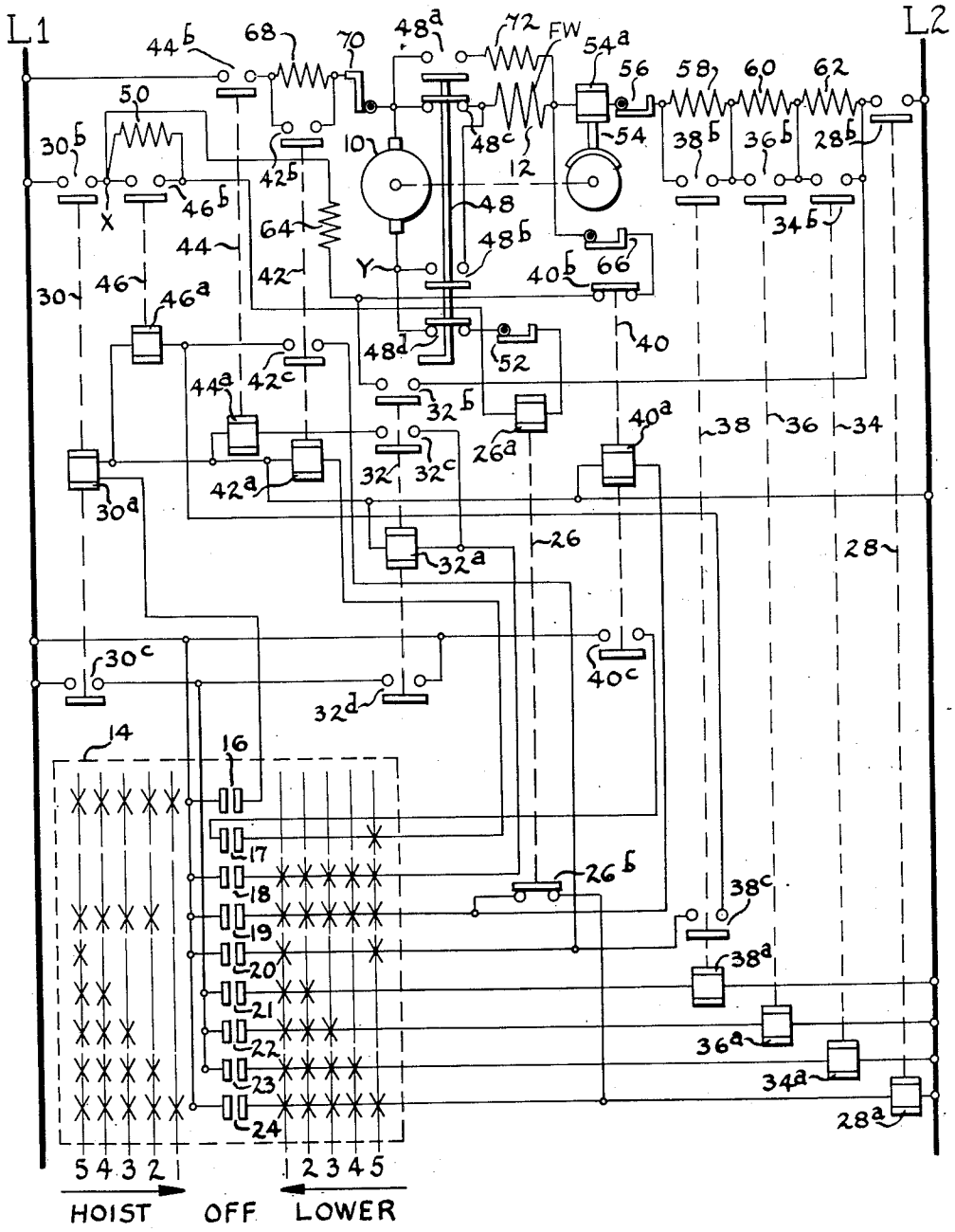
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CONTROL SYSTEMS FOR HOISTS AND THE LIKE

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CONTROL SYSTEMS FOR HOISTS AND THE LIKE

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This invention relates to control systems for hoists and the like employing direct current motors, and the invention relates more particularly to systems of the aforementioned type having a shunt circuit connected across the motor during certain operating conditions of the hoist.

Control systems for direct current hoist motors commonly include: Resistors which are connected, disconnected, and/or rearranged to limit the power delivered to the motor for operation of the hoist at various speeds; an electrically releasable hoist brake connected to be released by the current flowing through the motor, and means to interrupt the power connections to the motor and to reconnect the same for dynamic braking operation when the motor is operated beyond a predetermined hoisting limit.

A convenient method of obtaining low speed hoisting in such systems is to provide a shunt circuit around the motor in combination with a resistor in series with the motor to limit the voltage applied to the motor to a relatively low value. However, by including the shunt circuit in such control systems certain safety features provided by said hoist brake and said means are sacrificed. In certain prior hoist systems the loss of such safety features is tolerated; and in others elaborate and expensive circuits and devices such as additional trolley collector rails and resistors are added to the system to secure the advantages of such safety features.

Accordingly, a primary object of this invention is to provide improved control systems for hoists and the like including a motor shunt circuit.

Another object is to provide hoist control circuits of the character aforementioned incorporating means for maximum protection against abnormal and unsafe operation in the overhoisted condition with a minimum of equipment and at low cost.

A more specific object is to provide hoist control systems in which the advantages of the motor shunt circuit are realized without abnormal cycling operation of the hoist when overhoisted.

Various other objects and advantages of the invention will hereinafter appear.

One embodiment of the invention is shown in the accompanying drawing and will now be described, it being understood that certain modifications may be made therein without departing from the spirit of the invention or the scope of the appended claims.

In the drawing the numeral **10** designates the armature of a direct current hoist motor for driving a hoist drum to raise or lower a hook. Said motor has a series field winding **12** and is supplied with power from any suitable source, such as the direct current supply lines L1 and L2.

The motor is controlled by a multi-position, reversing type master switch **14** which has five hoisting and five lowering positions and an "off" position. The master switch **14** is shown schematically in the form of a control drum. Its contacts **16** through **24** are open in the

"off" position and remain open in other positions, except that the individual contacts are closed in those drum positions, in line horizontally with the respective contacts, which are designated X.

All of the contactors (the numeral **26** designates a relay having an operating winding **26a** and normally closed contacts **26b** and will hereinafter be more fully described) are energized through the master switch **14**, as follows: Coil **28a** of a main contactor **28** is energized in all hoisting and all lowering positions to close main contacts **28b**. Coil **30a** of the hoisting contactor **30** is energized in all hoisting positions to close hoisting contacts **30b** and hoisting interlock contacts **30c**. Coil **32a** of lowering contactor **32** is energized in all lowering positions to close lowering contacts **32b** and lowering interlock contacts **32c** and **32d**. Coil **34a** of the first accelerating contactor **34** is energized in hoisting positions **2**, **3**, **4** and **5** and in lowering positions **1**, **2**, **3** and **4**, provided that contacts **30c** or contacts **32d** are closed, to close the first accelerating contacts **34b**. Coil **36a** of the second accelerating contactor **36** is energized in hoisting positions **3**, **4** and **5** and in lowering positions **1**, **2** and **3**, provided that contacts **30c** or contacts **32d** are closed, to close the second accelerating contacts **36b**. Coil **38a** of the third accelerating contactor **38** is energized in hoisting positions **4** and **5** and in lowering positions **1** and **2**, provided that contacts **30c** or contacts **32d** are closed, to effect closure of third accelerating contacts **38b** and accelerating interlock contacts **38c**. Coil **40a** of dynamic braking contactor **40** is energized in all lowering positions and in hoisting positions **2**, **3**, **4** and **5** to open dynamic braking contacts **40b** and close dynamic braking interlock contacts **40c**. Coil **42a** of lowering accelerating contactor **42** is energized in lowering position **5**, provided that contacts **40c** are closed, to close lowering accelerating contacts **42b** and lowering accelerating interlock contacts **42c**. Coil **44a** of lowering contactor **44** is energized in all lowering positions, provided that contacts **32c** are closed, to close lowering contacts **44b**. Coil **46a** of armature accelerating contactor **46** is energized in lowering positions **1** and **5** and in hoisting position **5**, provided that contacts **38c** or contacts **42c** are closed, to close armature accelerating contacts **46b**. Normally open contacts **48a** and **48b** and normally closed contacts **48c** and **48d** comprise an overhoist limit switch which is responsive to operation of the hoist beyond a predetermined limit to reconnect series field winding **12** and armature **10** as hereinafter more fully described.

The system operates as follows: With master switch **14** set in the first hoisting position, the main contactor coil **28a** is energized through master switch contacts **24** and main contacts **28b** are closed. Also, hoisting contactor coil **30a** is energized to close hoisting contacts **30b** and interlock contacts **30c**. Current flow is permitted from line L1 through hoisting contacts **30b**, resistor **50**, operating winding **26a** of relay **26**, a collector trolley **52**, limit switch contacts **48d**, armature **10**, limit switch contacts **48c**, field winding **12**, the operating winding **54a** of an electrically released friction brake **54**, another collector trolley **56**, through accelerating resistors **58**, **60** and **62**, and through main contacts **28b** to line L2. The current flowing in brake winding **54a** effects release of the brake **54**, and the current flowing in operating winding **26a** causes contacts **26b** to open and prevent the dynamic braking contactor coil **40a** from being energized through contacts **24** of master switch **14**. Thus contacts **40b** remain closed to maintain a motor shunt circuit around armature **10** and field winding **12** through elements including a resistor **64**, contacts **40b** and collector trolley **66**. This shunt circuit diverts current around the motor, reducing the power delivered to the motor and providing low hoisting speed.

In hoist positions **2**, **3**, **4** and **5** dynamic braking con-

tactor coil 40a is energized through master switch contacts 19 to open contacts 40b and interrupt said shunt circuit, and to close contacts 40c. Line L1 is connected through contacts 30c of the hoisting contactor 30 to contacts 23, 22 and 21 of the master switch 14. Power is applied through these latter contacts to the coils of accelerating contactors 34, 36 and 38, respectively, in appropriate hoisting positions 2, 3, 4 and 5. When power is so applied, accelerating contacts 34b, 36b and 38b close to short-circuit accelerating resistors 62, 60 and 58, respectively, whereupon the motor is accelerated in the hoisting direction. Interlock contacts 38c are also closed. In hoisting position 5 accelerating contactor coil 46a is energized through master switch contacts 20 and interlock contacts 38c and close accelerating contacts 46b. When closed, contacts 46b short-circuit resistor 50 whereupon the motor is further accelerated in the hoisting direction.

With the master switch 14 set in lowering position 1, the main contactor coil 28a is energized through master switch contacts 24 to close main contacts 28b. The dynamic braking contactor coil 40a is energized through contacts 19 of master switch 14 to open dynamic braking contacts 40b and thereby open the motor shunt circuit which includes resistor 64, and to close interlock contacts 40c. Also, lowering contactor coil 32a is energized through master switch contacts 18 to close lowering contacts 32b and interlock contacts 32c and 32d. When closed, contacts 32c provide for energization of lowering contactor coil 44a through master switch contacts 18, to close lowering contacts 44b, and contacts 32d, when closed, connect master switch contacts 21, 22 and 23 to line L1.

Accelerating contactor coils 34a, 36a and 38a are energized through master switch contacts 23, 22 and 21, respectively, and their contacts short-circuit the accelerating resistors 62, 60 and 58, respectively. Interlock contacts 38c are also closed. Accelerating contactor coil 46a is energized through master switch contacts 20 and interlock contacts 38c, and its contacts 46b short-circuit accelerating resistor 50. Current is then permitted to flow from line L1 through contacts 44b, a resistor 68, a collector trolley 70, thence through a parallel circuit one branch of which consists of limit switch contacts 48c, field winding 12, brake winding 54a, collector trolley 56, contacts 38b, contacts 36b and contacts 34b, thence to main contacts 28b and line L2; and the other branch of which consists of armature 10, limit switch contacts 48d, collector trolley 52, operating winding 26a, contacts 46b, resistor 64 and lowering contacts 32b, thence to main contacts 28b and line L2. Thus in all lowering positions of the master switch 14, field winding 12 is connected in shunt with armature 10.

The circuit connections remain the same in all lowering positions except as hereinafter described. In lowering position 2 master switch contacts 20 are open so that accelerating contactor coil 46a is not energized and its contacts 46b do not short-circuit accelerating resistor 50. Thus resistor 50 acts to limit the current flowing through the motor armature.

In lowering position 3 the circuit connections are like those established in lowering position 2 except that master switch contacts 21 are open so that accelerating contactor coil 38a is de-energized thereby opening the short-circuit around accelerating resistor 58. In lowering position 4 the circuit connections are like those established in lowering position 3 except that master switch contacts 22 are open and accelerating contactor coil 36a is de-energized so that accelerating resistor 60 is not short-circuited by contacts 36b.

In lowering position 5 the circuit connections are like those established in lowering position 4 except that master switch contacts 23 are open and master switch contacts 17 and 20 are closed. Thus accelerating contactor coil 34a is de-energized to open the short-circuit around accelerating resistor 62, accelerating contactor coil 42a is energized through contactors 40c, and master switch contacts 17 to close interlock contacts 42c and short-circuit accelerating resistor 68, and accelerating contactor coil 46a is energized through contacts 42c and master switch contacts 20 to short-circuit accelerating resistor 50.

In the "off" position of the master switch all contactor coils are de-energized and a loop circuit including armature 10, limit switch contacts 48c, field winding 12, trolley collector 66, contacts 40b, resistor 64, resistor 50, operating winding 26a, collector trolley 52, and limit switch contacts 48d is established for dynamic braking of the motor when rotating in the lowering driection. Thus provision is made in the system for 5 lowering speeds, dynamic braking in the "off" position, and for 5 hoisting speeds.

If the motor is operated to raise the hoist hook (not shown) beyond a predetermined limit, limit switch 48 is actuated to open its contacts 48c and 48d and to close its contacts 48a and 48b. The power circuit to the motor and brake winding is thereby disconnected and the brake winding 54a is de-energized to brake the motor. Also, the field winding 12 is connected in reverse direction across armature 10 in a loop dynamic braking circuit including field winding 12, armature 10 and a dynamic braking resistor 72.

The operating winding 26a of relay 26 is connected, as shown, in series circuit with the armature between points X and Y. This circuit is termed the armature circuit because it is common to the hoisting armature circuit through the hoisting contacts 30b and to the lowering armature circuit through lowering contacts 32b, and does not include any portion of the motor shunt circuit. Normally closed contacts 26b are connected to bridge the connection between contacts 19 of master switch 14 and coil 40a of the dynamic braking contactor 40 with any point which has the same potential as line L1 when the master switch is in hoist position 1. The point to which such connection is made in the drawing, is in the connection between master switch contacts 24 and main contactor coil 28a. Several other points, for example, a point in the connection between master switch contacts 16 and the operating winding 30a of hoisting contactor 30, might have been selected.

The purpose of relay 26 is to effect energization of the dynamic braking contactor coil 40a in hoisting position 1, wherein master switch contacts 19 are open, but only if power is not being supplied to the motor from the source L1, L2. In other words, relay 26 signals the opening of the armature circuit by limit switch contacts 48d. It will be apparent that operating winding 26a may be connected as illustrated or may be connected in the armature circuit in parallel with a resistor. For example, it could be connected in parallel with resistor 50. During normal operation of the system in hoisting position 1, relay operating winding 26a is energized by current flowing in the armature circuit XY and relay contacts 26b are held open. Therefore, winding 36a is not energized so that contacts 40b are not opened and the motor shunt circuit is continuous. If, however, the overhoist limit switch 48 is actuated, contacts 48d will open to interrupt the armature circuit, operating winding 26a will be de-energized and contacts 26b will close. The coil 40a of dynamic braking contactor 40 will then be energized through master switch contacts 24 and relay contacts 26b to open contacts 40b and interrupt the motor shunt circuit. Thus the flow of current from line L1 through hoisting contacts 30b, resistor 64, contacts 40b, collector trolley 66, brake winding 54a, collector trolley 56, accelerating resistors 58, 60 and 62 and contacts 28b to line L2 (and which would prevent de-energization and application of brake 54) is interrupted. If the motor shunt circuit were not inter-

rupted when the motor was operated to raise the hoist hook above a safe limit, limit switch 48 would reconnect the motor for dynamic braking operation through dynamic braking resistor 72, but the series brake 54 would not be applied. The hoist hook and its load, if the load was heavy enough to overcome friction in the system, would be permitted to descend and reset the limit switch. The motor would then be reconnected for hoisting, and the cycle described would be continuously repeated until the master switch 14 was moved to the "off" or a lowering position.

I claim:

1. In a control system for hoists and the like, said system employing a direct current motor having an armature and a field winding and an electrically releasable brake operating winding connected in series circuit with said armature and said field winding for energization from a source of electrical power, said system having switch means responsive to operation of said motor beyond a predetermined limit to interrupt said series circuit and further having a motor shunt circuit connected in parallel with said armature and said field winding and said switch means, the improvement which comprises in combination, means responsive to said interruption of said series circuit to afford a signal, and means including contacts connected in said shunt circuit responsive to said signal to interrupt said shunt circuit.

2. In a control system for hoists and the like, in combination, a direct current motor having an armature and a field winding for energization from a source of electrical power, a first terminal of said armature being normally connected to a first terminal of said field winding, an electrically releasable hoist brake having an operating winding connected in series circuit with said field winding from a second terminal of the latter, the circuit of said armature including circuit means connected to a second terminal of said armature and having limit means therein to interrupt said armature circuit in response to operation of said motor beyond a predetermined limit, a motor shunt circuit comprising a resistor and being connected in shunt with said armature and said field winding, and electro-magnetic means comprising a winding connected in said circuit of said armature and contacts connected in series with said motor shunt circuit for interrupting said motor shunt circuit in response to interruption of said circuit of the armature by said first-mentioned means.

3. In a control system for hoists and the like, in combination, a direct current motor having an armature and a field winding for energization from a source of electrical power, a first terminal of said armature being normally connected to a first terminal of said field winding, an electrically releasable hoist brake having an operating winding connected in series circuit with said field winding from a second terminal of the latter, the circuit of said armature including circuit means connected to a second terminal of said armature and having limit means therein to interrupt said circuit of the armature in response to operation of said motor beyond a predetermined limit, contact means for connecting said circuit of the armature to one side of said power source, a motor shunt circuit comprising a resistor and being connected

in shunt with said armature and said field winding from a point intermediate said armature and said contact means to a point intermediate said field winding and said operating winding of said brake, and means comprising a winding connected in said circuit of the armature and contacts connected in series with said motor shunt circuit to interrupt said motor shunt circuit in response to interruption of said circuit of the armature by said limit means.

4. In a motor control system for hoists and the like, in combination, a motor having an armature and a field winding for energization from a source of electrical power, a main electrical switch, a limit switch responsive to operation of the hoist beyond a predetermined limit to open its contacts, an electrically releasable brake having an operating winding, a series circuit comprising in order said main switch and said limit switch and said armature and said field winding and said operating winding of said brake, a resistor and a contact of a contactor connected in series from a point in said series circuit intermediate said main switch and said limit switch to a point in said series circuit intermediate said field winding and said operating winding of said brake, said contactor further having an operating winding for energization from said source to actuate said contacts, a relay having a contact connected in series circuit with said operating winding of said contactor and having an operating winding connected in said series circuit at a point intermediate said main contactor and said armature and being responsive to interruption of said latter circuit to actuate said last-mentioned contact whereby said contactor is caused to open its contacts.

5. In a motor control system for hoists and the like, in combination, a hoist motor having an armature and a field winding, a series circuit comprising in order main hoisting contacts and a limit switch responsive to operation of said hoist beyond a predetermined limit to interrupt its contacts and said armature and said field winding and the operating winding of an electrically releasable hoist brake, a resistor and a normally closed contact of a contactor in series circuit from a point in said series circuit first mentioned between said main hoisting contacts and said limit switch to a point in said series circuit first mentioned between said field winding and said operating winding of said brake, said contactor further having an operating winding, a relay having a normally closed contact connected in series with said operating winding of said contactor and having an operating winding connected in said series circuit first mentioned and responsive to interruption of said series circuit first mentioned to close said last mentioned contact whereby said contactor is energized to open its contact.

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