July 22, 1941. W. SCHAELCHLIN 2,249,857

CONTROL SYSTEM

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Fig. 1.

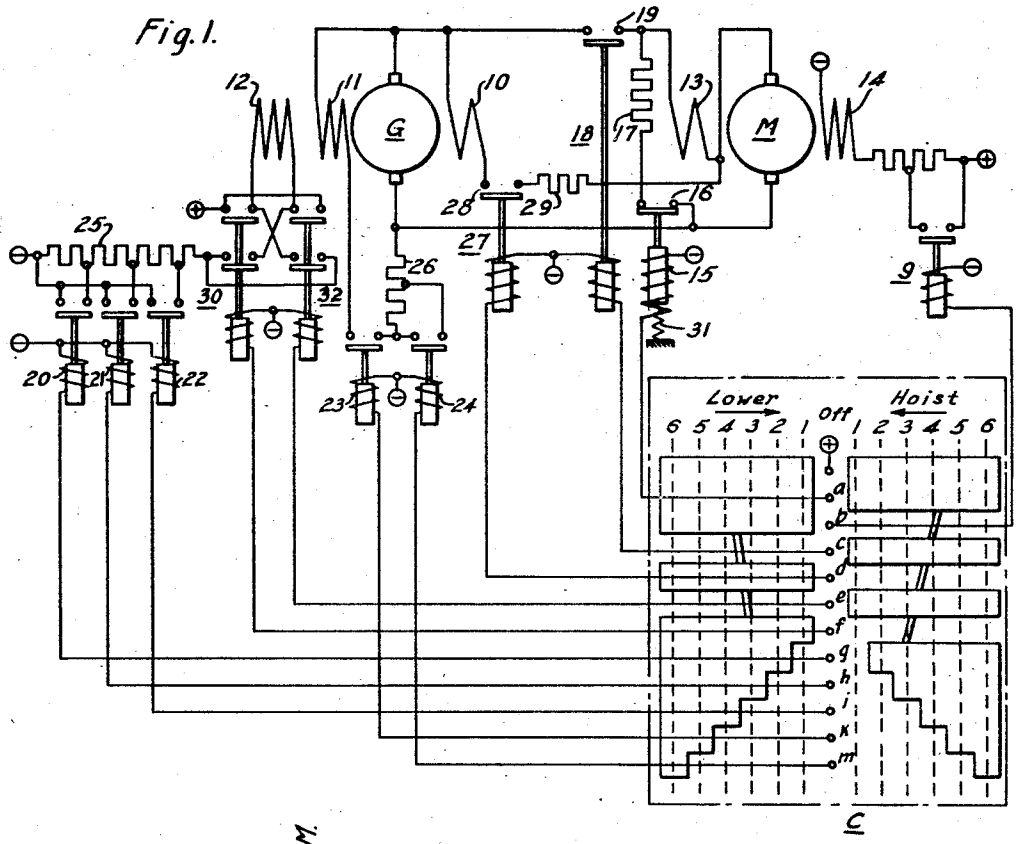


Fig. 2.

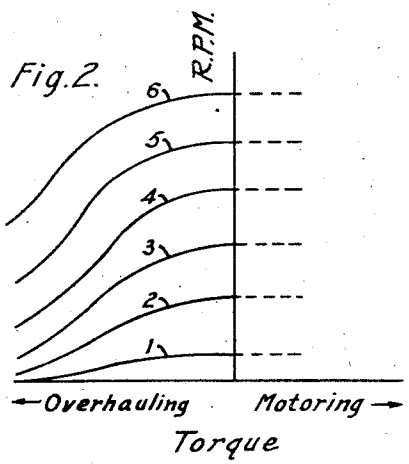
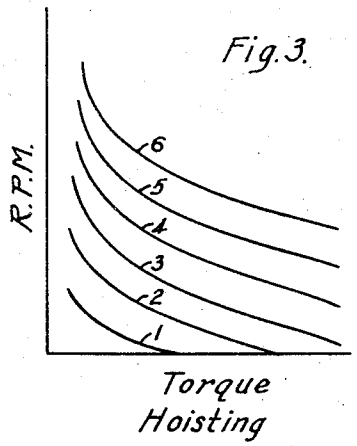


Fig. 3.



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CONTROL SYSTEM

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9 Claims. (Cl. 172—179)

My invention relates to a control system for driving an electric motor in either of two directions, and is more specifically directed to a variable voltage control system for driving a hoist motor, which system will afford highly desirable operating characteristics during hoisting, and more particularly, during overhauling of the motor in the lowering operation.

An object of my invention is to provide a variable voltage control system for a hoist motor which will afford a drooping speed-torque characteristic for not only the hoisting operation, but more particularly, for overhauling operation in the lowering direction, so that for any controller setting, an increase in load will cause a drooping speed-torque characteristic when the motor overhauls in the lowering direction.

Another object of my invention is to provide a simple and inexpensive but highly reliable control system for a hoist motor.

Still another object of my invention is to provide means for maintaining the hoist motor under positive and safe control at all times.

Other objects and advantages will become more apparent from a study of the following specification when considered in conjunction with the accompanying drawing, in which:

Figure 1 is a schematic showing of a control system embodying the principles of my invention; and

Figs. 2 and 3 are speed-torque characteristics for lowering and hoisting, respectively, of the hoist motor.

Referring more particularly to Fig. 1, a variable voltage control system including a generator G and a motor M energized thereby, is provided (the prime mover for the generator not being shown). The generator has a series field 10, a self-excited field winding 11 and a separately excited field 12, whereas the motor has a series field winding 13 and a saparately excited field winding 14. The respective separate field windings are excited by a direct-current source of potential indicated by + and —.

My invention may best be described by referring to the detailed operation of the circuit shown in Fig. 1. When the controller C is moved to the No. 1 hoist position, a circuit is completed through controller contact member *a* by virtue of the movement of the adjacent controller segment which will complete an energizing circuit through the coil of relay 15, thereby causing opening of contact members 16 and interruption of the normal shunt circuit through the dynamic braking resistor 17. It will be noted that this circuit is completed throughout not only the hoisting operation, but also the lowering operation.

Another energizing circuit will be completed through the controller contact member *c*, which will effect actuation of relay 18 and closing of contact member 19. This will effect completion of a circuit through the motor series field winding 13, which results in the inclusion of the motor series field winding in the main series circuit including the motor and generator armatures. Another energizing circuit is completed through controller contact member *e*, which will effect energization of the hoisting relay 32, which is so called because it completes an energizing circuit which effects current flow through the generator separate field winding 12 in such direction as to effect hoisting operation of the motor.

As the controller C is moved to the second, third, fourth, fifth and sixth hoist positions, successive energizing circuits will be completed through controller contact members *g*, *h*, *i*, *k* and *m*, which will effect successive operation of relays 20, 21, 22, 23 and 24. Successive operation of relays 20, 21 and 22 will effect progressive shunting of larger and larger portions of resistor 25 in series with the generator shunt field winding 12, which will effect gradual strengthening of the generator field winding 12. Followed by this, the operation of relay 23 will effect insertion of the self-excited generator field winding 11 in shunt circuit with the generator armature which is followed by the operation of relay 24, which effects shunting of the lower portion of resistor 26 having the effect of strengthening the generator self excited field winding 11. It will be noted that relay 27 remains deenergized during the hoisting operation; therefore, the generator series field winding 10 remains interrupted and is excluded from the circuit.

In other words, during the hoisting operation, the main circuit includes the generator and motor armatures and the motor series field winding 13. This results in operation of motor M as a compound motor during the hoisting operation, which motor is, of course, receiving power from the generator. The motor will have speed-torque characteristics during the hoisting operation as shown in Fig. 3; namely, for each of the 6 positions of the controller during hoisting operation there is a separate drooping speed-torque curve which indicates that with increasing load or torque the speed of the motor will decrease, which is highly satisfactory during hoisting.

If the controller were suddenly reversed and thrown into the first lowering position, there would be an energizing circuit completed through the controller contact member *b*, effecting energization of relay 9, which effects strengthening of the motor field winding 14. Another energizing circuit would be completed through controller contact member *d* which will effect energization of relay 27 and closing of contact members 28, which effects insertion of the generator series field winding 10, together with a stabilizing resistor 29 in the main series circuit including the motor and generator armatures.

Another energizing circuit will be completed through controller contact member *f* which will effect energization of the lowering relay 30, which will reverse the direction of energizing current flow through the separate field winding 12 (hoisting relay 32 now being deenergized), thereby effecting reversal of rotation of motor M. As the controller C is moved to the 2nd, 3rd, 4th, 5th and 6th lowering positions, it will effect the same successive operation of relays 20, 21, 22 and 23 as in the case of the hoisting operation so as to at first effect strengthening of the generator field winding 12, followed by the insertion of the self-excited field 11 and a strengthening thereof by the shunting of the lower portion of resistor 26.

For these successive lowering positions of the controller, speed-torque characteristics will be obtained such as shown in Fig. 2, which partially shows the motoring characteristic during lowering (in dotted lines), and which shows the overhauling characteristic (in full lines) during lowering. Of outstanding significance is the fact that for overhauling operation in the lowering direction, each of the speed-torque curves for the various controller positions 1 to 6 inclusive, has a drooping characteristic. In other words, in going from no-load to an increasingly heavier load, the speed will gradually decrease instead of increase as is usually the case in conventional hoist operation. This decrease in speed with increase in load is highly advantageous since it provides more positive control for heavy loads, which is very desirable in hoist operation.

It will be noted that during the lowering operation, the motor series field winding 13 is cut out of the circuit because relay 15 remains deenergized and contact member 15 is held closed by spring 31. When the motor is lowering an empty hook, the generator series field is additive, thereby insuring good acceleration of the separately excited hoist motor. When the motor is lowering also the generator series field during the motor operation is cumulative, but when the motor begins to overhaul, the generator series field becomes differential and thereby reduces the generator voltage as the load increases. The action of the self-excited fields tends to emphasize this feature. I have thus succeeded in providing a very simple control system which will give a drooping speed-torque curve for an overhauling lowering load which is ideal in the operation of a hoist, and which is very difficult to secure with the other types of hoist control.

When controller C is moved to the "off" position, all of the field windings are deenergized. At the same time, the spring closed contact member 16 will cause dynamic braking by connecting the motor armature and motor series field 13 across the dynamic braking resistor 17. It will be noted that in the event of power failure, dynamic braking is also insured during overhauling operation since the polarity of the residual magnetism is always in the right direction.

I am, of course, aware that others, particularly after having had the benefit of the teachings of my invention, may devise other systems of control embodying my invention, and I, therefore, do not wish to be limited to the specific showings made in the drawing and the descriptive disclosure hereinbefore made, but wish to be limited only by the scope of the appended claims and such prior art that may be pertinent.

I claim as my invention:

1. A hoist motor control system comprising, in combination, a variable voltage system including a generator and a motor energized thereby, said generator and motor each having shunt and series field windings, a source of energizing potential, circuit means including a reversing controller between said source and one of said field windings for effecting reversal of said motor and switching means for including the motor series field winding in the main motor circuit during hoisting and for excluding said motor series field winding during lowering operation thereby obtaining a drooping speed-torque characteristic for said motor during overhauling in the lowering direction.

2. A hoist motor control system comprising, in combination, a variable voltage system including a generator and a motor energized thereby, said generator and motor each having shunt and series field windings, a source of energizing potential, circuit means including a reversing controller between said source and one of said field windings for effecting reversal of said motor and switching means for including the motor series field winding and excluding the generator series field winding in the main motor circuit during hoisting and for including the generator series field winding and excluding said motor series field winding during lowering operation thereby obtaining a drooping speed-torque characteristic for said motor during overhauling in the lowering direction.

3. A hoist motor control system comprising, in combination, a variable voltage system including a generator and a motor energized thereby, said generator and motor each having shunt and series field windings, said generator also having a self excited field winding, a source of energizing potential, circuit means including a reversing controller between said source and the generator shunt field and separately excited field windings for effecting reversal of said motor and switching means for including the motor series field winding and excluding the generator series field winding in the main motor circuit during hoisting and for including the generator series field winding and excluding said motor series field winding during lowering operation thereby obtaining a drooping speed-torque characteristic for said motor during overhauling in the lowering direction.

4. A hoist motor control system comprising, in combination, a variable voltage system including a generator and a motor energized thereby, said generator and motor each having shunt and series field windings, a source of energizing potential, circuit means including a reversing controller between said source and one of said field windings for effecting reversal of said motor and

switching means for including successive steps of resistance in circuit relationship with said last mentioned field winding in either the hoisting or lowering operation and for including the motor series field winding in the main motor circuit during hoisting and for excluding said motor series field winding during lowering operation thereby obtaining a drooping speed-torque characteristic for said motor during overhauling in the lower direction for any given setting of said controller.

5. A variable voltage control system for a hoist motor comprising, in combination, a generator and motor each having a series field winding, an external source of energization for said generator, reversing switch means for reversing the direction of said energization and including contact members for selectively connecting the motor and generator armatures in series with the motor series field winding or the generator series field winding depending on whether said reversing switch means is thrown in the hoisting or lowering direction, respectively.

6. A variable voltage control system for a hoist motor comprising, in combination, a generator and motor each having a series field winding and a separately excited shunt field winding, said generator also having a self-excited shunt field winding, an external source of energization for said separately excited windings, reversing switch means for reversing the direction of said energization and including contact members for selectively connecting the motor and generator armatures in series with the motor series field winding or the generator series field winding depending on whether said reversing switch means is thrown in the hoisting or lowering direction, respectively, thereby obtaining a drooping "speed-torque" characteristic for said motor while overhauling in the lowering direction for increasing torque loads.

7. A variable voltage control system for a hoist motor comprising, in combination, a generator and motor each having a series field winding and a separately excited shunt field winding, said generator also having a self excited shunt field winding, an external source of energization for said separately excited windings, reversing switch means for including successive steps of resistance in circuit relationship with said last mentioned field winding in either the hoisting or lowering operation and for reversing the direction of said energization and including contact members for selectively connecting the motor and generator armatures in series with the motor series field winding or the generator series field winding depending on whether said reversing switch means is thrown in the hoisting or lowering direction, respectively, thereby obtaining a drooping "speed-torque" characteristic for said motor while overhauling in the lowering direction for increasing torque loads for any given setting of said controller.

8. A variable voltage control system for a hoist motor comprising, in combination, a generator and motor each having a series field winding, an external source of energization for said generator, reversing switch means for reversing the direction of said energization and including contact members for selectively connecting or disconnecting said generator series field winding from series circuit relationship with the motor and generator armatures depending upon whether said reversing switch means is thrown in the lowering or hoisting direction, respectively, so as to impart a drooping speed-torque characteristic to said motor while overhauling in the lowering direction.

9. A variable voltage control system for a hoist motor comprising, in combination, a generator and motor each having a series field winding and a separately excited shunt field winding, said generator also having a self excited shunt field winding, an external source of energization for said separately excited windings, reversing switch means for operating said motor as an ordinary compound motor in the hoisting direction and as a cumulative or differential compound motor in the lowering direction depending upon whether said motor is motoring or overhauling, respectively, so as to obtain a drooping "speed-torque" characteristic for the lowering, overhauling operation.

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