No. 725,681. PATENTED APR. 21, 1903.

H. P. DAVIS.

METHOD OF CONTROLLING INDUCTION MOTORS.

APPLICATION FILED DEC. 26, 1901.

NO MODEL. 4 SHEETS—SHEET 1.

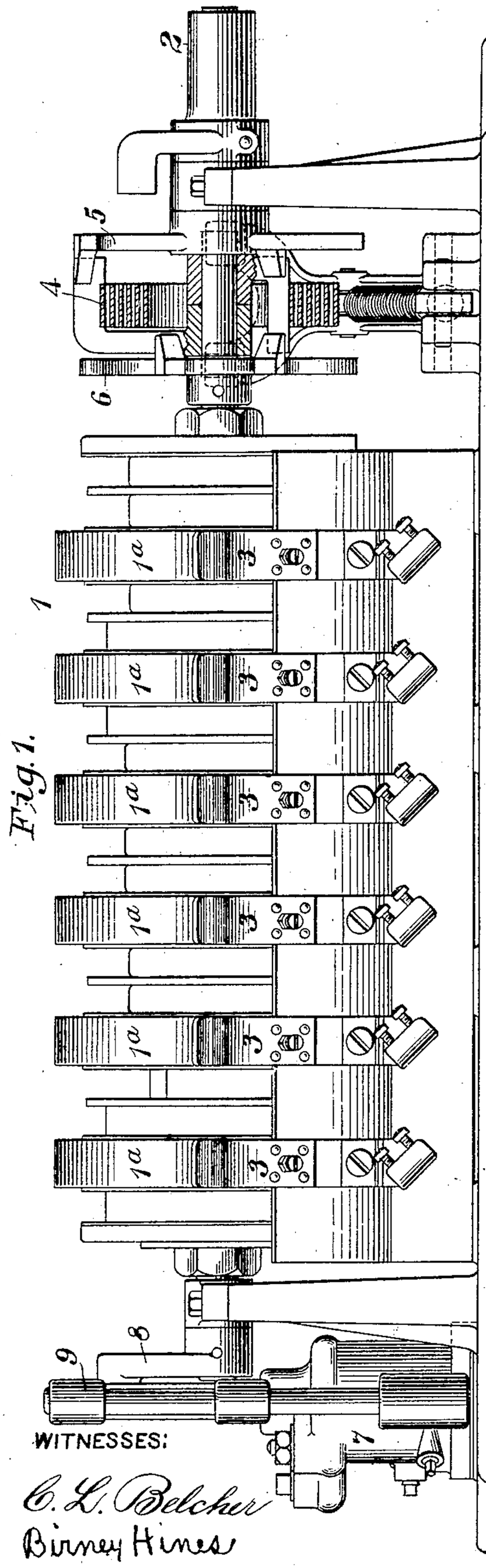


Fig. 1.

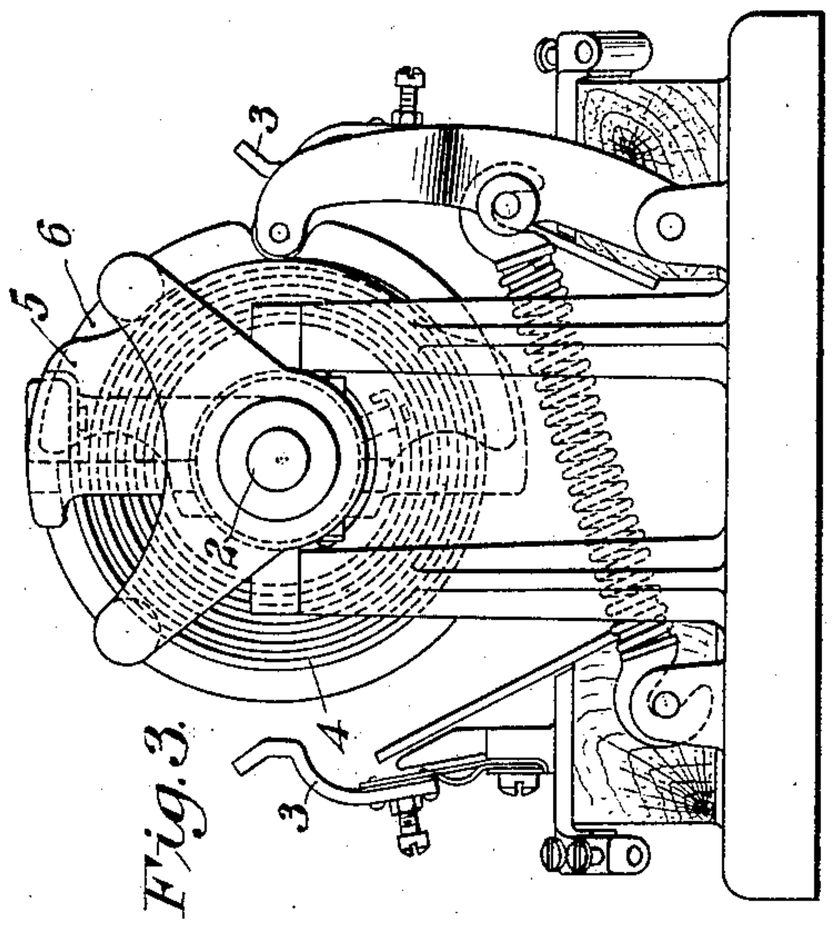


Fig. 3.

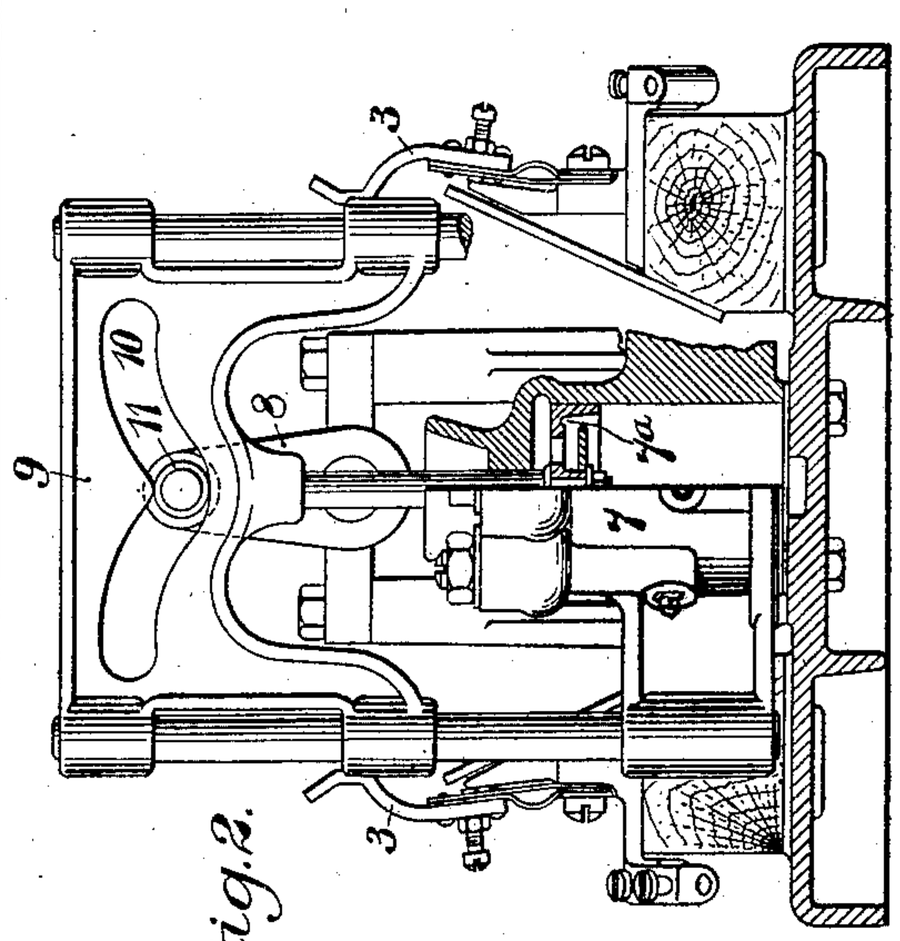


Fig. 2.

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NO MODEL. 4 SHEETS—SHEET 2.

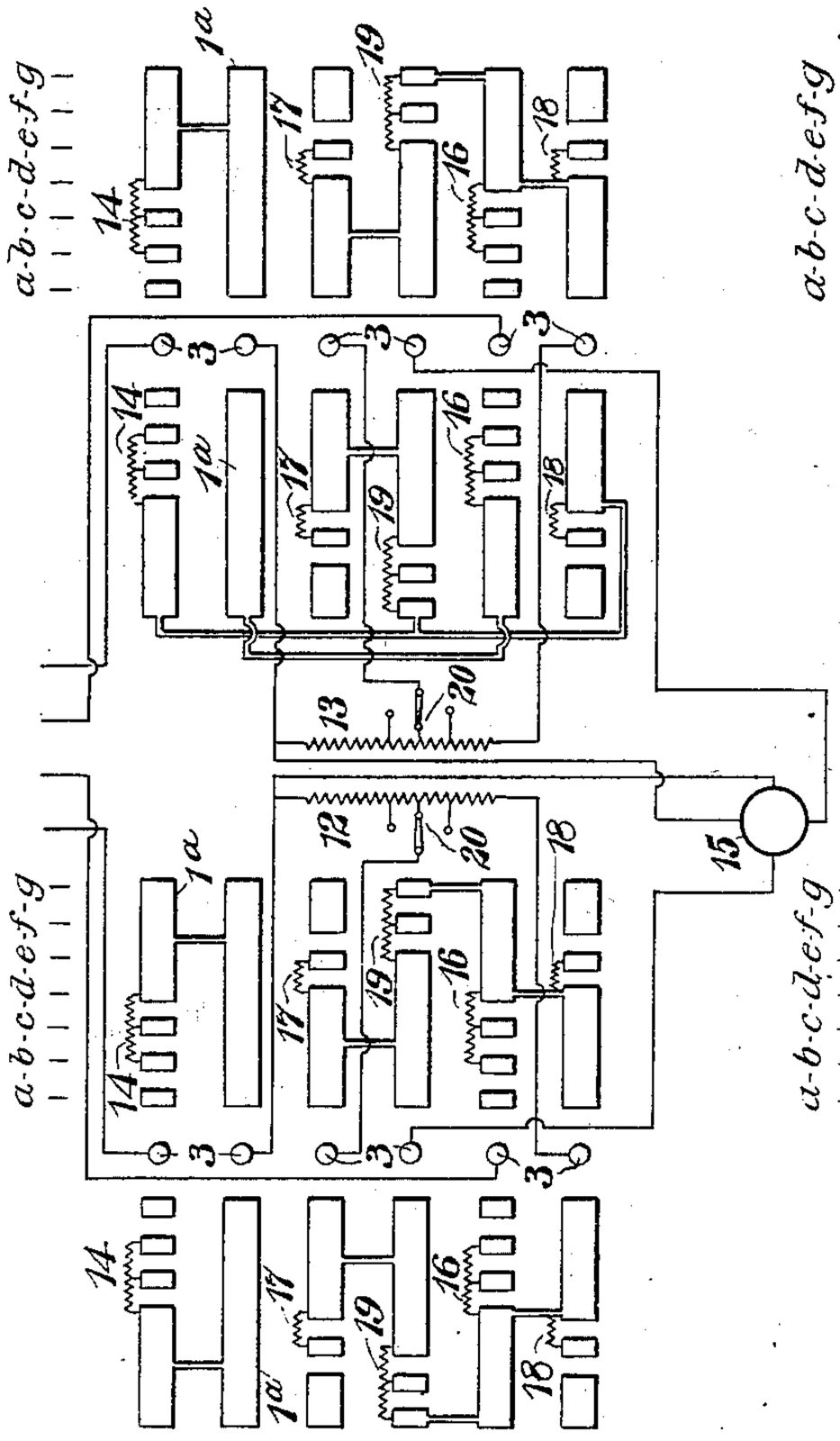


Fig. 4.

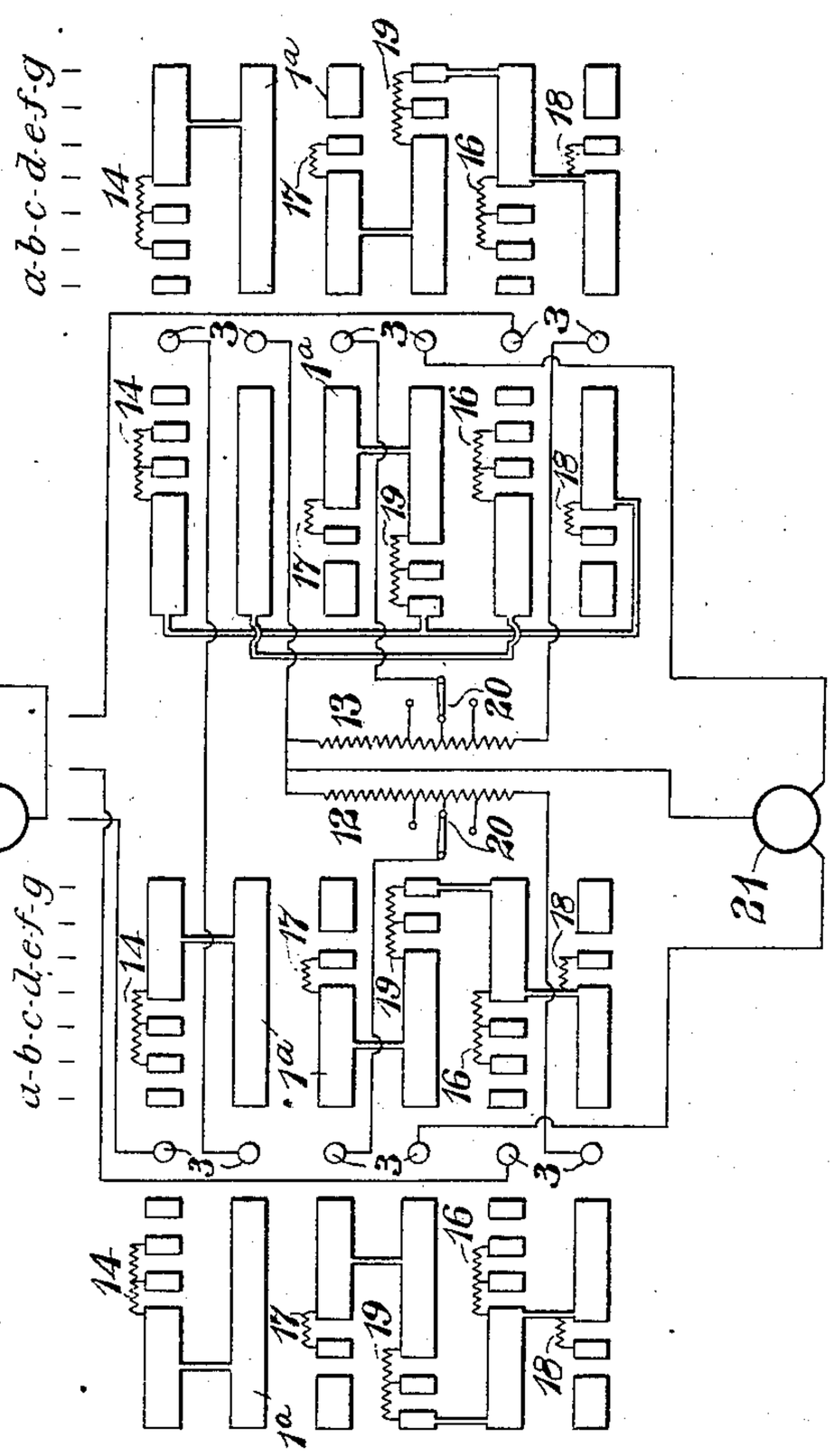


Fig. 5.

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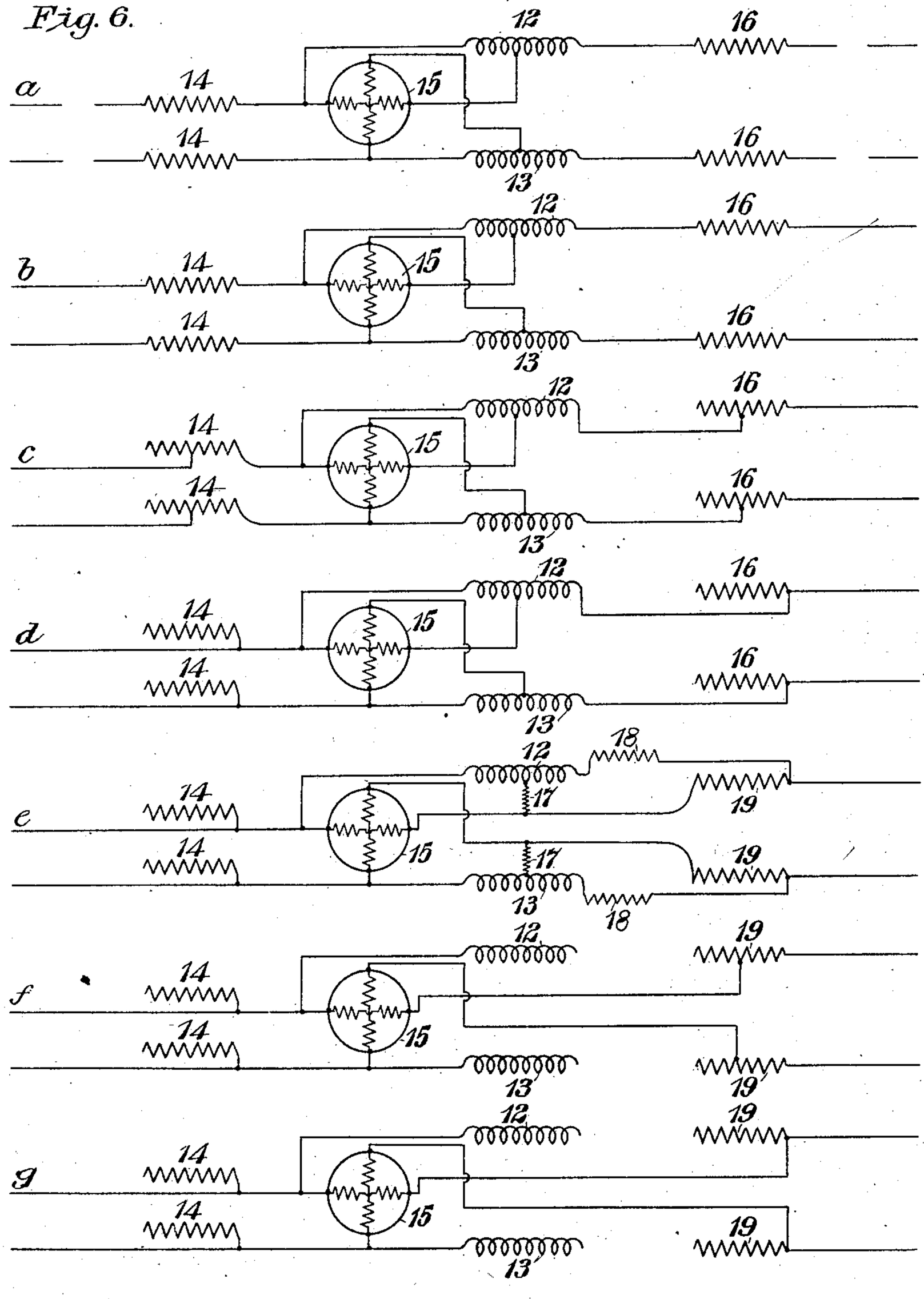
# METHOD OF CONTROLLING INDUCTION MOTORS.

APPLICATION FILED DEC. 26, 1901.

NO MODEL. 4 SHEETS—SHEET 3.

*Fig. 6.*

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No. 725,681. PATENTED APR. 21, 1903.

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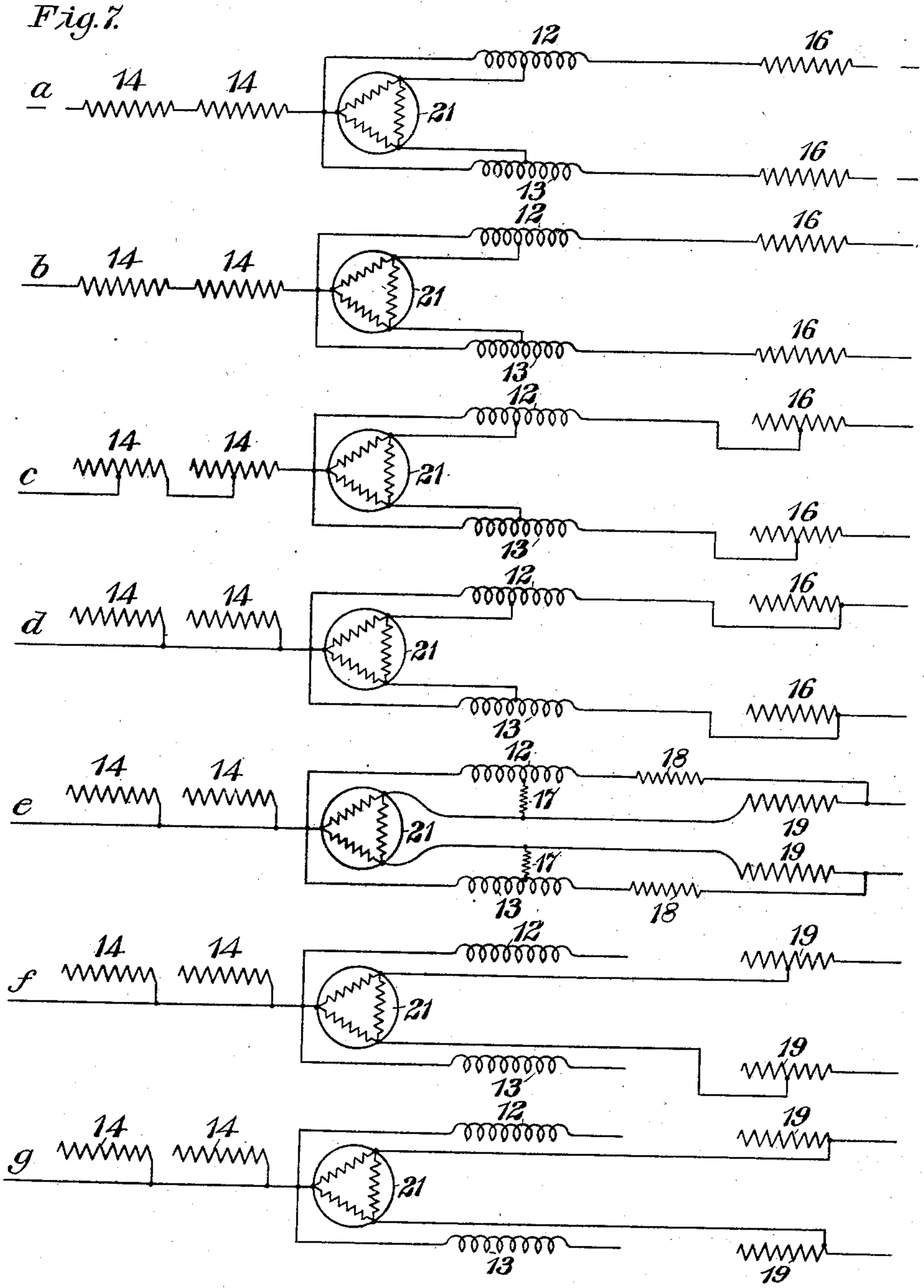
METHOD OF CONTROLLING INDUCTION MOTORS.

APPLICATION FILED DEC. 26, 1901.

NO MODEL. 4 SHEETS—SHEET 4.

*Fig. 7.*




WITNESSES:

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# UNITED STATES PATENT OFFICE.

HARRY PHILLIPS DAVIS, OF PITTSBURG, PENNSYLVANIA, ASSIGNOR TO WESTINGHOUSE ELECTRIC & MANUFACTURING CO., A CORPORATION OF PENNSYLVANIA.

## METHOD OF CONTROLLING INDUCTION-MOTORS.

SPECIFICATION forming part of Letters Patent No. 725,681, dated April 21, 1903.

Application filed December 26, 1901. Serial No. 87,304. (No model.)

*To all whom it may concern:*

Be it known that I, HARRY PHILLIPS DAVIS, a citizen of the United States, residing in Pittsburg, in the county of Allegheny and State of Pennsylvania, have invented certain new and useful Improvements in Methods of Controlling Induction-Motors, of which the following is a specification.

My invention relates to the control of alternating-current electric motors of the induction type, and it has particular reference to the control of motors of this character which are employed for operating elevators, though not necessarily restricted to this specific use.

The object of my invention is to provide a method of control which shall insure the starting, running, and stopping of the elevator or other mechanism operated by an induction-motor smoothly and without sudden rushes of current, such as would tend to injure or destroy the controller-contacts and the motor insulation.

My invention is illustrated in the accompanying drawings, in which—

Figure 1 is a view, mainly in side elevation, but partially in section, of the mechanical elements of a controller suitable for practicing my invention. Fig. 2 is a view, partially in elevation and partially in section, of one end of the controller shown in Fig. 1. Fig. 3 is an elevation of the opposite end of the controller from that shown in Fig. 2. Fig. 4 is a diagram showing a two-phase motor and a development of the controller-drum contacts and the circuits used in connection therewith. Fig. 5 is a view similar to Fig. 4, but showing a three-phase motor. Fig. 6 is a diagram of the circuit connections for the several positions of the controller-drum corresponding to the several sets of contact-plates on the drum as shown in Fig. 4, and Fig. 7 is a diagram of the circuit connections for the several positions of the controller-drum corresponding to the several sets of contact-plates on the drum as shown in Fig. 5.

The mechanical construction of the controller illustrated in Figs. 1 to 3, inclusive, is substantially the same as that set forth in the patent granted to the Westinghouse Electric & Manufacturing Company on the 25th day of July, 1899, No. 629,665, on an application filed by Gilbert Wright and myself, and reference may therefore be had to that patent for a description of such structural details as may not be specifically set forth herein.

The controller-drum 1 is so mounted upon the rotating shaft 2 that when the latter is rotated by means of a pulley and belt or other actuating means (not shown) to effect successive engagement of the drum contact-plates $1^a$ with the stationary contact-fingers 3 motion is transmitted from the shaft to the drum by means of a coiled spring 4 and cooperating arms 5 and 6, all substantially as set forth in the above-mentioned patent. A dash-pot 7 is provided at the other end of the drum, the piston $7^a$ of which is connected to the drum-shaft by means of a crank 8 and a sliding frame 9, having a slot 10, in which operates a roller 11 on the crank 8 in order to control the movement of the drum under the action of the spring 4. A starting voltage that is less than the full voltage of the supply-circuit is secured by means of autotransformers 12 and 13, as indicated in Figs. 4 to 7, inclusive.

Since my present invention relates to the method of controlling an operating-motor, the arrangement of the controller-contacts and other circuit connections may be most conveniently and satisfactorily described in connection with the operation, reference being first had to Figs. 4 and 6. The drum is here indicated in the off position, in which the stationary contact-fingers 3 are out of engagement with the contact-plates $1^a$ of the drum. Rotation of the drum in clockwise direction, so as to move the contact-plates from right to left, as indicated in the drawings, will serve to impart a forward movement to the motor and the mechanism driven thereby, and movement in the opposite direction will serve to impart a backward movement to the motor and the mechanism operated by it. Since the circuit connections and changes are the same for backward as for forward movement of the motor, except that one of the phases of current is reversed, a description of the forward movement only will suffice. In position *a* of the controller-drum the windings of

the motor 15 are connected in closed circuits, which respectively include portions of the autotransformer-windings 12 and 13, there being no connection with the supply-circuit. In position *b* the circuit for each phase of the motor 15 is through a resistance 14, the corresponding motor-winding, a portion of the corresponding autotransformer-winding 12 and 13, and a second resistance 16. The current also has a path in shunt to the motor through the entire transformer-winding. This affords a proper starting voltage, and in position *c* the circuits are the same, except that one-half of each of the resistances 14 and 16 is cut out. In position *d* resistances 14 and 16 are both cut out of circuit. In position *e* the resistances 14 and 16 are cut out of circuit, resistances 19 are connected in series with the motor, the autotransformers 12 and 13 and the resistances 18 are connected in series with each other in a shunt-path around the motor, and the resistances 19 and resistances 17 are connected in circuit between the motor and the service-loops of the autotransformers. In position *f* the resistances 14 and autotransformers 12 and 13 are cut out and the motor is connected directly to the supply-circuit, with one-half of the resistances 19 in series with it. In the final position *g* the resistances and the autotransformers 12 and 13 are all out of circuit and the motor is connected directly to the supply-circuit.

It is to be understood that intermediate circuit connections to the transformers may be made at any desired points, as indicated at 20 in Figs. 4 and 5, this adjustment being made to suit the conditions of the service and being independent of the operation of the controller. It will also be understood that the resistances 14, 16, 17, 18, and 19 are employed solely for preventing rushes of current, whereby sparking between the controller-drum contacts and the fingers in passing from one position to the next is obviated or materially reduced, and that they are intended to be in circuit only for an instant of time. They are not intended to and do not, in fact, regulate or control the speed of the motor or limit the starting-current to the motor under any conditions. The operation of the spring 4 in propelling the controller-drum is such, as has already been indicated, that the resistances are in circuit for only an instant, and the pause in position *a* of the drum places the motor-circuits entirely upon the autotransformer-loops, so that no current passes through the resistances at this time.

Referring now particularly to Figs. 5 and 7, the circuit changes are exactly the same as those shown in Figs. 4 and 6 and already described, except that the motor 21 is of the three-phase type and the resistances 14 are connected in series in one branch of the three-phase circuit. Except as regards the motor, therefore, the reference-numerals employed here are the same as in Figs. 4 and 6 and the description heretofore given may be read in connection with what is here shown.

While I have described specific means for practicing my invention, I desire it to be understood that the invention is not restricted thereto.

I claim as my invention—

1. The method of controlling an alternating-current induction-motor which consists in supplying successive voltages of different values thereto and momentarily introducing ohmic resistances into the primary circuits of the motor, between voltage steps, in such amounts as will prevent injurious rushes of current.

2. The method of controlling an alternating-current induction-motor which consists in supplying voltages of progressively-varying values thereto and momentarily introducing ohmic resistances into the primary circuits of the motor as the changes in voltage are made.

3. The method of controlling an alternating-current induction-motor which consists in varying the speed by varying the applied voltage and momentarily introducing ohmic resistances into the primary circuits of the motor at suitable intervals to prevent injury to the controller-contacts and the motor.

In testimony whereof I have hereunto subscribed my name this 16th day of December, 1901.

HARRY PHILLIPS DAVIS.

Witnesses:
H. N. BARTLETT,
JOS. W. ALEXANDER.