April 3, 1962 H. J. HOUBEN 3,027,993

TENSIONING MEANS FOR BELT CONVEYORS

Filed Sept. 28, 1960 3 Sheets-Sheet 1

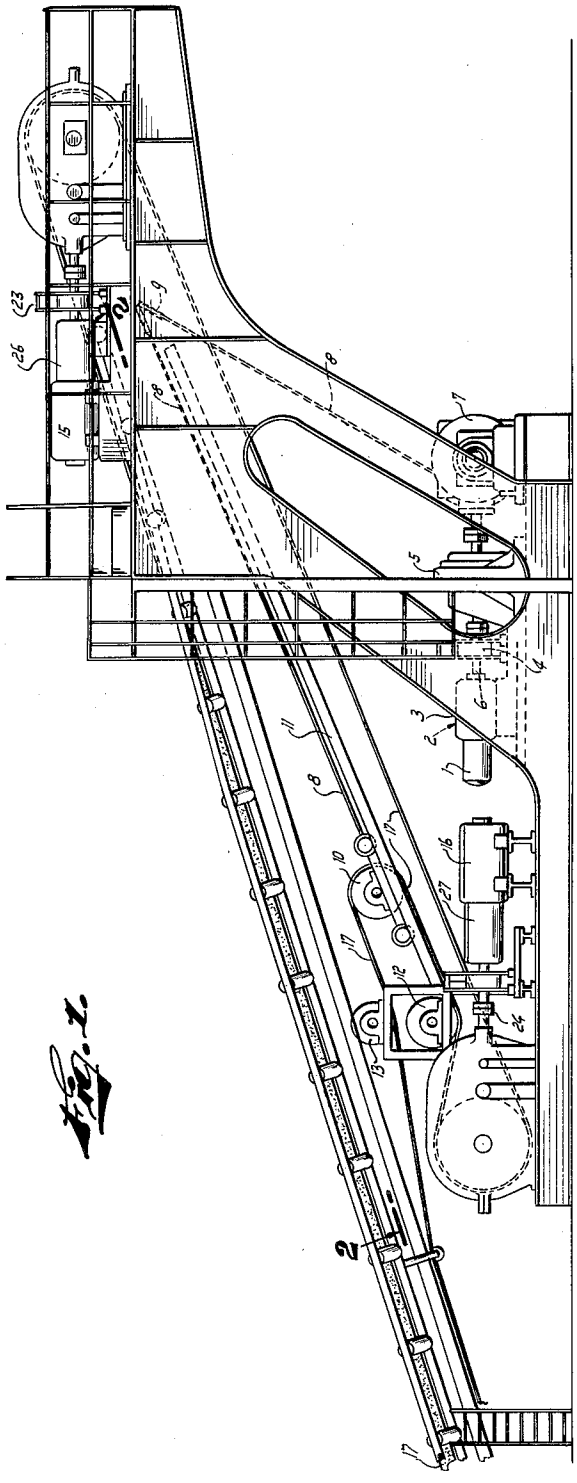


Fig. 1.

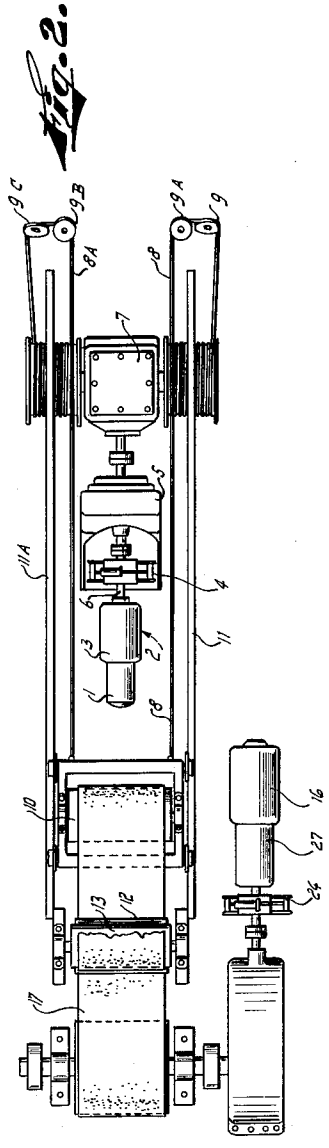


Fig. 2.

INVENTOR.
HEINZ J. HOUBEN
BY
Ernest H. Hoda
AGENT

April 3, 1962 H. J. HOUBEN 3,027,993

TENSIONING MEANS FOR BELT CONVEYORS

Filed Sept. 28, 1960 3 Sheets-Sheet 2

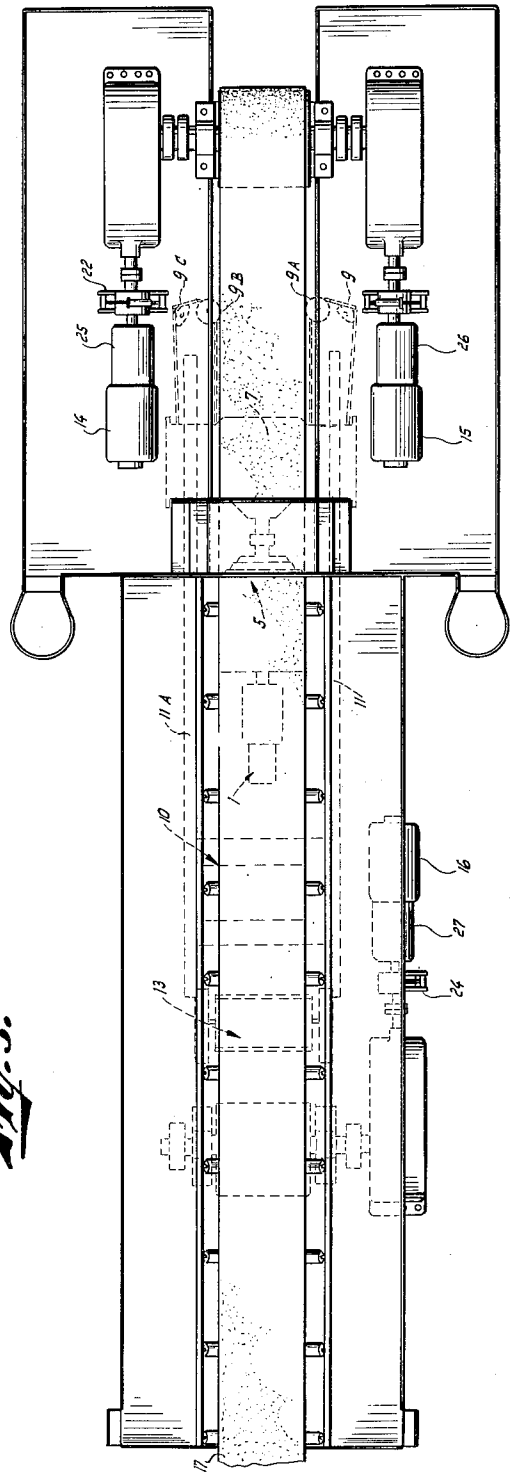


Fig. 3.

INVENTOR.
HEINZ J. HOUBEN
BY
Ernest H. Foda
AGENT

April 3, 1962 H. J. HOUBEN 3,027,993

TENSIONING MEANS FOR BELT CONVEYORS

Filed Sept. 28, 1960 3 Sheets-Sheet 3

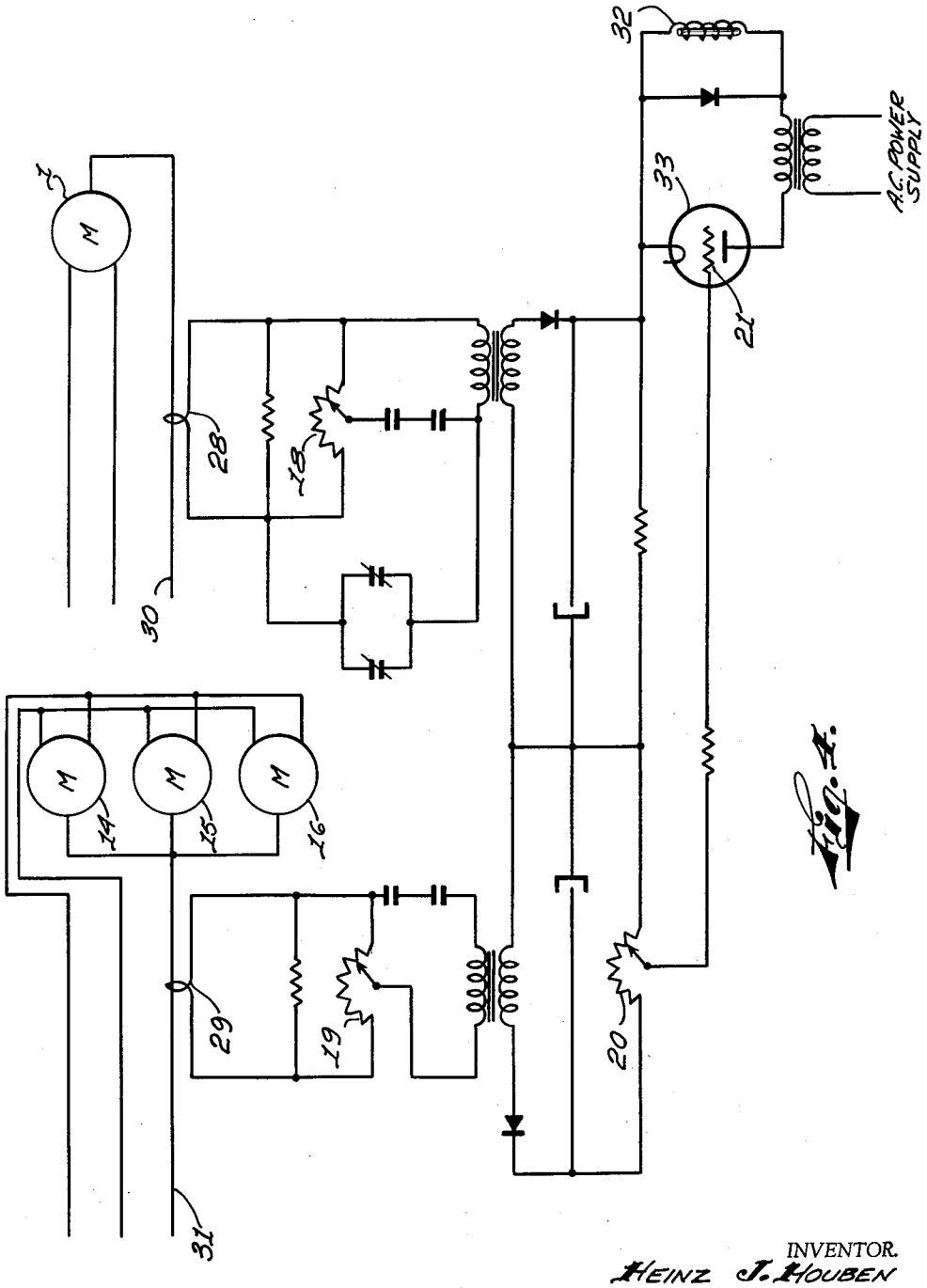


Fig. 4.

INVENTOR.
HEINZ J. HOUBEN
BY
AGENT

United States Patent Office 3,027,993 Patented Apr. 3, 1962

3,027,993

TENSIONING MEANS FOR BELT CONVEYORS

Heinz J. Houben, Woodland Hills, Calif., assignor to United States Borax & Chemical Corporation, Los Angeles, Calif., a corporation of Nevada

Filed Sept. 28, 1960, Ser. No. 58,994
3 Claims. (Cl. 198—208)

The present invention relates as indicated to a tensioning means for belt conveyors and has more particular reference to an electrical tensioning means which automatically controls belt take-up tension for varying load conditions.

Present conventional belt conveyors use counterweights and cables to supply a constant take-up tension to the belt; the amount of take-up tension applied is that which is required to start a fully loaded belt and is the maximum take-up tension necessary at any given time. Keeping a belt at maximum take-up tension at all times shortens the projected belt life considerably, and the use of counterweights and cables to supply take-up tension to the belt requires the use of large, space-consuming superstructures.

It is, therefore, the principal object of the present invention to provide an automatic electrical tensioning means so that the amount of take-up tension applied to the belt is varied to meet the load requirements of the belt at any specific time.

It is a further object of the invention to provide an electrical belt tensioning means which is compact and eliminates the necessity of large superstructures.

Other objects of the invention will appear as the description proceeds.

To the accomplishment of the foregoing and related ends, said invention then comprises the features hereinafter fully described and particularly pointed out in the claims, the following description and the annexed drawings setting forth in detail certain illustrative embodiments of the invention, these being indicative, however, of but a few of the various ways in which the principle of the invention may be employed.

In said annexed drawings:

FIG. 1 is an elevation of the present invention in assembled form;

FIG. 2 is a plan view taken through line 2—2 of FIG. 1;

FIG. 3 is a top plan view of the present apparatus in assembled form;

FIG. 4 is a schematic of the electrical measuring and relay system.

The amount of take-up tension which must be applied to the belt of any endless belt conveyor, to insure proper operation of the conveyor, is dependent on the horsepower which must be transmitted through the belt drive pulleys into the belt. The take-up tension necessary for proper operation of the conveyor when there is no load on the belt is the minimum take-up tension requirement for the system and the take-up tension necessary for proper operation of the conveyor when the belt is carrying a maximum load is the maximum take-up tension requirement for the system. The minimum and maximum take-up tension requirements can be precalculated for any endless belt conveyor, and once the minimum and maximum requirements have been established any point between can be determined easily.

The maximum take-up tension requirements of the conveyor system is determinative of the size of the equipment which comprises the present tensioning means. The take-up tension requirements can readily be translated into the amount of torque which must be exerted at an eddy current coupling to supply and maintain the required take-up tension. After the torque requirements have been calculated, the electrical control system can be preset so that

the take-up tension applied to the belt will vary as the load conditions on the belt vary.

Referring more particularly to the annexed drawings, the present tensioning means comprises various mechanical members and an electrical control system which automatically controls the mechanical members. The tensioning means comprises tensioning motor 1, eddy current coupling 2 in housing 3, electrical brake 4, gear box 5, coupling shaft 6, winch 7, cables 8 and 8A, pulleys 9, 9A, 9B and 9C, take-up pulley 10, tracks 11 and 11A, belt bend pulleys 12 and 13, two standard current transformers 28 and 29, one of which is connected to an input lead 30 of tensioning motor 1, and transmits current signals to signal compensating potentiometer 18, the other is connected to an input lead 31 from drive motors 14, 15 and 16 and transmits current signals to signal compensating potentiometer 19, balance potentiometer 20 and grid 21 which controls the firing of the torque control tube 33 which emits the current to the energizing coil 32 in eddy current coupling 2.

Eddy current coupling 2, enclosed in housing 3, is a type of magnetic clutch, which is well known to the art, therefore, a detailed description of the structure of the coupling has been omitted. The following simplified description of how the eddy current coupling functions is given to clearly establish it as one of the important components of the overall tensioning means.

Eddy current coupling 2 insures gradual and smooth starting of two coupling shafts when one shaft is rotating and the other is stationary. The coupling comprises two rings, one of which is attached to the hub of the rotating shaft of the tensioning motor, the other ring being attached to the hub of the stationary shaft connected to the gear means. The ring attached to the rotating shaft surrounds an energizing coil and when current is introduced to this coil a magnetic flux is set up in the second ring, and when the rings are rotating at different speeds electromotive forces are induced which causes eddy currents to flow and a torque is exerted. The amount of torque exerted varies with the strength of the current supplied to the coupling and to the difference in speed of the two rings. For a coupling such as the one used in the present invention, the rotational speed of the ring attached to the tensioning motor shaft is constant, therefore, the amount of current supplied to the coil is controlled to give controlled torque settings.

In the usual torque control circuit a voltage signal generated by a current transformer, attached to one leg of the motor input leads, applies a negative potential to the grid of a torque control tube or magnetic amplifier which supplies the current to the coupling coil. A positive potential is applied to the same grid from an outside source, the amount of positive potential being known and variable. By adjusting the amount of positive potential, firing of the torque control tube on the basis of the amount of negative potential as generated by the motor current can be controlled. Thus, as the positive potential is increased, the motor current increases and the amount of negative potential as seen by the torque control tube also increases.

The present torque control system differs from the usual torque control system in that the voltage signals and potentials are supplied by two separate motor circuits. The voltage signal generated by the current transformer connected to an input lead 30 of tensioning motor 1 supplies the negative potential which is transmitted to potentiometer 18. The voltage signal generated by the current transformer 29 connected to an input lead 31 of drive motors 14, 15 and 16 supplies the positive potential which is transmitted to potentiometer 19. Potentiometers 18 and 19 are preset so that only a precalculated amount of each transformer's signal, as determined by

the relative strength of the signals and by the previous torque calculations, is transmitted to potentiometer 20.

Potentiometer 20 is the balancing potentiometer and is the relay from which the total negative potential, the arithmetic sum of the two potentials as supplied to potentiometer 20, is transmitted to grid 21 which controls the firing of the torque control tube 33 or magnetic amplifier (not shown) which transmits the current supplied to the energizing coil 32 in eddy current coupling 2. Potentiometer 20 is preset and balanced prior to starting the conveyor system so that the amount of negative potential as seen by grid 21 is that amount which is required to supply the energizing coil 32 in eddy current coupling 2 with enough current to exert the minimum torque requirement when belt 17 is running with no load. Then as a load is placed on belt 17 the current signal from drive motors 14, 15 and 16 to potentiometer 19 increases; the strength of the signal is automatically adjusted and transmitted to potentiometer 20 which is then pulled out of balance. The current at tensioning motor 1 automatically increases so that the current signal emitted will be strong enough to regain equilibrium at potentiometer 20. The increase of current at tensioning motor 1 allows a greater negative potential to be received at grid 21 which causes more current to flow to the energizing coil 32 in eddy current coupling 2. This increased current then induces a greater torque to be exerted and the take-up tension on belt 17 increases proportionately.

In addition to the automatic torque control system the tensioning means has been equipped with a current response relay (not shown) connected to the input lead of drive motors 14, 15 and 16. If the current to drive motors 14, 15 and 16 were to become excessive, that is the belt were overloaded, the current response relay would cut off the torque control circuit, and 100% torque, maximum allowable take-up tension, would be exerted and maintained at eddy current coupling 2 until such time that the current signal from drive motors 14, 15 and 16 were returned to its normal range. The 100% torque system is also used in the start-up of the conveyor system; and after the entire conveyor system is operating, the automatic control system is placed in operation.

The other safety mechanism installed into the torque control system is that if the current signal from tensioning motor 1 is not strong enough to require minimum torque the entire conveyor installation shuts down.

Referring now to the mechanical section or the present tensioning means, tensioning motor 1 is always running when the conveyor system is in operation. When belt 17 is carrying no load coupling shaft 6 is stationary and the minimum torque requirement is exerted at eddy current coupling 2 so that the minimum take-up tension required for proper operation of belt 17 is being applied. When a load is placed on belt 17, current to tensioning motor 1 is increased and current to eddy current coupling 2 is increased via the torque control circuit. The increase of current at eddy current coupling 2 causes shaft 6 to rotate. As coupling shaft 6 rotates through gear box 5 winch 7 is also rotated which applies tension to cables 8 and 8A and take-up pulley 10 is pulled up tracks 11 and 11A until the proper belt take-up tension is applied at which time the torque exerted at eddy current coupling 2 is that which is called for by the torque control system and shaft 6 once again becomes stationary being held in place by the magnetic forces applied at the coupling 2.

As the load on belt 17 becomes smaller, the reverse procedure is followed. Current to tensioning motor 1 decreases, current to eddy current coupling 2 decreases, shaft 6 through gear box 5 begins to rotate, which causes winch 7 to rotate and slack is placed in cables 8 and 8A. Take-up pulley 10 is then lowered down tracks 11 and 11A until the required torque and take-up tension have been applied at which time coupling shaft 6 once again is stationary being held in place by the magnetic forces applied at eddy current coupling 2.

So that the present invention will be more easily understood, the following description is given for illustrative purposes.

Starting the entire belt conveyor installation comprises starting tensioning motor 1 and sequentially starting drive motors 14, 15 and 16 with all electrical brakes 4, 22, 23 and 24 on. After a time delay to allow the motors 1, 14, 15 and 16 to attain maximum speed, eddy current coupling 2 is excited and electrical brake 4 is released so that 100% torque is exerted at eddy current coupling 2 and maximum take-up tension is applied to belt 17. The drive motor couplings 25, 26 and 27 are then excited and electrical brakes 22, 23 and 24 are released. Belt 17 begins to accelerate and for the present conveyor system maximum speed is reached within a preset time of two and one-half minutes. When belt 17 has attained maximum speed, the 100% torque or maximum take-up tension requirement is released and the tensioning means goes directly to the current regulated state wherein the automatic torque control circuit becomes effective.

The automatic torque control system comprising the current transformers 28 and 29 potentiometers 18, 19 and 20, grid 21 and the torque control tube 33 is preset as described. If belt 17 is running empty after start-up and the 100% torque relay is released, the current transformer 29 connected to the input lead 31 of drive motors 14, 15 and 16 would be transmitting the lowest positive signal to potentiometer 19. The signal is then adjusted at potentiometer 19 and transmitted to potentiometer 20 which is then pulled out of balance and would call for the minimum negative signal from potentiometer 18 and the current to tensioning motor 1 would decrease automatically. As the current to tensioning motor 1 decreases and the signal from the current transformer 28 connected to the input lead 30 of tensioning motor 1 decreases, the total negative potential as seen by grid 21 would also decrease. The decrease in negative potential as seen by grid 21 causes a decrease in the current transmitted to the energizing coil 32 in eddy current coupling 2 and the torque exerted at the eddy current coupling decreases so that the take-up tension on belt 17 is decreased proportionately. The entire torque control system is circuited in a fraction of a second which is all the time required to change the amount of current applied to eddy current coupling 2.

As the torque exerted at eddy current coupling 2 is lessened, shaft 6 which was stationary at the 100% torque requirement rotates through gear box 5 which causes winch 7 to rotate, slack is given to cables 8 and 8A and belt pulley 10 is lowered down tracks 11 and 11A and the slack as in cables 8 and 8A is taken up by take-up pulley 10 through pulleys 9, 9A, 9B and 9C, the take-up tension on belt 17 is lessened until coupling shaft 6 once again becomes stationary.

Any change in the load on belt 17 would change the current required to drive the drive motors 14, 15 and 16. The change in current is then relayed to the torque control system which applies the proper torque at eddy current coupling 2 which in turn changes the take-up tension applied to belt 17. The system is completely automatic and compact and when mounted on rails as shown in FIGS. 1 and 4, where the conveyor system is no longer in use, the entire tensioning mechanism is easily moved to any other endless belt system.

It is to be noted that the present automatic tensioning means is applicable to any endless belt conveyor system where take-up tension on the belt is required. Due to the size of the present conveyor installation three drive motors 14, 15 and 16 are shown in the annexed drawings. The use of three drive motors is not to be taken as limiting the present invention, for it will work equally as well on a conveyor system which has one motor or on a conveyor system which has twenty or more motors, as long as the strength of the current signals emitted are corrected at the signal compensating potentiometers.

Other modes of applying the principle of the invention may be employed provided the features stated in any of the following claims or the equivalent of such be employed.

I, therefore, particularly point out and distinctly claim as my invention:

1. An apparatus for controlling the take-up tension of endless belt conveyors comprising in combination at least one electric motor having input leads for driving said belt conveyor, a current transformer connected to an input lead of said motor, said current transformer connected to a first signal compensating potentiometer, a tensioning motor having input leads, a second current transformer connected to an input lead of said tensioning motor, said second current transformer connected to a second signal compensating potentiometer, said first and second signal compensating potentiometers connected to the input of a balancing potentiometer, means for amplifying the current from said balancing potentiometer connected to the output of said balancing potentiometer, an eddy current coupling connected to the output of said amplifying means, said eddy current coupling having a first shaft connected directly to said tensioning motor and a second shaft connected directly to gear means, and said gear means connected to means for tensioning said conveyor belt.

2. An apparatus for controlling the take-up tension of endless belt conveyors comprising in combination at least one electric motor having a shaft for driving said belt conveyor, a coupling means for connecting said motor shaft to a second shaft, said second shaft connected to a belt drive pulley, an electrical brake connected to said second shaft, a first current transformer connected to an input lead of said electric motor, said first current transformer connected to a first signal compensating potentiometer, a tensioning motor having input leads, a second current transformer connected to an input lead of said tensioning motor, said second current transformer connected to a second signal compensating potentiometer, said first and second signal compensating potentiometers connected to the input of a balancing potentiometer, means for amplifying the current from said balancing potentiometer, an eddy current coupling connected to the output of said amplifying means, said eddy current coupling having a first shaft connected directly to said tensioning motor and a second shaft connected to gear means, an electrical brake connected to said second shaft and said gear means connected to means for tensioning said conveyor belt.

3. An apparatus for controlling the take-up tension of endless belt conveyors comprising in combination at least one electric motor having a shaft for driving said belt conveyor, a coupling means for connecting said motor shaft to a second shaft, said second shaft connected to a belt drive pulley, an electrical brake connected to said second shaft, a first current transformer connected to an input lead of said electric motor, said first current transformer connected to a first signal compensating potentiometer, a tensioning motor having input leads, a second current transformer connected to an input lead of said tensioning motor, said second current transformer connected to a second signal compensating potentiometer, said first and second signal compensating potentiometers connected to the input of a balancing potentiometer, a means for amplifying the current from said balancing potentiometer connected to the output of said balancing potentiometer, an eddy current coupling connected to the output of said amplifying means, said eddy current coupling having a first shaft connected directly to said tensioning motor and a second shaft connected to gear means, an electrical brake connected to said second shaft, said gear means connected directly to a winch, said winch having cables connected through a series of pulleys to a belt take-up pulley, said belt take-up pulley mounted on wheels which travel on rails and said belt pulley connected to said conveyor belt.

References Cited in the file of this patent

UNITED STATES PATENTS

2,788,116 Wood ---------- Apr. 9, 1957