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CONTROLLER FOR ALTERNATING CURRENT MOTORS

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13 Claims. (Cl. 318—363)

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This invention relates to improvements in controllers for alternating current motors, and is particularly advantageous in control of such motors where employed for hoisting and lowering widely varying loads.

For lowering it has been found very advantageous to effect unbalance of the motor primary through the medium of an autotransformer having an overhanging section and through one or another known method to obtain phase reversal of the motor for producing selectively a hoisting torque or a lowering torque at zero motor speed without resorting to interruption and reversal of two phases of the motor line connections, the hoisting torque thus made available for opposing descent of the load being limited to a value insufficient actually to effect hoisting. Such control generally meets all requirements but there are instances where a greater hoisting torque opposing descent of the load is desirable for spotting or checking the load just prior to setting it down at its destination, and the present invention has as an object thereof to supplement the aforementioned control to afford a satisfactory high torque spotting or checking point in lowering or a continuous very slow speed under heavy load.

Another object is to afford the desired increased hoisting torque for spotting or checking with an autotransformer of minimum size and through the medium of over-voltage which the motor can efficiently stand.

Another object is to render available the high torque for spotting or checking only upon backward or decelerating movement of the manual controller employed for governing acceleration and deceleration of the descending load.

Another object is to provide for automatic stopping when the motor is checked and reduced to a given speed, assuming the manual controller to be retained in spotting or checking position.

Other objects and advantages of the invention will hereinafter appear.

The accompanying drawing illustrates certain embodiments of the invention which will now be described, it being understood that the embodiments illustrated are susceptible of various modifications without departing from the scope of the appended claims.

In the drawings,

Figure 1 is a diagrammatic view showing in part a known system of control modified to afford a preferred form of the control constituting the subject matter of this application;

Fig. 2 shows certain characteristic curves, and

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Fig. 3 shows diagrammatically a modified form of control.

Referring to Fig. 1, the same shows a polyphase motor M having in the circuit of the secondary S thereof resistors R^1 , R^2 and R^3 to be controlled as desired in hoisting and lowering. The motor primary P has terminals T^1 , T^2 and T^3 to be supplied with power from a polyphase circuit L^1 , L^2 and L^3 through a triple pole electroresponsive main switch 10 under the control of a drum type master switch 11 movable in one direction for hoisting and in an opposite direction for lowering. It is assumed that the motor will be controlled in the usual well understood manner in hoisting and as the additions herein made to the control do not involve hoisting connections such connections including the drum contacts therefor have been omitted. The motor is shown as provided with a friction brake B having a releasing magnet B^1 which is connected across the terminals T^2 and T^3 of the motor. Thus the brake will be released when power is supplied to the motor for either hoisting or lowering.

For control of the motor in lowering there is shown an autotransformer T which through the medium of the drum 11 is interposed between the motor and the supply circuit to effect unbalancing of the motor primary. The drum 11 in lowering position, 1 establishes connections for energization of the motor primary P such as to produce at zero speed a small hoisting torque in accordance with the usual practice. More particularly the drum has a contact 15 connected to line L^3 which is engaged in all positions of the drum by a segment 16 to which is electrically connected a segment 17 engageable with a contact 18 to complete circuit from one terminal of the winding 10^a of main switch 10 to line L^3 , the other terminal of said winding being connected to line L^1 . Thus the drum in its first lowering position energizes the winding 10^a of main switch 10 to close said switch. Also the drum in moving from the off position shown to lowering position 1 acts through engagement of its interconnected segments 19 and 20 with contacts 21 and 22, respectively, to connect the portion of the autotransformer T between points 23 and 24 across lines L^1 and L^3 through the main switch 10. Also the drum in moving from off position to lowering position 1 connects end terminal 25 of the autotransformer to terminal T^1 of the motor by engagement of interconnected drum segments 26 and 27 with drum contacts 28 and 29, respectively. Moreover the drum in moving from off

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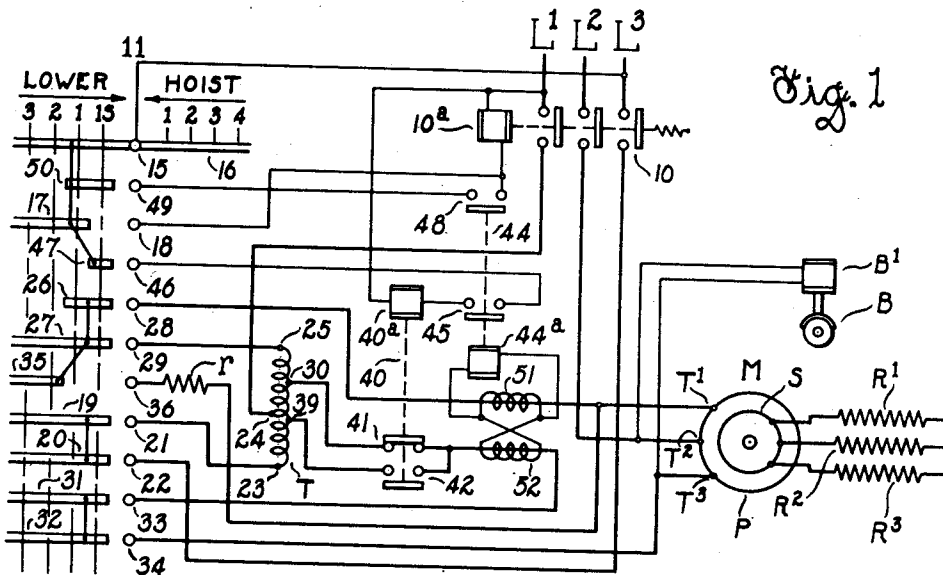


Fig. 3

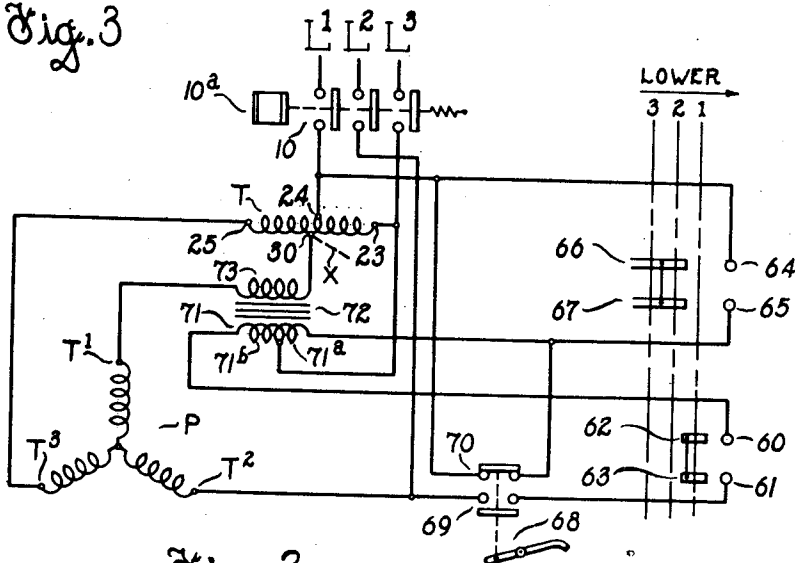
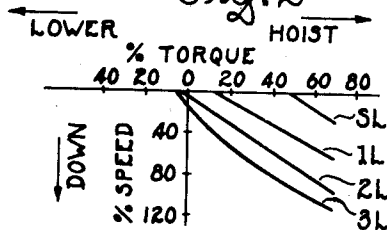
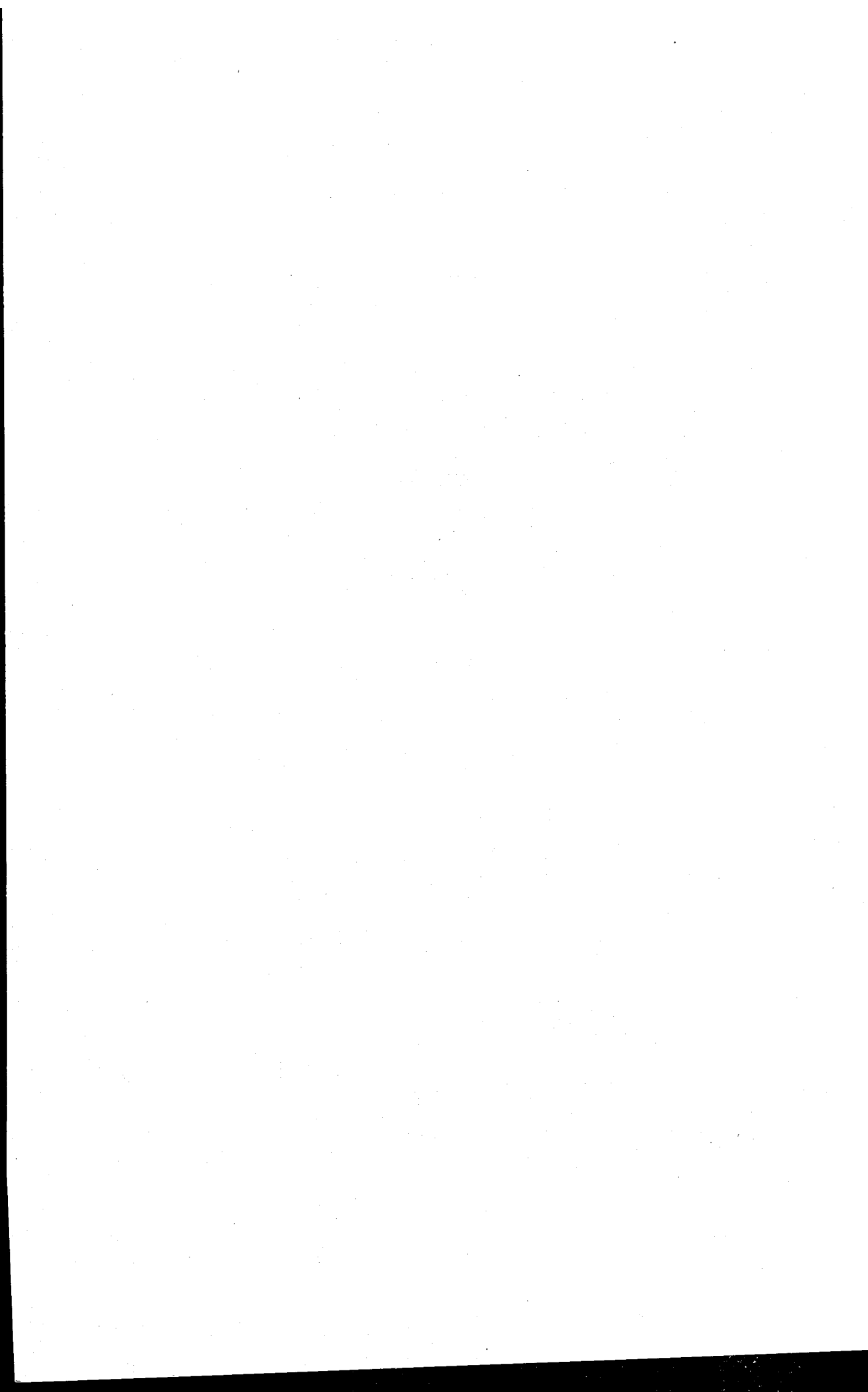


Fig. 2



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motor current and thus should be of the electromagnetic type which, of course, could be controlled in other ways than that illustrated, as through the medium of a hand or foot operated switch with or without interlock between such switch and the master switch. On the other hand, it will in some instances be desired to embody in a hand or foot operated switch the ultimate functions of the electromagnetic switch 40 to avoid need of an electromagnetic type of switch, and the modified control of Fig. 3 enables employment of such a hand or foot operated switch and affords an interlock between said switch and the master switch to limit effectiveness of the former to the first lowering point.

Fig. 3 shows even less of the full control than does Fig. 1 but ways of incorporating the features of Fig. 3 in a full control will be apparent to those skilled in the art. Also it will be apparent to those skilled in the art that the control of Fig. 3 may have added thereto features of the control of Fig. 1 which have been omitted for simplicity of illustration.

Referring to Fig. 3, it like Fig. 1 shows a motor primary P with terminals T¹, T², T³ to be supplied from lines L¹, L², L³ through an electroresponsive switch 10. Also like Fig. 1 it shows an autotransformer T with a portion thereof between terminals 23 and 24 connected across lines L¹ and L³ and with an end terminal 25 and tap 30 for connection to two terminals of the motor, the third motor terminal being connected directly to line L² through main switch 10. The drum contacts for control of the main switch and the commutable motor connections which may be similar to those of Fig. 1 except for omission of the contacts of position IS have been omitted for simplicity of illustration, whereas certain additional drum contacts have been shown. These additional drum contacts comprise contacts 60 and 61 to be engaged by interconnected segments 62 and 63 in lowering position 1 of the drum, and contacts 64 and 65 to be engaged by interconnected contacts 66 and 67 in lowering position 2 of the drum. The first mentioned set of drum contacts are engaged only on lowering point 1 while the second set of contacts may be engaged on all lowering points other than point 1.

In Fig. 3 a hand or foot operated switch 68 is employed in lieu of the electromagnetic switch 40 of Fig. 1, switch 68 having normally disengaged contacts 69 and normally engaged contacts 70. This switch jointly with the aforementioned drum contacts controls the circuit connections of the primary winding 71 of a transformer 72 which has a secondary winding 73 connected between motor terminal T¹ and tap 30 of the autotransformer T. The transformer winding 71 comprises a section 71^a to be connected across lines L¹ and L³ by drum contacts 64 to 67, or alternatively by contacts 70 of switch 68. Also the primary winding of transformer 72 comprises a section 71^b to be connected across lines L² and L³ by drum contacts 60 to 63 and contacts 69 of switch 68 jointly.

On lowering point 1 with the hand or foot operated switch 68 in normal position as shown, its contacts 70 connect section 71^a of the primary of transformer 72 across lines L¹ and L³, as heretofore explained, and hence the voltage of said transformer primary and that of its secondary will be of like phase to that of the voltage impressed on the motor terminals T¹ and T³ by the autotransformer T, and the same results as those obtained by the control of Fig. 1 on lowering point are obtainable by proper positioning of tap 30 75

of the autotransformer to take into account the additional voltage of transformer 72. On the other hand, on the first lowering point with contacts 60 to 63 engaged, operation of manual switch 68 disconnects section 71^a of the primary of transformer 72 from circuit, whereas contacts 69 of switch 68 jointly with drum contacts 60 to 63 connect sections 71^b of the primary of transformer 72 in circuit. As heretofore pointed out, the primary of transformer 72 is thereby connected across lines L², L³ whereby its voltage and that of its secondary is 120 deg. displaced from the voltage impressed on the motor terminals T¹, T³ by the autotransformer, and it is assumed that such displacement is in a counterclockwise direction. Then the voltage impressed on terminals T³, T¹ will be that from autotransformer tap 25 to some point along the dotted line X representing the voltage of different phase now supplied by the transformer 72. By proper design of the voltage and torque conditions may be made to correspond with those obtainable by the control of Fig. 1.

As will be apparent, the switch 68 is not required to handle the full motor current but only that supplied to the primary of transformer 72, thus rendering use of a manually operable switch entirely feasible. Also as will be apparent, the electrical interconnections of switch 68 and the drum contacts above described restrict effectiveness of the switch 68 to lowering point 1. In practice it may be desirable to design switch 68 for snap action to insure upon interruption of either circuit immediate closure of the other, thereby to insure continuous motor torque.

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

1. In combination, a polyphase alternating current motor subjected to overhauling loads, a power supply circuit therefor, an autotransformer, means to connect said autotransformer between the primary of said motor and said supply circuit to effect voltage unbalance of the motor primary, causing said motor at zero speed to produce a small torque in a direction opposite to that in which the overhauling load tends to move, and means associated with the former means to establish motor connections including said autotransformer which afford for spotting or checking the load a substantial increase in the aforesaid motor torque.

2. In combination, a polyphase alternating current motor to be subjected to overhauling loads of different values, a power supply circuit therefor, means including an autotransformer to connect said motor to said supply circuit for opposing overhauling loads, and providing selectively a plurality of speed points, said autotransformer effecting voltage unbalance of the motor primary and on a given speed point causing said motor at zero speed to produce a small torque in a direction opposite to that in which the overhauling load tends to move, and means associated with the former means to provide motor connections inclusive of said autotransformer which cause a substantial increase in the aforesaid motor torque, and to disconnect said motor from circuit automatically upon reduction of the motor speed to a predetermined value.

3. In combination, a polyphase alternating current motor to be subjected to overhauling loads of different values, a power supply circuit therefor, means including an autotransformer to connect said motor to said supply circuit for opposing

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overhauling loads, and providing selectively a plurality of speed points, said autotransformer effecting voltage unbalance of the motor primary and on a given speed point causing said motor at zero speed to produce a small torque in a direction opposite to that in which the overhauling load tends to move, and means associated with the former means to provide motor connections inclusive of said autotransformer which cause a substantial increase in the aforesaid motor torque, and to disconnect said motor from circuit automatically upon reduction of the motor speed to a predetermined value, the second recited means being effective only when the first recited means has a given setting, and said first recited means affording selection of any aforementioned speed point prior to operation of said second recited means to afford increased motor torque.

4. In combination, a polyphase alternating current motor to be subjected to overhauling loads, a polyphase supply circuit, an autotransformer, and means to connect said motor to said supply circuit with said autotransformer interposed for voltage unbalancing of the primary of said motor, said autotransformer being in part connected across lines of said supply circuit and having an extended portion, said means providing for selective connections between certain terminals of said motor and the extended portion of said transformer for causing said motor at zero speed to produce either a small torque or a materially increased torque in a direction opposite to that in which the overhauling load tends to move.

5. In combination, a polyphase alternating current motor to be subjected to overhauling loads of different values, a polyphase supply circuit, means to connect said motor to said supply circuit with said transformer interposed for voltage unbalancing of the primary of said motor, said transformer being in part connected across lines of said supply circuit and having an extended portion, said means affording selectively connections between certain terminals of said motor and the extended portion of said autotransformer to cause said motor at zero speed to produce either a small torque or a materially increased torque in a direction opposite to that in which the overhauling load tends to move, an electromagnetically controlled friction brake for said motor, and means to disconnect said motor from circuit automatically and to effect setting of said brake when the speed of said motor is reduced to a given value while operating to produce said increased torque.

6. In combination, a polyphase alternating current motor to be subjected to overhauling loads, a polyphase supply circuit, an autotransformer, means to connect said motor to said supply circuit with said autotransformer interposed for voltage unbalancing of the primary of said motor, said means comprising a master switch movable from an off position to other positions progressively to establish motor connections inclusive of said autotransformer which afford selectively a relatively high or a relatively low zero speed torque of the motor in a direction opposite to that in which the overhauling load tends to move, said means tending first to establish connections for producing the relatively high torque, and means preventing completion of the latter connections except upon movement of the master switch toward off position.

7. In combination, a polyphase alternating current motor to be subjected to overhauling loads, a polyphase supply circuit, an autotransformer,

means to connect said motor to said supply circuit with said autotransformer interposed for voltage unbalancing of the primary of said motor, said means comprising a master switch movable from an off position to other positions progressively to establish motor connections inclusive of said autotransformer which afford a relatively high or a relatively low zero speed torque of the motor in a direction opposite to that in which the overhauling load tends to move, and means preventing completion of connections for producing the relatively high torque of the motor except upon movement of the master switch toward off position, and effecting disconnection of said motor from circuit automatically when its speed is reduced to a given value while operating to produce said relatively high torque.

8. In combination, a polyphase alternating current motor to be subjected to overhauling loads, a polyphase supply circuit therefor, an autotransformer, means to connect said motor to said supply circuit with said autotransformer interposed for voltage unbalancing of the primary of said motor, an additional transformer having a secondary winding interposed between said autotransformer and a terminal of said motor, and means selectively to subject the primary of said additional transformer to the voltage of the lines of said circuit supplying said autotransformer thereby to cause said motor to produce at zero speed a relatively small torque or to the voltage of other lines of said circuit thereby to cause said motor to produce at zero speed a substantially higher torque, the torque in each instance being in a direction opposite to that in which the overhauling load tends to move.

9. In combination, a polyphase alternating current motor to be subjected to overhauling loads, a polyphase supply circuit therefor, an autotransformer, means to connect said motor to said supply circuit with said autotransformer interposed for voltage unbalancing of the primary of said motor, an additional transformer having a secondary winding interposed between said autotransformer and a terminal of said motor, and means selectively to subject the primary of said additional transformer to the voltage of the lines of said circuit supplying said autotransformer thereby to cause said motor to produce at zero speed a relatively small torque or to the voltage of other lines of said circuit thereby to cause said motor to produce at zero speed a substantially higher torque, the torque in each instance being in a direction opposite to that in which the overhauling load tends to move, and said means comprising a manually operable switch to commutate the circuit connections of said additional transformer and thus to effect either the low or the high torque excitation of said motor.

10. In combination, a polyphase alternating current motor subjected to overhauling loads, a power circuit, means to connect said motor to said circuit and to afford voltage unbalance of the primary of said motor for motor speed torque characteristics insuring against reversal of movement of the overhauling load, and means under the control of the former means to coast therewith to afford for spotting or checking of the load change in the motor speed torque characteristics thereby to provide at zero motor speed a substantial motor torque in a direction opposite to that in which the load tends to move, the second mentioned means including means insuring against such action thereof until directed by the first mentioned means as a special step of control

subsequent to action of the first mentioned means to obtain motor speed torque characteristics insuring against reversal of movement of the overhauling load.

11. In combination, a polyphase alternating current motor subjected to overhauling loads, a power circuit, means to connect said motor to said circuit and to afford voltage unbalance of the primary of said motor for motor speed torque characteristics insuring against reversal of movement of the overhauling load, and means under the control of the former means to coact therewith to afford for spotting or checking of the load change in the motor speed torque characteristics thereby to provide at zero motor speed a substantial motor torque in a direction opposite to that in which the load tends to move, the second mentioned means including means rendering such action thereof dependent upon overhauling load conditions and special setting of the first mentioned means subsequent to action of the first mentioned means to obtain motor speed torque characteristics insuring against reversal of movement of the overhauling load.

12. In combination, a polyphase alternating current motor subjected to overhauling loads, a power circuit, means, including a master switch, to connect said motor to said circuit and to afford voltage unbalance of the primary of said motor for motor speed torque characteristics insuring against reversal of movement of the overhauling load, said means being rendered effective and ineffective by movement of said master switch from an off position to an on position and vice versa, and coacting means under the control of said master switch to afford for spotting or checking of the load change in the motor speed torque characteristics thereby to provide at zero motor speed a substantial motor torque in a direction opposite to that in which the load tends to move, the second mentioned means including means rendering its action dependent upon positioning of said master switch intermediate its positions aforementioned by movement of said master

switch from said on position toward said off position.

13. In combination, a polyphase alternating current motor subjected to overhauling loads, a power circuit, means, including a master switch, to connect said motor to said circuit and to afford voltage unbalance of the primary of said motor for motor speed torque characteristics insuring against reversal of movement of the overhauling load, said means being rendered effective and ineffective by movement of said master switch from an off position to an on position and vice versa, and coacting means under the control of said master switch to afford for spotting or checking of the load change in the motor speed torque characteristics thereby to provide at zero motor speed a substantial motor torque in a direction opposite to that in which the load tends to move, the second mentioned means including means rendering its action dependent upon positioning of said master switch intermediate its positions aforementioned by movement of said master switch from said on position toward said off position, and the second mentioned means when active being operable automatically to effect disconnection of said motor from circuit upon reduction of the motor speed to a given value.

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