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HOIST APPARATUS INCLUDING CURRENT SENSITIVE MOTOR CONTROL

MEANS TO HOLD A VARIABLY LOADED CAGE CHAIRED

Filed Nov. 24, 1964

2 Sheets-Sheet 1

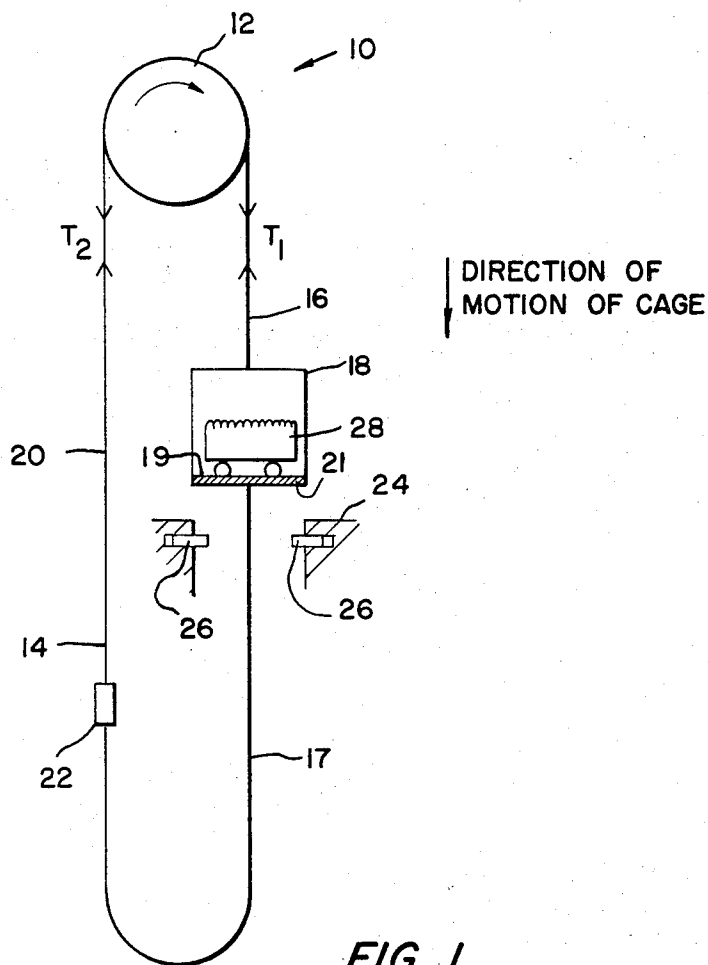


FIG. 1

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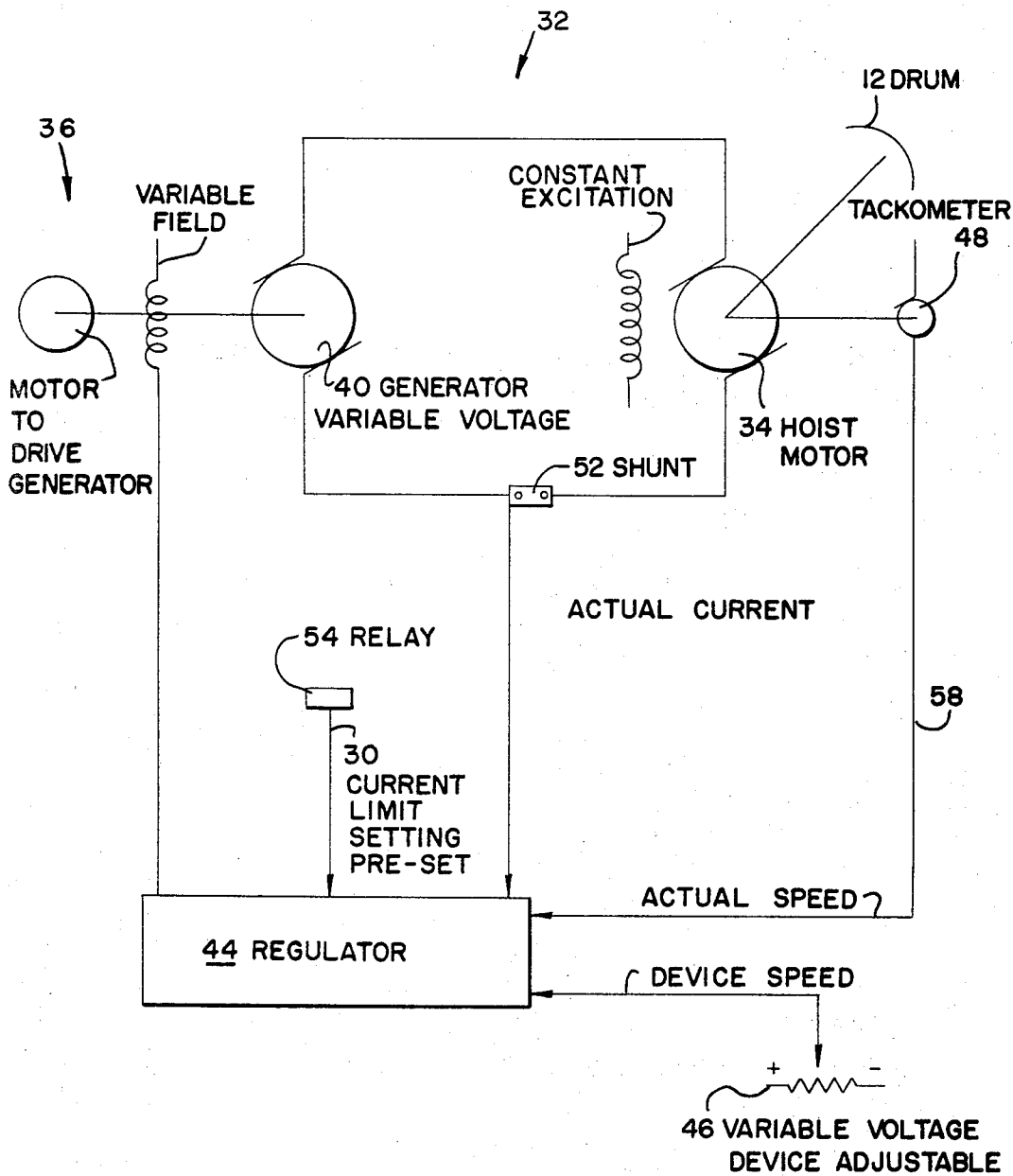


FIG. 2

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HOIST APPARATUS INCLUDING CURRENT SENSITIVE MOTOR CONTROL MEANS TO HOLD A VARIABLY LOADED CAGE CHAIRED

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6 Claims. (Cl. 187-29)

ABSTRACT OF THE DISCLOSURE

A hoist apparatus including a load vertically movable by rotation of an electrically driven drum into alignment with a loading level at which it is supported by a chairing system. An electrical means is provided for controlling the means rotatably driving the drum whereby the load, after being moved into alignment with the loading level, is maintained in alignment therewith despite variations in the weight of the load.

This invention relates to hoists and more particularly to hoist control.

When vehicles, and in particular cars running on rails, are to be rolled into and out of a mine hoist cage, it is essential that the floor of the cage, or rails in the floor, should align fairly accurately with the corresponding opposite member at the shaft station. From the hoist control standpoint, there is no difficulty in getting the cage to stop at the proper position, since positioning accuracy in a modern hoist is good. However, as the car is rolled on or off the cage on to the station floor, it changes the load on the ropes on which the cage is suspended, which results in attendant change of the cage position due to the inherent elasticity of the cage ropes. Therefore as a mine car is rolled on or off the cage, the rails may be aligned for the first pair of the mine car wheels, but as the load on the cage ropes is changed by the unloading or loading of the mine car, the vertical position of the cage will change resulting in the interruption of the alignment of the rails. When the rails are not in proper alignment, the second and subsequent pairs of wheels of the mine car will be forced to negotiate a bump which becomes intolerable when a large number of cars are to be handled.

It is the general object of the present invention to avoid and overcome the foregoing and other difficulties of and objections to prior art practices by the provision of a smoother operating hoist system.

This object, and those other objects of the invention which will be apparent from the following description taken in connection with the accompanying drawings, are attained by the provision of a hoist apparatus comprising a drum, at least one rope operatively associated with the drum for supporting a load, and a load carried by the rope. The drum is rotatable by electric drive means to vertically move the load onto a support; and means are responsive to the current drawn by the drum rotating means for controlling the tension on the rope when the load is on the support to prevent vertical movement of the load despite variations in the weight thereof.

For a better understanding of the present invention reference should be had to the accompanying drawings, wherein like numerals of reference indicate similar parts throughout the several views and wherein:

FIG. 1 is a diagrammatic view illustrating a hoist assembly;

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FIG. 2 is a diagrammatic view of an electrical control system for the present invention.

Although the principles of the present invention are broadly applicable to hoists the present invention is particularly adapted for use in conjunction with friction hoists and hence it has been so illustrated and will be so described.

With specific reference to the form of the present invention illustrated in the drawings, and referring particularly to FIG. 1, a hoist apparatus is indicated generally by the reference numeral 10. The hoist apparatus 10 has a circular rotating means, such as a drum 12 and a rope 14, being operated by the drum 12 to support load. The cage side 16 of the rope 14 supports load such as a cage 18 and cars 28 while the counterweight side 20 of the rope 14 is connected to a weight 22 for stabilization. Hence, rotation of the drum 12 is operable to lower the cage 18 on to a set of sliding chairs 26 so that the top surface 19 of the cage floor 21 is in alignment with the station floor 24, in order to ensure that a car 28 in the cage 18 can be rolled smoothly in and out of the cage 18.

It will be understood that, even if the top surface 19 of the cage floor 21 is initially aligned with the station floor 24, the moving of a car 28 in or out of the cage 18 will change the position of the cage 18 with respect to the position of the station floor 24 because the ropes 16 will change in length as the load changes. In order to keep the stop position of the cage 18 constant under varying load condition, means, such as an electrical control circuit, is provided as shown in FIG. 2.

Control circuit

The hoist 10 can be powered in many different manners, for example, by a variable voltage DC drive 32 as shown in FIG. 2. In the variable voltage DC drive 32, the drum 12 is driven by a DC separately excited hoist motor 34. The hoist motor 34 usually has a constant excitation (field). The hoist motor 34 is powered by a motor-generator assembly 36, the generator 40 of which motor-generator assembly 36 is also separately excited. The excitation of the generator 40, however, is variable and is utilized as the basis of the hoist control system. In the present illustration, the hoist 10 is manually controlled by means of a variable voltage device 46 which through a regulator 44, of the electronic or magnetic type, controls the field to the generator 40 thereby controlling the speed of the drum 12.

When the cage 18 is in motion, the hoist apparatus 10 is manually operated through a lever (not shown) connected to a standard variable voltage device 46 (FIG. 2). The motion of the operator's lever varies the voltage through the regulator 44 which causes the regulator 44 to vary the generator excitation. This varies the electro motive force (hereinafter referred to as EMF) developed in the generator armature 41. The hoist motor 34 will in turn endeavor to move in such a direction and at such a speed that its back EMF will balance the generator EMF. Thus the movement of the variable voltage lever will control the direction and speed of motion of the hoist motor 34.

It will therefore be understood that, when the drum 12 is to be speeded up, the generator excitation is increased thus increasing the generator EMF. The motor EMF is now less than the generator EMF resulting in the generator 40 feeding power to the hoist motor 34 thus accelerating the hoist motor 34. Where the generator excitation is reduced it reduces the speed of the hoist motor 34 thus reducing the speed of the drum 12.

Modern refinements have been mainly concerned with

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improving the accuracy of control. Most of these devices use the negative feedback principle with the hoist motor 34 being provided with a tachogenerator whose voltage output is accurately proportional to the speed of the drum 12. This voltage is fed to the regulator 44 where it is compared by the regulator 44 with the voltage fed into the regulator 44 by the variable voltage device 46. The difference between these two voltages is amplified by the regulator 44 and is applied to the generator 40 as a field of correct polarity. The generator 40 in turn corrects the speed of the hoist motor 34 so that the difference between the actual speed and the desired speed is reduced to a minimum.

To protect the direct current machines in the variable voltage DC drive 32 from excessive circulating current, a control circuit, such as a current limit circuit, is incorporated in the regulator 44. In the current limit circuit, a voltage proportional to the circulating current is obtained from a shunt 52 in the DC loop. This voltage is compared by the regulator 44 with a preset voltage fed into the regulator 44 by a relay 54. When the actual current exceeds the preset current, the generator field is changed in such a way as to reduce the excess current to a minimum. Thus it will be understood that the current limit circuit is only operative if the hoist assembly 10 is trying to draw an excessive current as for example, if the drum 12 were stalled against its brakes.

Inasmuch as the hoist motor current is proportional to the torque output of the hoist apparatus 10, under constant speed conditions and the motor torque under constant speed conditions is proportional to the equivalent rope pull (as hereinafter defined) exerted on the hoist ropes 14, the current limit setting may be used to stabilize the hoist apparatus when the cage 18 is stalled against the chairs 26. The control circuit therefore will limit the torque that the hoist motor 34 will exert by the preset current set in the relay 54.

The driving torque that the hoist motor 34 will exert can be expressed as an equivalent rope pull which is the force transmitted by the drum 12 to the rope 14. In order to stabilize the cage 18 on the chairs 26, the equivalent rope pull is applied in the direction tending to force the cage 18 down on the chairs 26.

It will be understood by those skilled in the art that on a counterweighted friction hoist with tail rope 17 as shown in FIG. 1, the static tension in the ropes on the counterweight side 20 is approximately constant at the drum 12 where the drum 12 is driving the cage 18 downward. The rope tension at the drum 12 at the cage side 16 will then be equal to the tension at the counterweight side 20 less the equivalent rope pull. Assuming the cage side tension to be T_1 and the counterweight side tension to be T_2 the relationship of the forces at the drum 12 can be expressed in equation form as follows:

$$T_1 = T_2 - \text{equivalent rope pull}$$

T_2 is equal to the combined weights of the counterweight 22 and the ropes on the counterweight side, and the equivalent rope pull can be set at a value leading to a safe value of T_1 so that the cage side tension T_1 can be chosen low enough to insure that the cage 18 will not rise off the chairs 26 when unloaded and yet not low enough to cause rope slip.

It will now be understood by those skilled in the art that with a preset equivalent rope pull, when the cage 18 is lowered on the chairs 26, the speed of the drum 12 will be controlled by the speed feedback circuit 58 from the tachogenerator 48 to the regulator 44. When the drum 12 is in motion the strength of the generator field is determined by the conditions in the speed feedback circuit. The drum 12 will be rotating at some desired speed and the current drawn by the motor 34 will not be high enough to be affected by preset current limit setting 30 in the current limit circuit.

When the cage 18 hits the chairs 26, the entire hoist

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apparatus will eventually stall. The actual speed of the drum 12 being near zero, will be way below the desired speed, which means that the hoist motor 34 will draw more current in an effort to increase the speed of the cage 18. The hoist motor current will now reach the current limit setting so that when the hoist assembly 10 finally comes to absolute rest the torque of the hoist motor 34 will be controlled by the current limit setting 30 in the current limit circuit thereby fixing the equivalent rope pull and thus setting the tension T_1 in the ropes at the hoist or the cage side 16. T_1 is chosen low enough so that the cage 18 will not rise in the chairs 26 when the car 28 or outer pay load is removed, yet not low enough to cause the ratio T_2/T_1 to rise to a value high enough to cause the ropes 14 to slip relative to the drum 12. In practice, this means that the reaction between chairs 26 and cage 18 is greater than the weight of the car 28, or other pay load.

It will be recognized by those skilled in the art that the objects of the present invention have been achieved by providing a smoother operating hoist system, using a conveyance which can be rested on an unyielding base without changing its vertical position with varying loads.

While in accordance with the patent statutes a preferred embodiment of the present invention has been illustrated and described in detail, it is to be particularly understood that the invention is not limited thereto or thereby.

I claim:

1. A hoist apparatus comprising:

a drum;

at least one rope operatively associated with said drum to support a load;

a load carried by said rope;

electric means for rotating said drum to vertically move said load onto a support; and

means responsive to the current drawn by said rotating means for controlling the tension on said rope when said load is on a support to prevent vertical movement of said load despite variations in the weight of said load.

2. A hoist apparatus comprising:

a drum;

at least one rope operatively associated with said drum to support a load;

a load carried by said rope;

electric means for rotating said drum to vertically move said load onto a support; and

electric control means responsive to the current drawn by said rotating means for controlling the tension on said rope when said load is on a support to prevent vertical movement of said load despite variations in the weight of said load.

3. A hoist apparatus comprising:

a drum;

at least one rope operatively associated with said drum to support a load;

a load carried by said rope;

means including an electric power circuit for rotating said drum to vertically move said load onto a support; and

means operatively associated with said electric power circuit and responsive to the current drawn by said rotating means for controlling the tension on said rope when said load is on a support to prevent vertical movement of said load despite variations in the weight of said load.

4. In combination with a loading level; a hoist apparatus comprising a load adapted to be vertically moved into alignment with said loading level; a rotatable drum, rope means associated with said drum and connected to said load such that rotation of said drum provides vertical movement of said load; electrical drive means for rotating said drum; chairing means cooperative with said load for supporting said load in alignment with said loading level; and electrical means for controlling said electrical

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drive means to cause said load, when supported by said chairing means, to be maintained on said chairing means despite variations in the weight of said load.

5. The combination of claim 4, further comprising said controlling means being responsive to the current drawn by said drive means to control the tension on said rope means for preventing vertical movement of said chairing means.

6. The combination of claim 8, further comprising said chairing means including a plurality of slidable hoist chairs.

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**UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION**

Patent No. 3,407,904

October 29, 1968

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It is certified that error appears in the above identified patent and that said Letters Patent are hereby corrected as shown below:

In the drawings, Sheets 1 and 2, in Fig. 1 of the drawings the facing, vertical edges of the station floor 24 should be considered as spaced further apart to clear the floor 21 of the cage 18; in Fig. 2, the generator 40 should be considered as having an armature 41 and "Tackometer 48" should be considered as the "Tachogenerator" of column 3, line 3 of the specification. Column 2, line 37, "axample" should read -- example --. Column 5, line claim reference numeral "8" should read -- 4 --.

Signed and sealed this 3rd day of March 1970.

(SEAL)

Attest:

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Commissioner of Patents