Safety Transport Device for Hydraulic Overhead Crane

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Abstract: *In this paper, zero speed is practiced in drive motor of an Electrical Overhead Traveling (EOT) crane by strategies for a powerful easing back system. There are two modes in the crane action. The first is running mode and another is hindering mode. In the zero speed easing back down, an acknowledgment motor is changed over as a hindering segment. The dynamic hindering circuit is incited during the hindering mode. In EOT crane, a motor easing back system is generally used and it is an electro-mechanical device. The motor brake is presented between the drive motor and gear box for controlling the stack anyway the electric power is failed. The motor brake is used to block the rotating speed of motor shaft and to stop it at needed position. The Thruster brake and drive motor are fortified simultaneously to run the crane/lift is known as the running mode and stop the crane/raise by both are de-animated is known as the hindering mode. A youth baseball differentiate (time cut) between the limit of motor and motor causes massive impact beat on the gear box/shaft. This impact heartbeat may lessen the apparatus box/shaft constantly that cause load drop disaster. For going without/restricting the time cut, the drive motor is changed over as a hindering contraption during the hindering mode. The drive motor will be gone to zero speed as opposed to de-animated.*
Key words: *Time clip, Shaft, Gearbox and Rope drum.*

I. Introduction

A quick stopping of an induction motor and its high inertia load can be achieved by connecting stator terminals to a D.C supply. Any two stator terminals can be connected to a D.C supply and third terminal may be kept open or connected directly to other stator terminal. This is called dynamic braking circuit [1]. The dynamic braking circuit is shown in Figure-1. The bridge diode can be used to get a D.C supply. Motor can be brought to rest quickly by the dynamic braking principle. In braking mode, the power supply to the stator winding is changed from A.C to D.C. The stator winding develops stationary magnetic field and the rotor conductors cut this magnetic field. An electromotive force (EMF) is generated in the rotor and current flows through the rotor conductors as they are short circuited. The kinetic energy of rotation is then dissipated as copper loss and the motor stops quickly. A rectifier converts AC to DC for dynamic braking purpose. Overhead cranes are the electro mechanical devices normally used to lift the heavy loads. Working temperature shall be in approximately from - 20º to 40º C. Overhead cranes are more efficient than using a group of workers or two motors to lift and move the materials. The Electrical Overhead Travelling (EOT) cranes are forbidden to use in explosive, combustible, high temperature and corrosive environment [2]. Several types of overhead cranes are used in industries, including double girder overhead crane, single girder overhead crane, Gantry crane, JIB crane, etc.
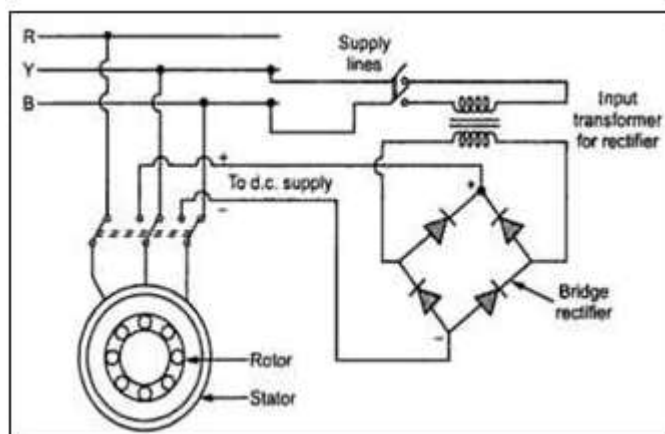

Figure 1 Dynamic Braking Circuit

The Zero speed braking system can be added for all type of electrical operated cranes. Due to dynamic braking effect the motor stops quickly. Prolonged application of D.C to stator winding will damage the winding

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due to excessive current and heat [6]. To prevent this issue we can provide timing relay or independent cooling system for the induction motor.

II. Layout Of Zero Speed Braking System

Electrical Overhead Travelling Crane contains a set of mechanical and electrical devices. Both the devices are contributing to lifting, lowering and braking operation. Gear box, rope drum and sheaves are the mechanical equipments, and drive motor, bus bar and electric panels are the electrical equipments. Thruster and pendants are electromechanical equipments [3]. All the equipments are working together for safe crane operation. These are basically designed for safety of human and materials. The cranes are basically driven by an electric motor. The hoist arrangements are called as grab which is used to lifting and lowering operation. Heavy load can be lifted by a small high speed electric motor. Speed of the motor is converted to useful torque. Huge speed reduction in gear box is used for converting the rotational speed into torque. A high speed motor is also required to operate the thruster [4]. The layout of Zero speed braking system is shown in Figure-2.
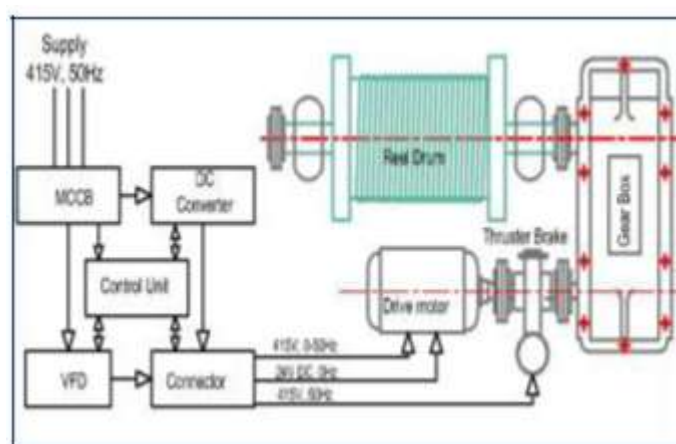

Figure 2 Layout of Zero Speed Braking System

A Cage induction motor is widely used in the EOT cranes as propellant [5]. The thruster brake system is installed after the drive motor and before the gear box as the rate of torque is relatively less at this location. A multi-stage high ratio gear box is provided at the third position. The gear box converts the rotational speed into the desired torque. The power is transmitted to the rope drum for lifting and lowering the load through sheaves and hooks. The electrical supply is distributed to the above arrangement by a control panel. The MCB, VFD and control units are the main components in the control panel. The Lifting speed, lowering speed and braking time are executed by the control panel. The set of arrangements are seated on the girder and directly operated through the pendant or any other control device. The girder may be a single or double and it moves in the horizontal direction on the bridge and runway.

In dynamic brake system, a Magneto Motive Force (MMF) is developed and it is a quantity appearing in the equation for the magnetic flux in a magnetic circuit, often called Ohm's law for magnetic circuits. It is the property of certain substances or phenomena that give rise to magnetic fields: $F = \Phi R$. Where Φ is the magnetic flux and R is the reluctance of the circuit [6]. It can be seen that the Magneto Motive Force plays a role in this equation analogous to the voltage V in Ohm's law: $V = IR$, since it is the cause of magnetic flux in a magnetic circuit.

The ampere-turn is the unit of MMF, represented by a direct current of one ampere flowing in a single-turn loop in a vacuum. The strength of the magnetic field is not linearly related to the ampere-turns when a magnetic material is used as a part of the system. Besides, the material within the magnet carrying the magnetic flux saturates at some point, after which adding more ampere-turns has little effect.

III. Operation Of Zero Speed Braking System

Figure 3 shows the power and control circuit diagram for dynamic braking of a squirrel cage induction motor. The DC current to the motor stator is controlled by a variable resistance R. In the N.C contact, a START push button is used in series with the DB coil for interlocking
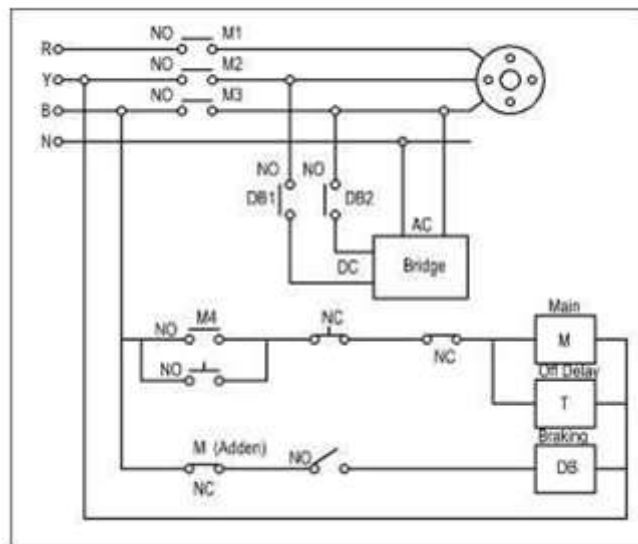This interlocking is to avoid simultaneous energizing of contactor M and DB and thereby making of AC and DC supply.

Figure 3 Dynamic Braking toggle Circuit

When the START button is pressed, the main contactor M gets energized. So, the sealing contact M1 closes. M2 is the electrical interlock to prevent energizing of dynamic braking contactor DB so long as main contactor M is energized is opened. 3 phase supply is going to the motor due to energizing of contactor M. Simultaneously the off-delay timer TR is energized and contact TR1 is kept closed. The motor keeps running. When the stop button is pressed, coil M is de-energized so main contacts [M-3]-[M-4]-[M-5] are opened. Then, the stator winding is disconnected from the 3 phase supply. [M-2] closes instantly energizing the coil DB. As soon as DB is energized, contact [DB-1] opens and provides electrical interlock and preventing energizing of coil M so long as DB is energized. Contact [DB-2]-[DB-3] is closed thereby applying DC to the stator winding from the rectifier.

Due to the dynamic braking effect, the motor stops quickly. Prolonged application of D.C to stator winding will damage the winding due to the presence of excessive current. To prevent this, a timing relay is used. As soon as coil M is de energized, braking begins. At the same time, coil TR is also de-energized and the motor is now ready for next starting. This circuit can be used where a smooth and fast stop is required. It also provides a stop without any tendency to reverse such as in plug stop. It produces less heat than the plug-stop, and hence it is a more suitable method of electric braking than plugging. The zero speed braking system can be added for all types of electrical operated cranes. Due to the dynamic braking effect, the motor stops quickly. Prolonged application of D.C to stator winding will damage the winding due to excessive current and heat. To prevent this issue, a timing relay or independent cooling system for the induction motor may be provided.

IV. Braking Torque And Magnetic Motive Force

A dynamometer is a machine used to measure the torque and the rotational speed (rpm) from which the power produced by an engine or any other rotating prime mover can be calculated. The dynamometer is an instrument for measuring force exerted by men, animals and machines. Here the apparatus is used to measure the braking torque for the given motor. The ampere-turn (At) is the MKS unit of magneto motive force (MMF) and it is represented by a direct current of one ampere flowing in a single-turn loop in a vacuum. The dynamic braking toggle circuit is shown in Figure-4.
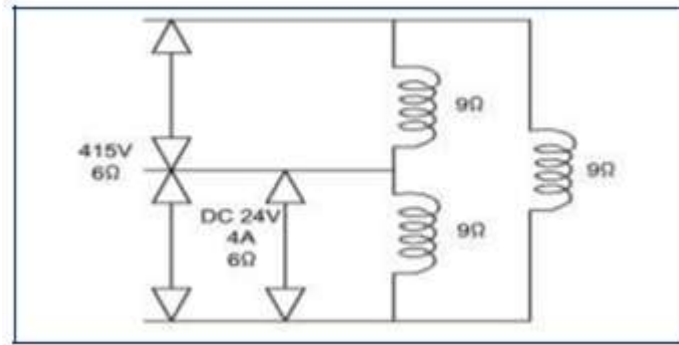
Figure 4 Dynamic Braking toggle Circuit

Resistance value in the 3Ø AC motor is calculated using the following equation.

$$\frac{1}{R_t} = \frac{1}{R} = \frac{1}{2R} \quad (1)$$

R   = 9 Ω / coil

       The torque required to lift the maximum load is called propellant torque. From the propellant torque, the braking torque is calculated. The braking torque is used to determine the lofting weight. A 3 phase power supply is brought out from the bus bar and inserted to the control panel through MCB. The connector MCB distributes the supply to VFD, control unit and the dynamic braking circuit. The control unit is the brain of the crane entire operation and it is controlled by an inserted program. Pendent or remote control is directly linked with the control unit. Thruster and drive motor are connected to the VFD. An out connector is a set of socket used to connect all the devises of crane with an electrical panel. The torque characteristic of load and ampere is presented in Figure-5. The torque test results are given in Table 1.
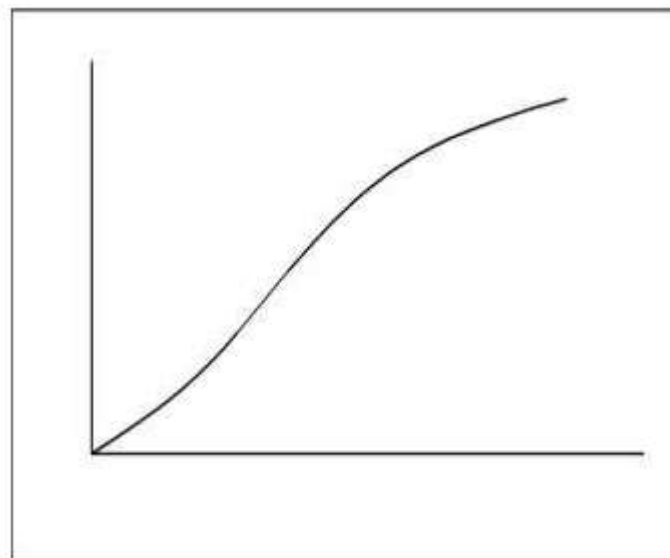

Figure 5 Torque characteristic of Load and ampere

Table 1 Torque test results

NO	Braking	Input Voltage	Motor Resistance	Coil Resistance	Current
1	75	24	6	9	4
2	65	20	6	9	3.3
3	52	18	6	9	3
4	34	15	6	9	2.5
5	20	12	6	9	2

In this work, DC dynamic braking circuit is added to the electric panel without disturbing existing setup. The device is configured with the control unit [5]. The dynamic braking is activated within 20 micro seconds after receiving the stop command. A total of 6 seconds duration is configured for zero speed braking circuit. This indicates that 6 seconds time span is enough to avoid the slip path of motor and thruster. As the DC braking system would produce heat on the stator coils, a small time span is programmed in the control unit. After 6 seconds, the dynamic braking circuit is sent to sleep. Tp perform this, an 110v pendant is provided for the crane.

V. Conclusion

In the present paper, zero speed braking circuit panels have been fabricated and tested on the Rope brake dynamometer. On validation, it is found that the addition of dynamic braking system is working satisfactorily to the expected level and the zero speed braking system is achieved. By this, the system can reduce the time gap between the engagement and disengagement of thruster and motor from three seconds to 10 microseconds. This is one of the best mechanisms which is being created to take hold of the sudden jerk in the load caused by the earlier mechanisms. Also, it safe guards the equipment and the lives of the people. The Zero speed braking system is very effective during the time of emergency stopping also. The reliability of overhead crane is increased while operation as well as emergency stopping.

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