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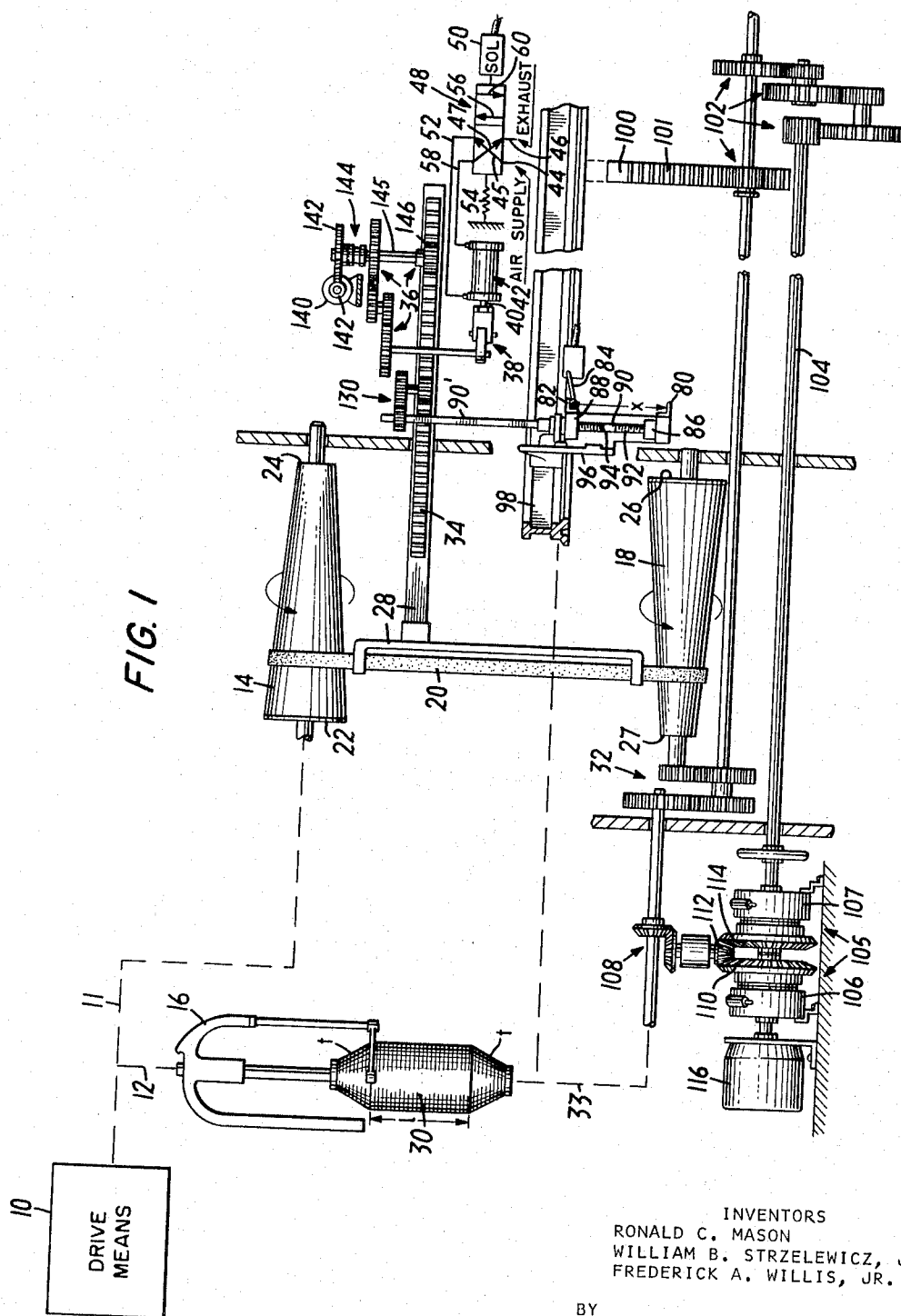
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3,316,701

WINDING APPARATUS WITH ELECTRIC CONTROL CIRCUIT

Filed Nov. 9, 1964

2 Sheets-Sheet 1



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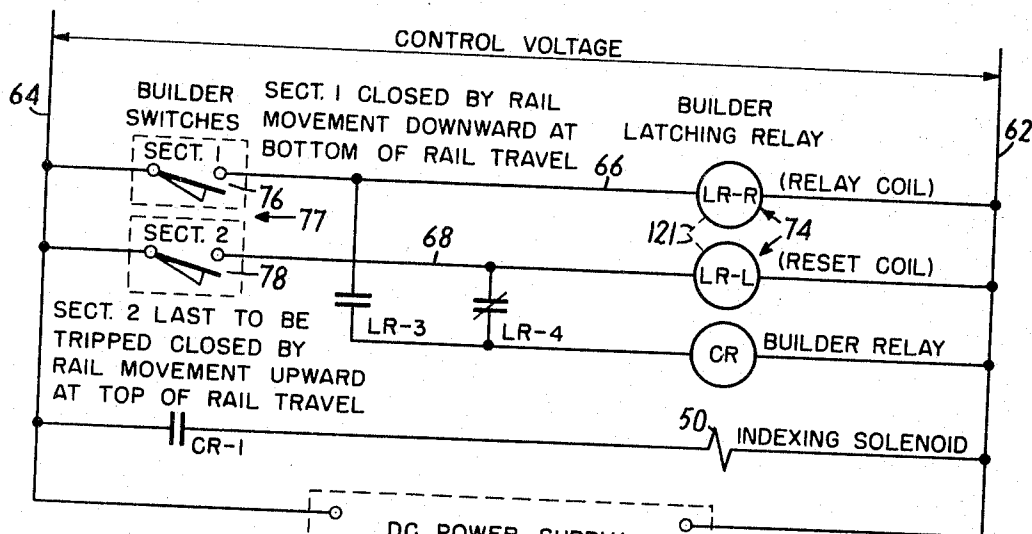


FIG. 3

NOTE:

LATCHING RELAY AS SHOWN INDICATES -
(A) RESET COIL (LR-L) LAST TO BE ENERGIZED
(B) RAIL TRAVELING DOWNWARD

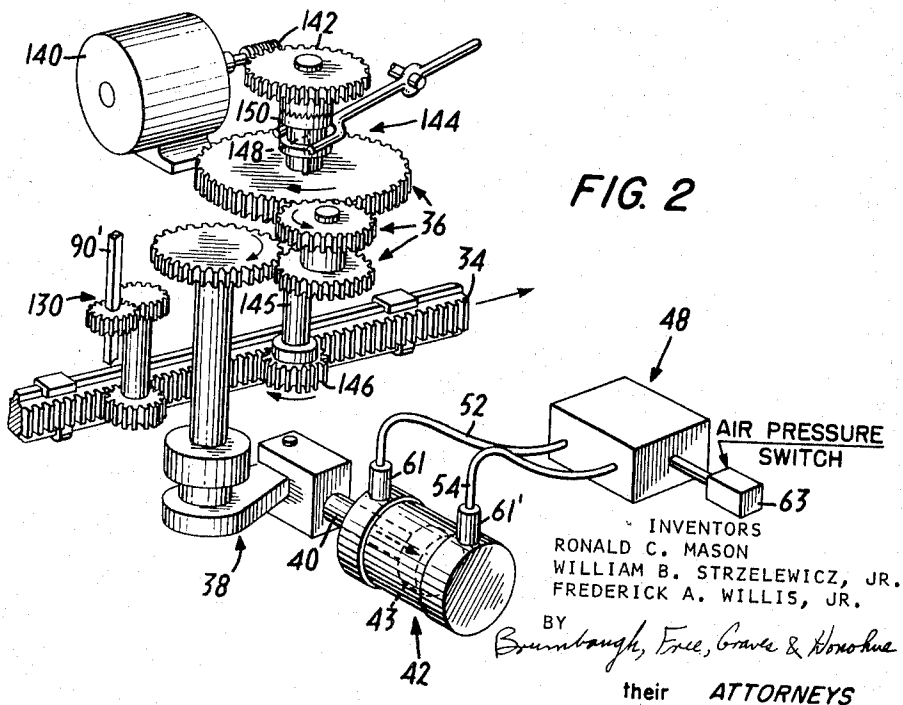


FIG. 2

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3,316,701

WINDING APPARATUS WITH ELECTRIC CONTROL CIRCUIT

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Filed Nov. 9, 1964, Ser. No. 409,916

3 Claims. (Cl. 57—98)

This invention relates to frames for paying off a filamentary material from a feed mechanism and winding the material onto a bobbin to form a package of the material on the bobbin.

The disclosure herein, though not the claimed invention, is substantially the same as disclosures in a copending commonly-assigned application Ser. No. 409,669 by Ronald C. Mason and William B. Strzelwicz, Jr., for "Winding Apparatus," filed concurrently herewith and a copending commonly-assigned application Ser. No. 409,899 by Frederick A. Willis, Jr., for "Electric Control Circuit," also filed concurrently herewith.

Conventional frames for paying off a filamentary material from a feed mechanism such as a roving frame and winding the material onto a bobbin to form a package of the material on the bobbin are disclosed in, for example, a patent to Hendrickson No. 2,003,362, assigned to the assignee of the present application. Such machines marked a considerable advance in the art at the time of their introduction, but further improvement of them is desirable.

For example, the conventional design gives rise to a harsh, noisy action of the contact shaft, which must be suddenly geared into a high-speed rotating shaft (the top cone shaft) and suddenly stopped after only half a revolution with much noise and shock to the skip gear, contact dogs, builder nuts, and contact shaft.

Further, conventional apparatus is subject to rail "run overs" because of the period of "no drive" when the twin bevel gears are being shifted.

Also, the front roll speed of the conventional frame must be limited to about 300 rotations per minute, because the skip gear does not mesh properly with the top cone bevel gear at speeds greater than that.

Finally, conventional machines may not be stopped safely from an operational point of view at all positions of rail travel.

An object of the present invention is to provide a combination of a specific winding apparatus and a specific electric control which remedies the shortcomings of the conventional apparatus pointed out above.

This and other objects of the invention are accomplished by providing, in a frame for paying off a filamentary material from a feed mechanism and winding the material onto a bobbin, the improvement comprising drive means for establishing a relative rotation of the feed mechanism and bobbin with respect to each other and a relative traverse of the feed mechanism and bobbin with respect to each other longitudinally of the axis of rotation of the bobbin and control means for limiting the traverse length to a value 1. The control means include first and second contact dog means spaced apart from each other a distance x of which the value 1 is a function and third contact dog means adapted to engage alternately the first and second contact dog means at opposite ends of the traverse. First and second relay coils are also provided, the first relay coil being energized by engagement of the first and third contact dog means and the second relay coil being energized by engagement of the second and third contact dog means. First, second, third, and

fourth pairs of contacts are provided governed by the first and second coils, and a control relay coil is also provided. The first pair of contacts is adapted alternately to occupy first and second states and caused to occupy the first state on energization of the first coil and the second state on energization of the second coil. The second pair of contacts is adapted alternately to occupy third and fourth states and caused to occupy the third state on energization of the first coil and the fourth state on energization of the second coil. The third pair of contacts is adapted alternately to occupy fifth and sixth states and caused to occupy the fifth state on energization of the first coil and the sixth state on energization of the second coil. The fourth pair of contacts is adapted alternately to occupy seventh and eighth states and caused to occupy the seventh state on energization of the first coil and the eighth state on energization of the second coil. All of the pairs of contacts are prevented from changing states when both the first and second coils are de-energized. The first pair of contacts in its first state facilitates traverse movement in a first direction, the second pair of contacts in its fourth state facilitates traverse movement in a second direction opposite the first direction, the third pair of contacts in its fifth state facilitates energization of the control relay coil, and the fourth pair of contacts in its eighth state facilitates energization of the control relay coil. A fifth pair of contacts is also provided adapted alternately to occupy ninth and tenth states and caused to occupy the ninth state on energization of the control relay coil and the tenth state on de-energization of the control relay coil. One of the ninth and tenth states facilitates altering the distance x and hence the value 1.

An understanding of further particulars of the invention may be gained from a consideration of the following detailed description of a representative embodiment thereof taken in conjunction with the accompanying figures in the drawings, of which:

FIG. 1 is a fragmentary, partly-schematic partly-sectional view of a portion of one form of apparatus constructed in accordance with the invention;

FIG. 2 is an enlarged perspective diagram of a portion of the apparatus of FIG. 1; and

FIG. 3 is a schematic diagram of an electric circuit constituting the remaining portion of the embodiment of FIGS. 1 and 2.

FIG. 1 shows drive means 10 connected by suitable linkages 11, 12 to a top cone pulley 14 and a flier 16, respectively, to rotate the top cone pulley 14 at constant speed and the flier at constant speed.

The top cone pulley 14 is connected to a bottom cone pulley 18 by a cone pulley belt 20 extending therebetween and tightly drawn thereabout so that the rotation of the top cone pulley 14 in the direction indicated by the arrow associated with the top cone pulley 14 is effective to rotate the bottom cone pulley 18 in the direction indicated by the arrow associated with the bottom cone pulley 18.

The top cone pulley 14 is tapered, either linearly as shown or non-linearly, so that its diameter perpendicular to its axis of rotation adjacent to its base 22 (the cone-frustum base to the left as seen in the figure) is larger than the corresponding diameter adjacent to its base 24. Similarly, the bottom cone pulley 18 is tapered, either linearly as shown or non-linearly, and has a large base 26 and a small base 27. The bottom cone pulley is arranged, however, with its large base 26 to the right of its small base 27 as seen in the figure rather than to the left.

A cone-pulley-belt guide or shipper 28 envelops a portion of the belt 20 to guide the belt 20 and move it longitudinally of the axes of the upper and lower cone pulleys

14, 18. Those skilled in the art will readily understand that the cone pulleys 14, 18 and the belt 20 constitute a variable-mechanical-advantage means and that, for example, when the belt 20 is moved to the left as indicated in FIG. 1, the rotational speed of the lower cone pulley 18 increases and that, when the belt 20 is moved to the right as seen in FIG. 1, the rotational speed of the lower cone pulley 18 decreases.

In the winding of roving, for example, it is normally desired to shift the belt towards the right as seen in FIG. 1 following each traverse with respect to each other of the flier 16 and a bobbin 30 on which the roving is to be wound. The flier 16 is made to rotate, as noted above, by the drive means 10 at a constant speed. The bobbin 30, being connected to the lower cone pulley 18 by suitable linkages 32, 33, rotates in the same direction in which the flier 16 rotates but more rapidly than the flier 16. The feed mechanism and bobbin thus rotate with respect to each other at a rotational velocity w . As the thickness of the package of roving increases, the tangential speed of the package would become excessively great, except for the fact that the rotational speed of the bobbin 30 decreases with each successive traverse as the belt 20 moves to the right as seen in FIG. 1. Also, in order to provide the tapered bobbin shape indicated at t , the length of each successive traverse is preferably decreased.

The belt shipper 28 has formed thereon a rack 34 adapted to be driven by gearing 36 which is in turn actuated by a ratchet 38 under the control of a piston rod 40 of a piston-cylinder assembly 42.

Thus, movement of the piston 43 (FIG. 2) of the piston-cylinder assembly 42 to, for example, the right as seen in FIG. 1 and in the direction of the lower arrow in FIG. 2, actuates the gearing mechanism 36 through the ratchet assembly 38 to move the rack 34 and hence the shipper 28 to the right as seen in FIG. 1 and therefore shift the belt 20 to the right and change the mechanical advantage of the variable-mechanical-advantage means constituted by the cone pulleys 14, 18 and the belt 20. The directions of rotation of the gears constituting the gearing mechanism 36 are shown by appropriate arrows in FIG. 2. Movement of the piston 43 in the opposite direction—i.e., to the left as seen in FIG. 1—has no effect on the location of the belt 20 longitudinally of the axes of the cone pulley 14, 18, inasmuch as the ratchet 38 is free wheeling in response to such movement of the piston 43.

The piston 43 of the piston-cylinder assembly 42 is actuated by an air supply line 44 and an air exhaust line 46 communicating with a shiftable valve 48 under the control of a solenoid 50 and spring 54. The valve 48 moves to the position shown in response to energization of the solenoid 50. In the position of the valve shown, the air supply line 44 communicates through a passage 45 in the valve 48 with a line 52 for moving the piston 43 of the piston-cylinder assembly 42 to the right as seen in FIG. 1 and performing an indexing function—i.e., shifting the cone guide 28. A line 58 communicating with a passage 47 in the valve 48 permits the exhaust of air from the right-hand end of the cylinder to the exhaust line 46. With the valve 48 shifted to the left under the influence of the spring 54, the solenoid 50 being de-energized, the air supply line 44 is connected through a passage 56 in the valve 48 with the line 58 to the right-hand end of the piston-cylinder assembly 42 to drive the piston of the piston-cylinder assembly to the left as seen in FIG. 1. In this position, the left-hand end of the piston-cylinder assembly 42 is connected to a passage 60 in the valve 48 to permit exhaust of air in the left-hand end of the piston-cylinder assembly 42 through the exhaust line 46.

Flow-control valves 61, 61' (FIG. 2) control the speed of the piston 43 and prevent shock loads.

An air pressure switch 63 stops the frame from operating if the air pressure in the mill falls below a safe build-

er operating pressure—usually about 40 pounds per square inch.

The solenoid 50 is shown also in FIG. 3. As that figure shows, the indexing solenoid 50 is energized when contacts CR-1 are closed, inasmuch as the contacts CR-1 and solenoid 50 are in series between lines 62, 64, across which a D.C. control voltage is applied.

The contacts CR-1 are in turn closed when a builder relay CR is energized. Provision may be made to energize the builder relay at either end of the relative traverse of the feed mechanism or flier 16 and bobbin 30 with respect to each other, but provision is preferably made for energizing the builder relay CR at each end of the relative traverse of the feed mechanism 16 and the bobbin 30 with respect to each other. To this end, the builder relay CR is connected by a pair of normally-open contacts LR-3 to a line 66 and by a pair of normally-closed contacts LR-4 to a line 68.

The lines 66 and 68 extend between the control-voltage leads 62 and 64 and therefore provide means for energizing the relay coil LR-R and reset coil LR-L, respectively, of a building latching relay 74. The relay coil LR-R of the latching relay 74 is energized upon closing of a first section 76 of a builder switch 77, and the reset coil LR-L is energized upon closing of a second section 78 of the builder switch 77.

The first and second sections 76 and 78 of the builder switch 77 are in turn closed at opposite ends of the relative traverse of the flier 16 and bobbin 30 with respect to each other by contact of first and second contact dogs 80 and 82 with a third contact dog 84 (FIG. 1). The contact dogs 80 and 82 are mounted on builder nuts 86 and 88, respectively, which are in turn threadedly engaged with a rotatable screw 90 having a lower portion 92 threaded oppositely to an upper portion 94 and a topmost portion 90' square in cross section so as to be rotatable by a gear train 130. The nuts 86, 88, screw 90, and contact dogs 80, 82 are mounted on supports means 96 rigidly retained on a bobbin rail 98 on which is also mounted the bobbin 30. The bobbin rail 98 is made to reciprocate upwardly and downwardly, so that a relative traverse of length l and at velocity v of the feed mechanism or flier 16 and bobbin 30 with respect to each other is established. The means for establishing the relative traverse includes a rail lifter 100 having thereon a rack 101 engaged with a train of gears 102 connected to a shaft 104. The shaft 104 in turn is driven through a reversible clutch mechanism 105 having clutches 106, 107 which are driven respectively by a pair of bevel gears 110, 114. The gears 110 and 114 rotate in opposite directions with respect to each other, inasmuch as they are coaxial and are driven by a bevel gear 112 in constant engagement with the gears 110, 114 and having its axis normal to the axes of the gears 110, 114.

As noted above, the gear train 32 is driven by the lower cone pulley 18 at a speed depending on the location of the belt 20. Inasmuch as the lower cone pulley 18 always turns in the same direction, the gear train 32 and the bevel gears 108, 112 also always turn in the same direction.

Depending on which of the clutches 106, 107 is coupled to the shaft 104 (the other clutch being disengaged from the shaft 104 and free wheeling), the shaft 104 turns in one direction or the other and, through the gear train 102 and the rack 101 and lifter element 100, reciprocates the bobbin rail 98 and the bobbin 30 upwardly and downwardly. For example, as shown in FIG. 1, energization of the clutch 106 causes the bobbin rail 98 to move downwardly and energization of the clutch 107 causes the rail 98 to move upwardly.

A brake 116 is provided for immobilizing the shaft 104 and hence the bobbin 98 in the event of failure of both clutches, such as might occur during power failure. During normal operation, the brake 116 is elec-

trically held open; under power-off conditions, the brake is spring set.

The clutches 106 and 107 are preferably electrically operated by the circuit shown in FIG. 3. The clutch 107 is energized to cause the bobbin rail 98 to move upwardly when normally-open contacts LR-1 are closed between D.C. leads 118 and 120. Similarly, the rail-down clutch 106 is energized to move the rail 98 downwardly when the normally-closed contacts LR-2 are closed between the same two leads 118 and 120. The current-delay characteristics inherent in the electric reversing clutches insure adequate holding power during rail reversal. Thus, rail "run overs" are eliminated.

All of the contacts LR-1, LR-2, LR-3, and LR-4 are under the control of the builder latching relay 74. The coils LR-R and LR-L of the latching relay 74 are adapted to be alternately energized, and the latching relay 74 is constructed in such a manner that, regardless of whether the relay coil LR-R or the reset coil LR-L is energized, all four of the contacts LR-1, LR-2, LR-3, and LR-4 are reversed and remain in their new states until energization of the other of the coils LR-R and LR-L. To this end, the contacts LR-1, LR-2, LR-3, and LR-4 are directly attracted by the electromagnet of the relay coil LR-R. Energization of the coil LR-R therefore magnetically moves the contacts LR-1, LR-2, LR-3, and LR-4 to their magnetically-caused states, in which states they are mechanically held by mechanical holding means represented at 121, regardless of whether the relay coil LR-R remains energized. The electromagnet of the reset coil LR-L does not act directly on the contacts LR-1, LR-2, LR-3, and LR-4 but acts, instead, on the mechanical holding means 121 to release the mechanical holding means 121 and permit the contacts LR-1, LR-2, LR-3, and LR-4 to return to their normal or mechanically-caused states shown in FIG. 3. The holding means 121 provides a memory to prevent the rail 98 from going in the wrong direction on start-up after the frame has been stopped for any reason.

Inasmuch as there are five pairs of contacts LR-1, LR-2, LR-3, LR-4, and CR-1, each adapted to occupy alternately either of two states, there are ten different contact states which need to be separately identified. Also, there are four different times which need to be considered in a traverse cycle: time t_1 , during which the coil LR-R is energized and the coil LR-L is de-energized; time t_2 , during which both coils LR-R and LR-L are de-energized; time t_3 , during which the coil LR-L is energized and the coil LR-R is de-energized; and time t_4 , during which both coils LR-R and LR-L are de-energized. Times t_1 and t_3 are of substantially equal duration and time t_2 and t_4 are of duration substantially equal to each other and substantially exceeding the duration of times t_1 and t_3 . Finally, it is to be noted that the contacts LR-1 in their closed state facilitate the performance of a first function such as energizing the rail-up clutch 107 to cause the rail 98 to move upwardly; the contacts LR-2 in their closed state facilitate the performance of a second function such as energizing the rail-down clutch 106 to cause the rail 98 to move downwardly; and the contacts CR-1 in their closed state facilitate the performance of a third function such as energization of the solenoid 50 to index the guide or shipper 28.

The operation of the apparatus of the invention will now be readily understood by those skilled in the art. FIG. 3 illustrates the case where the reset coil LR-L was the last to be energized, so that all contacts LR-1, LR-2, LR-3, and LR-4 are shown in their normal or mechanically-caused states. Thus, the contacts LR-2 are closed, energizing the rail-down clutch 106 and causing the bobbin 30 to move downwardly with respect to the flier 16. At the bottom of the traverse, the contact dogs 82 and 84 (FIG. 1) engage each other, closing the switch 76 shown in FIG. 3. This closing of the switch 76 energizes the relay coil LR-R and reverses all of the contacts LR-1,

LR-2, LR-3, and LR-4. The contacts LR-1 are therefore closed, energizing the rail-up clutch, and contacts LR-2 are open, de-energizing the rail-down clutch, so that the rail begins to move up. The delay characteristic referred to above eliminates "run over" of the rail 98 during the reversal of traverse motion. At the same time, the contacts LR-3 close, completing a circuit through the switch 76, the contacts LR-3, and the builder relay CR. This causes the contacts CR-1 under the control of the builder relay to close, indexing the indexing solenoid 50. The indexing of the solenoid 50 shifts the piston of the piston-cylinder assembly 42 in the manner noted above to move the cone guide belt shipper 28 to the right through the gear train 36, as shown in FIG. 1.

A gear train 130 is actuated by movement of the rack 34 to turn the rod 90 and bring the nuts 86 and 88 closer together to shorten the succeeding traverse. The length l of a given traverse is of course a function of the distance x between the contact dogs 80 and 82.

When the rail-up clutch 106 has caused the rail 98 to move upwardly sufficiently to disengage the contact dogs 82 and 84 from each other, the switch 76 is opened, so that the relay coil LR-R is de-energized. Because the relay coil 74 is a latching relay the contacts LR-1, LR-2, LR-3, and LR-4 remain in the magnetically-caused states even though the relay coil LR-R is de-energized. The opening of the switch 76 breaks the circuit through the now-closed contacts LR-3 and the builder relay CR, however, so that the relay CR is de-energized, the contacts CR-1 open, and the indexing solenoid 50 returns to its normal position under the urging of the spring 54 (it is to be noted that FIG. 1 shows the valve 48 in its indexing rather than in its normal position). When the valve 48 returns to its normal position, the ratchet 38 free-wheels and does not move the guide or shipper 28 to the left; the shipper accordingly remains in its new position.

At the upper end of the traverse, the contact dogs 80 and 84 make contact with each other, closing the switch 78 and energizing the reset coil LR-L of the building latching relay 74. This causes reversal of all contacts LR-1, LR-2, LR-3, and LR-4 to their normal positions as shown in FIG. 3 and energizes the rail-down clutch 106 to cause the rail 98 to move downwardly, while again avoiding rail "run over." Also, the closing of the switch 78 actuates the builder relay CR through the contacts LR-4, closes the contacts LR-1, and indexes the indexing solenoid 50 as noted above. When the rail has moved downwardly sufficiently to separate the contact dogs 80 and 84, the switch 78 is opened, thereby de-energizing the reset coil LR-L. Inasmuch, however, as the relay is a latching relay and all contacts are in their normal or mechanically-caused states, the contacts LR-1, LR-2, LR-3, and LR-4 remain in their new states, even though the reset coil LR-L is de-energized. The opening of the switch 78 also breaks the circuit through the contacts LR-4 and the builder relay CR, so that the relay CR is de-energized, the contacts CR-1 open, and the indexing solenoid 50 returns to its normal position under the urging of the spring 54. The ratchet 38 again free-wheels, so that the shipper 28 remains in its new position.

A wind-back motor 140 is connected through gearing 142, a clutch 144, and a shaft 145 and pinion 146 forming a portion of the gear train 36 to the rack 34 to return the guide 28 and builder nuts 86, 88 to their starting positions at the end of the package-building operation. The clutch 144 is keyed to a shaft 145 by a keyway 148 but movable axially along the shaft by clutch-control means 150. The clutch 144 is disengaged during the building operation and engaged at the end thereof to eliminate the need for manual rewinding.

The subject matter of the present invention relates not to the disclosure of FIGS. 1 and 2 alone or to the disclosure of FIG. 3 alone but only to the combination of the details of the disclosure of FIGS. 1 and 2 on the one hand with the details of the disclosure of FIG. 3 on the

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other. The subject matter of FIGS. 1 and 2 considered by itself is a separate invention by Ronald C. Mason and William B. Strzelewicz, Jr., in said above noted application Ser. No. 409,669. The subject matter of FIG. 3 considered by itself is a separate invention of Frederick A. Willis, Jr., in said above noted application Ser. No. 409,899.

Thus, there is provided in accordance with the invention novel and highly-effective means for paying off a filamentary material from a feed mechanism and winding the material onto a bobbin to form a package of the material on the bobbin. The use of a pneumatic piston-cylinder assembly eliminates the harsh, noisy action of the contact shaft and the shock to the skip gear, contact dogs, builder nuts, and contact shaft. The reversing clutches eliminate rail "run overs" during reversal of rail movement by always maintaining positive holding of the rail. The front roll speed may be varied independently of frame speed and may be substantially in excess of 300 rotations per minute, thereby facilitating greater manufacturing efficiency. Further, the machine may be stopped safely in any position of rail travel. Many alternative embodiments within the scope of the invention will readily occur to those skilled in the art. Accordingly, the invention is to be construed as including all of the modifications thereof which fall within the scope of the appended claims.

We claim:

1. In a frame for paying off a filamentary material from a feed mechanism and winding the material onto a bobbin, the improvement comprising drive means for establishing a relative rotation of the feed mechanism and bobbin with respect to each other and a relative traverse of the feed mechanism and bobbin with respect to each other longitudinally of the axis of rotation of the bobbin and control means for limiting the traverse length to a value 1, the control means including (a) first and second contact means spaced apart from each other a distance x of which the value 1 is a function (b) third contact means adapted to engage alternately the first and second contact means at opposite ends of the traverse, (c) first and second relay coils, the first relay coil being energized by engagement of the first and third contact means and the second relay coil being energized by engagement of the second and third contact means, (d) first, second, third, and fourth pairs of contacts governed by the first and second coils, and (e) a control relay coil, the first pair of contacts being adapted alternately to occupy first and second states and being caused to occupy the first state on energization of the first coil and the second state on energization of the second coil, the second pair of contacts being adapted alternately to occupy third and fourth states and being caused to occupy the third state on energization of the first coil and the fourth state on energization of the second coil, the third pair of contacts being adapted alternately to occupy fifth and sixth states and being caused to occupy the fifth state on energization of the first coil and the sixth state on energization of the second coil, and the fourth pair of contacts being adapted alternately to occupy seventh and eighth states and being caused to occupy the seventh state on energization of the first coil and the eighth state on energization of the second coil, and the first, second, third, and fourth pairs of contacts being prevented from changing states when both the first coil and the second coil are de-energized, the first pair of contacts in its first state facilitating traverse movement in a first direction, the second pair of contacts in its fourth state facilitating traverse movement in a second direction opposite the first direction, the third pair of contacts in its fifth state facilitating energization of the control relay coil, and the fourth pair of contacts in its eighth state facilitating energization of the control relay coil, and a fifth pair of contacts adapted alternately to occupy ninth and tenth states and being caused to occupy the ninth state on energization of the control relay coil and the tenth state

on de-energization of the control relay coil, one of the ninth and tenth states facilitating altering of the distance x and hence the value 1.

2. In a frame for paying off a filamentary material from a feed mechanism and winding the material onto a bobbin, the improvement comprising drive means for establishing a relative rotation of the feed mechanism and bobbin with respect to each other and a relative traverse of the feed mechanism and bobbin with respect to each other longitudinally of the axis of rotation of the bobbin and control means for limiting the traverse length to a value 1, the control means including (a) first and second contact dog means spaced apart from each other a distance x of which the value 1 is a function, (b) third contact dog means adapted to engage alternately the first and second contact means at opposite ends of the traverse, (c) first and second relay coils, the first relay coil being energized by engagement of the first and third contact means and the second relay coil being energized by engagement of the second and third contact means, (d) first, second, third, and fourth pairs of contacts governed by the first and second coils, and (e) a control relay coil, the first pair of contacts being adapted to occupy alternately closed and open states and being caused to occupy the closed state on energization of the first coil and the open state on energization of the second coil, the second pair of contacts being adapted to occupy alternately open and closed states and being caused to occupy the open state on energization of the first coil and the closed state on energization of the second coil, the third pair of contacts being adapted to occupy alternately closed and open states and being caused to occupy the closed state on energization of the first coil and the open state on energization of the second coil, and the fourth pair of contacts being adapted to occupy alternately open and closed states and being caused to occupy the open state on energization of the first coil and the closed state on energization of the second coil, the first, second, third, and fourth pairs of contacts being prevented from changing states when both the first coil and the second coil are de-energized, the first pair of contacts in its closed state facilitating traverse movement in a first direction, the second pair of contacts in its closed state facilitating traverse movement in a second direction opposite the first direction, the third pair of contacts in its closed state facilitating energization of the control relay coil, and the fourth pair of contacts in its closed state facilitating energization of the control relay coil, and a fifth pair of contacts adapted alternately to occupy open and closed states and caused to occupy the open state on de-energization of the control relay coil, the closed state of the fifth pair of contacts facilitating altering the distance x and hence the value 1.

3. In a frame for paying off a filamentary material from a feed mechanism and winding the material onto a bobbin, the improvement comprising drive means for establishing a relative rotation of the feed mechanism and bobbin with respect to each other and a relative traverse of the feed mechanism and bobbin with respect to each other longitudinally of the axis of rotation of the bobbin and control means for limiting the traverse length to a value 1, the control means including (a) first and second contact dog means spaced apart from each other a distance x of which the value 1 is a function, (b) third contact dog means adapted to engage alternately the first and second contact means at opposite ends of the traverse, (c) first and second relay coils, the first relay coil being energized by engagement of the first and third contact means and the second relay coil being energized by engagement of the second and third contact means, (d) first, second, third, and fourth pairs of contacts governed by the first and second coils, and (e) a control relay coil, the first pair of contacts being adapted alternately to

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occupy first and second states and being magnetically caused to occupy the first state on energization of the first coil and mechanically caused to occupy the second state on energization of the second coil, the second pair of contacts being adapted alternately to occupy third and fourth states and being magnetically caused to occupy the third state on energization of the first coil and mechanically caused to occupy the fourth state on energization of the second coil, the third pair of contacts being adapted alternately to occupy fifth and sixth states and being magnetically caused to occupy the fifth state on energization of the first coil and mechanically caused to occupy the sixth state on energization of the second coil, and the fourth pair of contacts being adapted alternately to occupy the seventh and eighth states and being magnetically caused to occupy the seventh state on energization of the first coil and mechanically caused to occupy the eighth state on energization of the second coil, and the first, second, third, and fourth pairs of contacts being mechanically prevented from changing states when both the first coil and the second coil are de-energized, the first pair of contacts in its first state facilitating traverse movement in a first direction, the second pair of contacts in its fourth state facilitating traverse

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movement in a second direction opposite the first direction, the third pair of contacts in its fifth state facilitating energization of the control relay coil, and the fourth pair of contacts in its eighth state facilitating energization of the control relay coil, and a fifth pair of contacts adapted alternately to occupy open and closed states and being mechanically caused to occupy the open state on de-energization of the control relay coil and magnetically caused to occupy the closed state on energization of the control relay coil, indexing means adapted when actuated to produce an output, and means coupling the output to the first and second contact dog means to vary the distance x and hence the value 1, the closed state of the fifth pair of contacts facilitating actuation of the indexing means.

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FRANK J. COHEN, *Primary Examiner*.

J. PETRAKES, *Assistant Examiner*.