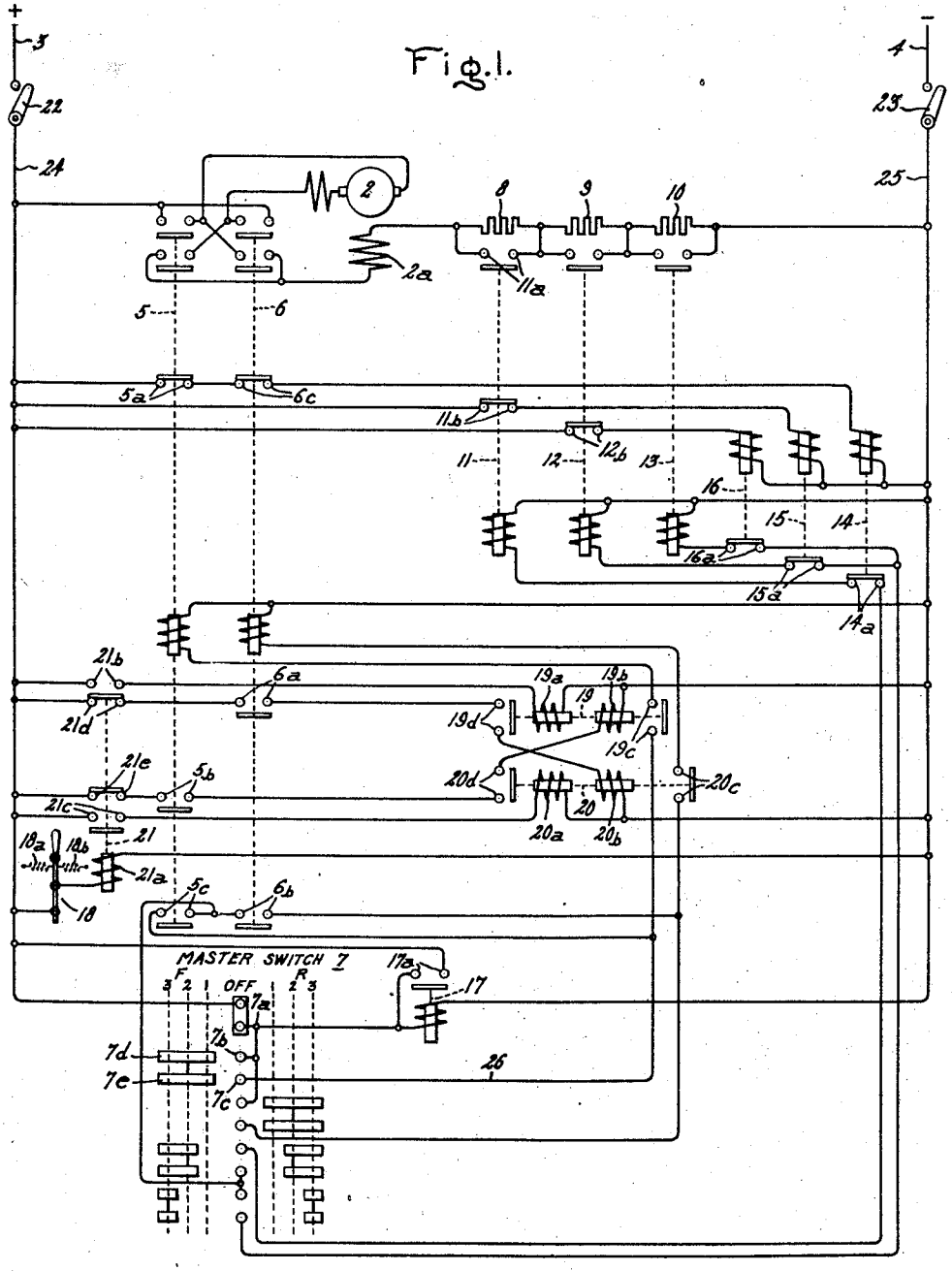
Dec. 9, 1947. G. W. HEUMANN 2,432,313

SINGLE LIMIT SWITCH REVERSING CONTROL

Filed April 6, 1946 2 Sheets-Sheet 1

Fig. 1.



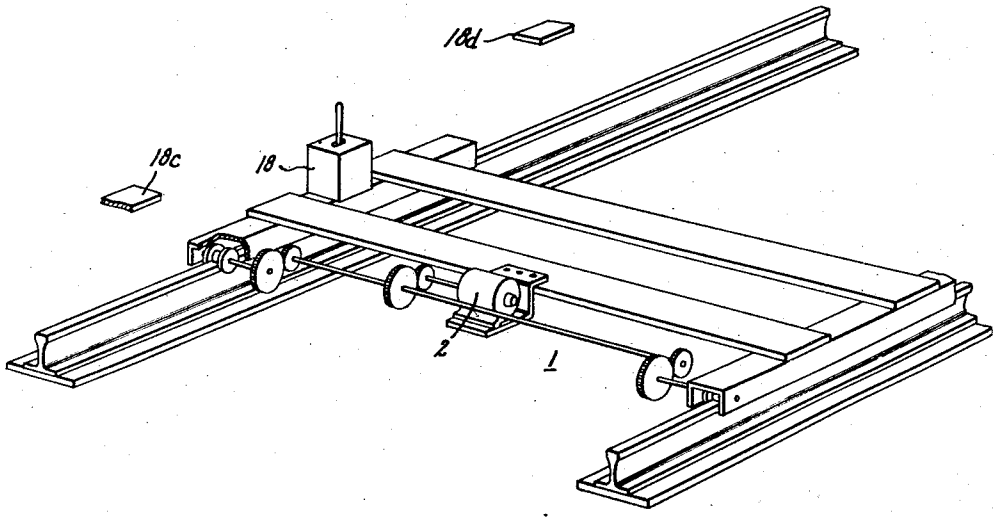
Inventor:
Gerhart W. Heumann,
by Claude H. Mott.
His Attorney.

Dec. 9, 1947. G. W. HEUMANN 2,432,313

SINGLE LIMIT SWITCH REVERSING CONTROL

Filed April 6, 1946 2 Sheets-Sheet 2

Fig. 2.



Inventor:
Gerhart W. Heumann,
by Claude A. Mott.
His Attorney.

Patented Dec. 9, 1947

2,432,313

UNITED STATES PATENT OFFICE

2,432,313

SINGLE LIMIT SWITCH REVERSING CONTROL

Gerhart W. Heumann, Schenectady, N. Y., assignor to General Electric Company, a corporation of New York

Application April 6, 1946, Serial No. 660,085

3 Claims. (Cl. 318—256)

1

This invention relates to control systems, more particularly to systems for controlling the operations of electric motors, and it has for an object the provision of a simple, reliable and improved control system of this character.

More specifically the invention relates to reversing control systems in which limit switch protection is provided at two opposite limits of operation. On numerous applications conditions exist which make it impractical to employ more than one limit switch. This limit switch must stop the motion of the drive of the reversing drive when the overtravel position is reached in either of the two directions. Heretofore reversing controllers have been provided with an auxiliary switch for bypassing the contacts of the limit switch to enable the operator to energize the drive to back out of the limit by reversing the master switch. The bypass switch introduces a hazard because a careless operator may make a false move of the master switch and instead of backing out of the limit zone he may drive further into it. This may cause damage to the mechanical equipment.

Also, cases have been known in which the operator tied or weighted down the bypass switch thereby rendering the limit protection entirely inoperative. Accordingly a further object of the invention is the provision of a reversing control system with limit protection and in which the bypass switch is eliminated and backing out of the limit is accomplished by reversal of the master switch.

In carrying the invention into effect in one form thereof, a load object is driven between two limits by means of an electric motor. The direction of rotation of the motor is controlled by means of forward and reverse contactors under the control of a reversing master switch. Two control relays are provided each of which has contacts in the energizing circuit of one of the directional contactors. A single limit switch has normally closed contacts which are opened at each limit. A third relay responds to the closing of the limit switch contacts to pick up both forward and reverse control relays to prepare energizing circuits for the directional contactors which are selectively completed by the master switch. The opening of the limit switch contacts causes this third relay to drop out the control relay which prepared the energizing circuit for the energized directional contactor which thereupon drops out to disconnect the motor from the source.

For a better and more complete understanding of the invention, reference should now be had to the following specification and to the accompanying drawing of which Fig. 1 is a simple diagrammatical sketch of an embodiment of the invention, and Fig. 2 is a perspective sketch of an application of the invention to a crane.

2

Referring now to the drawing, a crane structure 1 is driven by an electric motor 2 between two limits. The motor 2 is illustrated as a D.-C. series motor. It is supplied from a suitable source such as represented by the supply conductors 3 and 4, to which it may be connected for rotation in either direction by means of forward and reverse directional contactors 5 and 6. These directional contactors are under the control of a suitable multi-position reversing type master switch 7. Left-hand positions of the master switch control the forward operation and right-hand positions control the reverse operation.

The acceleration of the motor is effected by three accelerating resistor sections 8, 9 and 10 which are arranged to be successively short circuited by means of accelerating contactors 11, 12 and 13 respectively. The closing of the accelerating contactors 11, 12 and 13 in timed sequence is controlled by accelerating control relays 14, 15 and 16 respectively which are preferably of the inductive time delay type. Suitable undervoltage protection is provided by means of undervoltage relay 17.

For the purpose of preventing operation of the crane beyond predetermined limts, a single limit switch 18 is provided. It is mounted in a suitable position on the crane. As shown in Fig. 1, its contacts are normally closed by the centering springs 18*a* and 18*b*. Suitable means, such as limit stops 18*c* and 18*d*, are provided for opening the limit switch contacts at each of the limits of operation.

The dropping out of the directional contactors is controlled by means of forward and reverse control relays 19 and 20. These relays are preferably of the latched-in type. The significant feature of a latched-in relay is that it remains in the last position to which it was operated even after deenergization of the operating coil. Any type of latched-in relay may be used such, for example, as a permanent magnet type or a mechanical latched-in type may be used. The relays 19 and 20 have closing coils 19*a* and 20*a* respectively and opening coils 19*b* and 20*b* respectively.

Energization of the opening and closing coils

of the relays 19 and 20 is controlled by means of a third control relay 21 which is directly controlled by the limit switch 18. The contacts of the limit switch are included in circuit with the operating coil 21*a* of the control relay.

With the foregoing understanding of the elements and their organization, the operation is readily understood from the following description.

The line switches 22 and 23 are closed to connect the supply buses 24 and 25 to the source. Responsively to energization, the accelerating relays 14, 15 and 16 pick up and open their normally closed contacts 14*a*, 15*a*, and 16*a* which are in the circuits of the operating coils of the accelerating contactors 11, 12, and 13 respectively. The undervoltage relay 17 is energized and picked up to close its contacts 17*a*.

Assuming the crane to be in a position between the two limits, the contacts of the limit switch are closed to complete an energizing circuit for the operating coil 21*a* of the control relay 21. In response to energization the relay 21 picks up to close its normally open contacts 21*b* and 21*c* and to open its normally closed contacts 21*d* and 21*e*. Contacts 21*b* and 21*c*, when closed, complete energizing circuits for the pick up coils 19*a* and 20*a* respectively of the forward and reverse control relays 19 and 20. Responsively to energization relays 19 and 20 pick up and close their contacts 19*c* and 19*d* and 20*c* and 20*d*. In closing, contacts 19*c* and 20*c* prepare energizing circuits for the operating coils of the reversing contactors.

If it is desired to drive the crane in the forward direction, the master switch 7 is moved from the central or off position in which it is illustrated to the third position forward. In the first position forward, an energizing circuit is completed for the operating coil of the forward contactor. This circuit is traced from the positive bus 24, through the previously closed contacts 17*a* of the undervoltage relay to the power terminal 7*a* of the master switch, thence through fingers 7*b* and 7*c* bridged by segments 7*d* and 7*e*, conductor 26, contacts 19*c* in the closed position thereof, operating coil of the forward contactor 5 to the negative bus 25. Contactor 5 picks up and closes its main contacts to connect the armature and series field winding 2*a* to the supply buses through the current limiting resistors 8, 9 and 10. The motor begins to rotate at slow speed. Simultaneously the forward contactor opens its normally closed auxiliary 5*a* and closes its normally open auxiliary contacts 5*b* and 5*c*.

Contacts 5*a*, in opening, interrupt the energizing circuit of the accelerating relay 14 which drops out after a time interval and closes its contacts 14*a* to complete an energizing circuit for the operating coil of the accelerating contactor 11, provided the master switch has reached the second position. In response to energization, the accelerating contactor closes its main contacts 11*a* to short circuit the accelerating resistor 8 thereby to increase the speed of the motor. Simultaneously contactor 11 opens its auxiliary contacts 11*b* to interrupt the energizing circuit of the accelerating relay 15.

After a time interval, the relay 15 drops out and closes its contacts 15*a* to complete an energizing circuit for the accelerating contactor 12, provided the master switch has reached the third position. Responsively to energization, contactor 12 picks up and short circuits resistor section 9 thereby to accelerate the motor to a higher speed.

Similarly, after a further time delay, contactor 13 is picked up to short circuit the final resistor section 10 as a result of which the motor is accelerated to full speed.

The crane is driven in a forward direction toward the limit stop 18*c*. If the drive is continued into the limit, the contacts of the limit switch are opened by the limit stop 18*c*, thereby interrupting the energizing circuit for the control relay which drops out to open its contacts 21*b* and 21*c* and to close its contacts 21*d* and 21*e*. In opening, contacts 21*b* and 21*c* interrupt the energizing circuits for the closing coils of the directional selective control relays 19 and 20. Contacts 21*e* in closing complete an energizing for the opening coil of the forward relay 19. This circuit is traced through the contacts 5*b* of the forward directional contactor, contacts 20*d* of the reverse relay 20 and opening coil 19*b*. Relay 19 responds and opens its contacts 19*d* and 19*c*. The opening of contacts 19*c* deenergizes the directional contactor 5 which drops out to open its main contacts and auxiliary contacts 5*b* and 5*c* and to close its contacts 5*a*.

The main contacts in opening disconnect the motor 2 from the source and the motor is quickly brought to rest by suitable braking means (not shown). Contacts 5*c*, in opening interrupt the energizing circuits for the accelerating contactors 11, 12 and 13 which thereupon drop out to insert the accelerating resistor sections in the motor circuit. The closing of contacts 5*a* and 11*b* and 12*b* picks up the accelerating relays 14, 15 and 16, leaving the system in a reset condition for a subsequent operation.

Since the interlock contacts 6*a* of the reverse directional contactor 6 and the interlock contacts 19*d* of the forward selective relay 19 are open, the opening coil 20*b* of the reverse selective relay 20 cannot be energized. Consequently, the contacts 20*c* remain closed, preparing an energizing circuit for the operating coil of the reverse directional contactor which is completed upon operation of the master switch 7 to the first reverse position. Contactor 6 picks up and closes its main contacts to connect the motor 2 to the source for rotation in the reverse direction. It also closes its interlock contacts 6*a* and 6*b* and opens its auxiliary contacts 6*c*. In closing, contacts 6*b* complete the power connections to the accelerating fingers of the master switch and the accelerating contactors 11, 12 and 13 are again closed in timed sequence as the master switch is moved through its successive positions reverse, and the motor is accelerated to full speed in a manner similar to that described in the foregoing.

As the crane backs out of the limit zone, the contacts of the limit switch 18 are reclosed, thereby to pick up the control relay 21 which closes its contacts 21*b* and 21*c* and opens its contacts 21*d* and 21*e*. The latter contacts, in opening, interrupt the opening coil circuits of the selective directional control relays 19 and 20 and contacts 21*b* and 21*c*, in closing, complete energizing circuits for the closing coils of the selective control relays. Relay 20 is already in the closed position and consequently the energization of the closing coil has no effect on the operation at this point. However, the energization of the closing coil of the forward relay 19 picks up this relay to close its contacts to prepare an energizing circuit for the operating coil of the forward co

tactor which can be completed the next time the master switch is moved to its forward positions.

At this point in the operation, the motor may be stopped and reversed by operation of the master switch and the crane will again be driven into the forward limit and stopped as described in the foregoing. Likewise, if the drive is continued in the reverse direction until the crane reaches the reverse limit zone, the limit switch contacts are opened to deenergize the control relay **21** which drops out to open contacts **21***b* and **21***c* and to close contacts **21***d* and **21***e*. Contacts **21***b* and **21***c*, in opening, deenergize the closing coils of the directional selective relays and contacts **21***d*, in closing, complete an energizing for the opening coil **20***b* of the reverse selective relay through contacts **6***a* of the directional contactor and interlock contacts **19***d* of the forward selective relay. The reverse selective relay opens its contacts **20***d* and **20***c*. The latter contacts in opening interrupt the energizing circuit for the reverse contactor **6** which drops out to disconnect the motor **2** from the source and thereby stop the crane at the reverse limit zone. The remainder of the stopping operation is substantially the same as the corresponding part of the stopping operation in the forward direction as described in the foregoing.

The crane may be backed out of the reverse limit zone by moving the master switch to its forward positions.

Although in accordance with the provisions of the patent statutes this invention is described as embodied in concrete form and the principle thereof has been explained together with the best mode in which it is now contemplated applying that principle, it will be understood that the elements shown and described are merely illustrative and that the invention is not limited thereto since alterations and modifications will readily suggest themselves to persons skilled in the art without departing from the true spirit of this invention or from the scope of the annexed claims.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A control system for a movable load object comprising an electric motor for driving said object in either direction between two limits, a reversing master switch and forward and reverse contactors controlled thereby for controlling the direction of rotation of said motor, a limit switch adapted to be mounted on said object and having normally closed contacts, means for opening said contacts at each of said limits, a forward control relay having contacts in the energizing circuit of said forward contactor, a reverse control relay having contacts in the energizing circuit of said reverse contactor, a third relay having its operating coil in circuit with said limit switch contacts and responsive to closing of said limit switch contacts for picking up said forward and reverse control relays to prepare energizing circuits for said contactors to be selectively completed in response to operation of said master switch, and responsive to opening of said limit switch contacts for dropping out the control relay corresponding to the energized directional contactor thereby to deenergize said energized contactor to stop said motor.

2. A control system for a movable load object comprising an electric motor for driving said object in either direction between two limits, a reversing master switch and forward and reverse contactors controlled thereby for controlling the direction of rotation of said motor, each of said contactors having a pair of auxiliary contacts, a limit switch having normally closed contacts, means at each of said limits for opening said contacts, forward and reverse control relays having contacts in the energizing circuits of said forward and reverse contactors respectively, a third control relay responsive to closing of said limit switch contacts for picking up both said first and second control relays to prepare energizing circuits for said contactors to be selectively completed in response to operation of said master switch, and responsive to opening of said limit switch contacts for cooperating with the auxiliary contacts of the energized contactor to drop out the corresponding control relay to drop out the energized directional contactor and stop said motor.

3. A control system for a movable load object comprising an electric motor for driving said object between two limits, a reversing limit switch, forward and reverse directional contactors controlled thereby each provided with main contacts for controlling the direction of rotation of said motor and also provided with auxiliary contacts, a limit switch having normally closed contacts, means for opening said limit switch contacts at each of said limits, forward and reverse control relays having contacts in the energizing circuits of said forward and reverse contactors respectively and each provided with opening and closing coils, a third relay responsive to closing of said limit switch contacts for energizing both said closing coils to pick up both said control relays to prepare energizing circuits for said contactors to be selectively completed in response to operation of said master switch, and responsive to opening of said limit switch contacts for cooperating with the energized directional contactor to complete an energizing circuit for the opening coil of the control relay corresponding to the energized directional contactor thereby to drop out said corresponding relay and directional contactor to stop said motor.

GERHART W. HEUMANN.