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AUTOMATIC REEL DRIVE CONTROL

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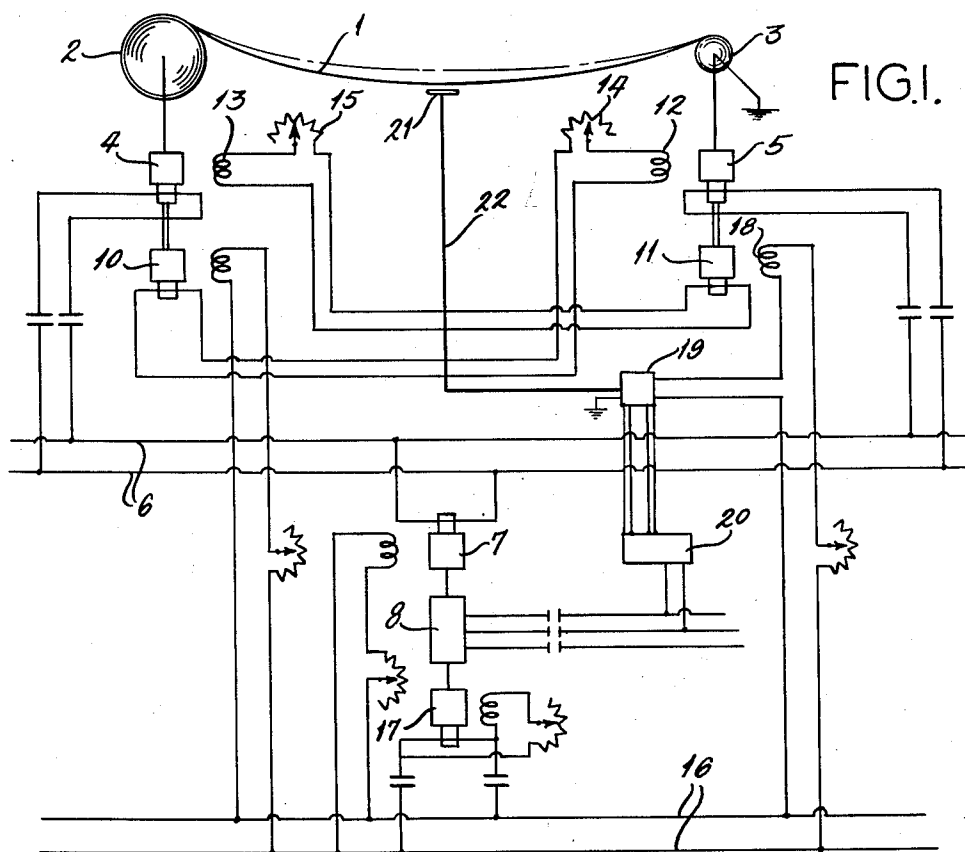


FIG. 1.

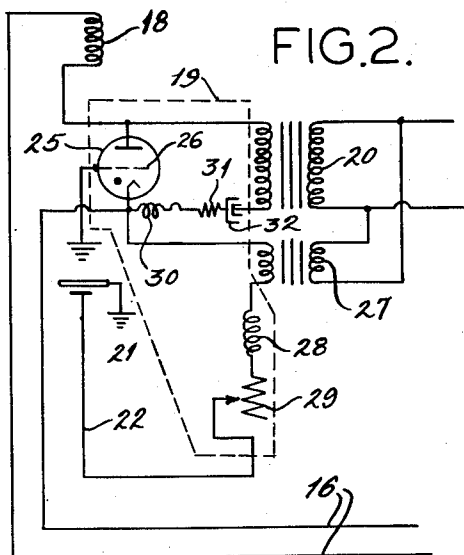


FIG. 2.

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AUTOMATIC REEL DRIVE CONTROL

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This invention relates generally to the control of winding and unwinding machines such as are commonly employed in the unwinding of strip stock from one reel and simultaneously winding it upon another reel.

In devices of the character mentioned, the diameter of the winding reel is constantly increasing while the diameter of the unwinding reel is constantly decreasing. The lineal velocity at which the two reels move must be maintained substantially equal, however, as otherwise the strip of stock which inter-connects the representative reels will either sag or be subjected to too much tension. The subsection of the inter-connecting strip of stock to tension is in many cases quite undesirable, but despite this fact devices commonly employed for the purpose have involved the application of a brake to the unwinding reel and thus deliberately transmit force from the winding reel through the inter-connecting strip to rotate the unwinding reel against the action of the brake. This has many objections well-known to the art, such as scratching and stretching the metal.

The object of the present invention generally stated is to provide an apparatus of the character referred to wherein the strip of stock extending between the winding and unwinding reels is subjected to no more tension than that imposed by its dead weight.

Another object of the invention is to provide an apparatus of the character referred to wherein the rotational speed of an electric motor driving the winding reel is automatically decreased as the diameter of the winding reel increases and the speed of an electric motor driving the unwinding reel is automatically increased as the diameter of the unwinding reel decreases.

Still another object of the invention is to provide a control system for electric motors whereby increase in the rotational speed of one automatically effects a reduction in the rotational speed of the other.

In accordance with the present invention, reeling apparatus is provided wherein both the winding and the unwinding reels are motor-driven and the respective motors have their armatures energized in parallel circuit relationship from a common source of power. The invention particularly contemplates that each of the reel-driving motors be equipped with a generator. The generator on one motor is connected to excite the field of the other motor and vice-versa. Accordingly, as the rotational speed of the winding motor decreases (as the convolutions of stock build up upon the wind-

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ing reel), the rotational speed of the generator connected to that motor likewise decreases and consequently the output voltage of that generator decreases. Accordingly, the excitation of the field of the unwinding motor is decreased proportionately and as a consequence thereof the rotational speed of the unwinding motor increases (as it must to maintain the linear velocity of the strip at the decreasing radius of convolutions on the unwinding reel).

In order to assure that the sag in the strip inter-connecting the two reels be maintained on or near its optimum value, the invention further contemplates the provision of means responsive to the decrease of sag in the inter-connecting strip for increasing or decreasing, as the case may be, the excitation of one or the other of the generators aforesaid. While both said generators preferably have their fields constantly excited from a common source, an auxiliary source of excitation may be provided for boosting or bucking the voltage from the normal source of excitation. Where such auxiliary source of excitation is introduced into the field circuit of the generator driven by the winding motor, it is connected so as to effect an increase in the excitation of that generator and a speed reduction at the unwinding motor as the amount of sag in the inter-connecting strip increases above the optimum value. Conversely, as the amount of sag in the inter-connecting strip decreases below the optimum value, the voltage impressed upon the generator's field circuit is reduced so as to actually reduce the normal excitation of the generator driven by the winding motor. In the latter case, decrease of the field voltage on the generator connected with the winding motor results in an increase of the rotational speed of the unwinding motor and consequently an increase in sag. Any of a great variety of devices may be utilized for controlling the excitation of one of the motors in accordance with the degree of sag of the strip. Such may be accomplished by a variable resistor actuated between full-out and full-in positions either mechanically or electronically in accordance with the position of the valley of the inter-connecting strip. Preferably, however, the invention contemplates that the strip itself constitute one plate of a condenser, the opposite plate of which is arranged adjacent the path of the strip either above the position of minimum sag or below the position of maximum sag, and such condenser is connected to vary the voltage output of the booster, depending upon whether the strip being wound is close to or remote from the fixed condenser plate.

Other objects and advantages of the invention will be apparent to those skilled in the art when the following description is read in connection with the accompanying drawings in which:

Figure 1 is a diagrammatic representation of the reeling apparatus and the appurtenant electrical connections.

Figure 2 is a diagrammatic view showing one form of electronic generator and its connections, suitable for use in connection with the present invention.

Referring now to the drawings for an illustrative embodiment of the invention, a sagging strip of metal 1 is being simultaneously unwound from a reel 2 and wound upon a reel 3. The term "sagging strip" is herein employed in the sense of meaning a strip substantially free of all tension except that caused by the weight of the strip. The reel 2 is driven by an electric motor 4 and the reel 3 is driven by an electric motor 5.

The motors 4 and 5 have their armatures connected in parallel with a supply circuit 6 energized by a generator 7 which in the embodiment shown is driven by alternating current motor 8. In the embodiment shown, the motors 4 and 5 and the generator 7 are direct current machines.

Connected so as to be driven by the motors 4 and 5 respectively, there is provided a pair of generators 10 and 11. The generator 10 supplies the voltage for energizing the field circuit 12 of motor 5 and the generator 11 supplies the voltage for energizing the field circuit 13 of motor 4. Suitable rheostats 14 and 15 are provided in series with the field windings 12 and 13 respectively.

The field windings of the several generators 7, 10, and 11 are energized from a supply circuit 16 which is connected with an exciter generator 17 driven by the motor 8.

The field winding 18 for generator 11 is connected in series with a supplemental source of voltage 19 which may reduce or increase the voltage supplied field 13 by generator 17, depending upon the sag existing in the strip 1 between reels 2 and 3. In the embodiment shown, the control 19 is in the form of an electronic generator (one type of which is shown in Figure 2), energized through a transformer 23 connected with the source supplying motor 8, or otherwise suitably energized.

A fixed condenser plate 21 is located adjacent the path of the strip 1 and preferably immediately below the position of maximum optimum sag (shown in full line) of the strip 1; but may be located above the position of minimum sag (shown in broken line) of the strip 1. The condenser plate 21 is insulated from ground and connected through a conductor 22 to the filter circuit of the power tube of booster 19. The strip 1 is grounded through one or both of the unwinding reels and when in physically spaced-relationship to the fixed condenser plate 21 constitutes therewith a condenser whose capacity varies as the position of the strip 1 varies between the extremes shown by the full and dotted lines.

The electronic generator 19 may be any well-known electronic generator circuit, one suitable form of which is shown in Figure 2, and consists essentially of a gas-filled triode or grid-controlled rectifier tube 25 energized from transformer 20. The grid element 26 of tube 25 is connected in a firing circuit energized by an auxiliary transformer 27, the primary of which is connected in parallel circuit relationship with the primary of

transformer 20. The grid circuit includes a suitable inductance 28 and a variable resistor 29, from which the grid circuit extends through conductor 22 to the fixed condenser plate 21 above-described. The plate circuit of the tube 25 in series with the secondary of transformer 20 includes an inductance 30, a resistor 31, and a condenser 32, all of which are appropriately balanced with the elements of the grid circuit, so that as strip 1 approaches plate 21, the less is the output voltage of rectifier 25 and vice-versa. The output voltage of rectifier 25 is arranged to buck the voltage supplied by circuit 16 to field 18. Consequently, the net voltage across field 18 is greatest when strip 1 is in its closest position to plate 21 and is least when strip 1 is in its most remote position from plate 21.

Accordingly, the closer strip 1 moves to plate 21, the stronger the field of generator 11 and the higher the voltage output thereof. The increased voltage output of generator 11 strengthens the field 13 of motor 4 and reduces the speed thereof. Upon such reduction in speed of motor 4, the voltage output of generator 10 is reduced, which weakens the field 12 of motor 5 and speeds that motor accordingly. As the speed of motor 4 (reel 2) is reduced concomitantly with an increase in speed of motor 5 (reel 3), the amount of sag in strip 1 will be reduced.

As the amount of sag in strip 1 approaches the minimum value indicated by the dotted line, the distance between the two plates of the condenser at 21 increases so that the control 19 now bucks the voltage supplied field 13 from supply circuit 16 to its maximum extent, with the result that the field of generator 11 is weakened and that generator consequently reduces its output voltage. This weakens the field of motor 4 and causes the speed thereof to increase. As the speed of motor 4 increases, the voltage output from generator 4 increases, strengthening the field 12 of motor 5 and thus causing that motor to slow. As a result of the increase in speed of reel 2, and decrease in speed of reel 3, the amount of sag in the strip 1 increases.

By appropriate adjustment of the several rheostats, the system even without control 19 and condenser 21 may be balanced so that the increasing speed of unwinding reel motor, occurring simultaneously with the decrease in speed of the winding reel motor, functions to maintain a fairly constant amount of sag in the inter-connecting loop of strip 1 between the reels. For some purposes, the variation in the amount of sag might therefore be controlled, within the desired limits, without utilizing the control 19 or any equivalent source of auxiliary voltage. In other cases, however, where it is desired to have greater stability and maintain the amount of sag within very close limits, such may be accomplished by varying the auxiliary source of voltage in accordance with the position of the valley in the strip 1.

From the foregoing description, those skilled in the art should readily understand the construction, operation, and advantages of the present invention and realize that it accomplishes its objects. While one specific embodiment of the invention has been disclosed in detail, it will be readily apparent to those skilled in the art that various equivalent and alternative means may be substituted to accomplish the functions of the several elements, respectively.

Having thus described the invention, what

is claimed and desired to be secured by Letters Patent is:

1. A reeling system having a winding motor and unwinding motor, said motors driving reels interconnected by a sagging strip of metal being wound at one end and unwound at the other end, the armatures of said motors being simultaneously energized in parallel from a common source, and the fields of said motors respectively being energized at varying voltages proportional to the speed of the other motor, whereby as the speed of the winding motor decreases the speed of the unwinding motor increases.

2. A reeling system having a winding motor and unwinding motor, said motors driving reels interconnected by a sagging strip of metal being wound at one end and unwound at the other end, the armatures of said motors being simultaneously energized in parallel from a common source, generators driven by each of said motors, the generator on each motor being connected to excite the field of the other motor.

3. A reeling system having a winding motor and unwinding motor, said motors driving reels interconnected by a sagging strip of metal being wound at one end and unwound at the other end, the armatures of said motors being simultaneously energized in parallel from a common source, generators driven by each of said motors, the generator on each motor being connected to excite the field of the other motor, and means responsive to the slack of said strip between the reels to vary the excitation of one of said generators.

4. A reeling system having a winding motor and unwinding motor, said motors driving reels interconnected by a sagging strip of metal being wound at one end and unwound at the other end, the armatures of said motors being simultaneously energized in parallel from a common source, generators driven by each of said motors, the generator on each motor being connected to excite the field of the other motor, and means responsive to the slack of said strip between the reels to increase the excitation on the generator driven by the winding motor and thereby increase the excitation on the field of the unwinding motor when the slack of said strip is greater than optimum and vice-versa.

5. The combination of claim 3 wherein the strip constitutes one plate of a condenser, the opposite plate of which is disposed adjacent the path of the strip between the reels, and said condenser is connected to control the output voltage of a separate voltage source connected in series with the field of said one of said generators.

6. A reeling system having a winding motor and an unwinding motor, both of said motors continuously driving reels interconnected by a sagging strip of metal being wound at one

end and unwound at the other end, first control means for gradually increasing the speed of the unwinding motor to feed the strip from the reel at a constant lineal speed, second control means for gradually reducing the speed of the winding motor to pick up the strip at a constant lineal speed, the slack in the strip being such that the two said control means are not influenced by the tension in the strip, and means responsive to the degree of sag in said strip between said reels to modulate said speed-varying means and maintain the degree of sag in said strip between limits.

7. A reeling system having winding and unwinding reels interconnected by a sagging strip substantially free of tension other than that resulting from the weight of the strip, independent electrically-controlled variable speed drives for said reels, a first electric circuit connected to control the speed of the winding reel, a second electric circuit connected to control the speed of the unwinding reel, said first control circuit having a speed-responsive voltage source connected to decrease the speed of the winding reel in direct proportion to increase in the speed of the unwinding reel, said second control having a speed-responsive voltage source connected to increase the speed of the unwinding reel in direct proportion to decrease in the speed of the winding reel, and both circuits being connected for simultaneous control of the responsive electric drives.

8. Apparatus as set forth in claim 7, wherein one of said circuits further includes a voltage source responsive to variations in the sag of the strip, said sag-responsive voltage source being connected to increase the speed of the winding reel and decrease the speed of the unwinding reel in response to increase in sag, and to decrease the speed of the winding reel and increase the speed of the unwinding reel in response to decrease in sag.

9. Apparatus as set forth in claim 8, wherein said sag-responsive voltage source comprises sag-detecting means constituted by a fixed electrode located adjacent said sagging strip, said electrode in combination with said strip forming a capacitor, the capacitance of which varies in proportion to the spacing between the strip and fixed electrode.

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