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MOTOR CONTROL

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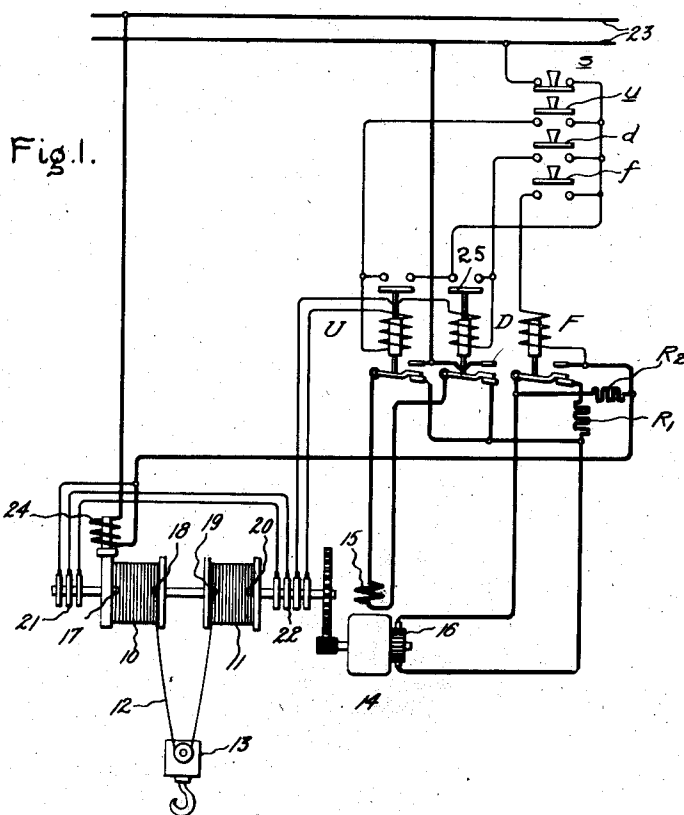


Fig. 2.

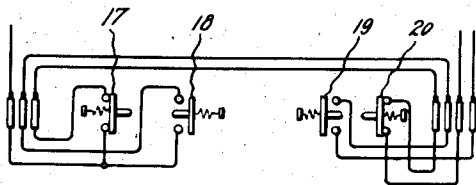
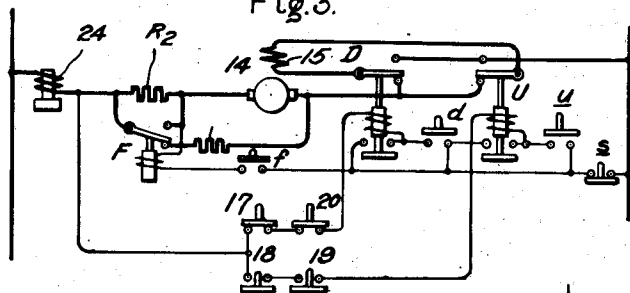


Fig. 3.



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MOTOR CONTROL

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My invention relates to improvements in systems of control for electric motors, and in particular to such systems intended for the control of motor driven hoists.

Among the objects of the invention, as applied to motor driven hoists, for example, are the following:

1. To provide an improved arrangement for limiting the extent of movement of the hoisting device.

2. To provide an improved system in which the hoisting and lowering operations are governed by separately operable manually operated switches, such as push button switches or the like.

3. To provide a system in which when either an "up" or a "down" push button switch is momentarily operated the hoist is caused to proceed in the corresponding direction at low speed and the speed thereof may be increased by operating a "fast" push button, the arrangement being such that the fast speed is maintained (within the limits of operation of the hoist) as long as the "fast" push button is maintained operated and when the fast button is released the speed of the hoist is automatically reduced to the said low speed.

4. To provide a system in which in case the hoist is proceeding in either direction and the push button for the other direction of operation is operated, the hoist will be automatically stopped and cannot be restarted until after the "stop" push button switch is first operated.

For an understanding of the features of construction and mode of operation of a present preferred embodiment of the invention, reference is had to the accompanying drawings in which Fig. 1 shows in simplified diagram a system of control for an electric motor connected to operate a hoist, Fig. 2 is a detail of the arrangement of Fig. 1 for the purpose of showing the circuit arrangement and other features of the switch mechanism whereby the extent of operation of the hoist is limited, and Fig. 3 is a diagrammatic representation of the system of control showing Figs. 1 and 2.

Referring to the drawings, the hoist is in-

dicated as having two drums 10 and 11 on which the cable 12 is wound and unwound. The cable 12 supports the hoisting block 13. The hoisting drums are driven by the electric motor 14 which is indicated as of the series type having a series field winding 15 and an armature 16. This motor is controlled by the controlling means to be presently described and the controlling means has provision for accomplishing the stated objects of the invention. The controlling means comprises a pair of directional electromagnetic switches or contactors, one of which is designated U, indicating that this contactor is provided for effecting rotation of the motor 14 to raise the hoisting block 13 and the other contactor is designated D to indicate that this contactor is provided for effecting connections of the motor 14 to produce a lowering of the hoisting block 13. These contactors are each provided with a set of main contacts which are closed when the contactor is in the deenergized position and another set of main contacts which are closed when the contactor is in the energized or attracted position. The arrangement is such that when either the U or D contactor is closed, the motor 14 is caused to operate at low speed, the resistor R1 being connected in multiple relation with the motor armature and the resistor R2 being connected in series relation with the motor armature.

The contactor designated F is provided for effecting high speed connections for the motor. In the deenergized position of this contactor, the resistor R1 is connected in multiple relation with the motor armature and the resistor R2 in series relation therewith, and in the attracted position of this contactor the resistors R1 and R2 are excluded from the motor armature circuit and the motor is connected directly to the source of supply for high speed operation.

A control of the contactors U, D and F is had through the separately operable manually operable switches which are indicated conventionally as push button switches and are interconnected in the manner shown. The upper push button switch is designated s and performs the function of a stop con-

trolling switch. The next lower push button switch is designated *u* and is provided for controlling the up contactor U. The next lower push button switch is designated *d* and is provided for controlling the down contactor D. The bottom push button switch is designated *f* and this push button is provided for controlling the fast or speed up contactor F.

One of the features of my invention is an improved arrangement whereby the limits of movement of the hoisting block 13 are accurately determined. This limit or travel protection is provided by means of the push button switches 17, 18, 19 and 20. These switches are each carried by an associated hoisting drum and are mounted on the periphery of the associated drum so as to be engaged by the hoisting cable 12 to effect operation thereof. In other words, each push button switch will be assembled as a unit and mounted in a suitable aperture in the outer periphery of the associated hoisting drum, with the button of the switch projecting from the periphery of the drum so as to be engaged by the hoisting cable as the cable is wound upon the associated drum. The switches 17 and 20 form one pair of switches and the switches 18 and 19 form another pair.

The circuit connections of the switches 17, 18, 19 and 20 will be better understood from a description of Fig. 2. It will be seen from this figure that each push button switch is provided with a compression spring which tends to maintain the push button switch contacts in a definite position. Thus, the switches 17 and 20 are of the normally open type, and the switches 18 and 19 are of the normally closed type. By reference to Fig. 1, it will be seen that the cable 12 is wound upon the drums 10 and 11 to such an extent that the switches 17 and 20 which are provided for limiting the downward movement of the hoisting block 13 have their respective contacts closed against the tension of the respective biasing springs, whereas the switches 18 and 19 which are provided for limiting the upward travel of the hoisting block have their respective contacts opened, due to the action of the cable 12 pressing on the operating button of these respective switches. The switches 17, 18, 19 and 20 are interconnected in the manner shown in Fig. 2, the sets 21 and 22 of conducting rings and brushes being provided for establishing electrical connections to the push button switches carried by the respective drums.

As thus constructed and arranged and with the parts in their respective positions indicated in the drawing, the operation of my invention is as follows:—The hoisting block 13 has been raised to its upper limit of travel and further movement

in this direction is prevented so that the only movement of the hoisting block which is permitted is in the down direction. To cause the block 13 to move downwardly, the down push button *d* is momentarily depressed, thereby completing a circuit from the lower conductor of the source 23, winding of directional contactor D through the corresponding conducting ring of the set 22, the contacts of limit switch 20 through the right-hand conducting ring of the set 21, the contacts of limit switch 17, through the winding of electromagnetic brake 24 to the upper supply conductor. The current through the winding of the electromagnetic brake will not be sufficient to effect release of this brake and the brake will not be released until after the contactor D is closed in response to the energization thereof. When this contactor closes, an auxiliary switch 25 associated therewith establishes a holding circuit for the winding of the contactor D, through the stop push button *s* so that the down push button may be released.

With the main switch member of contactor D in its upper position, a circuit is made which may be traced as follows:—from the lower conductor of the source 23, through the upper main stationary contact of contactor D, movable switch member of this contactor, through the motor series field 15, through the lower main contacts of contactor U, through the motor armature 16 and the resistor R2, with the resistor R1 included in multiple relation with the motor armature, through the winding of the electromagnetic brake 24 to the upper supply conductor. The electromagnetic friction brake 24 will be released and the motor 14 will be energized in such a direction as to cause downward movement of the hoisting block 13. After this motion has proceeded for a small distance, the cable 12 will be unwound from the drums 10 and 11 to such an extent that the limit switches 18 and 19 will be permitted to close their respective contacts in accordance with the bias produced by their respective compression springs. This will produce no result at this time but will make it possible to effect a raising of the hoisting block 13 in case that is desired.

In case the operator desires to stop the downward movement of the hoisting block 13, he may do so by depressing either the stop push button *s* or the up push button *u*. In case the stop push button *s* is depressed momentarily, the holding circuit through the contactor D is open and this contactor opens its upper set of main contacts and closes its lower set. This includes the series field 15 of the motor in a local circuit and because of the fact that the lower main con-

tacts of the contactor F are closed, the motor armature is included in a dynamic brake circuit. The motor is thus stopped by being disconnected from the source of supply and by being connected in a dynamic braking circuit. If instead of depressing the stop push button *s* momentarily, the operator had momentarily depressed the up push button *u*, the motor would likewise have been disconnected from the source of supply and be included in a dynamic brake circuit. Thus with the down contactor D energized, the momentary depression of the up push button *u* will effect the energization of the up contactor U through a circuit which includes the stop push button *s*, the up push button contacts *u*, winding of up contactor U, through the limit switches 19 and 18, to the upper supply contactor. The up conductor U will open its lower set of main contacts, thereby disconnecting the motor from the source of supply and the circuit established through the upper main contacts of this contactor connects the series field 15 in a local circuit. The armature of the motor is included in a local dynamic brake circuit as was previously the case when the stop push button *s* was depressed. When the motor is thus disconnected from the source of supply, the winding of the electromagnetic brake 24 is simultaneously deenergized and this brake is caused to apply and thereby hold the hoisting drums and the hoisting block in position, as is common in equipments of this character.

When the hoist is thus stopped by the depression of the up push button *u*, it is necessary for the operator to momentarily depress the stop push button *s* prior to being able to again start the hoist in either direction. That is because of the fact that when the up contactor is energized, it closes its upper auxiliary contacts and establishes a holding circuit for the winding of this contactor. This holding circuit is maintained as long as the stop push button *s* remains closed. After the stop push button *s* has been momentarily depressed, the equipment may be started and stopped in the customary manner.

Assume that after the hoist had been started, as previously explained, for the lowering of the hoist block 13, an increase of the lowering speed is desired. This is effected by depressing the "fast" push button *f*, thereby energizing the winding of contactor F through a circuit which may be readily traced. When the contactor F is thus energized, it opens its lower main contacts and closes its upper main contacts. The opening of the lower main contacts opens the circuit through the armature shunting resistor R1 and the closing of the upper main contacts effects the shunting of the armature series resistor R2. The motor

is thus connected directly to the source of supply and high speed operation of the hoist will continue (within the limits of hoist travel as determined by the limit switches 17 and 20) as long as the "fast" push button *f* is maintained depressed. When this push button is released, the connections for the motor armature revert to those previously explained for the slow speed down direction of movement of the hoisting block. If the cable 12 is unwound from the hoisting drums 10 and 11 to such an extent that the limit switches 17 and 20 are released to open in accordance with their bias, the controlling circuit for the down contactor D is opened and the motor is thus disconnected from the source of supply and included in a dynamic brake circuit and at the same time the electromagnetic brake 24 is applied to hold the hoist.

It is believed that those skilled in the art will readily understand the operation of the manually operable push button switches to effect movement of the hoisting block from either limit of movement thereof to the other, as well as to effect movement of the hoisting block between its limits of operation, in such a direction and at such a speed as the operator desires, without a further detailed description of the arrangement.

Among the features of advantage of my invention is that by reason of the fact that the limit switches are carried by the hoisting drums and are operated directly by the cable as the cable is wound upon and unwound from the hoisting drums, a certainty of operation of these limit switches is had which is desirable. Another feature of advantage is that no complicated electrical interlocking or expensive mechanical interlocking between the directional contactors U and D is necessary to prevent both these contactors being closed at a time, as is the case in other systems with which I am familiar, since in case either contactor is closed to effect movement of the hoisting block in the selected direction, if the other contactor for the other direction of operation is closed, the hoist will merely stop. Another feature of advantage is that merely a momentary operation of the push buttons through which a control of the hoist is effected is necessary to effect either slow speed operation of the hoist in either direction or the stopping of the hoist from either direction of movement, so that in case the operator desires to speed up the hoist, he need merely depress the fast push button *f*. As long as this fast push button is depressed, the fast speed will be maintained (within the limits of operation of the hoisting block). I would have it understood that in practice, the push buttons *s*, *u*, *d* and *f* will be mounted in a common assembly and for

certain applications this push button assembly will be interconnected with the controlling contactors by a single multiple conductor cable. Thus, the push button switch assembly may be of the pendant type, a general construction well known and understood by those skilled in the art. It will further be observed that the wiring connections are very simple and will readily be understood by electricians whose duty it is to maintain the operation of equipments of this nature.

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

1. In a system of motor control, an electric motor, and controlling means therefor including a pair of directional switches, means including a pair of separately operable manually-operable controlling switches and connections controlled thereby for effecting operation of the motor in either direction when the corresponding one of said controlling switches is momentarily operated and the stopping of the motor when the other controlling switch is subsequently operated, and switching means for controlling the stopping of said motor at the will of the operator, said switching means being connected so that the motor after being stopped by the subsequent operation of said other switch cannot be restarted until said switching means is operated.

2. In a system of motor control, an electric motor, and controlling means therefor including a pair of directional contactors, a separate manually operated controlling switch for each of said contactors, a separate manually-operated switch for controlling the stopping of the motor at the will of the operator, and electrical connections through which when either one of said first mentioned controlling switches is momentarily operated operation of the motor in the selected direction is effected and the stopping of the motor is effected when the other of said first mentioned controlling switches is momentarily operated, the said connections being such that after the stopping of the motor is thus effected, the motor cannot be restarted until after said stop controlling switch is operated.

3. In a system of motor control, an electric motor and controlling means therefor comprising a pair of directional contactors, a resistance normally included in the motor armature circuit, a fast speed contactor for controlling said resistance, a separate manually-operable controlling switch for each of said contactors and electrical connections controlled thereby through which a momentary operation of a corresponding one of said controlling switches effects operation of a corresponding one of said directional contactors to cause operation of said motor in a direction corresponding to the controlling

switch which is operated, and a subsequent operation of the controlling switch for said fast speed contactor disconnects said resistance so as to effect an increase in the motor speed irrespectively of the direction of rotation and biasing means for automatically causing said last mentioned switch to reconnect said resistance to reduce the speed of the motor to its former value at the termination of said subsequent operation.

4. In a system of motor control, an electric motor and controlling means therefor including a pair of directional contactors, a resistance normally included in series with the motor armature, and a second resistance normally connected in parallel therewith, a fast speed contactor for controlling said resistances, a separate manually operable controlling switch for each of said contactors, electrical connections through which a momentary operation of a corresponding one of said controlling switches effects operation of a corresponding one of said directional contactors to cause slow speed operation of said motor in a direction corresponding to the controlling switch which is operated and a subsequent operation of the controlling switch for said fast speed contactor causes said fast speed contactor to disconnect said resistances so as to effect an increase in the motor speed irrespectively of the direction of rotation, and biasing means for causing said last mentioned switch to reconnect said resistances so as to effect slow speed operation of the motor at the termination of said subsequent operation.

In witness whereof, I have hereunto set my hand this 25th day of July, 1927.

ISAAC F. BAKER.