

Feb. 5, 1963

C. F. VAN HOOK

3,076,618

WOUND MATERIAL TENSIONING DEVICE

Filed June 30, 1959

5 Sheets-Sheet 1

FIG. 2

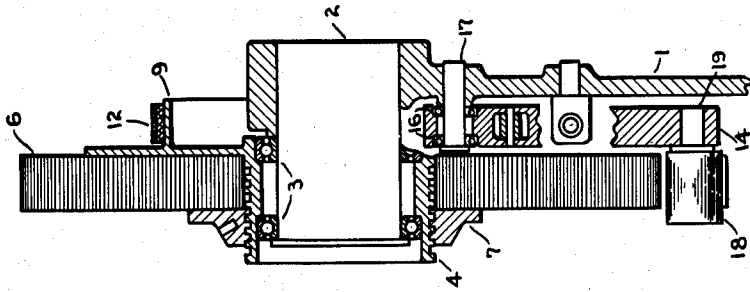
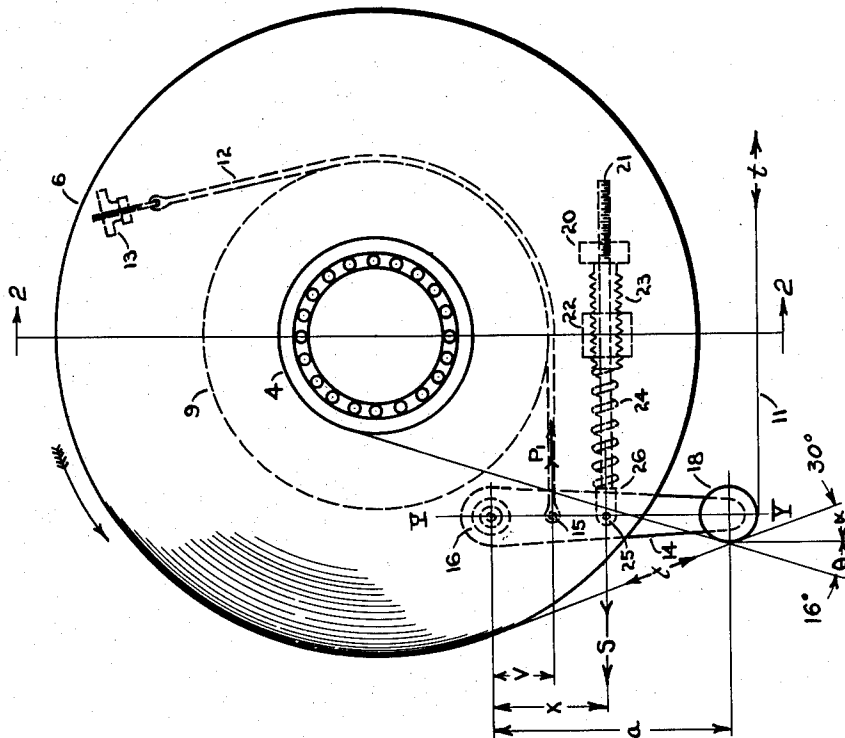


FIG. 1



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FIG. 4

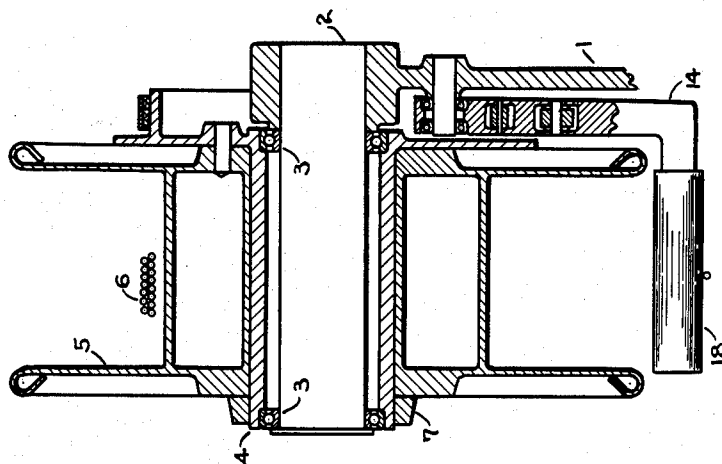
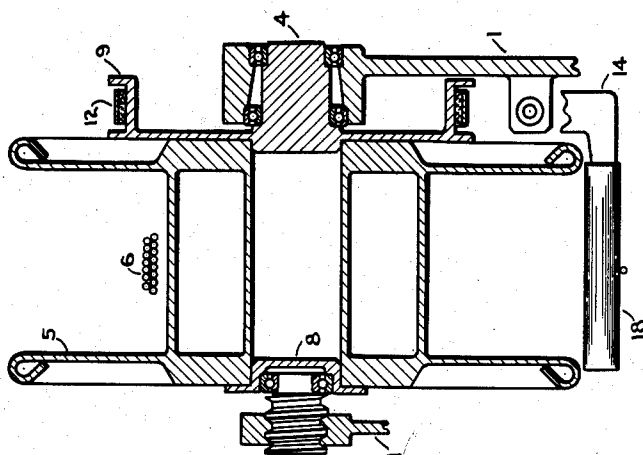


FIG. 3



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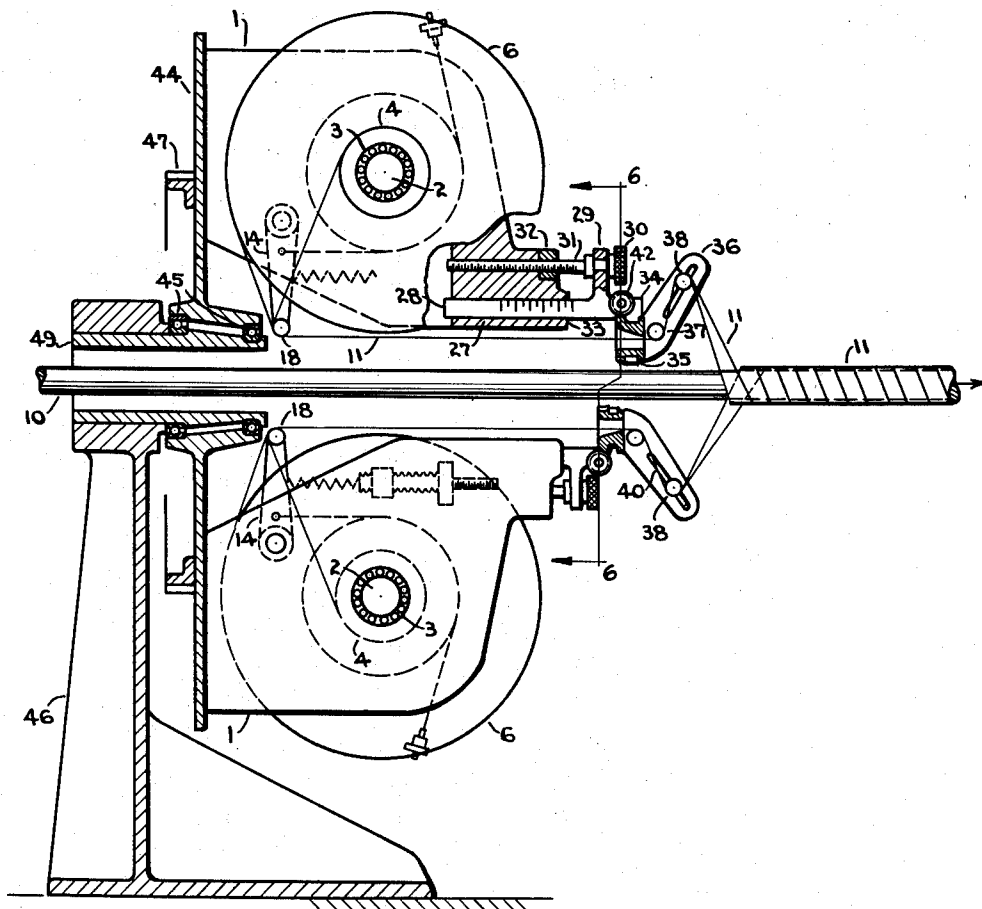
**3,076,618**

## WOUND MATERIAL TENSIONING DEVICE

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**FIG. 5**



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WOUND MATERIAL TENSIONING DEVICE

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FIG. 6

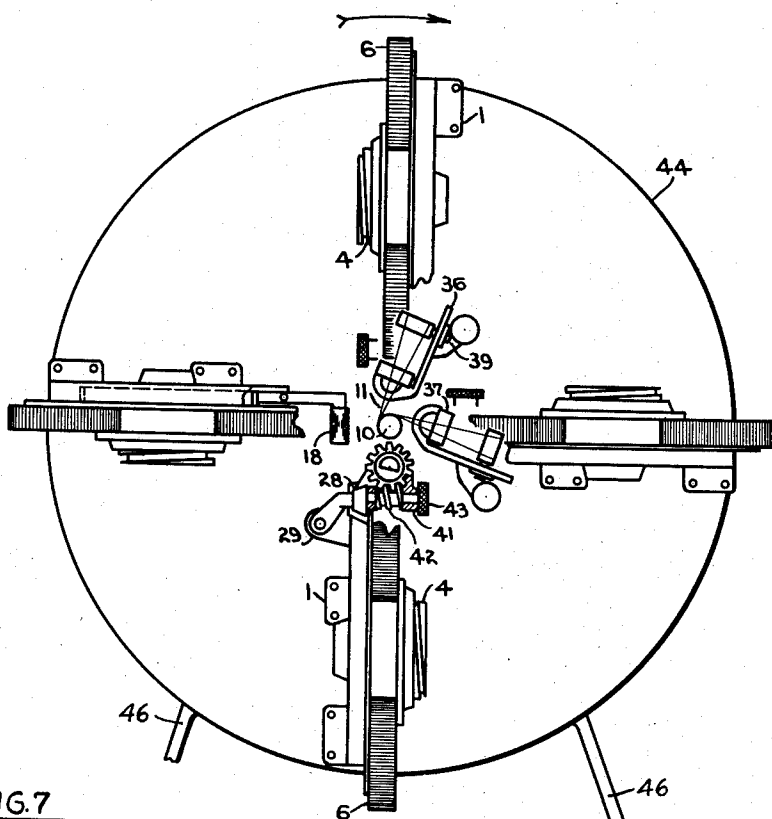
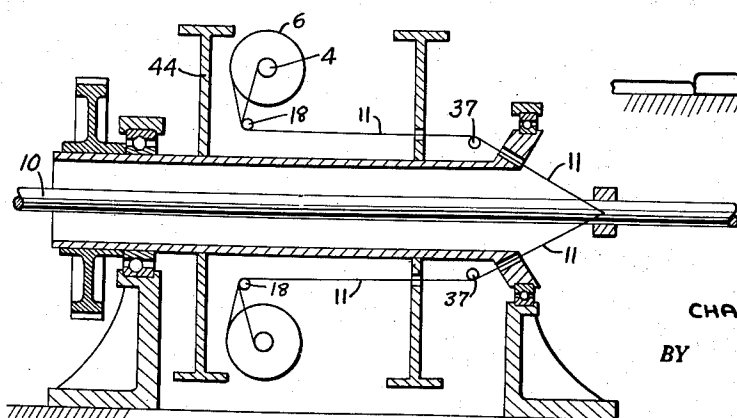


FIG. 7



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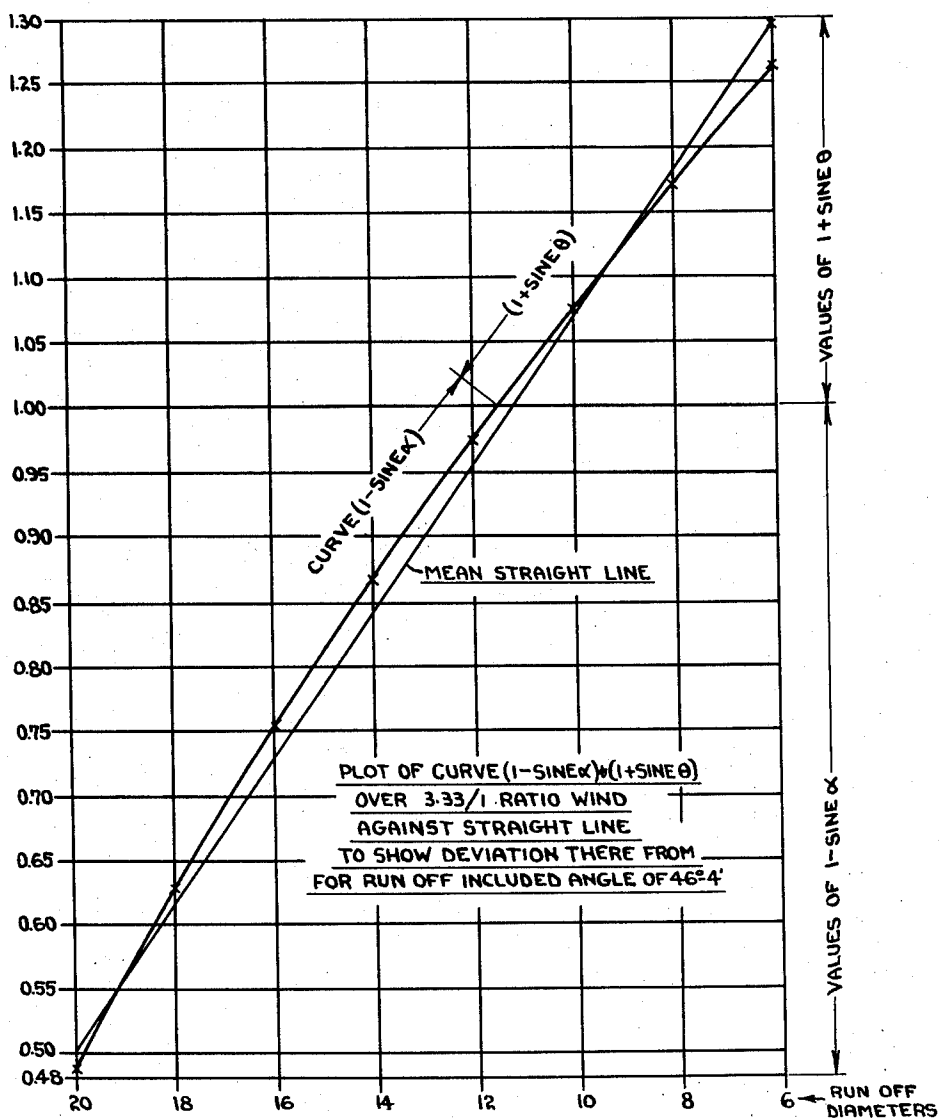
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WOUND MATERIAL TENSIONING DEVICE

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FIG. 8



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**WOUND MATERIAL TENSIONING DEVICE**  
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Filed June 30, 1959, Ser. No. 824,091  
8 Claims. (Cl. 242—75.42)

The invention herein disclosed relates to means for applying and controlling the tension of and to attached means for the guiding of a flexible material of wire or strip form from a center or spool, particularly in the manufacture of wire and cable and wire rope, said means consisting of lever-governed adjustable-torque band brake mechanism for maintaining tension in the unwinding material at a substantially uniform value throughout the run-out of the material supply.

When properly mounted in a machine unit, functioning of this device is not affected by translational or rotational movement, as evidenced by the drawings.

In the unwinding of a substantially flexible material such as tape, sheet, wire, filament or cord form from about a center or spool rotating about its principal axis, said axis stationary relative to earth; or carried in a circular path in machines of the character described, the application and control of torque to the material-carrying center or spool, by the use of mechanical means, is attained in such manner as to result in the tension in the material being of substantially uniform value from the "Full" to "Empty" condition of the center or spool.

This is of particular value in operations such as:

(1) In the feeding from a spool or center in a stationary position, of a wound form of material under a desired uniform tension.

(2) In applying tapes on wire, cable, hose, etc. from a pad or roll form.

(3) In applying wires and strands from a spool in the manufacture of wire and cordage.

I have provided a mechanism permitting single calibrated settings of the device for the entire run-out of the material, thus eliminating the necessity for changes in settings to procure substantial uniformity of tension in the material as the wound diameter on the center or spool changes.

Tension setting is adjustable to allow range of values which employment of this device requires. The control lever, spring and band brake arrangement of my invention is such that when the material being run over the control lever roller severs, the brake torque resultingly rises considerably, to prevent continuing rotation of the supply, preventing loosening of the convolutions of the material carried in supply thereon.

While I regard as unattainable, a mechanical device resulting in an exactly constant tension in a material throughout its unwinding from a decreasing diameter of supply, this mechanism will produce results so close to uniformity as to be of considerable advancement over any known existing mechanical device now employed in the operations hereinbefore described.

This arrangement of wound-material tensioning device has reference to any run of a flexible material from a progressively decreasing diameter, with only a single setting required for any tension desired in the material, particularly as in the employment of wound rolls of tape-type material and spools of wire in the manufacture of electrical wire and cable and wire rope and cordage.

In the drawings accompanying this specification, practical embodiments of the invention are depicted, in which

FIGURE 1 is a view looking in line with the rotational axis of the roll of tape form material, and which shows

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the functional principle of the action of the fundamental elements of the device.

FIGURE 2 is a cross-section on line 2—2 of FIGURE 1 showing a roll of tape material mounted on anti-friction bearing center, with the central axle mounted in a frame; the control lever in line YY being cut away to allow clarity of view of the pivot mounting of the spring adjusting sleeve shown on main cross-sectional line of the figure.

FIGURE 3 is a cross-section showing a spool for wound material supply carried on and between anti-friction bearing pintles of a conventional frame mounting, with control lever cut away again, to show pivot mounting of spring adjusting sleeve.

FIGURE 4 is a cross-section showing a spool for the material supply carried on the anti-friction bearings of the cantilever-type axle of a frame mounting, the control lever section of which occupies the same position relative to spool axis, as the control lever of line YY of FIGURE 1.

FIGURE 5 is a cross-section of a head with guides for applying tapes 11 about the core 10 to form a product such as cable or hose, and is one of one or more heads for applying such material in sequence as the core 10 is drawn along the central axis of the head.

FIGURE 6 is a view from the right-hand end of FIGURE 5, and shows four of the wound material supply units radially spaced to apply up to four tapes. This figure also depicts two of the tapes winding around the core; the third unit is cut away on line YY of FIGURE 1 to show control lever position, while the fourth unit is cut away on line 6—6 of FIGURE 5 to show means of adjusting the final pair of guide rolls to attain straight run of product to the periphery of core.

FIGURE 7 is a schematic cross-sectional outline of a Wire Stranding Machine on which the units of FIGURES 3 and 4 are shown mounted in the rotor to carry spools of wire to form strand layers at the die holder at the exit end of rotor, and is for the purpose only of illustrating mountings of spool-type units of FIGURES 3 and 4.

FIGURE 8 is a plot of curve " $1 - \sin \alpha$ " and " $1 + \sin \theta$ " for a package run-off angle from "Full" to "Empty" of 46 degrees on diameter change ratio of 3.33:1.

This description here deals primarily with the fundamental mechanism for controlling the tension in the material as it leaves the control lever roll which constitutes material guide means or a roller of the device, for I am not dealing with the method for advancing the product 10 to which it is applied, nor with whatever means is employed for exerting the pull on the material as it is removed from its carrier center 4 or spool 5.

This description, for the present, deals with FIGURES 1, 2, 5 and 6, describing in detail the device, and with the particular guide employed in the application of flat strip material to a core; but it should also be evident that FIGURES 1, 3 and 4 apply likewise to the control of tensioning of wound form material such as wire, cord or other filament forms in their multiple application by rotating machine units in the manufacture of strands, ropes and cables.

In FIGURE 6 the product is assumed coming toward the observer, and in FIGURE 5 it is being advanced from the left-hand side to the right-hand side, to have wrapped about it, in the instance depicted, the bands of flat strip material 11, these being supplied from the rolls 6 thereof, which are wrapped on the drums or holders 4 in convolution form.

It is here deemed best to describe the path of the material and the action of the mechanism in applying the tension thereto, as the wound material passes from its supply

source on FIGURES 1 and 2, to being delivered from the tension control lever roll 18.

The roll of flat strip material 6 in FIGURES 1 and 2 is carried on a center drum 4, which rotates on anti-friction bearings 3 mounted on axle 2, which, in turn, is attached to and forms part of frame 1, this frame being one of any number of stationary relative-to-earth types, or a carrier frame of the general character depicted in the rotating machine unit of FIGURES 5 and 6.

It is to be understood that the angles of approach or tangential paths indicated on FIGURE 1 of the drawings are given by way of example only and that the relative size and ratio of these angles to one another will vary to accord with the ratio of the diameters of the roll 6 from its full to empty positions to achieve constancy of tension as hereinafter more clearly disclosed.

Frame mountings for spool-carrying-assemblies are depicted by FIGURES 3 and 4.

In FIGURE 2 the roll of material 6 is held on the drum 4 by the removable nut 7.

In FIGURE 4 the spool 5, carrying wound material supply, is likewise held on drum 4 by nut 7.

In FIGURE 3 the spool 5, carrying wound material supply, is mounted on anti-friction bearing pintles 4 and 8, the latter being retractable to remove spool.

In all three FIGURES 2, 3 and 4, the member 4 carrying the material supply has, attached to and forming part of it, a brake drum 9.

Brake band 12 envelopes an arc of drum 9, and is attached at one end to stud 13, which is secured in frame 1. The opposite end of band is attached to lever 14 at pin 15, at a distance of V from lever main fulcrum axis. Control lever 14 is mounted on anti-friction bearings 16 carried on stud 17 which is fixed in frame 1.

Anti-friction-equipped guide roll or means 18 is mounted on control lever stud 19 in control lever.

Tension-adjusting quill 20 has its body exterior 23 threaded into pivot 22 which is part of frame 1. The quill 20 is tubular to centralize and pass the stem 21 of spring rod which is fastened at one end by the cross-pin 25 to control lever 14. Over the stem rod 21 is placed compression spring 24 so that it is compressed between head 26 of rod 21 and end of quill 20 as the quill is adjusted in the threads of pivot 22.

Thus, all of the functional parts of the device are described to where the material 11 leaves the guide roll 18, where its path beyond from this guide roll must, by succeeding conventional rolls, sheaves or means of like manner, be essentially at right angles to the axis YY of the control lever 14.

Referring now to FIGURES 5 and 6, where units of the device of FIGURE 1 are mounted in a rotating taping stand to apply flat tapes 11 helicoidally about core 10: this particular mounting is chosen for the reason that in non-circular wound material helicoidal applying, the guidance thereof, beyond departure from guide roll 18 on control lever 14, it is desirable and necessary to reduce the path changes to the maximum of simplicity.

On each of the units of FIGURE 1, mounted as shown on FIGURES 5 and 6, there is mounted in a slide slot 27 of frame 1, an indexed slide 28. This slide 28 has an extended boss 29; centered in this boss 29 is the held end of adjusting screw 31, on the end of which is the knurled handwheel 30 for rotative purpose and also to hold the screw end within the boss 29.

The threaded end of the screw 31 engages the interior of threads of boss 32 which is part of frame 1. Thus, rotation of handwheel 30 imparts longitudinal movement of slide 28 within slot 27 of frame, and index lines shown on slide 28 register its position relative to frame 1, face 33, to adjust the offset of successive tapes 11 on core 10 with respect to each other.

At the end, and forming part of slide 28, the hollow boss 34 centers within it the pivot 35 of final guide bracket 36. This pivot axis is the continuation of line 11

coming from periphery of roll 18 on control lever 14. This same axis, continued through the said pivot to the right, is tangential to the periphery of anti-friction bearing roll 37 mounted on fixed pin in the bracket 36. On this same guide bracket is anti-friction bearing roll 38 on axle 39, adjustable and indexed in and along slot 40 of the bracket.

Between two wings 41 on boss 34 of slide 28, there is worm 42 which is mounted on the through shaft of adjusting wheel 43. The worm 42 engages matching teeth in flange of pivot 35 and, by its rotation manually by wheel 43, the pair of final guide rolls 37 and 38, in their mounting bracket 36, are adjusted around pivot 35 axis so that the final guide roll pair main axes are at right angles to a tangent drawn from the periphery of the core 10, and, of more importance, the material between roll 18 and roll 37 is twisted on its own longitudinal center simultaneously, this being of extreme importance in tapes of very low tensile strength, so that fibres of the tape thus are stretched equally on both sides of its main central axis.

This entire guide assembly for the material beyond the roll 18, is here particularly shown for the helicoidal uniform spacing of multiple tapes 11 on center core 10 as core 10 is drawn through a head having a disc 44.

While the disc 44 shows only four tape assemblies of FIGURE 1, each with complete guiding means, such disc 44 may be increased in diameter to space any reasonable number of such assemblies as may be economically operated, such being the case also where unit assemblies for spool-carried materials, as on FIGURES 3 and 4, are mounted as in FIGURE 7, in wire stranding and cordage twisting machines.

The roll 38 on its axle 39 is adjustable in slot 40 of guide bracket 36, to give proper lead length of tape 11 from roll 38 to core 10, where a 90-degree twist of flat tape occurs.

As shown in FIGURE 5, the frames 1 are mounted on the disc 44 which is, in this instance, carried and rotates on anti-friction bearings 45 which are, in turn, mounted on stationary extension spindle 49 of main stand 46. The disc 44 is driven through gear 47 which is attached directly thereto. The disc 44 may also be of the type having a hollow center carried inside of and rotating in anti-friction bearings mounted within the stand hub; but the FIGURE 5 shows the preferred mounting.

To now explain the fundamental principle of the control of the tension from the wound material position on center 4 to where it leaves the periphery of roll 18 on control lever 14.

It is well known that the torque of a band brake varies directly with the pulls on the band, the coefficient of friction of the surface in contact with the brake drum and the angle of contact of band on brake drum. In this device, for any predetermined package size of wound material 6 and its carrier, the angle of band contact, the size of brake drum 9, and the braking material, are fixed by design.

It will be noted from FIGURE 1 that the control lever 14 has acting upon it, to cause moments about axis 16, three separate forces at three different arm lengths, viz:

The brake band pull  $P_1$  at arm length V (producing a contraclockwise moment).

The spring push S at arm length "x," (producing a clockwise moment).

The resultant of tape pulls "t" entering upon and departing from roll 18 on arm of "a" length (producing a net contraclockwise moment).

When the supply package 6 is "Full," the resultant tape pull force at arm length "a" producing lever moment is equal to " $t - t \sin \alpha$ ."

When the supply package or roll approaches the "Empty" diameter at 4, the resultant tape pull force at arm length "a" producing lever moment is equal to

$$"t + t \sin \theta"$$

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Therefore we have on the control lever, a sum of moments at supply run-off angles of:

$$\begin{aligned} \alpha \text{ to zero: of } \Sigma M: Sx &= PV + (t - t \sin \alpha)a \\ &= PV + (1 - \sin \alpha)ta = I \\ \text{zero to } \theta: \text{ of } \Sigma M: Sx &= PV + (t + t \sin \theta)a \\ &= PV + (1 + \sin \theta)ta = II \end{aligned}$$

With spring setting "S" set for any run-off, it follows that, as the value of "1 - sin  $\alpha$ " rises through the drop in sin  $\alpha$  through unity to a maximum of "1 + sin  $\theta$ " as run-down progresses to emptying of supply, then the value of "P" must fall inversely, for the spring moment remains constant.

With the brake band 12 continually in contact with drum 9, as the value "P" falls, the torque of the brake falls therewith, and as the unwinding diameter at which the product leaves the supply is decreasing throughout the angle " $\alpha + \theta$ " the tension "t" from "Full" to "Empty" condition of supply package is very nearly constant, for the mechanism proportions are disposed from the preceding formulae in equating I to II, for Sx must be the same for a single setting throughout the run of a supply package.

Thus it will be perceived that—with spring push "S" remaining constant, as resultant of pulls of "t" on arm increases, the tension "P" in brake band decreases, and with the proper disposition of angles of swing " $\alpha$ " and " $\theta$ " on the roll 18 of the control lever 14, relative to the run-off diameters of the roll 6, the tension "t" is equal at "Empty" and "Full" conditions of the roll, and is very close to that value when  $\alpha$  and  $\theta$  and their sines are zero.

As the material 11 arcs over the roll 18, the slightest increase in "t" causes a multiplied incremental (due to shorter arm) decrease in band tension "P," so that the band is accordingly varied in tension, consequently varying the torque of the brake, as the supply diameter changes.

The amount of deviation from constancy of tension in the material is shown by the departure from the straight line of the curve 1 - sin  $\alpha$  through 1 + sin  $\theta$  of FIGURE 8, where the tension value at "Full" condition of supply is equal to the tension value at "Empty" condition, and is shown for an overall swing arc of run-down lead from supply to control lever roller 18 of 46 degrees. The curve is plotted against run-off diameters of material supply, for the angles  $\alpha$  and  $\theta$  do not vary uniformly with diameter change, and this is the principal reason for the deviation from exact constancy of the tension in the material during a run-off. In this particular plot the deviations from the mean straight line, which line indicates the perfect rise necessary to produce uniform fall in band torque to give exactly uniform tension in material, are, from the plot, very close to: 2.7% at the 20" diameter; 2.6% at the 14" diameter, and 2.35% at the 6" diameter.

It will be obvious that various changes may be made by those skilled in the art, in the details of the device disclosed above, within the principle and scope of the invention as expressed in the appended claims.

Having thus described my invention, I claim and desire to secure, by Letters Patent, the following:

1. In a wound material tensioning device the combination comprising, a support frame, a circular drum rotatably journaled with respect to said frame and operative to concentrically hold wound material to be tensioned in its withdrawal from said drum, said drum having a concentric braking surface, a brake band continually in contact with said braking surface, a control lever pivoted at one end to said frame on a swing axis parallel to and spaced from the rotational axis of said drum, said swing axis being positioned on a line substantially midway between the outer and inner diameters of the wound material, the leading end of said band being attached to said control lever at a first radial distance from its swing axis, the other end of said band being at-

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tached to said frame, a material guide roll rotatably journaled with respect to said control lever at a second radial distance from said swing axis greater than said first radial distance and on an axis parallel to said swing axis, a spring acting upon said control lever and operative to cause a moment with respect to said control lever about said lever axis in the direction opposite to the pull of said band, the position of said guide roll relative the widely varying angles of approach thereto of the wound material at the beginning and end of run-off when said wound material on said drum is pulled from around said guide roll in a direction substantially perpendicular to the longitudinal axis of said control lever being such that the tension in the wound material in leaving the guide roll will be substantially equal at all conditions of run-off from full to empty.

2. In a machine for applying and tensioning wound material of uniform cross-section helicoidally on an elongated core member moving along its longitudinal axis, the combination comprising, a disc member having a central opening for through passage of said core member, means for rotating said disc member about its center in a plurality of support frames mounted on said disc member in arcuately spaced relation about said central axis, a plurality of circular drums, one for each frame member, rotatably journaled with respect to said frame members about axis substantially tangent to a circle concentric with said central axis, each drum being adapted to concentrically hold a supply of wound material to be tensioned in its withdrawal from said drum, each drum having a concentric braking surface, a brake band continually in contact with said braking surface, a control lever pivoted at one end to said frame on a swing axis parallel to and spaced from the rotational axis of said drum, said swing axis being positioned on a line substantially midway between the outer and inner diameters of the wound material, the leading end of said band being attached to said control lever at a first radial distance from its swing axis, the other end of said band being attached to said frame, a material guide roll rotatably journaled with respect to said control lever at a second radial distance from said swing axis greater than said first radial distance and on an axis parallel to said swing axis, a spring acting upon said control lever and operative to cause a moment with respect to said control lever about said lever axis in the direction opposite to the pull of said band, the position of said guide roll relative the widely varying angles of approach thereto of the wound material at the beginning and end of run-off when said wound material on said drum is pulled from around said guide roll in a direction substantially perpendicular to the longitudinal axis of said control lever being such that the tension in the wound material in leaving the guide roll will be substantially equal at all conditions of run-off from full to empty.

3. A machine as defined in claim 2, including roller guide means for transporting the wound material in spaced parallel paths along the rotary axis of said disc from each of said guide rolls, and for rotationally adjusting said paths at the zone of application to the core member.

4. A machine as defined in claim 3 wherein said roller guide transporting means for each of said guide rollers comprises a pair of rollers in a roller mounting arm one end of which is rotatably journaled with respect to its pertaining frame member, one each of said guide rollers being adjustably mounted along its pertaining roller mounting arm.

5. A machine as defined in claim 1 including means for adjusting said spring means to confine said tension to a preselected degree.

6. In a machine for supplying and tensioning material, the combination comprising, a support frame, a drum rotatably mounted on said support frame and adapted to hold a roll of material, said drum having a braking surface, a brake band operatively associated with said braking

surface, a control lever pivotally mounted on said frame and spaced from the rotational axis of said drum so that the pivotal axis of said control lever is positioned adjacent a line substantially midway between the outer and inner diameters of the roll of material, said control lever being operatively connected to said brake band, material guide means supported on the free end of said control lever, a spring secured to said control lever and operative to cause a movement of said control lever about said pivotal axis in a direction to actuate said brake band, the position of said guide means relative the angles of approach thereto of the material at the beginning and end of run-off when said material on said drum is pulled from around said guide means in a direction perpendicular to the longitudinal axis of said control lever being such that the tension in the material in leaving the guide means will be substantially equal at all conditions of run-off from full to empty.

7. In means for supplying and tensioning material, a support, a holder rotatably mounted on said support and adapted to hold a spirally wound roll of material for run-off from full to empty positions toward a work source, said holder having a braking surface, a brake band operatively associated with said braking surface, control means operatively connected to said brake band and pivotally carried by said support in spaced relation with the rotational axis of said holder and with its pivotal axis being confined to a location adjacent a line midway between said positions, a spring secured to said control means for pivoting the latter to actuate said brake band, the position of said control means, relative to angles of approach of the material thereto during said run-off from said full to empty positions and when material travels from said control means to the work source during run-off, being such that material travelling from said con-

trol means will be of a substantially uniform tension from said full to empty positions during run-off.

8. In means for supplying and tensioning material, a support, a holder rotatably mounted on said support and adapted to hold a spirally wound roll of material for run-off from full to empty positions to a work source, said holder having a braking surface, a brake band operatively associated with said braking surface control means pivotally carried by said support in spaced relation with the rotational axis of said holder and having its pivotal axis adjacent a line midway between said positions, said control means being operatively connected to said brake band, actuating means for pivoting said control means about said pivotal axis to actuate said brake mechanism and including a spring connected to said control means, a material guide roller carried on said control means in spaced relation to said pivotal axis for engaging material between said holder and the work source, said roller being positioned relative to said holder to define varying tangential paths for material leading from said holder to said roller and a path from said roller toward the work source to increase the extent of the engagement of said roller with the material by the varying tangential paths during said run-off, whereby material leading from said roller will be of a substantial uniform tension from said full to empty positions during run-off.

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