No. 816,869.

PATENTED APR. 3, 1906.

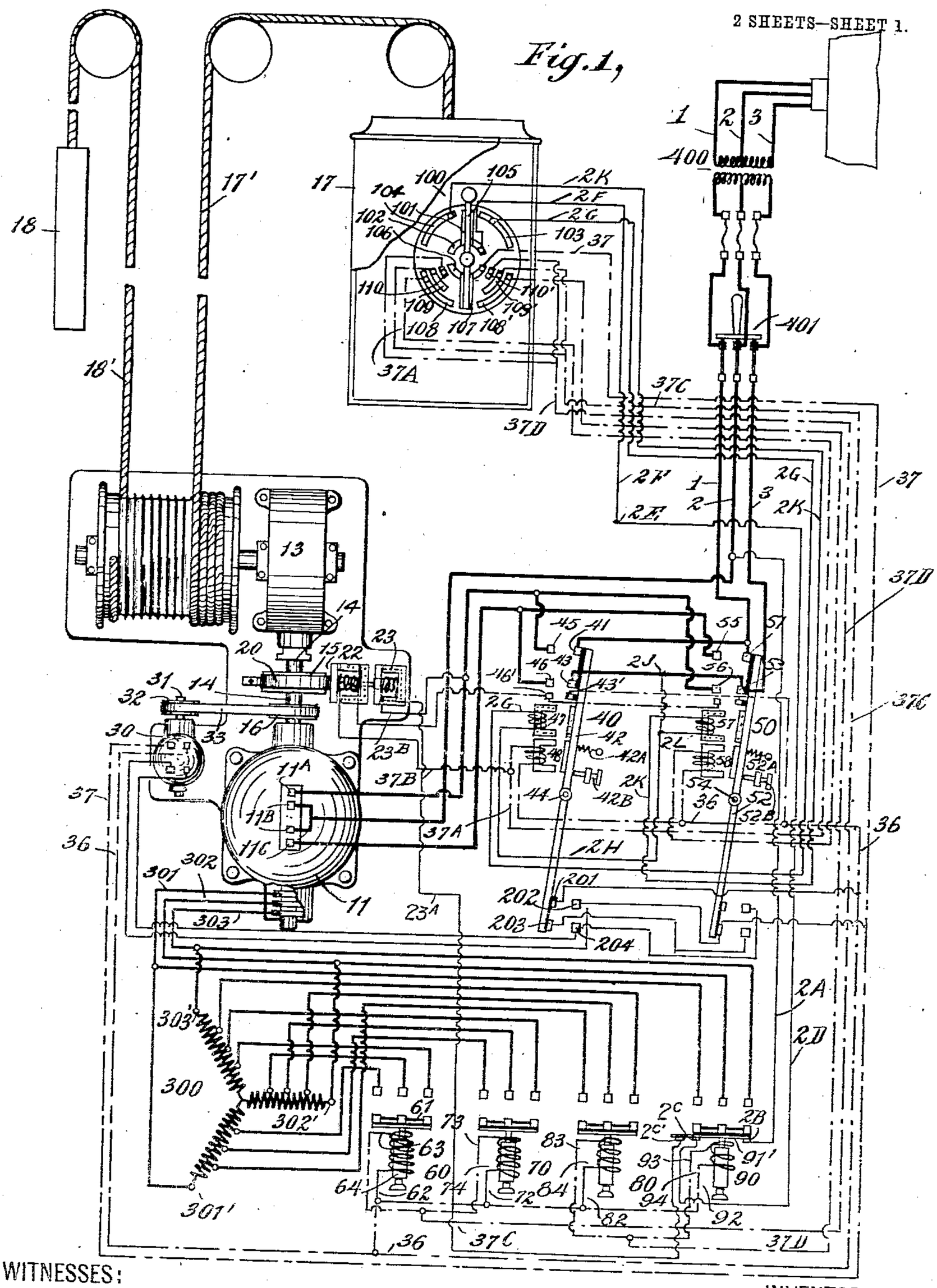
A. MAGNUSON.

ELECTRIC ELEVATOR SYSTEM.

APPLICATION FILED MAY 23, 1905.

2 SHEETS—SHEET 1.

Fig. 1,



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2 SHEETS—SHEET 2.

Fig. 2,

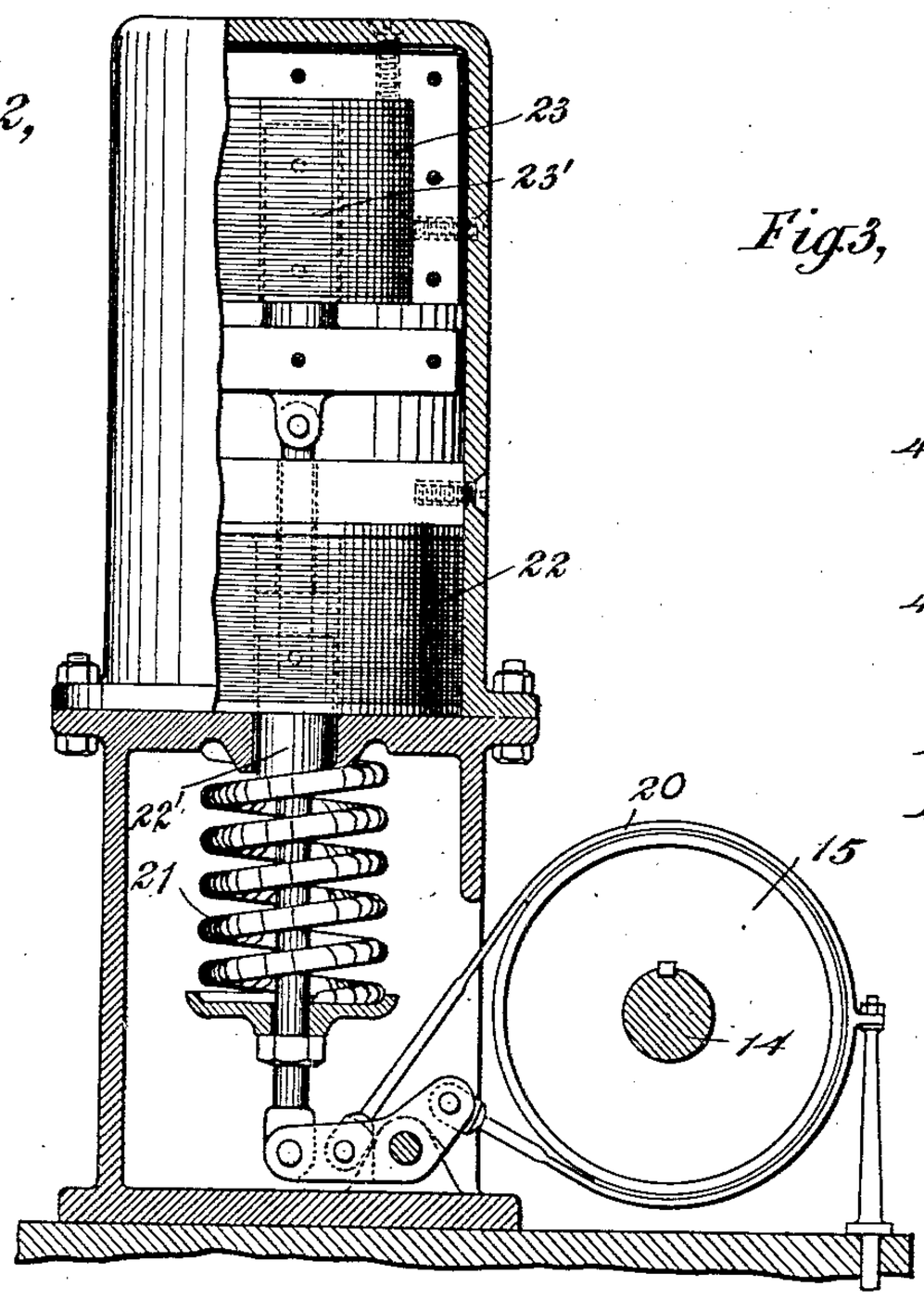


Fig. 3,

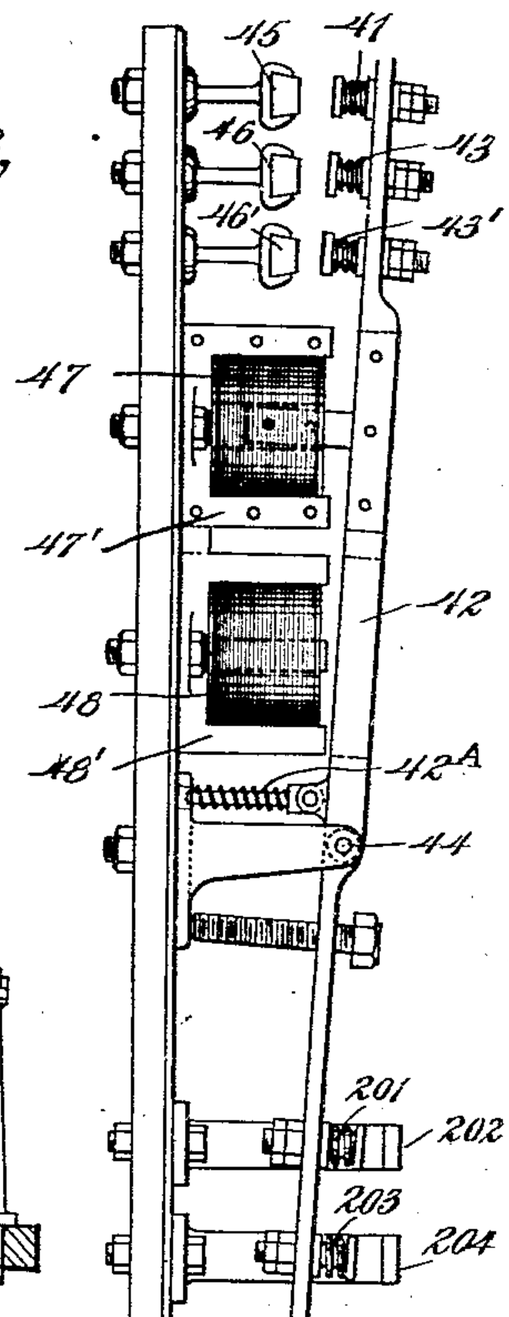
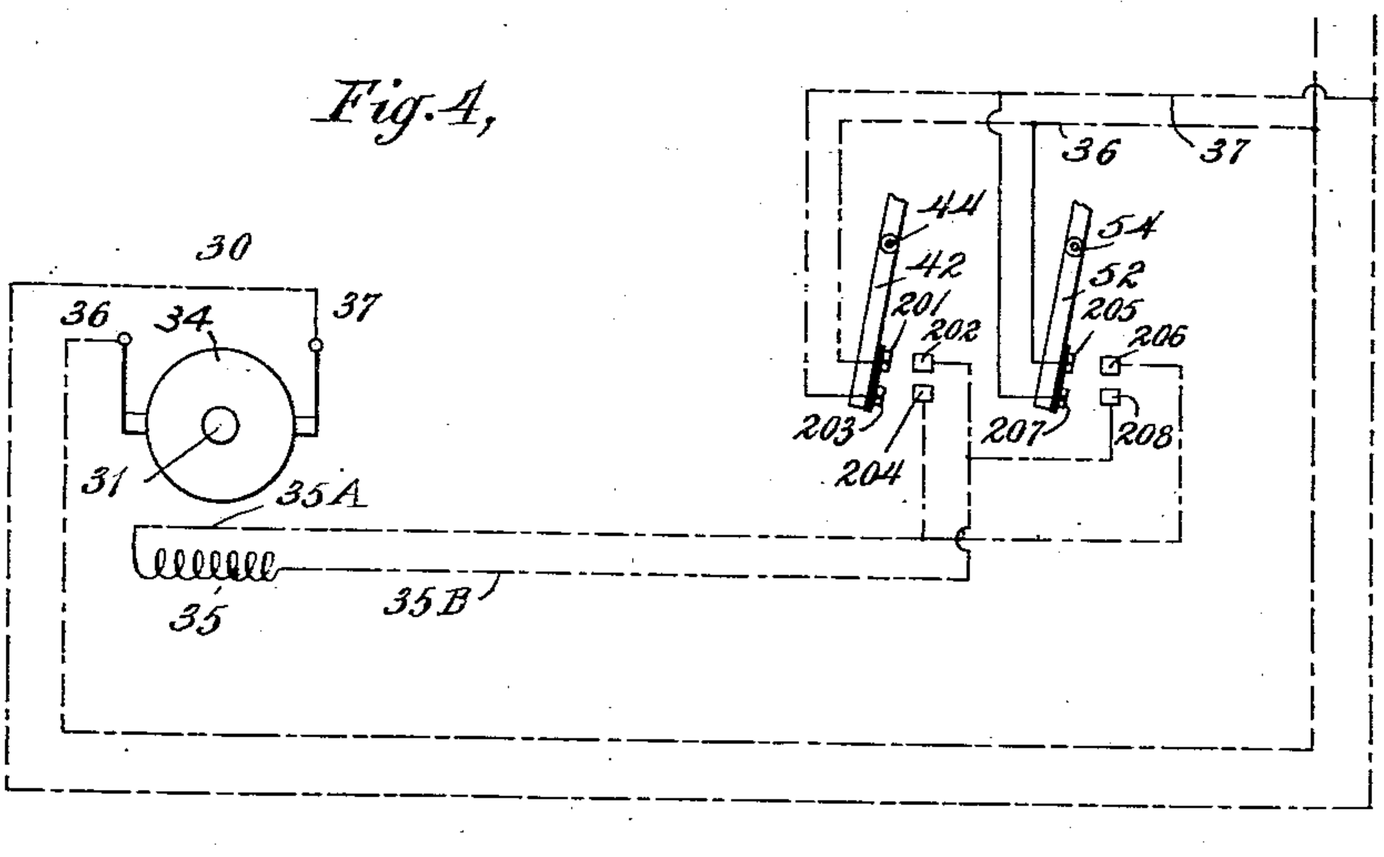


Fig. 4,



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UNITED STATES PATENT OFFICE.

AXEL MAGNUSON, OF NEW YORK, N. Y., ASSIGNOR, BY MESNE ASSIGNMENTS, TO OTIS ELEVATOR COMPANY, OF JERSEY CITY, NEW JERSEY, A CORPORATION OF NEW JERSEY.

ELECTRIC-ELEVATOR SYSTEM.

No. 816,869. Specification of Letters Patent. Patented April 3, 1906.

Application filed May 23, 1905. Serial No. 261,803.

To all whom it may concern:

Be it known that I, AXEL MAGNUSON, a citizen of the United States, and a resident of New York city, in the county of New York and State of New York, have made certain new and useful Improvements in Electric-Elevator Systems, of which the following is a specification.

My invention relates to electric elevators; and its object is to provide an improved system of control for such elevators, which system is particularly adaptable to electric elevators which are operated by alternating currents.

This invention embodies a principle of motor control for which I have applied for Letters Patent, Serial No. 241,592, January 18, 1905, and is for certain improvements and developments on that former invention which I have made in applying it to an elevator system.

I will describe an electric-elevator system made according to my present invention and point out the novel features thereof in claims.

Referring to the drawings, Figure 1 is a diagram of an electric elevator, showing the various circuits and certain parts of the apparatus. Fig. 2 is a side elevation, mostly in section, of a special brake. Fig. 3 is a side elevation of an improved magnetically-actuated switch. Fig. 4 shows a detail of wiring.

Like characters of reference designate corresponding parts in all of the figures.

10 designates a hoisting apparatus which comprises a motor 11 and a winding-drum 12, which are connected together by suitable gearing which is within a casing 13.

14 designates the motor-shaft, to which is attached a brake-pulley 15. Another pulley 16 is also attached to this shaft 14.

17 designates an elevator-car which is connected to the winding-drum 12 by means of a cable 17′. 18 is a counterweight which is connected to the winding-drum by another cable 18′.

20 designates a brake-band which is arranged to be tightened about the brake-pulley 15 by means of a spring 21 through a well-known form of connecting mechanism. It is arranged to be released from the pulley by electromagnets 22 and 23, which will be described more fully hereinafter.

30 is a generator connected to run with the hoisting apparatus. It is here shown with a pulley 32 attached to its shaft 31 and connected to the pulley 16 on the motor-shaft by a belt 33.

40 and 50 are switches for starting the elevator in one direction or the other and constitute a reversing-switch for the motor 11.

60, 70, 80, and 90 are accelerating-magnets which are arranged to control the acceleration of the motor and the elevator in starting and stopping.

I will now trace the various electrical circuits which are shown in the drawings.

Referring to Fig. 1, 1, 2, and 3 designate mains leading from a suitable source of alternating-current supply. They pass through a transformer 400 and a switch 401 and thence to the various parts of the apparatus, as is shown by heavy lines in the diagram. 1 passes to and is connected to insulated contacts 41 and 51 on the swinging arms 42 and 52 of the reversing-switch. These arms are pivoted, respectively, at 44 and 54. The other main 2 goes directly to the motor 11 and is connected to its central terminals 11^B. The motor-terminal 11^A is connected to the stationary contacts 45 and 56 of the reversing-switch, and the motor-terminal 11^C is connected to the stationary contacts 46 and 55 of the reversing-switch. It is evident, then, that when the insulated contacts 41 and 43 are moved over against the stationary contacts 45 and 46 or the insulated contacts 51 and 53 are moved over against the stationary contacts 55 and 56 the main line is connected to the motor in such a way that the current will pass through the motor in one direction or the other, and this will cause the motor to rotate in one direction or the other. I will now show how the swinging arms 42 and 52 are operated. A conductor 2^A is connected to one of the mains 2 and runs to a stationary contact 2^B, which is in electrical connection with a similar contact 2^C, because the two contacts are bridged by a plate 91′, which is controlled by the accelerating-magnet 90 in a manner which will be fully shown later. From contact 2^C a circuit is continued through a conductor 2^D to a point 2^E, and thence by 2^F to a manually-controlled switch or circuit-closer 100 in the elevator-car. This conductor is connected to a stationary contact-segment 102 in the car-switch. The car-switch is provided with a pivoted arm 105, which carries a plate 101, which may be

moved to the right or left at will, and thereby made to bridge the segment 102 and either one of two other stationary contact-segments 103 or 104. If the arm 105 is moved to the right, a circuit will thereby be established which will include the conductors just pointed out and will extend through the car-switch and through a conductor 2^{c}, through the winding of an alternating-current magnet 47, conductor 2^{H} to the point 2^{J}, where it is joined to another of the mains 3. The magnet 47 will thereby become energized and will attract the upper part of the swinging arm 42 and cause it to move over until the insulated contacts 41 and 43, which it carries, are brought against the stationary contacts 45 and 46. This arm 42 also carries other insulated contacts 43′, 201, and 203, which will at the same time the other contacts are brought together be moved against the stationary contacts 46′, 202, and 204, respectively. When the contacts 43 46 come together, they close a circuit through the winding of the brake-magnet 23, which circuit begins at contact $2^{C'}$, which is now connected with the main 2 through contact-plate 91′ and conductor 2^{A}. This circuit extends through a conductor 23^{A}, the winding of the magnet 23, and through a conductor 23^{B} to the conductor which connects the motor-terminal 11^{A} to the stationary contact 45, which is now in electrical connection with the insulated contact 41, and therefore completes the circuit to the main 1. The magnet 23 will thus become energized and will release the brake by attracting its core and compressing the spring 21, which is shown in Fig. 2. This will leave the motor free to rotate and it will actuate the hoisting mechanism, and the motor will then cause the car to travel. In the drawings circuits which carry alternating currents are indicated by solid lines. If the operator should move the pivoted arm 105 to the left, the operation would be similar; but in this case circuits would have been closed across the contact-segments 102 and 104, through conductor 2^{K}, winding of magnet 57, and conductor 2^{L} to the main 3 at 2^{J}, and the pivoted arm 52, with its insulated contacts, would have been moved. This would cause the mains to have been connected to the motor in the opposite way and would cause the motor to rotate and the car to travel in the opposite direction. Thus it will appear that an operator in the car may by means of the car-switch 100 cause the car to travel up or down at will.

Now as soon as the motor 11 begins to rotate it will drive the generator 30 through its connecting mechanism. This generator 30 may be of any desired type which may be adaptable for generating direct currents. It may, for example, be a magneto or a series dynamo or a shunt-wound dynamo. The latter is a preferred type and is the kind shown in the drawings. It will, of course, have a speed proportional to that of the motor 11, which drives it, and will consequently generate a voltage proportional to the speed of this motor. I make use of this direct current of variable pressure to control the acceleration of the motor in starting and stopping and to perform certain other functions in connection with my present invention, some of which I will now point out. It will be noted that in the diagrams all of the circuits which are used to carry the direct current are indicated by light lines composed of dots and dashes. In the first, place I will point out the purpose of the contacts which are shown directly below the reversing-switch 40 50, referring particularly to Fig. 4. In this diagram, Fig. 4, 34 designates the armature of the generator 30, and 35 designates a shunt-field. 36 and 37 are leads from the armature of the generator, and these are connected, respectively, to the insulated contacts 201 205 and 203 207, which are mounted upon the lower part of the pivoted arms 42 and 52. One of the leads 35^{A} from the shunt-field 35 is connected to the stationary contacts 204 and 206, and the other lead 35^{B} is connected to the stationary contacts 202 and 208. When the pivoted arm 42 is moved to close its contacts, the armature-leads 36 and 37 will be connected thereby to the field-terminals 35^{B} and 35^{A}, respectively; but when the pivoted arm 52 is moved to close its contacts the armature-leads 36 and 37 will be connected thereby to the field-terminals 35^{A} and 35^{B}, respectively. In this way the shunt-field connections will be reversed through the reversing-switch; but as the reversing-switch will cause the motor, and consequently the generator, to rotate in opposite directions this will insure the current generated in the armature of the generator to flow always in the same direction, regardless of the direction of rotation of the armature. Referring now to Fig. 1, 300 designates a resistance or other opposition element in the motor-circuit. This may be connected, as shown, to the rotor of the motor 11 by leads 301, 302, and 303, which are connected to the outer points of the resistance, as shown at 301′, 302′, and 303′. The resistance 300 is arranged to be short-circuited step by step in four steps by accelerating-magnets 60, 70, 80, and 90. These magnets each comprise a core and a winding and are arranged to actuate certain contacts successively as the current in the generator 30 increases. This successive actuation may be obtained by providing each magnet-winding with a different number of turns, as shown. They are arranged to be connected across the main from the generator, so that as the voltage increases the magnets will be actuated thereby in the following order: 60, 70, 80, and 90. Each of these magnets is provided with a core, as at 64, and each core

carries upon it an insulated contact-plate, as at 61. When each magnet is energized, it lifts its core and raises its attached contact-plate up against stationary contacts, which are shown above and are connected to the resistance. I will now trace the rest of the direct-current circuits which are shown on the diagram and are designated by light lines composed of dots and dashes. The main 37 is led to the car-switch and is connected to a segmental contact 106. A bridging-plate 107 on the pivoted arm 105 rests upon this contact and is arranged to connect it with other stationary contacts when it is moved to one side or the other. When it is moved to the left, it will first connect contact 106 with contact 108. A circuit will thereby be closed through conductor 37^A, winding of direct-current magnet 48 to the other main 36. At the same time a circuit will also be closed through conductors 37^A 37^B, direct-current magnet 22 on the brake, contacts 46′ and 43′ to the other main 36. These two magnets 48 and 22 will then become energized and will coöperate with magnets 47 and 23 to hold their parts firmly in place and to thus prevent any chattering which might be produced by the alternating current. If the plate 107 had been moved onto contact 108′, the result would have been similar; but in this case the magnets 58 and 22 would have had their circuits closed. A further movement of plate 107 to the left or right will bring it onto contacts 109 or 109′. These contacts are connected together and through the conductor 37^C to the upper terminals 63 and 73 of magnets 60 and 70. The lower terminals 64, 74, 84, and 94 of all of these four magnets are connected to the other main 36. These two magnets 60 and 70 will then have their windings connected across the mains of the generator 30. A still further movement of plate 107 will bring it onto contact 110 or 110′. These are connected together and to the upper terminals 83 and 93 of magnets 80 and 90 by the conductor 37^D, so that all of the four accelerating-magnets will now be connected across the mains from generator 30. Of course an opposite movement of plate 107 will first cut out magnets 80 and 90, then magnets 60 and 70, and finally the reversing-switch magnets 48 or 58, and through their action the brake-magnet 22. At this point I will show that springs 42^A and 52^A are provided to bring the pivoted arms 42 and 52 back to their initial position whenever current is cut off from their actuating-magnets. Adjustable stops 42^B and 52^B may also be provided to limit this movement. Whenever the car-switch is moved back to its central position, it will not only cut off the direct current in the circuits just shown, but will also cut off the alternating currents which it controls by its upper contacts. These alternating-current circuits which have already been traced are connected across two of the three mains, and may therefore be arranged to carry only a single-phase current, no matter what the phase of the mains may be. Of course pulsating or intermittent currents may be used in this system with like results to that obtained from alternating currents.

I have formerly shown that the alternating-current circuits pass through contacts 2^B and 2^C and $2^{C'}$, which are bridged by a plate 91′, insulated from but attached to the core of magnet 90. It will now be seen that when the direct current has obtained sufficient strength to cause the magnet 90 to be actuated the alternating-current currents in the reversing-switch and brake-magnets will thereby be cut off. This is a preferred arrangement, as it is merely a matter of adjustment to arrange this operation to take only when the direct current has attained sufficient strength to hold the reversing-switch closed and the brake released. A separate magnet may be provided for this purpose, if desired.

In Fig. 2 it may be seen that the direct-current magnet 22 has a solid core 22′ and that the core 23′ of the alternating-current magnet 23 is laminated. A similar construction is shown at 48′ and 47′ of Fig. 3, which shows two of the actuating-magnets of the reversing-switch.

In Fig. 1 conductors are shown leading to the elevator-car 17. These may be flexibly connected to the car in a well-known manner.

This invention is applicable to many forms of electric elevators. One of its principal advantages is that it provides a completely automatic system of control and yet makes it possible for the operator in the car to positively control the various automatic devices at will. The operator can control the acceleration of the car in starting and can slow it down before stopping.

I use in some of the claims the expression "constant in value" in connection with the current in the mains. This, of course, means a current of practically constant value, such as is usually found in power-mains.

I have shown and described my system as applied to alternating-current elevators; but it may be applied also to direct-current elevators.

Having described my invention, what I claim is—

1. In an elevator the combination of a hoisting mechanism, a movable car connected thereto, a stationary alternating-current motor for actuating the hoisting mechanism, an external source of current-supply, a second source of current-supply, dependent upon the motion of the hoisting mechanism, suitable electrical circuits, and a switch in the car arranged to control the movement of the car by controlling both current-supplies.

2. In an elevator system the combination

of a car, two electric machines, one adapted to propel or drive the car, the other to generate a current in proportion to the speed of the car, automatic means for controlling the acceleration of the car by said generated current, a manually-operated switch in the car arranged to start and stop said first electric machine and to directly control said automatic controlling means.

3. In an elevator system, a motor, a reversing-switch for the motor, two sources of current-supply one of which is pulsating and is arranged to close the reversing-switch, the other of which is direct and is arranged to hold the reversing-switch in closed position, means for controlling the two current-supplies, and means for automatically cutting out the pulsating current.

4. In an elevator system, a motor and a car, a reversing-switch for the motor, two sources of current-supply, one of which is pulsating and constant in value and is arranged to close the reversing-switch to start the motor, the other of which is direct and proportional in strength to the speed of the car and is arranged to hold the reversing-switch in closed position while the car is running, a switch in the car for controlling both the pulsating and direct currents, and means for automatically cutting out the pulsating current.

5. In an elevator system, a motor and a car, a reversing-switch for the motor, two sources of current-supply, one of which is pulsating and constant in value and is arranged to close the reversing-switch to start the motor, the other of which is direct and proportional in strength to the speed of the car and is arranged to hold the reversing-switch in closed position while the car is running, a switch in the car for controlling both the pulsating and direct currents, and means for automatically cutting out the pulsating current when the direct current reaches a predetermined strength.

6. In an elevator system, an alternating-current motor, a source of alternating-current supply, an electromagnetically-actuated reversing-switch for the motor, a single-phase current arranged to close the reversing-switch and a direct current arranged to hold the reversing-switch, and means for cutting out the single-phase current after the motor has started.

7. In an elevator system, an alternating-current motor, a source of alternating-current supply, an electromagnetically-actuated reversing-switch for the motor, a single-phase current arranged to close the reversing-switch and a direct current arranged to hold the reversing-switch, a manually-operated switch for controlling the single-phase current, and means for automatically cutting out the single-phase current after the motor has started.

8. The combination with an alternating-current motor, a reversing-switch therefor, a generator connected to run with the motor and arranged to produce a direct current proportional in strength to the speed of the motor, means for controlling the motor by the direct current thus produced, and means on the reversing-switch for causing the generator to produce its current in the same direction when the generator is run in one direction or the other.

9. In an elevator system, an alternating-current motor, a source of alternating-current supply, a generator connected to run with the motor and arranged to produce a direct current proportional in strength to the speed of the motor, an electroresponsive device for controlling the acceleration of the motor, said electroresponsive device being actuated by the direct current, and a manually-operated switch for directly controlling the direct-current circuit to the electroresponsive device.

10. In combination with a hoisting apparatus, an electric brake having two windings, one adapted for alternating currents and arranged to release the brake, the other adapted for direct currents and arranged to hold the brake in released position.

11. In combination with a hoisting apparatus, an electric brake therefor, an external source of current-supply arranged to release the brake in starting the apparatus, and an independent source of current-supply generated by the movement of the apparatus and arranged to coöperate with said first source of supply in holding the brake in released position.

12. In combination with a hoisting apparatus, an electric brake therefor, an external source of current-supply arranged to release the brake before starting the apparatus, and an independent source of current-supply generated by the movement of the apparatus and arranged to hold the brake in released position while the apparatus is running.

13. In combination with a hoisting apparatus, an electric brake therefor, an external source of alternating-current supply arranged to release the brake before starting the apparatus, and an independent source of direct-current supply generated by the movement of the apparatus and arranged to hold the brake in released position while the apparatus is running.

14. In combination with a hoisting apparatus, an electric brake therefor, an external source of alternating-current supply arranged to release the brake before starting the apparatus, an independent source of direct-current supply generated by the move-

ment of the apparatus and arranged to hold the brake in released position while the apparatus is running, and means for automatically cutting off the alternating current after the direct current holds the brake.

15. In combination with a hoisting apparatus, an electric brake, an alternating-current electromagnet comprising a winding and a laminated core, and a direct-current electromagnet comprising a winding and a solid core both of said electromagnets being arranged to actuate the brake.

16. In combination with a hoisting apparatus, an alternating-current motor for driving the same, a source of alternating-current supply, an electric brake, a reversing-switch for applying the alternating current to the motor and to the brake, a direct current generated by the movement of the motor and arranged to coöperate with the alternating current to actuate the brake.

17. In combination with a hoisting apparatus, an alternating-current motor for driving the same, a source of alternating-current supply, an electric brake, a reversing-switch for applying the alternating current to the motor and to the brake, a direct current generated by the movement of the motor and arranged to coöperate with the alternating current to actuate the brake, and a manually-operated switch for controlling the reversing-switch.

18. In combination with a hoisting apparatus, an electric motor, a source of current-supply, an electric brake for the apparatus, and a generator driven by the apparatus and arranged to control the acceleration of the motor and to hold the brake in released position while the motor is running.

19. In an elevator system, an alternating-current motor, a source of alternating-current supply, a generator connected to run with the motor and arranged to produce a direct current proportional in strength to the speed of the motor, a brake and a starting-switch for the motor, both of which are actuated by a single-phase current in starting and by the direct current after starting the motor, an electroresponsive device actuated by the direct current for controlling the acceleration of the motor, and a manually-operated switch whereby the starting, stopping and acceleration of the elevator is controlled.

20. In an elevator system, a car, an alternating-current motor, a source of alternating-current supply, a generator connected to run with the motor and arranged to produce a direct current proportional in strength to the speed of the motor, a brake and a starting-switch for the motor, both of which are actuated by the alternating current in starting the motor and are held by the direct current after the motor has started, an electroresponsive device actuated by the direct current for controlling the acceleration of the motor and arranged to cut off the alternating current from the brake and the starting-switch, and a manually-operated car-switch whereby the brake, the starting-switch and the electroresponsive device are controlled.

21. In an elevator system, a car, an alternating-current motor, a source of alternating-current supply, a generator connected to run with the motor and arranged to produce a direct current proportional in strength to the speed of the motor, a brake and a starting-switch for the motor both of which are actuated by the alternating current in starting the motor and are held by the direct current after the motor has started, an electroresponsive device comprising a series of electromagnets actuated by the direct current for controlling the acceleration of the motor step by step, one of which is arranged to cut off the alternating current from the brake and the starting-switch, and a manually-operated car-switch whereby the brake, the starting-switch and the electroresponsive device are controlled.

22. In an electric-elevator system, a car, a hoisting apparatus connected thereto, an alternating-current motor for actuating the hoisting apparatus, an opposition element in the motor-circuit, a source of alternating-current supply, a generator connected to run with the apparatus and arranged to produce a direct current proportional in strength to the speed of the car, a brake, a reversing-switch, alternating-current circuits and direct-current circuits for the brake and the reversing-switch, an electroresponsive device comprising a plurality of electromagnets actuated by the direct current for controlling the acceleration of the motor step by step by removing the opposition element from the motor-circuit, one of said magnets being arranged to cut off the alternating current from the brake and the reversing-switch, and a manually-operated switch in the car for controlling the alternating-current circuits and the direct-current circuits and thereby controlling the starting, stopping and acceleration of the car.

23. In an elevator system, an alternating-current motor, a source of alternating-current supply, an electromagnetically-actuated reversing-switch for the motor, the alternating current arranged to close the reversing-switch, a direct current arranged to hold the reversing-switch, and means for cutting out the actuating alternating current from the reversing-switch after the motor has started.

24. In an elevator system, an alternating-current motor, a source of alternating-current supply, an electromagnetically-actuated reversing-switch for the motor, the alternating current arranged to close the reversing-switch, a direct current arranged to hold

the reversing-switch, a manually-operated switch for controlling the alternating current, and means for automatically cutting out the alternating current after the motor has started.

25. In combination with an electric motor, a reversing-switch therefor, a generator connected to run with the motor and arranged to produce a current proportional in strength to the speed of the motor, means for controlling the motor by the current thus produced, and means on the reversing-switch for causing the generator to produce its current in the same direction when the generator is run in one direction or the other.

26. In an elevator system, an electric motor, a source of current-supply, a generator connected to run with the motor and arranged to produce a current proportional in strength to the speed of the motor, an electroresponsive device for controlling the acceleration of the motor, said electroresponsive device being actuated by the current produced by said generator, suitable circuits therefor, and a manually-operated switch for directly controlling the circuits to the electroresponsive device.

27. In an elevator system, an electric motor, a source of current-supply, a generator connected to run with the motor and arranged to produce a current proportional in strength to the speed of the motor, an electroresponsive device for controlling the acceleration of the motor, said electroresponsive device being actuated by the current produced by said generator, suitable circuits therefor, and a manually-operated switch arranged to cut in or out a part or all of the electroresponsive device at will.

28. A controlling device for an elevator-motor, a stationary motor, a source of current-supply connected thereto and adapted to start the motor and to drive the motor, a movable car, an electric generator connected with the elevator mechanism arranged to generate a current in proportion to the speed of the elevator mechanism, said current adapted to actuate the motor-controlling device, and a switch in the car adapted to control the controlling device to control the starting, the speed, the reversing and the stopping of the elevator mechanism.

29. In an elevator-controlling mechanism of the class described, an external source of supply constant in value, said source adapted to start and drive the elevator mechanism, another source of supply obtained only after the elevator has started and proportional in value to the speed of the elevator mechanism, an elevator-car, a manually-operated switch in the elevator-car, contacts in the switch-wires connected to the car and adapted to travel with the car, said wires being directly connected to the various contacts in the car-switch and also directly connected to the motor-controlling means, some of said wires carrying the circuits for the external source of supply and some carrying the circuits for the source of supply generated by the movement of the elevator mechanism and being adapted to conjointly communicate the operation from the car-switch to the motor-controller.

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

AXEL MAGNUSON.

Witnesses:

HENRY E. KIRBY,

ERNEST W. MARSHALL.