

SPECIFICATION

WINDING MACHINE STOPPING METHOD

FIELD OF THE ART

The present invention relates to a method of stopping a winding machine which is used for winching a crane rope up and down.

BACKGROUND ART

Winding machines of this type, which use electric motors for driving and electromagnetic brakes for stopping, are compelled to manage the critical timing of the operation of the motor and electromagnetic brake during the transition from working to stopping. For example, when an operator wishes to winch down a load with a crane rope and stop the crane when the load reaches a certain height, if the activation of the electromagnetic brake comes after the motor stops, the crane rope will temporarily be in a no-torque state, resulting in the dangerous descent of the load.

To deal with this matter, Unexamined Japanese Patent publication No. Sho 59-124690 discloses a method of controlling the timing of the operation of the motor and electromagnetic brake in which the electromagnetic brake is activated immediately before the motor stops, thereby halting the descent of load. Fig. 1 is a block

diagram of the control circuit of this prior art, and Fig.2 is the timing chart at stopping.

In the figure, a winch induction motor M_1 has its output shaft coupled at one end to the drum of an electromagnetic brake MB and at another end to the winch drum D through a reduction gear G. Connected between the primary winder of the induction motor M_1 and the power source is a variable-voltage, variable-frequency inverter I_1 , which is also connected to the electromagnetic brake MB by way of a brake controller BC.

The operation of the system will be explained with reference to Fig. 2. When a stop command SR is issued to the inverter I_1 at time t_7 , the speed command N_{REF} to the induction motor M_1 decreases, and the motor speed N_{FB} falls accordingly. When the motor speed N_{FB} has fallen to a prescribed level (immediately before the stop), a brake command BR is issued to the electromagnetic brake MB at time t_8 thereby to activate it.

In the above prior art method of stopping of a winding machine, the electromagnetic brake is activated during the rotation of the motor, and therefore has the problem of prematurely wearing the electromagnetic brake. Another problem is that the control ceases at time t_9 when the speed command N_{REF} reaches zero, causing the current command to become zero, even if the

electromagnetic brake is not activated, in which case the descent of the load will occur.

DISCLOSURE OF THE INVENTION

Accordingly, an object of the present invention is to prevent abrasion of the electromagnetic brake and the descent of the load.

In order to achieve the above objective, the inventive method of stopping of a winding machine, which operates to winch a load up or down in response to a torque command to an electric motor produced by a speed controller in accordance with a speed command generated by a speed command generation circuit, is designed to stop the motor control at the cessation of the machine if the motor speed is zero after the torque command for the motor is brought to zero for a predetermined length of time following the issuance of a brake command to the electromagnetic brake which is coupled directly to the motor.

In the inventive method of stopping of a winding machine, if the motor does not rotate when the torque command is reduced to zero for a predetermined length of time following the activation of the electromagnetic brake after the motor has stopped completely based on the operation of the above-mentioned means, it can be judged that the electromagnetic brake is producing a torque sufficient to withstand the load at that time, and therefore the descent of load can be prevented even

in the absence of the motor control. By activating the electromagnetic brake during the stoppage of the motor, the brake will incur abrasion.

The present invention resides in the winding control for winching a load up or down based on the issuance of a torque command to the motor produced by a speed controller in accordance with a speed command generated by a speed command generation circuit, wherein the motor control ceases at the stopping of the machine if the motor speed is zero after the torque command to the motor is brought to zero for a predetermined length of time following the issuance of a brake command to the electromagnetic brake which is coupled directly to the motor, whereby the abrasion of brake and the descent of load can be prevented.

BRIEF DESCRIPTION OF DRAWINGS

Fig. 1 is a schematic diagram showing the arrangement of a conventional winding machine; Fig. 2 is a timing chart used to explain the operation at the stopping of the winding machine; Fig. 3 is a block diagram showing the principal arrangement of an embodiment of this invention of a method of stopping of a winding machine; Fig. 4 is a timing chart used to explain the operation of this embodiment; and Fig. 5 is a flowchart of the control sequence for the brake command generation circuit based on this invention.

BEST MODE FOR CARRYING OUT THE INVENTION

An embodiment of this invention will be explained with reference to the drawings.

In Fig. 3, reference symbol M denotes an induction motor. The difference in the speed N_{FB} of the induction motor M detected by a speed detector PG, such as a pulse tachogenerator, from the speed command N_{REF} produced by a speed command generation circuit NRC is fed to a speed controller ASR. A following torque command limit circuit TLIM which limits the torque command value produces a torque command T_{REF} , which is fed to a vector-control inverter INV, by which the induction motor M is driven. The stop command SR and the motor speed N_{FB} detected by the speed detector PG are fed to a brake command generation circuit BRC, which issues a brake command BR to an electromagnetic brake B.

The operation of the circuit shown in Fig. 3 will be explained in connection with the timing chart of Fig. 4.

During the operation of the induction motor M, when a stop command SR shown in Fig. 3 is issued at time t_1 (step 100 in Fig. 5), the speed command generation circuit NRC produces a decreasing speed command N_{REF} , and the motor speed N_{FB} falls accordingly. After the motor speed N_{FB} has reached zero at time t_2 , the brake command generation circuit BRC issues a brake command BR to the electromagnetic brake B at time t_3 , and it operates accordingly. Since the electromagnetic brake B

operates in the state of zero motor speed N_{FB} , it does not suffer any abrasion. The time period from t_3 to t_4 is to allow for the delay in operation of the electromagnetic brake B. Torque command limit circuit TLIM reduces the torque command T_{REF} to zero within the time period from t_4 to t_5 . After time t_4 , if the motor speed N_{FB} remains at zero at a zero torque command, indicative of the generation by the electromagnetic brake B of a braking torque which withstands the load, the descent of the load will not occur even though the control of the induction motor has ceased. Accordingly, the control of the induction motor can be stopped at time t_6 .

Fig. 5 shows the control sequence of braking implemented by the brake command generation circuit BRC. In the figure, when the circuit BRC receives a stop command SR (step 100), it monitors the motor speed N_{FB} (step 110), and it operates a timer to measure the time after the motor speed N_{FB} has reached zero (step 120). When the timer value has fallen below the value of $t_3 - t_2$ (step 130), the brake command generation circuit BRC issues a brake command BR to the electromagnetic brake B to thereby activate it (step 140).

INDUSTRIAL APPLICABILITY

The present invention can be applied to the field of winding machines used for overhead traveling cranes in various plants and storage yards.

CLAIMS

1. A method of stopping of a winding machine which operates to winch a load up or down in response to a torque command to an electric motor produced by a speed controller in accordance the a speed command generated by a speed command generation circuit, wherein at the stopping of the machine the motor control is ceased if the motor speed N_{FB} is zero after the torque command to said motor is brought to zero for a predetermined length of time following the issuance of a brake command to an electromagnetic brake which is coupled directly to said motor.

2. A method of stopping of a winding machine according to claim 1, wherein a timer is operated to keep track of the time after the motor speed has reached zero, and a brake command is issued by a brake command generation circuit to said electromagnetic brake when the timer value has fallen below a prescribed value thereby to activate said electromagnetic brake.



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