

Oct. 25, 1966

O. JENSEN

3,281,633

LOWERING SPEED CONTROL FOR A-C. HOIST

Filed July 5, 1963

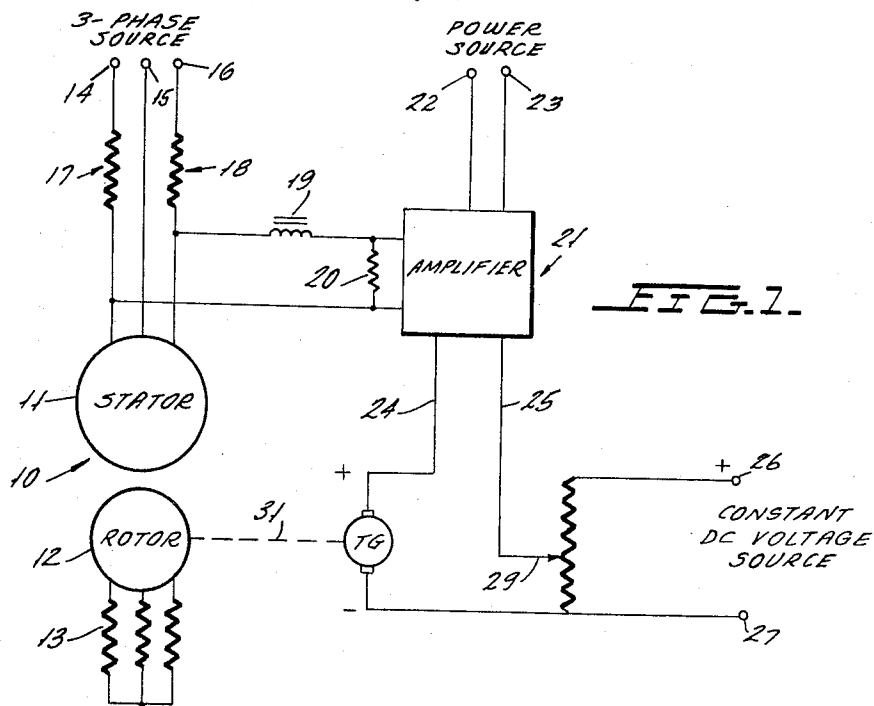
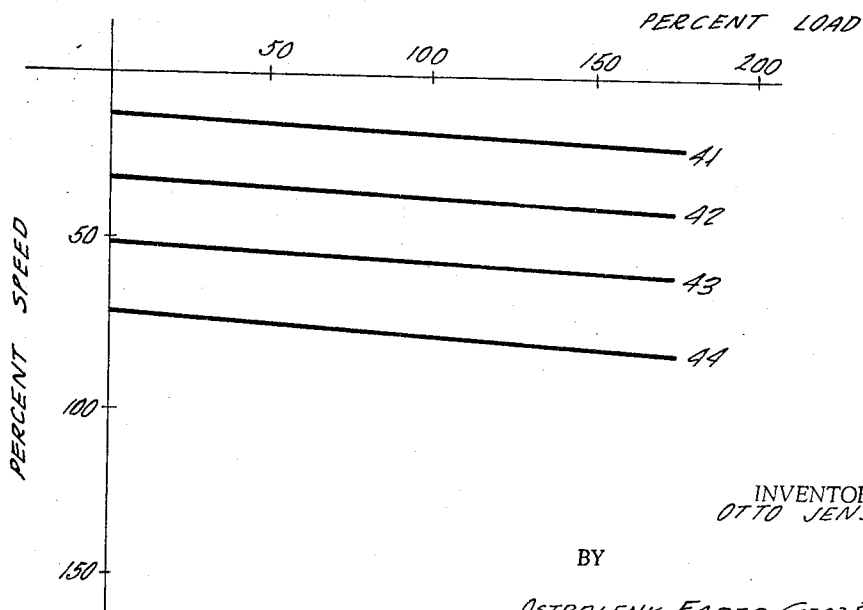


FIG. 2.



INVENTOR.  
OTTO JENSEN

BY

OSTROLENK, FABER, GERB & SOFFEN  
ATTORNEYS

1

3,281,633

**LOWERING SPEED CONTROL FOR A-C. HOIST**  
Otto Jensen, Malvern, Pa., assignor to I-T-E Circuit  
Breaker Company, Philadelphia, Pa., a corporation of  
Pennsylvania

Filed July 5, 1963, Ser. No. 292,908

4 Claims. (Cl. 318-212)

My invention relates to a novel speed control system for an A-C. hoist, and more specifically relates to an improvement of copending application Serial No. 212,335 filed July 25, 1962 entitled "A-C. Hoist Control System" in the name of Donald I. Bohn and assigned to the assignee of the present invention, now U.S. Patent No. 3,166,701 in which the D-C. current simultaneously applied with A-C. voltage to the stator winding of an induction motor during lowering is controlled in a stepless manner.

The above noted copending application Serial No. 212,335 describes a novel structure for an A-C. hoist which permits substantial duplication of the characteristics of a D-C. motor. More specifically, during the lowering mode of operation, A-C. power is applied to the stator winding to drive the rotor in the same direction as the load on the rotor. At the same time, D-C. power is applied to the stator winding to create an opposing torque to the lowering torque whereby accurately controlled lowering operation is achieved. However, with the system set forth in the above noted application, lowering speed is not automatically controlled, but may be controlled only in steps and is dependent upon load.

The principle of the present invention is to provide a novel automatic regulation system for regulating the D-C. power applied to the stator to control lowering speed at the operator's will independently of load and in a stepless manner. More specifically, and in accordance with the invention, D-C. current is injected into the D-C. control circuit from an amplifier which is controlled as a function of an adjustable constant voltage and a voltage which is responsive to the speed of rotation of the rotor. The constant voltage source thereby serves as a reference voltage source in a servo system wherein the output signal is derived from a tachogenerator connected to the rotor. The output voltage from the tachogenerator is then compared to the reference voltage to serve as an input signal for the amplifier regulator whereby the current injected into the D-C. control circuit will be of a value that requires the rotor to turn at some speed determined by the level of the constant voltage source. Therefore, a constant lowering speed is achieved which can be varied in a stepless manner by the stepless variation of a constant D-C. voltage source.

Accordingly, a primary object of this invention is to provide a novel lowering speed control system for an A-C. hoist.

Another object of this invention is to utilize the speed of rotation of the rotor of an A-C. hoist as an indication of the lowering speed of the hoist for use as an input signal in a servo system.

Another object of this invention is to provide a novel lowering control system for an A-C. hoist which controls lowering speed at the operator's will and is independent of load.

These and other objects of my novel invention will become apparent from the following description when taken in connection with the drawings, in which:

FIGURE 1 shows a circuit diagram of the present invention in connection with an A-C. motor and a control system of the type shown in above noted copending application Serial No. 212,335, now U.S. Patent No. 3,166,701.

2

FIGURE 2 illustrates lowering speed as a function of load for different settings of control voltage.

Referring first to FIGURE 1, I have illustrated therein an A-C. motor 10 having a three-phase stator winding 11 and a three-phase rotor winding 12. The winding 12 is then connected to resistors 13, as illustrated, and stator 11 is connected to a three-phase power source at terminals 14, 15 and 16.

A D-C. current injection system is then connected to the two outer phases of stator winding 11 and includes a saturable-type reactor 19, resistor 20 and a D-C. source 21 which, in the present invention, is comprised of an amplifier structure, the output leads of which are connected to resistor 20.

The circuit described to this point is identical to the circuit of above noted application Serial No. 212,335, now Patent Number 3,166,701, which is incorporated herein by reference as a part of the instant specification and details for the operation of the circuit may be found in that application. Generally, and during the lowering mode of operation, A-C. power is connected to stator 11 in such a direction as to drive rotor 12 in a lowering direction. That is to say, the torque due to the A-C. power is in the same direction as the torque due to the load on the rotor 12.

The injected D-C. current coming through reactor 19 then creates a magnetic field in stator winding 11 which is in a direction to oppose the torques due to the load and the A-C. power whereby accurately controllable lowering torques is achieved. However, the D-C. currents injected into the stator winding 11 in the above noted application were applied in a stepped manner whereby there was some loss of control of lowering speed within that step. Moreover, a particular D-C. current setting gave a lowering speed which depends on load.

With the novel circuit of the present invention, a suitable power source connected at terminals 22 and 23 drives an amplifier 21 which has a D-C. output connected across resistor 20. Input control power is then connected to amplifier 21 over leads 24 and 25 whereby the signal appearing at leads 24 and 25 adjusts the D-C. output of amplifier 21.

A constant D-C. voltage source is then connected to terminals 26 and 27 which are, in turn, connected across a potentiometer 28 which has a wiper 29 connected to lead 25. The rotor 12 is then adapted with a tachogenerator 30, as indicated by dotted lines 31, which will deliver an output voltage of the polarity illustrated when the rotor 12 rotates to lower a load. Generator 30 is then connected in lead 24 and to the bottom of potentiometer 28 so that the output voltage of generator 30 is in opposition to the output voltage of potentiometer 28.

In operation, the operator will set wiper 29 of potentiometer 28 at some particular position depending upon which lowering speed he desires. As the load is lowered, an output voltage will appear across leads 24 and 25 as an error signal for amplifier 21 which depends on the difference in the output voltages of potentiometer 28 and generator 30. This will cause a change in the output of amplifier 21 across the resistor 20 so that the injected current of the D-C. control circuit will vary until the output voltage of generator 30 equals, or is suitably related to, the output voltage of potentiometer 28. Thus, a servo system is formed to require a specific speed of rotation for rotor 12 which corresponds to a specific position of wiper 29 of potentiometer 28.

Accordingly, the operator, by setting potentiometer 28 at a particular value, will be automatically insured of a given lowering speed which is independent of the load on rotor 12.

This operation is illustrated in FIGURE 2 which illustrates percent load as a function of percentage lowering speed. The lines 41, 42, 43 and 44 correspond to respective discrete settings of potentiometer 28 where it will be seen, for example, for setting 41, that lowering speed will vary less than 10% when going from operation on zero load to operation on 175% load. Thus, there is a relatively constant lowering speed obtained for that specific potentiometer setting regardless of the load on rotor 12. Clearly, any desired lowering speed may be obtained by shifting the position of wiper 29 of FIGURE 1 which will then place the operation of the system on some line intermediate and parallel to lines 41 through 44.

Although I have described my novel invention with respect to its preferred embodiments, it should be understood that many variations and modifications will now be obvious those skilled in the art, and I prefer therefore to be limited not by the specific disclosure herein but only by the appended claims.

The embodiments of the invention in which an exclusive privilege or property is claimed are defined as follows:

1. In an A.-C. hoist comprising an A.-C. motor having a stator energizable from an A.-C. source, a rotor, and a D.-C. current injection circuit independent of said A.-C. source for injecting D.-C. current into said stator during lowering operation simultaneously with the application of lowering A.-C. power to said stator; said D.-C. current injection circuit including an amplifier means, a first adjustable constant D.-C. voltage source, and a second D.-C. source having a voltage output responsive to the speed of said rotor; said amplifier means having an output circuit for injecting said D.-C. current into said stator and an input circuit for controlling the current magnitude of

said output circuit; said input circuit being connected in series with said first and second D.-C. sources with the polarities of said first and second D.-C. sources opposing one another; said speed of said rotor being changed by injected D.-C. current in said stator in a direction to decrease the output voltage difference between said first and second D.-C. sources.

2. The device of claim 1 wherein said second D.-C. source includes a tachogenerator driven by said rotor.

3. The device of claim 1 wherein the adjusted output of said first voltage source determines the lowering speed of said rotor.

4. A constant speed lowering circuit for an A.-C. hoist having a stator and a rotor comprising a D.-C. circuit for supplying D.-C. braking current to said stator of said hoist; said D.-C. circuit including a D.-C. voltage generator driven by said rotor, a D.-C. adjustable reference voltage means connected in series opposition with said D.-C. voltage generator, and amplifier means having an input circuit connected to the difference voltage created by said D.-C. voltage generator and said D.-C. reference voltage and an output circuit connected to said stator; said amplifier output supplying a braking current to said stator having a value to change the speed of rotation of said rotor in a direction to reduce said difference voltage.

#### References Cited by the Examiner

##### UNITED STATES PATENTS

2,919,391 12/1959 Charbonneaux ----- 318—230 X

ORIS L. RADER, *Primary Examiner*.

G. Z. RUBINSON, *Assistant Examiner*.