Sept. 1, 1964 A. F. VOGT 3,147,418

PLURAL MOTOR HOIST WITH SATURABLE REACTOR CONTROL

Filed Jan. 29, 1962

Fig. 1

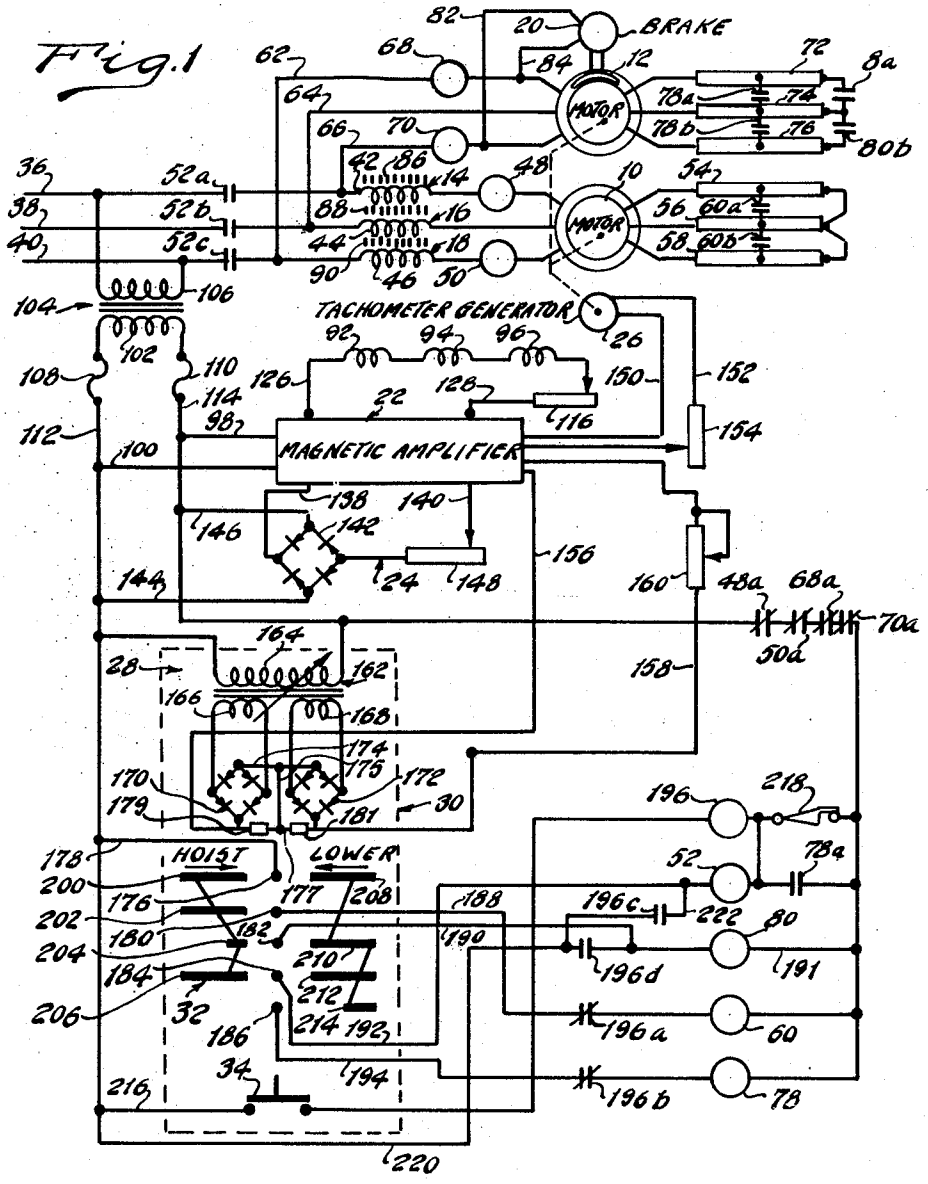
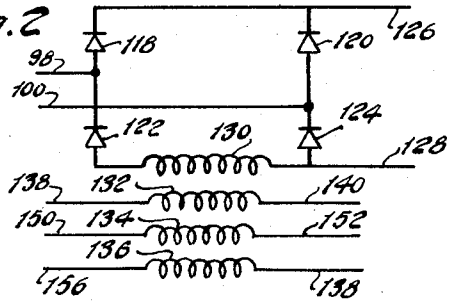


Fig. 2



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United States Patent Office 3,147,418 Patented Sept. 1, 1964

3,147,418

PLURAL MOTOR HOIST WITH SATURABLE REACTOR CONTROL

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Filed Jan. 29, 1962, Ser. No. 169,330
18 Claims. (Cl. 318—48)

The invention relates to electrical controls and refers more specifically to a control for a hoist or similar equipment operable to provide stepless operation of the equipment in opposite directions at a substantially uniform speed independent of load which control includes means for easing the equipment up or down or floating a load carried thereby.

In the past hoist controls have been deficient in that they have generally been incapable of providing stepless operation over wide ranges of speed. Such controls have further usually lacked the ability to maintain a substantially constant selected hoist speed in opposite directions under different load conditions. Further, wherein controls have been provided in the past capable of stepless operation in both directions at a predetermined constant speed, it has been difficult or impossible to ease the load on the hoist in opposite directions or float a load in a predetermined position. Also, wherein such operation has been attempted in the past, the controls have been particularly complicated and therefore difficult to manufacture, inefficient and unreliable in use.

It is therefore an object of the present invention to provide an improved stepless control for hoists or similar apparatus.

Another object is to provide a stepless hoist control for positively driving a hoist in opposite directions at a selected substantially constant speed without regard to load.

Another object is to provide a stepless hoist control including means for easing a load supported thereby up or down or floating the load in a predetermined position as desired.

Another object is to provide a stepless hoist control including a main motor for driving the hoist in an up direction and an auxiliary motor and brake for regulating the movement of the hoist in a down direction, and a saturable reactor for controlling the operation of the main motor controlled by a magnetic amplifier which is responsive to a plurality of bias voltages applied thereto.

Another object is to provide a stepless hoist control as set forth above including a tachometer operably associated with the hoist to produce a voltage the polarity and magnitude of which is representative of the speed and direction of rotation of the hoist which voltage is used as one of the plurality of biases to regulate the output voltage of the magnetic amplifier.

Another object is to provide a stepless hoist control as set forth above including a master switch and associated circuitry for providing a variable bias to the magnetic amplifier of a magnitude and polarity determined by the direction of movement of a main control member from a center position thereof for energizing the main motor in either direction of movement of the main control member, for providing increased torque for the main motor when the main control member is moved in the hoist direction and for energizing the auxiliary motor on moving of the master switch main control member in the lower direction.

Another object is to provide a stepless hoist control including a master switch as set forth above wherein means are also provided to energize the auxiliary motor for an initial portion of the movement of the master switch in a hoist direction.

Another object is to provide a stepless hoist control as

set forth above including means for increasing the torque of the auxiliary motor over the latter part of the movement of the master switch in a lower direction.

Another object is to provide a stepless hoist control as set forth above wherein the master switch includes means for continually energizing the main and auxiliary motors in all positions of the control member to permit easing of a load in a hoist or lower direction or floating of the load in any predetermined position without setting the brake.

Another object is to provide an electric control for a hoist or similar apparatus which is simple in construction, economical to manufacture and efficient in use.

Other objects and features of the invention will become apparent as the description proceeds, especially when taken in conjunction with the accompanying drawings, illustrating a preferred embodiment of the invention, wherein:

FIGURE 1 is a partly schematic and partly diagrammatic representation of a stepless control for a hoist or similar apparatus constructed in accordance with the invention.

FIGURE 2 is a schematic representation of a magnetic amplifier for use in the control illustrated in FIGURE 1.

With particular reference to the figures of the drawing one embodiment of the invention will now be disclosed.

As shown in FIGURE 1 the electric control of the invention is adapted to produce controlled movement of a hoist (not shown) which may be positively driven in hoist or lower directions by the main and auxiliary electric motors **10** and **12** respectively. The electric motors **10** and **12** are controlled in their operation by saturable reactors **14**, **16** and **18** and the shoe brake **20**.

In turn the saturable reactors are regulated to produce desired hoist movement by means of the magnetic amplifier **22** which is responsive to the bias voltage applied thereto by the fixed bias voltage apparatus **24** and the variable bias voltages from the tachometer generator **26** and the bias portion **28** of the master control switch **30**.

The master control switch **30** further operates to control the direction of operation of the main and auxiliary motors **10** and **12** and the output power thereof by means of the main switching portion **32** thereof. Easing of a load carried by a hoist controlled by the motors **10** and **12** in an up or down direction or floating of such load in any predetermined position is also accomplished by means of a grip switch **34** which is a part of the master control switch **30**.

In operation on movement of a main control member (not shown) of the master switch **30** a load supported by a hoist controlled by the hoist control may be raised or lowered at a substantially constant speed regardless of variations in the load. Further on operation of the grip switch **34** the main control member of the master switch **30** may be moved in opposite directions to ease the load on the hoist in a hoist or lower direction or to float a hoist load in a predetermined position without setting the brake **20**.

More specifically the main hoist motor **10** as shown is a three phase induction motor which receives energizing voltage over the three phase input conductors **36**, **38** and **40** through the primary windings **42**, **44** and **46** of the saturable reactors **14**, **16** and **18** and the over-load relays **48** and **50** in the conductors **36** and **40** on closing of the relay contacts **52***a*, **52***b* and **52***c*. The main hoist motor **10** further includes the external resistances **54**, **56**, and **58** a part of which may be shorted out by closing of the contactor contacts **60***a* and **60***b* to increase the available torque for a given electrical energization of the motor.

The auxiliary motor may be similar to the main hoist motor **10** and is energized through the three phase conductors **62**, **64** and **66** and the overload relays **68** and **70**

connected to the conductors 36, 38 and 40 when the contacts 52*a*, 52*b* and 52*c* are closed. The auxiliary motor 10 also includes the external resistances 72, 74 and 76 which permit more or less torque to be developed by the auxiliary motor 12 depending on whether the contacts 78*a* and 78*b* or 80*a* and 80*b* are closed.

The motors 10 and 12 are adapted to be connected in driving relation to a hoist (not shown) so that the main hoist motor 10 always tends to drive the hoist in an up direction and the auxiliary motor 12 when connected tends to drive the hoist in a down direction. The direction of movement of the hoist when both of the motors are energized will therefore depend on which of the motors exerts the greatest torque on the hoist. The main hoist motor 10 is connected to exert a much greater torque on the hoist than the auxiliary motor in most phases of operation. The auxiliary motor in fact has very little effect on the hoist operation when a relatively heavy load is placed on the hoist.

The brake 20 is a friction shoe brake. Brake 20 is connected to be disengaged from the auxiliary motor 12 at any time the contacts 52*a* and 52*c* are closed since the brake 20 is energized through conductors 82 and 84 which are connected to the conductors 62 and 66 respectively.

The saturable reactors 14, 16 and 18 further include the cores 86, 88 and 90 and the secondary or control winding 92, 94 and 96 which control windings are operable on a direct current passing therethrough to saturate the cores 86, 88 and 90 respectively to substantially reduce the reactance of the alternating current primary windings 42, 44 and 46 of the saturable reactors and permit more electrical energy to be applied to the main hoist motor 10 in accordance with the usual operation of saturable reactors.

The saturable reactor control windings 92, 94 and 96 are energized from magnetic amplifier 22 which is in turn energized over conductors 98 and 100 from the secondary winding 102 of transformer 104, the primary winding 106 of which is connected across the conductors 36 and 40. Protective fuses 108 and 110 for the electric control of the invention are provided in the conductors 112 and 114 from the secondary winding 102 of the transformer 104 as shown. The electrical signal in the saturable reactor control windings 92, 94 and 96 for any given bias applied to the magnetic amplifier may be regulated by means of the rheostat 116.

The magnetic amplifier 22 which is well known in the electrical arts includes the rectifiers 118, 120, 122 and 124 connected between the input conductors 98 and 100 and the output conductors 126 and 128 to the saturable reactor control windings as best shown in FIGURE 2. A plurality of bias signals are applied to the magnetic amplifier 22 through the coil 130 from coils 132, 134 and 136 to control the output signal of the magnetic amplifier.

The bias coil 132 is connected across the conductors 138 and 140 which as shown in FIGURE 1 are connected across the output terminals of a full wave rectifier 142. Rectifier 142 is energized over conductors 144 and 146 connected to the conductors 112 and 114 respectively. The rheostat 148 is provided in conductor 140 to vary the fixed bias applied to the magnetic amplifier through the coil 132 so that with no other bias signals applied to the magnetic amplifier no output signal will be provided across the conductors 126 and 128, the cores of the saturable reactors 14, 16 and 18 will be unsaturated and the energy applied to the main hoist motor 10 when the contacts 52*a*, 52*b* and 52*c* are closed will be limited.

A variable bias is provided in the magnetic amplifier through coil 134 which is connected to the tachometer generator 26 through conductors 150 and 152. The rheostat 154 is provided in the conductor 152 to initially set the amount of feed back provided the magnetic amplifier for a given speed of rotation of the hoist with which the tachometer generator is associated. The tachometer

generator is operable to provide a biasing signal for the magnetic amplifier 22 the magnitude and polarity of which is representative of the rotational speed and direction of rotation of the hoist under control of the electric control of the invention.

A further bias signal is provided the magnetic amplifier 22 through the coil 136 over conductors 156 and 158 from the bias portion 28 of the master switch 30. The bias applied to the magnetic amplifier over conductors 156 and 158 is adjusted in accordance with the initial setting of the rheostat 160.

The bias portion 28 of the master switch 30 comprises a transformer 162 having a single primary coil 164 and two secondary windings 166 and 168. The transformer 162 includes means for varying the coupling of the secondary windings 166 and 168 to the primary winding 164 in opposite directions. Separate full wave rectifiers 170 and 172 are connected across the transformer secondary windings 166 and 168 respectively. In addition the full wave rectifiers 170 and 172 are connected by conductors 174, 175 and 177, load resistors 179 and 181 are provided in series in conductor 177 on opposite sides of conductor 175 and conductor 177 is connected at opposite ends to the conductors 156 and 158 respectively as shown in FIGURE 1 to produce bucking electric signals from the transformer secondary windings 166 and 168.

Thus when the main control member (not shown) of the master switch 30 is in a central position the coupling of the secondary windings 166 and 168 of transformer 162 to the primary winding 164 thereof is equal so that no electrical signal is provided on the conductors 156 and 158. Further on movement of the main control member of the master switch 30 in opposite directions the coupling of the transformer secondary windings 166 and 168 will be varied to produce an electrical signal in conductors 156 and 158 the magnitude of which will be proportioned to the movement of the main control member from a neutral position thereof and the polarity of which will indicate the direction of movement of the main control member from the neutral position.

The main switching portion 32 of the master switch 30 includes the contact member 176 connected by conductor 178 to the conductor 112 and the contact members 180, 182, 184 and 186 connected through conductors 188, 190 and 191, 192 and 194, respectively, to the conductor 114. The normally closed relay contacts 196*a* and the contactor 60 are provided in the conductor 188, the contactor 80 is provided in the conductor 191 while the contactor 52 and the contactor contacts 78*a* are provided in the conductor 192 and the normally closed relay contacts 196*b* and relay 78 are provided in conductor 194.

In operation of the main control member of the master switch 30, which for the purpose of explanation may be considered to be of the pivotally supported arcuately moving type having arcuate contact elements, the contact elements 200, 202, 204 and 206 are placed in electrical engagement with the contacts 176, 180, 182 and 184 on initial movement of the main control member in an up or hoist direction after approximately five degrees of movement thereof from a neutral position. The contacts 200, 202 and 206 remain in engagement with the contacts 176, 180 and 184 for approximately forty-five degrees of movement of the main control member while the contact 204 remains in engagement with the contact 182 only during the movement of the main control member between five and fifteen degrees thereof.

Similarly the contact elements 208, 210 and 212 of the main switching portion 32 of the master switch 30 engage the contacts 176, 182 and 184 after an initial five degrees of movement of the main control member of the master switch 30 in an opposite or lower direction from the neutral position thereof. The contact elements 208, 210 and 212 remain in engagement with the contacts 176, 182 and 180 for approximately forty-five degrees of move-

ment of the main control member in the lower direction. In addition the contact element **214** engages the contact **186** after the initial thirty degrees of rotation of the main control member in the lower direction.

The master switch **30** is completed by the grip switch **34** positioned in series in conductor **216** with the relay **196** and the upper limit switch **218**. The relay **196** serves to close the normally open relay contacts **196***c* and **196***d* and to open the relay contacts **196***a* and **196***b* in conductors **220** and **222** on closing of the grip switch **34** with the hoist in other than an upper limiting position and with the over-load relay contacts **48***a*, **50***a*, **68***a*, and **70***a* closed.

Thus it will be understood that the master switch **30** while diagrammatically illustrated is comprised of a single main control member which is movable in a hoist direction from a neutral position to move the contact elements **200, 202, 204,** and **206** into engagement with the contacts **176, 180, 182** and **184** and at the same time to vary the coupling between the transformer primary coil **164** and the secondary coils **166** and **168** thereof in one direction and which is similarly movable in an opposite direction from the neutral position to engage the contact members **208, 210, 212** and **214** with the contacts **176, 182, 184** and **186** and to vary the coupling of the secondary coils **166** and **168** of the transformer **162** with respect to the primary coil **164** thereof in the opposite direction. In addition the master switch **30** includes the grip switch **34** operable separately from the main control member to permit easing of a load supported by a hoist controlled by the control of the invention in either an up or down direction or to permit floating of the load in any position as will be considered more fully in the total operation of the control of the invention.

In over-all operation of the stepless hoist control illustrated in FIGURE 1 it will be assumed that the conductors **36, 38** and **40** are connected to a source of three-phase electrical energy and that a hoist connected to the main hoist motor **10** and auxiliary motor **12** is in an intermediate stationary position with a load supported thereby. It will further be assumed that the rheostat **148** is set to provide a fixed bias for the magnetic amplifier **22** so that with the main control member of the master switch **30** in a neutral position no signal is provided in the saturable reactor control windings **92, 94** and **96**. Additionally it will be assumed that the grip switch **34** which may be a spring loaded push button switch is in an open position and that all of the relays and contactors are initially in the condition illustrated in FIGURE 1.

With the control of the invention in the condition assumed when it is desired to move the load on the hoist in an up direction the main control member of the master switch **30** is moved in the hoist direction which is to the right as shown in FIGURE 1. Movement of the main control member to the right will vary the coupling between the transformer secondary coils **166** and **168** and the primary winding **164** to provide an electrical signal through the bias winding **136** of magnetic amplifier **22** of a polarity to cause a signal to flow through the saturable control windings **92, 94** and **96** to saturate the cores **86, 88** and **90** thereof whereby the impedance of the coils **42, 44** and **46** is reduced and the electrical signal fed to the main hoist motor **10** on closing of the contacts **52***a*, **52***b* and **52***c* is increased in accordance with the magnitude of movement of the main control member in a rightward direction.

At the same time and with the same movement of the main control member of the master switch **30** the contact member **200** is caused to engage the contact **176** after initial movement of the control member of approximately five degrees at the same time the contact members **202, 204** and **206** are caused to engage the contacts **180, 182** and **184.**

Thus the contactor **60** is energized to close the contacts **60***a* and **60***b* in the secondary circuit of the motor **10** to provide maximum torque output for a given electrical signal input thereto. Also the motor contactor **52** is energized through the upper limit switch **218** to close the motor contacts **52***a*, **52***b* and **52***c*

The closing of contacts **52***a*, **52***b*, and **52***c* releases the brake **20** which acts in connection with the auxiliary motor **12** and permits energization of the main hoist motor **10** as previously indicated. Since the main hoist motor **10** is connected to always move the hoist associated with the motors **10** and **12** in an up direction the hoist is thus moved up. Further, the hoist is moved in an up direction at a speed proportional to the position of the main control member in a hoist direction from a neutral position since the bias applied to the magnetic amplifier is proportional to such displacement.

The speed at which the motor **10** will raise the load is maintained substantially constant regardless of the load due to the provision of the tachometer generator **26** which provides a bias through the coil **134** of the magnetic amplifier of a polarity to counteract the bias in the coil **136** thereof due to movement of the main control member. Thus if the speed of the motor **10** increases due to a lighter load the bias applied to the magnetic amplifier through the tachometer generator which tends to decrease the speed of the motor through control of the current passing through the saturable reactor control windings will be increased and the speed of the motor reduced. Similarly if the motor tends to slow down due to a larger load on the hoist associated therewith the bias applied to the magnetic amplifier **22** from the tachometer generator is reduced whereby the motor speed will be increased.

The contact member **204** which is engaged with the contact **182** on movement of the main control member of the master switch **30** in a rightward direction as shown in FIGURE 1 energizes the auxiliary motor **12** in a low torque condition due to closing of the contacts **80***a* and **80***b* on energization of the contactor coil **80** in opposition to the main hoist motor **10.** The operation of the auxiliary motor **12** over the first ten degrees of operation of the main hoist motor increases the response of the hoist with a light load or no load thereon when slowing down. When it is desired to run the main motor at higher speeds the auxiliary motor is not in operation due to the contacts **80***a* and **80***b* being open.

When it is desired to lower the hoist the main control member of the master switch **30** is moved in a lower or leftward direction as shown in FIGURE 1. Such action will cause the contacts **80***a* and **80***b* to be closed due to energization of the relay coil **80.** Further the motor relay **52** will also be energized at this time to close the motor contacts **52***a*, **52***b* and **52***c*.

At the same time and with the same movement of the main control member the coupling between the primary and secondary coils of the transformer **162** will be varied so that the bias signal provided the magnetic amplifier **22** will be of the opposite polarity from that provided when the main control member was moved to the right in FIGURE 1.

In this condition the torque of the auxiliary motor **12** will cause the hoist to be driven in a downward direction. The speed of lowering of the hoist is regulated by the bias voltage fed back to the magnetic amplifier **22** by the tachometer generator **26** associated with the hoist which bias voltage is now of a polarity to tend to increase the speed at which the hoist is lowered while the bias voltage provided through bias coil **136** tends to decrease the speed of lowering of the hoist.

Also in the lower operation it will be noted that at about thirty degrees of angular movement of the main control member the contact member **214** engages the contact **186** to energize the contactor coil **78** and thus increase the torque capabilities of the auxiliary motor due to closing of the contacts **78***a* and **78***b*.

At any time during the operation of the stepless hoist control illustrated in FIGURE 1 the grip switch **34** may

be closed so that the relay coil 196 is energized to open contacts 196*a* and 196*b* and close the contacts 196*c* and 196*d*. Thus as long as the grip switch 34 is depressed the motor contacts 52*a*, 52*b* and 52*c* will be held closed and the auxiliary motor 12 will be energized due to closing of the contacts 80*a* and 80*b*. With such connections the load on the hoist may be eased up or down merely by moving the main control member of the master switch 30 in opposite directions through the neutral position. Alternatively the load may be floated in any given position by maintaining a proper setting of the main control member.

Therefore sensitive stepless control of the hoist is provided in opposite directions with the present control without the necessity of setting and unsetting the brake 20. On release of the grip switch 34 the normal up or down operation of the hoist may be accomplished by actuation of the main control member as described above.

Thus in accordance with the invention there is provided an electric control for a hoist or similar apparatus which is simple in construction, economical to manufacture and efficient in use. Further, the hoist control disclosed provides stepless control at a substantially constant speed in operation of the hoist in either direction and provides for easing a hoist load up or down or floating the load in a predetermined position. In addition, while one modification of the invention has been disclosed in detail it will be understood that other modifications are contemplated by the inventor and that all modifications of the invention which come within the scope of the appended claims are intended to be encompassed by the invention.

What I claim as my invention is:

1. A hoist control comprising a main motor directly connected to the hoist for driving the hoist in a hoisting direction, an auxiliary motor directly connected to the hoist and the main motor tending to always drive the hoist in a lowering direction on being energized and an electric circuit connected to the motors for controlling the energization of the main and auxiliary motors to determine the direction and speed of driving of the hoist, including a saturable reactor in circuit with the main motor having a control winding, a magnetic amplifier operably associated with the saturable reactor for regulating the saturable reactor and thereby controlling the electrical energy received by the main motor, said magnetic amplifier having an output circuit including the control winding of the saturable reactor and a plurality of means in the electric circuit for biasing the magnetic amplifier to control the output thereof applied to the control winding of the saturable reactor.

2. Structure as claimed in claim 1 wherein one of the means for biasing the magnetic amplifier comprises a variable fixed bias for controling the magnetic amplifier so that with no other bias applied to the magnetic amplifier no signal will be provided to the control winding of the saturable reactor.

3. Structure as claimed in claim 1 wherein one of the means for biasing the magnetic amplifier comprises means operably associated with the hoist for producing a biasing signal the magnitude and polarity of which is proportional to the speed and direction of hoist drive whereby substantially constant hoist speed is maintained independent of hoist load.

4. Structure as set forth in claim 3 wherein the means for producing a biasing signal comprises a tachometer generator.

5. Structure as set forth in claim 1 wherein one of the means for biasing the magnetic amplifier comprises a main control member and means for producing a bias signal the magnitude and polarity of which is proportional to the direction and magnitude of movement of the main control member from a neutral position thereof.

6. Structure as set forth in claim 5 wherein the means for producing a bias signal comprises a transformer having a single primary winding and a pair of secondary windings connected in a bucking circuit and means for changing the coupling between the primary and secondary windings in accordance with the direction and magnitude of movement of the main control member.

7. A hoist control comprising a main motor directly connected to the hoist for driving the hoist in a hoisting direction, an auxiliary motor directly connected to the hoist and the main motor tending to always drive the hoist in a lowering direction on being energized and an electric circuit connected to the motors for controlling the energization of the main and auxiliary motors to determine the direction and speed of driving of the hoist, including a saturable reactor in circuit with the main motor, a magnetic amplifier operably associated with the saturable reactor for regulating the saturable reactor and thereby controlling the electrical energy received by the main motor and a master switch connected in said electric circuit for determining the direction and speed of driving of the hoist.

8. Structure as claimed in claim 7 wherein the electric circuit further includes means for providing additional main motor torque in response to closing of the master switch in a hoist direction only.

9. Structure as claimed in claim 7 wherein the electric circuit further includes means for energizing the main motor on closing of the master switch in a hoist direction and for energizing the auxiliary motor during low speed operation of the main motor.

10. A hoist control comprising a main motor directly connected to the hoist for driving the hoist in a hoisting direction, an auxiliary motor directly connected to the hoist and the main motor tending to always drive the hoist in a lowering direction on being energized and an electric circuit connected to the motors for controlling the energization of the main and auxiliary motors to determine the direction and speed of driving of the hoist, including a saturable reactor in circuit with the main motor, a magnetic amplifier operably associated with the saturable reactor for regulating the saturable reactor and thereby controlling the electrical energy received by the main motor and means connected in the electric circuit for increasing the torque of the auxiliary motor when high speed driving of the hoist in a lowering direction is desired.

11. A hoist control comprising a main motor directly connected to the hoist for driving the hoist in a hoisting direction, an auxiliary motor directly connected to the hoist and the main motor tending to always drive the hoist in a lowering direction on being energized and an electric circuit connected to the motors for controlling the energization of the main and auxiliary motors to determine the direction and speed of driving of the hoist, including a saturable reactor in circuit with the main motor, a magnetic amplifier operably associated with the saturable reactor for regulating the saturable reactor and thereby controlling the electrical energy received by the main motor and means connected in the electric circuit for easing a load carried by the hoist in hoisting and lowering directions and for floating the load in any selected position thereof.

12. A hoist control for driving a hoist in opposite directions comprising a main motor for driving the hoist in a hoisting direction on being energized connected to a polyphase source of alternating electrical energy, saturable reactors connected between the main motor and the source of electrical energy for controlling the electrical energy fed to the main motor, an auxiliary motor connected to the source of electrical energy before the saturable reactors for driving the hoist in a lowering direction on being energized, a magnetic amplifier connected to the source of electrical energy for regulating the saturable reactors in accordance with the output signal thereof as regulated by the bias applied to the magnetic amplifier, means providing a permanent bias on said magnetic amplifier operable to prevent output therefrom when no other bias is

present thereat, means responsive to rotation of the motors for biasing the magnetic amplifier in a direction to maintain a substantially constant motor speed, a master switch including a variable transformer for supplying a bias voltage to said magnetic amplifier of selected polarity and varying magnitude, and an electrical control circuit operably associated with said master switch for selectively energizing said main and auxiliary motors in conjunction with the master switch including means for energizing said auxiliary motor during low speed energizing of the main motor, means for providing additional main motor torque in response to closing of the master switch in a hoist direction only and means for increasing the torque of the auxiliary motor when high speed driving of the hoist in a lowering direction is desired and means operably associated with said master switch and control circuit for easing a load carried by the hoist in hoisting and lowering directions and for floating the load in any selected position thereof.

13. Structure as set forth in claim 12 wherein the means responsive to the rotation of the motors for varying the bias of the magnetic amplifier to provide substantially constant motor speed comprises a tachometer generator connected to the motors for actuation in accordance with the speed thereof and a variable resistor in series with the output of the tachometer generator.

14. Structure as set forth in claim 12 wherein the means for easing the load in hoisting and lowering directions and for floating the load in a predetermined position comprises a push-button actuated switch in said master switch and circuitry responsive to actuation of said push-button switch for energizing both the main and auxiliary motors in a low torque condition simultaneously.

15. Structure as set forth in claim 12 and further including a brake in conjunction with said auxiliary motor and means connecting the brake to a source of electrical energy at any time the auxiliary motor is energized.

16. Structure as set forth in claim 12 wherein the means for providing the magnetic amplifier with a bias selectively variable in polarity and magnitude comprises a transformer having a single primary winding and a pair of oppositely wound secondary windings positioned in variable relation with respect to said primary winding for movement relative to said primary winding in accordance with the position of said master switch.

17. Structure as set forth in claim 12 and further including loading resistors in the circuit of the primary motor and wherein the means for providing additional main motor torque includes contactors for shorting out a portion of the resistance.

18. Structure as set forth in claim 12 and further including loading resistors in the circuit of the auxiliary motor and wherein the means for increasing the torque of the auxiliary motor on high speed driving of the hoist in a lowering direction comprises means for shorting out a portion of the resistors.

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