United States Patent

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[54] TAPE TENSION CONTROL APPARATUS

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[30] **Foreign Application Priority Data**

June 18, 1969 Great Britain.....30,938/69

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[51] **Int. Cl.**.....**B65h 23/08**, B65h 25/28

[58] **Field of Search**.....242/75.45, 75.42, 75.43, 75.5, 242/68.7, 156.1, 156.2

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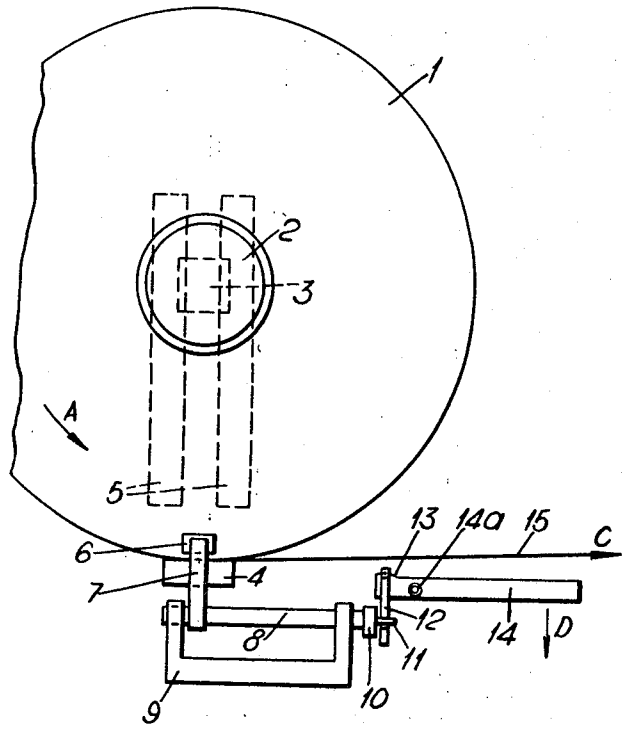
[57] **ABSTRACT**

An apparatus for controlling the tension and acceleration of a strip being unwound from a spirally wound roll includes means for rotatably mounting the roll about its center, a stop member disposed against a peripherial portion of the circumference of the roll for establishing tension in the strip being unwound, means for allowing the center of the roll to approach the stop member as the diameter of the roll decreases, and brake means for applying braking force to each side of the roll for maintaining the tension of the strip at a constant level.

8 Claims, 8 Drawing Figures



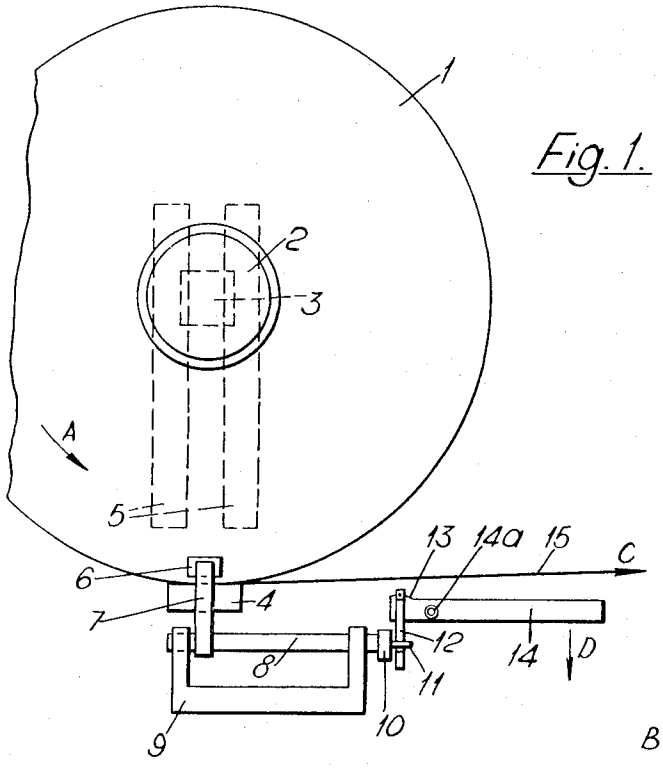


Fig. 1.

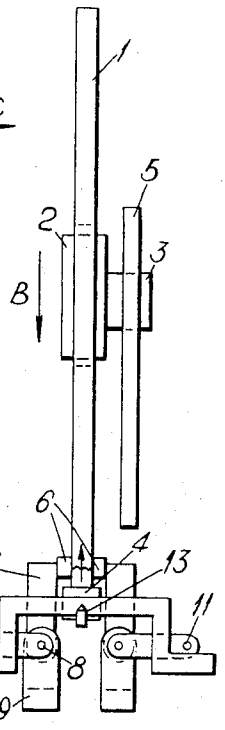
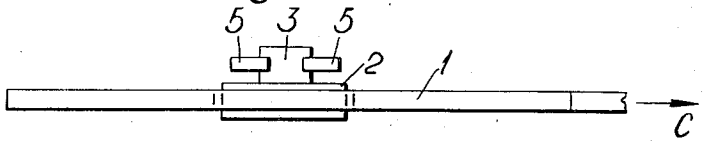


Fig. 2.

Fig. 3.



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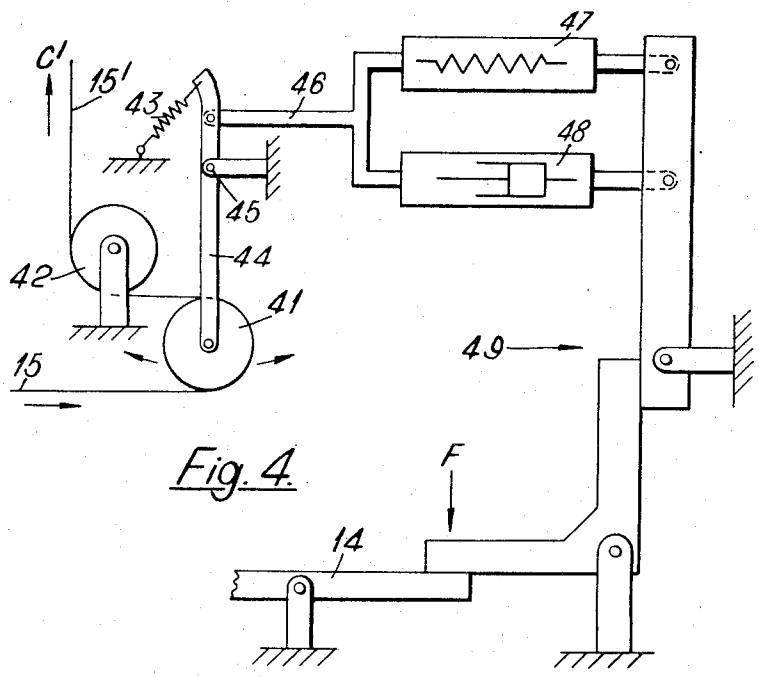


Fig. 4.

Fig. 5.

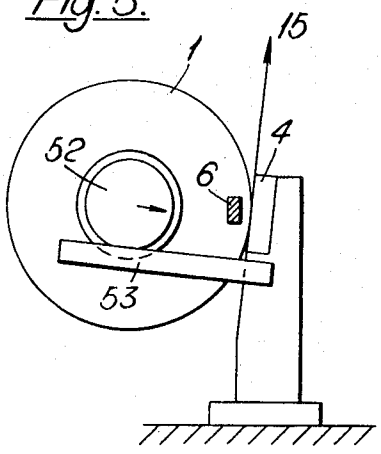


Fig. 6.

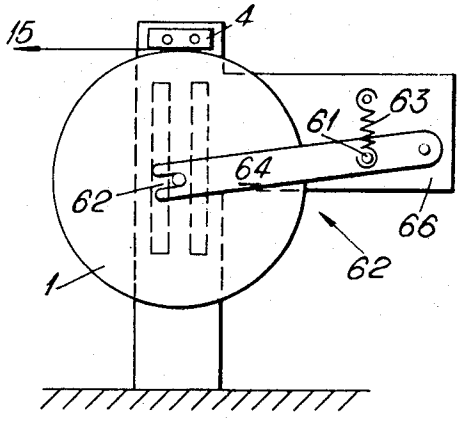


Fig. 7a.

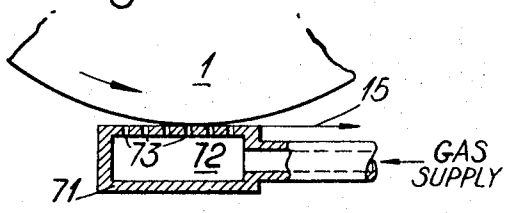
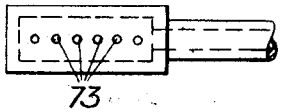


Fig. 7b.



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TAPE TENSION CONTROL APPARATUS

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to an apparatus for controlling the tension and acceleration of a thin strip of material being unwound from a spirally wound roll, and more particularly, to means provided in the apparatus for maintaining the tension and acceleration of the strip at a constant predetermined level.

2. Description of the Prior Art

According to the prior art, it is generally known that the tension of the strip being unwound from a spirally wound roll is controlled by an application of the brake pads having an axis of rotation fixed in space, with the braking torque either applied by brake pads or shoes through fixed or rotating flanges. It is also known to mount the spirally wound roll such that the center thereof approaches a stop member as the diameter of the roll decreases. In this manner, the weight of the roll provides a continuing drag and cooperates with the stop member in maintaining the tension in the tape. It has been found that the tension provided in the tape in this manner tends to decrease as the weight of the roll decreases and the diameter of the pad decreases. It has also been found that the tension of the strip tends to fluctuate rather widely and that the acceleration of the strip tends to increase as the diameter of the pad decreases. The adverse effects of these shortcomings are more serious in the situation where the tension of the strip must be maintained as evenly as possible, as is the case where the tape is used to wrap continuously advancing cable or strands of material.

SUMMARY OF THE INVENTION

It is an object of the present invention to overcome the aforementioned shortcomings in the prior art and, more particularly, to provide improved means to maintain tension of the strip being unwound at a predetermined constant level and to maintain better control of the tape acceleration.

These and other objects of the invention are obtained by an apparatus which includes means for rotatably mounting the roll about its center, a stop member disposed against a portion of the circumference of the roll for establishing a predetermined level of tension in the strip being unwound, means for allowing the center of the roll to approach the stop member as the diameter of the pad decreases, and means for applying a braking force on the sides of the roll at a position near its circumference for maintaining the tension of the strip at said predetermined level.

The present invention will be more fully apprehended from the following detailed description of the preferred embodiments in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a first side view of one embodiment of the invention;

FIG. 2 shows a second side view of the embodiment of FIG. 1;

FIG. 3 shows a top view of part of the embodiment of FIG. 1;

FIG. 4 is a schematic diagram of a closed-loop control system designed to cooperate with the strip tension control apparatus shown in FIGS. 1–3;

FIGS. 5 and 6 respectively show an alternative embodiment of the apparatus shown in FIGS. 1–3; and

FIGS. 7*a* and 7*b* show views of a gas bearing which can be used in place of the friction type stop member used in the other embodiments shown in FIGS. 1–6.

DETAILED DESCRIPTION OF THE INVENTION

In FIGS. 1–3, a roll 1 of spirally wound strip material, for example, paper insulation used in helically wrapping a plurality of electrical conductors into a telephone cable, is provided

with a rotatable center 2, to which a slide member 3 is rigidly attached. Slide member 3 is adapted to run between two slide ways 5 such that as the diameter of the roll decreases during unwinding, slide member 3 is guided by guide ways 5 as the roll falls under gravity. The rotatable center 2 and slide member 3 are such that the roll 1 rotates in the direction shown by arrow A while falling in the direction indicated by arrow B. Roll 1 rests on a stop member 4 which is designed so as to support the weight of the roll without adding substantially to the tension of the strip 15 being pulled off in the direction indicated by the arrow C.

Braking force to control the tension and acceleration of the strip 15 is maintained at a constant level by two brake pads 6, each carried by a caliper 7. The two brake pads 6 act on opposite sides of the roll as shown in FIGS. 1 and 2, and may, for example, be of tungsten carbide. The calipers 7 are each rigidly attached to individual torsion bars 8 which are free to rotate about their longitudinal axis in bearing blocks 9. The brake pads 6 thus move along arcs of a circle as they are brought into and out of contact with roll 1. Rigidly attached to each torsion bar 8 is a torque arm 10 having a peg 11 fitted to it. A balancing arm 12 is used to divide the braking force applied to a braking lever 14 equally between the two pegs 11 and thence to the brake pads 6. To enable the brake pads 6 to float with the roll 1 the balancing arm 12 is pivoted on a knife edge 13 forming part of the braking lever 14.

To apply the brake pads 6 to the roll 1, the braking lever 14 is moved downward in the direction shown by arrow D. This action causes pivoting of the lever 14 about a pivot 14*a* and the lifting of balancing arm 12 to bring it into contact with the pegs 11. This then causes the torque arm 10 to be lifted and rotate with the torsion bars 8, thus rotating the two opposing calipers 7 to bring the brake pads 6 into contact with the two opposing sides of the roll 1. Alternatively, one of the calipers 7 may be fixed while the other is movable, while allowing the roll 1 to align itself by means of a self-aligning bearing in the center 2.

The actual braking force applied to lever 14 may be supplied by a closed-loop control system, such as that shown schematically in FIG. 4, which cooperates with the strip tension and acceleration control apparatus shown in FIGS. 1–3. In the system, a movable pulley 41 is used as an acceleration comparator to sense the difference in the acceleration between the strip 15 being supplied to it from the roll 1 and the strip 15′ being pulled away from it via a pulley 42 in the direction shown by an arrow C′. The resulting motion of this pulley is transmitted to a linkage 46 via a lever arm 44 and lever fulcrum 45. The linkage 46 acts upon a suitable force transducing means consisting of a compression spring 47 which senses displacement of the linkage caused by the movement of the pulley 41, and a velocity dependent mechanical damper 48 which senses the velocity of the displacement.

The force resulting from the pulley motion is applied via the transducer means. A lever mechanism 49 is designed to amplify the force and then apply the amplified force to the braking lever 14 as shown with an arrow F in the drawing. Tension is imparted to the paper strip 15 by means of the extension or retraction of a balance spring 43 acting on the pulley lever arm 44 in such a way that the resultant torque on the lever arm is practically independent of the position of the arm. The braking force F is produced when a partial drop occurs in tension of the paper strip via the compression spring 47, mechanical damper 48 and the lever mechanism 49.

FIG. 5 shows another embodiment in which, the center 2 of the roll 1, instead of being constrained to move vertically downwards during unwinding as shown in FIGS. 1–3, is constrained to run down an inclined plane so that the force applied to the stop member 4 is a small portion of the weight of the roll 1 and will not add substantially to the tension. The arrangement includes an incline 53 adjusted to a suitable angle and containing two guideways for the two sides of the roll. The roll may be advantageously fitted with a flange 52 on each side thereof, to ride on the incline. This arrangement allows the

roll periphery to rest against the stop with a much lower force, thus reducing the friction.

FIG. 6 shows still another embodiment in which the roll 1 is supported by a counterbalancing mechanism 62 in such a way that the roll is lifted upward into a contacting relationship with the stop member 4. Advantageously the cooperating elements in the arrangement, such as lever member 64, one end of which is coupled pivotally to a support base 66 and the other end of which is coupled to the roll, and a spring member 63 coupled to the lever for lifting the roll end of the lever, are so designed that the force with which the roll 1 is applied to the stop member 4 is minimal or at any suitable predetermined level. In this manner, the friction between the stop member 4 and the strip can be readily kept minimal or at any predetermined level.

In the case where the strip is sticky or extremely fragile, it is preferable that the stop member does not physically touch the strip being unwound, while still applying some amount of force against the strip. FIGS. 7*a* and 7*b* show a gas bearing which can be used in place of the conventional contact type stop member 4 shown in FIGS. 1–3, 5 and 6, and which does not touch the strip. The gas bearing includes a block 71 having a reservoir 72 and a plurality of nozzles or holes 73. The reservoir 72 is connected to a gas supply, for example, compressed air. Jets of the compressed gas are directed to the strip of roll 1 through the plurality of nozzles or holes 73. The pressure of the jet streams of the gas being ejected from the nozzles 73 provides the necessary force against the strip and thereby establishes the level of tension in the strip.

The present invention thus has various advantages over the known devices which consist of pads having an axis of rotation fixed in space, with the braking torque either applied through the center or through rotating of fixed flanges. With the present invention the back tension in the strip material 15 is constant no matter how the pad diameter varies: there is less likelihood of the pad breaking up as is the case when the braking force is applied to the center; flanges on the center are not required, resulting in a considerable reduction of inertia in the case of rotating flanges, or elimination of friction on the pad in the case of fixed flanges, and imperfect pads can be utilized without trouble.

It is to be understood that the foregoing description of specific examples of this invention is made by way of example only and is not to be considered as a limitation on its scope.

What is claimed is:

1. An apparatus for controlling the acceleration and tension of a strip of a material being unwound from a spirally wound roll, comprising means for rotatably mounting said roll about the center thereof, a stop member adjacent a portion of the circumference of said roll for establishing a predetermined level of tension in the strip being unwound, means for allowing the center of said roll to approach the stop member as the diameter of the roll decreases, and means for applying a braking force to the sides of the roll at a position near its circumference for maintaining the tension of strip at said predetermined level, said means for applying a braking force including a pair of brake pads mounted on opposite sides of said roll, support means pivotally supporting said brake pads on each side, pivotal lever means extending in a tangential direction from said roll, a balance arm mounted on said lever means and extending between said brake pads at said opposite sides and adapted to engage said support means, pivotal movement of said lever means causing said balance arm to engage said support means and pivot the respective brake pads into engagement with said opposite sides of said roll, said balance arm dividing the brake force equally between said pair of brake pads.

2. An apparatus in accordance with claim 1, wherein said stop member includes a gas bearing having a gas reservoir, and a plurality of nozzles facing said strip for applying jets of gas from said reservoir against said portion.

3. An apparatus in accordance with claim 1, wherein said means for allowing the center of the roll to approach the stp member includes a slide member attached to said center and a pair of vertical parallel guide ways for guiding said slide member as the roll falls toward said stop member under its own gravity.

4. An apparatus in accordance with claim 1, wherein said means for allowing the center of the roll to approach the stop member includes a slide member attached to said center, and a pair of parallel guide ways inclined at an angle such that, as the diameter of the roll decreases, the center thereof runs down said guide ways.

5. An apparatus in accordance with claim 1, further including a proportional counterbalancing means coupled to the center of said roll for supporting the weight of the roll while lifting it toward said stop member.

6. An apparatus in accordance with claim 1, wherein said support means includes a pair of caliper arms, a pair of rotatable torsion bars, each of said brake pads being rigidly connected to a corresponding one of said caliper arms, each caliper arm being rigidly connected to a corresponding one of said pair of rotatable torsion bars, and a pair of torsion arms extending respectively from said torsion bars, each said torsion arm including a peg, said lever having a knife edge, said balance arm being pivotable about said knife edge, and disposed to engage and rotatably lift the respective pegs when braking force is applied to said lever to rotate the respective torsion arms, torsion bars and calipers and cause the brake pads to be applied to the roll.

7. An apparatus in accordance with claim 6, further including a closed-loop control system cooperating with said brake lever for adjusting the brake force applied against said roll.

8. An apparatus in accordance with claim 1, wherein the stop member supports the weight of the roll.

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