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R. D. HEFFELFINGER

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UNIFORM STRAND TENSION DEVICE

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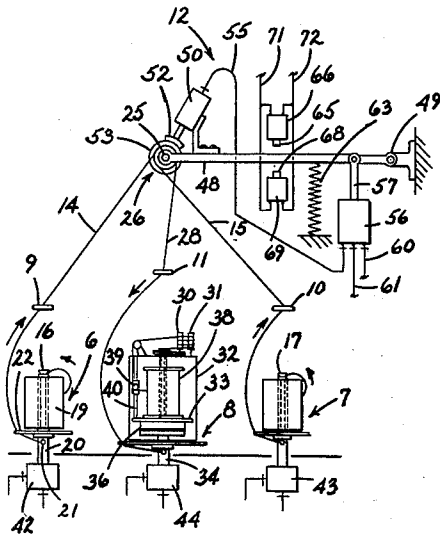


Fig. 1

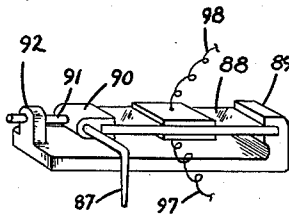


Fig. 3

Fig. 2

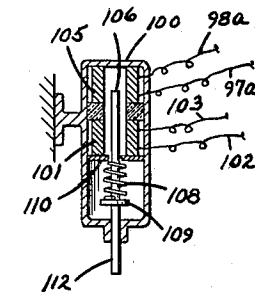
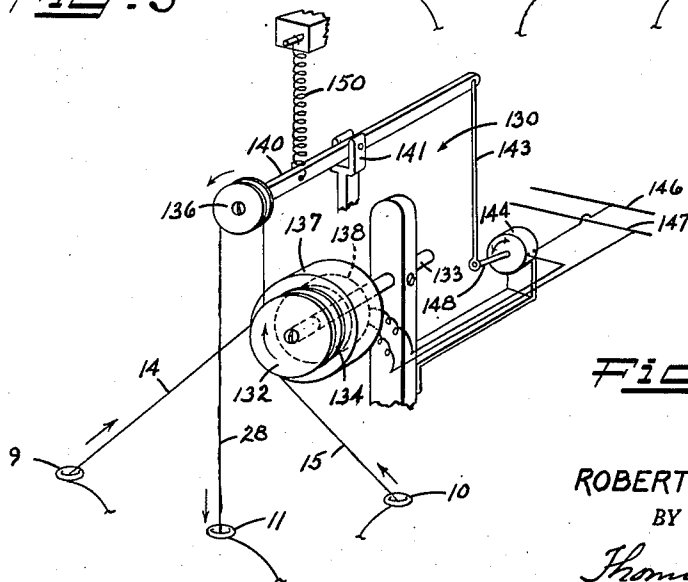


Fig. 4

Fig. 5

Fig. 6

INVENTOR.
ROBERT D. HEFFELFINGER
BY

Thomas P. O'Malley
ATTORNEY.

UNITED STATES PATENT OFFICE

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UNIFORM STRAND TENSION DEVICE

Robert D. Heffelfinger, Lansdowne, Pa.

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14 Claims. (Cl. 57—58)

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This invention relates to mechanism for regulating the size and contour of a balloon and the tension in the strands passing through this balloon to a strand doubling unit from the supply sources.

It is an object of the present invention to provide cord-twisting apparatus capable of continuous operation with freedom from trouble arising from variable strand tensions. It is also an object to provide a cord twister of the down-twisting type which operates with a stable balloon. Still another object is to provide cord-twisting apparatus for doublers of the down-twisting type which automatically controls, by self-compensating means, the strand tension within the balloon formed around the doubler as the strand passes thereto. Other objects, features and advantages will be apparent from the following description of the invention and the drawing relating thereto in which

Fig. 1 is a diagrammatic view in elevation of doubling apparatus having an adjustable automatically compensating tension-controlling system;

Fig. 2 is an elevation of a modified tension-controlling system;

Fig. 3 is a pictorial view of a portion of an electronic pick-up device;

Fig. 4 is a section view of another electronic pick-up device;

Fig. 5 is a section view of strand-retarding mechanism in the apparatus of Fig. 2; and

Fig. 6 is a diagrammatic pictorial view of another automatic tension-controlling system.

To accomplish the above stated objects and others ancillary thereto, cord twisting apparatus is provided comprising supply sources for a plurality of strands, a doubler of the down-twister type having a strand-drawing device for positively engaging the strand which is driven in synchronism with and by the drive means for the doubler, and mechanism for receiving the plurality of strands, gathering them into a group, and discharging them toward the doubler. This latter mechanism comprises a gathering roll or pulley driven by the strand group and an automatically adjustable system for controlling and restraining the rotation of the roll, or other rotatable strand-gathering member, which is inversely responsive to the tension in the strand group traversing a balloon formed around the doubler, i. e. the greater the tension, the less is the restraint exerted on the rotation of the roll.

Fig. 1 diagrammatically illustrates a doubling system such as generally shown and described in

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U. S. application Serial No. 93,939, filed May 8, 1949. The doubling system comprises up-twisting type singles twisters 6 and 7, a down-twisting type doubler 8 (the singles twisters and doubler being shown as multiple twist types of twist-
5 ers and specifically as the two-for-one type), guides 9, 10, and 11 mounted axially over twist-
10 ers 6, 7 and 8, respectively to define the upper limit of the balloon in the strand associated with each
15 twister, and an automatic or self-compensating tension device 12. The initial tension in the individual supply strands 14 and 15 passing from
20 their respective singles twisters is established by tensions devices 16 and 17, respectively, mounted
25 over, or supported by, packages being unwound while supported on the singles twisters. The
30 strand 14 is led through the device 16 in being unwound from the package 19. The strand
35 passes downwardly through a hollow spindle 20, out a lateral opening 21, over the periphery of
40 a flyer 2, and upwardly through the guide 9. The strand 15 traverses a similar path. Both singles
45 strands pass onto an annular surface 25 of a gathering roll 26 to be wrapped therearound and
50 discharged as a strand group hereinafter designated as strand 28. The strands 14 and 15 are
55 preferably wrapped or lapped around the surface 25 to the extent of one or more windings to provide
sufficient frictional engagement between the strands and the surface 25 to prevent slippage as
the result of any difference between (a) the aggregate tension in the strands received by the
surface 25 and (b) the tension in the strand 28 discharged therefrom. It is for the utilization of
this difference in tension that this invention is designed in order to control and maintain a substantially uniform tension in the strand within the balloon of the doubler 8. In a doubling system wherein the aggregate tension in the
strands passing from the supply sources to the gathering mechanism exceeds that in the doubled
strand passing into the doubler, the strands may be fed to the gathering mechanism, or the
gathering roll or rotor thereof may be connected with a driving means. Normally, however, the
tension in the doubled strand exceeds that of the sum of the tensions in the supply strands, and
the gathering roll operates as an idler, being driven merely by the strands wrapped there
around. The embodiments of this invention are hereinafter described with respect to this latter
condition.

The strand 28, as well as the strands 14 and 15 which constitute the larger strand 28, are pulled through the doubling system by means such as a

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pair of driven capstan rolls 30 and 31 rotatably mounted on a cage 32. The cage as well as a package holder 33 are rotatably mounted on the hollow spindle 34 of the doubler. The cage, however, is held from rotation by being weighted on one side (the spindle being in this case inclined), or by a stationary magnetic holding device (not shown) mounted exteriorly of the balloon and the strand 28, such as well known in the art; the package holder, on the other hand, is driven by the spindle through a slip-drive transmission, such as a magnetic clutch 36 having a driving member attached to the spindle and a driven member attached to the holder. The strand 28 is guided onto a package 38 by a reciprocating guide 39 which traverses an elongate member 40 extending longitudinally of the cage 32. Any well-known arrangement for traversing the guide 39 may be used. For example, the guide may be mounted on the member 40 which may comprise a reverse threaded rod in threaded relationship with the guide 39 and be rotated by a pawl-and-ratchet system driven by a cam surface disposed along an annular surface of the package holder, such as illustrated in application Serial No. 93,939.

The twisting units 6, 7 and 8 may be driven by hydraulic motors 42, 43 and 44 respectively, such as described in U. S. Patent 2,576,936, December 4, 1951, or by individual electrical motors, or connected together in drive relationship by gears, belts and pulleys, etc.

It is very desirable to control the tension and the size and contour of the balloon of the strand 28 as it passes from the guide 11 into the doubler 8 in order that the quality of the doubled strand may be satisfactory and that the doubler system may be operated without shutdowns as the result of the balloon getting out of control and the strand becoming subsequently fouled in the machine. To obtain a balloon of a desired size and contour, it is merely necessary to control the tension in the strand 28 so as to maintain it at a substantially uniform value. Heretofore, in strand doubling practice, it was extremely difficult to maintain a uniform tension in the strand passing to a doubling unit because of, for example, the variations of tension occurring in the strands being supplied to the unit or the doubled strand being withdrawn from the balloon. However, in the practice of the present invention, the several strands of the group being twisted into a cord are first passed around the gathering roll 26 of Fig. 1. The rotation of the roll 26 is controlled in a manner such as to produce substantially uniform tension in the strand group after leaving said roll.

Lever 48 provides rotatable support for the roll 26. The lever is pivotally attached to a stationary support at 49; the lever also supports a fluid cylinder 50 having a piston for actuating a pressure shoe 52 which engages an annular surface 53 of the roll 26. The surfaces 25 and 53 are shown as having a different diameter but they need not be different.

Tension in the cord 28 is automatically controlled by variation in the pressure of the brake shoe 52 upon the annular surface 53 caused by variations in the fluid pressure applied to the cylinder 50. These pressure variations are transmitted through a line 55 from a pressure sensitive valve 56 operated by a link 57 pivotally attached to the lever 48. Fluid, preferably a liquid comprising a low viscosity oil, is supplied under pressure to the valve 56 through line 60

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connected with a fluid supply source (not shown) maintained preferably at uniform pressure. Fluid is discharged from the valve at atmospheric or a substantially lower pressure than that maintained in line 60 through a line 61. Fluid leaving the valve passes simultaneously into lines 55 and 61. The relative amounts passing into these lines is determined by the movement transmitted to the valve through the link 57 as the result of force applied by the strand 28 to the capstan or roll 26. A moment applied to the lever 48 by the strand 28 is resisted by a spring 63 which engages the lever and urges the end thereof supporting the capstan in a direction away from the guide 11.

Movement of the link 57 in the valve 56 in response to a decrease in tension causes diversion of a lesser proportion of the liquid into the line 61 and a resulting increase in pressure in line 55 which is transmitted to the cylinder 50. The increase in braking pressure upon the annular surface 53 produced by operation of the fluid cylinder causes an increase in the tension of the cord 28. Conversely, an increase in tension in the cord 28 produces a downward movement of the capstan 26 and the lever 48 with respect to the pivot 49. Such a movement causes the valve 56 to exhaust or reduce the pressure in the line 55 and the cylinder 50, thus relieving a portion of the braking force applied to the capstan 26. As a result, the capstan is allowed to turn with greater freedom and to effect a reduction in tension to offset the excess of tension which set the system in operation.

The machine may be adjusted so that a drastic and sudden change in tension such as caused by breakage of the strand 28 or parting of one of the strands 14 and 15, produces such a reduction in tension that the lever 48, urged upward or clockwise about the pivot at 49 by the spring 63, engages a button 65 and the switch 66 to stop the doubling system. Similarly, should sudden snagging or tangling of the strands 14 and 15 occur, the lever 46 is forced downward against a button 68 of the switch 69 to stop the machine. The lines 71 and 72 may be connected within the circuit for supplying electrical power to the driving motor of a fluid-circulating system (not shown) for supplying fluid to the twister motors 42, 43 and 44.

Figs. 2 and 5 illustrate an automatic tension system 75 which may be substituted for the apparatus generally indicated by numeral 12 of Fig. 1. The apparatus 75 is similarly mounted in superimposition over the guides 9, 10 and 11. In using apparatus 75, strands 14 and 15 pass onto a gathering sheave or pulley 77 and are discharged over the pulley 78 together and toward or through the guide 11. The pulley 78 may move in a direction toward and away from the guide 11 as the result of being mounted on a lever 79 which is pivotally attached to a stationary bracket 80 at 81. In operation, the lever 79 is tilted as the result of changes in tension in the strand 28. The end of the lever supporting the pulley 78 and the pulley are urged in a direction away from the guide 11 by a tension spring 82 secured by one end to a stationary mounting 83 and by its other end to a portion of the lever 79 between the pulley 78 and the pivot 81.

An electronic pick-up device 85 is supported on a stationary mounting 86 adjacent to but spaced from the lever 79 so that a feeler element 87 of the device engages the upper surface of the lever 79. The device 85 in one preferred form has a construction similar to that of a conven-

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tional phonograph pick-up. The principle of operation of such a device is illustrated in Fig. 3 wherein one end of a crystal 88 (Rochelle salt crystals being commonly used) is shown secured within a grooved portion of a frame 89 and the other end is secured within the grooved portion of a trunnion element 90. An axle portion 91 of the element 90 extends through a bearing portion 92 of the frame 89. An annularly spaced feeler 87 extends laterally from the trunnion element 90. When the feeler 87 rests on a movable surface such as the upper surface of the lever 79, movement of the surface in a direction normal to itself (the frame 89 being stationary) results in one end of the crystal 88 being twisted with respect to its other end. The strain produced in the crystal results in a small sustained electrical potential between opposite side surfaces of the crystal which may be connected with a suitable electronic amplifier of conventional design such as the amplifying unit 95 of Fig. 2 by wires 97 and 98. A signal voltage is developed, for example, in a circuit including the grid of an electronic tube, such as used in an amplifying device, and the crystal, which is proportional to the movement of the feeler 87 and the consequent deformation or deflection of the crystal. The assembly of Fig. 3 is supported within a suitable case (not shown) with the frame 89 secured firmly thereto and the feeler 87 projecting from the case.

Fig. 4 is illustrative of another type of device that may be used as a pick-up instrument to produce sustained electric potential values varying in accordance with the magnitude of movement of the lever 79. Enclosed within a stationarily mounted case 100 is a primary coil connected by leads 102 and 103 with an alternating current source not shown. An induced current is developed within a coil 105 in accordance with the degree of projection therethrough of a rod-like magnetic element 106 which extends through the primary coil 101. The current induced within the coil 105 is transmitted to an amplifier, such as the amplifying unit 95, through the pair of leads 97a and 98a. The element 106 works in opposition to a spring 108 which engages an enlarged portion 109 of the element and a non-magnetic washer 110. The element 106 projects through the case 100 and terminates in a feeler section 112 which may be used to engage the lever 79. When the lever 79 comprises a magnetic material, motion may be transmitted to the element 106 through a spacer of non-magnetic material supported between portion 112 and the lever. If desired, however, the device of Fig. 4 may be fabricated and the primary and secondary coils wound in such a manner as to produce a substantial induced current in the secondary coil which may be transmitted directly to the electromagnetic unit 120, making it thus unnecessary to amplify the induced current and thereby eliminating the amplifier 95.

Differences in current voltages received along lines 114 and 115 by the unit 95 are converted proportionally into a current of sufficient strength to control electrically actuated retarding mechanism for the gathering roll 77 and an annular shell or drum 117 attached thereto. The gathering roll 77 and the drum 117 constitute a rotor which may be constructed separately or as a unit, if desired. The roll or sheave 77 and the drum are rotatable with respect to a stator comprising a stationary hollow shaft 118 and an electromagnetic unit 120 mounted non-rotatably on the

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shaft within the region enclosed by the drum. The electromagnetic unit 120 is limited in size to provide considerable clearance with the inner surface of the drum so that a quantity of fluid 119 containing magnetic particles may be stored within the clearance region. Suitable sealing structure, such as the packing gland 122, is provided adjacent the bearings at both ends of the drum to prevent loss of the fluid from the drum. The fluid is preferably a low viscosity liquid hydrocarbon material in which is suspended very fine particles of iron. The viscosity of the fluid is controlled by the strength of the current passed through the electromagnetic unit 120 by lines 123 and 124 connecting the unit 120 with the amplifying device 95. The degree of retardation exerted by the fluid 119 on the drum and the sheave 77 is proportional to the fluid viscosity. A dash pot 126 may be connected to the lever 79 to dampen the response of the lever to changes of tension in the strand 28. The retarding mechanism of Figs. 2 and 5 may be operated as a simple eddy-current brake when the drum 117 of the rotor comprises a magnetically-sensitive material and does not contain a magnetically-sensitive fluid.

In operation, the apparatus 75 automatically controls the tension of the strand 28 within a very small range of tension required to operate the apparatus. For example, a slight increase in the tension of strand 28 produces a downward movement of the pulley 78 and an upward movement of the portion of the lever 79 in engagement with electronic pick-up feeler 87. The feeler 87 is moved upwardly and actuates the pick-up device to reduce the voltage of the current transmitted through lines 97 and 98 to the amplifier 95. The resulting proportional decrease in the amplified current carried by the circuit comprising lines 123 and 124 and the electromagnetic unit 120 causes a reduction in the viscosity of the magnetically-sensitive fluid 119. Thus, the drag imposed by the fluid on the drum 117 and the pulley 77 is lessened and the strand 28 passes more freely toward the guide 11 to reduce the tension therein to a desired level. Conversely when the tension in the strand 28 drops slightly below the desired level, the pulley 78 moves slightly upwardly and the portion of lever 79 engaged by the feeler 87 moves downwardly. In response, a current of increased voltage is developed within the pick-up unit and transmitted to the amplifier 95 which actuates the retarding mechanism, already described, within the drum 117 to restrain the rotation of the pulley 77 and to increase the tension in the yarn 28 to the desired level.

Fig. 6 illustrates pictorially another tension-controlling system 130 which may be used in place of the apparatus 12 of Fig. 1 to control the tension in strand material passing between singles twistors and a doubling unit such as shown and described with respect to Fig. 1. Apparatus 130 comprises a rotor 132 rotatably supported on a stationary shaft 133. The rotor 132 has an annular strand-gathering surface 134 for receiving the strands 14 and 15 and discharging them over a movable pulley 136. Rotor 132 also has an annularly recessed section 137 comprising, at least in part, a magnetically-sensitive material. An electromagnetic member 138 is supported on the shaft 133 adjacent or within the magnetically-sensitive portion 137 of rotor 132. The rotor is so positioned that the surface 134 is in proper alignment to receive strands from guides 9 and 10 and to discharge the strands together

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toward pulley 136. The pulley is rotatably supported on a lever 140 which tilts on a stationary pivot 141.

As shown, the portion of the lever 140 on the side of pivot 141 opposite the pulley 136 is connected by a link to a rheostat 144 or other current-regulating device. The rheostat and the electro-magnetic member 138 are connected in series with power supply lines 146 and 147. The rheostat is electrically connected within the circuit shown and is mechanically connected with the lever 140 in such a manner that movement of the control element 148 thereof in a clockwise direction as indicated by the arrow increases the resistance of the rheostat and decreases the electrical power supplied to the electromagnetic member 138; movement in a counterclockwise direction increases the power to said member. Thus, in operation when the tension in the strand 28 is increased, the pulley 136 is pulled toward the guide 11 to tilt the portion of the bar attached to link 143 in the opposite direction. Such tilting of the bar is resisted by a spring 150 which urges the end of lever 140 supporting the pulley 136 in a direction away from the guide 11. Consequently, as the rheostat 148 is adjusted in a clockwise direction, the power which energizes the member 138 is reduced and the rotor 132 is permitted to turn with greater freedom and to feed strand into the balloon of the doubler 8 at a greater rate; the tension is thus reduced to the desired tension. Conversely, as the tension in the strand 28 falls below normal, the pulley 136 moves upwardly, thus tilting the lever 140 so that the rheostat is adjusted in a counterclockwise direction to reduce its resistance. The power transmitted to the member 138 is increased and the rotation of rotor 132 is retarded to raise the tension to the desired level.

While preferred embodiments of the invention have been shown and described, it is to be understood that changes and variations may be made without departing from the spirit and scope of the invention as defined in the appended claims.

I claim:

1. A system for doubling a plurality of strands into a cord comprising a plurality of strand supplies, a doubling means having a flyer for strand balloon formation, means mounted on the doubling means for drawing the strands from the supplies through the doubling position and then the cord into the balloon of the doubling means, and a tension device mounted to receive the strands from the supplies and to discharge them as a group toward the doubling means, said device comprising means for positively engaging the strands, means associated with the strand-engaging means for detecting the tension of the strand group leaving the device, and means associated with the detecting means for controlling the strand-engaging means, said control means being inversely responsive to the magnitude of the tension detected.

2. A system for doubling a plurality of strands into a cord comprising a plurality of strand supplies, a multiple-twist type of twister for doubling the strands and collecting the cord, means mounted on the take-up twister for drawing the strands from the supplies through the doubling position and then the cord through the balloon of the take-up twister, and a tension device mounted to receive the strands from the supplies and to discharge them as a group toward

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the take-up twister, said device comprising means for positively engaging the strands, means associated with the strand-engaging means for detecting the tension of the strand group leaving the device, means associated with the detecting means for controlling the strand-engaging means, said control means being inversely responsive to the magnitude of the tension detected.

3. A multiple spindle twisting apparatus comprising a plurality of singles twisters, a cord twister having a driving spindle and a take-up mechanism connected in positive drive relationship with the driving spindle for positively forwarding strand material, and an automatically adjustable strand tension device mounted to receive strands from the singles twisters, gather them into a group and discharge the group toward the cord twister at substantially uniform tension, said device comprising a movable member about which the strand group is passed to the cord twister, said member being movable in response to tension in the strand material, resilient means for urging the member in a direction opposite to movement caused by an increase in tension of the strand group, means for varying the speed of passage of the group about the member, and means responsive to the movement of the member for automatically actuating the speed-varying means.

4. A multiple spindle twisting apparatus comprising a plurality of singles twisters, a cord twister having a driving spindle and a take-up mechanism connected in positive drive relationship with the driving spindle for positively forwarding strand material, and an automatically adjustable strand tension device mounted to receive strands from the singles twisters, gather them into a group and discharge the group toward the cord twister at substantially uniform tension, said device comprising a resiliently supported lever which is movable in the direction of departure of the strand group from the device, a rotary member supported by the lever having an annular gathering surface for the group and an annular braking surface, a movable brake shoe adapted to engage the brake surface and being movable in a direction toward and away from the brake surface, fluid pressure control means responsive to the movement of the lever and connected with the shoe to vary the pressure of the shoe on the surface, said control means being connected with the lever to reduce the pressure of the shoe against the surface when the fluid pressure in the control means is reduced in response to movement of the lever in the direction of departure of the strand group from the gathering surface.

5. A strand-forming machine comprising a plurality of singles twisters; means for doubling a plurality of strands into a cord, tension-controlling means positioned between the singles twisters and the doubling means for collecting strands passing from the singles twisters to the doubling means into a group and discharging the group toward the doubling means at substantially a uniform tension; said doubling means comprising a driving spindle rotatably mounted on the spindle, a package holder, slip-drive means for transmitting torque from the spindle to the holder, and mechanism in positive drive relationship with the spindle for engaging and positively forwarding the strand group from the tension-controlling means to the package holder; said tension-controlling means comprising a resiliently supported lever which is movable in the

direction of departure of the strand group from the device, a rotary member supported by the lever having an annular gathering surface for the strands and an annular braking surface, a movable annular brake shoe adapted to engage the brake surface and being movable in a direction toward and away from the brake surface, liquid-pressure control means responsive to the movement of the lever and connected with the shoe to vary the pressure of the shoe on the surface, said control means being connected with the lever to reduce the pressure of the shoe against the surface when the liquid-pressure in the control means is reduced in response to movement of the lever in the direction of departure of the strand group from the gathering surface.

6. Cord-twisting apparatus comprising supply sources for a plurality of strands, a doubler of the down-twister type having take-up means for positively engaging a strand material, drive means for the doubler, said take-up means being connected in positive drive relationship with the drive means, a stationary strand guide mounted axially from the doubler, and mechanism for receiving the plurality of strands, gathering them into a group and discharging the group through the guide toward the doubler, the mechanism comprising a rotor having an annular surface for receiving the plurality of strands, a shaft for rotatably supporting the rotor, said rotor having an annular portion thereof comprising a magnetically-sensitive material, electromagnetic means nonrotatably mounted on the shaft in adjacent spaced relationship to said annular rotor portion, current-regulating means, electrical current supply means in electrical connection with the current-regulating means and the electromagnetic means, control means for actuating the current-regulating means, a pulley, means for movably supporting the pulley along an ambit extending toward and away from the guide and spaced laterally from said annular surface of the rotor, means for connecting the support means of the pulley and the control means, said connecting means being responsive to movement of the pulley along said ambit, said connecting means actuating the current-regulating means to decrease the power transmitted to the electromagnetic means in proportion to movement of the pulley toward the guide, and means for acting on the support means to urge the pulley along said ambit away from the guide.

7. Cord twisting apparatus comprising supply sources for a plurality of strands, a doubler of the down-twister type having take-up means for positively engaging a strand material, drive means for the doubler, said take-up means being connected in positive drive relationship with the drive means, a stationary strand guide mounted in spaced axial relationship with the doubler, and an automatically adjustable tension-controlling mechanism for receiving the plurality of strands, gathering them into a group, and discharging the group toward and through the guide, the mechanism comprising a rotor having an annular surface for receiving the plurality of strands and a hollow annular-walled portion, a stator comprising a shaft and an electromagnetic unit, said rotor being supported on the shaft within the hollow portion surrounding the electromagnetic unit and having clearance therewith to provide a tightly enclosed clearance region, a liquid comprising a magnetically-sensitive material supported within the clearance re-

gion, an electrical current supply means, a current-regulating means in electrical connection with the current supply means and the electromagnetic unit for controlling the flow of electrical energy to said unit, control means for actuating the regulating means, a pulley, means for movably supporting the pulley along an ambit extending toward and away from the guide and spaced laterally from said annular strand-receiving surface of the rotor, said control means being connected with the support means to actuate the current-regulating means in response to movement of the support means, said current-regulating means being actuated by the control means to decrease the power transmitted to the electromagnetic means in proportion to movement of the pulley toward the guide, and means for acting on the support means to urge the pulley along said ambit away from the guide.

8. Cord twisting apparatus comprising supply sources for a plurality of strands, a doubler of the down-twister type having take-up means for positively engaging a strand material, drive means for the doubler, said take-up means being connected in positive drive relationship with the drive means, a stationary strand guide mounted in spaced axial relationship with the doubler and an automatically adjustable tension controlling mechanism for receiving the plurality of strands, gathering them into a group and discharging the group toward and through the guide, the mechanism comprising a rotor having an annular surface for receiving the plurality of strands and a hollow annular-walled portion, a stator comprising a shaft and an electromagnetic unit, said rotor being supported on the shaft with the hollow portion surrounding and substantially sealing from the atmosphere a clearance region between the annular wall and the electromagnetic unit, a liquid comprising a magnetically-sensitive material supported within and substantially filling the clearance region, an electrical current supply means, an electrical amplifying unit in electrical connection with the current supply means, a pulley, means for movably supporting the pulley along an ambit extending toward and away from the guide and spaced laterally from the strand-receiving surface of the rotor, an electrical pick-up device stationarily mounted with a feeler element thereof in engagement with a surface of the support means having movement toward and away from the device, said device being electrically connected with the amplifying unit and adapted to transmit an electrical current varying inversely in strength to the magnitude of movement of the pulley toward the guide, said amplifying unit being electrically connected with the electromagnetic unit to transmit a current which is amplified with respect to the current transmitted to the amplifying unit from the pick-up device.

9. Apparatus as in claim 8 wherein the pick-up device comprises a crystal firmly supported by one portion thereof within the device, said feeler being attached to another portion of the crystal to produce deformation thereof when said feeler undergoes movement, and opposite surfaces of the crystal being electrically connected with the amplifying unit.

10. Apparatus as in claim 8 wherein the pick-up device comprises axially spaced primary and secondary coils, an elongate magnetically-sensitive member movably supported within the primary coil for movement into and out of an open region encircled by the secondary coil, said feeler

being attached to the magnetically-sensitive member, and resilient means for urging the magnetically-sensitive member endwise from the open region, alternating current means for energizing the primary coil, and means for connecting the secondary coil to an amplifier.

11. Cord twisting apparatus comprising supply sources for a plurality of strands, a doubler of the down-twister type having take-up means for positively engaging a strand material, drive means for the doubler, said take-up means being connected in positive drive relationship with the drive means, a stationary strand guide mounted in spaced axial relationship with the doubler and an automatically adjustable tension controlling mechanism for receiving the plurality of strands, gathering them into a group and discharging the group toward and through the guide, the mechanism comprising a rotor having an annular surface for receiving the plurality of strands and a hollow annular-walled portion, a stator comprising a shaft and an electromagnetic unit, said rotor being supported on the shaft with the hollow portion enclosing a clearance region between the annular-wall and the electromagnetic unit, a liquid comprising a magnetically-sensitive material supported within and substantially filling the clearance region, an alternating current supply means, a pulley, means for movably supporting the pulley along an ambit extending toward and away from the guide, said ambit spaced laterally from the strand-receiving surface of the rotor, an electrical pick-up device stationarily mounted with a feeler element thereof in engagement with a surface of the support means having movement toward and away from the device, said pick-up device comprising a primary coil connected with the electrical current supply means, a secondary coil in axially spaced, and coaxial, relationship with the primary coil, and being electrically connected with the electromagnetic unit, an elongate member comprising a magnetically-sensitive material movably supported within the primary coil for movement in an axial direction into and out of an open region encircled by the secondary coil, said feeler being attached to the magnetically-sensitive member, and resilient means for urging the magnetically-sensitive member endwise from the open region.

12. Cord twisting apparatus comprising supply sources for a plurality of strands, a doubler of the down-twister type having take-up means for positively engaging a strand material, drive means for the doubler, said take-up means being connected in positive drive relationship with the drive means, a stationary strand guide mounted in spaced axial relationship with the doubler, and an automatically adjustable tension-controlling mechanism for receiving the plurality of strands, gathering them into a group and discharging the group toward and through the guide, the mechanism comprising a rotor having an annular surface for receiving the plurality of strands, and an annular hollow portion thereof comprising a magnetically-sensitive material, a shaft for rotatably supporting the rotor, electromagnetic means non-rotatably mounted on the shaft within, and at clearance with the hollow portion of the rotor, an alternating current supply means, a pulley, means for movably supporting the pulley along an ambit extending toward and away from the guide, said ambit spaced laterally from the strand-receiving surface of the rotor, an electrical pick-up device stationarily mounted with

a feeler element thereof in engagement with the surface of the support means having movement toward and away from the device, said pick-up device comprising a primary coil connected with the alternating current supply means, a secondary coil in axially spaced and coaxial relationship with the primary coil and being electrically connected with the electro-magnetic unit, and an elongate magnetically-sensitive member movably supported within the primary coil for axial movement into and out of an open region encircled by the secondary coil, said feeler being attached to the magnetically-sensitive member, and resilient means for urging the magnetically-sensitive member endwise from the open region.

13. Apparatus for twisting elongated flexible filamentary material such as yarn in one continuous operation comprising a plurality of twisting spindles each of the type which forms filamentary material extending therefrom into a free-flying first balloon, means associated with each spindle for imposing a predetermined back tension on such material, a twisting device of the type forming and receiving filamentary material from a second free-flying balloon, said device including means for drawing in twisted material from the latter balloon, means for gathering together the twisted materials from the first balloons and leading such materials in gathered relation into the second balloon to form the latter, tension compensating means for maintaining said second balloon under yielding variable tension, said last named means acting to maintain the tension in the second balloon in balance with the sum of the tensions in the first balloons, said tension compensating means comprising means for detecting the tension in the second balloon, and means responsive to the tension detecting means for imposing a variable added tension on the material, and means for driving said twisting spindles and said twisting device in synchronism.

14. Apparatus for twisting elongated flexible filamentary material such as yarn in one continuous operation comprising a plurality of two-for-one twisting spindles each of the type which forms filamentary material extending therefrom into a free-flying first balloon, means associated with each spindle for imposing a predetermined back tension on such material, a two-for-one twisting device of the type forming and receiving filamentary material from a second free-flying balloon, said device including means for drawing in twisted material from the latter balloon, means for gathering together the twisted materials from the first balloons and leading such materials in gathered relation into the second balloon to form the latter, tension compensating means for maintaining said second balloon under yielding variable tension, said last named means acting to maintain the tension in the second balloon in balance with the sum of the tensions in the first balloons, said tension compensating means comprising means for detecting the tension in the second balloon, said detecting means including means deflected in response to changes of tension of the material and a friction means positioned by said deflected means and responsive to deflections thereof to impose a variable tension upon the material, and means for driving said twisting spindles and said twisting device in synchronism.

ROBERT D. HEFFELFINGER.

No references cited.