

Jan. 22, 1924.

1,481,372

R. B. HUNTER

ELECTRICAL CONTROLLER

Filed Jan. 18, 1922

2 Sheets-Sheet 1

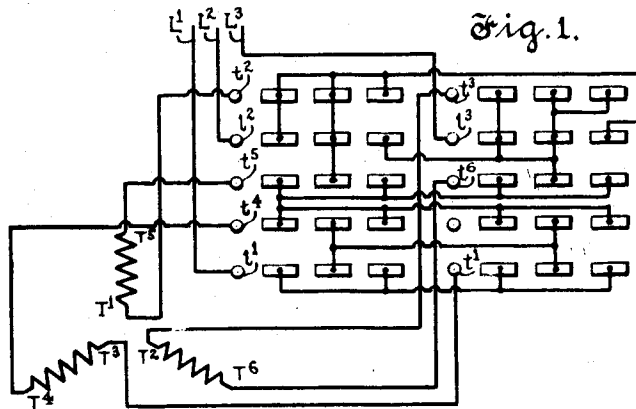
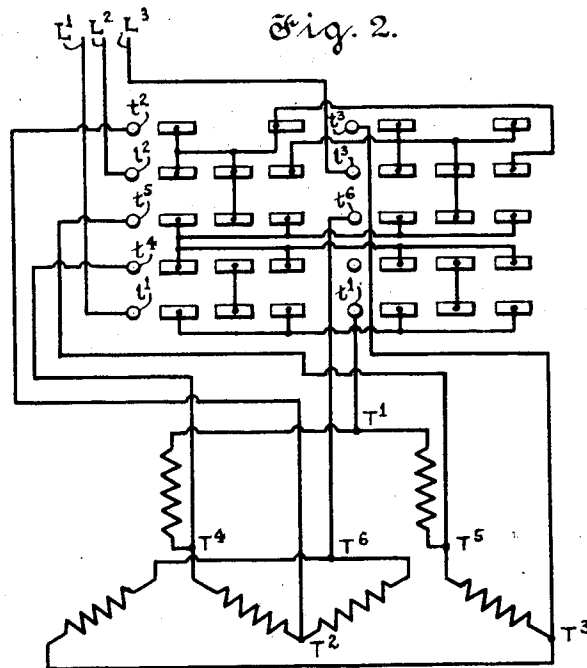
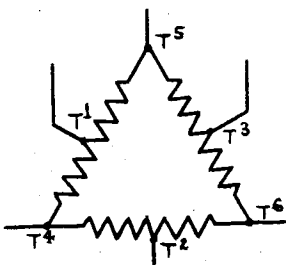


Fig. 2a



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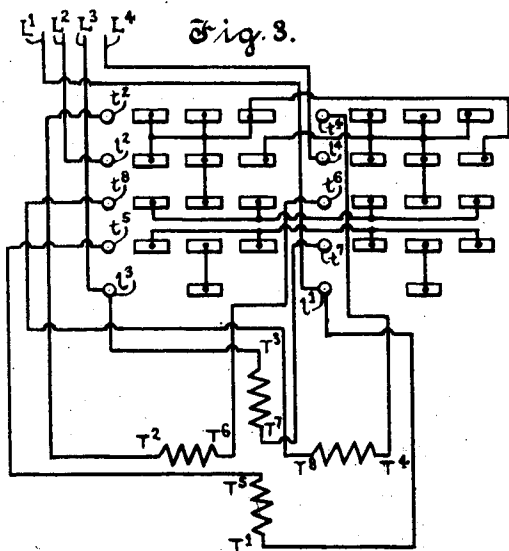
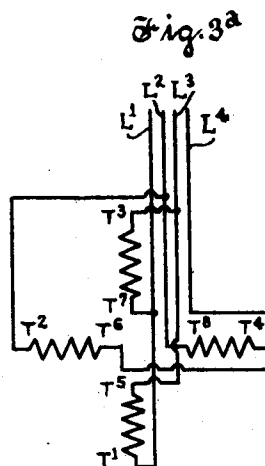
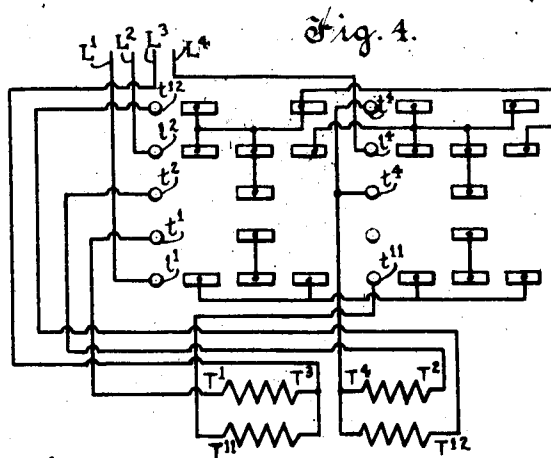
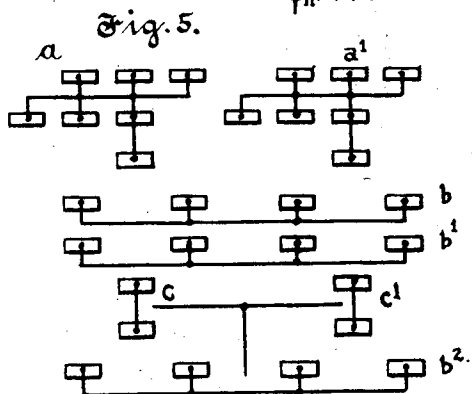
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ELECTRICAL CONTROLLER

Filed Jan. 18, 1922

2 Sheets-Sheet 2



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UNITED STATES PATENT OFFICE.

RICHARD B. HUNTER, OF MILWAUKEE, WISCONSIN, ASSIGNOR TO THE CUTLER-HAMMER MFG. CO., OF MILWAUKEE, WISCONSIN, A CORPORATION OF WISCONSIN.

ELECTRICAL CONTROLLER.

Application filed January 18, 1922. Serial No. 530,081.

To all whom it may concern:

Be it known that I, RICHARD B. HUNTER, a citizen of the United States, residing at Milwaukee, in the county of Milwaukee and State of Wisconsin, have invented new and useful Improvements in Electrical Controllers, of which the following is a full, clear, concise, and exact description, reference being had to the accompanying drawing, forming a part of this specification.

This invention relates to electrical controllers and more particularly to controllers of the drum type.

In the control of alternating current motors it is frequently desirable to provide for commutation of the circuit connections in a plurality of relations for operation of the motor in a given direction and in certain only of such relations for reverse operation and the present invention has as an object that of providing an improved and simplified drum controller adapted to so function.

Another object is that of providing such a controller wherein the range of angular travel required to effect the foregoing commutation is so reduced and the parts are so arranged as to adapt the same to progressive actuation in a given direction for effecting a plurality of complete cycles of such commutations for each revolution of the drum.

Another object is that of providing a controller whereof certain physical dimensions are materially reduced through more efficient correlation and arrangement of elements.

Another object is that of providing a drum structure and system of connections therefor enabling adaptation of the same without substantial structural modification to the control of numerous and widely different types of devices in different ways.

Other objects and advantages will hereinafter appear.

In the accompanying drawing, wherein are illustrated diagrammatically certain adaptations of a given embodiment of the invention;

Figures 1 and 2 illustrate the drum as adapted to effect different characters of control of three phase motors;

Fig. 2^a illustrates certain substitute connections obtainable by the drum arrangement of Fig. 3;

Figs. 3 and 4 illustrate the drum as adapt-

ed to the control of different types of motor supplied by a two phase four wire system;

Fig. 3^a illustrates certain substitute connections obtainable by the drum arrangement of Fig. 3; while,

Fig. 5 illustrates the arrangement and grouping of the drum segments.

The drum illustrated is in each instance adapted to progressive actuation in the direction indicated through eight distinct positions including two diametrically opposed off positions and six on positions arranged in two equal groups between successive off positions. Further the arrangement is such that during each half revolution of the drum from either off position, the controlled motor is first provided with line connections affording certain operative characteristics therefor, thereafter the connections are so commutated as to vary certain operative characteristics of the motor, such as speed, torque or the like, without reversal, and subsequently the original connections are re-established except for such transpositions as to effect reversal of the motor.

As exemplary of the possible uses to which the herein contemplated drum may be readily adapted, four distinct types of control by means of such drum are illustrated diagrammatically and will now be described, two of such types relating to three phase systems and two to two phase four wire systems. The motors to be controlled are of the induction type and only the primary windings thereof are considered herein, it being assumed that where secondary control is desired any preferred character of such control is to be employed. The drum terminals or fingers are designated by reference characters corresponding with those of the elements permanently in electrical connection therewith.

Referring to Fig. 1 of the drawing, the same illustrates an adaptation of the drum to the control of a three phase motor, such as to provide for the motor sequentially for each half revolution of the drum star, delta and reverse star connections.

Thus upon movement of the drum from off position to its first "on" position, drum terminals t' and t'' , t^2 and t^2 , t^3 and t^3 are respectively bridged by appropriate drum segments thereby obviously connecting the corresponding terminals of the several motor windings to their respective supply lines

in the sequence indicated, whereas, drum terminals t^4 , t^5 and t^6 are also interconnected by appropriate interconnected drum segments, thus obviously providing line connection of the several motor windings in star relation to one another.

Upon movement of the drum to its second "on" position, the aforescribed connections are commutated as follows, that is to say, drum terminals t' , t'' and t''' are interconnected by appropriate segments whereas drum terminals t^2 , t^4 and t^6 and also the group t^3 , t^5 and t^7 are similarly connected, thereby connecting the motor windings with their respective supply lines in delta relation and with reference to the phase rotation in the same relation as before. Upon movement of the drum to its third "on" position, drum terminals t^4 , t^5 and t^6 are interconnected as upon the first point whereas terminals t' and t^2 , t^2 and t'' , and t^3 and t^7 are respectively bridged, thereby serving to connect the corresponding motor terminals with their supply lines again in star but in a relation providing for reverse operation of the motor.

Upon further progressive movement of the drum beyond the "off" position, the relation of the two halves of the drum with reference to their respectively associated groups of fixed terminals is reversed. However, it is at once apparent that the arrangement of the drum segments together with the manner of their interconnection is such that precisely the same circuit commutations are now effected in the same order upon progressive step by step movement of the drum through the three "on" positions included in the second half of a complete revolution, whereas the precise manner in which such commutation is effected is believed to be too obvious to warrant more extended description.

Referring now to Fig. 2, the same also relates to the control of a three phase motor, the cycle of connection being, as illustrated, first double star, second delta, third reverse double star. The arrangement of the drum terminals or fingers is the same as that of the preceding figure whereas the structure of the drum itself is likewise the same except for omission of certain electrical connections and optional omission of the second and third segments from the upper horizontal row, since such segments do not participate in the control.

With the circuit arrangement illustrated obviously double star circuit connection of the motor windings is effected upon the first control point, the same sets of drum terminals being bridged as upon the first point of the previous adaption of the drum. Upon the second point the motor windings are provided with delta circuit connections as illustrated in Fig. 2^a, drum terminals t' and

t^4 , t^2 and t^5 , and t^3 and t^6 being respectively bridged by the appropriate drum segments and drum terminals t' , t^2 and t^3 being unenergized whereby the correspondingly designated motor terminals are not commutated. Upon the third point the connections represented in the main figure 2 are re-established except that the motor terminals T^2 and T^3 are interchanged with reference to their supply lines thereby providing for reverse operation of the motor.

Fig. 3 shows an adaptation of the drum to the purpose of effecting series paralleling control of the windings of a two phase motor to be supplied from a four wire system L^1 , L^2 , L^3 , L^4 , the phases being between L^1 , L^3 and L^2 , L^4 respectively.

In this instance the drum segments which were discarded in Fig. 2 are restored but on the other hand the lowermost group of four connected segments of the two preceding adaptations is removed or otherwise rendered inactive. The arrangement of the drum terminals has also been modified, such modification including permanent connection of motor terminal T^1 to line L^1 and T^3 to line L^3 .

Upon the first control point obviously drum terminals t^2 and t^3 , and t^4 and t^5 are respectively bridged thereby providing corresponding line connections for the similarly designated motor terminals, motor terminal T^3 being also connected to line L^3 as shown. Also drum terminals t^6 and t^7 , and t^8 and t^9 are respectively interconnected thus interconnecting the corresponding pairs of motor terminals, completing connection of the motor windings in series related pairs across their respective phase supply lines.

Upon the second point groups of drum terminals t' and t^7 , t^2 and t^8 , t^3 and t^9 , and t^4 , t^5 and t^6 are respectively interconnected thereby effecting the arrangement of connections of the motor windings, illustrated in Fig. 3^a wherein said windings are connected in pairs in parallel with one another across their respective supply circuits.

Upon the third point the connections established are the same as upon the first point except for interchange of the connections of motor terminals T^2 and T^4 with reference to their supply lines, thus providing for reversal of the motor.

Fig. 4 illustrates the adaptation of the drum to the control of a two phase motor of the separate circuit type to be supplied from lines L^1 , L^2 , L^3 , L^4 , the phases being between L^1 , L^3 and L^2 , L^4 respectively. In this instance the same two segments of the upper horizontal row are omitted as in the construction of Fig. 1 whereas the upper group of eight interconnected segments of said earlier figure is also omitted or otherwise rendered inactive.

With this arrangement, upon the first

point, groups of drum terminals l' and t^{11} , l^2 and t^{12} , and l^4 and t^4 are interconnected thus effecting connection of the corresponding line and motor terminals, the motor terminal T^3 being permanently connected with line L^3 as shown, whereby obviously only the lower pair of motor windings are connected in circuit.

Upon the second point the line connections of motor terminals T^3 and T^4 are maintained whereas drum terminals t^{11} and t^{12} are de-energized and terminals t' and t^2 are connected respectively with terminals l' and l^2 , whereby obviously only the upper pair of motor windings are connected in circuit.

Upon the third point the connections are the same as upon the first point except for interchange of the connections of motor terminals T^4 and T^{12} with reference to their respective supply lines whereby reversal of the motor is effected.

Upon consideration of the foregoing adaptations of the controller it is apparent that for effecting the characters of control depicted in Figs. 1, 2 and 4 a minimum of nine connections must be commutated whereas for the control illustrated in Figs. 3 and 3^a the minimum number of connections requiring commutation is ten. Also since in each case the controller is required to effect two complete cycles of control for each revolution of the drum the number of rows of fixed terminals or contact fingers perpendicular to the direction of rotation of the drum is practically restricted to two, whereby the drum controller must necessarily be of sufficient length to provide for five fixed contacts in a single row, whereas, in none of the foregoing adaptations does the length of the drum controller exceed such minimum.

Further it is obvious that for effecting the required character of control the drum must necessarily provide, as regards either row of fixed contacts, eight distinct positions including two off and six on positions, which minimum number of positions or points is in no instance exceeded, and from the foregoing it is apparent that the physical dimensions of the drum structure hereinbefore described are in each instance minimized, such dimensions being obviously the same in all the foregoing adaptations.

Considering now the particular structure and segment arrangement of the drum itself, with reference particularly to Fig. 5, it is seen that the complete drum comprises thirty single point contact segments having electrical interconnections providing seven distinct groups, a , a' , b , b' , b^2 , c and c' , whereas under certain conditions the groups b and b' and also the groups c , c' and b^2 are to be interconnected. Moreover in each instance the groups designated by the same reference letter are structurally similar

whereby but three shapes of segment castings are required, that is to say, the complete drum may conveniently comprise two castings a , three castings b and two castings c , suitably arranged and interconnected as required.

Thus for the adaptation of Fig. 1 the full number of castings is required, the groups b and b' and also the groups c , c' and b^2 being interconnected as shown.

For performance of the control depicted in Fig. 2 only the groups b and b' are interconnected, whereas, one segment is omitted or rendered inactive in each of groups a and a' as aforescribed.

For the purposes of Fig. 3 the total number of segments of groups a and a' is employed, the groups b and b' and c and c' are disconnected from one another and the group b^2 is omitted entirely.

For the control illustrated in Fig. 4 the number of segments of groups a and a' is reduced as in Fig. 2, the groups c , c' and b^2 are unconnected while groups b and b' are omitted.

From the foregoing it is apparent that by suitable arrangement and interconnection of but four shapes of segment castings, one of said shapes comprising a single segment, together with suitable connection of a maximum number of ten drum terminals or contact fingers provision is made for effecting numerous and widely differing types of control, including all the types aforescribed, the control apparatus being moreover of minimized physical dimensions and of extreme simplicity.

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

1. A rotatable drum controller for motors and the like, comprising line contacts and other contacts to be in connection with the motor, and segments to co-operate with said contacts, said contacts being so arranged and said segments having such interconnections as during each revolution of the drum to provide for effecting a plurality of similar cycles of commutations of the connections of the motor to the line, the number of said contacts being not in excess of the number of said connections and the number of distinct contacting surfaces of said segments being not in excess of the product of the number of commutations per cycle times one more than the number of contacts.

2. A rotatable drum controller for motors and the like comprising line contacts and other contacts to be in connection with the motor, and segments to co-operate with said contacts, said contacts being so arranged and said segments having such interconnections as during each revolution of the drum to provide for effecting a plurality of similar cycles of commutations of the connections of the motor to the line, the number of said

- contacts being not in excess of the number of said connections and the number of distinct contacting surfaces of said segments being not in excess of the product of the number of commutations per cycle times one more than the number of contacts, the arrangement further providing for variation of the character of control effected by the controller while maintaining a fixed number and relation of the line contacts.
3. A rotatable drum controller for three phase motors comprising a number of fixed contacts not to exceed ten and a number of similar contacting surfaces not to exceed thirty to co-operate therewith, said contacts and said surfaces being so arranged as during each complete revolution of the drum, to effect two cycles of control, each cycle including star, delta and reverse star connections and also de-energization of the motor.
4. A rotatable drum controller for three phase motors comprising a number of fixed contacts not to exceed ten and a number of similar contacting surfaces, not to exceed thirty, to co-operate therewith, said contacts and said surfaces being so arranged as, during each complete revolution of the drum, to effect two cycles of control, each cycle including star, delta and reverse star connections and also de-energization of the motor, and wherein provision is also made for substitution of double star connections for the star connections of such cycle.
5. A rotatable drum controller for three phase motors comprising a number of fixed contacts not to exceed ten and segments providing a number of similar contacting surfaces, not to exceed thirty, to co-operate therewith, said contacts and said surfaces being so arranged as, during each complete revolution of the drum, to effect two cycles of control, each cycle including star, delta and reverse star connections and also de-energization of the motor, and wherein provision is also made for substitution of double star connections for the star connections of such cycle, without increase in the number of co-operating contacts.
6. A rotatable drum controller for three phase motors comprising a number of fixed contacts not to exceed ten and segments providing a number of similar contacting surfaces not to exceed thirty to co-operate therewith, said contacts and said surfaces being so arranged as, during each complete revolution of the drum, to effect two cycles of control, each cycle including star, delta and reverse star connections and also deenergization of the motor, and wherein provision is also made for substitution of double star connections for the star connections of such cycle through varying the relation of certain controller contacts to the motor and reduction in the number of active drum segments.
7. A rotatable drum controller for poly-phase motors adapted during each revolution of the drum to effect two similar cycles of control each cycle comprising establishment sequentially of low speed, high speed and reverse low speed connections and final de-energization of the motor, comprising contacts and co-operating segments having contacting surfaces so arranged and so connected as to provide for effecting such control of a three phase motor or optionally of a two phase four wire motor.
8. A rotatable drum controller for poly-phase motors adapted during each revolution of the drum to effect two similar cycles of control each cycle comprising establishment sequentially of low speed, high speed and reverse low speed connections and final de-energization of the motor, comprising contacts and segments providing co-operating contacting surfaces so arranged and so connected as to provide for effecting such control of a three phase motor or optionally of a two phase four wire motor, the number of said contacts being not in excess of the number of circuit connections requiring commutation in one given instance,
9. A rotatable drum controller for poly-phase motors adapted during each revolution of the drum to effect two similar cycles of control, each cycle comprising establishment sequentially of starting, running and reverse starting connections and final de-energization of the motor, comprising contacts and co-operating segments so arranged and so connected as to provide for effecting such control of a three phase motor or optionally of a two phase four wire motor, the number of said contacts being not in excess of the number of circuit connections requiring commutation in one given instance, and the number of segments being not greater than the product of such maximum number of contacts times the number of circuit commutations per cycle of control.
10. A rotatable drum controller adapted to commutate the connections of a three phase motor to a three wire supply circuit or of a two phase motor to a four wire supply circuit in two complete cycles during each revolution of the drum, each of said cycles comprising establishment sequentially of starting, running and reverse starting connections with final de-energization of the motor, comprising fixed contacts and a plurality of drum segments arranged in seven groups of interconnected segments, said groups to include but three dissimilar types.
11. A rotatable drum controller adapted to commutate the connections of a three phase motor to a three wire supply circuit or of a two phase motor to a four wire supply circuit in two complete cycles during each revolution of the drum, each of said

cycles comprising establishment sequentially of starting, running and reverse starting connections with final de-energization of the motor, comprising fixed contacts and a plurality of drum segments arranged in seven groups of interconnected segments, said groups to include but three dissimilar types,

and said segments being so arranged and interconnected as to render the same functionally symmetrical with respect to two diametrically opposed elements of the drum. 10

In witness whereof, I have hereunto subscribed my name.

RICHARD B. HUNTER.