Jan. 22, 1963 C. J. MANNEY 3,075,134

CONTROL FOR ELECTRIC HOISTS

Filed Oct. 31, 1960

3 Sheets-Sheet 1

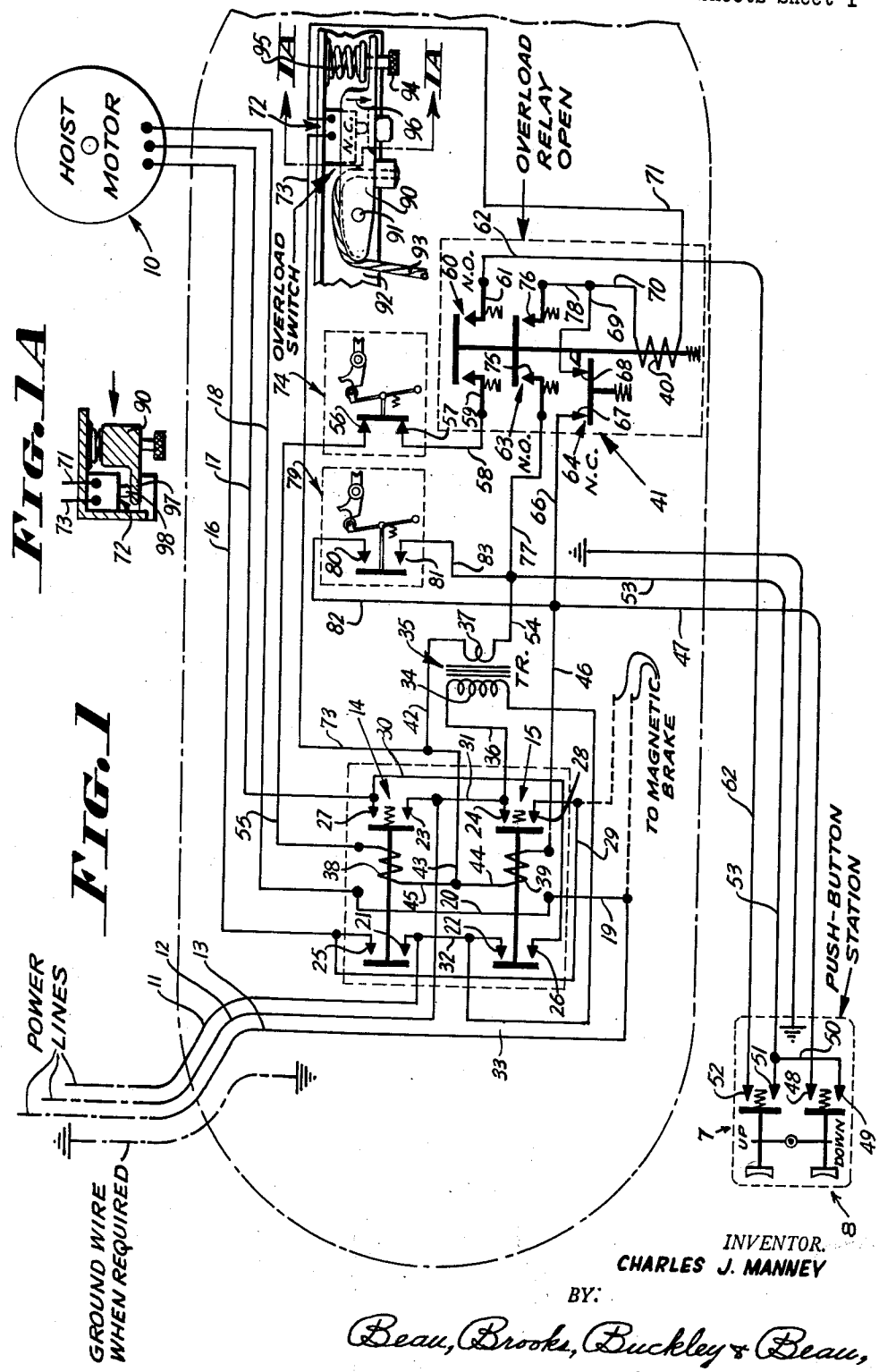

FIG. 1A

FIG. 1

INVENTOR.
CHARLES J. MANNEY

BY:

Beau, Brooks, Buckley & Beau,
ATTORNEYS.

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Filed Oct. 31, 1960 3 Sheets-Sheet 2

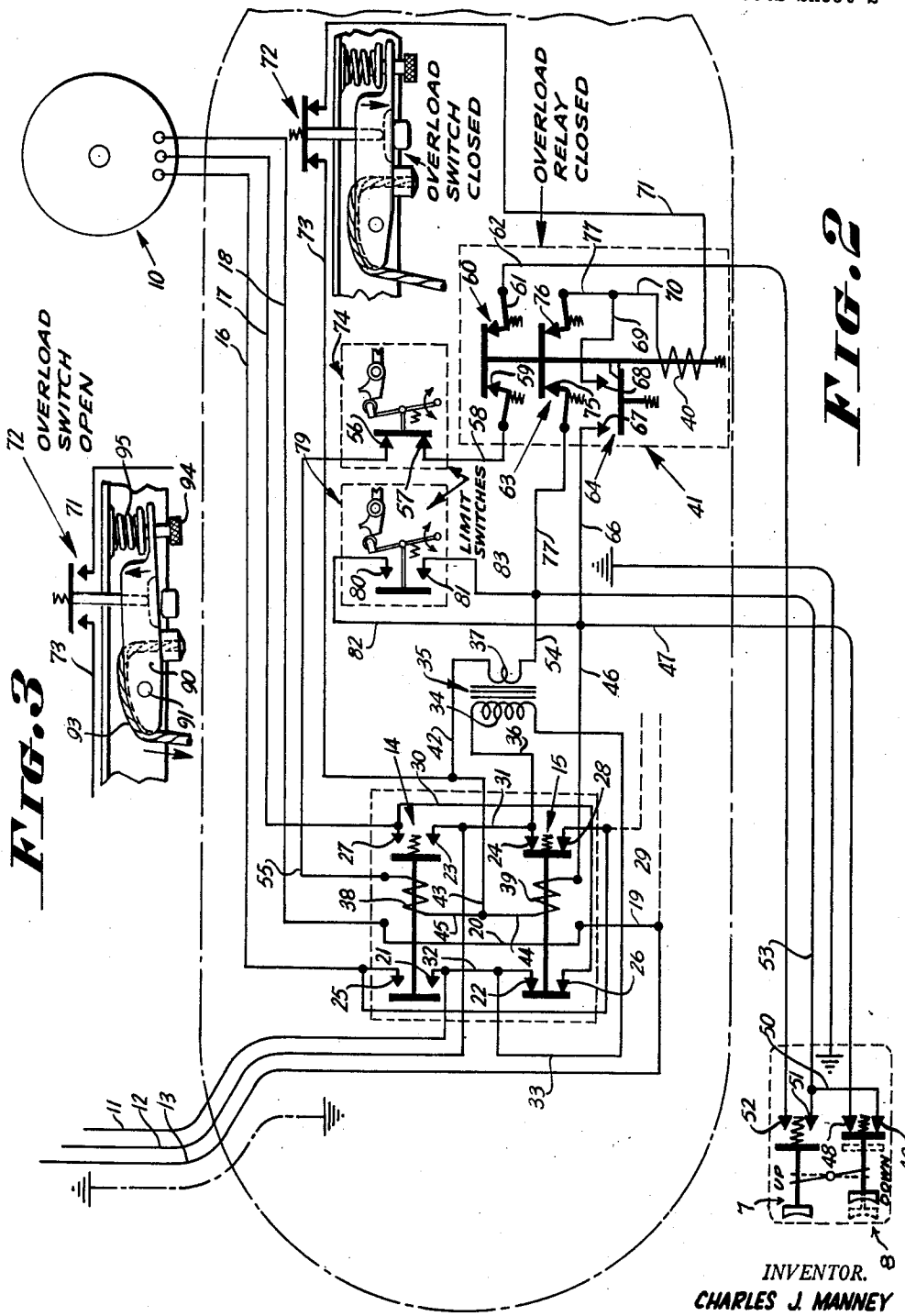

FIG. 2

FIG. 3

INVENTOR.
CHARLES J. MANNEY

BY:
Beau, Brooke, Buckley & Beau,
ATTORNEYS.

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3 Sheets-Sheet 3

FIG. 4

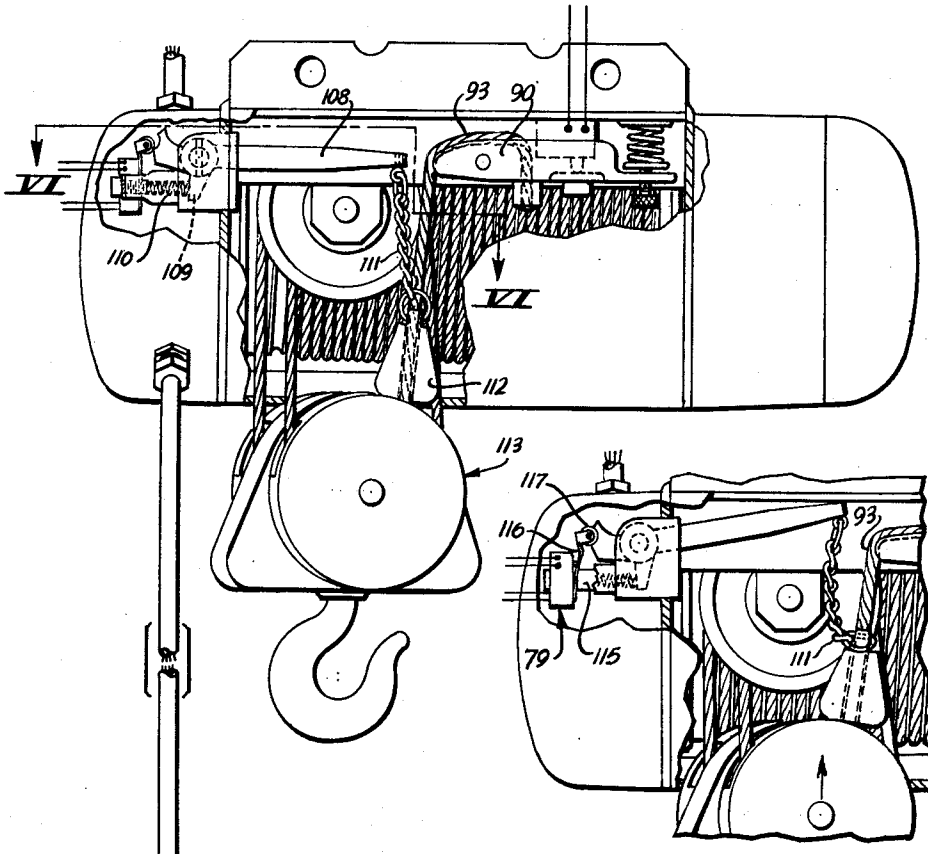

FIG. 5

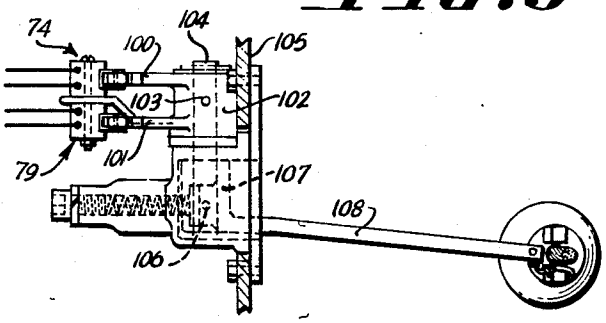

FIG. 6

INVENTOR.
CHARLES J. MANNEY

BY:
Beau, Brooks, Buckley & Beau,
ATTORNEYS.

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CONTROL FOR ELECTRIC HOISTS

Charles J. Manney, Kenmore, N.Y., assignor to Columbus McKinnon Corporation, Tonawanda, N.Y.

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This invention relates to hoists, and more particularly to control assemblies for electrically driven hoist assemblies.

There are several forms of switches and other devices presently used for stopping the motor of an electric hoist when there is an overload on the lift chain or cable. Usually, these switch assemblies or devices are self-resetting. That is, as the magnitude of the load rises above a predetermined setting, the switch or other device opens and when the magnitude of the load is reduced, the switch will close. Devices of this type are sensitive not only to the actual load being lifted but also to any additional forces due to impact and/or acceleration of the load, and since such forces as impact and acceleration loads are only momentary, the switch cuts off power and then restores it again after these forces subside, which results in a jerky or spasmodic start and stop action while the load is ascending.

It is of primary concern in connection with the present invention to provide an overload limit circuit system including an overload switch responsive to the imposed load and a plurality of associated and cooperating relays, whereby once the switch is tripped due to an overload, the motor will stop and cannot be restarted to lift the load unless the system is reset first by pressing on the "lowering" button to prepare or ready the circuitry for actuation of the hoist in the "lift" direction.

With the above, and other objects in view that will hereinafter appear, the nature of the invention will be more clearly understood by reference to the following detailed description, the appended claims, and the several views illustrated in the accompanying drawings.

In the drawings:

FIGURE 1 is a diagrammatic view showing the circuitry in connection with the present invention and illustrating structural details of the overload switch;

FIGURE 1A is a sectional view taken along the plane of the section line 1A—1A in FIGURE 1, illustrating further details of the overload switch;

FIGURE 2 is a view similar to FIGURE 1, but showing the condition of the circuit subsequent to energization of the "down" switch;

FIGURE 3 is an elevational view of the overload switch in the open position;

FIGURE 4 is an elevational view of a hoist mechanism utilizing the circuitry of the present invention;

FIGURE 5 is a view showing a portion of the assembly of FIGURE 4 and illustrating one position of the limit switch mechanism; and

FIGURE 6 is an enlarged sectional view taken along the plane of section line VI—VI of FIGURE 5, showing further details of the limit switch mechanism.

Referring more particularly at this time to FIGURE 1, the circuitry as shown therein is in a deenergized condition, as will be more particularly described hereinafter. The hoist motor is designated generally by the reference character **10**, and the source of power therefor is provided by the electrical power lines **11**, **12** and **13**. Two of these lines, **11** and **12**, are connected to relay mechanisms **14** and **15** for selective connection to lines **16** and **17** leading to the hoist motor **10**. The power line **13** is directly connected to motor line **18** through the conductors **19** and **20**, as shown.

Relay **14** includes a normally open switch having a contact **21** directly connected to power line **11**, the other

contact **25** of this switch being directly connected to motor line **16**. This relay also includes a further normally open switch having contacts **23** and **27**, the former of which is directly connected to power line **12** and the latter of which is directly connected to motor line **17**. Thus, when the relay **14** is energized and its normally open switch is closed, hoist motor **10** will be energized to operate in one direction of rotation which, in the particular circuit as shown, will correspond to the "up" direction of the hoist mechanism.

Relay **15**, on the other hand, is operative to actuate motor **10** in the lowering direction. Relay **15**, therefore, is operative when energized to connect power line **11** to motor line **17** and power line **12** to motor line **16**, just the reverse of the connections effected upon energization of relay **14**. These connections effected by relay **15** are achieved by virtue of two switches incorporated therein, consisting of pairs of normally open contacts **22**, **26** and **24**, **28**. Contact **22** is connected through conductor **32** to contact **21** of relay **14** and in common therewith to power line **11**. Its cooperative contact **26** is connected to contact **27** of relay **14** and thus to motor line **17** through conductor **30**. The other switch of relay **15** includes contact **24** connected through conductor **31** to contact **23** of relay **14** and in common therewith to power line **12**. Its cooperative contact **28** is connected through conductor **29** to contact **25** of relay **14** and in common therewith to motor line **16**.

To power the control system, any suitable arrangement may be made, such as connecting power line **11**, by means of conductor **33** to the primary winding **34** of auxiliary supply transformer **35**, the other side of this primary being connected through conductor **36** to power line **12**. Thus, the transformer primary winding is constantly energized.

The secondary **37** of this transformer supplies the automatic and manual control power source. To this end, the secondary is connected to the several relay coils **38**, **39** and **40**. Relay coil **38** energizes relay **14**, coil **39** energizes relay **15**, and coil **40** energizes overload relay **41**. One conductor, **42**, connects the secondary **37** to conductor **43** having branches **44** and **45** leading to the two coils **38** and **39**.

To complete the circuit through coil **39**, conductor **46** is provided which leads to conductor **47** extending to contact **48** of a "down" push button switch. When the "down" switch is closed, contact **49** is bridged to contact **48** and conductors **50**, **53** and **54** complete the circuit to the opposite side of secondary **37**.

For energization of relay coil **38** and consequent "up" operation, contacts **51** and **52** of the "up" push button switch and bridged. One side of coil **38** is connected through conductor **55** to contact **56** of normally closed limit switch **74** and from the other contact **57** thereof, conductor **58** connects to contact **59** of the normally open switch **60** of overload relay **41**. The other contact **61** of switch **60** is connected, through conductor **62**, back to contact **52** of the "up" push button switch. Thus, it will be evident that "up" operation is not permitted unless the overload relay **41** is energized.

The only manner in which the overload relay **41** may be initially energized is by operation of the "down" push button switch. For this purpose, previously mentioned conductor **47** is connected to normally closed switch **64** of overload relay **41** by means of conductor **66** extending to contact **67**. The other contact **68** of this switch is connected, through conductors **69** and **70** to relay coil **40**, the other side of this coil being connected through conductor **71**, overload microswitch **72** and conductor **73** back to the other side of transformer secondary **37**. Thus, upon actuation of the "down" push button switch, the overload relay is energized.

A holding circuit across the relay coil 40 is provided through the medium of contacts 75 and 76 of normally open switch 63 of overload relay 41. Contact 75 is connected to one side of the transformer secondary 37 by means of conductor 77 leading to conductor 54 and the connection to the other side of the secondary is effected by conductor 78 leading from contact 76 to conductor 70, through coil 40, conductor 71, overload microswitch 72 and conductor 73. This latter circuit is operative to maintain relay coil 40 energized once the "down" push button switch has initiated energization of the overload relay.

A second limit switch 79 is provided in the system having a pair of normally open contacts 80 and 81. Contact 80 is connected to the conductor 46 by means of conductor 82, and contact 81 is connected to conductor 54 by means of conductor 83, the purpose of which will be presently apparent.

Neutral Position—Figure 1

The condition of the circuit, as shown in FIGURE 1, is the condition in which the circuit is automatically placed whenever the overload switch mechanism is actuated, that is, whenever normally closed switch 72 is opened momentarily. When the circuit is in this condition, the hoist cannot be operated in the "lift" direction, but only in the "lower" direction. This eliminates jerky, spasmodic lifting by the hoist. When the overload switch has been actuated, the operator must lower the load before it is again lifted.

The circuit of "lift" push button switch 7 when in the condition as shown in FIGURE 1 comprises the contacts 51 and 52, conductor 62, normally open switch 60, conductor 58, normally closed limit switch 74, conductor 55, relay coil 38, conductors 45, 43 and 42, transformer secondary 37, and conductors 53 and 54 back to the "lift" push button switch. Thus, it will be apparent that in the condition of the circuit as shown in FIGURE 1, the hoist mechanism cannot be operated in the "lift" direction.

Instead, the hoist must be operated at least momentarily in the "lower" direction. The circuit of "lower" push button switch 8 when in the condition as in FIGURE 1 comprises the contacts 48 and 49, conductors 47 and 46, relay coil 39, conductors 44, 43 and 42, transformer secondary 37, and conductors 54 and 53 back to the "lower" push button switch. This is operative to energize the relay 15 and actuate the hoist motor 10 in a "lower" direction. At the same time, a parallel circuit through the overload relay is closed. This latter circuit comprises conductors 47 and 66, normally closed switch 64, conductors 69 and 70, overload relay coil 40, conductor 71, normally closed overload switch 72, conductors 73 and 42, transformer secondary 37, and conductors 54 and 53 back to the "lower" push button switch 8. This will, of course, energize the overload relay and the holding circuit, independent of the push button switches, is simultaneously closed. This holding circuit comprises the normally open switch 63, conductors 78 and 70, relay coil 40, conductor 71, normally closed overload switch 72, conductors 73 and 42, transformer secondary 37, and conductors 54 and 77 back to switch 63.

Operative or Ready Position—Figure 2

At this point, the circuitry will be in the condition shown in FIGURE 2. It will be noted that the "down" relay 15 is energized as is the overload relay. Actuation of the overload relay readies the circuit for actuation of the "up" or "lift" push button 7 by closing normally open switch 60. Thus, the direction of the hoist mechanism can now be reversed to lift the load by pushing the "up" push button 7 after releasing the "down" push button 8.

If the "up" push button 7 is closed, the "up" relay 14 will be energized, the overload relay remaining energized. If, during ascent of the load, the overload switch 72 is opened, the holding circuit through overload relay switch 63, as well as the "lift" circuit, will be opened, stopping ascent of the load and deenergizing the overload relay, returning the circuitry to the condition of FIGURE 1.

Limit Switches 74 and 79

Should the load be raised too high relative to the body of the hoist mechanism, the limit switches perform in the following manner. Normally closed limit switch 74 will be opened, and since it is in series with relay coil 38, ascent of the load will cease. However, normally open limit switch 79 is then closed which immediately effects a reversal of the hoist motor rotation. In this respect, it is to be noted that limit switch 79 is in parallel with the "down" push button switch so that it closes the same circuitry as does the "down" push button switch. The two limit switches, as will be apparent presently, are actuated as a function of the height to which a load is raised relative to the body of the hoist mechanism and the limit switch 79 is effective to automatically lower the load slightly if it has been raised too high as described above, and it therefore resets both limit switches to their normal positions automatically.

As can be seen in FIGURES 1 and 1A, the mechanism for operating the overload limit switch 72 is in the form of a lever 90 pivoted by means of a pin 91 to the frame 92 of the hoist mechanism and to which one end of the hoisting cable mechanism 93 is attached, as shown. The remote end of the lever 90, is provided with an adjustable screw mechanism 94 seating upon a compression spring 95 in turn abutted against the frame 92 to normally urge the lever 90 in the position of the arrow 96 in FIGURE 1. As can be seen best in FIGURE 1A, the lever 90 is provided with a lateral foot or projection 97 underlying the overload switch mechanism 72 and engaged with the actuating button 98 thereof which operates this microswitch mechanism. Obviously, if too great a load is imposed upon the cable 93, the lever 90 will be rotated counterclockwise in FIGURE 1 to open the normally closed overload switch 72.

Referring now more particularly to FIGURES 4, 5 and 6, it will be seen that the limit switches are actuated by means of a pair of cam arms 100 and 101 mounted on a common boss member 102 pinned, as at 103, to a cross-shaft 104 suitably rotatably mounted from a portion 105 of the frame of the hoist mechanism. Also pinned to this cross-shaft 104 by means of a pin 106 is the boss portion 107 of an actuating lever 108 provided with a downwardly projecting finger portion 109 engaged against an adjustable compression spring 110 to adjust the operation of the limit switch operating mechanism.

Attached to the free end of the lever 108 is a flexible member, such as the chain 111, connected to a weight 112 which is guidably mounted on the cable 93 but which is capable of movement therealong. Obviously, it will be apparent that the mass of the weight 112 is chosen such as to overcome the compression spring 110 and normally move the lever 108 to a downwardly rotated position, that is, clockwise in FIGURE 4. Since the weight 112 is slidably mounted on the cable 93, when the block assembly 113 moves upwardly to engage the weight 112 and lift the same, compression spring 110 will rotate the lever 108, see FIGURE 5, and permit the cam arms 100 and 101 to operate the two limit switches 74 and 79.

The two limit switches 74 and 79 are mounted on a suitable brace or arm member 115 attached to the frame of the hoist mechanism and actuating fingers, such as the finger 116, carrying a roller 117 effect the actual closing of each switch. As stated previously, as soon as these two limit switches 79 and 74 are actuated from their normal positions, ascent of the load is terminated

so as to avoid damaging the hoist mechanism and the direction of rotation of the hoist motor is reversed so as to slightly lower the load until the weight **112**, being once again free and unsupported by the block assembly **113**, or at least substantially so, is effective to overcome the pressure of the compression spring **110** and return the two limit switches **74** and **79** to their normal positions.

What is claimed is:

1. A control circuit for electric hoist mechanisms comprising an electric power source, an electric hoist motor, relay means for selectively connecting said power source to said motor for operation of the motor selectively in both directions of its rotation to impart either a lifting or a lowering motion to an associated load, an overload relay, a pair of manually controlled switches, one for operating the hoist motor in the lifting direction and the other for operating the hoist motor in the lowering direction, each of said manually controlled switches being connected to said relay means and said overload relay, said overload relay including a normally open switch through which said one manual switch is connected to said relay means whereby a load may be lifted only when said overload relay is energized, the connection between said other manual switch and said overload relay being effective to energize said overload relay upon closing of such other switch whereby the initiation of energization of the overload relay is accomplished by closing said other manual switch to lower an associated load, and a holding circuit for said overload relay including overload responsive means for open circuiting the holding circuit to deenergize said overload relay.

2. A control circuit for electric hoist mechanisms comprising first and second relay means, an electric power source, an electric hoist motor of the reversible type, said electric power source being connected to said motor for selective reversible actuation of the latter through said first and second relay means, manual switches for selectively controlling the direction of rotation of said motor and connected to said first and second relay means, means responsive to actuation of the motor in one direction of rotation thereof to prepare the motor for operation in the other direction of rotation, and a holding circuit for the last mentioned means including overload responsive means effective to deenergize said last mentioned means, requiring subsequent operation of the motor in said one direction prior to operation thereof again in said other direction.

3. A control circuit for electric hoist mechanisms comprising an electric power source and an electric motor for connection to the power source for selective reversible rotation of the motor, a pair of relay members operable independently of each other with one being effective to connect the power source to the motor for rotation of the latter in one direction of rotation thereof and the other being effective to connect the power source to the motor for rotation thereof in the opposite direction, an overload relay member, a pair of push button switches, one of which being connected to said one relay member for energization thereof and the other being connected to said other relay member for energization thereof, the connection from said one push button switch to said one relay member being directly thereto whereby at any time such one push button switch is actuated, said one relay member will be energized and said one push button switch being also connected to said overload relay to energize the same, the connection of said other push button switch to said other relay member being through a normally open switch of said overload relay whereby said other relay member may be energized only when said overload relay is energized to close said normally open switch thereof, and a holding circuit for said overload relay including overload responsive means for open circuiting such holding circuit.

4. A control circuit for electric hoist mechanisms comprising an electric power source, an electric hoist motor, relay means for selectively connecting said power source to said motor for operation of the motor selectively in both directions of its rotation to impart either a lifting or a lowering motion to an associated load, an overload relay, a pair of manually controlled switches, one for operating the hoist motor in the lifting direction and the other for operating the hoist motor in the lowering direction, each of said manually controlled switches being connected to said relay means and said overload relay, said overload relay including a normally open switch through which said one manual switch is connected to said relay means whereby a load may be lifted only when said overload relay is energized, the connection between said other manual switch and said overload relay being effective to energize said overload relay upon closing of such other switch whereby the initiation of energization of the overload relay is accomplished by closing said other manual switch to lower an associated load, a holding circuit for said overload relay including overload responsive means to open circuit said holding circuit and deenergize said overload relay.

5. A control circuit for electric hoist mechanisms comprising first and second relay means, an electric power source, an electric hoist motor of the reversible type, said electric power source being connected to said motor for selective reversible actuation of the latter through said first and second relay means, manual switches for selectively controlling the direction of rotation of said motor and connected to said first and second relay means, said first relay means comprising a pair of independently operable relays and energized in response to individual ones of said manual switches, means responsive to actuation of the motor in said other direction of rotation thereof to prepare the motor for operation in said one direction of rotation, a holding circuit for the last mentioned means including load responsive means effective to deenergize said last mentioned means, requiring subsequent operation of the motor in said one direction prior to operation thereof again in said other direction.

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