July 18, 1944. W. BERTHOLD ET AL 2,353,639

METHOD OF AND APPARATUS FOR CONTROLLING SPOOLING MOTORS

Filed Nov. 28, 1941

FIG. 1

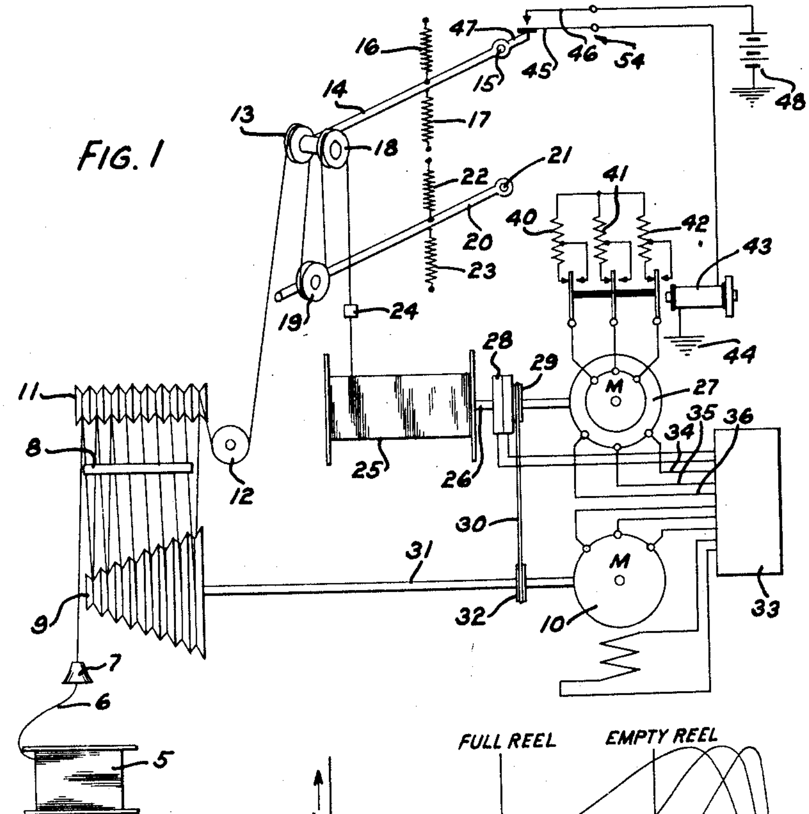


FIG. 2

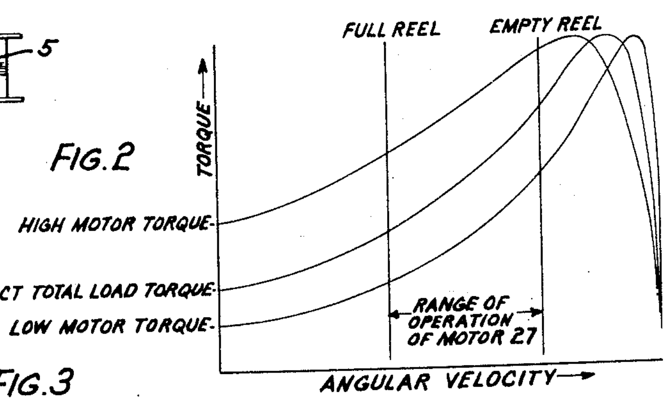


FIG. 3

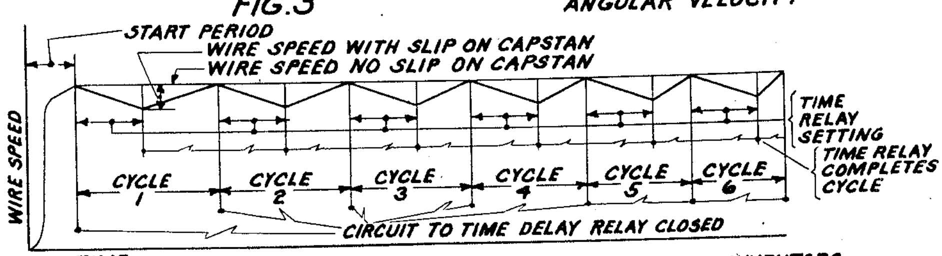
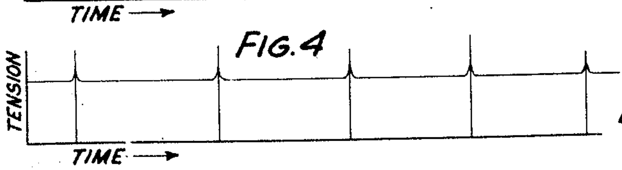


FIG. 4



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Patented July 18, 1944 2,353,639

UNITED STATES PATENT OFFICE

2,353,639

METHOD OF AND APPARATUS FOR CONTROLLING SPOOLING MOTORS

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Application November 28, 1941, Serial No. 420,768

14 Claims. (Cl. 242—45)

This invention relates to a method of and apparatus for controlling spooling motors and more particularly to a method of and apparatus for controlling the takeup spool operation of a wire drawing machine.

In the operation of modern high speed wire drawing machines used in the manufacture of fine wire, it has been the practice, in some instances, to permit the wire on the last step of the wire drawing capstan to slip slightly in order to prevent breakage of the wire. In order to permit this slip, it is essential that the takeup mechanism does not apply excessive tension to the wire and that the average wire speed be held lower than the surface speed of the last capstan. Furthermore, there have been continued attempts to draw greater lengths of wire without breakage in the wire, resulting in the use of relatively large spools having drums of small diameter so that the spool will hold a large amount of fine wire. In apparatus of this type, great difficulty has been experienced in controlling the speed of the takeup spool for the wire drawing apparatus so that there is the least possible tendency for the takeup spool to apply excessive tension to the wire.

It is an object of the present invention to provide an improved method of and apparatus for obtaining a selected average tension on strands in strand handling machines.

In accordance with one embodiment of the invention, the speed of the wire between the last step of the wire drawing capstan and the takeup spool is controlled by varying the torque of the spooler motor in cycles between a relatively high value and a relatively low value, to maintain a controlled slip on the last capstan and thereby maintaining the tension in the wire between the capstan and takeup spool substantially constant throughout most of the cycle of the apparatus. The decrease in motor torque is initiated, in accordance with the present method, by by-passing a portion of the resistance of the spooling motor's rotor circuit under control of a tension arm between the capstan of the wire drawing apparatus and the takeup spool, which tension arm will close a circuit to a slow to release or time delay relay when the tension on the wire reaches a predetermined point. The slow to release or time delay relay, upon being energized, will cut out a portion of the resistance in the rotor circuit for a definite short period of time and since the motor normally operates on the portion of its speed torque curve where both speed and torque are descending, the by-passing of part of its resistance will reduce its torque. The time during which the resistance is cut out of the spooling motor's rotor circuit may be set to control the maximum slip between the last step of the capstan and the wire.

A better understanding of the invention may be had by reference to the drawing, wherein

Fig. 1 shows, diagrammatically, a wire drawing apparatus and its spooling motor, together with a control circuit for the spooling motor operated in accordance with the present method;

Fig. 2 shows, diagrammatically, the speed torque curve of the spooler motor;

Fig. 3 shows, diagrammatically, the wire speed-time curve, and

Fig. 4 shows, diagrammatically, the wire tension-time curve.

In the drawing, the numeral **5** designates a supply spool on which there is wound a supply of relatively coarse wire **6**. Suitably mounted adjacent the supply spool **5** is a bell-shaped guide **7** for directing wire from the supply spool **5** to the first wire drawing die mounted in a die block **8**. The wire will be withdrawn from the supply spool **5** by a wire drawing capstan **9**, driven by a drawing motor **10**, suitable guide rollers **11** being provided for guiding the wire **6** in its passage between the capstan **9** and the dies in the die block **8**.

After the wire has been passed through the dies in the die block **8**, wrapped a predetermined number of times around the capstan **9** and passed over the guide rollers **11**, it is directed from the last pass of the capstan **9** to a guide roller **12**. Cooperating with the guide roller **12** is a movable guide roller **13**, mounted upon a tension or upper cushioning arm **14**, which is, in turn, pivoted at **15**. The arm **14**, which supports the guide roller **13**, is normally held in a predetermined position by cooperating springs **16** and **17** and carries a second guide roller **18**.

The wire, after being passed around one of the idler guide rollers on the cushioning arm **14** is directed to an idler roller **19**, back to the other roller on **14** and down to the distributor **24**. The idler roller **19** is mounted on a cushioning arm **20**, similar to the arm **14**, the arm **20** being pivoted at **21** and being held in its normal position by cooperating springs **22** and **23**. With this arrangement, the cushioning arms may be moved relatively close together, at which time there will be a comparatively short length of wire between the fixed idler **12** and a distributor **24**, or when the tension on the wire is released somewhat, a relatively large amount of wire may be held under a definite tension between the roller **12** and the distributor 24 due to the displacement of the cushioning arms 14 and 20 and the guide rollers carried by them away from each other. The distributor 24, which is shown diagrammatically, distributes the wire over the face of the takeup spool 25 mounted upon a shaft 26 and adapted to be driven by a spooler motor 27. The shaft 26 also has mounted on it an electromagnetic type of clutch 28, which, upon energization, will connect the shaft 26 directly to a sheave 29, thereby to connect the shaft 26 through a driving element 30 to a shaft 31, which interconnects the motor 10 and capstan 9, the shaft 31 being provided with a driving sheave 32. This just described magnetic clutch and driving connection serves to connect the capstan and takeup spool during the starting periods of the machine, suitable interlocks being illustrated diagrammatically at 33. These interlocks may be of the type disclosed in the co-pending application of C. O. Haase No. 292,787, filed August 31, 1939, now Patent No. 2,266,861, issued December 23, 1941, or may be of any other suitable type which will serve to positively interconnect the takeup spool and capstan during the periods of acceleration on the starting of the apparatus. Any suitable means may be utilized for controlling the apparatus during deceleration, but since it does not pertain to the present invention, it has not been shown.

After the interlock illustrated diagrammatically at 33 has controlled the starting of the apparatus and the capstan and takeup spool have reached their normal operating speeds, the electromagnetic clutch 28 will be deenergized and the motor 27, which is preferably a 3 phase induction motor, will control the speed of the takeup spool or reel 25. The motor 27 has its stator field supplied with current through the leads 34, 35 and 36 and normally has the resistances 40, 41 and 42 connected in its rotor circuit through the break contacts of a relay 43, which may be of the slow to release type or may be a time relay settable to release after a predetermined interval upon being energized. In the diagram of Fig. 1, this device has been shown in the form of a slow to release relay in order to simplify the disclosure, but it will be understood that any suitable time delay relay may be substituted for the slow to release relay. The relay 43 has one side of its winding connected to ground at 44 and has the other side of its winding connected to one terminal of a highly sensitive switching device 54 comprising contacts 45 and 46. The contact 45 is connected to the winding of the relay 43 and is positioned to be closed by an extending portion 47 of the cushioning arm 14 when the tension in the wire between the distributor 24 and guide roller 12 reaches a predetermined relatively high value. The contact 46 of switch 54 is connected to grounded battery at 48 and when the switch 54 closes, the grounded battery at 48 will be connected through the winding of the relay 43 to ground at 44 to energize the relay 43, thus by-passing part of the resistance of the rotor circuit of motor 27.

By reference to Fig. 2, it will be seen that the range of operation of motor 27, which, as pointed out hereinbefore, is a 3 phase induction motor, is in that portion of the speed torque curve where both the speed and the torque are descending. Since the load torque is also descending at this time, the by-passing of a portion of the resistance of the rotor circuit of the motor will result in a decrease in the torque output of the motor, thereby to decrease the speed of the motor, create slip and lower the tension in the wire 6 between the roller 12 and the takeup spool 25.

Since it is desirable to operate the apparatus with a slight slip on the last pass of the wire drawing capstan, the control of the speed relation and consequent tension between the capstan and the takeup spool must be maintained within a relatively close range and, with the apparatus described hereinbefore, this is accomplished by by-passing a portion of the resistance in the rotor circuit of the takeup motor for definite time intervals. After the spooling motor or takeup motor 27 and drawing motor 10 have been started in operation and have reached their normal operating speed, the slip on the last step of the wire drawing capstan 9 will be maintained within the desired range by by-passing a part of the resistance of the rotor circuit of the spooler motor 27 at variable intervals under control of the switch 54, which will be actuated by the cushioning arm 14 when the tension in the wire reaches a predetermined value. This operation is illustrated diagrammatically in Fig. 3, wherein the time cycles of the apparatus have been illustrated and designated cycles 1 to 6, inclusive. By reference to Fig. 4, it will be seen that the tension in the wire is substantially constant over a major portion of the winding operation and when the slip at the last capstan is taken up, the tension will rise rapidly to a predetermined value, effecting closure of switch 54 and introducing a definite period of deceleration of the takeup spool. In order to illustrate this portion of the operation, the curve illustrating wire speed has been exaggerated; that is, the decrease in the time during which the resistance is normal in the rotor circuit of motor 27 has been shown as decreasing quite rapidly to bring out the fact that while the time interval during which part of the resistance of the rotor circuit of the spooler motor is by-passed is constant, the time intervals during which the resistance is in the rotor circuit of the spooler motor decreases gradually as the takeup spool 25 goes from an empty to a full condition. It is believed to be apparent from the foregoing that after the apparatus has gone through its starting period of acceleration and reached its normal operating speed, the increase in tension to a predetermined point in the wire between the capstan and takeup spool will cause the closure of switch 54 and the consequent by-passing of a portion of the resistance of the rotor circuit of the spooler motor 27 and that this by-passing of resistance will be maintained for a definite set interval, depending upon the setting or time delay characteristics of the relay 43, whereupon the resistance will automatically be cut back into the rotor circuit and will remain in the rotor circuit a variable period of time until the accumulation of wire between the rollers 13, 18 and 19 is taken up by the takeup spool and the cushioning arms 14 and 20 are moved close enough together to cause the portion 47 of arm 14 to again close switch 54. In this manner, the tension in the wire between the capstan and takeup spool and the consequent degree of slip of the wire on the last pass of the capstan will be varied within a definite predetermined range.

Although a specific embodiment of the invention has been described hereinbefore, it will be understood that modifications thereof may be made without departing from the invention, which is defined by the appended claims.

What is claimed is:

1. A method of controlling the tension of a strand in a takeup mechanism which comprises increasing the tension until it reaches a predetermined upper limit and then decreasing the tension a predetermined amount for a predetermined time, and repeating these steps to obtain a selected average tension.

2. The method of controlling the speed of a takeup spool motor relative to an associated material working apparatus which comprises applying a relatively high torque to the motor of the takeup spool tending to place the material under tension between the working apparatus and takeup spool, decreasing the resistance of the circuit of the spool motor in response to a predetermined tension in the material, and maintaining said lower resistance in the spool motor circuit for a definite length of time, thereby to alternately apply a high and low torque to the spool.

3. A method of controlling the range of tension of a strand in a takeup mechanism which comprises automatically varying the speed of the strand between fixed high and low values, initiating the low speed condition at intervals in response to a predetermined increase in tension on the strand, and maintaining said low speed condition for predetermined definite intervals.

4. A method of controlling the range of tension of a strand in a takeup mechanism which comprises automatically varying the speed of the strand between high and low values, initiating the low speed condition at intervals in response to a predetermined increase in tension on the strand, and maintaining said low speed condition for the same interval of time after each initiation thereof.

5. A method of controlling the tension of a strand between a strand working apparatus and a takeup mechanism which comprises maintaining a variable supply of strand between the working apparatus and takeup mechanism, reducing the amount of said supply to a predetermined amount, then increasing said supply at a predetermined rate for a definite time interval, and repeating these steps alternately to obtain a tension within a selected range.

6. In a strand takeup mechanism, a takeup spool, a motor for driving said spool, a tension arm movable in response to tension in the strand, means for varying the torque of the motor, and means actuated by the tension arm for rendering the means for varying the torque of the motor operative for a definite fixed interval of time.

7. In a strand takeup mechanism, a takeup spool, a motor for driving the spool, means responsive each time the strand is subjected to a predetermined amount of tension for decreasing the torque output of the motor by a predetermined amount, and means for maintaining the tension responsive means effective for a predetermined interval of time each time it is rendered effective by the tension of the strand reaching said predetermined amount.

8. In a strand takeup mechanism, a takeup spool, a motor for driving the takeup spool, resiliently supported means for maintaining a loop of strand adjacent the takeup spool, means operable by said resiliently supported means upon a predetermined decrease in the size of said loop for decreasing the torque of said motor, and means associated with said last mentioned means for maintaining said last-mentioned means operative for a predetermined time interval.

9. In a strand takeup mechanism, a takeup spool, a motor for driving the takeup spool, resiliently supported means for maintaining a loop of strand adjacent the takeup spool, means actuated by the resiliently mounted means in response to a predetermined tension in the loop for reducing the torque of the motor to increase the size of said loop, and means for maintaining said last mentioned means operative for a predetermined length of time.

10. In a strand takeup mechanism, a takeup motor operable in the portion of its speed-torque curve where torque and speed are increasing, said motor having a rotor resistance of a definite value, a takeup spool driven by said motor, guiding means for supporting a variable supply of strand adjacent said takeup spool, means actuated by the guiding means for by-passing a portion of the resistance of the rotor circuit of the motor to decrease the torque of the motor, and means for holding the last mentioned means operative for a predetermined length of time to increase the supply of strand supported by guiding means.

11. A method of controlling the tension of a strand in a takeup mechanism which comprises driving the takeup mechanism at a relatively high speed until the tension in the strand reaches a predetermined upper limit and then decreasing the speed of the takeup mechanism to a predetermined fixed speed for a fixed time, and repeating these steps to obtain a selected average tension in the strand.

12. In a strand takeup mechanism, a takeup spool, a motor for driving said spool, a tension arm movable in response to tension in the strand, means for varying the speed at which the motor drives said spool, and means actuated by the tension arm for rendering said last mentioned means operative for a definite interval of time each time the tension arm actuates it.

13. In a strand takeup mechanism, a takeup spool, a drive motor for driving the takeup spool, means for maintaining a loop of strand adjacent the takeup spool, means operable by the means for maintaining a loop of strand when the size of the loop is decreased a predetermined amount for decreasing the speed of the motor, and means associated with said last-mentioned means for maintaining said last-mentioned means operative for a predetermined time interval.

14. In a strand takeup mechanism, a takeup spool, a motor for driving said takeup spool, resiliently supported means for maintaining a loop of strand adjacent the take-up spool, means operable by said resiliently supported means when a predetermined decrease in the size of said loop occurs for decreasing the speed of said motor, and means associated with said last-mentioned means for maintaining said last mentioned means operative for a predetermined time interval.

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