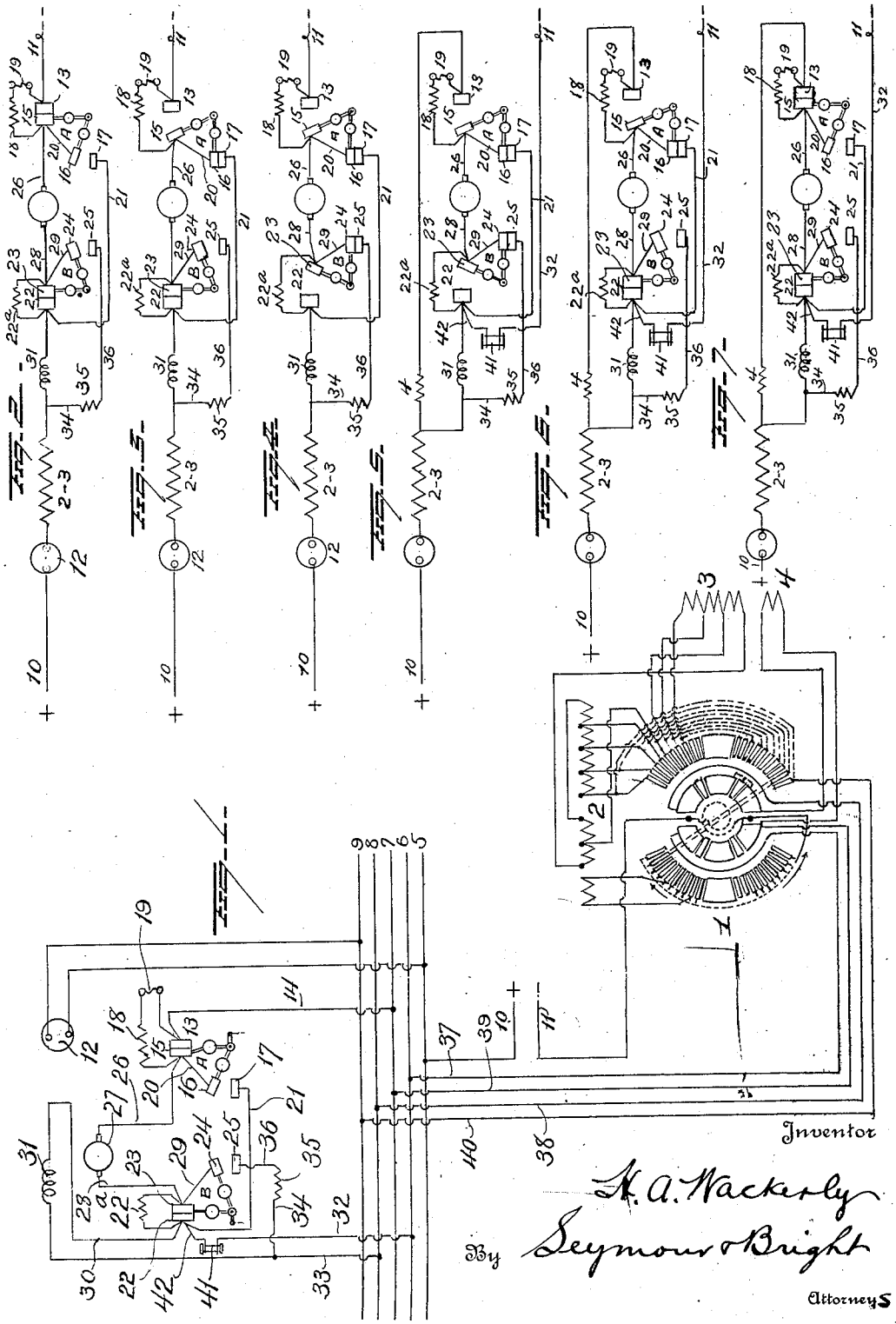
April 29, 1930. H. A. WACKERLY 1,756,714

LIMIT SWITCH DEVICE

Filed May 25, 1922 2 Sheets-Sheet 1



Inventor

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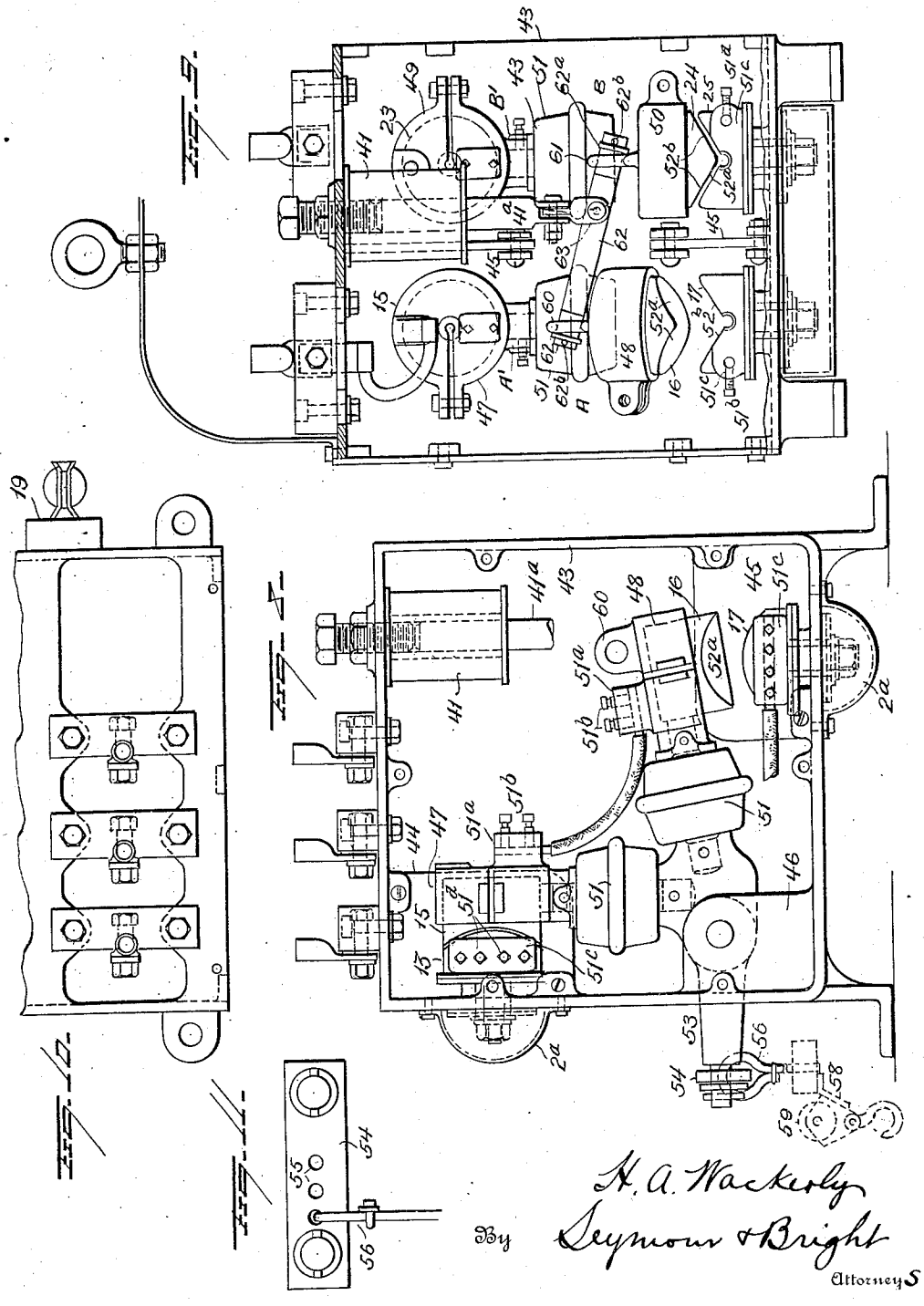
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LIMIT SWITCH DEVICE

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UNITED STATES PATENT OFFICE

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LIMIT-SWITCH DEVICE

Application filed May 25, 1922. Serial No. 563,734.

This invention relates to improvements in limit switch devices for hoisting mechanism,—one object of the invention being to provide simple and efficient switch mechanism operable by a traveling part of hoisting means and embodying electrically controlled means for resetting the switch devices when the circuit of the electric motor which operates the hoisting mechanism is reversed and when dynamic braking is used.

A further object is to so construct the switch mechanism embodying electro-magnetic resetting means, that after the switch devices have been tripped by the travelling member of the hoist, it will be impossible for the load to be carried any higher, thus positively preventing all danger of hoisting after the cut-out switch devices have been tripped.

A further object is to so construct and arrange limit switch mechanism for electrically operated hoisting means that lowering of the load will be prevented should the operator fail to move the controller to "off" position with the main line switch closed.

A further object is to improve limit switch mechanism in various other respects as hereinafter pointed out.

With these and other objects in view, the invention consists in certain novel features of construction and combinations and arrangements of parts as hereinafter set forth and pointed out in the claims.

In the accompanying drawings, Figure 1 is a diagrammatical view illustrating the arrangements of circuits and devices when my improvements are applied to a motor driven hoist mechanism; Figures 2, 3, 4, 5, 6 and 7 are diagrammatical views illustrating the operation of the mechanism; Figure 8 is a view in elevation showing the construction and arrangement of the limit switch mechanism; Figure 9 is a view taken at right angles to Figure 8; and Figures 10 and 11 are detail views.

The several diagrammatic views, Figs. 1 to 7, will be better understood by noting:

Figure 1 gives a general diagrammatic representation of the apparatus and connections of the invention.

Figures 2 and 7 represent work circuits in normal running relation, Fig. 2 for hoisting and Fig. 7 for lowering.

Figures 3 and 4 represent dynamic braking circuits, acting under automatic control conditions.

Figures 5 and 6 represent circuits determined by the operator to bring the system back to normal running relation.

In Figure 1 of the drawings, I have illustrated a controller at 1 provided with suitable contacts whereby shifting of the circuit through the resistance and the motor windings may be effected,—said controller being provided with suitable step resistance elements illustrated at 2 and 3 and with a permanent resistance 4 for the armature circuit. Conductors are indicated at 5, 6, 7, 8 and 9, and the conductor from the positive side of the source of electrical supply is indicated at 10 as connected with the conductor 5. The conductor 11 from the negative side of the source of supply is connected with the controller. The conductors 5 and 9 are connected, respectively, with the respective terminals of the solenoid of a brake indicated at 12. One contact 13, of a service limit switch A is connected by a conductor 14 with the conductor 7. This limit switch includes also a contact 15 with which the contact 13 cooperates and also cooperating contacts 16 and 17. A resistance 18 is included in a circuit bridging the contacts 13—15 and this circuit may also include a fuse or blow-out 19. The contact 15 is connected by a conductor 20 with the contact 16 and the contact 17 is connected by a conductor 21 with the contact 22 of an emergency limit switch B and the latter also includes a contact 23 cooperable with the contact 22 and contacts 24 and 25 cooperable with each other. A resistance 22^a is included in a circuit bridging the contacts 22—23. The contact 15 of the service limit switch A is connected by a conductor 26 with one side of the armature 27 of a driving motor and the other side of said armature is connected by a conductor 28 with the contact 23 of the emergency limit switch B and said contact (23) is connected by a conductor 29 with the contact 24. The contact 22 of the limit switch B is connected by a conductor 30 with one

terminal of the field coil 31 of the motor while the other terminal of the field coil is connected by a conductor 33 with the conductor 8 and said conductor 33 is connected by a conductor 34 with a resistance 35, the latter being connected, through a conductor 36 with the contact 25 of the limit switch B. The conductors 6 and 8 (with which the conductors 32 and 33 are connected) are connected by conductors 37 and 38 with the controller and the conductors 7 and 9 are connected by conductors 39 and 40 with the controller.

One terminal of the coil of a solenoid 41 is connected by a conductor 42 with the contact 22 of the limit switch B, while the other terminal of this coil is connected by a conductor 32 with the conductor 6,—the circuit including this solenoid coil being closed only when the circuit connections of the motor armature shall have been reversed and the circuits and devices are arranged for lowering of the hoist.

The limit switches A and B are arranged side by side in a frame or casing 43 and the coil of the solenoid 41 is secured to and depends from the top of said frame or casing. In order to prevent arcing across the contacts of the respective switches A and B arc shields 44 and 45 are secured in the frame or casing so as to be disposed between the contacts of the respective switches.

Standards or supports 46 are located in the lower portion of the frame and provide bearings for the bell-cranks A^1 and B^1 of the switches A and B,—the contacts 13—16 and 23—24 of these switches being preferably made of carbon and clamped in holders 47—48 and 49—50 forming, in effect, portions of the bell-cranks of the switches, and said contacts and their holders are electrically separated from the remaining portions of the bell-cranks and their supports, by means of substantial insulators 51. Each of said contact holders is provided with a perforated lug 51^a to receive a wire connection, which latter is secured to the lug by set screws 51^b. The stationary contacts 15—17 and 22—25 are secured to but suitably insulated from the bottom of the frame or casing and are provided with perforated lugs 51^c to receive wire connections, which latter are secured in place by set screws 51^d. The projecting portions of the fastening means for the stationary contacts may be protected by hoods 2^a. Each movable contact is beveled from its transverse center to diametrically opposite portions to form two beveled faces 52^a and the fixed contacts, which are preferably made of copper are recessed forming beveled faces 52^b to conform to the beveled movable contacts. In other words, the free end portions of the movable contacts are made V-shaped and the stationary contacts are made with V-shaped recesses. By thus constructing the contacts, I am enabled to obtain larger contacting surfaces and better electrical contacts than when the contact devices are made with flat faces.

The bell-cranks of the limit switches are provided with arms 53 connected (exteriorly of the frame or casing 43) by a cross bar 54, the end portions of which are loosely mounted on the arms 53 of the respective switches and said cross bar is provided intermediate of its ends with perforations 55 for connection (at any one of them) of a cord or cable 56. This cord or cable may carry a suspended weight 57 to be engaged and lifted by a part 58 on a member of the hoisting mechanism as indicated at 59.

The clamps or holders 48 and 50 which carry the contacts 16 and 24 of the respective limit switches, are provided with perforated lugs 60, 61 and these lugs are connected by a cross bar 62 of fiber or other suitable non-conducting material,—the respective end portions of said cross bar passing loosely through the perforated lugs 60, 61 and prevented from displacement by rings 62^a which are held against escape by pins 62^b. A coupling member 63 is pivotally connected with the cross bar 62 between the center of the latter and its connection with one of the contact holders and this coupling member serves to connect connecting means for the movable core 41^a of the solenoid with said cross bar.

It will be understood that the switches will normally be held in the positions shown in Figures 1, 8 and 9 by the action of the weight 57 and that when said weight is raised by the upward travel of the hoisting means, the switches will be shifted,—the weight of the horizontal arms of the bell-cranks and the parts connected with said horizontal arms overbalancing the upright arms of said bell-cranks. The arrangements of the two limit switches and their connections with the means which operate them are such that the switch A will close the circuit at contacts 16—17 prior to the closing of a circuit at 24—25 by the movement of the bell-crank of switch B. The reason for such successive operation of the two limit switches will be clearly understood from the following description of the operation of my improvements and the circuits and devices with which they are employed.

In Figure 2 of the drawing is shown the arrangement of circuits when both limit switches are in normal positions, the circuits being such that the field and armature of the motor are in series with each other,—the step resistance of the controller being also shown in this same circuit. The positions of the two switches A and B are the same in Figures 1 and 2 and the circuits of Figure 2 during raising of the load, may be traced on Figure 1 as follows: from the plus terminal at 10 to the conductor 5, thence to one terminal of the brake 12; from the other terminal of said brake to the conductor 9; from the latter, by conductor 40 to the controller 1; through con-

troller resistance 2 and 3 and thence to conductor 38, and by the latter to conductor 8; from the latter by conductor 33 to field coil 31; thence from said coil, by conductor 30 to contact 22 of switch B; from contact 23 of said switch, by conductor 28 to one terminal of the motor 27; from the other terminal of the motor, by conductor 26 to contact 15 of switch A; from contact 13 of said switch, by conductor 14 to conductor 7; from the latter, by conductor 39 and through the controller and finally, by conductor 11 to the minus terminal. When the weight is raised by the upward travel of the hoisting means, the bell-crank of the service limit switch A will first be shifted to separate the contacts 13—15 and close the contacts 16—17. This shifting of the switch will operate to short-circuit the armature of the motor as shown in Figure 3. The same shifting of the switch A will, in addition to short circuiting the armature, insert the resistance 18 to choke the excessive current which would otherwise flow through the field windings, as also indicated in Figure 3. The separation of the upper contacts of the service switch will cause slowing down of the motor armature by introducing the resistance 18 into the line in series with the armature, and the inserting of said resistance and the safety fuse in the line reduces the arcing effect between the contacts. Immediately after the switch A has been shifted, producing the results described, the emergency switch B will be shifted, thus separating the contacts 22—23 and closing the contacts 24—25. The armature and field are now connected in a closed circuit in shunt to the resistance 22^a,—both switches having been tripped, as shown in Figure 4, and a quick stop of the motor is insured, with the controller handle in any position or in off position or even if the line voltage fails about the time the weight 57 is lifted by the hoisting means. The circuit including the armature and field in a closed circuit in shunt with the resistance 22^a, may be traced on Figure 4 as follows: from one terminal of field 31 to conductor 34, through resistance 35 to conductor 36 to contact 25 to contact 24, by conductor 29 and 28 to armature, from the latter by conductor 26, to contact 15, to conductor 20, to contact 16, to contact 17, by conductor 21 to contact 22, and then to other terminal of field coil 31.

During the entire time that the service switch is tripped, a small amount of current will flow through the resistance 18 and safety fuse 19 and should the operator carelessly leave the controller in "hoisting position", or should the supply of current resume after having been suspended, after a short time, the safety fuse will blow out, cutting off the motor entirely from the source of power, and under these conditions the load would be prevented from lowering.

To effect the lowering of the hoisting mechanism, the controller will be operated to reverse the current in the armature, when the circuits will be as indicated in Figure 5. This view however, illustrates a transition step wherein the controller has been reversed to lower, but before the solenoid has reset the switch. When the current in the armature circuit is thus reversed, the coil of the solenoid will be included in a closed circuit and said solenoid 41 will be energized and its core 41^a actuated to shift the limit switches through the connections previously described and re-set said switches successively, the emergency switch being first reset so that the circuits will be as shown in Figure 6 and immediately afterwards, the service switch will be shifted so that the circuit connections will be as shown in Figure 7, said Figures 6 and 7 showing the circuits in lowering positions, Fig. 7, with both switches reset.

With the use of the solenoids 41 included in the circuit and having its core connected with the switches as previously explained, after the switches have been tripped by the hoisting means, it will be impossible for the load to be carried any higher because there can be no current in the solenoid coil as said solenoid is energized only when the controller has been shifted to reverse the motor and the circuits are in lowering position and the only direction the load can possibly be moved will be downwardly. Thus all danger of hoisting after the switches have been tripped will be positively prevented.

Having fully described my invention what I claim as new and desire to secure by Letters-Patent, is:—

1. Limit switch means for motor control, comprising a movable member carrying contacts, fixed contacts for cooperation with the movable contacts, means connected with the movable member of said switch and operable by an electric motor driven means for shifting the movable switch member in one direction, and single solenoid electro-magnetic means connected with the movable member of the switch and operable to shift the same in the reverse direction when the circuit of the electric motor is reversed.

2. Limit switch means for motor control, comprising a movable member carrying contacts, fixed contacts cooperable with the movable contacts, means connected with said movable member and operable by an electric motor driven part to move it, single solenoid electro-magnetic resetting means for the switch connected with the movable switch member, and means whereby said electro-magnetic shifting means is energized only when the motor circuits are arranged to cause the motor to operate in one direction.

3. Limit switch means comprising a movable member carrying contacts, fixed contacts to cooperate with the movable contacts, means

connected with said movable member and operable by an electric motor driven part to shift the switch when the motor is running in one direction, and single solenoid electromagnetic means connected with said movable member for resetting the switch when the motor circuit is arranged to cause the motor to run in the reverse direction.

4. Limit switch means, comprising two switches, each of said switches comprising a movable member carrying contacts, and fixed contacts to cooperate with the movable contacts, a cross bar loosely connecting the movable members of said switches, connected arms on said movable members and operable by a part driven by an electric motor when the same is running in one direction to shift said movable members successively, and a solenoid having its movable core connected with said cross bar and operable when the circuit of the motor is reversed to reset said switches successively.

5. Limit switch means comprising a movable member carrying contacts, fixed contacts, means connected with a part driven by an electric motor for shifting the movable switch member when the part driven by the motor has reached the limit of its travel, and a bridge connecting one of the movable contacts with the fixed contact with which it cooperates, and a resistance and a fuse included in said bridge.

6. Limit switch means comprising a movable member carrying contacts, fixed contacts, means connected with a part driven by an electric motor for shifting the movable switch member when the part driven by the motor approaches the limit of its travel, a resistance connecting one of the movable contacts with the fixed contact with which it cooperates, another resistance, and means whereby the last-mentioned resistance may be brought in series with the source of power.

7. Limit switch means comprising a movable member carrying contacts, fixed contacts, means connected with a part driven by an electric motor for shifting the movable switch member when the part driven by the motor approaches the limit of its travel, a resistance connecting one of the movable contacts with the fixed contact with which it cooperates, another resistance, and a switch whereby the last-mentioned resistance may be brought in series with the source of power.

In testimony whereof, I have signed this specification.

HARRY A. WACKERLY.