No. 870,595. PATENTED NOV. 12, 1907.

L. L. TATUM.

CONTROLLER.

APPLICATION FILED APR. 16, 1906.

2 SHEETS—SHEET 1.

Fig. 1.

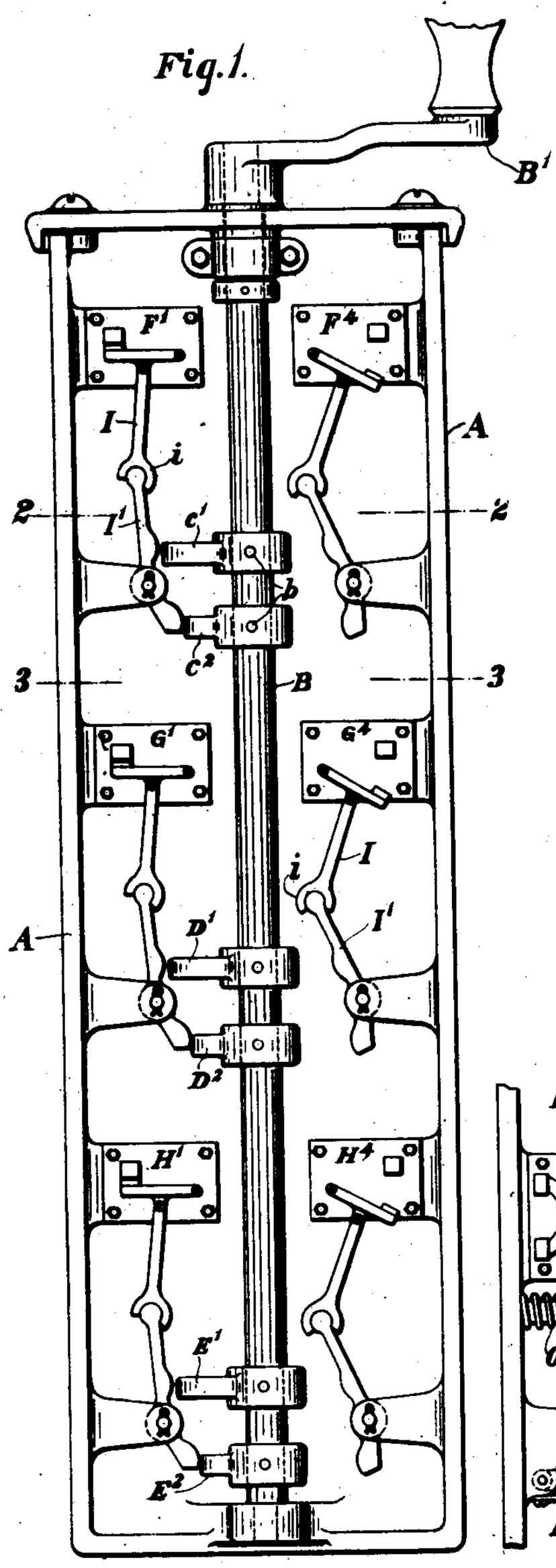


Fig. 2.

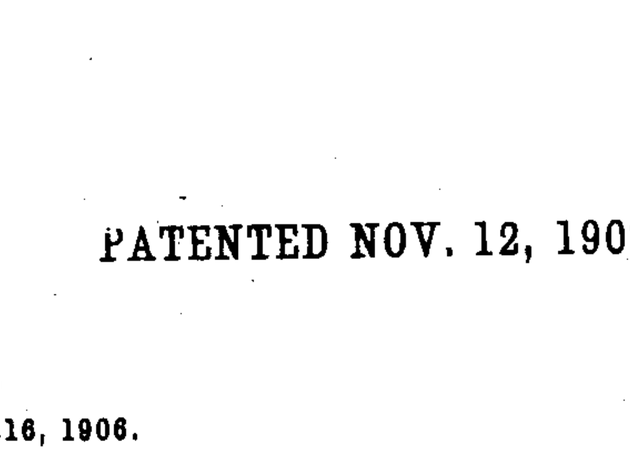


Fig. 3.

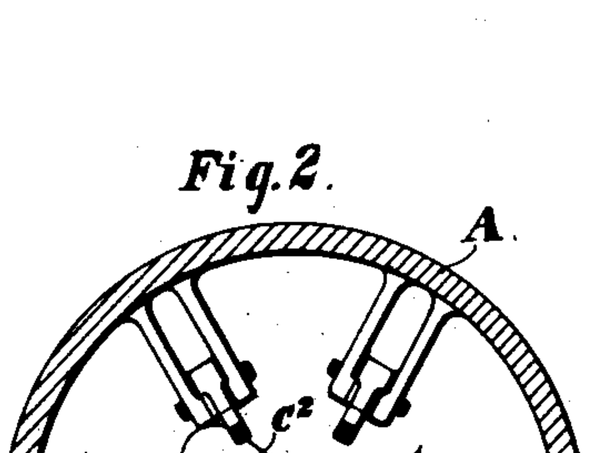


Fig. 5.

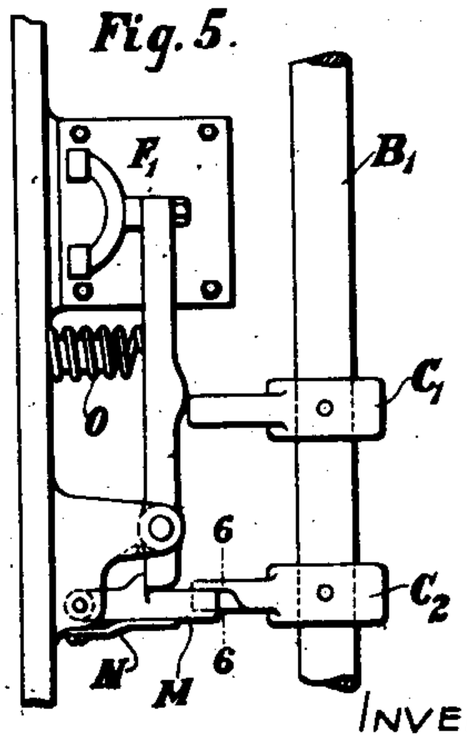


Fig. 4.

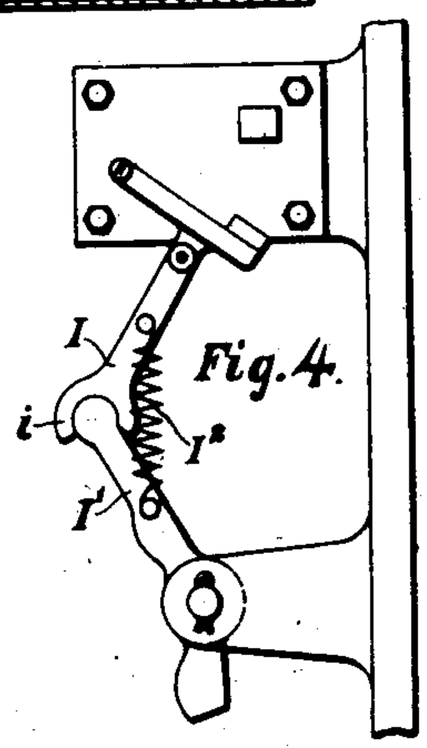


Fig. 6.

WITNESSES

Olivia Sharman

Fred J. Kinsey

INVENTOR

Lewis L. Tatum

BY

Chas. E. Lord

ATTORNEY

No. 870,595. PATENTED NOV. 12. 1907.

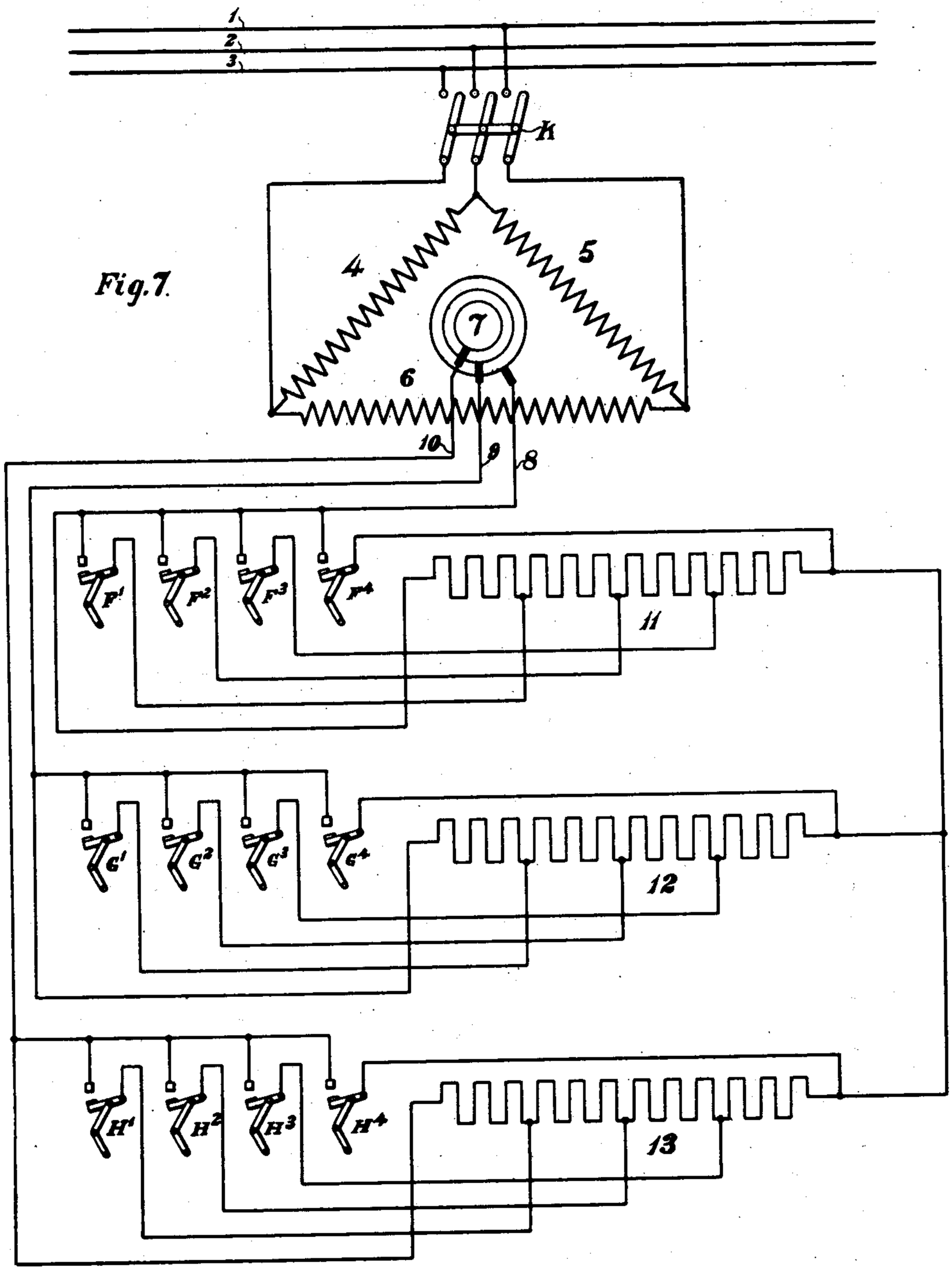
L. L. TATUM.

CONTROLLER.

APPLICATION FILED APR. 16, 1906.

2 SHEETS—SHEET 2.

Fig. 7.



WITNESSES

Oliver W. Harmon.

Fred J. Kinney

INVENTOR

Lewis L. Tatum

BY

Chas. E. Lord

ATTORNEY

UNITED STATES PATENT OFFICE.

LEWIS L. TATUM, OF NORWOOD, OHIO, ASSIGNOR TO ALLIS-CHALMERS COMPANY, A CORPORATION OF NEW JERSEY, AND THE BULLOCK ELECTRIC MANUFACTURING COMPANY, A CORPORATION OF OHIO.

CONTROLLER.

No. 870,595. Specification of Letters Patent. Patented Nov. 12, 1907.

Application filed April 16, 1906. Serial No. 311,843.

To all whom it may concern:

Be it known that I, LEWIS L. TATUM, a citizen of the United States, residing at Norwood, in the county of Hamilton and State of Ohio, have invented certain new and useful Improvements in Controllers, of which the following is a full, clear, and exact specification.

My invention relates to controllers for electric motors, and particularly to controllers for starting and regulating polyphase induction motors.

The object of my invention is to provide a simple, compact and inexpensive controller for use with heavy currents or high voltages, which shall be capable of sure operation with greatly reduced labor.

Heretofore controllers for heavy currents have either had large sliding contacts under great spring pressure, in which case the labor of operating the controller was excessive, or else have used separate solenoid switches under the control of a master controller, in which case there were losses of energy in the solenoids and great complications in the system of wiring.

With my invention the great labor in operation, the energy loss in solenoids, and the complicated wiring of the controlling circuits are all avoided and the contacts of the controller are positively closed with a firm contact, and positively and widely opened with a quick break, thereby being able to carry heavy currents safely and at the same time preventing dangerous arcing.

My invention is especially applicable to mill motors and mine hoists where it is necessary to frequently start, stop and reverse the motors. It is also well adapted for use on electric locomotives, and in all places when large currents or high voltages are to be controlled. The current carrying parts may be as large as desired and are positively and quickly operated both in opening and closing, the greatest pressure being applied in closing at the time when the contacts engage so that a firm contact is insured. The operating mechanism may be of small radius but the switches controlled thereby may be arranged on a much larger radius. And in addition the controller is simple in operation and construction, compact in form, and inexpensive to manufacture.

In one aspect, my invention comprises a shaft carrying cams, and a plurality of snap switches arranged to be operated by said cams as the shaft is rotated.

In a more specific aspect, my invention comprises a rotatable shaft, a plurality of cams on the shaft, and a plurality of similar groups of snap switches, the corresponding switches of the groups being simultaneously closed and the different switches of each group successively closed by certain of the cams as the shaft is rotated in one direction, and the corresponding switches of the groups being simultaneously opened and the different switches of each group successively opened by others of the cams as the shaft is rotated in the other direction.

From another point of view my invention consists of the combination of a rotatable shaft, with a plurality of cams on said shaft, and a plurality of snap switches arranged to be closed by some of said cams and opened by others of said cams as the shaft is rotated.

In another aspect, my invention consists of an induction motor, resistance in the rotor circuit of the motor, a plurality of snap switches each arranged to short-circuit a portion of said resistance, a rotatable shaft, a pair of cams on said shaft, so arranged that one of said cams closes said switches successively as the shaft is rotated in one direction and the other cam opens said switches as the shaft is rotated in the other direction.

Still more specifically my invention comprises a three-phase induction motor, a Y-connected resistance in its rotor circuit, a group of snap switches associated with each section of said resistance, a rotatable shaft, and a pair of cams on said shaft for each group of switches, one of each pair of cams being arranged to close its associated switches successively as the shaft is rotated in one direction, the other of each pair of cams being arranged to open said switches successively as the shaft is rotated in the other direction, corresponding switches of the various groups being operated simultaneously.

Figure 1 is an elevation of my controller with half of the casing removed. Fig. 2 is a section on the line 2—2 of Fig. 1. Fig. 3 is a section on the line 3—3 of Fig. 1. Fig. 4 is a modification showing a spring actuated toggle switch. Fig. 5 is another modification showing a latched spring opened snap switch. Fig. 6 is a section on the line 6—6 of Fig. 5, showing a detail of the trip lever and lower cam in Fig. 5, and Fig. 7 is a diagram of connections showing my invention applied to a three-phase induction motor.

In the drawings A is a controller casing in which is journaled a shaft B, operated by the usual handle B′. Fixed to the shaft as by pins *b*, are cams C′, C², D′, D², and E′, E², arranged in pairs. If desired, the cams may be provided with anti-friction rollers at their ends. The cams C′, D′ and E′ are arranged vertically in line, the cams C², D² and E² being arranged in another vertical line. These two lines of cams are angularly displaced from each other, as shown in Figs. 2 and 3.

Mounted on the casing are groups of snap switches F′, F², F³, F⁴; G′, G², G³, G⁴; and H′, H², H³, H⁴, the switches of each group, as F′, F², F³ and F⁴, being horizontally in line, and the corresponding switch of the different groups, as F′, G′ and H′, being vertically in line. Each of these snap switches is arranged to be operated by a toggle I, I′, the toggles in turn being operated by the cams C′, C² etc. As the

shaft is rotated the cams engage the arms I′ either above or below the pivotal points of the latter, engagement above the pivotal points, as by cams C′, D′ and E′, straightening the toggles and closing the switches as shown by switches F′, G′ and H′ in Fig. 1, and engagement below the pivotal points, as by cams C^2, D^2 and E^2, tripping the switches by throwing the toggles out of line and allowing gravity to open the switches with a snap. The switches F^4, G^4 and H^4 are shown open in Fig. 1. When the switches are closed the arms I, I′ are moved a little beyond alinement, so that the switches will be locked closed, too great movement in this direction being prevented by fingers *i* on arms I. In closing the switch, the first part of the movement is against no pressure, and the toggle then needs and has but a comparatively small mechanical advantage, but when the switch contacts engage, the toggle arms are nearly in line, and the mechanical advantage of the cams in forcing the contacts firmly together is very great. This gives a good contact and saves labor on the part of the operator. In opening the switches gravity may be assisted by springs I^2 as shown in Fig. 4, or, if the controller toggles are placed horizontally or the controller inverted, the springs act alone.

When the shaft is in "off" position, *i. e.* when it has been moved as far as it will go in an anti-clockwise direction, all of the snap switches are open. As the shaft is rotated in a clockwise direction the opening cams C^2, D^2, and E^2 swing freely past the lower ends of arms I′, doing nothing, but the closing cams C′, D′ and E′, which are but a small angular distance behind the opening cams, engage the upper ends of arms I′ closing the corresponding switches of the various groups, as F′, G′ and H′, simultaneously and the different switches of the same group as F′, F^2, F^3 and F^4, successively. As the shaft is rotated in an anti-clockwise direction, the reverse action takes place, the closing cams first passing the arms I′, doing nothing, and the opening cams following and engaging the lower parts of the arms I′, to simultaneously trip corresponding switches of the various groups and successively trip the different switches of the same group. When either the opening or the closing cams operate the switches, the other set of cams is entirely out of the way, so as not to interfere with the free action of the switches.

In Figs. 5 and 6 is shown a modification of the snap switch of my controller. On the shaft B_1 are mounted the cams C_1 and C_2, the cam C_1 being similar to the cams C′ above described and acting to close the snap switch F_1 directly instead of through a toggle I, I′. The switch F_1 is held closed by a latch M, pressed upwardly by a leaf spring N. The upper surface of latch M is rounded, as shown in Fig. 6, the lower surface of cam C_2 being correspondingly rounded or beveled, so that as the shaft B is rotated and the cam C_2 engages latch M, the latter is pressed downwardly against spring N and the switch F_1 tripped, thus allowing it to be opened by the compression spring O.

It would not always be necessary to arrange the snap switches in groups, corresponding switches of the groups being operated simultaneously, but all of the switches could be arranged to be operated successively if it were so desired. I have shown and described my controller with groups of switches, however, because, the controller is primarily intended to be used for starting and regulating induction motors, and especially three-phase induction motors.

In Fig. 7 is shown diagrammatically my controller applied to a three-phase induction motor. The supply mains are represented by 1, 2 and 3, the stator windings by 4, 5 and 6, and the rotor by 7. The stator windings are here shown delta connected but it is obvious that other methods of connecting could be used. Leading from the slip rings of the rotor are wires 8, 9 and 10, which lead to resistance sections 11, 12 and 13. The resistances may be connected in any desired manner but are here shown Y-connected, to correspond with the rotor winding. The method of connecting the resistance depends on the method of connecting the rotor windings, the two generally corresponding. Each section of resistance is associated with a group of the switches of the controller, and each switch is arranged to cut-out a part of its resistance section. When it is desired to start the motor, the controller being in "off" or high resistance position, the hand switch K is closed. The rotor circuit now has all the resistance 11, 12 and 13 in circuit. When the motor has gained sufficient speed, the controller is moved to simultaneously close the corresponding switches F′, G′ and H′ to cut out parts of the resistance sections. As the motor gains greater and greater speed, the controller is moved to cut out more and more resistance until finally, by closing switches F^4, G^4 and H^4, all the resistance is cut out. When the controller is moved in the other direction the snap switches are opened to cut in the resistance again and the opening of switch K stops the motor. It is not absolutely necessary to close corresponding switches of the various groups simultaneously, but it is better to do so in order to keep the system balanced.

If desired instead of having just one opening cam for each group of switches, there may be two such cams arranged in the same horizontal plane, and preferably integral. The closing cam is then arranged to be both preceded and followed by an opening cam, so that as soon as the closing cam closes one of a group of switches, the closing cam which follows it opens the preceding switch. With this arrangement no two switches of a group are closed simultaneously, which sometimes may be very desirable.

I have described my invention in what I now consider to be its preferred form, but it is not limited to the precise structure shown and described. It is obvious that many equivalents may be substituted for the various parts shown and described without departing from the spirit of my invention, and I claim all such obvious modifications as falling thereunder.

What I claim as new and desire to secure by Letters Patent is:—

1. In a controller, a rotatable shaft, a plurality of cams thereon, and a plurality of snap switches operated by each of said cams as said shaft is rotated.

2. In a controller, a rotatable shaft, a cam on said shaft, and a plurality of snap switches operated by said cam as the shaft is rotated.

3. In a controller, a rotatable shaft, cams on said shaft, and a plurality of snap switches arranged to be closed by one of said cams and opened by another of said cams as the shaft is rotated in one direction or the other.

4. In a controller, a rotatable shaft, cams on said shaft,

and a plurality of toggle switches arranged to be operated by each of said cams as the shaft is rotated.

5. In a controller, a rotatable shaft, a plurality of cams on said shaft, and a plurality of snap switches, each cam being arranged to operate a number of said switches successively as the shaft is rotated.

6. In a controller, a rotatable shaft, a plurality of cams on said shaft and a plurality of snap switches arranged to be closed successively by some of said cams and opened successively by others of said cams as the shaft is rotated, each cam operating more than one of said switches.

7. In a controller, a rotatable shaft, a plurality of cams on said shaft, and a plurality of snap switches arranged to be simultaneously closed by some of said cams and simultaneously opened by others of said cams as the shaft is rotated in one direction or the other.

8. In a controller, a rotatable shaft, a pair of cams on said shaft, and a plurality of switches arranged to be closed by one of said cams and opened by the other of said cams as the shaft is rotated.

9. In a controller, a rotatable shaft, a pair of cams on said shaft, and a plurality of snap switches arranged to be successively closed by one of said cams as the shaft is rotated in one direction and to be successively opened by the other cam as the shaft is rotated in the other direction.

10. In a controller, a rotatable shaft, a pair of cams on said shaft, and a plurality of toggle switches arranged to be closed by one of said cams and opened by the other.

11. In a controller, a rotatable shaft, cams on said shaft, and a plurality of switches arranged to be operated by one of said cams as the shaft is rotated in one direction, and by another of said cams as the shaft is rotated in the other direction.

12. In a controller, a rotatable shaft, a pair of cams on said shaft, a switch, and means normally in the path of one of said cams and arranged to be moved by said cam into the path of the other cam as the shaft is rotated in one direction, and to be moved by said other cam into the path of the first as the shaft is rotated in the other direction, said means operating the switch as it is moved.

13. In a controller, a rotatable shaft, a plurality of cams on said shaft, and a plurality of groups of snap switches, the different switches of a group being arranged to be successively operated by said cams as the shaft is rotated.

14. In a controller, a shaft, a plurality of cams on said shaft, and a plurality of groups of snap switches, the different switches of a group being arranged to be successively closed by some of the cams as the shaft is rotated in one direction and successively opened by other cams as the shaft is rotated in the other direction.

15. In a controller, a shaft, a plurality of cams on said shaft, and a plurality of similar groups of snap switches, corresponding switches of the groups being arranged to be simultaneously operated by the cams as the shaft is rotated.

16. In a controller, a shaft, a plurality of cams on said shaft, and a plurality of similar groups of snap switches, the corresponding switches of the groups being arranged to be simultaneously closed by some of the cams as the shaft is rotated in one direction, and simultaneously opened by others of the cams as the shaft is rotated in the other direction.

17. In a controller, a shaft, a plurality of cams on said shaft and a plurality of similar groups of snap switches, the corresponding switches of the groups being simultaneously operated and the different switches of each group being successively operated by the cams as the shaft is rotated.

18. In a controller, a shaft, a plurality of cams on said shaft, and a plurality of similar groups of snap switches, the corresponding switches of the groups being simultaneously closed and the different switches of each group successively closed by certain of the cams as the shaft is rotated in one direction, and the corresponding switches of the groups being simultaneously opened and the different switches of each group successively opened by others of the cams as the shaft is rotated in the other direction.

19. In a controller, a rotatable shaft, a plurality of groups of snap switches, and a pair of cams on the shaft for each group of switches, one of each pair of cams being arranged to close its group of switches as the shaft is rotated in one direction, the other of each pair of cams being arranged to open its group of switches as the shaft is rotated in the other direction.

20. In a controller, a rotatable shaft, a plurality of groups of snap switches, and a cam on the shaft for each group of switches, each of said cams being arranged to operate its group of switches as the shaft is rotated.

21. In a controller, a rotatable shaft, a plurality of groups of snap switches, and a pair of cams on the shaft for each group of switches, said cams being arranged to close the different switches of their respective groups successively as the shaft is rotated in one direction and to open said switches successively as the shaft is rotated in the other direction.

22. In a controller for induction motors, a shaft, a group of switches for each current phase of the motor, and a cam on the shaft for each group of switches arranged to operate the different switches of its group successively as the shaft is rotated.

23. In a controller for induction motors, a shaft, a group of switches for each current phase of the motor, and a cam on the shaft for each group of switches arranged to operate the corresponding switches of the different groups simultaneously as the shaft is rotated.

24. In a controller for induction motors, a shaft, a group of switches for each current phase of the motor, and a pair of cams on the shaft for each group of switches so arranged that one of each pair of cams closes its switches successively as the shaft is rotated in one direction and the other of each pair opens its switches successively as the shaft is rotated in the other direction.

25. In combination, an induction motor, a resistance in the rotor circuit of said motor, a plurality of snap switches, each arranged to short circuit a portion of said resistance, a rotatable shaft, and a cam on said shaft arranged to operate said switches as the shaft is rotated.

26. In combination, an induction motor, a resistance in the rotor circuit thereof, a plurality of snap switches, each arranged to short-circuit a portion of said resistance, a rotatable shaft, and a pair of cams on said shaft, so arranged that one of said cams closes said switches successively as the shaft is rotated in one direction and the other cam opens said switches as the shaft is rotated in the other direction.

27. In combination, a polyphase induction motor, a resistance for each phase of the rotor circuit of the motor, a group of snap switches associated with the resistance for each phase, each switch being arranged to short-circuit a portion of its associated resistance, a rotatable shaft, and a cam on the shaft for each group of switches arranged to operate its switches successively as the shaft is rotated.

28. In combination, a polyphase induction motor, a resistance for each phase of the rotor circuit of the motor, a group of snap switches associated with the resistance for each phase, each switch being arranged to short-circuit a portion of its associated resistance, a rotatable shaft, and a cam on the shaft for each group of switches arranged to operate corresponding switches of the various groups simultaneously as the shaft is rotated.

29. In combination, a polyphase induction motor, a resistance for each phase of the rotor circuit of the motor, a group of snap switches associated with the resistance for each phase, each switch being arranged to short-circuit a portion of its associated resistance, a rotatable shaft, and a cam on the shaft for each group of switches arranged to operate corresponding switches of the various groups simultaneously and the different switches of each group successively as the shaft is rotated.

30. In combination, a polyphase induction motor, a resistance for each phase of the rotor circuit of the motor, a group of snap switches associated with the resistance for each phase, each switch being arranged to short-circuit a portion of its associated resistance, a rotatable shaft, and a pair of cams on the shaft for each group of switches, one of each pair of cams closing its associated switches successively as the shaft is rotated in one direction, and the other of each pair of cams opening said switches successively as the shaft is rotated in the other direction.

31. In combination, a polyphase induction motor, a resistance for each phase of the rotor circuit of the motor, a group of snap switches associated with the resistance of each phase, each switch being arranged to short-circuit a portion of its associated resistance, a rotatable shaft, and a pair of cams on the shaft for each group of switches, one of each pair of cams closing the corresponding switches of the various groups simultaneously as the shaft is rotated in one direction and the other of each pair of cams opening said corresponding switches simultaneously as the shaft is rotated in the other direction.

32. In combination, a three-phase induction motor, a Y-connected resistance in its rotor circuit, a group of snap switches associated with each section of said resistance, and means for operating the different switches of each group successively to gradually cut out said resistance.

33. In combination, a three-phase induction motor, a Y-connected resistance in its rotor circuit, a group of snap switches associated with each section of said resistance, and means for operating the corresponding switches of the various groups simultaneously to cut out parts of their associated resistance sections.

34. In combination, a three-phase induction motor, a Y-connected resistance in its rotor circuit, a group of snap switches associated with each section of said resistance, a rotatable shaft, and cams on said shaft for opening or closing said switches according to the direction of rotation of said shaft.

35. In combination, a three-phase induction motor, a Y-connected resistance in its rotor circuit, a group of snap switches associated with each section of said resistance, a rotatable shaft and a pair of cams on said shaft for each group of switches for closing corresponding switches of the various groups simultaneously as the shaft is rotated in one direction and opening said corresponding switches simultaneously as the shaft is rotated in the other direction.

36. In combination, a three-phase induction motor, a Y-connected resistance in its rotor circuit, a group of snap switches associated with each section of said resistance, a rotatable shaft, and a pair of cams on said shaft for each group of switches, one of each pair of cams being arranged to close its associated switches as the shaft is rotated in one direction, the other of each pair of cams being arranged to open said switches successively as the shaft is rotated in the other direction.

37. In combination, a three-phase induction motor, a Y-connected resistance in its rotor circuit, a group of snap switches associated with each section of said resistance, a rotatable shaft, and a pair of cams on said shaft for each group of switches, one of each pair of cams being arranged to close its associated switches successively as the shaft is rotated in one direction, the other of each pair of cams being arranged to open said switches successively as the shaft is rotated in the other direction, corresponding switches of the various groups being operated simultaneously.

In testimony whereof I affix my signature, in the presence of two witnesses.

LEWIS L. TATUM.

Witnesses:
GEO. B. SCHLEY,
FRED J. KINSEY.