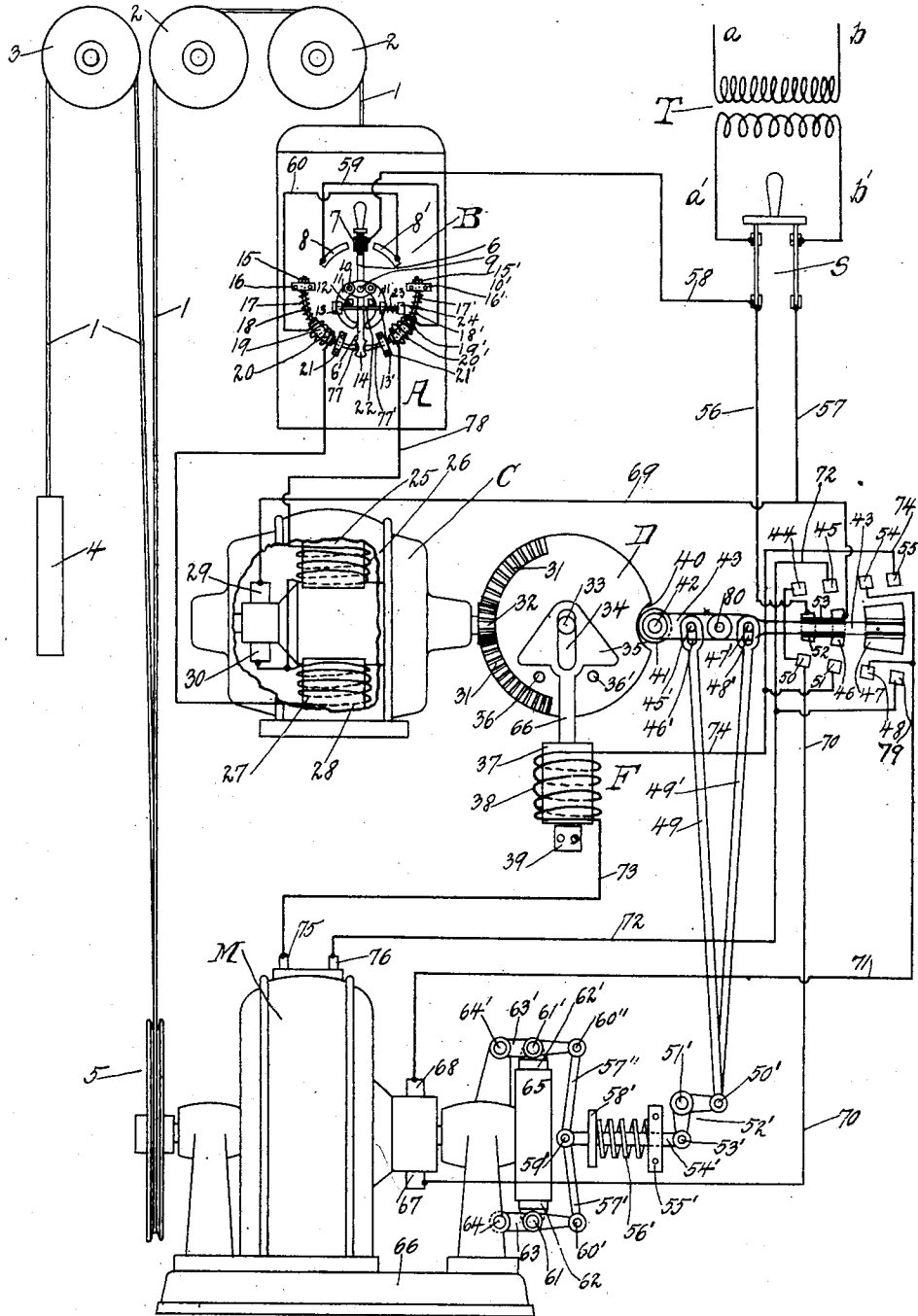


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INDUCTIVE MOTOR CONTROL.
APPLICATION FILED JUNE 27, 1907.

982,695.

Patented Jan. 24, 1911.



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UNITED STATES PATENT OFFICE.

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INDUCTIVE-MOTOR CONTROL.

982,695.

Specification of Letters Patent.

Patented Jan. 24, 1911.

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To all whom it may concern:

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

My invention relates to the control of alternating current electric motors, and one of its objects is the provision of simple and efficient means to accelerate a motor in inverse proportion to its load.

A further object of the present invention is to provide an alternating current motor controlling system containing a minimum number of moving contacts and which shall be substantially noiseless in operation.

Other objects of the invention will appear more fully hereinafter, the novel combinations of elements being set forth in the appended claims.

The accompanying sheet of drawings illustrates my invention applied to a traction or direct drive elevator apparatus to which it is particularly adapted, but it should be understood that it may have a general application; and while I show for purposes of illustration a single phase alternating current wiring diagram, it is within the scope of my invention to employ alternating currents of any kind or phase.

A designates an elevator car which carries a manually operated controlling switch B comprising the switch lever 6 which carries an insulated contact 7 and is pivoted at 9. This switch lever 6 has a lower extension 6' provided at its lower end with an enlarged portion 14 which normally engages two arc-shaped rods 18 and 18', one on either side. These arc-shaped rods carry the magnet cores 19, 19' preferably rigidly attached thereto and springs 17, 17' which bear against the upper ends of the cores 19, 19' and against the fixed guides 16, 16', respectively, and limit the movement of the said rods in one direction.

21 and 21' are fixed guides for the respective rods 77, 77'. The switch lever 6 is provided with a centering device comprising two arc-shaped levers 11 and 11' pivoted at 10 and 10', respectively. The other ends of the levers 11, 11' bear against the opposite sides of the extension 6' and are held firmly against such extension by the compression

spring 23 carried by the rod 22 which is connected to the lever 11 at 13 and passes freely through a projection 13' on the lever 11'. The other end of the rod has a fixed collar 24 against which the spring 23 bears.

12 and 12' are fixed stops which limit the inward movement of the arc-shaped levers 11 and 11'.

8 and 8' designate fixed contacts arranged to be engaged by the insulated contact 7 carried by the switch lever 6, when the latter is moved to the left or right, respectively.

C designates a pilot motor and is shown as an alternating current motor of the series commutator bipolar type.

25 and 27 are the field poles provided with the windings 26 and 28, respectively, which are wound differentially so that if both field windings receive current of equal strength at the same time the resulting magnetism of the fields would substantially counteract each other and there would be no tendency for the pilot motor armature to revolve.

D designates a circular plate arranged to revolve about a fixed pivot 33 and carries a segmental gear 31 which meshes with the bevel gear 32 securely attached to one end of the pilot motor shaft. The circular plate D is provided with a cutaway portion or recess 40 in which is a roller 41 pivoted at 42 to a switch lever 43. The latter is arranged to swing about pivot 80 and carries on its right hand arm the contacts 52, 46 and 47. The contacts 52 and 46 are insulated from each other and from the switch lever by insulating material 53. The contact 47 is likewise insulated from the switch lever as shown. Adjacent the contacts carried by the switch lever are fixed contacts 44, 45, 54 and 55 on one side and fixed contacts 50, 51, 48 and 79 on the other side. These stationary contacts are in the path of movement of and are arranged to be engaged by the contacts carried by the switch arm as will more clearly appear hereinafter.

Mounted upon the switch lever 43 and at substantially equal distances from the pivot 80 are pins 45' and 47' which extend into slots 46' and 48' provided in the enlarged ends of the rods 49 and 49', respectively. These rods extend downwardly and are both connected at 50' to one arm of the bell crank lever 52' which is pivoted at 51'. The other arm of the lever 52' is connected at 53' to a rod 54' to the other end of which is con-

5 nected at 59' the toggle levers 57' and 57''. The latter are connected at 60' and 60'' to the brake levers 63 and 63', respectively. These levers are pivoted at 64 and 64' to a
 10 stationary support, which may be as shown one of the standards which support the motor bearings. Each of the levers 63 and 63' carries a brake shoe 62 and 62', respectively, connected at 61 and 61' and arranged to en-
 15 gage substantially diametrically opposite sides of the friction pulley 65 which is connected to the motor shaft to rotate therewith. The rod 54' slides freely through a fixed guide piece 55' and is surrounded by a compression spring 56' which bears against a collar 58' secured to the rod 54' and against the fixed guide piece 55'. The tendency of the spring 56' is to forcibly move the rod 54' to the left, thereby causing the toggle levers 57' and 57'' to apply the brake shoes to the
 20 outer periphery of the brake pulley 65.

The circular plate D is provided with two fixed pins 36 and 36' in the path of movement of which is arranged a lower extension 66 of a triangular-shaped piece 35. Into a slot 34 of the latter extends a lug or projection 33 at the pivotal point of the plate D. The lower extension or rod 66 is connected to the upper end of a magnet core 37 movable in a solenoid 38. The downward movement of the triangular-shaped piece 35, the rods 66 and the core 37 is limited by the fixed stop 39 in the path of movement of the core 37.

35 The armature shaft of the hoisting motor M carries a driving sheave 5 which frictionally engages the hoisting cables 1, the ends of which are connected to a car A and to the counterweight 4 after passing over the overhead sheaves 2, 2 and 3, the latter being mounted on fixed overhead beams for instance. The combined weight of the car and counterweight brings the cables into engagement with the grooved sheave 5 and the resulting friction is sufficient to prevent slipping so long as the car and counterweight are properly counterbalanced.

50 T designates a transformer to which are connected the conductors a and b leading from a source of alternating current supply of high potential desired. The secondary winding of the transformer then reduces the potential so that the resulting current through the mains a' and b' will be suitable for operating the electric motor M and the controlling apparatus therefor. The mains a' and b' are connected to the controlling apparatus by means of the manual switch S.

60 I will now trace the various circuits and explain the operation of the controlling apparatus. Assuming the main line switch S to be closed as shown, it will be seen that a circuit to the main motor M is open at the 65 contacts 52 and 46; also the operating cir-

cuit is open at the contact 7 of the car switch B. In order to operate the system it will be necessary to move the car switch lever 6 to the right or left until the contact 7 comes into electrical engagement with either of the stationary contacts 8 or 8'. Let it be assumed that the switch lever 6 is moved to the left so that the contact 7 engages the segment 8. A circuit will then be established from the main switch S through conductor 58 to contacts 7 and 8, and thence through the conductor 59, solenoid 20', conductor 78, series field winding 26 of the pilot motor or auxiliary motor C, brush 30, pilot motor armature, brush 29, and conductors 69 and 57 of the main b'. The solenoid 20' and the pilot motor now receive current and the latter will start to revolve, although the torque of its armature will be comparatively small since the pilot motor circuit contains a comparatively large amount of impedance due to the choking effect of the core 19' in the solenoid 20'. As the pilot motor rotates the circular plate D is also rotated since it is positively geared thereto. If it be assumed that the plate D revolves in a clockwise direction the roller 41 will be engaged by the cam surface 40 until the said roller rides on the outer circular periphery of the plate D. The left hand arm of the lever 43 will be moved downwardly by this action and the right hand arm upwardly, thus effecting the electrical engagement of the contacts 52 and 44; 46 and 45, respectively, while the contact 47 will engage or bridge both of the contacts 54 and 55. The closure of this switch will at once establish a circuit to the main motor M, which circuit may be traced as follows,—from the main conductor 56 to and through the contacts 52, 44, conductor 70, motor armature by way of brushes 67 and 68, conductor 71, contacts 54, 47 and 55, conductor 74, magnet winding solenoid 38, conductor 73, terminal 75 of the series field winding of the motor M, terminal 76 after passing through the series field winding, conductor 72, contacts 45, 46, to the main conductor 57. A circuit is therefore closed through the main motor M including the choking or impedance coil 38 of the electro-magnet F, and since the core 37 of this coil substantially fills the space in the latter, the choking effect is at a maximum and but little current will pass through the motor winding.

120 When the switch lever 43 operates in the manner stated the rod 49' will be lifted by the pin 47' and the bell crank lever 52' will therefore be actuated against the action of the brake spring 56'. The toggle connection will therefore be operated to release the brake shoes 62 and 62' from the brake pulley 65. The motor may now start at slow speed. As the pilot motor receives at this time but a small amount of current due to 130

the impedance in its circuit it will rotate the plate D only slowly, and the rotation of the latter not only causes the main circuit to the motor to be closed and the brake apparatus to be released but it also moves the pin 36 so that it will engage the lower surface of the triangular piece 35 and upon further movement will lift the rod 66 and its connected core 37 a short distance out of the solenoid 38. The current which is now flowing to the main motor must necessarily traverse the winding of the solenoid 38 and this current produces a downward pull upon the core 37, the effect of which is to counteract the rotative effect of the pilot motor armature, and the result will be that after the core 37 has been lifted out of its solenoid a short distance this downward pull of the core will counterbalance the torque of the pilot motor and the latter will come to rest. The main motor has in the meantime been running at slow speed accompanied by slow upward or downward travel of the elevator car, the direction of car travel depending of course upon the direction of rotation of the main motor M and the sheave 5 rotating therewith.

In order to accelerate the main motor the car switch lever 6 is moved farther to the left, thereby causing the lower end 14 of the switch lever to move the rod 18' and its connected core 19' to the right against the action of the spring 17', and also moving the centering lever 11' outwardly against the action of the centering spring 23. Since the core 19' has thus been partially withdrawn from the winding 20' the reluctance to the magnetic lines of force is increased and the impedance of the circuit comprising this winding and the pilot motor C is thereby decreased and more current will consequently flow through this circuit. A torque of the pilot motor is therefore increased to overcome the counteracting pull of the electro-magnet F, and the core 37 of the latter is therefore farther withdrawn from its winding or solenoid 38, thereby diminishing the impedance of the main motor circuit and allowing more current to flow through the motor to effect an increase of speed of the latter. The additional current now flowing through the winding or the choking coil 38 produces a correspondingly greater downward pull on the core 37 which increases as the core moves upwardly toward the center of the latter, until finally the downward pull of the electro-magnet F will balance the torque of the pilot motor and the latter will come to rest. It will therefore be seen that the speed of the motor will depend upon the position of the car switch. To obtain full normal speed of the main motor the car switch lever is thrown to its extreme position, when the pilot motor will receive more current to effect a reduction of impedance in

the main motor circuit by lifting the core 37 still farther out of the choking coil 38. The additional current which will now flow through the winding of the choking coil 38 will cause an increased pull on the core 37 which will again effect the balance with the torque of the pilot motor and the latter will again be brought to rest, the main motor in the meantime having been brought up to full normal speed.

If it is desired to reduce the speed of the main motor the car switch lever 6 is moved a short distance back to the right or toward its central or vertical position. The spring 17' then moves the core 19' back into the winding 20' a corresponding distance and thus increases the impedance in the circuit of which this winding is a part. This reduces the current flowing in the pilot motor and also reduces its torque. This at once destroys the balance existing between the pilot motor torque and the downward pull of the electro-magnet F. The latter will therefore cause the pilot motor to be rotated backward until the balance is again established between the two. As the pilot motor rotates backward, however, more of the core 37 is included in the winding 38, and the increased impedance thus introduced into the main motor circuit causes less current to flow in the latter and the motor will therefore run at a diminished speed.

In order to stop the motor the car switch lever is brought back to its vertical, central or "off" position, when the circuit to the pilot motor is open at the contacts 7 and 8. The pilot motor is now rotated backward, due to the weight of the core 37 and its connected parts and to the downward pull of the magnet F under the influence of the energization produced by the current flowing through the winding 38. Just before the circular plate D reaches its normal or central position the roller 41 starts to enter the cam recess 40 and the brake spring 56 acting through the bell crank 52, the rod 49' will forcibly rotate the plate D back to center and at the same time will open the main motor switch at the contacts 44, 45, 54 and 55. The brake shoes 62 and 62' will again engage the periphery of the brake pulley 65 and the main motor will come to rest. Should the operator in the car at any time remove his hand from the car switch B the latter will automatically return to center, the centering spring 23 and either one of the springs 17' or 17' acting in conjunction with each other to automatically move the switch lever to central position, with the ultimate result that in any event all the parts will be returned to normal starting position and the motor and car stopped.

In order to operate the main motor in a reverse direction the car switch lever is moved to the right until the contact 7 en-

gages the stationary contact 8', whereupon a circuit is closed through the magnet winding 20 and the series field winding 28 of the pilot motor. The latter at once starts and rotates the circular plate D in a counter-clockwise direction, in which event the movable contacts 52, 46 and 47 carried by the switch arm 43 will engage the stationary contacts 50, 51, 48 and 79, respectively, and a circuit will be closed to the main motor M as before, excepting that the direction of current in the main motor field is reversed, the direction of the armature current remaining the same. This relative change in the direction of current flow through the main motor windings causes the latter to rotate in a reversed direction. The brake rod 49 now releases the motor brake mechanism while the pin 47' is free to move downwardly in the slot 48' of the brake rod 49'. The operation and control of the various parts will be the same as before, only this time the pin 36' lifts the core 37 out of the winding 38.

From the foregoing description it is readily seen that the operation of the car switch controls the movement of the pilot motor armature, which movement is more or less counterbalanced by the opposing action of the choking coil 38, and since this opposing action depends upon the current flowing through the main motor, which bears a close relation to the load upon the motor, it necessarily follows that the rate of acceleration of the main motor will be substantially inversely proportional to its load. That is if the car switch is moved to a certain point and it is desired that the motor be accelerated to a corresponding speed, the acceleration will be rapid if the load is light, while if the load be heavy the acceleration will be slower. Should an attempt be made to start the motor when the same is heavily overloaded, the heavy current in the choking coil 38 would not permit the pilot motor to lift the core 37 in the choking coil. Therefore, while it is possible to allow the motor normal starting current under any conditions of load, the automatic action of the system will not allow the current flow to become excessive or dangerous to the safety of the motor. Even though the motor has attained full speed and a sudden overload should come on, the current will be kept within safe limits by the automatic action of the choking coil 38 which would immediately increase the impedance in the motor circuit and thereby check the excessive current flow. Another important feature of my invention is the entire absence of chattering contacts so common to motor controlling systems using alternating current magnetic devices. The motor switch contacts may be spring pressed to allow for slight irregularities in the periphery of the

plate D, but it is evident that any vibration of the plate D, due to alternations of current in the pilot motor C and the electro-magnet F, will not be transmitted to the main motor switch contacts, as the plate D and the roller 41 will simply roll back and forth on each other to an extent depending upon the vibration.

Obviously those skilled in the art may make various changes in the details and arrangement of parts without departing from the spirit and scope of my invention, and I desire therefore not to be limited to the precise construction herein disclosed.

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

1. The combination with an alternating current motor and a source of current supply, of an inductance coil in the motor circuit, and means for automatically varying the inductance as the current varies.

2. The combination with an alternating current motor and a source of current supply, of an inductance coil in the motor circuit, a core for the coil, and means for moving the core to vary the inductance as the current through the motor varies.

3. The combination with an alternating current motor and a source of current supply, of an inductance coil in the motor circuit, a core for the coil, and means for moving the core in and out of the coil as the current increases or decreases, respectively.

4. The combination with an alternating current motor and a source of current supply, of an impedance in the motor circuit, means for automatically varying the impedance substantially in proportion to the current through the motor, and a manually controlled device for varying said impedance.

5. The combination with an alternating current motor and a source of current supply, of an impedance coil in the motor circuit, a magnetic core movable into and out of said coil, and means for exerting a yielding outward pull on the core which is balanced by the magnetic pull of the coil on the core when the motor circuit is excited, said coil and its core being designed to control the speed of the motor by the variation of the impedance in said coil.

6. The combination with an alternating current electric motor and a source of current supply, of an impedance coil in the motor circuit, a magnetic core movable into and out of the coil and controlling the speed of the motor by varying the impedance in said coil, and means for exerting a yielding outward tension on the core balanced by the magnetic pull of the coil on the core, and holding the core in a position varying with the current.

7. The combination with an alternating

current motor and a source of current supply, of an impedance coil in the motor circuit, a magnetic core for the coil movable into positions to vary the impedance in the motor circuit, means for exerting tension on the core to retract it to a position in which it is balanced by the magnetic pull of the coil, and means for varying the tension on the core.

8. The combination with an alternating current main motor and a source of current supply, of an impedance connected in circuit between the motor and source of current supply, a secondary motor, means operated by the latter for varying said impedance to correspond to the strength of current flowing through the main motor, and thereby controlling the acceleration of the main motor when it is connected to the source of current supply, and a manual device for controlling the speed of the secondary motor.

9. The combination with an alternating current main motor and a source of current supply therefor, of a pilot motor, means operated thereby for varying the impedance in the main motor circuit as the load varies, and a device controlling the pilot motor and thereby varying said impedance for any given load on the main motor.

10. The combination with an alternating current main motor and a source of current supply, of a pilot motor, an impedance coil in a circuit of the main motor, a magnetic core movable into and out of the coil, and connections between the core and the pilot motor.

11. The combination with an alternating current main motor and a source of current supply, of a pilot motor, an impedance coil in the field circuit of the main motor, a magnetic core movable in the coil to vary its impedance, and driving connections between the pilot motor and the core to move the core into a position in which it is balanced between the torque of the pilot motor and the magnetic pull of the coil.

12. The combination with an alternating current main motor and a source of current supply, of an inductance coil in the field circuit of the main motor, a magnetic core in the coil movable to vary the inductance of the coil, a pilot motor, driving connections therefrom to the core, to move the core into a balanced position between the torque of the motor and the magnetic pull on the core, said position being variable with the load on the motor, and means for varying the current through the pilot motor.

13. The combination with an alternating current electric motor, of a source of current supply therefor, an inductance coil in a circuit of the motor, a magnetic core in the coil, and manually controlled means for au-

tomatically varying the position of the core to vary the impedance in the motor circuit.

14. The combination with an alternating current motor and a source of current supply therefor, of an inductance coil in the motor circuit, means for varying the inductance of said coil, and a switch in the motor circuit operatively connected with said means.

15. The combination with an alternating current motor and a source of current supply therefor, of a reversing switch in the motor circuit, an inductance coil in each side of the circuit, and means operated by the switch for varying the inductance in the coils.

16. The combination with conductors leading from a source of alternating current supply, of a translating device, an inductance coil and a reversing switch in the circuit of the translating device, and means operable upon the movement of the reversing switch for varying the inductance of said coil.

17. The combination with a source of alternating current supply, of a translating device, a plurality of circuits through said device, spaced contacts in the circuits, a switch lever, a contact carried thereby and connected to the source of current supply, said lever being movable into positions to bring its contact into engagement with either of the fixed contacts, an inductance coil in each circuit, and means operated by said lever to vary the inductance of either coil when the lever is operated to close its circuit.

18. The combination with an inductance coil, of a fixed contact in the circuit of the coil, a lever carrying a contact movable into engagement with the fixed contact to complete the circuit through the coil, a movable core for the coil, and an extension carried by the core in the path of movement of the lever.

19. The combination with a plurality of inductance coils, of spaced contacts in the circuits of the coils, a lever, a contact carried by the lever and movable therewith into engagement with either of the contacts, a movable core for each coil and an extension carried by each core in the path of movement of the lever and movable by said lever to vary the inductance of its coil when the lever is moved to close the circuit of said coil.

20. The combination with a switch lever pivoted intermediate its ends, of inductance coils on opposite sides of the lever, arc-shaped members extending into the coils and carrying magnetic cores for the coils, the inner ends of said members being in the path of movement of one end of the lever, fixed contacts on opposite sides of the other end of the lever and in the circuits of the coils, a contact on the lever movable into engage-

ment with either of the fixed contacts to close the circuit through its coil, said members being movable with the lever to vary the inductance in the coils when their circuits have been closed, means for yieldingly holding the lever in its central position, and means for returning the arc-shaped members to their normal positions.

21. The combination with a main motor, a source of alternating current supply and a pilot motor, of an inductance coil in a circuit of the main motor, a magnetic core in the coil, driving connections between the pilot motor and the core for moving the core into position where it is balanced between the magnetic pull of the coil and the pull due to the torque of the pilot motor, an inductance coil in a circuit of the pilot motor, a magnetic core in said coil, a switch in the pilot motor circuit, and a connection between the switch and said last-named core for varying the position of the core, and thereby varying the current in the pilot motor.

22. The combination with an electric motor and a source of current supply, of a brake, means to normally apply the brake, a switch in the motor circuit comprising a pivoted switch lever, links connected to the lever on opposite sides of its fulcrum, and means connected to said links for releasing the brake when the lever is moved in either direction.

23. The combination with a source of alternating current supply, a main motor and a pilot motor, of an inductive resistance and a switch in the main motor circuit, and means operated by the pilot motor for closing the switch and thereby supplying current to the main motor, and operative while said switch is closed to automatically vary the inductive resistance to correspond with variations in the current strength.

24. The combination with a source of alternating current supply, a main motor and a pilot motor, of a reversing switch and an inductive resistance in the main motor circuit, and means operated by the pilot motor for successively closing the switch and varying the inductive resistance to a degree corresponding to the strength of current through the main motor.

25. The combination with a source of alternating current supply, a main motor and a pilot motor, of a reversing switch and an inductive resistance in the main motor circuit, a brake, and means operated by the pilot motor for closing the switch, and automatically varying the inductive resistance to an extent dependent upon the volume of current flowing through the main motor, and operating connections between the said switch and the said brake.

26. The combination with a main motor, a

pilot motor and a source of current supply for the motors, of an inductive resistance and a switch in the main motor circuit, means for automatically varying the resistance to correspond with the volume of current flowing through the main motor, and an oscillating member connected to the pilot motor, the switch and the resistance-varying-means.

27. The combination with a source of current supply, a main motor and a pilot motor, of an inductance coil and a switch in the main motor circuit, a magnetic core in the coil, an oscillatable member geared to the pilot motor, and operative connections between said member and the switch and magnetic core.

28. The combination with a main motor, a pilot motor and a source of alternating current supply, of an inductance coil in the main motor circuit, a magnetic core movable to vary the inductance of the coil, a movable member connected to the pilot motor, and operative connections between the said member and the magnetic core to move said core to balanced position between the magnetic pull of the coil and the pull due to the torque of the pilot motor.

29. The combination with a source of current supply, a main motor and a pilot motor, of a reversing switch and an inductance coil in a circuit of the main motor, a magnetic core movable in the coil to vary the impedance of the motor circuit, an extension on the core, a pinion on the pilot motor shaft, an oscillating member geared to said pinion and having a recess in its periphery with which the lever of the reversing switch engages, and means carried by the said oscillating member engaging the extension on the magnetic core to move the core.

30. In an elevator system, the combination with a car, a main motor, a pilot motor and a source of current supply, of a reversing switch in the main motor circuits, an inductive resistance in a circuit of the main motor, means operated by the pilot motor for controlling the switch and proportioning the inductive resistance to the power applied to the pilot motor, an inductive resistance in the pilot motor circuit, a switch in said circuit, and means operated by the movement of the switch lever for varying the inductive resistance in the pilot motor circuit.

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

AUGUST SUNDH

Witnesses:

CHAS. M. NISSEN,
NORMAN VEITCH.