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MOTOR CONTROLLER.

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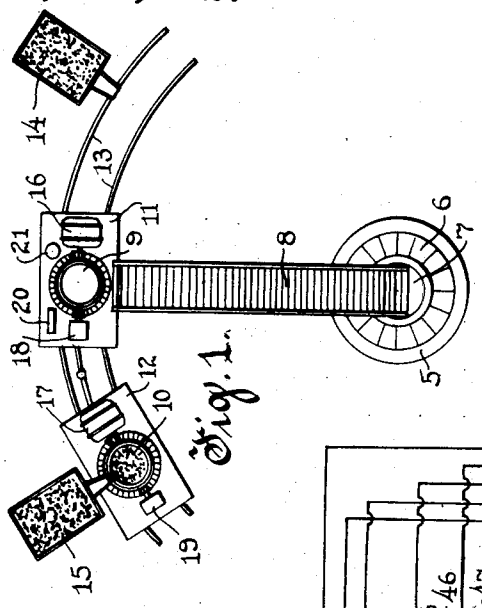


Fig. 1.

Fig. 2.

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MOTOR CONTROLLER.

1,403,342. Specification of Letters Patent. Patented Jan. 10, 1922.

Application filed April 30, 1920. Serial No. 377,798.

To all whom it may concern:

Be it known that I, NIELS L. MORTENSEN, 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 Motor 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 motor controllers and more particularly to controllers for associated motor operated mechanisms adapted to coact in predetermined cycles, of which class of mechanisms charging devices for blast furnaces may be taken as exemplary.

It has heretofore been proposed to operate a given motor driven mechanism intermittently in stages of dissimilar range or extent and to provide for repetition of a predetermined cycle or sequence of such dissimilar stages of operation of the driven mechanism. Thus in the operation of charging a blast furnace, in order to compensate for uneven distribution of the material within the hopper and to provide for uniform disposition of the successively dumped bodies of material circumferentially of the large bell prior to introduction of such material into the furnace proper, it has been proposed to effect a partial rotation of the hopper following each introduction of material therewithin and prior to dumping thereof, and to vary progressively the angular range of such successive partial rotations. The foregoing action, however, obviously involves location of certain moving parts at or near the top of the furnace which location is in certain instances disadvantageous and the present invention has among its objects that of obviating such disadvantage.

Another object is that of providing a device for effecting such disposition of the charging material for blast furnaces and the like, prior to elevation of such material, as to provide for adequate distribution of the material upon introduction thereof into such furnace or the like.

Another object is that of providing a device for effecting such preliminary movements of the loaded buckets supplying charging materials to a blast furnace or the like as to enable adequate distribution of such material upon simple elevation and dumping thereof within such furnace or the like in the usual manner.

Another object is that of providing a controller adapted to effect operation of a plurality of motor driven mechanisms in similar cycles overlapping one another in point of time and each cycle comprising a plurality of intermittent stages of unlike range or extent.

Another object is that of providing a controller of the aforesaid character including means for preventing derangement of the cycle of operation of the controlled mechanisms in the event of failure of power or in other contingencies.

Other objects and advantages will hereinafter appear.

In the accompanying drawing, wherein is illustrated an embodiment of the invention,

Figure 1 is a diagrammatic illustration thereof, while

Figure 2 is a similar view illustrating certain proposed circuit connections more in detail.

Referring to Fig. 1 of the drawing, the same illustrates at 5 the upper portion of a blast furnace including a large bell 6 and a receiving hopper 7. A skip hoist 8 is arranged to deliver charging material to the hopper 7, such material being conveyed in buckets 9 and 10 and the latter being respectively mounted upon cars 11 and 12 and removable therefrom by the hoist mechanism. Said cars are arranged to traverse a curved track 13 for transporting the individual buckets from the respective spouts or loading points 14 and 15 to the foot of the hoist, the arrangement providing for loading of one bucket during elevation and dumping of another.

Obviously the material as spouted into the buckets will not ordinarily distribute itself equally about the inner periphery thereof but will be more or less heaped at certain points and hollowed at others, which points, moreover, will always occur in substantially the same angular relation with reference to the particular loading spout, assuming uniform positioning of the bucket thereunder. It is therefore proposed, following loading of each bucket and prior to delivery thereof to the hoist, to turn such bucket through a predetermined horizontal angle, and following successive loading of either bucket to

increase progressively the angular range of such turning, preferably by an increment equal to such predetermined first angle which is preferably a factor of 360 degrees. After a number of turns such that the range of the last turn differs from 360 degrees only by such common increment, the bucket is filled and dumped once without intermediate turning and the aforedescribed cycle is thereafter repeated.

Such sequential loading, turning and dumping of the several buckets serves to compensate for uneven disposition of the charging material therein and provides for uniform distribution of the individual ingredients of such material upon the large bell of the furnace, assuming the use of an individual bucket for handling each of the principal ingredients of the charge.

The aforedescribed turning of the several buckets is effected by individual motors 16 and 17 located upon the respective cars and acting through suitable gearing. The necessary correlation and control of said motors is effected by means of control mechanism including individual limit switches 18 and 19 to be driven in synchronism with the respective buckets and a common ratchet operated selector device 20, the latter being in turn controllable by a master controller 21 which in practice may be actuated either voluntarily by the operator or automatically through the reverse movements of the cars upon the track, or in other ways.

More specifically the master controller includes a series of stationary contacts 22 to 27 and a co-operating contact-carrying drum 28 movable in opposite directions from an intermediate off position to provide a line connection for either of the motors 16 and 17 selectively, and to complete a power connection for effecting actuation of the selector device 20 to complete the energizing circuit of such motor through its associated limit switch. The selector device is designed to provide for starting of the motors in alternate order by the master controller, whereas the respective limit switches are adapted to effect automatic stopping of their associated motors following a degree or range of operation thereof determined by the setting of the selector device.

The limit switches 18 and 19 are of similar construction and each comprises a plurality of fixed contacts, having circuit connections to be hereinafter described, and a co-operating set of interconnected contact segments of different lengths adapted to move jointly in synchronism with the respective buckets.

The selector device 20 comprises an insulating base 29 carrying contact buttons arranged in two concentric rows, each of like number of buttons.

The buttons of the outer row are insulated from one another and numbered consecutively from 31 to 54, whereas the alternate buttons of the inner row are electrically interconnected and are collectively designated by numbers 55 and 56 respectively. Slip rings 57 and 58 are arranged adjacent the respective outer and inner rows of contact buttons and concentric therewith, while a contactor 59 is pivoted concentrically of said buttons and slip rings and provided with oppositely located sets of electrically connected brushes 60 and 61 adapted in different positions of said contactor to connect individual buttons of each of said inner and outer rows with their respective slip rings, the latter having individual line connections. A ratchet wheel 62 having a number of teeth equal to the number of buttons in either row is secured concentrically of said contactor, while a solenoid operated ratchet lever 63 is adapted to co-operate with said ratchet wheel for effecting step by step rotation of said contactor in a clockwise direction.

The interconnected groups 55 and 56 of selector contacts are respectively connected with individual fixed contacts of the master controller for selective energization of said groups of contacts upon movement of the master controller to either of its extreme positions, the contactor brushes 61 being of such width as to be always in engagement with at least one of said buttons. Moreover, the line connection of slip ring 58 includes the winding 64 of solenoid 65, whereby it is always possible to effect energization of said winding through operation of the master from off position to one or the other extreme position, whereas movement of the master from one extreme position to the other similarly effects energization of said winding to advance the contactor one step. A switch 66 operated by the solenoid 65 serves when closed to maintain energization of said winding through the master controller, irrespective of separation of the contactor brushes 61 from the selector contact through which such energization was effected.

The outer contact buttons of the selector device are utilized directly for controlling completion of the circuits of motors 16 and 17, buttons having odd reference numerals being respectively connected with corresponding fixed contacts of limit switch 18 for control of motor 16 and buttons having even numbers being similarly connected with corresponding contacts of limit switch 19 for control of motor 17. Thus step by step movement of the contactor 59 serves to effect energization of said motors alternately, since movement of said contactor prerequires suitable positioning of the master controller, whereas the limit switches are adapted in all cases to complete an advance circuit connection prior to interruption of

the active connection. The selector buttons 31, 38, 43 and 50 are unprovided with circuit connections and therefore positioning of the contactor brush 60 upon any one of said dead buttons corresponds with that phase of operation of the device wherein the bucket is not turned prior to dumping.

Each limit switch, in addition to the usual continuously engaged energizing contact and segment, is provided with ten fixed contacts individually connected with buttons of the selector device as aforedescribed, and for convenience each of said fixed contacts is designated by a reference numeral greater by one hundred than the numeral of its corresponding selector button.

The lengths of the various limit switch segments and their arrangement with reference to the fixed contacts thereof are such as to provide for progressive and uniform increase in the angle through which each bucket is successively turned, such increase continuing up to the point at which further increase would result in complete revolution of the bucket at which point, however, the contactor brush is adapted to engage one of the dead contacts and the bucket is not rotated, the cycle of operation being thereafter recommenced.

The various controller parts being in the relative positions illustrated the operation thereof may be described as follows: Movement of the master controller to position "*a*" completes the energizing circuit of solenoid magnet winding 64 from line L^1 to contact 24 of the master controller, thence by conductor 67 to the group 56 of selector contact buttons one of which buttons is engaged by the contactor brush 61, thence to slip ring 58, thence by conductor 68 through the winding 64 of the solenoid magnet and by conductors 69 and 70 to line L^2. Said solenoid magnet thereupon responds, drawing in its plunger and advancing said contactor one step, thus disengaging the button 56 and engaging the next button 55, which is unenergized at this time. However, prior to such disengagement of button 56 the switch 66 is adapted to close thus completing a maintaining circuit of the winding of said solenoid magnet, said circuit extending from line L^1 to contact 23 of the master controller and by conductor 71 through said solenoid switch, thence by conductor 72 through the winding of said solenoid magnet and by conductors 69 and 70 to line L^2. Such action obviously serves to transfer the control of said winding 64 from the selector device to the master controller and to maintain said winding energized pending movement of said master controller to off position.

The aforedescribed movement of the contactor 59 also serves to bring the brushes 60 into such position as to connect the button 31 with the slip ring 57. However, as said button is dead, no action of either motor is effected, this being the stage wherein the bucket 9 is not turned prior to dumping.

Upon shifting the master controller to the position "*b*" the contactor 59 is again advanced one step in the manner just described. However, in this instance, the energizing circuit of the solenoid winding extends through contact 25 of the master controller thence by conductor 73 to the group 55 of selector contacts and thence through the contactor brushes 61 as formerly traced.

Such second shifting of the contactor brings the brushes 60 thereof into engagement with the button 32 thereby completing the circuit of motor 17, said circuit extending from line L′ through contact 27 of the master controller, thence by conductor 74 through the field and armature of said motor to limit switch 19, thence through contact 132 thereof which is electrically connected with said selector button 32, thence through brushes 60 to slip ring 57 and by conductor 70 to line L^2. Motor 17 thereupon functions to turn its associated bucket through an angle corresponding with the angular extent of the limit switch segment which is then engaged by said contact 132, and at the end of such movement the motor circuit is interrupted at said segment.

Return movement of the master controller to position "*a*" serves again to advance the selector one step and similarly to effect energization of motor 16 by circuit connections extending through contact 26 of the master controller, by conductor 75 through the field and armature of said motor 16 thence to limit switch 18 and to contact 133 thereof which is electrically connected with button 33 of the selector device thence through brushes 60 and slip ring 57 and thence to line L^2. Motor 16 thereupon acts to rotate its associated bucket through an angle determined by the length of the segment which is then in engagement with said contact 133.

Thus successive movements of the master controller from one extreme position to the other serve to effect energization of the respective motors alternately for rotation of the respective buckets through progressively increasing angles until the contactor brushes 60 engage the contact numbered 38 which position corresponds with the stage of operation wherein the bucket 10 is not rotated. Whereupon the cycle of operation of this bucket recommences at this point.

The controller illustrated is designed to effect operation of each bucket in cycles each comprising five turns and one neutral stage, the first turn being 60° and each succeeding turn being increased by 60° over the preceding turn, although obviously different cyclic combinations may readily be obtained by varying the number of contact elements and

the relative lengths of the limit switch segments.

To provide for execution of the particular cycles aforedescribed, each limit switch is provided with a number of control segments equal to the number of times its associated bucket is to be turned, viz. 5. Moreover, the shortest segment subtends an angle of 60° and each successively acting segment subtends an angle greater by 60° than that of the preceding segment. Also, since the travel of the limit switch is cumulative each limit switch making two and one half revolutions to each complete cycle of its bucket, it is obvious that each limit switch, at the end of each cycle of its bucket, occupies a position 180° in advance of its position at the end of the previous cycle. It is therefore advantageous to employ a number of fixed contacts equal to twice the number of control segments and to arrange said contacts in two rows displaced 180° angularly, whereby said rows of contacts participate alternately for control of the bucket in similar cycles, irrespective of the fact that the limit switch does not return to starting position at the end of each cycle.

Obviously the number of active control contacts 31 to 54 of the selector device equals the total number of fixed control contacts of both limit switches, whereby one complete revolution of said selector device corresponds with two complete cycles of each bucket, the dead contacts 31, 38, 43 and 50 being arranged in insure proper sequential relation of the neutral stage for each cycle of either bucket.

The inner row of selector buttons 55 and 56 serve in conjunction with their associated contactor brushes and the solenoid switch 66 to provide an interlock for preventing derangement of the cycle of control in the event of failure of power supplied to the controller. Thus upon failure of power during energization of the solenoid winding 64, the master controller being necessarily in on position, the solenoid plunger will merely drop, whereas upon restoration of power no action of the selector device will occur until after movement of the master to the opposite on position whereupon the next stage of the cycle will be executed in its normal order.

Obviously emergency stopping of either motor may be effected at any time through movement of the master controller to off position and such motor may then be restarted for completion of the interrupted stage of operation by return of the master to the position from which it was so moved.

What I claim as new and desire by Letters Patent—

1. In a controller for associated motor driven devices, the combination with means for effecting starting connections for the driving motors alternately, of means to be driven in synchronism with the respective devices for effecting stopping of said motors selectively following predetermined different ranges of operation of said devices.

2. In a controller for associated motor driven devices, the combination with means for effecting starting of the driving motors sequentially, of associated means for effecting stopping of the respective motors following operation of said devices throughout predetermined ranges and for progressively varying the successive operative ranges of said devices.

3. In a controller for associated motor driven devices, the combination with means for effecting starting of the driving motors sequentially, of associated means for effecting stopping of the respective motors following operation of their associated driven devices throughout a predetermined range and for automatically varying the successive operative ranges of the individual driven devices in cycles.

4. In a controller for associated motor driven devices, the combination with means for effecting starting of said devices sequentially, of associated means for effecting stopping of each of said devices following operation thereof throughout a predetermined range and for automatically and progressively varying the successive operating ranges of said devices.

5. A controller for effecting operation of associated driven devices sequentially and each in stages of dissimilar range comprising common means for effecting selective starting of said devices and associated individual means for effecting stopping of the respective devices and for progressively varying the range of the successive operations of each.

6. A controller for effecting operation of associated independently driven devices in cycles which include a succession of operative stages of dissimilar range, comprising means common to said devices for effecting repeated sequential starting thereof while providing for operations thereof singly, and associated individual means for effecting stopping of the respective devices and for varying cyclically the successive operative ranges of each.

7. A controller for associated mechanisms having individual driving motors comprising starting means providing for operation of said motors alternately and singly and associated stopping means providing for operation of each of said motors in cycles of similar operative stages of progressively varying range.

8. A controller for associated mechanisms having individual driving motors, comprising a master controller for effecting partial circuit connections for said motors selec-

tively, a selector device controllable by said master controller for completing the circuits of said motors sequentially and associated means for effecting stopping of each motor following progressively varying ranges of operation thereof.

9. A controller for associated mechanisms having individual driving motors, comprising a master controller for effecting partial circuit connections for said motors selectively, a selector device controllable by said master controller for completing the circuits of said motors, said master controller and said selector device having an interlock providing against completion of said circuits except in a predetermined order and associated means for effecting stopping of each motor following progressively varying ranges of operation thereof.

10. A controller for associated mechanisms having individual driving motors, comprising a master controller for effecting partial circuit connections for said motors selectively, a selector device for completing the circuits of said motors sequentially, operating means for said selector device including an electromagnetic winding having its energizing circuit controllable by said device and said master controller jointly, and associated means for effecting stopping of each motor following progressively varying ranges of operation thereof.

11. In a controller for associated motors, the combination with a master controller for effecting partial circuit connections for said motors selectively and a selector device for completing the circuits of said motors in a predetermined order, of operating means for said selector device including an electromagnetic winding having its energizing circuit arranged to be completed by said master controller through a portion of said device and operation of said device serving to interrupt the connection through which said circuit was established, and an interlock for transferring the control of said operating means to said master controller prior to such interruption of said connection.

12. In a controller for associated motors, the combination with a master controller for effecting partial circuit connections for said motors selectively and a selector device for completing the circuits of said motors in a predetermined order, of operating means for said selector device including an electromagnetic winding having its energizing circuit arranged to be completed by said master controller through a portion of said device and operation of said device serving to interrupt the connection through which said circuit was established, and to establish a connection for subsequent completion of said circuit by a different positioning of said master controller, an interlock for transferring the control of said operating means to said master controller prior to such interruption of said connection to provide for operation of said selector device only in a step by step manner irrespective of failure and restoration of power or of inappropriate actuation of the master controller.

In witness whereof, I have hereunto subscribed my name.

NIELS L. MORTENSEN.

Certificate of Correction.

It is hereby certified that in Letters Patent No. 1,403,342, granted January 10. 1922, upon the application of Niels L. Mortensen, of Milwaukee, Wisconsin, for an improvement in "Motor Controllers," errors appear in the printed specification requiring correction as follows: Page 4, line 35, for the word "in" read *to*, and line 122, claim 7, strike out the words "and singly;" and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 25th day of April, A. D., 1922.

[SEAL.]

KARL FENNING,

Acting Commissioner of Patents.