No. 689,683. Patented Dec. 24, 1901.

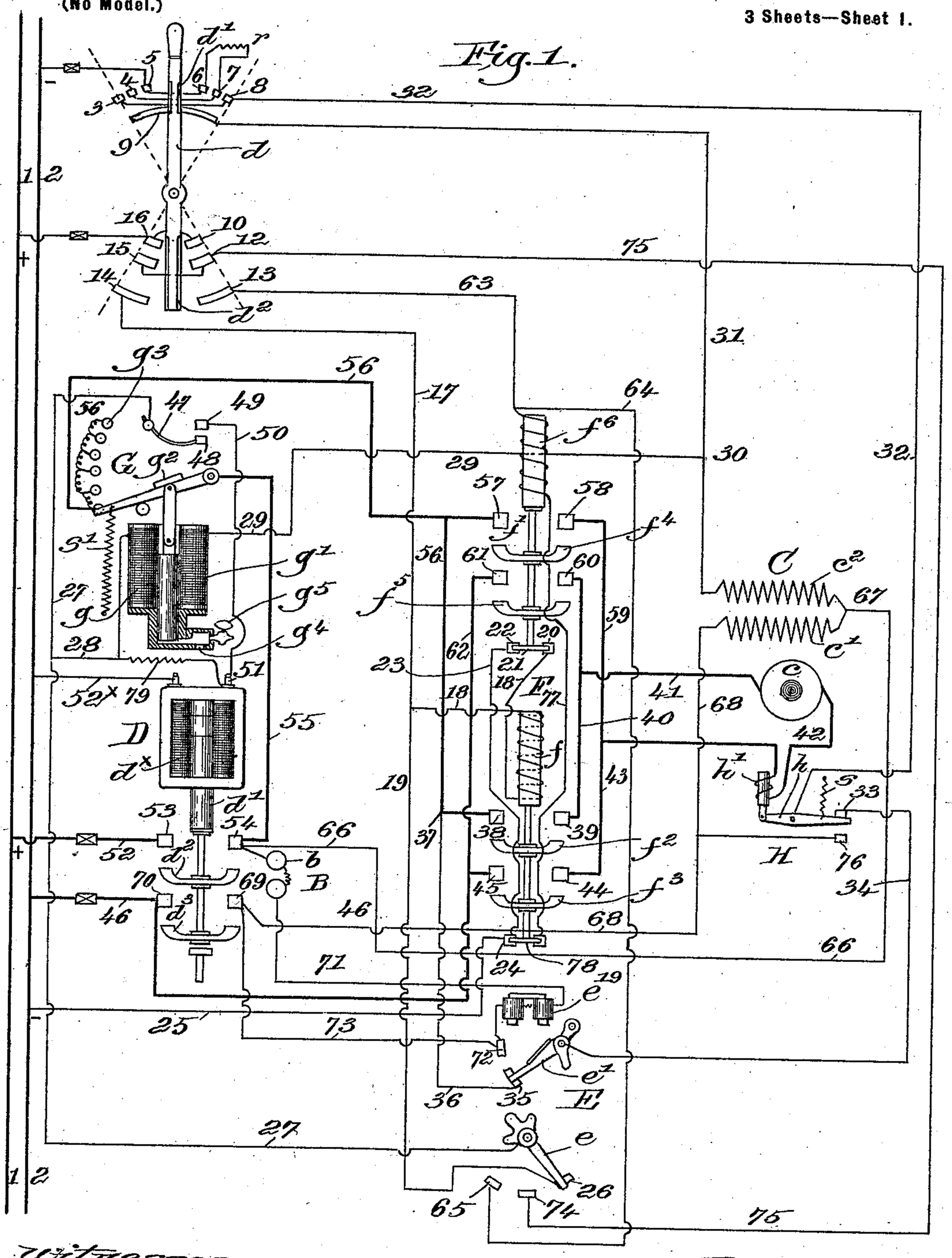
J. W. MOORE.

ELECTRIC ELEVATOR.

(Application filed June 17, 1901.)

(No Model.) 3 Sheets—Sheet 1.

Fig. 1.



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(No Model.) 3 Sheets—Sheet 2.

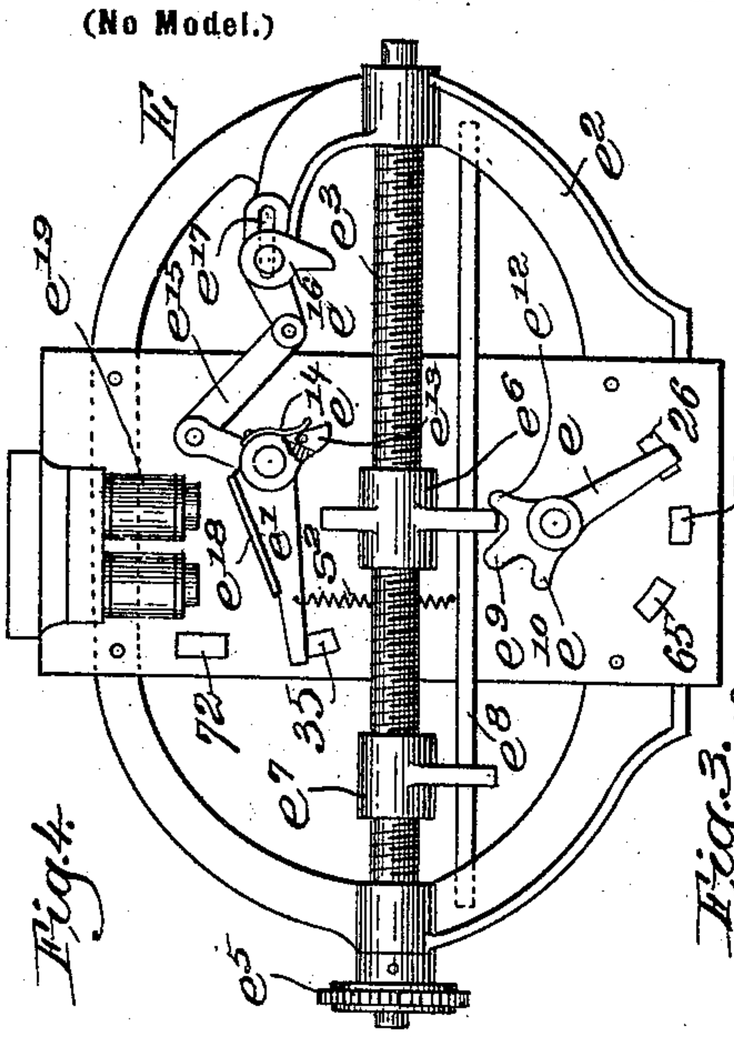

Fig. 4.

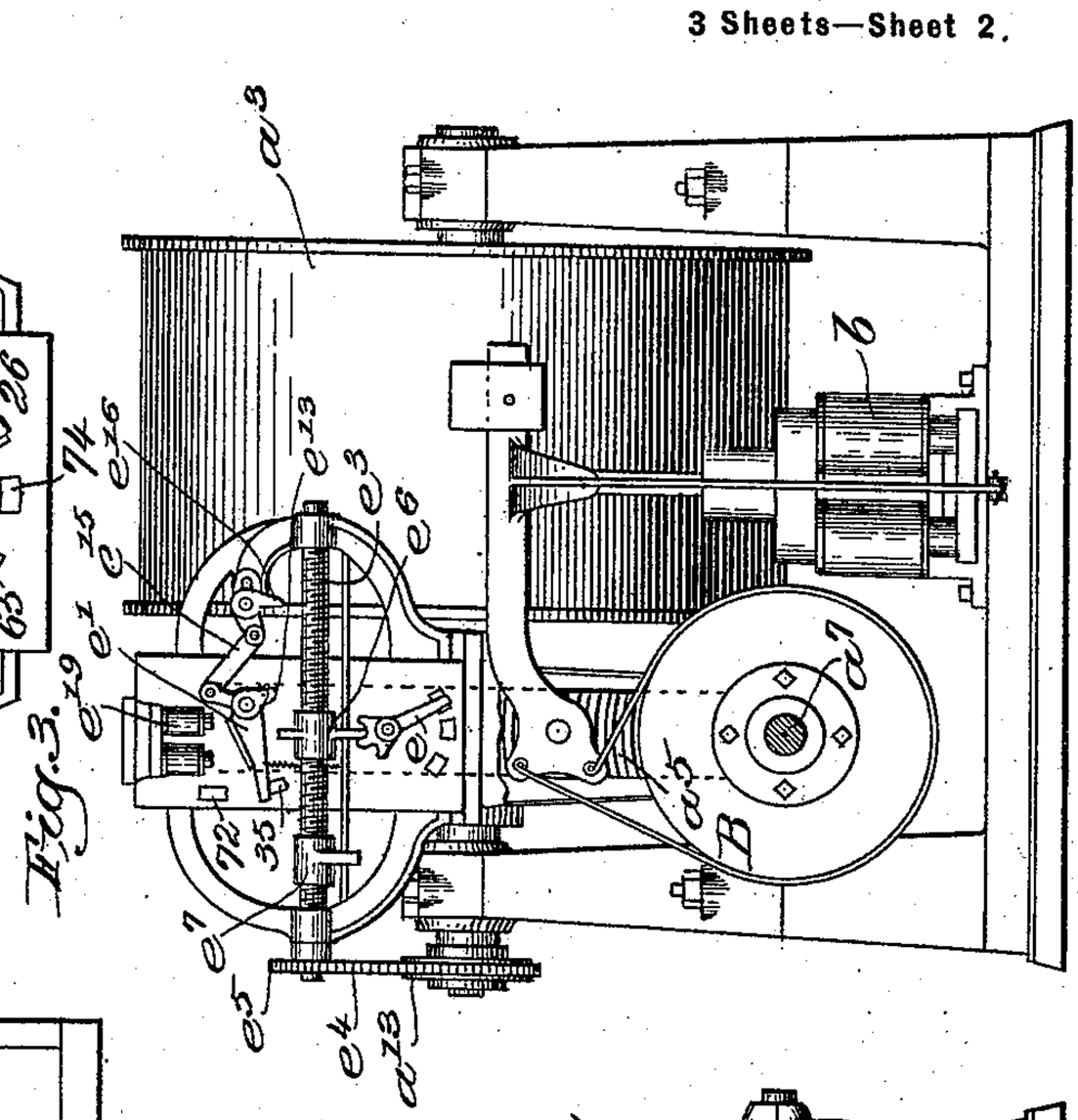

Fig. 3.

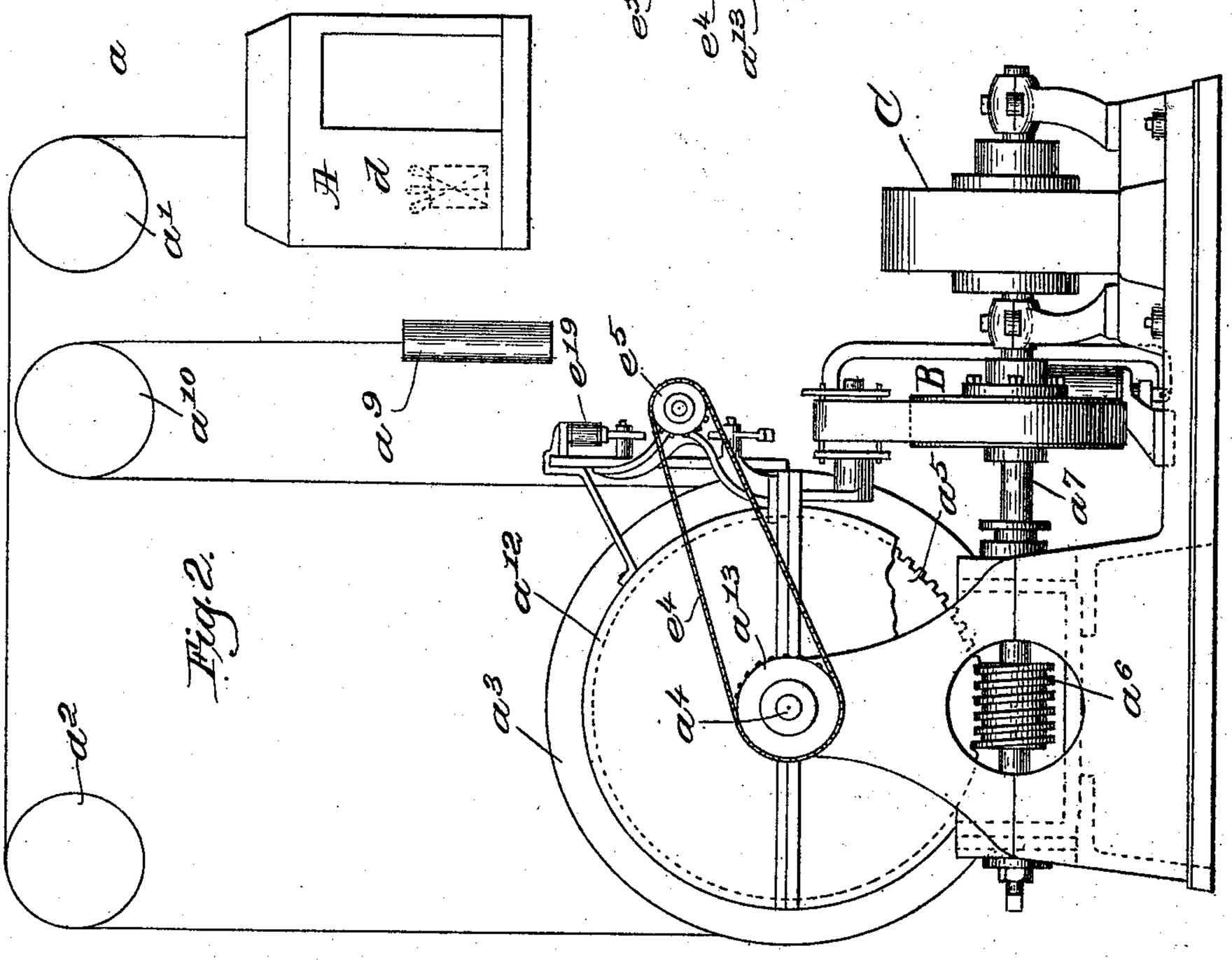

Fig. 2.

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(No Model.) 3 Sheets—Sheet 3.

Fig. 5.

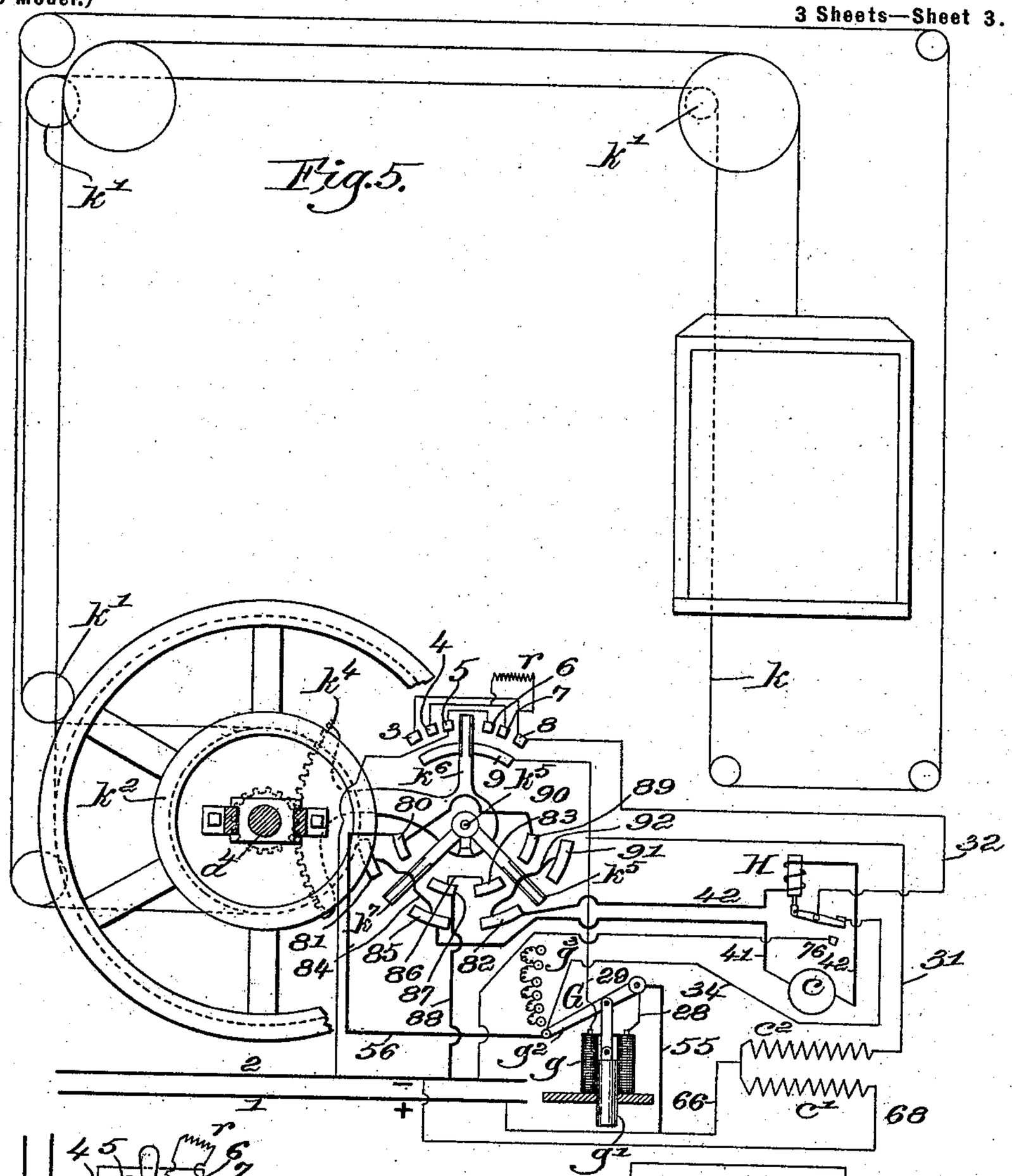
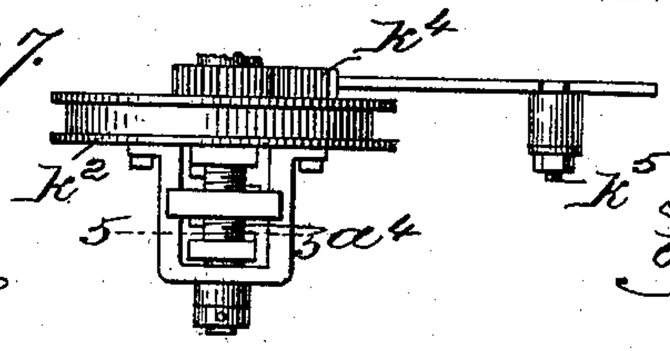


Fig. 6.

Fig. 7.



Witnesses.
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UNITED STATES PATENT OFFICE.

JOSEPH W. MOORE, OF NEWTON HIGHLANDS, MASSACHUSETTS.

ELECTRIC ELEVATOR.

SPECIFICATION forming part of Letters Patent No. 689,683, dated December 24, 1901.

Application filed June 17, 1901. Serial No. 64,824. (No model.)

To all whom it may concern:

Be it known that I, JOSEPH W. MOORE, a citizen of the United States, residing at Newton Highlands, county of Middlesex, State of Massachusetts, have invented an Improvement in Electric Elevators, of which the following description, in connection with the accompanying drawings, is a specification, like letters and numerals on the drawings representing like parts.

My invention is an improvement in electric elevators, hoists, and the like, and relates more particularly to the devices and connections for starting, controlling, and stopping the elevator.

My invention has for its leading object the provision of simple and economical means for applying maximum power for starting purposes, and then when once started properly accelerating the speed according to the load, and also when it is desired to stop the elevator quickly reducing the speed independently of the load and stopping without shock or danger to the apparatus or passengers.

My invention also includes a complete system of manual control in combination with automatic control operating independently of the operator on approaching the limits of travel, together with automatic means for keeping the current within the limits of safety of the apparatus and for increasing the torque of the armature.

The speed control of my invention is obtained by varying the field strength of the motor and by controlling the potential of the armature-circuit by means of a rheostat working in harmony with the field control, as will be more fully set forth presently.

The various details of construction, wiring, &c., will be more fully pointed out in the course of the following description, reference being had to the accompanying drawings, which illustrate preferred embodiments of my invention, and the latter will be more particularly defined in the appended claims.

In the drawings, Figure 1 represents my invention diagrammatically. Fig. 2 shows in side elevation sufficient details of the hoisting mechanism and connected parts to enable the invention to be understood. Fig. 3 is an end elevation of the hoisting mechanism. Fig. 4 is an enlarged front elevation of one form of automatic controller. Fig. 5 is a view similar to Fig. 2, showing a slightly-modified form of apparatus. Fig. 6 is a diagrammatic view illustrating a further modification; and Fig. 7 is a top plan view, partly broken out, showing a detail of Fig. 5.

For purposes of illustration I have indicated my invention as applied to a worm and worm-wheel elevator, (best shown in Figs. 2 and 3,) in which any usual cage or elevator A is suspended by a cable or cables a, passing over direction-pulleys a' a^2 to a drum a^3, mounted on and driven by a shaft a^4 by means of a worm-wheel a^5 and worm a^6 on a shaft a^7, connected by a combined coupling and brake-wheel B to a motor C, the elevator being counterbalanced in usual manner by the weight a^9, connected over a pulley a^{10} with the drum a^3.

Referring now to Fig. 1, in which the general plan of wiring and arrangement of parts is indicated diagrammatically, I have indicated a manual controlling device or hand-lever d, which may be located as desired on the car, at the motor or elsewhere, and serves to make and break connections between the mains 1 2 and the motor C, main switch D, automatic controller E, reversing-switch F, rheostat G, and automatic safety-switch H, all of which are shown as employed in the complete system exhibited in Fig. 1, although, as will be explained later, certain of these parts for some purposes may be omitted and various changes made within my invention.

The hand-lever d is provided with brushes or contact-makers d' d^2, which coöperate with suitable contacts 3 to 16, inclusive, and from these contacts suitable connections are made to the various parts, a wire 17 connecting by a branch 18 with one of the switch-solenoids f of the switch F and by another branch 19 with a contact 26 for a switch knife or lever e of the automatic switch, the branch 18 connecting from the solenoid f to a contact 20 and thence by a bar 21 of the upper portion f' of the reversing-switch to a contact 22 and by a wire 23 to a contact 24 and a wire 25 to the main 2. The branch 19 connects with a contact 26 through the lever e, as stated, with a wire 27, from which a branch 28 leads to a solenoid g of the rheostat G, and from said solenoid a wire 29 connects at 30 with a wire 31, which leads to the contact 9 of the manual

switch. The latter, through its brush d', connects when moved to the right, Fig. 1, with a wire 32, leading to the safety-switch H and normally making connection through the lever h of the latter with a contact 33 and wire 34 to a pivoted contact-knife e' of the automatic switch E. The latter when in the position shown in Fig. 1, in which the elevator is at the bottom of its travel, connects with a contact 35, from which a wire 36 leads to a point 37, where it unites with the main armature-circuit leading across the switch F at the contacts 38 39 when joined by a contact-maker f^2 of the switch, and thence by wires 40 41 to the armature c of the motor. From the latter the current is conducted by wire 42 in series with the safety-switch actuator, shown as a solenoid h', to a wire 43 and back across the reversing-switch by contacts 44 45 and contact-maker f^3 to the main 2 by means of a conductor 46. The main switch D is operated as a result of the current passing through the solenoid g of the rheostat G, the lifting of whose core g' raises the arm g^2 thereof against a spring 47, thereby bringing a contact-maker 48 into connection with the contact 49 and completing the circuit from the conductor 27 to a wire 50, secured at 51 to the solenoid $d^\times$ of the switch D, the opposite end thereof having connection $52^\times$ with the main line, thereby instantly raising the core d' and closing the switch, whose arms d^2 d^3 complete the circuit between the mains by means of the conductors 52 and 46, the former through the contact-maker d^2 and contacts 53 54 connecting with a wire 55 to the rheostat-lever g^2, which, it will be remembered, is in raised position in connection with the upper contact g^3 thereof, and thence through the resistance to a wire 56, and thence at the point 37 across the reversing-switch at 38 39 and to the armature through the wires 40 41, and thence back through the safety-switch and wire 43, &c., to the main. It will thus be seen that the exciter-circuit for the rheostat-solenoid and also the main armature-circuit both pass through the armature across the contacts 38 39 of the reversing-switch and return across the contacts 44 45 of said switch. In the same manner the exciting-current of the rheostat-solenoid passes across the reversing-switch between contacts 57 58 when the switch F is reversed, and thence through the wire 59, safety-switch solenoid h', and wire 42 in an opposite direction through the armature and back over the wires 41 40 across the reversing-switch by the contacts 60 61 and wires 62 and 46 to the main, it being understood that the contact-makers f^4 f^5 of the reversing-switch properly connect the contacts when actuated by their solenoid f^6, energized by current from the wire 63. So, likewise, the main switch D is operated by current from the wire 63 in the same manner that it was previously operated by current from the wire 17, the current in this instance passing by a branch 64 to a contact 65, which when the parts have been reversed, as now supposed, is connected with the lever e, which completes the circuit to the switch D in the same manner as already described in connection with contact 26. The reversing-switch and connections having been properly operated either in one direction or the other and the main switch D having been accordingly closed, the field-current of the motor passes from the main across the contacts 53 54 by the contact-maker d^2 of the switch D to a wire 66 to the field-winding at 67, where it divides into two windings, one of which, c', leads directly back to the main by a wire 68 across the contacts 69 70 by the contact-maker d^3 of the main switch. The other branch c^2 of the field-winding connects at 30 with the wire 31, already mentioned, and thence through the hand-operated switch back by the wire 32 and safety-switch H, contact 33, wire 34, and lever e', contact 35, wire 36, contacts 38 39, wires 40 41, through the armature, and back to the main over the wires 42 43, contacts 44 45, and wire 46, thus placing the field-winding c^2 in series with the armature, although not with the main armature-circuit.

Simultaneously with the operating of the main switch D the brake B is made to operate by a current passing across the contacts 53 54 and through the solenoids b of said brake to a wire 71, which leads through the automatic switch-magnet e^{19}, leaving the same at a contact 72 and connecting by a wire 73 back across the contact 69 70 to the main.

The general construction of the rheostat G and safety-switch H will be understood from the figures without detailed description, the levers thereof being held in normal position by springs s s' and the solenoid action of the rheostat being given quick upward movement by a valve g^4 and slow downward movement by a valve g^5.

The general details of the automatic reversing-switch will be more fully understood by reference to Figs. 3 and 4, where it will be seen that in a suitable frame e^2, mounted on a shield or cover a^{12} of the hoist for the worm-gear a^5 of the hoist, is journaled a threaded shaft e^3, driven by the hoisting-shaft a^4 by a sprocket-chain e^4, passing over sprocket-wheels a^{13} e^5, mounted, respectively, on said shafts. On this threaded shaft are mounted two traveling insulated nuts or dogs e^6 e^7, held against rotation by any suitable means, as by a rod e^8 passing therethrough and held in the frame e^2. These dogs e^6 e^7 are arranged to coöperate with the knives or levers e e', already mentioned, the former for this purpose having a central stop e^9 and two lateral fingers e^{10} e^{12}, so that as the dog e^6 moves from the position shown in Fig. 4 to the right it will automatically swing the lever e away from the contact 26 and into connection with a central contact 74, and when the dog e^7, moving in the same direction, comes in contact with the stop e^9 it will swing the knife e still farther to the left against the contact 65. The knife e' is provided with a pivoted arm e^{13},

normally held in the position shown by the spring e^{14}, said arm yielding freely to permit the dog e^6 to pass to the right, but being unyielding to movement in an opposite direction and also has connection by a link e^{15} with a bell-crank e^{16}, adjustably mounted at e^{17} on the frame e^2, so that when the dog e^6 moves to the extreme right after having shifted the knife e to the intermediate contact 74 it comes into engagement with the depending end of the bell-crank e^{16}, and thereby through the link e^{15} raises the knife e' against the action of its spring s^2 into connection with the contact 72 and brings the armature e^{18} thereof within the attractive power of an electromagnet e^{19}, which is located in some active circuit of the system, shown for convenience as in the brake-circuit. The purpose of this automatic switch is to accomplish automatically the same object as to stopping that is accomplished manually by the switch-lever d—namely, quickly slowing down and stopping the elevator without jar or danger—and therefore I will describe the further operation thereof later in connection with the general description of the entire invention.

In operation let us suppose that the elevator is at the bottom of its run, the parts being in the relative positions shown in the drawings. In order to start the elevator, the operator shifts the lever d over to the right, thereby completing connection between the contacts 16 and 14 at one end of the lever and 9 and 8 at the other end thereof. This instantly operates the lower portion of the reversing-switch, so as to provide the proper direction of current for the armature, and thereupon the main switch D is closed by the operation of the rheostat and contacts 48 49, (in the form shown in Fig. 1,) so that the main current is passed through the armature, said main current being governed by the resistance of the rheostat, which is then in series with it. At the same time both windings c' c^2 of the field of the motor are energized to their maximum strength. The result is that the motor has its maximum power at the very start. As, however, the field-winding c^2 and the solenoid-winding of the rheostat (whose energizing controls the position of the rheostat-arm g^2) are in parallel circuits with the starting resistance of the rheostat and are in series with the armature of the motor, it follows that as the armature begins to increase in speed its counter electromotive force weakens said circuits and permits the contact-arm of the rheostat to lower, cutting out the resistance and also practically cutting out the field-winding c^2, thus quickly accelérating the speed of the motor. Because of the windings and connections, as stated, the field-winding c^2 and solenoid-winding g, being in parallel with the resistance and in series with the armature, the strength of current in said circuits is due to the difference of potential caused by the starting resistance and is directly influenced by the varying potential due to the counter electromotive force in the armature-circuit, but is independent of the strength of current in said armature-circuit. In other words, the rate of variation is dependent on the rate of acceleration of the motor and is thus self-regulating. The speed will quickly increase to a maximum, at which point the current in the two series circuits, which include the field-winding c^2 and the solenoid g, becomes zero, and the motor will under these conditions run at a uniform maximum speed independent of its load until the circuits are again altered. When the car approaches a landing at which it is desired to stop, the operator shifts the lever d to the contact 6. This leaves the reversing-switch and the main circuits as before, but renders the circuits active or increases the currents therein in the field-circuit c^2, the rheostat solenoid-circuit thereby introducing resistance into the armature-circuit and at the same time strengthening the field, and hence rapidly decreasing the speed of the motor, whereupon a further movement of the lever d to its central position serves to open the switches F and D, which cuts out all current from the motor and permits the brake B to operate. It is to be noted that these operations are entirely independent of the load—that is to say, they operate the same whether the car is empty or is carrying its maximum load—because the circuits which include the field-winding c^2 and solenoid g are thrown directly across the mains, the movement of the lever d from the contact 8 to the contact 6 cutting out the wire 32, which served to connect the winding c^2 and solenoid g in series with the armature, and making direct connection by means of the wire 31, contact 9, contacts 6 and 5 to the main 2. To prevent short-circuiting the armature as the lever d passes from contact 8 to contact 6, I provide an intermediate contact 7 and resistance r. Said short-circuiting would take place from the main 1 across the switch D by the wire 55, while the machine is running with the rheostat-arm g^2 in the position shown, by current from the wires 56 36 through the switch E, and wire 34, switch H, wire 32, and contacts 8 and 6 brought into short-circuiting relation by the passage of the brush d' as the latter moves from one to the other and thence to the main by contact 5. By inserting the resistance r the tendency of the current to flow through this otherwise direct path is prevented, and the current is caused to continue along its proper circuit through the armature. Another important advantage of the provision of this intermediate contact 7 and resistance r is that it makes it impossible for the field-circuit c^2 and the solenoid-circuit g or either of them to be opened when the switch-lever d passes from its position on contact 8 to its position on contact 6, which would cause the sudden weakening of the field, and by cutting out the resistance g^3 would per-

mit an abnormal and perhaps destructive current to pass through the armature. This is prevented by placing the intermediate contact 7 and resistance r between the contacts 6 and 8, so that a continuous circuit is insured. This is also of service, if desired, for providing an intermediate field strength or speed reduction, as by stopping the lever d on the contact 7 the resistance r is introduced, permitting some current to flow through the field-winding c^2, but not a maximum current, as is the case when the lever d has moved to the contact 6.

The provision for effectually slowing down and stopping the elevator without shock independently of the load is practically very important. Various electrical arrangements have been used, the most common depending upon the strength of the current in the armature-circuit, introducing a starting resistance, together with a coarse series field-winding in series with the main armature-circuit, which are cut out for speed and cut in for slowing down; but such construction is obviously dependent upon the load, because the strength in said series field-circuit is dependent upon the current in the armature-circuit, and as the current in the armature varies as the load it follows that with an exceedingly heavy load in descending there would be practically no armature-current, so that the cutting in of the series field would simply introduce a zero quantity and accomplish nothing, and so likewise the introducing of the resistance under such circumstances is ineffective, because there is no appreciable current flowing in its circuit. Also my construction is of like advantage over the usual friction-brake, which is likewise dependent on the load for its action, because if the brake is adjusted to positively stop the elevator it will with a light load, cause injurious shock to the machinery and passengers by stopping the elevator too suddenly, and with a heavy load it will slip more or less. All these objections are obviated by my invention, because whatever varying of the armature-current may be caused by varying loads does not in any way interfere with my obtaining full field strength simply by shifting the lever d from the contact 8 to the contact 6, and this is supplemented by the effect of the resistance g^3 on whatever current may be passing through the armature-circuit.

Upon approaching the end of the travel the operator may stop the elevator by means of the hand-lever d, as just explained; but in case he neglects to do so the automatic switch E will do it automatically by reason of the engagement of the dogs e^6 e^7 with the respective lugs, as already explained, this taking place at a predetermined point in the travel, according to the position to which said dogs are respectively adjusted on the shaft e^3. If the elevator is ascending, the dog e^6 first engages the bell-crank e^{16} and shifts the knife e' upwardly, Fig. 4, to the contact 72, thereby shifting the circuit, including the wire 34, contact 33, wires 32 31, and winding c^2 (and also wire 29 of the solenoid-circuit) into circuit with wire 73, contacts 69 70, arm d^3, and wire 46 to main 2, and then the dog e^7 engages the lug e^9 and shifts the lever e to the left from its intermediate contact 74 to the contact 65, thereby breaking the circuit of the switch D—viz., wire $52^\times$, solenoid $d^\times$, wires 28 27, lever e, contact 74, wire 75, contacts 12, 15, d^2, 16, and thence to main 1. The first operation accomplishes the reduction of speed by introducing the full field strength by connecting the field-winding c^2 and also the solenoid-circuit g directly across the mains, and the second operation (shifting the circuit from 74 to 65) accomplishes the stopping by breaking the switch-circuit D, permitting the brake B to operate. To maintain effective the speed-reduction positions until the elevator is stopped, I have provided the knife e' with an armature e^{18}, by which it is held under the influence of the electromagnet e^{19} against the contact 72 until the circuits are broken by the movement of the knife e to stopping position, (at the left hand going up and right hand going down.) As soon as the main circuits are broken for stopping the elevator the knife e' is permitted to fall away from the contact 72 to the contact 35 again, thereby restoring the circuits of the field, winding c^2 and solenoid g to their original positions, so that the elevator may again start with maximum power and quickly accelerate its speed. In other words, the provision of means for restoring the knife e' to the contact 35 immediately upon the stopping of the elevator makes it certain that the subsequent starting of the elevator will invariably take place under the same advantageous conditions of power and speed. The transfer of the circuit from the contact 74 to the contact 65 (or when approaching the bottom contact 26) opens the circuit at that time closed by the lever d in its right-hand position and containing the car-switch contacts 16, 15, and 14, said circuit also including the main-switch magnet $d^\times$, so that thereafter the hand-lever d can only be moved operatively to start the elevator in the right direction—*i. e*, the only starting-circuit it can complete is the one containing the contacts 10 12 13, as the opposite circuit is still broken by the switch-lever e. When the elevator is next started, it will, as explained, be obliged to start in the right direction, and the first movement will start the dogs e^7 e^6 traveling in a reverse direction, the dog e^7 immediately shifting the knife e again to its intermediate contact 74. By this construction it results that the elevator may be started by the hand-lever d in either direction between the limits of travel, as the wire 75, which leads from the contact 74, is connected directly to both of the contacts 12 and 15, the contacts 10 and 16 be-

ing similarly connected, so that the circuit is closed by the movement of the lever *d* in either direction.

I have already explained the construction by which it becomes impossible to start the elevator in the wrong direction at either limit of its travel, and in this connection I wish to point out that in my invention, where the entire system is electrically operated, it becomes important to make not only such provision as that just referred to, but to make other provisions, which I will now describe.

If for any cause dangerously-excessive armature-current becomes present, the safety-switch H by the energizing of its solenoid h' will be operated, shifting the lever *h* from the contact 33 to the contact 76, thereby throwing the field-coil c^2 and rheostat-solenoid *g* directly across the mains by the wires 31 32, switch-lever *h*, contact 76, wire 68, contacts 69 and 70, and wire 46, thus increasing the field and consequent power of the motor and introducing resistance g^3 into the armature-circuit and cutting the current down within safety limits. It will be understood that here, as elsewhere, I describe the more complete and preferred means of accomplishing my purpose, the purpose being to keep current within safety limits, and the most complete means of doing it consisting in both increasing the field magnetization and consequent torque of the armature and decreasing the armature-current, although either may be used alone with good effect. When the armature-current falls sufficiently, the solenoid h' will permit the switch-lever *h* to be restored to the contact 33 again.

Another danger which is possible with circuits arranged according to my invention is the short-circuiting of the armature-circuit by the simultaneous closing of both portions of the reversing-switch F, and to prevent this I have connected the solenoids $f f^6$, respectively, in series with a contact-maker operated by the other part of said switch, the solenoid *f* being connected by a wire 18 with a contact-maker 21 of the opposite part of the switch, and on the other hand the solenoid f^6 being connected by a wire 77 with a contact-maker 78 of the lower part of the switch, both of these contact-makers 21 and 78 making their circuits when the circuits controlled by the reversing-switch are broken. By this provision it is evident that when either part of the reversing-switch is operated it thereby breaks the circuit of the solenoid of the opposite part of the switch, so that said solenoid part cannot be operated.

As already remarked, the main switch D does not operate until the rheostat-lever g^2 has been put in position for including the resistance in the armature-circuit, as otherwise the armature-circuit might be completed by the operation of the switch D before any resistance was included and with disastrous results. I accomplish this proper order of operation of the said switch and rheostat by interposing between the wire 28 and the terminal 51 a resistance 79, which prevents current passing thereover to the solenoid $d^\times$ in sufficient quantity to operate the switch D, the main body of the current passing through the solenoid *g*, thereby introducing the resistance g^3 before the operation of the switch-solenoid $d^\times$, said operation being effected on the making of the circuit at 48 49 by the raising of the rheostat-arm g^2. When once raised, however, the core d' of the switch D will be held raised by the weak current which is permitted to pass through the resistance 79 after the main energizing-current thereof has been cut off by the separation of the contacts 48 49.

By reason of the provisions thus far explained it will be evident to those skilled in the art that my system is entirely electrical, and although the elevator is under the control of the operator by means of the hand-lever *d* it is yet independent of said operator to the extent that no disastrous results can follow his inattention or lack of skill.

Usually the hand-lever *d* will be located in the elevator-car, as indicated in Fig. 2; but I do not restrict myself in this respect, as said lever is primarily a manual controller and may be operated either directly in the car or from the car or in any other location and by any suitable means. For instance, in Fig. 5 I have shown a modified construction in which the controlling-lever is located at the hoisting-drum, being operated therefrom by a hand-rope *k*, passing over suitable direction-pulleys k' to a wheel k^2, carrying a pinion k^3, in mesh with the toothed sector or arm k^4, fast on a shaft k^5, which carries the switching device corresponding to the hand-lever *d*.

In this construction, however, I have introduced certain further features, and at this point I wish to remark that I do not restrict myself to all the constructional details and various arrangements of my preferred embodiment; but, as will be more evident from the subsequent claims, my invention is capable of varied applications.

While the construction shown in Fig. 1 is the most complete and satisfactory, especially for high-class work, I do not restrict my invention and claims thereto, and, in fact, certain features of my invention are of importance outside of elevator-work—as, for example, the effective slowing down and stopping arrangement, as also the effective starting and accelerating, the various automatic arrangements, and provisions for safety.

Referring again to Fig. 5, it will be seen that I have provided a switch-lever having an arm k^6 and a double arm k^7 k^8 independently pivoted on the shaft k^5, the upper arm performing precisely the same operations as the upper portion of the lever *d* and the lower arms performing the same operations as the reversing-switch F and starting-switch D, as I will now explain. The arm k^6 extends between the branches of the double arm k^7 k^8 and is adapted to engage and move the

latter after securing a certain degree of lost motion, as will be presently explained. Upon moving the lever k^6 over to the right in order to start the elevator up (by pulling down on the rope k) the part k^7 makes connection between the contacts 80 and 81, and the part k^8 makes simultaneous connection between the contacts 82 83, which movement operates to switch the main current through the armature, the resistance of the rheostat and the winding c^2 of the field having been already inserted by the connection between the contacts 9 and 6 made by the arm k^6, it being observed that I have provided means for obtaining a lost motion between the movement of k^6 and the two-armed lever k^{10}. The lost motion permits the upper contacts to be brought into action prior to the lower contacts. The circuits are made by the said movement of the arm k^7 and k^8 as follows: For starting the elevator up the main line 1 connects with the contact 80 through the wire 56, resistance g^3, arm g^2, and wire 55, and from said contact 80 through the arm k^7 the circuit continues from the contact 81 by a wire 84 to a contact 85 and wire 41 to the armature and from the armature by wire 42 through switch H to contact 82, which connects by arm k^8 to contact 83, and thence by wire 86 to contact 87, which connects by wire 88 to the main line 2. For stopping, the movement of the rope k is reversed—*i. e.*, pulled up—thereby moving the arm k^6 to the left into contact with 6 and 9, which increases the field strength by introducing the winding c^2 and the solenoid g across the mains and throws the resistance g^3 into series with the armature, thus slowing down the elevator, and a further movement of the rope k engages the lower end of lever k^6 with k^8, thereby breaking the connections between k^7 and its contacts 80 81 and the connections between k^8 and its contacts 82 83, thus opening the main circuit, applying the brake, and stopping the elevator. When it is desired to start the elevator down, the rope k is raised, thereby turning the lever k^6 over to the left and the levers k^7 k^8 to the right, thereby throwing the main line 1 again in the circuit by a contact 89, which connects by a wire 90 with the contact 80, and thence to the main line 1, the same as before. The contact 89 is joined by the arm k^8 to a contact 91, which connects by a wire 92 to contact 82, from which the current passes over the wire 42 through the armature in a direction opposite to its previous course, and from its armature it is conducted by wire 41 to contact 85, which is now connected by arm k^7 to contact 87, and thence by wire 88 to the main line 2. In this modified form of my invention I have also shown an automatic automatical switch. (See Figs. 5 and 7.) The wheel k^2 and its pinion k^3 are mounted loosely on a hoisting-shaft a^4, which has a threaded end k^9 projecting beyond said wheel and provided with two stops k^{10} k^{12}, fast on the shaft. Between the stops k^{10} is a traveling nut k^{13}, held against rotation by a guide shown in the form of a yoke k^{14}, the result being that when the nut has reached the end of its travel, which corresponds to the limit of travel of the elevator, it engages with one or the other of the stops k^{10} k^{12}, as the case may be, and is compelled thereby to rotate with the shaft, and through its connection with the guide k^{14} said nut turns the wheel k^2 and its pinion k^3, thereby operating the switch, whose arm k^6 first makes connection between contacts 9 and 6 or 9 and 5, passing over the intermediate contacts 7 or 4.

As thus far explained, the cutting out of the resistance of the rheostat is dependent upon the counter electromotive force of the armature; but for some purposes it is desirable to have it controlled directly by the starting and stopping mechanism, one form thereof being shown in Fig. 6, where it will be observed that in addition to the contacts shown in Fig. 1 I provide contacts 100 101, connected to each other by a wire 102 and at one side of the solenoid g by a wire 103, a solenoid being connected to the main 2 by wire 104. In this case the automatic switch E is provided with a special contact 72 for breaking the circuit of the solenoid g at the proper time, so as to permit the core g' to fall and introduce the resistance g^3 into the armature-circuit, and for this purpose the wire 103 connects to a pivoted contact 72, normally in engagement with a fixed contact 105, so that upon the automatic movement of the knife e' away from the contact 35 it engages the contact 72 and swings the same out of connection with the contact 105, thereby breaking the solenoid-circuit, as required.

It will be understood that many other modifications are possible within the spirit and scope of my invention and that while I have shown a general form of magnetic controller I do not intend in any wise to limit myself thereto, excepting as may be expressed in certain of the claims. It will also be understood, for example, that while the apparatus is described as being operated by "closed circuits" I use this expression in the claims in the customary manner, meaning merely that the particular circuit is placed in an operative condition.

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

1. In an apparatus of the kind described, a shunt-motor having its field-winding in two sections in shunt across the mains, and means for throwing one part of said winding in series with the armature for accelerating the speed of the motor.

2. In an apparatus of the kind described, a motor having a double field-winding, means for connecting both parts of said winding across the mains for giving power, and means for connecting one part of said winding in series with the armature for giving speed.

3. In an apparatus of the kind described, a motor, a resistance, an electric circuit for operating said resistance, and means for throwing said circuit into and out of series with the armature.

4. In an apparatus of the kind described, a resistance, an actuating-circuit therefor, a motor having a double field-winding in shunt across the mains, and means for throwing part of said field-winding and said actuating-circuit of the resistance into series with said armature, bringing them under the direct influence of the counter electromotive force of the armature.

5. In an apparatus of the kind described, a rheostat containing a resistance, an actuating-circuit therefor, a motor having a double field-winding in shunt across the mains, and means for placing part of said field-winding and said rheostat-actuating circuit in series with said armature and in parallel with said resistance.

6. In an apparatus of the kind described, a motor, field and armature circuits for operating the same, means for varying the strength of said field-circuit, including means for instantly raising the same from a minimum operating strength to a maximum strength independent of the load.

7. In an apparatus of the kind described, a motor, field and armature circuits for operating the same, means for varying the strength of said field-circuit, including means for instantly raising the same from a minimum operating strength to a maximum strength independent of the load, and means for simultaneously weakening the armature-circuit.

8. In an apparatus of the kind described, a motor, field and armature circuits for operating the same, means for varying the strength of said field-circuit, including means for instantly raising the same from a minimum operating strength to a maximum strength independent of the load, means for simultaneously weakening the armature-circuit, and means immediately thereafter to cut out the supply-circuit and stop the motor.

9. In an apparatus of the kind described, a motor, field and armature circuits for operating the same, and means for varying the strength of said field-circuit, including automatic means for instantly raising said field-circuit from a minimum operating strength to a maximum strength independent of the load.

10. In an apparatus of the kind described, a motor, field and armature circuits for operating the same, means for varying the strength of said field-circuit, including means for instantly raising the same from a minimum operating strength to a maximum strength independent of the load, and automatic means for simultaneously weakening the armature-circuit.

11. In an apparatus of the kind described, a motor, field and armature circuits for operating the same, means for varying the strength of said field-circuit, including automatic means for instantly raising said field-circuit from a minimum operating strength to a maximum strength independent of the load, and automatic means for simultaneously weakening the armature-circuit.

12. In an apparatus of the kind described, a motor, having field and armature circuits, a resistance adapted to be included in the armature-circuit, actuating mechanism therefor, a main switch controlling said armature-circuit, and means for operating said actuating mechanism to bring said resistance into the circuit of said armature prior to the closing of said main switch.

13. In an apparatus of the kind described, a motor, having field and armature circuits, a resistance adapted to be included in the armature-circuit, actuating mechanism therefor, a main switch controlling said armature-circuit, and an actuating-circuit for said main switch, said switch-actuating circuit being rendered operative by the movement of said resistance-actuating means.

14. In an apparatus of the kind described, a motor, field and armature circuits therefor, a resistance adapted to be included in said armature-circuit, actuating means for rendering said resistance operative in said circuit, a main switch for controlling said armature-circuit, means for operating said switch, said switch being moved to closed position by the operation of said resistance-actuating means.

15. In an apparatus of the kind described, a motor, field and armature circuits therefor, a resistance adapted to be included in said armature-circuit, actuating means for rendering said resistance operative in said circuit, a main switch for controlling said armature-circuit, an actuating-circuit for said switch, said switch-circuit being normally open, and means operated by said resistance-actuating means for closing said switch-circuit.

16. In an apparatus of the kind described, a motor, field and armature circuits therefor, a resistance adapted to be included in said armature-circuit, actuating means for rendering said resistance operative in said circuit, a main switch for controlling said armature-circuit, an actuating-circuit for said switch, said switch-circuit being normally open, means operated by said resistance-actuating means for closing said switch-circuit, and means independent of said actuating-circuit for maintaining said switch closed.

17. In an apparatus of the kind described, a motor, field and armature circuits therefor, a resistance adapted to be included in said armature-circuit, actuating means for rendering said resistance operative in said circuit, a main switch for controlling said armature-circuit, an actuating-circuit for supplying full current strength for operating said switch, said circuit being normally inoperative for said purpose, a resistance in shunt across said switch-circuit to the switch, said circuit

being rendered operative to close said switch by the movement of said resistance-actuating means, and current through said shunt resistance maintaining said switch in closed position thereafter.

18. In an apparatus of the kind described, a motor, field and armature circuits therefor, an electric reversing-switch for reversing the direction of travel of the car or object moved, the reversing-switch circuit, automatic means for maintaining said armature-circuit operative for either direction of reversal between certain fixed limits of said travel, and automatic means for rendering said armature-circuit inoperative beyond said limits.

19. In an apparatus of the kind described, a motor, field and armature circuits therefor, a reversing-switch for reversing the direction of current in said armature-circuit for changing the direction of travel of the car or body moved, and an automatic switch governing the armature-circuit, said switch including a contact and circuit for completing the armature-circuit in either position of said reversing-switch, and mechanism actuated at certain fixed limits of said travel to break connection with said contact.

20. In an apparatus of the kind described, a motor, field and armature circuits therefor, a reversing-switch for reversing the direction of current in said armature-circuit for changing the direction of travel of the car or body moved, and an automatic switch governing the armature-circuit, said switch including three contacts and circuits, one for completing the armature-circuit in either position of said reversing-switch, the second for completing said armature-circuit in one position of said reversing-switch, and the third for completing said armature-circuit in the other position of said reversing-switch, and mechanism actuated at certain fixed limits of said travel to break connection with said first contact and make connection with one of the other contacts according to the direction of said travel.

21. In an apparatus of the kind described, a motor, field and armature circuits therefor, an electric reversing-switch for reversing the direction of travel of the car or object moved, an operating-circuit for said reversing-switch, a controlling device therefor, a main switch for the armature-circuit, a main-switch-operating circuit included in the circuit of said controlling device, an automatic switch having a contact also in said main-switch-operating circuit, said automatic switch including operating mechanism actuated at certain fixed limits of said travel to break connection with said contact.

22. In an apparatus of the kind described, a motor, field and armature circuits therefor, an electric reversing-switch for said motor, and an automatic switch controlled by the motor, said automatic switch including an intermediate circuit controlling the current-supply for said armature-circuit, said automatic switch, excepting at the limits of its movement, being in a position to complete said intermediate circuit, permitting the flow of current in the armature-circuit in either position of said electric reversing-switch, said reversing-switch having two movable portions, each having its own actuating-circuit, each of said actuating-circuits being in series with a movable part of the other portion of the reversing-switch, the movable part of one portion of the switch breaking the actuating-circuit of the opposite portion of the switch when the first-mentioned portion is in closed position.

23. In an apparatus of the kind described, a motor having a double field-winding and an armature-winding, a safety-switch normally connecting one of said field-windings in series with the armature, said switch being actuated by the armature-current and responding to abnormal armature-current to transfer its field-winding from in series with said armature to a circuit across the mains.

24. In an apparatus of the kind described, a motor having a double field-winding, and an armature-winding, a resistance, a safety-switch, normally connecting one of said field-windings in series with the armature, said switch being actuated by the armature-current and responding to abnormal armature-current to transfer its field-winding to a circuit across the mains and to place said resistance in series with the armature.

25. In an apparatus of the kind described, a motor having a double field-winding and an armature-winding, one of said field-windings being transferable into and out of series with the armature, and the other field-winding being across the mains, and an automatic switch containing means for automatically transferring said field-winding from series with the armature to a circuit across the mains, and means for maintaining the latter condition until the motor is stopped.

26. In an apparatus of the kind described, a motor having a double field-winding and an armature-winding, a circuit for one of said field-windings in series with the armature, and the other field-winding being in circuit across the mains, a manually-operated switch for said first-mentioned field-winding, and an automatic switch containing means for automatically transferring said first-mentioned field-winding from series with the armature to a circuit across the mains, and means for maintaining the latter condition until the motor is stopped, the automatic switch, after the motor is stopped, restoring the said transferred field-winding to its original series connection permitting thereby the rapid acceleration of the motor upon the proper movement of the manually-operated switch.

27. In an apparatus of the kind described, a motor having a double field-winding and an armature-winding, one of said field-windings being transferable into and out of series with the armature, and the other field-wind-

ing being across the mains, an automatic switch containing means for automatically transferring said field-winding from series with the armature to a circuit across the mains, a brake whose operation is controlled by said switch, and means for maintaining said switch in position with said series field-winding in a circuit across the mains until the brake has operated.

28. In an apparatus of the kind described, a motor, slowing-down mechanism, and stopping mechanism, an automatic switch controlling the operation of said slowing-down mechanism and of said stopping mechanism, and means for maintaining said switch in position for operating said slowing-down mechanism until said stopping mechanism has operated.

29. In an apparatus of the kind described, a motor having field and armature windings, an automatic stop-switch controlling said windings, a brake, the action of said brake being controlled by the operation of said switch, and automatic means for maintaining said switch in stopping position until the brake has been actuated to stop the elevator.

30. In an apparatus of the kind described, a motor having field and armature windings, a stop-switch controlling said windings, a brake, the action of said brake being controlled by the operation of said switch, and automatic means for maintaining said switch in stopping position until the brake has been actuated to stop the elevator.

31. In an apparatus of the kind described, a motor having an armature-winding, and a field-winding transferable into series with the armature and out of series therewith into a circuit across the mains, a switch for transferring said field-winding, and means for preventing the short-circuiting of the armature across the mains by the movement of the switch in transferring said field-circuit.

32. In an apparatus of the kind described, a motor having an armature-winding, and a field-winding transferable into series with the armature and out of series therewith into a circuit across the mains, a switch for transferring said field-winding, and means for maintaining continuous current in the field while said transfer is taking place.

33. In an apparatus of the kind described, a motor having an armature-winding, and a field-winding transferable into series with the armature and out of series therewith into a circuit across the mains, a switch for transferring said field-winding, said switch being provided with proper contacts for said transfer, an intermediate contact, and a resistance between said contact and the main.

34. In an apparatus of the kind described, a motor having an armature-winding, and a field-winding transferable into series with the armature and out of series therewith into a circuit across the mains, a switch for transferring said field-winding, said switch being provided with proper contacts and a contact-maker for said transfer, and means for preventing the opening of the circuit by the passage of the contact-maker of the switch from one of said contacts to the other.

35. In an apparatus of the kind described, a motor having an armature-winding, and a field-winding transferable into series with the armature and out of series therewith into a circuit across the mains thereby providing different field strengths, and means for introducing an intermediate field strength.

36. In an apparatus of the kind described, a motor having an armature-winding, and a field-winding transferable into series with the armature and out of series therewith into a circuit across the mains thereby providing different field strengths, and mechanism for introducing an intermediate field strength during the transfer of said field-winding from one circuit to the other.

37. In an apparatus of the kind described, a motor having an armature-winding, and a field-winding transferable into series with the armature and out of series therewith into a circuit across the mains thereby providing different field strengths, a switch for making said transfer, and means for obtaining an intermediate field strength, said means being introduced into the field by the movement of said switch between the transfer of said field-winding from one circuit to the other.

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

JOSEPH W. MOORE.

Witnesses:
GEO. H. MAXWELL,
WILHELMINA C. HEUSER.