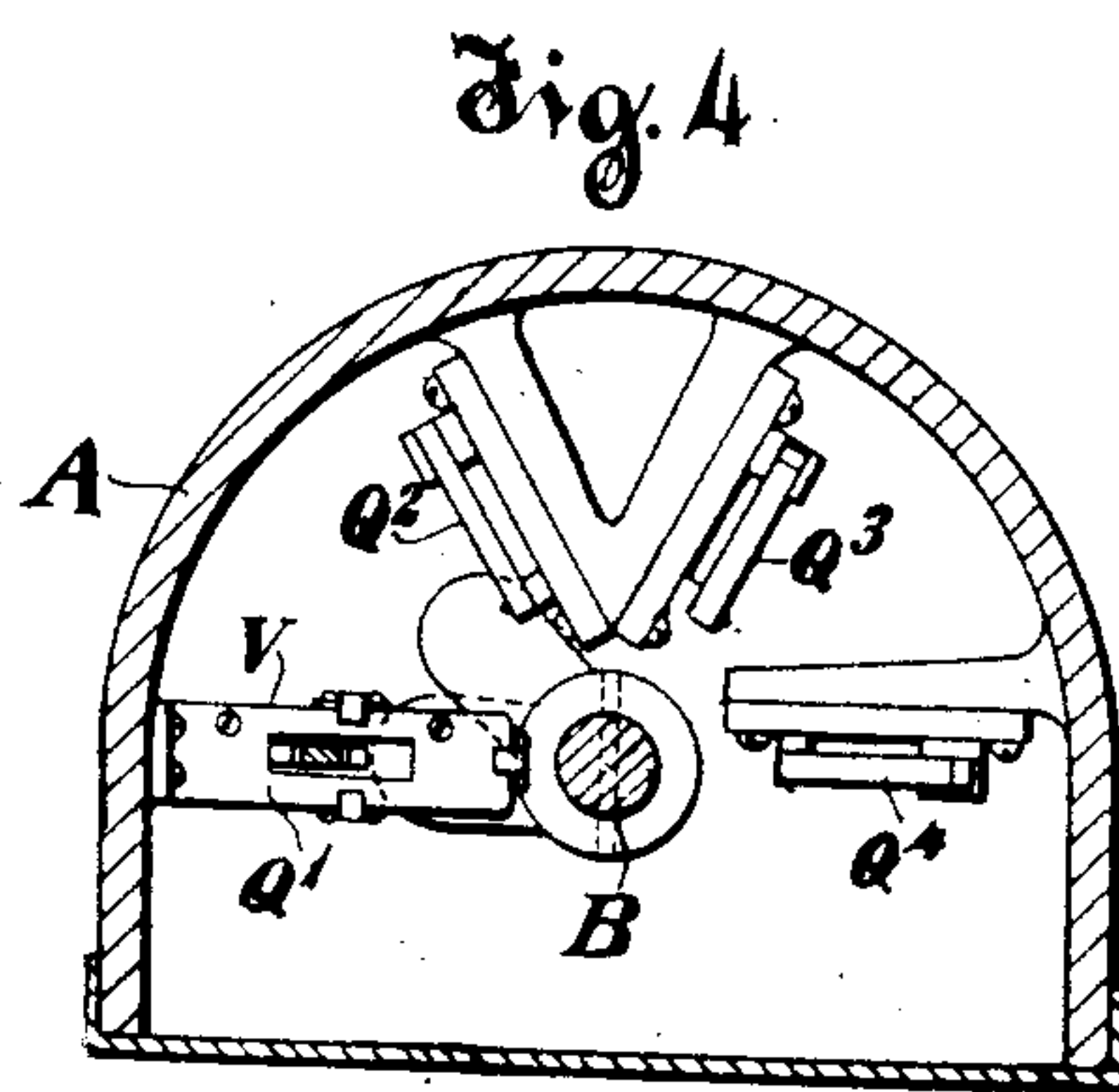
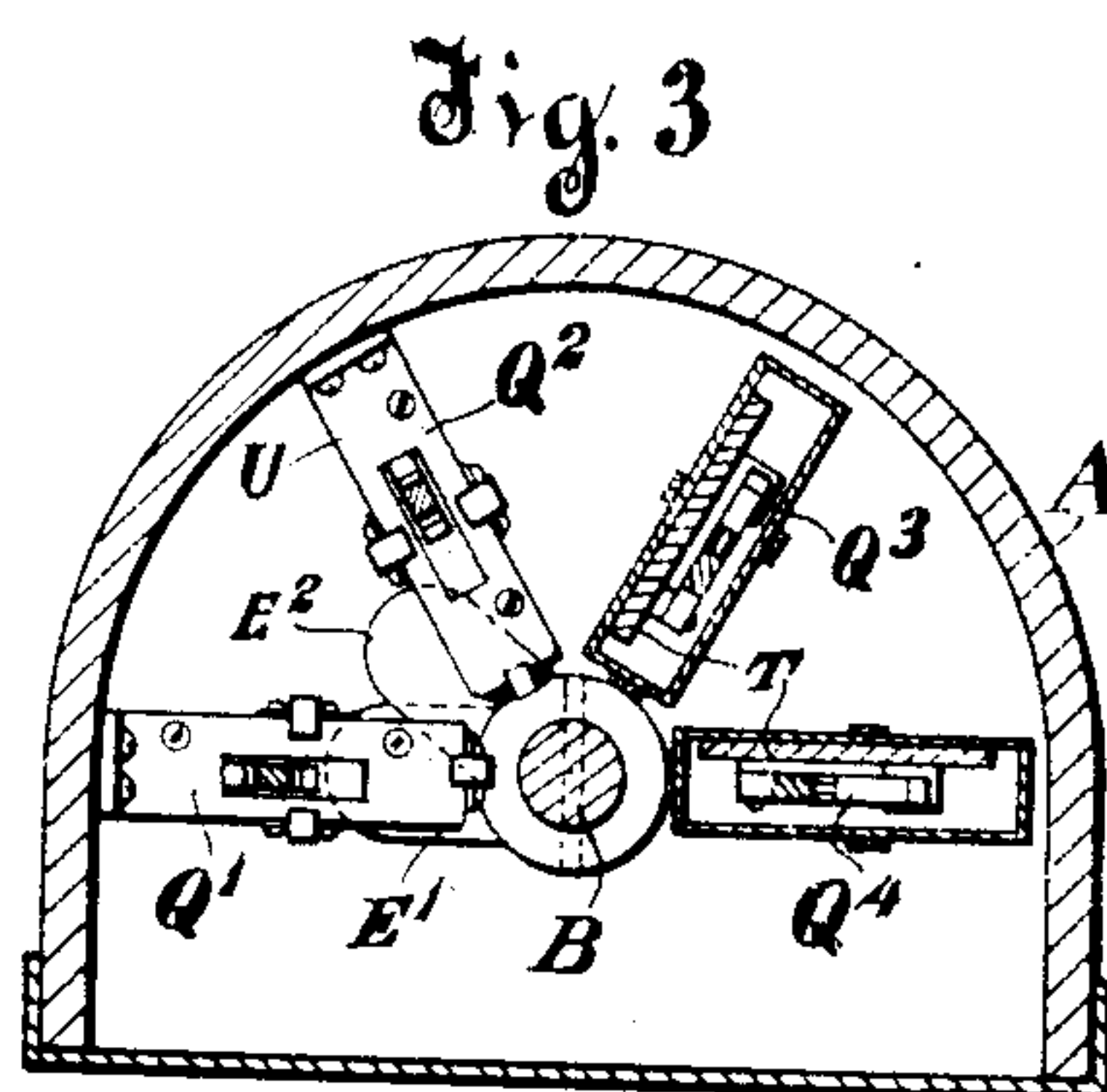
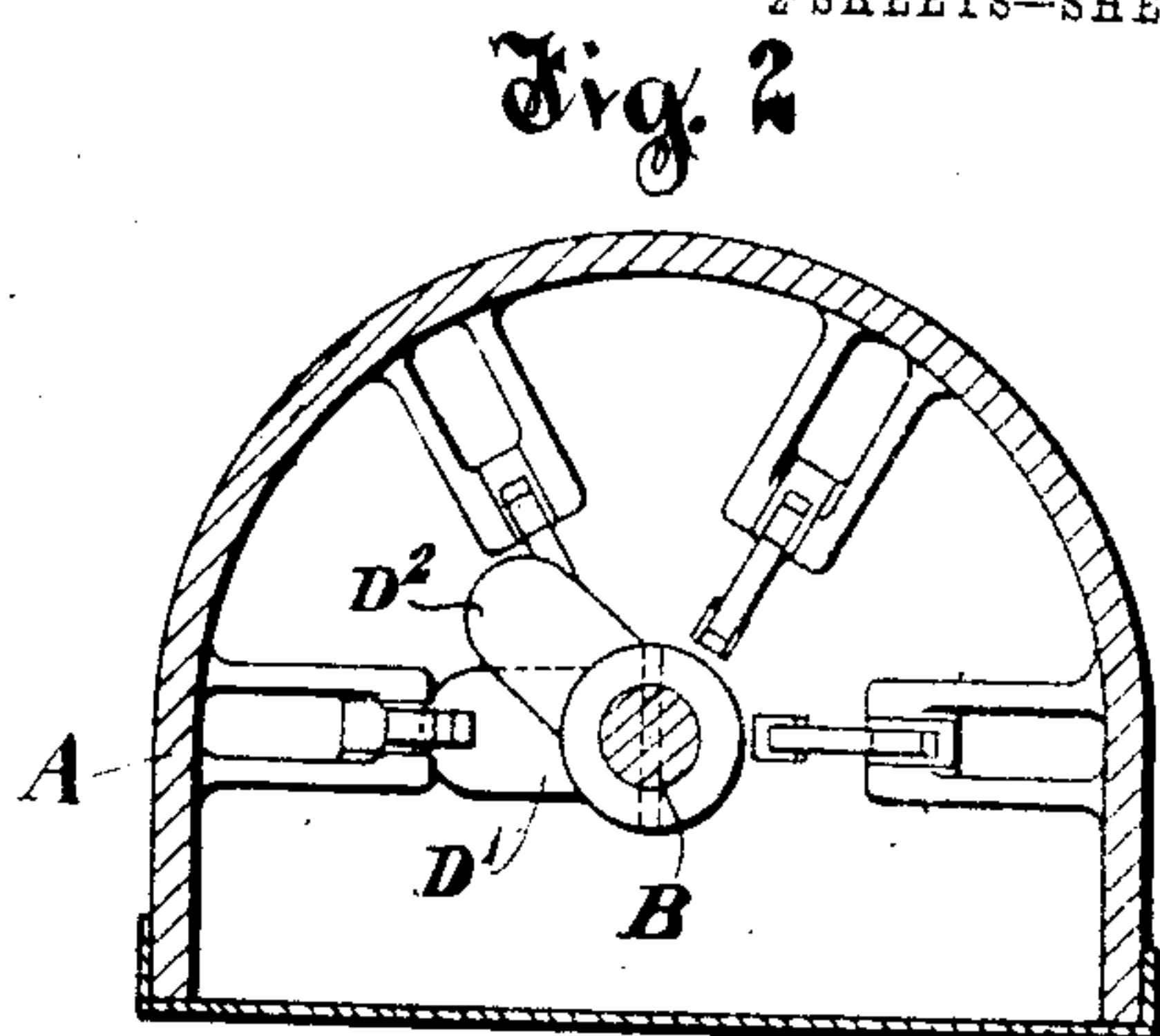
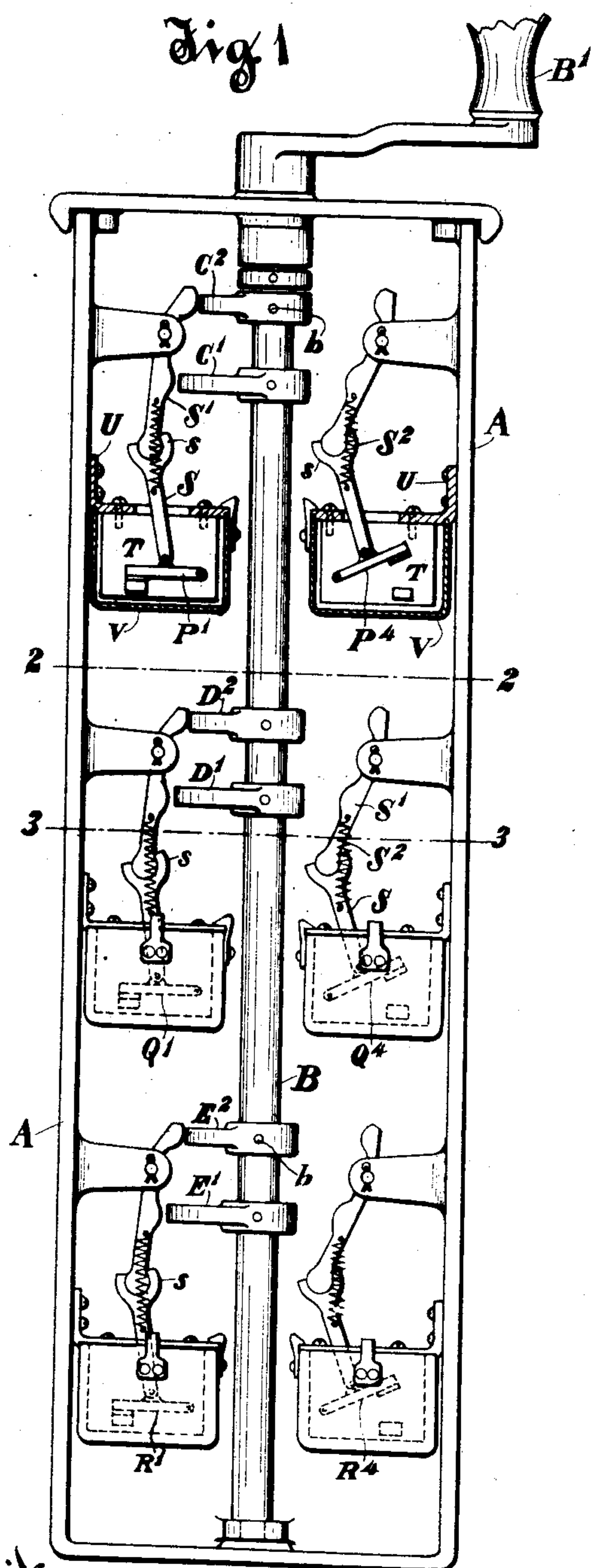


No. 870,596.

PATENTED NOV. 12, 1907.

L. L. TATUM.  
MOTOR CONTROLLER.  
APPLICATION FILED AUG. 31, 1906.

2 SHEETS—SHEET 1.



Witnesses  
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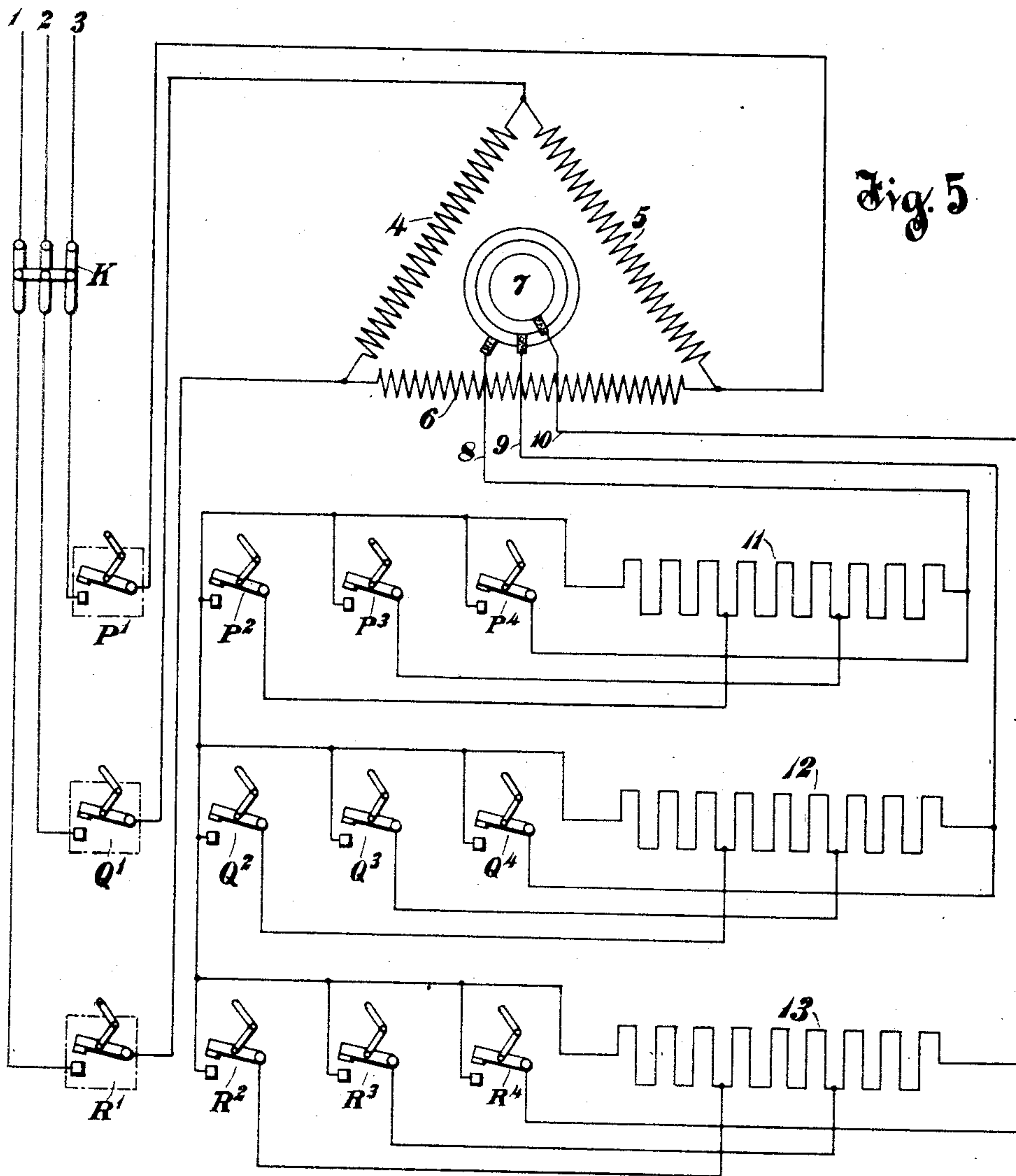
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Witnesses

Olive H. Haman

Fred J. Kinsey

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Chas. E. Lord  
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# 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.

## MOTOR-CONTROLLER.

No. 870,596.

Specification of Letters Patent.

Patented Nov. 12, 1907.

Application filed August 31, 1906. Serial No. 332,728.

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  
5 new and useful Improvements in Motor-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, rotor-wound induction motors.  
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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.

15 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 solenoid switches under the control of a master controller, in which case there  
20 were losses of energy in the solenoids and great complications in the system of wiring. With my invention the great labor of operation, the energy loss in the solenoids and the complicated wiring of the controlling circuits are all avoided and the contacts of the controller are  
25 positively closed with a firm contact and positively and widely opened with a quick break, thereby being able to carry a heavy current 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 stop, start and reverse the motors. It is also well adapted for use upon electric locomotives and in all places  
30 where large currents or high voltages are to be controlled.

35 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 secured. The operating mechanism  
40 may be of a small radius, but the switches controlled thereby may be arranged on a much larger radius. Arcing at the contacts may be reduced by having some or all of the switches immersed in oil. In addition the controller is simple in operation and construction, compact in form and inexpensive to manufacture. In carrying out my invention I employ a plurality of oil immersed switches and arrange same to be operated by a  
45 plurality of cams.

My invention further comprises the combination of a  
50 rotatable shaft, a plurality of cams on the shaft and a plurality of similar groups of oil immersed 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  
55 of the group 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 with a rotatable shaft of a plurality of  
60 cams on said shaft, and a plurality of oil immersed 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 alternating current motor, a resistance in the rotor circuit of  
65 the motor, a plurality of oil 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  
70 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 oil immersed switches associated with each section of said resistance, a rotatable  
75 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 when 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 controller casing removed. Fig. 2 is a section on  
85 the line 2—2 of Fig. 1. Fig. 3 is a section on the line 3—3 of Fig. 1. Fig. 4 is a view similar to Fig. 3 but showing only one switch of a group immersed in oil; and Fig. 5 is a diagram of connections showing my invention applied to a three-phase induction motor.  
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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', C<sup>2</sup>, D', D<sup>2</sup>, and E', E<sup>2</sup>, arranged in pairs. If desired the cams may be provided with anti-friction rollers at their ends. The  
95 cams C', D' and E' are arranged vertically in line, the cams C<sup>2</sup>, D<sup>2</sup> and E<sup>2</sup> being arranged in another vertical line. These two lines of cams are angularly displaced from each other.

Mounted on the casing are groups of switches P', P<sup>2</sup>,  
100 P<sup>3</sup>, P<sup>4</sup>; Q', Q<sup>2</sup>, Q<sup>3</sup>, Q<sup>4</sup>; and R', R<sup>2</sup>, R<sup>3</sup>, R<sup>4</sup>, the switches of each group as P', P<sup>2</sup>, P<sup>3</sup> and P<sup>4</sup> being horizontally in line and the corresponding switches of the different groups as P', Q' and R' being vertically in line. Each of these switches is arranged to be operated by a toggle  
105 S, S' the toggles in turn being operated by the cams C', C<sup>2</sup> etc. As the shaft B is rotated the cams engage the arms S' either above or below the pivotal points of the



latter, engagement below the pivotal points, as by cams C', D' and E', straightening the toggles and closing the switches as shown by switches P', Q', R' in Fig. 1, and engagement above the pivotal points, as by cams C<sup>2</sup>, D<sup>2</sup> and E<sup>2</sup>, tripping the switches by throwing the toggles out of line and allowing the switches to be opened with a snap by a spring S<sup>2</sup>. The switches P<sup>4</sup>, Q<sup>4</sup> and R<sup>4</sup> are shown open in Fig. 1. When the switches are closed the arms S, S' of the toggle are moved a little beyond alignment, so that the switches will be locked closed, too great a movement in this direction being prevented by fingers s on arms S. In closing the switch the first part of the movement is against no pressure of the switch contacts, 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.

Each of the switches of the controller is mounted on a plate T suspended from a bracket U which in turn is supported by the controller casing. The bracket U also supports a tank V containing oil in which the switch is immersed. These oil tanks may be removably attached to the bracket U in any desired manner.

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 switches are open. As the shaft is rotated in a clockwise direction the opening cams C<sup>2</sup>, D<sup>2</sup> and E<sup>2</sup> swing freely past the upper ends of arms S', doing nothing, but the closing cams C', D', E', which are but a small angular distance behind the opening cams engage the lower ends of arms S', closing the corresponding switches of the various groups as P', Q' and R', simultaneously, and the different switches of the same group as P', P<sup>2</sup>, P<sup>3</sup>, and P<sup>4</sup> successively. As the shaft is rotated in an anti-clockwise direction, the reverse action takes place, the closing cams first passing the arms S', doing nothing, and the opening cams following and engaging the upper parts of arms S' 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.

It will not always be necessary to arrange the 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. 5 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 respectively. 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. The first switch of each group of the controller switches P', Q' and R' is arranged to admit current to the stator winding of the motor and each of the other switches is arranged to cut out a part of the resistance section associated with that group. When it is desired to start the motor, the controller being in "off" position and the switch K being closed, the controller is moved in a clockwise direction to first simultaneously close the switches P', Q' and R' to admit current to the motor. 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 P<sup>2</sup>, Q<sup>2</sup> and R<sup>2</sup> to cut out parts of the resistance sections. As the motor gains speed the controller is moved to cut out more and more resistance until finally by closing switches P<sup>4</sup>, Q<sup>4</sup> and R<sup>4</sup> all of the resistance is cut out. When the controller is moved in the other direction the switches are opened to cut in the resistance again, and by the opening of the switches P', Q' and R' to stop 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.

In Fig. 4 an arrangement is shown in which only one of each group of switches is immersed in oil. This view is similar to Fig. 3 and shows switch Q' in oil in the tank V while the switches Q<sup>2</sup>, Q<sup>3</sup> and Q<sup>4</sup> are not oil immersed. This simplifies the construction of the controller to some extent and may often be advantageous especially with the system of connections as shown in Fig. 5, where the switches P', Q' and R' control the main circuit and are compelled to carry a large current and to be insulated for high voltages, while the other switches only short circuit sections of the resistance and often do not require any oil insulation.

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 here shown and described without departing from the spirit and scope of my invention, and I claim all such obvious modifications as fall thereunder.

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

1. In a controller, a rotatable shaft, a cam on said shaft, and a plurality of oil immersed snap switches operated by said cam as the shaft is rotated.
2. In a controller, a rotatable shaft, cams on said shaft, and a plurality of oil immersed 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.
3. In a controller, a rotatable shaft, cams on said shaft, and a plurality of oil immersed toggle switches arranged to be operated by each of said cams as the shaft is rotated.
4. In a controller, a rotatable shaft, a plurality of cams on said shaft, and a plurality of oil immersed switches, each cam being arranged to operate a number of said switches successively as the shaft is rotated.
5. In a controller, a rotatable shaft, a plurality of cams on said shaft, and a plurality of oil immersed 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 switch.

5 6. In a controller, a rotatable shaft, a plurality of cams on said shaft, and a plurality of oil immersed 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 respectively.

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

15 8. In a controller, a rotatable shaft, a pair of cams on said shaft, and a plurality of oil immersed 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.

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

25 10. In a controller, a rotatable shaft, cams on said shaft, and a plurality of oil immersed 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.

30 11. In a controller, a rotatable shaft, a pair of cams on said shaft, an oil immersed 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 the other 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.

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

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

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

55 15. In a controller, a shaft, a plurality of cams on said shaft, and a plurality of similar groups of oil immersed 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.

60 16. In a controller, a shaft, a plurality of cams on said shaft and a plurality of similar groups of oil immersed 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.

65 17. In a controller, a shaft, a plurality of cams on said shaft, and a plurality of similar groups of oil immersed 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.

70 18. In a controller, a rotatable shaft, a plurality of groups of oil immersed 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.

19. In a controller, a rotatable shaft, a plurality of groups of oil immersed 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.

20. In a controller, a rotatable shaft, a plurality of groups of oil immersed 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.

21. In a controller for induction motors, a shaft, a group of oil immersed 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.

22. In a controller for induction motors, a shaft, a group of oil immersed 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.

23. In a controller for induction motors, a shaft, a group of oil immersed 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.

24. In combination, an induction motor, a resistance in the rotor circuit of said motor, a plurality of oil immersed 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.

25. In combination, an induction motor, a resistance in the rotor circuit thereof, a plurality of oil immersed 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.

26. In combination, a polyphase induction motor, a resistance for each phase of the rotor circuit of the motor, a group of oil immersed 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.

27. In combination, a polyphase induction motor, a resistance for each phase of the rotor circuit of the motor, a group of oil immersed 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.

28. In combination, a polyphase induction motor, a resistance for each phase of the rotor circuit of the motor, a group of oil immersed 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.

29. In combination, a polyphase induction motor, a resistance for each phase of the rotor circuit of the motor, a group of oil immersed 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 as

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sociated 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.

- 5 30. In combination, a polyphase induction motor, a resistance for each phase of the rotor circuit of the motor, a group of oil immersed 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.

- 10 31. In combination, a three-phase induction motor, a Y-connected resistance in its rotor circuit, a group of oil immersed 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.

- 15 32. In combination, a three-phase induction motor, a Y-connected resistance in its rotor circuit, a group of oil immersed 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.

- 20 33. In combination, a three-phase induction motor, a Y-connected resistance in its rotor circuit, a group of oil immersed 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.

- 25 34. In combination, a three-phase induction motor, a Y-connected resistance in its rotor circuit, a group of oil immersed 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.

35. In combination, a three-phase induction motor, a Y-connected resistance in its rotor circuit, a group of oil immersed 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.

36. In combination, a three-phase induction motor, a Y-connected resistance in its rotor circuit, a group of oil immersed 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.

37. In a controller, a rotatable shaft, a plurality of independent current admitting switches and of resistance varying switches arranged to be operated by said shaft in its rotation, said current admitting switches being immersed in oil.

38. In a controller, a rotatable shaft, a plurality of switches arranged to be operated by the rotation of said shaft, and a separate oil tank for each switch.

39. In a controller, a rotatable shaft, a plurality of switches arranged to be operated by the rotation of said shaft, and a separate removable oil tank for each switch. In testimony whereof I affix my signature, in the presence of two witnesses.

LEWIS L. TATUM.

Witnesses:

RUBY ROBINSON,  
FRED J. KINSEY.