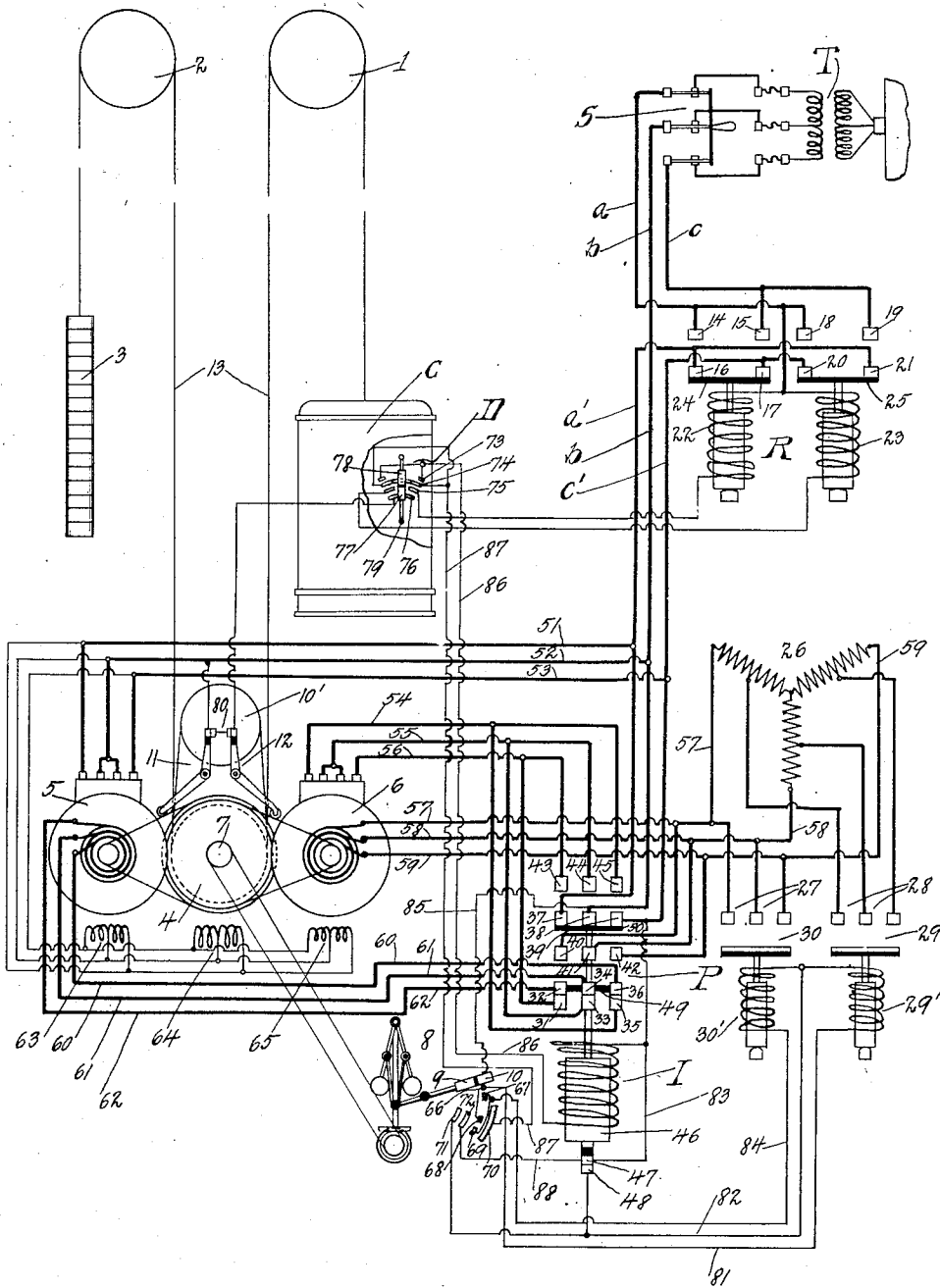


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ALTERNATING CURRENT ELECTRIC ELEVATOR.
APPLICATION FILED SEPT. 10, 1907.

954,035.

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Witnesses:

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UNITED STATES PATENT OFFICE.

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ALTERNATING-CURRENT ELECTRIC ELEVATOR.

954,035.

Specification of Letters Patent. Patented Apr. 5, 1910.

Application filed September 10, 1907. Serial No. 392,120.

To all whom it may concern:

Be it known that I, DAVID LARSON, a subject of the King of Sweden, residing in Yonkers, in the county of Westchester and State of New York, have invented a new and useful Improvement in Alternating-Current Electric Elevators, of which the following is a specification.

My invention relates to alternating current electric apparatus, and more particularly to alternating current electric elevator apparatus of the traction or direct drive type; and one of its objects is the provision of improved means for controlling a plurality of alternating current driving motors.

Other objects will appear more fully hereinafter, the novel combinations of elements being pointed out in the claims hereunto annexed.

The accompanying drawing illustrates diagrammatically a traction elevator apparatus embodying my invention, and, while the said invention is adapted more particularly for use in connection with traction drive elevators, it may be applied in other relations, and the details of construction and arrangement of parts may be varied to adapt it to different conditions without departing from the spirit and scope of the invention as defined by the claims, and, therefore, I do not wish to be limited to the precise construction and connections disclosed.

Broadly speaking, my invention contemplates the use of a double motor driving system in which both motors are suitably belted or otherwise connected to a hoisting member, in the present instance shown as a traction driving sheave. Furthermore, I propose to control the operation of the motors by varying their relative connections in conjunction with a variable non-inductive resistance. With this general statement I will now proceed to describe more in detail the construction and arrangement of parts illustrated.

C designates an elevator car in which is located a controlling switch D. The car is suspended by cables 13 which pass over a sheave 1 and down and around a traction or driving sheave 4 and an idler tension sheave 10'; from thence the said cables pass up and over a sheave 2 and are finally connected to a counterbalance weight 3. The driving sheave 4 may be belted, geared, or otherwise

suitably connected to two alternating current motors 5 and 6. These motors are of any desired construction but preferably similar in every respect, and are here shown as three-phase alternating current motors in which the motor windings are open-circuited and have terminals which lead out to slip-rings carried upon the rotor shafts in a well known way.

T is a transformer which supplies three-phase alternating current to the mains *a*, *b* and *c* by way of the three-pole main line switch S.

R designates a reversing switch and comprises two similar solenoid magnets, one of which consists of a magnet core lying in a solenoid 22 and carrying at its upper end a rod to which is connected an insulation piece 24 carrying upon it two contacts 16 and 17. Directly above these contacts are fixed contacts 14 and 15, respectively, which are adapted to be engaged thereby when the solenoid magnet 22 is properly energized. A similar arrangement is shown in connection with the solenoid 23 which operates to connect or bring into electrical engagement the contacts 20 and 18 and the contacts 21 and 19, respectively.

P is an electric switch controlled by the electro-magnet I, comprising a magnet winding or solenoid in which lies a core 46. On one end of the latter is a rod carrying insulated pieces 49 and 50. The insulation piece 49 carries three contacts 32, 34 and 36, while the insulation piece 50 carries three contacts 37, 38 and 39. The first of three contacts are normally in engagement with three fixed contacts 31, 33 and 35, respectively, but when in their lifted position they engage three fixed contacts 40, 41 and 42, respectively. The contacts 37, 38 and 39 carried by the insulation piece 50, when in their upper position effect an electrical engagement with the fixed contacts 43, 44 and 45, respectively.

The stator winding of the motor 5 is permanently connected through the wires 51, 52 and 53 to the main wires *a'*, *b'* and *c'*, respectively, while the rotor winding of the motor 5 is connected through its slip rings and the wires 60, 61 and 62 to the contacts 36, 34 and 32, respectively, of the switch P. The stator winding of the motor 6 is connected by the wires 54, 55 and 56 to the contacts 45, 44, and 43, respectively, and also

to the contacts 35, 33 and 31, while the rotor winding of this motor is connected by its slip-rings and the wires 57, 58 and 59 to the contacts 40, 41 and 42, respectively, and also to the terminals of the star connected non-inductive resistance 26. These terminals are also connected to the contacts 27. This non-inductive resistance 26 is controlled by two switches 29 and 30 which are operated successively in a predetermined order by the electro-magnets 29' and 30' to cut out or short-circuit, the resistance 26. The magnet switch 29 operates to electrically connect the contacts 28, thereby short-circuiting a portion of the resistance 26; which the switch 30 operates to electrically connect the contacts 27, thereby short-circuiting the remainder of the resistance 26. The operation of the magnet I, as well as that of the switch magnets 29' and 30', is controlled by a governor switch 8 which may be of the usual fly-ball type in which a pivoted switch arm carrying two contacts 9 and 10 is actuated to cause the latter to slide over and electrically engage a series of fixed contacts 66, 67, 70, 68, 72, 71 and 69 arranged in proper relation thereto as will be pointed out hereinafter. The governor rotates at a speed proportional to that of the driving motors 5 and 6, since it is belted or otherwise suitably connected to the shaft 7 of the driving sheave 4. Therefore the movement of the governor switch arm and its connected contacts 9 and 10 is controlled by the speed of the hoisting apparatus and consequently that of the traveling elevator car.

Each motor, as well as the driving sheave 4, is provided with a friction brake apparatus which is well known in the art and needs no description, it being sufficient to say that a spring or other suitable means is employed to apply the brakes, while the same may be released by electrical means indicated on the drawing by the three-phase magnet windings 63, 64 and 65.

The switch D located in the elevator car C comprises a swinging lever pivoted at 79 and carrying contacts 77 and 78 insulated from each other and arranged to engage a series of fixed contacts, such as 76, 75, 74 and 73, when thrown over to one side, and to engage a similar set of contacts when thrown over to the opposite side. 11 and 12 are pivoted bell crank switch arms carrying contacts at one end and provided with rollers at the other ends which normally engage and rest upon the driving elements connecting the motors to the driving sheave 4. In the present instance, each motor being belted to the hoisting sheave 4, the driving elements are represented as belts, although other driving means may be substituted therefor.

I will now point out the operation of the

present embodiment of my invention and trace the various electrical circuits used in connection therewith.

Assuming the main line switch S is closed as shown and a suitable source of alternating current is available, it is seen that a circuit to the elevator apparatus by wire *a* is open at the reversing switch contacts 14 and 18, while a circuit by wire *c* is open at the contacts 15 and 19. Now in order to close these circuits and thus operate the system it will first be necessary to operate one of the reversing switches. To do this let the car switch lever be moved to the right until the contact 77 electrically engages the contact 75, thereby establishing a circuit from the main *b* by wire 52, contacts 80, car switch contacts 76, 77 and 75 to one terminal of the solenoid 22 of the left-hand reversing switch magnet. The other terminal of this solenoid, as well as the corresponding terminal of its companion solenoid 23, is permanently connected to the main wire *a*. Therefore the solenoid 22 receives single-phase current from the mains *a* and *b* and immediately operates to lift its core and connected contacts, thereby bringing into electrical engagement the contacts 16 and 14 and the contacts 17 and 15, respectively. This operation closes a circuit to the stator winding of the hoisting motor 5 by way of the wires 51, 52 and 53. The wire 52 it will be noticed is connected directly to the main line switch S without passing through the reversing switch contacts. The energization of the stator of the motor 5 sets up an induced current in its rotor which flows by way of the rotor slip-rings and wires 60, 61 and 62 through the lower series of contacts of the switch P and thence to the stator winding of the motor 6 by way of the wires 54, 55 and 56. The motor 6 thereupon becomes energized and an induced current is set up in its rotor windings, which flows by way of the slip-rings and connected wires 57, 58 and 59 to the terminals of the non-inductive starting resistance 26. A circuit is also closed at this time through the brake windings 63, 64 and 65, since they are connected directly to the motor leads 51, 52 and 53, and the same are energized to release the brake apparatus co-operating therewith in a well known way. Both motors now receive current limited in amount by the resistance 26, and the same operate to drive the hoisting sheave 4 through the connecting mechanism, in the present instance shown as belting, and the same effects a lifting or lowering of the elevator car depending upon the direction of rotation of the hoisting sheave. As the driving motors accelerate, the governor switch 8 driven thereby operates to move the switch arm and contacts 9 and 10 mounted thereon until the contact 10 en-

gages the fixed contact 66. This closes a circuit from the wire *c'* by way of conductor 83, switch contacts 47, 48, conductor 82, magnet 29', conductor 81, contact 66, switch member 10, conductor 84 to the middle main *b*. Thus the electro-magnet 29' is connected across the main wires *c'*, *b*, receives single-phase current and is thereby energized to lift its core and thus bridge or electrically connect the contacts 28 which, as before pointed out, short-circuits a portion of the starting resistance 26. The motors now receive additional current attended by an increase of speed and the governor switch 8 operates further to electrically connect the contacts 10 and 67. A circuit for the electro-magnet 30' is now closed through the governor switch and the wire 84 in parallel with the conductor 81.

The magnet 30' is energized to electrically connect the contacts 27, which not only short-circuits the entire resistance 26 but the rotor winding of the motor 6 as well. It will be seen that the motors 5 and 6 are now connected in series, that is, the mains are connected to the stator of the motor 5 whose rotor winding is connected to the stator of motor 6 while the rotor of motor 6 is short-circuited upon itself. Due to the cutting out or short-circuiting of the starting resistance 26 and the short circuiting of the rotor winding of motor 6 both motors accelerate still further, causing the governor switch 8 to move the contact 10 off of the contact 66 and into engagement with the contact 70 but still remaining in engagement with the contact 67. Thus the circuit for the electro-magnet 29' is broken and the same becomes deenergized, dropping its core and opening the switch 29. This has no further effect, as the resistance 26 still remains short-circuited by the switch 30. Should the speed of the motors further increase, causing the governor contact 10 to pass off of the contact 67, the magnet 30' would immediately become deenergized to effect the opening of the switch 30 and the re-inserting of the starting resistance 26 in the rotor circuit of the motor 6, thereby tending to slow down the motors. This will cause a reverse movement of the governor switch, and the magnet 30' will again become energized which will once more cut the resistance 26 out of circuit. Thus the motors continue to run at a substantially constant speed. To further increase the speed of the driving motors the car switch *D* is operated to its extreme right-hand position, in which position the contact 77 connects the contacts 76 and 75 while the contact 78 connects the contacts 74 and 73. A circuit is now established from the main wire *c'* by conductor 83 through the electro-magnet *I*, conductor 86, car switch contacts 73, 78 and 74, conductor 87, contact 70, switch member 10, conductor 85 to main *b*.

The magnet *I* is thereupon energized to lift the core 46 and the connections carried thereby. The contacts 47 and 48 will first become separated, thus breaking the circuit to the magnets 29' and 30' through the feed wire 83 and the resistance 26 is again placed in circuit by the opening of the switches 29 and 30. As soon as the core 46 reaches its upper position the contacts 32, 34 and 36 which are carried away from the contacts 31, 33 and 35, will engage the contacts 40, 41 and 42, respectively, and the contacts 37, 38 and 39 will engage the contacts 43, 44 and 45, respectively. The motors 5 and 6 are now no longer in series with each other, but are connected in parallel, since the main wires 51, 52 and 53 which are permanently connected to the stator winding of motor 5 are now also connected to the stator winding of the motor 6 through the contacts 37, 38 and 39 and contacts 43, 44 and 45. The rotors of the motors are also connected in parallel through the contacts 32, 34 and 36 and contacts 40, 41 and 42, while the starting resistance 26 remains in the circuits common to the windings of both rotors. Having thus changed the connections between the motors from a series to a parallel relation with respect to each other, the motors will further accelerate in speed, causing the governor contact 10 to move onto the contact 68 and the contact 9 onto both contacts 71 and 72. This again closes a circuit to the magnet 29' from the main wire *c'*, wire 83, contact 47, wire 88, contacts 72, 9, 71, wire 82, magnet 29', wire 81, contacts 68, member 10, conductor 85 to the main *b*. A portion of the resistance 26 is again cut out, followed by a corresponding increase of motor speed and the governor finally carries the contact 10 onto contact 69, when the remaining portion of the resistance 26 is cut out of circuit and the motors run at full normal speed with no starting resistance whatever in circuit. The final position of the governor switch carries the contact 10 off of contact 68 and the magnet 29' is deenergized, thus avoiding a useless waste of current through this magnet.

It will be seen that a circuit to the magnet *I* must pass through the car switch contacts 73, 78 and 74, also the governor switch contacts 10 and 70. Therefore it follows that the speed of the motors must be sufficient to enable the governor to connect its contacts 10 and 70 before it is possible to energize the magnet *I*, so as to change the motor connections from series to parallel relation. Furthermore, upon energizing the magnet *I* and before the same operates to connect the motors in parallel the contact 47 is separated from the contact 48, and since these contacts are normally included in the circuit to the resistance controlling magnets 29' and 30' these switches 29 and

30 open to insert the resistance 26 in circuit before the motors are finally connected in parallel. There is no possibility of changing the connections of the motors from series to parallel without first re-inserting the resistance 26, thus the motors will never be subjected to any abnormal rush of current.

The switch levers 11 and 12 are normally in the position as shown and are maintained in this position by the pressure of the belts which connect the driving motors to the hoisting sheave 4 upon the rollers carried by each switch arm. Thus if either or both of these belts should become unduly slack or should break, either or both of these switch levers would move from normal position to effect the interruption at the contacts 80, of the circuit for the magnet 22 or 23 of the reversing switch R and the latter would immediately open, cutting off all current supply to the motors and the brake magnets 63, 64 and 65, and the motors would at once come to rest and all parts would return to their initial position as shown, and the system would be inoperative until the proper running conditions had been restored.

When the car switch lever is in its extreme right-hand position and the various parts are in a corresponding full speed condition as above described and it is desired to reduce the motor speed, the car switch lever is moved to the left or toward the center until the contact 78 disengages the contact 73. This opens the circuit through the magnet I and the same operates to change the motor connections from parallel to series, which will cause the motors to run at a reduced speed. As this speed reduces, the governor moves the contact 10 back to a position corresponding to the speed conditions. The contact 10 first engages the contact 68, then passes off of contact 69, and the magnet 29' closes the switch 29, after which the magnet 30' becomes de-energized. A portion of the resistance 26 will therefore be re-inserted. Upon further movement of the governor the contact 10 rides off of the contacts 68 and the contacts 71 and 72. This opens the circuit for the magnet 29' and the latter permits the switch 29 to open the entire resistance 26 and the motors will then run at normal slow speed. In order to stop the motors and the elevator car the car switch lever is brought back to central position. The circuit for one of the reversing switch magnets is interrupted at the car switch contact 75, and the reversing switch is opened, thus cutting off the current supply to the motors. At the same time the current supply to the brake magnets 63, 64 and 65 is interrupted and the apparatus comes to rest. When it is desired to operate the elevator car in an opposite di-

rection the lever of the switch D is moved to the left, in which case the reversing switch magnet 23 is energized and the current now supplied to the motors causes them to rotate in the opposite direction. The cycle of operation is similar to that before described in every particular, the only difference being in the direction of rotation of the motors and the direction of car travel.

The alternating current motors, which for purposes of illustration are herein shown as three-phase motors of conventional type, may be of any desired phase or type, as, for example, series single-phase motors, and are suitably geared or otherwise operatively connected to the hoisting mechanism of an elevator apparatus. I have herein shown a traction or direct drive elevator to illustrate the application of my invention, although it is not limited to any particular apparatus or type thereof, but may be advantageously used for many and various purposes where alternating current motors are employed for power transmission. While in order to simplify the wiring as much as possible I have shown but two switches 29 and 30 for controlling the starting resistance 26, any desired number may be used, depending largely upon the duty and capacity of the motors. The greater the number of switches and sub-divisions of the co-acting resistance 26, the smoother will be the acceleration of the motors, and for every additional resistance controlling switch a corresponding contact would be added to the governor switch 8. Furthermore, in place of the governor switch 8 I may use an electrically operated switch having substantially the same arrangement of contacts herein shown, the energizing magnet of said switch being connected to operate on the variation of current flow in the motor circuit, which, as is well known, bears a close relation to the motor speed.

The foregoing description will enable those skilled in the art to construct and use the apparatus embodying my invention and I do not wish to be limited to the precise construction and arrangement of parts as shown, as many and various changes and additions would readily suggest themselves to those skilled in the art without departing from the spirit and scope of my invention.

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

1. In a motor control system, the combination with a plurality of electric motors connected in series, of a starting resistance, and coöperating means including a speed governor for successively cutting out the resistance, inserting the resistance and connecting the motors in parallel, and again cutting out the resistance.

2. In a motor control system, the combi-

nation with a plurality of electric motors connected in series, of starting resistance therefor, a mechanical speed governor and automatic means controlled by said governor for successively cutting out the starting resistance, inserting said resistance and connecting the motors in parallel, and again cutting out said resistance.

3. In a motor control system, the combination with a plurality of electric motors connected in series, of sectional starting resistance therefor, means for changing the circuits in the following successive steps and at predetermined speeds of the motors:—first, successively cutting out the sections of starting resistance; second, inserting the resistance and connecting the motors in parallel; and third, again successively cutting out the sections of starting resistance, and a speed governor controlling the operation of said means.

4. In a motor control system, the combination with conductors leading from a source of alternating current supply, of two electric motors, connections between said conductors and the stator of one motor, connections between the rotor of the last-named motor and the stator of the other motor, resistance in circuit with the rotor of the second motor, and means controlled by the speed of the motors for successively cutting out the resistance, re-inserting said resistance upon connecting the stators in parallel and the rotors in parallel with the resistance in circuit with both rotors, and then again cutting out said resistance.

5. In a motor control system, the combination with conductors leading from a source of alternating current supply, of electric motors mechanically connected for simultaneous operation, starting resistance in circuit with one of the rotors, relays controlling said resistance, and means controlled by the speed of the motors for automatically and successively cutting out the resistance, connecting the rotors in parallel and the resistance in circuit with both the rotors, and then again cutting out the resistance.

6. In a motor control system, the combination with conductors leading from a source of alternating current supply, of electric motors mechanically connected for simultaneous operation, electrical connections between the said conductors and the primary of one motor, electrical connections between the secondary of said motor and the primary of the other motor, a sectional starting resistance in circuit with the secondary of the second motor, relays controlling the starting resistance, and automatic means controlled by the speed of the motor for successively operating the relays to short-circuit the starting resistance, permitting the relays to re-insert the resistance and con-

necting the secondaries in parallel and the primaries in parallel, and again operating the relays to short-circuit the resistance.

7. The combination with conductors leading from a source of alternating current supply, of a plurality of alternating current motors, a driven member, driving connections between the motors and said member, a speed governor connected to said member, and means operated by said governor for controlling the motor circuits and maintaining an approximately constant speed of said member.

8. In a motor control system, the combination with conductors leading from a source of current supply, a motor, and starting resistance, of a speed governor, and means operated by the governor for successively short-circuiting the resistance when the motor reaches a predetermined speed, maintaining the resistance short-circuited during a certain increase of speed, and again inserting the resistance in circuit when the motor speed exceeds a predetermined limit.

9. In a motor control system, the combination with conductors leading from a source of current supply, an electric motor, and a sectional starting resistance connected to the motor, of relays controlling the starting resistance, a speed governor connected to the motor, a switch connected to the governor and controlling the relay circuits, said switch being movable into position to successively operate the relays to effect the short-circuiting of the sections of starting resistance as the motor speed increases, maintain the resistance short-circuited during a certain further increase of speed, and again inserting the resistance when the speed exceeds a certain limit.

10. In a motor control system, the combination with conductors leading from a source of current supply, electric motors having the rotor of one connected in circuit with the stator of the other, a starting resistance in circuit with the rotor of the second motor, an open circuit for the stator of the second motor, a manually operable controlling switch, means controlled thereby for connecting the source of current supply with the stator of the first motor when the manual switch is moved to one position, means controlled by the speed of the motor for automatically short-circuiting the starting resistance, and means controlled by the manual switch and operable when said switch is moved to a second position to insert the starting resistance in circuit, connect the rotor circuits in parallel, and connect the stator circuits in parallel.

11. In a motor control system, the combination with conductors leading from a source of alternating current supply, alternating current motors mechanically con-

nected for simultaneous operation, and hav-
 ing the rotor of the first in circuit with the
 stator of the second, a starting resistance
 in circuit with the rotor of the second motor,
 5 reversing switch mechanism between the
 aforesaid conductors and the stator of the
 first motor, a manually operable switch con-
 trolling upon initial movement thereof the
 reversing switch mechanism to close the first
 10 stator circuit, means controlled by the speed
 of the motor for cutting out the starting re-
 sistance, a relay controlled by further move-
 ment of the manually operable switch to re-
 insert the starting resistance, and connect
 15 the motors in parallel.

12. In a motor control system, the combi-
 nation with conductors leading from a
 source of current supply, a plurality of mo-
 tors with their circuits normally in series
 20 relation, and starting resistance for said
 motors, of one or more accelerating relays
 for controlling said starting resistance, a
 master relay to change the motor circuits
 from a series to a parallel relation, and an
 25 auxiliary switch opened by said master re-
 lay when thus operated, to cut off current
 from the accelerating relays to effect the re-
 insertion of said resistance.

13. In a motor control system, the combi-
 30 nation with conductors leading from a
 source of current supply, a plurality of mo-
 tors with their circuits normally in series
 relation, and starting resistance, of an elec-
 tro-magnet, a switch operated thereby when
 35 the magnet is energized to short-circuit the
 starting resistance, an electro-magnetic de-
 vice operable to change the motor circuits
 from a series to a parallel relation, a nor-
 mally closed switch in the circuit of the first
 40 electro-magnet, a connection between said
 switch and the electro-magnetic device for
 opening the switch when said device is
 operated, a normally open shunt circuit

around said last-named switch, and means
 for automatically closing the shunt circuit 45
 when the speed of the motor reaches a pre-
 determined value.

14. In an elevator system, the combination
 with a drive sheave, a car, and a cable, of
 electric motors, driving connections between 50
 the motors and sheave, conductors leading
 from a source of current supply, electrical
 connections between said source of supply
 and the stator of one motor, connections nor-
 mally uniting the rotor of said motor and 55
 the stator of the second motor in series, a
 starting resistance, and means controlled by
 the speed of the motors for successively
 short-circuiting the resistance, inserting the
 resistance in circuit, and connecting the 60
 motor circuits in parallel, and again short-
 circuiting the resistance.

15. The combination with a frictional
 driving sheave, an elevator car and hoisting
 cables, of a plurality of alternating current 65
 motors, accelerating apparatus therefor,
 flexible driving connections between the mo-
 tors and said sheave, reversing switch mech-
 anism, a switch in the car for controlling
 said reversing switch mechanism to direct 70
 the current to the motors to effect a lifting
 or lowering of the car, and one or more
 switch devices for rendering the reversing
 switch mechanism inoperative and conse-
 quently cutting off the power to the motors 75
 to stop the car when the said flexible driv-
 ing connections or a portion thereof be-
 comes too slack or breaks.

In testimony whereof, I have signed my
 name to this specification in the presence of 80
 two subscribing witnesses.

DAVID LARSON.

Witnesses:

E. FRED. CHYTRAUS,
 N. N. KEYS.