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Nittschalk et al.

[11] **3,876,167**

[45] **Apr. 8, 1975**

[54] **APPARATUS FOR CONTROLLING THE DRIVE OF A LAYING DEVICE IN A WINDING MACHINE**

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[22] Filed: **June 27, 1973**

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[52] **U.S. Cl.**..... **242/158.4 R;** 242/25 R; 242/158.2

[51] **Int. Cl.**..... **B65h 54/28**

[58] **Field of Search**..... 242/158.4 R, 158.4 A, 158, 242/158.2, 25 R, 25 A

[56] **References Cited**

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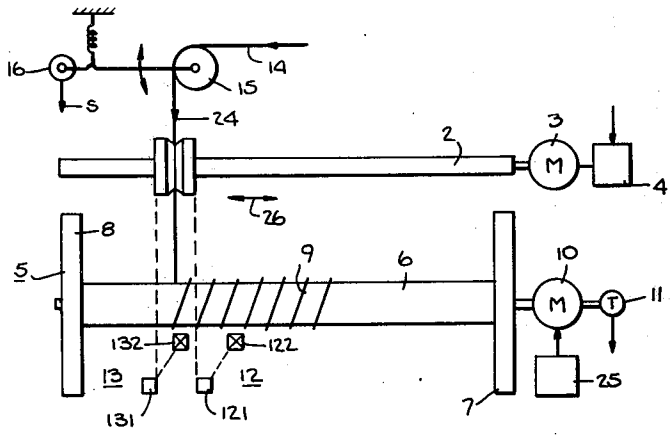
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Attorney, Agent, or Firm—Kenyon & Kenyon Reilly Carr & Chapin

[57] **ABSTRACT**

A winding machine including a wire laying means, a reel on which the wire is wound, a motor for driving the wire laying means, and means for reversing the driving motor. The improvement comprises means for controlling the reversal of the wire laying means including means for sensing the ends of the reel and generating an output signal indicative thereof; means coupled to the sensing means and the motor reversing means, and responsive to the output signal generated by the sensing means, for transmitting the generated signal to the motor reversing means after a predetermined delay period; means for sensing non-uniform distribution of the wire at the ends of the reel and generating a second output signal indicative thereof; means coupled to the first output signal transmitting means and responsive to the second output signal generated for adjusting the predetermined delay period; and means coupled to the first output signal transmitting means for gradually restoring the signal delay period to the predetermined delay period.

5 Claims, 2 Drawing Figures



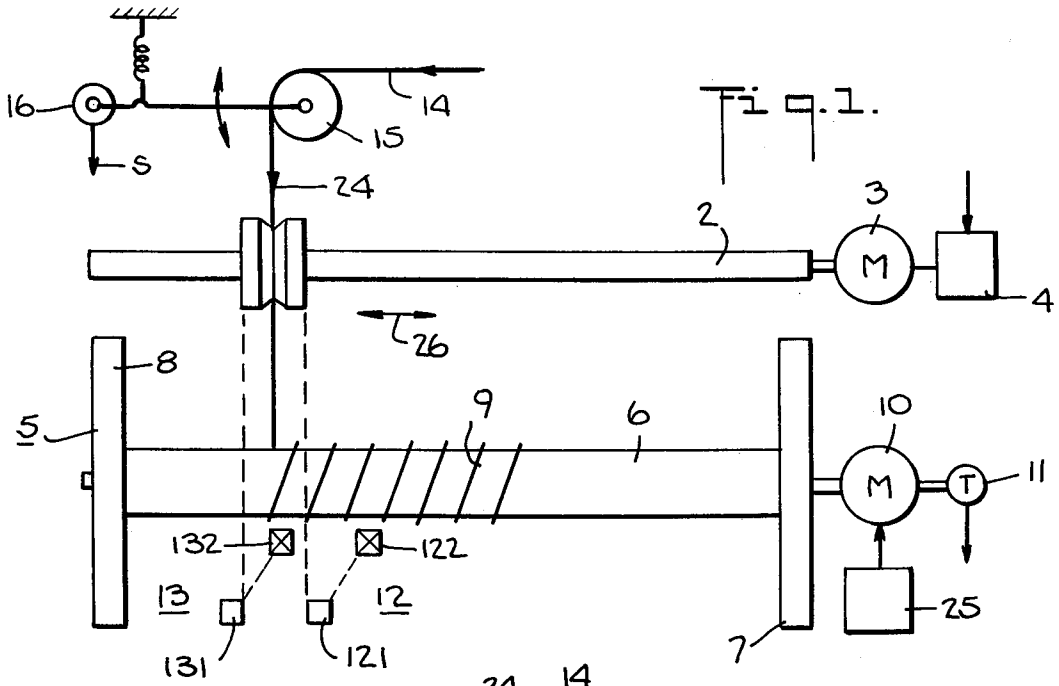

16
S
15
14
24
2
3
M
4
26
8
5
9
6
10
M
T
11
132
122
13
12
131
121
7
25

Fig. 1.

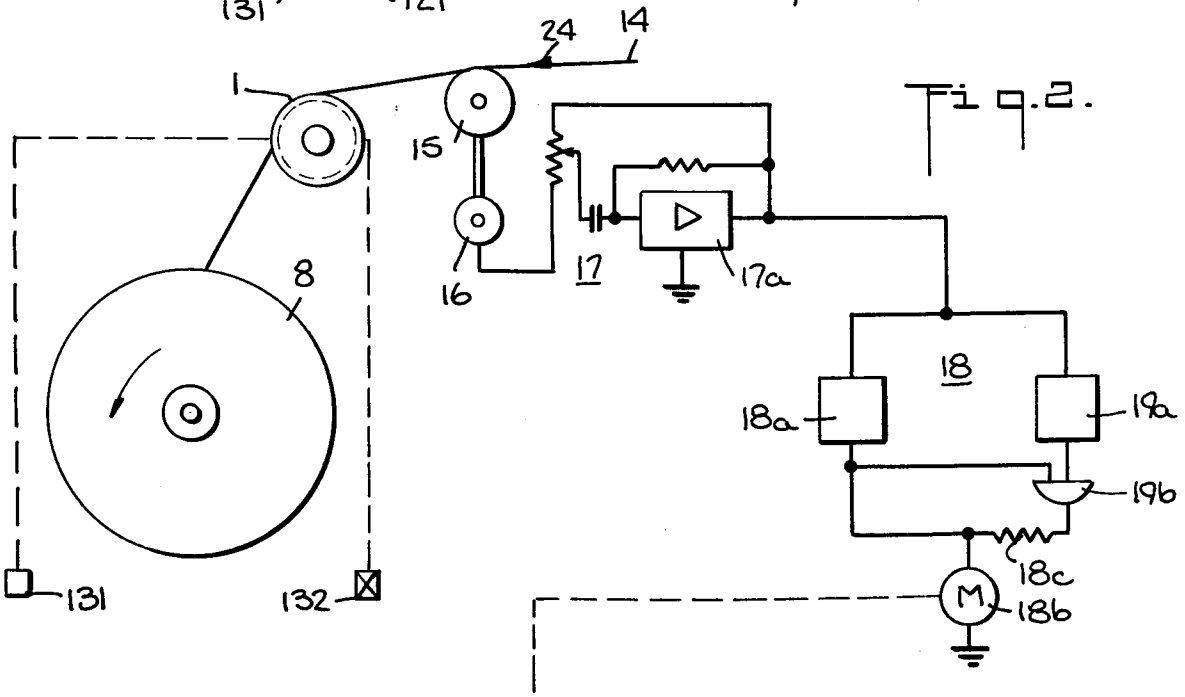
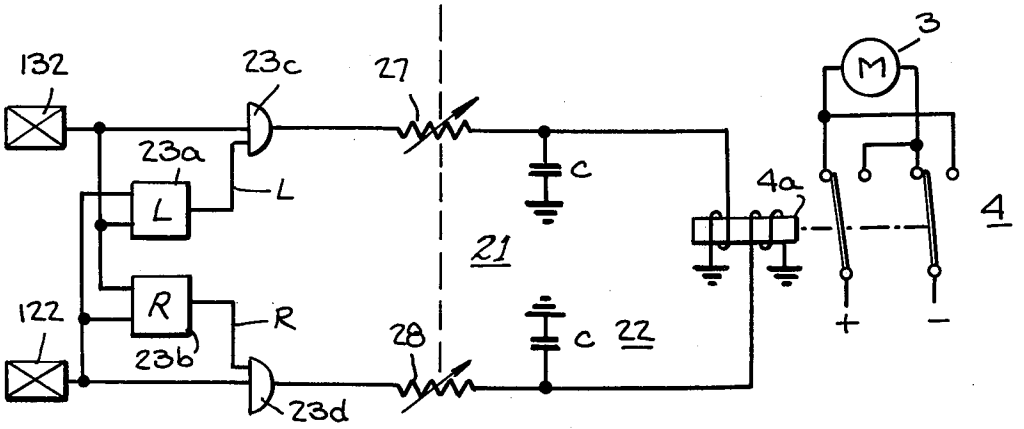

24
14
1
15
16
17
17a
8
18
18a
18b
18c
M
18b
131
132

Fig. 2.


132
23c
27
3
M
23a
L
L
c
4a
4
21
122
R
R
23b
28
c
22
23d
+
−

APPARATUS FOR CONTROLLING THE DRIVE OF A LAYING DEVICE IN A WINDING MACHINE

BACKGROUND OF THE INVENTION

This invention relates to winding machines in general and more particularly to an improved manner of controlling the drive of a laying device in such a winding machine.

In winding materials, such as wire obtained from a wire drawing machine, on to reels or the like, a laying device is generally employed which moves back and forth across the reel to evenly distribute the material being wound as the reel rotates. At each end of the reel means are provided to cause the laying device to reverse so that it continually moves back and forth across the reel. Some devices used in initiating reversal at the end point use cams and limit switches. For example, see U.S. Pat. No. 2,845,229. With a device of this nature, a new setting is often required when reels are changed. This requirement constitutes a disadvantage particularly when using automatically operated dual reels. With devices such as this, as with any type of reversal control device, it is important that the reversing points be accurately set so that turns do not pile up at these points. Such piling up or the opposite condition i.e. a depression, are quite undesirable from a winding technology view point.

To avoid the disadvantages of mechanical devices, systems have been developed using sensors which operate without physical contact. These sensors may be placed on the ends of a rod coupled to the laying device so that the sensors function without any physical contact and interact with the real flanges. Optical, pneumatic, or electrical sensors may be used for this purpose to provide the reversing signal for the laying device. Such a system is shown in German Offenlegungsschrift 2,033,284.

In winding systems of this nature, the speed of rotation of the reel is sometimes controlled using the motion of a feeler roller which is arranged ahead of the laying device. Typical of such a device is that shown in German Offenlegungsschrift 2,005,503. In the system illustrated therein, the reversal of the laying device is obtained in response to signals from limit switches. In addition, the signal taken off at the feeler roller is used for shifting the reversing points or to change the velocity of the laying device at the reversal points to thereby prevent piling up or thinning out of the turns as the laying device reverses. With this arrangement, the reversal command is given earlier if the turns have piled up at the end of the reel. This achieves a certain degree of compensation. However, tests have shown that a pile up can occur ahead of the end of the reel. This pile up in turn can cause, via the sensing of the feeler roller, erroneous pulses in the next reversal command and can lead to a thinning out of the reel ends which cannot be made up.

Thus, there is a need for an improved control apparatus for such laying devices which avoids problems of build up and thinning out.

SUMMARY OF THE INVENTION

The present invention achieves these ends by providing a control arrangement for a laying device such as that described above which assures that the feeler roller will not provide erroneous information to the reversing control and thus a uniform or other predetermined distribution of winding on the reel will be obtained. To accomplish this, means are provided to cancel, over a period of time, the delay which is inserted in response to outputs of the feeler roller. This prevents the variations of the measured value, which may be caused by a change of the reversing point, from entering the control process as interfering signals. In a preferred embodiment, sensors in the form of light gates which react with the reel flanges are used. The outputs of these devices are provided through delay elements, whose delay characteristics can be changed, if a predetermined value of the velocity of the feeler roller motion is exceeded. The delay inserted is then returned to a starting value over a period of time using a further timer. In this manner a decrease in the delay time caused, for example, by a pile up of turns, can be cancelled out as a function of time. For example, the delay can be preset to cancel out over a one minute period.

A particularly advantageous drive for the laying device is obtained using an electric stepping motor. Such a motor provides an almost instantaneous reversal at any desired point without any dead time. This substantially reduces the problems associated with piling up and thinning out. In addition, stepping motor are easily adaptable to provide other desired winding geometries.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is an elevation view, partially shown in block and schematic diagram form, of a laying device according to the present invention.

FIG. 2 is a side view of FIG. 1 and showing the control elements in block diagram form.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

As shown on FIG. 1, the material 14 to be wound which would be, for example, copper wire is fed from a wire drawing machine (not shown) with a velocity of in the order of 50 meters per second in the direction of arrow 24 to be wound in turns 9 on a reel 5. Reel 5 comprises a central cylindrical core 6 attached to end flanges 7 and 8 and is mounted for rotation in conventional fashion and driven by a motor 10. The wire 14 is brought over a feeler roller 15 to the laying device 1 which guides it back and forth in the direction of arrow 26 across the core 6 of reel 5. At each of the flanges 7 and 8 the laying device 1 must reverse its direction. Laying device 1 will be, for example, a pulley-like member threaded on the inside and driven by a spindle 2 having matching threads so that the rotation of the spindle 2 will cause motion of the laying device 1. Spindle 2 is driven by a motor 3 which is controlled by a control device 4. Control device 4 causes motor 3 to rotate in either a clockwise or counterclockwise direction to thereby cause the laying device 1 to move in one of the two direction indicated by arrow 26. The position of the feeler roller 15 is converted by a rotary potentiometer 16 into an electrical quantity in a well known manner. The motor 10, driving the reel 5 is controlled by control means 25 in a manner such that the winding velocity of the wire remains constant. That is, with increasing diameter of the winding of the speed of rotation is reduced for example from 8,000 RPM when the reel is empty to 4,000 RPM with a fully wind reel. Such a drive system is disclosed in the above referenced German offenlegungsschrift 2,005,503. A tachometer 11 which will provide an electrical signal pro-

portional to the speed of the motor **10** at its output is also shown.

To determine the proper point of reversal, there is attached to each side of the laying device **1**a light gates **12** and **13** respectively. Light gate **13** comprises a transmitter **131** and a receiver **132.** Similarly light gate **12** comprises a transmitter **121** and a receiver **122.** Transmitters **131** and **121** will comprise a light source which will direct a beam of light toward their respective receivers **132** and **122.** The receivers **132** and **122** may by any conventional light detector. When between the flanges, the light emitted by the transmitters will be detected by the receivers and each will provide an output signal. However, when either end of the reel is reached one of the light paths will be broken by a reel flange and the signal will disappear. This may then be detected to initiate a reversal as will be described below. For example, when moving to the left, the light gate **13** will have its light path interrupted by the reel flange **8** causing a reversal and motion to the right. When the laying device **1** gets all the way to the right hand side, the light path of the light gate **12** will be broken by the reel flange **7** causing a reversal of direction and motion to the left.

The control system for the laying device of the present invention is illustrated in more detail by the block diagram of FIG. **2.** The outputs of the receivers **122** and **132** are respectively provided to AND gates **23***c* and **23***d*. Gate **23***c* has an enabling signal designated L from a flip flop **23**a indicating motion in the left hand direction and gate **23**d an enabling signal designated R from a flip flop **23***b* indicating motion in the right hand direction. Thus, the light gate **12** and its associated receiver **122** is enabled only when moving toward the right. Similarly, the light gate **13** and its receiver **132** are only enabled when moving to the left. The signal from transmitter **132** provides a set input to flip flop **23***b* and a reset input to flip flop **23***a*. Similarly the signal from transmitter **122** is used to set flip flop **23***a* and reset flip flop **23***b*. Thus when the laying device moves all the way left flip flop **23***b* is set to enable the gate **23***d* associated with transmitter **122** for detecting the end of motion to the right. The opposite occurs when the laying device moves all the way left. The signal provided at the output of transmitter **132** is provided through the gate **23***c* and a delay means **21,** to be described below, to the control means **4.** In like manner, the output of the receiver **122** is provided through gate **23***d* and a time delay **22** to control means **4.** Control means **4** will, for example, comprise a bidirectional latching relay **4**a having the respective outputs of delays **21** and **22** as its two inputs, the contact of relay **4**a switching in response thereto to reverse the direction of the motor **3** of FIG. **1.** Delay means **21** and **22** can comprise conventional resistor capacitor delay circuits which include respectively variable resistors **27** and **28** each having an associated capacitor to ground at its output and which resistors are controlled in a manner to be described below. Thus, by setting of the variable resistors or potentiometers **27** and **28** it is possible to vary the amount of delay between the time when one of the receivers **122** and **132** first generates a reversing signal and the time when the reversing occurs at motor **3.** In general terms, the delay time is initially adjusted based on the dead time of the reversing drive and, as will be described below, also on the value S as output by the potentiometer **16.**

The output of the potentiometer **16,** providing an electrical signal which is proportional to the position S of the feeler roller **15,** is provided to a differentiator **17** which comprises a conventional operational amplifier **17***a* having input and feed back circuits arranged to provide differentiation. This differentiation will result in the value ds/dt or the velocity of pivotal motion of the feeler roller **15.** This value of velocity is then used as the input to a control stage **18.** Its value is sensed and, if that value exceeds a predetermined level, it is used to control the time delay of the delay means **21** and **22** by adjusting the value of the resistances **27** and **28.** As shown, the control stage **18** includes monostable multivibrator **18***a* arranged to trigger when the output of differentiator **17** exceeds a preset value. The output of multivibrator **18**a is coupled to a motor which positions the potentiometers **27** and **28.** Similarly, control of the resistances **27** and **28** may be done wholly electronically, for example, by converting the sampled voltage in a analog to digital converter and using the digital output to switch in appropriate resistances.

In operation, when a build up occurs on the reel **5,** it is detected by the feeler roller **15.** A build up will cause the feeler roller to be jerked down. This change in S will be transmitted by the potentiometer **16** and after differentiation will result as an output from differentiator **17** indicating a significant velocity which exceeds the preset level. In response to this multivibrator **18***a* will provide a voltage output of a polarity to drive motor **18***b* as to adjust the potentiometers **27** or **28** to provide a shorter delay time so that reversal occurs before the wire gets all the way up to the end where the pile up occurred. This will result in the rest of the winding being brought up to where it is even with the build-up portion near the edge. However, if this delay is not changed, the result will be a thinning out near the edges. That is reversal occurs early so that wire is not wound near the flanges. Thus, it is essential that over a time period, during which the remainder of the winding has time to build up, the delay again be lengthened so as to continue winding wire all the way to the flanges without a thinning out. To accomplish this, a second multivibrator **19***a*, a gate **19***b* and resistor **18***c* are provided. The multivibrator **19***a* will trigger at the same time as multivibrator **18***a*. This output will be blocked initially at gate **19***b* by the output of multivibrator **18***a*. At the end of the signal from multivibrator **18***a* the output of gate **19***b* will provide through resistor **18***c* a signal of opposite polarity to slowly return the motor **18***b* to its original position. This results in a fast correction with a slow cancelation thereof. Multivibrator **18***a* will output a pulse shorter than that of multivibrator **19***a* so that the required operation occurs properly. The end result of operation in this manner is that peaks are detected and removed without the danger of thinning out portions of the winding.

The operation of this system will now be summarized. Primary control of the laying of the wire or the like on the reel **5** is controlled through the light gates **12** and **13** which will cause a reversal as the ends of the reels are reached. The use of light gates permits using reels of different size without any modification. Based on the known characteristics of the device a predetermined time delay is determined and set into the time delay means **21** and **22** in such a manner as to compensate for the dead time of this system in reversing. However, since this cannot be done with complete accuracy, the

velocity of the feeler roller over the laying device **1** is obtained and used to shorten the delay time when a build up is sensed near the ends. This will result in the winding not reaching all the way to the ends of the reel. If allowed to continue, a valley would develop which would not be sensed since the winding would never reach the point of the valley and thus the feeler roller **15** would not respond thereto. To avoid this problem, additional means are provided which gradually restore the time delay of the delay means **21** and **22** to their normal delay length thus resulting in the winding gradually moving out to the edges and the peak being eliminated without the danger of having valleys at the end of the reels.

Various modifications may be made to the present invention. For example, instead of using a feeler roller, a tachometer roller or a tension measuring device may also be used. A peak in the winding also causes an increase in the wire velocity which would be sensed by the tachometer roller. Due to the mass inertia of the deflection roller in a tension measuring device, a peak will cause an increase in wire tension which can also be sensed. These and other modifications may be made without departing from the spirit of the invention which is intended to be limited solely by the appended claims.

What is to be claimed is:

1. In a winding machine including a wire laying means, a reel on which the wire is wound, a motor for driving the wire laying means, and means for reversing the driving motor, means for controlling the reversal of the wire laying means, comprising:

means for sensing the ends of said reel and generating a first output signal indicative thereof;

means, coupled to said sensing means and said motor reversing means, and responsive to said output signal, for transmitting said signal to said motor reversing means after a predetermined delay period;

means for sensing non-uniform distribution of the wire at the ends of said reel and generating a second output signal indicative thereof;

means, coupled to said first output signal transmitting means and responsive to said second output signal, for adjusting said predetermined delay period; and

means, coupled to said first output signal transmitting means, for gradually restoring the signal delay period to said predetermined delay period.

2. The invention according to claim **1**, wherein said reel comprises a central core and two end flanges, and wherein said means for sensing the ends of said reel comprise light gates arranged to intersect the flanges of said reel.

3. The invention according to claim **2** wherein a pivotable roller is installed ahead of the laying device in engagement with the wire, and said means for sensing non-uniform wire distribution comprises means for sensing the velocity of pivotal motion of said feeler roller and means for adjusting said predetermined delay period when said feeler roller velocity exceeds a predetermined value.

4. The invention according to claim **1** wherein said driving motor comprises an electric stepping motor.

5. A method of controlling the reversal of direction of a wire laying means driven by a motor, which winds the wire on a reel in a winding machine, comprising the steps of:

moving the wire laying means to distribute wire on the reel;

sensing the point at which the ends of the reel are reached by said wire laying means;

reversing the direction of the wire laying means a predetermined delay time after said reel ends are sensed;

sensing the uniformity of distribution of the wire wound on the reel;

adjusting said delay time when non-uniform wire distribution on said reel is sensed; and

gradually restoring said delay time to said predetermined delay time.

* * * * *

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 3,876,167
DATED : April 8, 1975
INVENTOR(S) : Rainer Nittschalk et al

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

In column 4, line 8, change "feeler roller 15." to read --feeler roller 15 about its axis--

Signed and Sealed this

seventh Day of October 1975

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks