May 16, 1944. R. W. SPAFFORD 2,349,120

MONORAIL CONTROL SYSTEM

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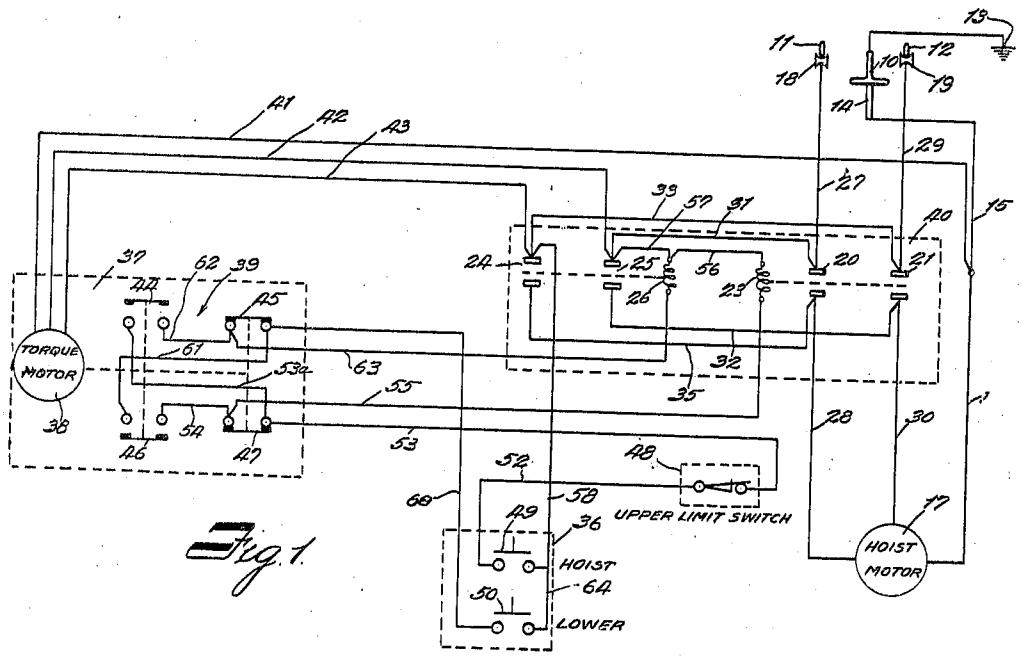


Fig. 1.

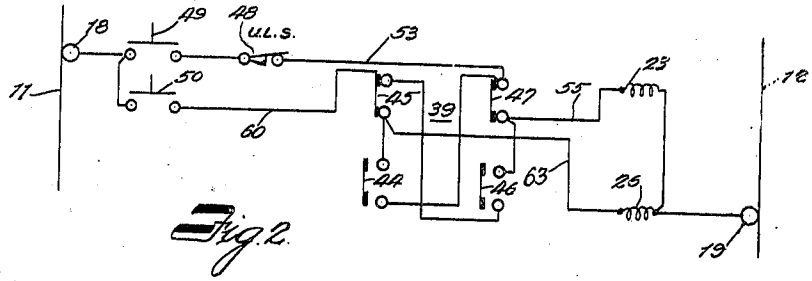


Fig. 2.

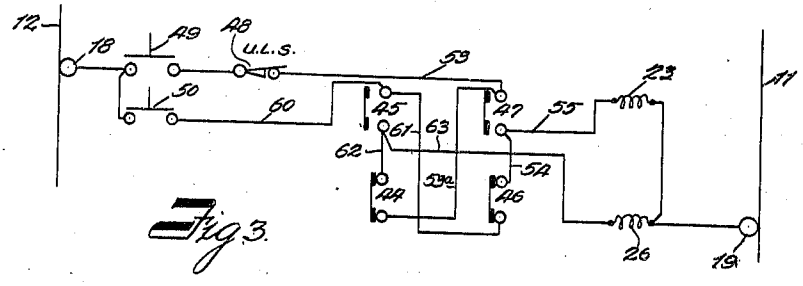


Fig. 3.

Inventor:
Ralph W. Spafford:
By. Thiess, Olson & Mecklenburger
Attys.

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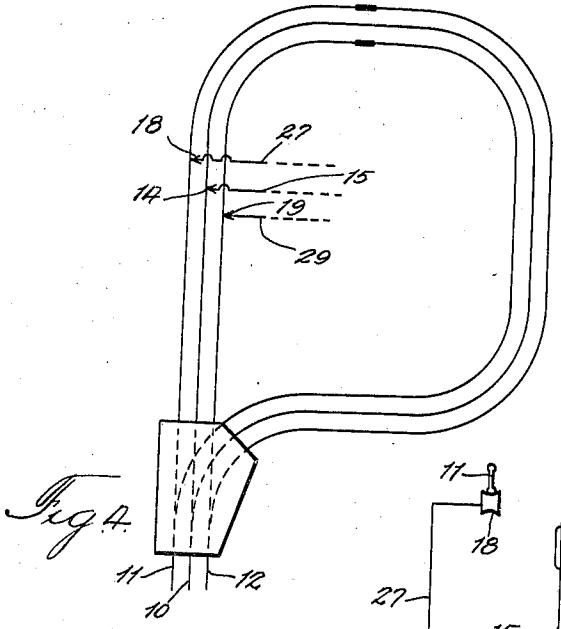


Fig 4.

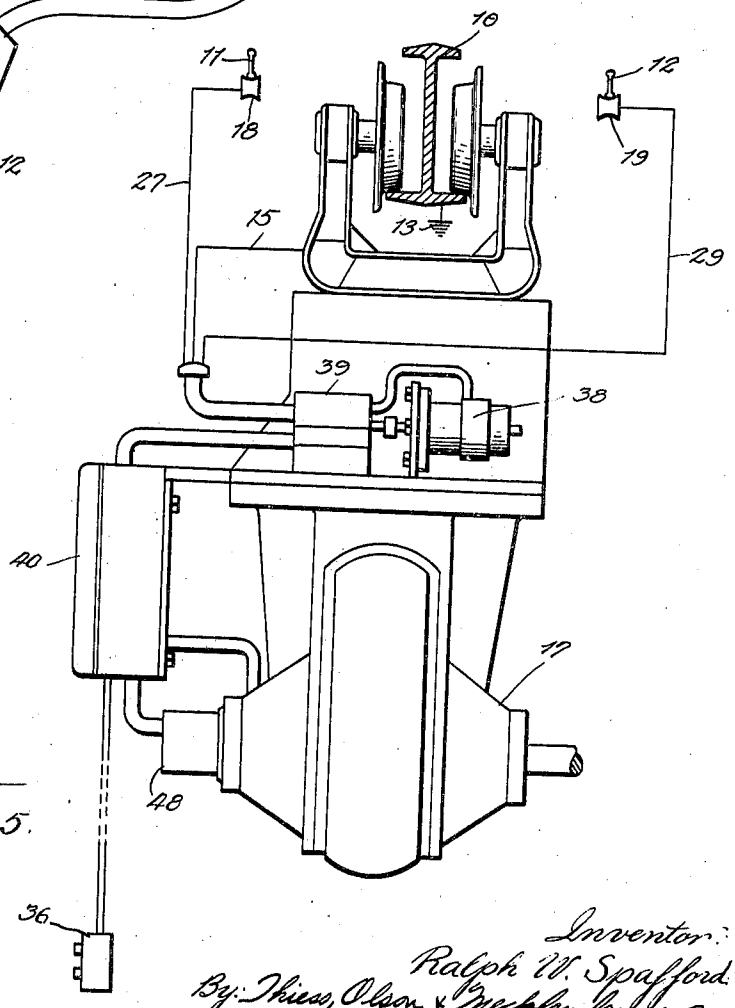


Fig 5.

Inventor:
Ralph W. Spafford
By: Thiess, Olson & Mecklenburger
Attys.

Patented May 16, 1944

2,349,120

UNITED STATES PATENT OFFICE

2,349,120

MONORAIL CONTROL SYSTEM

Ralph W. Spafford, Fairfield, Iowa, assignor to The Louden Machinery Company, Fairfield, Iowa, a corporation of Iowa

Application January 16, 1943, Serial No. 472,561

4 Claims. (Cl. 212—132)

This invention relates to material handling systems, more particularly to monorail conveyor systems of the turn-around type operating on polyphase alternating current, and the invention has for an object the provision of improved systems of this character.

Monorail conveyor systems of the above indicated character, wherein the overhead track is grounded and utilized as one conductor of a polyphase alternating current system, have heretofore been provided with bus bars forming additional conductors of the polyphase system extending along opposite sides of the track for engagement by suitable collector contacts or shoes carried by the trolley or carriage. The trolley also is provided, in most cases, with polyphase alternating current motors which may be either hoist motors or trolley propulsion motors, and in systems utilizing turn-arounds, by virtue of which the position of the trolley or carriage is reversed on the rail, means have been provided for insuring that the motors operate in the desired direction even though the collector contacts engaging the bus bars are reversed during the turn-around operation.

In systems of this character the hoist motor is, of course, provided with a suitable motor circuit reversing switch adapted to reverse the phase connections of the motor for hoisting and lowering operation, and unless means are provided to take care of the phase reversal of the collector contacts when the trolley is reversed on the track, it will be apparent that an intended hoisting or lowering operation of the reversing switch would result in an opposite and undesired operation whenever the collector contacts are in their reversed positions. Previously it has been proposed to remedy this situation by providing a second motor reversing switch arranged automatically to reverse the phase of the motor circuit conductors whenever the collector contacts are reversed, so that operation of the "hoist" and "lower" reversing switch will always effect the desired operation.

Systems of this character have been to a large extent satisfactory from the operating standpoint, but are unduly expensive because of the character of the second reversing switch which must be provided. Particularly where large capacity hoist motors are used, a reversing switch capable of handling the motor circuit current constitutes a considerable item of expense. Furthermore, since the size and capacity of the hoist motor provided in a system of this character depends upon the type of work and the magnitude of the loads to be handled, it is necessary for the manufacturer to maintain in stock a variety of sizes of motor circuit reversing switches or to supply, on small capacity installations, an oversize motor circuit switch which of course unnecessarily increases the expense.

It is a further object of the present invention to provide a control system for a monorail conveyor of the above character wherein only a single motor circuit reversing switch is provided, together with control means for insuring proper control of the motor circuits through this single motor circuit reversing switch regardless of the phase relation of the collector contacts.

In carrying out the invention in one form, a motor circuit reversing switch is provided with control means operable between two positions for selectively energizing the reversing switch for operation to either of its two positions, and a reverse phase relay, energizable from the collector contacts, is arranged to automatically change the circuit connections between the control means and the reversing switch whenever the collector contacts are turned around, so that operation of the control means between its two positions effects a corresponding operation of the motor regardless of the phase relation of the collector contacts.

For a more complete understanding of the invention, reference should now be had to the drawings in which:

Fig. 1 is a circuit diagram of a system embodying the present invention;

Fig. 2 is a line-to-line diagram indicating the control circuits with the collector contacts in one phase relation;

Fig. 3 is a similar line-to-line diagram of the control circuits with the collector contacts in reverse phase relation;

Fig. 4 shows in diagrammatic form a well known form of turn-around for a monorail system; and

Fig. 5 shows in somewhat schematic form the trolley unit and its associated controls.

Referring now to the drawings, the monorail conveyor system and trolley is indicated diagrammatically in Fig. 1 as comprising a suitably suspended track or rail 10 having a pair of bus bars 11 and 12 extending therealong on opposite sides thereof. The track or rail 10 forms one conductor of a three-phase alternating current system and is preferably grounded as indicated at 13. It will of course be understood that the car-

riage or trolley, the physical construction of which is diagrammatically illustrated in Fig. 5 of the drawings, includes suitable track-engaging wheels by means of which the trolley or carriage is supported on the rail 10, and while in Fig. 1 a suitable brush or shoe 14 is shown through which the track 10 is permanently connected through suitable conductors 15 and 16 to one terminal of a hoist motor 17, the track-engaging wheels may of course be utilized in place of the separate brush 14 for forming the above-described electrical connection.

In order to complete the electrical connections from the alternating current system to the hoist motor, the trolley is also provided with collector contacts 18 and 19 which are adapted to engage the bus bars or conductors 11 and 12. In the position of the trolley indicated in Fig. 1, the collector contact 18 engages bus bar 11 and the collector contact 19 engages the bus bar 12. However, when the trolley is turned around on the track 10, it will be understood from an inspection of Fig. 4 that the collector contact 18 will then engage the bus bar 12 and the collector contact 19 will engage the bus bar 11 so that the phase relation of the three-phase current supplied to the trolley will be reversed.

The hoist motor 17 is of course of the reversible type in order to provide for both hoisting and lowering operation, and in accordance with the present invention the collector contacts 18 and 19 are connected to the terminals of the hoist motor through a suitable reversing switch 40 which is shown as constituting an electromagnetic switch of a type well known in the art, wherein two pairs of contacts 20 and 21, operable between open and closed circuit positions by a suitable energizing winding 23, provide for operation of the motor in one direction, and a second set of contacts 24 and 25, operable by a suitable energizing winding 26, provide for operation of the motor in the opposite direction. When both of the windings 23 and 26 are deenergized, the motor 17 is disconnected from the energizing circuit, and when either of the windings 23 and 26 is energized the motor will be connected to the circuit for operation in a predetermined direction. In reversing switches of this type mechanical interlock means are usually provided to insure that both sets of contacts cannot be closed at the same time even though both of the windings 23 and 26 should be accidentally simultaneously energized.

When the operating winding 23 is energized so as to close the contacts 20 and 21, one phase of the motor circuit may be traced from the collector contact 18 through a conductor 27, the contacts 20 and a conductor 28 to the motor, and the other phase of the motor circuit may be traced from the collector contact 19 through a conductor 29, the contacts 21 and a conductor 30 to the motor, thus energizing the motor in predetermined phase relation for operation in one direction. When the operating winding 26 is energized to close the contacts 24 and 25, one phase of the motor circuit may be traced from the collector contact 18 through conductor 27, a suitable jumper conductor 31, the contacts 25, and a second jumper conductor 32 to the conductor 30 which is connected to the motor. Thus it will be seen that the collector contact 18, which in the previously described case was connected to the motor through the conductor 28, is now connected to the motor through the conductor 30 so as to provide a different phase relation.

Similarly, the circuit from the collector contact 19 extends through the conductor 29, a jumper connection 33, the contacts 24 and a jumper connection 35 to the conductor 28 which is connected to the motor, thus connecting the collector contact 19, which was formerly connected to the conductor 30, to the conductor 28.

Since energization of the operating winding 23 will always connect the collector contacts 18 and 19 to the motor 17 in one phase relation, and energization of the winding 26 will connect them in opposite phase relation, it will be apparent that reversal of the collector contacts with respect to the bus bars 11 and 12 will effect reversal of the motor energization normally produced by energization of the windings 23 and 26. Therefore, if the usual control means for the windings 23 and 26, comprising merely a "hoist" and "lower" push-button station connected selectively to energize the windings, were provided, the operator would be unable to determine ahead of time what direction of operation he would obtain by operating the "hoist" button of the control means.

Whether hoisting or lowering operation of the motor would result from closure of the "hoist" button would depend entirely upon the phase relation of the collector contacts with respect to the bus bars. In accordance with the present invention, control means are provided for insuring that operation of the "hoist" or "lower" button of a conventional push-button station will effect a corresponding operation of the hoist motor regardless of the phase relation of the collector contacts 18 and 19 relative to the bus bars 11 and 12.

As shown in Fig. 1, there is provided, in addition to a push-button station 36, a suitable reverse phase relay 37 which is indicated diagrammatically as constituting a three-phase torque motor 38 adapted to operate a cam type drum controller 39. The torque motor 38 is energized directly from the collector contacts and the track or rail, so that a reversal of the collector contacts 18 and 19 will effect a simultaneous reversal of the phase relation of the current supplied to the torque motor. One terminal of the torque motor, as shown in Fig. 1, is connected through a conductor 41 and the conductor 15 to the brush 14 which engages the track 10. The second terminal of the torque motor is connected through a suitable contactor 42, the jumper connection 31, and the conductor 27 to the collector contact 18, and the third terminal of the torque motor is connected through a conductor 43, the jumper connection 33 and the conductor 29 to the collector contact 19.

The cam switch 39, adapted to be driven by the torque motor 38, comprises a plurality of contacts 44, 45, 46, and 47 adapted to be operated by the torque motor so that contacts 45 and 47 will be closed and the remaining contacts will be open when the torque motor is energized in one phase relation, and the contacts 44 and 46 will be closed and the remaining contacts will be open when the torque motor is energized in the opposite phase relation. The contacts 44, 45, 46, and 47 are connected in circuit with the push-button station 36 and the energizing windings 23 and 26 of the reversing switch 40, so as to automatically change the circuit connections therebetween whenever the phase relation of the contacts 18 and 19 is reversed. In the control of hoist motors in systems of this character, it is necessary to provide a suitable limit switch which will auto-

matically terminate the hoisting operation whenever the hoist reaches its uppermost position, and consequently a suitable limit switch 48 is provided connected in circuit with the "hoist" button 49 of the push-button station 36.

As shown in Fig. 1, one side of the "hoist" button 49 is connected through a conductor 52 to one side of the limit switch 48, the other side of which is connected through a conductor 53 to one of the contacts 47 of the cam switch 39, which contact is connected by a jumper conductor 53a to one of the contacts 44. The other one of the contacts 47 is connected by a suitable jumper 54 to one of the contacts 46, and is likewise connected through a suitable conductor 55 to the operating winding 23, the other terminal of the operating winding 23 being connected through a conductor 56 to one terminal of the winding 26, which is in turn connected through a conductor 57 and the jumper 31 to the conductor 27 which extends from the collector contact 18. The other side of the "hoist" button 49 is connected through a suitable conductor 58 and the jumper 33 to the conductor 29 which leads to the collector contact 19. The circuit connections for the "lower" button 50 extend from one side thereof through a conductor 60 to one of the contacts 45, which contact is connected through a suitable jumper 61 to one of the contacts 46. The other one of the contacts 45 is connected by a suitable jumper 62 to one of the contacts 44 and is likewise connected by a conductor 63 to one terminal of the operating winding 26, the other terminal of this winding, as previously described, being connected through the conductor 57, the jumper 31, and the conductor 27 to the collector contact 18. The other side of the "lower" button 50 is connected through a conductor 64 to the corresponding side of the "hoist" button 49, and thus through the conductor 58, the jumper 33, and the conductor 29 to the collector contact 19.

The operation of the above-described control system will best be understood by reference to Figs. 2 and 3. In Fig. 2 the system is shown with the collector contacts 18 and 19 respectively engaging the bus bars 11 and 12, just as in Fig. 1, and with the phase relation thus established, the torque motor 38 has operated the cam switch 39 to a position in which the contacts 45 and 47 are closed and the contacts 44 and 46 are open. Under these conditions, operation of the "hoist" button 49 to its closed circuit position establishes an energizing circuit which may be traced from the collector contact 18 through the "hoist" button 49, the upper limit switch 48, the conductor 53, the contacts 47, the conductor 55, and the operating winding 23 to the collector contact 19. Thus the operating winding 23 will be energized to connect the motor for hoisting operation through the contacts 20 and 21 of the reversing switch 40.

Operation of the "lower" button 50 similarly establishes an energizing circuit for the operating winding 26 which may be traced from the collector contact 18, through the "lower" button 50, the conductor 60, the contacts 45, the conductor 63, and the operating winding 26 to the collector contact 19, whereupon the hoist motor 17 will be energized for lowering operation through the contacts 24 and 25 of the reversing switch 40. It will be observed that the upper limit switch in the above-described circuit arrangement is connected in circuit with the "hoist" button and the operating winding 23, so that operation of the limit switch during a hoisting operation will automatically deenergize the hoist motor and terminate the operation at its upper limit.

In Fig. 3 the circuit connections are shown with the collector contacts 18 and 19 reversed so that the collector contact 18 engages the bus bar 12 and the collector contact 19 engages the bus bar 11. Under these conditions the torque motor 38 will automatically operate the cam switch 39 to close the contacts 44 and 46 and open the contacts 45 and 47. Operation of the "hoist" button 49 under these conditions establishes an energizing circuit which extends from the collector contact 18 through the "hoist" button 49, the upper limit switch 48, the conductors 53 and 53a, the contacts 44, the conductors 62 and 63, and the operating winding 26 to the collector contact 19. Thus, while operation of the "hoist" button under the circuit conditions shown in Fig. 2 was effective to energize the operating winding 23, it is now effective to energize the operating winding 26. Consequently, the hoist motor will be energized through the contacts 24 and 25 of the reversing switch, and since the phase relation of the collector contacts 18 and 19 is also reversed, the motor will be energized in the same phase relation as in the previously described case. It will again be noted that in the circuit connections shown in Fig. 3 the upper limit switch is interposed in the energizing circuit between the "hoist" button 49 and the operating winding controlled thereby for providing hoisting operation.

When the lower button 50 is closed under the circuit conditions shown in Fig. 3, an energizing circuit will be established which extends from the collector contact 18 through the "lower" button 50, the conductors 60 and 61, the contacts 46, and the conductors 54 and 55, and by way of the operating winding 23 to the collector contact 19. Thus the operating winding 23 is controlled by the "lower" button instead of the operating winding 26, as in the circuit conditions illustrated in Fig. 2, and lowering operation will be obtained through closure of the reversing switch contacts 20 and 21, the collector contacts 18 and 19 being reversed so as to maintain the same phase relation at the hoist motor 17.

Inasmuch as the reverse phase relay 37, which includes the torque motor 38 and the cam switch 39, is required to handle only the very small control current necessary to energize the operating windings 23 and 26 of the reversing switch 40, a very small capacity and relatively inexpensive device may be employed, regardless of the size of the hoist motor 17 and the magnitude of the motor circuit currents to be controlled. Accordingly, only one size of reverse phase relay need be maintained in stock, and the cost of a second heavy-duty motor circuit reversing switch, such as was necessary in previously known systems, is eliminated.

While I have shown particular embodiments of my invention, it will be understood, of course, that I do not wish to be limited thereto since many modifications may be made, and I, therefore contemplate by the appended claims to cover any such modifications as fall within the true spirit and scope of my invention.

Having thus described my invention, what I claim and desire to secure by Letters Patent is:

1. In a monorail conveyor system of the type having a trolley operable on a track and energizable from bus bars which extend along the

track and form two conductors of a polyphase alternating current system, said trolley including collector contacts respectively engaging said bus bars and adapted to engage said bus bars in reverse phase relation when said trolley is turned around on said track, the combination of a polyphase alternating current motor on said trolley, a reversing switch operable between two positions selectively to connect said motor to said collector contacts for operation in either of two directions, control means in circuit with said reversing switch and operable between two positions for selectively energizing said reversing switch to operate said switch between said two switch positions, and a reverse phase relay energizable from said collector contacts for automatically changing the circuit connections between said control means and said reversing switch when said collector contacts are turned around, whereby operation of said control means between its said two positions effects operation of said motor in corresponding directions regardless of the phase relation of said collector contacts.

2. In a monorail conveyor system of the type having a trolley operable on a track and energizable from bus bars which extend along the track and form two conductors of a polyphase alternating current system, said trolley including collector contacts respectively engaging said bus bars and adapted to engage said bus bars in reverse phase relation when said trolley is turned around on said track, the combination of a polyphase hoist motor on said trolley, a motor circuit reversing switch having contacts for connecting said motor to said collector contacts for energization therefrom, said reversing switch being operable between two positions selectively to connect said motor for hoisting or lowering operation, control means in circuit with said reversing switch and operable between hoist and lower positions for selectively energizing said reversing switch for operation between said two positions, and a reverse phase relay energizable from said collector contacts for automatically changing the control circuit connections between said control means and said reversing switch when said collector contacts are turned around whereby operation of said control means to said hoist position or said lower position effects corresponding hoisting or lowering operation of said motor regardless of the phase relation of said collector contacts.

3. In a monorail conveyor system of the type having a trolley operable on a track and energizable from bus bars which extend along the track and form two conductors of a polyphase alternating current system, said trolley including collector contacts respectively engaging said bus bars and adapted to engage said bus bars in reverse phase relation when said trolley is turned around on said track, the combination of a polyphase hoist motor on said trolley, a motor circuit reversing switch having a plurality of contacts in circuit with said motor and said collector contacts, said reversing switch having a pair of operating windings selectively energizable to operate selected sets of said reversing switch contacts to energize said motor for hoisting or lowering operation, control means in circuit with said operating windings and operable between hoist and lower positions for selectively energizing said operating windings, and a reverse phase relay energizable from said collector contacts for automatically changing the circuit connection between said control means and said operating windings whereby operation of said control means to either said hoist or lower position energizes the one of said windings which will effect corresponding hoisting or lowering operation of said motor regardless of the phase relation of said collector contacts.

4. In a monorail conveyor system of the type having a trolley operable on a track and energizable from bus bars which extend along the track and form two conductors of a polyphase alternating current system, said trolley including collector contacts respectively engaging said bus bars and adapted to engage said bus bars in reverse phase relation when said trolley is turned around on said track, the combination of an alternating current hoist motor on said trolley, a motor circuit reversing switch having two pairs of contacts for connecting said motor in circuit with said collector contacts, an operating winding for each pair of contacts, control means including a hoist switch and a lower switch, circuit connections between said hoist and lower switches and said operating windings for effecting energization of one winding through said hoist switch and of the other winding through said lower switch whereby said reversing switch contacts may be selectively operated to effect hoisting or lowering operation of said motor, limit switch means in circuit with said hoist switch for automatically terminating the hoisting operation of said hoist motor, and a reverse phase relay energizable from said collector contacts for automatically changing said circuit connections of said hoist and lower switches when said collector contacts are turned around so that said hoist and lower switches thereafter effect energization of the opposite windings of said reversing switch, whereby hoisting or lowering operation of said motor is effected by said hoist or lower switches regardless of the phase relation of said collector contacts, said limit switch being maintained at all times in circuit with said hoist switch.

RALPH W. SPAFFORD.