth-floor landing.

It will be seen that when one reversing-switch is operated either the contacts 138 or 139 are opened, which has the effect of preventing interference by manipulation of any of the floor-buttons while the car is running and the reversing-switch is in its upper position. Should it be desired to stop the car at any point in its travel without waiting for it

to travel to its destination, the safety-button 131 is operated. It is apparent from Fig. 2 that when the wires 146 and 147 are disconnected there is no return-wire for the current through the magnets of the reversing-switches, and said magnets therefore become deënergized to allow the circuits to the motor and brake-magnet to become interrupted. Considering at a certain instant of time that the main 16 is the common return, if the wire 146 is interrupted current can no longer pass through the solenoids of the magnet 74 from the mains 15 and 17 and no current can traverse the coils of magnet 75, as the circuits including them are broken at the controlling-board.

Should the safety-button 131 be operated to stop the car before it reaches the floor to which it has been sent, it will be seen that although the motor may be stopped by holding open the safety-button switch-contacts the motor will again start when the said button is released. This is apparent, for the reason that the lever 96 corresponding to the fifth floor is left in its lower position, the cam 8 not having reached it to break the reversing-switch-magnet circuits established thereby. To provide against the car from thus starting up again when not desired, I arrange in proximity to the inner ends 173 of the levers 96 a striking-disk 174 for automatically returning the lever 96 last operated to its circuit-closing position. This disk 174 is secured to the upper end of a vertical rod 175, which passes downwardly through an opening 176 in the center of the disk 7 of the controller-table 6. The lower end of this rod 175 passes through a guide 180 and rests loosely on the outer end of a horizontal lever 176, which is pivoted to a fixed point 177. The inner end 179 of this horizontal lever is arranged in the path of a collar 178, adjustably secured to the brake-rod 94.

A stop 181 is provided to limit the upward movement of the inner end 179 of the lever 176, so that the collar may be a short distance above this lever and out of contact therewith when the brake is released. Upon the application of the brake, however, the collar 178 will be moved quickly downward by the spring 41 and will strike a sudden blow against the lever 176. This force will be transmitted to the rod 175, the effect being that the disk 174 will be forcibly thrown upward against the inner ends 173 of the levers 96 to restore any one which may be in circuit-closing position.

In Fig. 5 is illustrated electrical means for automatically returning a controller-board-circuit-closing lever 96 to its original position. The safety-switch 131′ is here shown as comprising a lever 201, pivoted at 203, and provided with a circuit-closer 199 at its other end, which is adapted to engage the contact 198 or the contact 200. The lever is normally held by the spring 202 in the position shown; but when the button 204 is pressed a circuit is closed from one of the mains, as 15, to the solenoid 109 of the restoring-magnet and through the same to wire 197, contacts 200 199, switch-lever 201 to another main, as 16. In other words, by the operation of the safety-switch the solenoid 109 is connected in one of the phases and will therefore receive single-phase current. As soon as the circuit is closed current is induced in the copper ring 112, lying loosely on top of the magnet, and is repelled in an upward direction, being guided by the spool extension or neck 111. In being thus thrown suddenly upward the ring 185 will strike against the legs 185 of a small table 184, which is preferably composed of fiber or other light and strong material, and force the disk 174 against the inner ends of the levers 96 to restore any one in its closed position to its normal or open position. The disk 174 is rigidly attached to the table 184 by means of the rod 175, which latter is guided in its upward movement by the guides 182 and 183.

If desired, no guides for the rod 175 need be used, but a spider secured to a rod projecting downwardly from the center of the table 184 into the interior of the neck 111. In this case the spider would be continually in contact with the inner wall of said neck, and thus keep the rod 175 in a vertical and central position.

In order to provide an additional safeguard against any lever 96 being left in its closed position when the car stops, I combine automatic circuit-closers with the reversing-switches for the restoring-magnet. To the strip of insulation 172 carrying the movable contacts is connected by the rods 186 187 an additional strip of insulation 188, to which is secured the movable contact 189. The additional strip 188, however, is free to slide up and down on the rods 186 187 and is supported by the springs 190 191, which are retained in place by the adjustable nuts 192 193. Below the movable contact 189 is a fixed contact 195. Normally these contacts are separated, the movable contact being supported by the springs in the position shown in Fig. 5. When a reversing-switch has been operated and is then released, the armature and movable contacts drop until the strip of insulation 172 strikes against the fixed stops 194 and 205. The movable contact 189 is made sufficiently heavy so that it acquires a certain momentum to cause it to continue in its downward movement against the action of the springs 190 and 191 and make a firm contact with the fixed contact-block 195 for a short period of time. A circuit will thus be closed from main 15 to and through solenoid 109, wires 197 196, and

contacts 189 195 to the main 16. It will be noticed that these contacts connected with the reversing-switches are arranged in parallel, so that when either is restored to normal position the controller-restoring magnet will be operated.

It is to be understood that the arrangement shown in Fig. 5 may be substituted for the positive restoring means shown in Fig. 1, retaining the non-interference switches 138 and 139. The positive restoring means operated by the brake mechanism when applied is preferable, however, for in that case if the main-line current is cut off and a floor-switch is left in closed position it will nevertheless be restored, whereas the arrangement shown in Fig. 5 is dependent on the main-line-current supply for its operation. In place of the repulsion restoring-magnets attraction restoring-magnets may be used.

In Fig. 6 is a modification of the electric restoring means for the floor-controlling switches. I have associated with each reversing-switch magnet (only one being shown for the sake of clearness) an armature 212, which is pivoted at 213 and has a horizontal arm 214 secured thereto or integral therewith. The outer end of this horizontal arm is provided with a hook which is adapted to coact with a corresponding hook on the end of a rod 207. This rod is connected to a piston 208 in a dash-pot 209 and is movable through the guide 219. The upper end of this rod is horizontal, and its bend or knee 218 is normally in the proximity of the fixed contact 206. When a reversing-switch is operated, the armature 212 is drawn toward the right and the hook 215 engages the hook 217 to effect an upward movement of the vertical rod 207. The dash-pot is so constructed that the piston may easily be moved upwardly, but is retarded in its downward movement. This may be done in various ways well known to those skilled in the art. In this instance, by way of example, I have shown two openings 220 and 221 in the piston 208, one of said openings being provided with a valve on the under side of the piston to close said opening when the piston moves downwardly. This piston is made somewhat heavy, so that it will restore itself automatically.

The operation of the construction shown in Fig. 6 is as follows: When the reversing-switch last operated is restored to normal, the arm will fall back to normal position against the stop 223. The rod 207 will be retarded in its downward movement by the dash-pot 209. Therefore upon the release of the armature the knee 218 will fly to the left and suddenly make contact with the fixed contact-block 206. The rod 207 may be so constructed at its upper end to have sufficient spring action to bring the contact 206 and knee 218 into engagement momentarily. Although this might in some cases be sufficient to cause the ring 112 to be thrown upwardly to restore the floor-controller switch, it is preferable by reason of high time constants of some magnets, particularly those operated by alternating currents, to allow the circuit to be closed through the solenoid 109 for an appreciable length of time. This is accomplished by the provision of the dash-pot. The circuit closed by the release of the rod 207 is from the main 15 to and through the solenoid 109, wires 197 196, contact 206, knee 218, and rod 207 to point 210, to which is connected the main 16. When the armature is attracted, the knee 218 does not engage with contact 206 in its upward movement.

It will be noticed that the current through the floor-controlling magnets or through the restoring-magnet flows for only a short space of time, avoiding heating of the magnet-coils and also useless consumption of current during the operation of the elevator-car. Furthermore, as the current is on only momentarily either the attraction or the repulsion magnets may be so wound that the applied voltage may be varied widely without interfering with their normal operation. The floor-controller-switch levers may be so nearly balanced that a slight blow from the projected ring is all that would be required to restore said levers to their normal positions. The invention combines in one device both a floor-controller and floor-magnets, making the combination compact, and, furthermore, is so arranged that the operation is absolutely positive in its action.

In the forms outlined the horizontal controller-table would be secured in position at a convenient place either to the hoisting-motor or separate from it on its foundation, preferably the former. On this controller-table are mounted the contact-levers, proportioned in number to the number of landings to be served by the elevator. These levers could be mounted on separate bases so arranged that by a convenient fastening for securing the lever to the controller-table the point at which the elevator would be brought to rest could be adjusted exactly after the elevator-hoisting mechanism and controlling devices were in position, thus making unnecessary any information beforehand relating to the distance between floors other than a general knowledge of the varying heights of the floors.

One form of adjusting means is shown in Fig. 11, in that the position of the cam-roller frame 115 may be varied in position circumferentially in the slot 223 in the lever 96. It is evident that this slot may be made as long as desired to allow different degrees of adjusting—that is, different distances of travel for the cam 8 before it strikes the roller 116 to

lift the contacts 100 and 101 out of engage-gagement with the contact-strips 102 and 103, respectively. From Fig. 10 it is clear that by loosening the nut 224 on the bolt 225 the frame 115 may be shifted from one position to another and then again secured to the lever 96.

Referring now to Fig. 12 a complete single push-button elevator-control system embodying my invention will be described. This may best be done by setting forth its operation, as the connections of nearly all the parts have hereinbefore been explained. Let it therefore be assumed that one of the hall-buttons—say 126—corresponding to the fifth floor, is operated. A circuit will thereupon be closed through the fifth-floor-controlling magnets 12 and 12′ in parallel; but only the magnet 12 will be effective in releasing its floor-controlling switch-lever 96, as the other lever is held in its lifted position by the cam 8, this cam being in such position that the car is at the lowermost landing. The circuit closed by the operation of the button 126 may be traced as follows: from main 17 to wire 132 and through magnets 12 and 12′ in parallel to switch-contact 126′, button-contact 126, wire 137, non-interference contacts 138 and 139, wire 226 to another main 16. The magnet 12 will thereupon operate its tripping mechanism and release its floor-controlling switch to closed position. A current will now be established through the "up" reversing-switch magnet as follows: from main 17 by wires 161 and 132 to wire 162, contact 100′, contact-strip 102′, wire 144 to magnet 74, wire 160, limit-switches 227 229, slack-cable switch 231, wire 232, safety-switch 131, wires 233 234 226 to the main 16; also, from main 15 by wire 140 to and through wire 141, contact 101′, strip 103′, wire 145, limit-switches 242 and 240, other coils of magnet 74, (see Fig. 2,) wire 159 to the main 16. The armature 163 and contacts carried thereby will now be lifted to close the circuits to the motor. In doing so the contacts 138 are separated, de-energizing not only the hall-switches and car-switches, but also the controller-magnets 12 12′. So long as the up reversing-switch is in closed position, therefore, the operation on any push-button will not interfere with the travel of the car.

The circuits established to the motor 1 are as follows: from main 15 to floor-controller limit-switch contact 56 and lever 59, wire 84′, contacts 76′, wire 79 to motor-terminal 87, from main 16 to contact 55, lever 58, wire 83′, contacts 77′, wire 80 to terminal 86, and from main 17 to contact 54, lever 57, wire 82′, contacts 78′, wire 81 to the motor-terminal 85. Preferably the rotor is connected in circuit with sectional resistance, which is gradually cut out as the motor increases in speed, or the motor may be so constructed as to start as a repulsion-motor, and therefore with a large torque and after acquiring a certain speed be automatically changed to an ordinary lag induction-motor. The form of motor and the various ways of starting the same are specifically no part of my invention, and I deem is unnecessary to illustrate any such devices.

When the up reversing-switch is closed, circuits are also closed through the brake-magnet 40 through wires 88, 89, and 90, whereupon the brake 37 will be released and the motor will start in such direction as to cause the car to ascend.

If the car should travel upwardly to its limit of travel, a traveling nut on an extension of the hoisting-drum shaft would operate the cam 235 to open one of the limit-switches 227. When the car again descends, the weight 236 would restore the cam to normal position and the compression-spring 237 would effect a closure of the opened switch. Should the car run beyond the limits of its travel, the car itself would open one of the additional limit-switches 229 242 or 230 243 in the hatchway. In either case a circuit, including the coils of the reversing-switch magnet 74, would be broken, whereupon the switch would drop to open position. In a similar manner the reversing-switch would be opened when the cable becomes so slack as to open the slack-cable switches 231. The effect of the opening of the reversing-switch is of course the cutting off of the current to the motor, the application of the brake, and the stopping of the motor.

Additional switches are mounted adjacent the floor-controller-cam cylinder to be operated by cams secured to said cylinder when the car runs beyond the desired limits of travel, the result being the breaking of the main lines to the reversing-switch just operated. If desired, these switches may be operated to stop the car at the limits of its travel.

After the car has been started, as stated, by the operation of the button 126 the cam 8 will be rotated until it arrives at the lever corresponding to the fifth floor, when said lever will be lifted and the contacts 100 and 101 disengaged from the strips 102 and 103. This will cut off the current to the reversing-switch magnet 74 and cause the stopping of the car at the desired landing. At this time the cam has lifted the lever 96 adjacent magnet 12, but has not released that adjacent magnet 12′, so that upon further manipulation of the button 126, although both magnets 12 and 12′ are energized, no effect is produced. Upon operation of the button 125 the car may travel to the sixth or top floor, but can go no farther. The cam 8 will then hold the upper five levers in normal position and only the lower magnets—viz., 9′,

10′, 11′, 12′, and 13′—will be operative when energized to operate the lever-tripping devices. Upon the operation of the button 126 again the car would travel back to the fifth floor and stop there or it would travel to any other desired floor and automatically stop there, depending upon which button is operated.

It will be noticed that the car is provided with a bank of push-buttons corresponding to the hall-buttons and connected in parallel with them—for instance, the operation of the button 126″ in the car would have the same effect as the hall-button 126. If the safety-button 131 in the car should be operated so that the car would be stopped between floors, it may be returned to a lower floor or continued to another floor. For example, if the car should stop between the fourth and fifth floors and the restoring-table 174 operated to bring back the lever 96 opposite magnet 12 to its original position the cam 8 will have released the lever 96 opposite magnet 11′. Consequently if the fourth-floor button 127″ in the car be operated the magnet 11′ would be effective in operating its tripping device and causing the "down" reversing-switch to be operated and the motor revolved in reverse direction to return the car. The cam 8 will again lift the lever of magnet 11′ as soon as the car reaches the fourth floor, where it would be stopped.

Without limiting myself to the precise construction of the details and arrangement of parts, what I claim, and desire to secure by Letters Patent of the United States, is—

1. The combination with an electric motor, of a repulsion electroresponsive device, and motor-controlling means dependent upon a brief action of said electroresponsive device for effecting the operation of said motor.

2. The combination with a motor, of repulsion-magnets, and means set into operation by an initial energization of short duration of one of said repulsion-magnets for controlling said motor.

3. The combination with an alternating-current motor, of repulsion-magnets, and means controlled by an initial energization of short duration of any one of said repulsion-magnets for operating said motor.

4. The combination with a motor, controlling means therefor, and a repulsion electroresponsive device operated by momentary current to control a single-phase circuit to said motor-controlling means.

5. The combination with an alternating-current motor, controlling means therefor, and single-phase repulsion-magnets set into action by brief currents for operating said controlling means.

6. The combination with a multiphase motor, of controlling means therefor, a repulsion-magnet, and means in a circuit connected across any two of the mains of said motor and controlled by said magnet for closing circuits to said motor-controlling means.

7. The combination with an alternating-current motor, of controlling means therefor, a repulsion electroresponsive device connected in a single-phase circuit to mains of said motor, and means for closing a circuit to said electroresponsive device to effect the operation of said controlling means.

8. The combination with a motor, of a controller-board, repulsion-magnets mounted on said controller-board, and means operated by said repulsion-magnets for effecting the closure of the motor-circuit and the maintaining of same in firmly-closed position to control said motor.

9. The combination with a motor, of reversing-switches therefor, repulsion-magnets, and means controlled by said repulsion-magnets for closing circuits to said reversing-switches.

10. The combination with a motor, of controlling means therefor, circuits and connections for said controlling means, a circuit-closer normally in open positon, a repulsion-magnet, and means operated by said repulsion-magnet to effect a closure of said circuit-closer and the operation of said motor.

11. The combination with a motor, of motor-controlling means, a normally open circuit-closer, a tripping device, an electromagnet for operating said tripping device to effect the closure of said circuit-closer by gravity, circuits and connections between said circuit-closer and motor-controlling means, and means independent of current being maintained in the main line for automatically restoring said circuit-closer to normal position.

12. The combination with a motor, of reversing-switches, a controller-board, a plurality of repulsion-electromagnets on said controller-board, a plurality of normally open circuit-closers on said board, a plurality of tripping devices operable by said electromagnets to effect the automatic closure of said circuit-closers, and circuits and connections for starting the motor upon the closure of any one circuit-closer.

13. The combination with a motor, of motor-controlling means, a circular board, a series of radially-arranged circuit-closers, tripping devices normally holding said circuit-closers in open position, a series of circularly-arranged electromagnets for operating said tripping devices to release said circuit-closers to closed position, and circuits and connections between said circuit-closers and said motor-controlling means.

14. The combination with a motor, of motor-controlling means, a circuit-closer, means for normally holding said circuit-closer in open position, an electromagnet for actuating said holding means to release said cir-

cuit-closer, circuits and connections between said circuit-closer and said motor-controlling means, and means independent of current being maintained in the main line for automatically restoring said circuit-closer to normal position.

15. The combination with an alternating-current motor, of motor-controlling means, a circuit-closer, means for normally holding said circuit-closer in open position, a repulsion-electromagnet for actuating said holding means to release said circuit-closer, circuits and connections between said circuit-closer and said motor-controlling means, and mechanical means for automatically restoring said circuit-closer to normal position.

16. The combination with a motor, of motor-controlling means, a circuit-closer, means for normally holding said circuit-closer in open position, an electromagnet for actuating said holding means to release said circuit-closer, circuits and connections between said circuit-closer and said motor-controlling means, and means for automatically restoring said circuit-closer to normal position upon the stopping of the motor.

17. The combination with a motor, of reversing-switches therefor, brake mechanism, a circuit-closer, means for normally holding said circuit-closer in open position, means for tripping said holding means to effect the closure of said circuit-closer, circuits and connections between said circuit-closer and said reversing-switches, and means actuated by said brake mechanism to restore said circuit-closer to normal position when said brake mechanism operates to stop the motor.

18. The combination with a motor, of reversing-switches for said motor; multiphase circuits for said reversing-switches, circuit-closers, and single-phase magnets for operating said circuit-closers to close said multiphase circuits.

19. The combination with an alternating-current motor, of reversing-switches, circuit-closers, single-phase repulsion-magnets for effecting the operation of said circuit-closers, and circuits and connections between said circuit-closers and said reversing-switches.

20. The combination with a polyphase motor, of reversing-switches, circuit-closers, single-phase electromagnets for effecting the closure of said circuit-closers, and multiphase circuits and connections for said circuit-closers and the reversing-switches.

21. The combination with a motor, of motor-controlling means, a circuit-closing lever, means for holding said lever normally in open position, an electromagnet for operating said holding means to effect the closure of the circuits controlled by said circuit-closing lever, and a cam for automatically restoring said lever to normal position at will.

22. The combination with a motor; of motor-controlling means; a plurality of radially-arranged circuit-closing levers; means for normally holding said levers in open position, a plurality of circularly-arranged electromagnets for operating said holding means to trip said levers to closed position; circuits and connections for said motor-controlling means, said circuit-closing levers; and said tripping-electromagnets, and an arc-shaped cam for restoring said levers and holding means to normal position.

23. The combination with a polyphase motor, of motor-controlling means, radially-arranged circuit-closing levers, means for normally holding said levers in open position, electromagnets for operating said holding means to trip said levers to closed position, multiphase circuits and connections for said reversing-switches, single-phase circuits and connections for said electromagnets, and an arc-shaped cam for restoring said levers to normal position.

24. The combination with a motor, of motor-controlling means, a table provided with a circular slot dividing said table into an inner disk and an outer annulus, a plurality of arc-shaped contact-strips mounted on the disk, a plurality of radially-arranged levers, contacts carried by said levers to coöperate with said contact-strips, means for normally holding said levers in raised position with their contacts out of engagement with the contact-strips, a plurality of circularly-arranged electromagnets for operating said holding means to trip said levers and effect the engagement of said contacts and strips, circuits and connections for the aforementioned elements, and an arc-shaped cam movable in said circular slot for restoring said levers and holding means to normal position.

25. The combination with a motor, of motor-controlling means, a plurality of circuit-closers, means for normally holding said circuit-closers in open position, electromagnets for actuating said holding means to effect the closure of said circuit-closers, circuits and connections between said circuit-closers and motor-controlling means, brake mechanism, and means operable by said brake mechanism for positively actuating said circuit-closers to restore the same to normal position.

26. The combination with a motor, of motor-controlling means, circuit-closing levers, circuits and connections between said levers and said motor-controlling means, means for holding said levers in open position, electromagnets for releasing said holding means, brake mechanism and means coacting with said brake mechanism for restoring said levers to open position.

27. The combination with a motor, of controlling means therefor, a table, a plurality of radially-arranged circuit-closing levers mounted on said table, circuits and connec-

tions for said motor-controlling means and said levers, means for holding said levers in open position, electromagnets for releasing said holding means, means extending through an opening in said table for positively actuating the inner ends of said levers to restore the same to open position, brake mechanism, and connections between said restoring means and said brake mechanism.

28. The combination with an alternating-current motor, of motor-controlling means, a plurality of circuit-closers, means for holding said circuit-closers in open position, single-phase electromagnets for releasing said holding means, and circuits and connections between said circuit-closers and said motor-controlling means, and means coacting with said circuits and connections permitting the closure of only one circuit-closer at a time.

29. The combination with a polyphase motor, of motor-controlling means, a plurality of circuit-closers, means for holding said circuit-closers in open position, single-phase electromagnets for releasing said holding means, circuits and connections, means coacting with said circuits and connections for permitting the closure of only one circuit-closer at a time, brake mechanism for the motor, and means coacting with said brake mechanism for automatically restoring the closed circuit-closer to open position.

30. The combination with a motor, of motor-controlling means, a plurality of radially-arranged circuit-closing levers, electromagnetic mechanism for effecting a closure of the circuits controlled by said levers, circuits and connections between said levers and motor-controlling means, means for preventing the operation of more than one circuit-closing lever at a time to closed position, and adjustable means for restoring the operated lever after the motor has made a predetermined number of revolutions.

31. The combination with a motor, of motor-controlling means, a plurality of circuit-closers, electromagnetic mechanism for operating said circuit-closers, circuits and connections between said circuit-closers and said motor-controlling means, means coacting with said circuits and connections for permitting the closure of only one circuit-closer at a time, means for restoring the closed circuit-closer upon the motor completing a predetermined number of revolutions, and means for adjusting said restoring means to vary said number of revolutions.

32. The combination with a motor, of controlling means therefor, main-line circuits and connections for said motor-controlling means, a cylinder rotatably and positively connected to the motor-shaft, limit-switches in said main-line circuits, and cams carried by said cylinder to open said switches to stop the motor after the same has made a predetermined number of revolutions.

33. The combination with an alternating-current motor, of motor-controlling means, polyphase circuits for said motor-controlling means, and circuits and connections of a single push-button-controlled elevator system comprising a floor-controller and single-phase magnets for operating the same.

34. The combination with a multiphase motor; of motor-controlling means; multiphase circuits for said motor-controlling means; and circuits and connections of an automatic push-button-controlled elevator system comprising single-phase magnets corresponding to the various floors, and a floor-controller.

35. The combination with a car and its motor, of motor-controlling means, a floor-controller, and means controlled from the car or from a landing and operated by current of short duration for setting said floor-controller, so that the car shall automatically stop at a predetermined point in its travel.

36. The combination with a car, of hoisting mechanism therefor, a motor for operating said hoisting mechanism, motor-controlling means, a floor-controller, means operated by current of short duration for setting and locking said floor-controller from a distant point, and circuits and connections for effecting the starting of said motor upon the setting of said floor-controller, and means for restoring said floor-controller to normal upon the car reaching the selected point in its travel.

37. The combination with a car and its motor, of motor-controlling means, a floor-controller, circuits and connections of an automatic push-button-controlled elevator system for effecting the setting of the floor-controller upon the operation of one of the push-buttons, means for preventing interference by any floor push-button after one button has been operated, and means for automatically restoring said floor-controller to normal upon the car reaching the selected floor.

38. The combination with a car and its motor, of reversing-switches for said motor, a floor-controller comprising repulsion-electromagnets, circuits and connections for said floor-controller, and means coacting with said reversing-switches for rendering said repulsion-magnets inoperative.

39. The combination with a car and its motor, of motor-controlling means, a floor-controller comprising single-phase repulsion-electromagnets, circuits and connections of an automatic push-button-controlled elevator system including said floor-controller, and means coacting with said motor-controlling means for preventing a circuit from being completed through any of said electromagnets during the operation of the motor.

40. The combination with a car, of a multiphase motor, reversing-switches for said motor, multiphase circuits for said motor

and reversing-switches, limit-switches, means for operating said limit-switches to effect the automatic stopping of the car at the limits of its travel, a floor-controller comprising single-phase repulsion-electromagnets, circuits and connections of an automatic push-button-controlled elevator system including said floor-controller, means coacting with said reversing-switches for rendering said repulsion-magnets inoperative during the travel of the car, and means for automatically restoring said floor-controller to normal upon the car arriving at the selected floor.

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

WILLIAM N. DICKINSON, JR.

Witnesses:

CHARLES M. NISSEN,

RAYMOND W. CHARLES.