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[54] UNWINDING DEVICE FOR YARN SPOOLS

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[30] **Foreign Application Priority Data**

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[51] **Int. Cl.** **B65h 49/00,** D01h 7/16

[58] **Field of Search** 242/129.5–130.2

[56] **References Cited**

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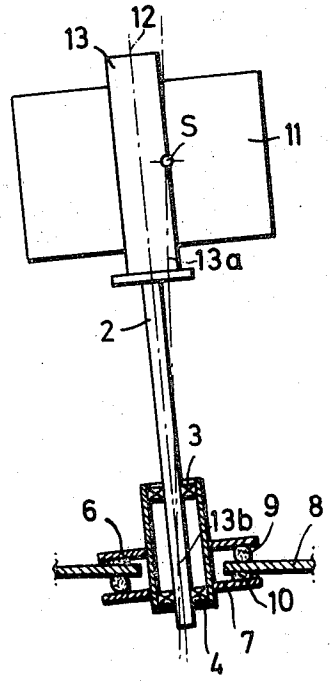
[57] **ABSTRACT**

An unspooling or unwinding device of particular utility for use in unwinding and respooling thread prior to further processing. The device includes a spindle assembly resiliently mounted to enable the assembly and a spool of thread thereon to rotate about the center of gravity of the assembly. To reduce the effect of an unbalanced spool, the spindle within the spool takes the form of a heavy cylindrical weight with the result that the center of gravity of the assembly shifts only slightly relative to the geometric center, during rapid rotation of the spool and spindle during unwinding. The spindle shaft is supported for rotation by spaced apart bearings at a location spaced from the spindle, and the supports for the bearings are resiliently mounted so the shaft can tilt or move radially to allow the spool and spindle to rotate about their common center of gravity.

13 Claims, 6 Drawing Figures



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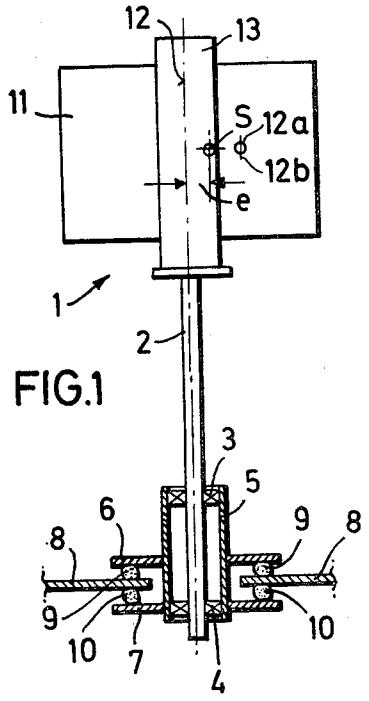

FIG.1

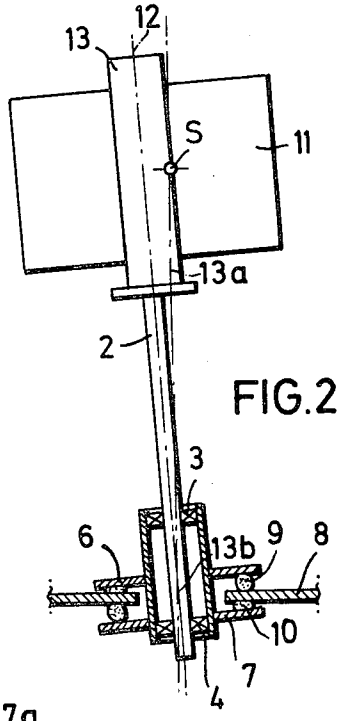

FIG.2

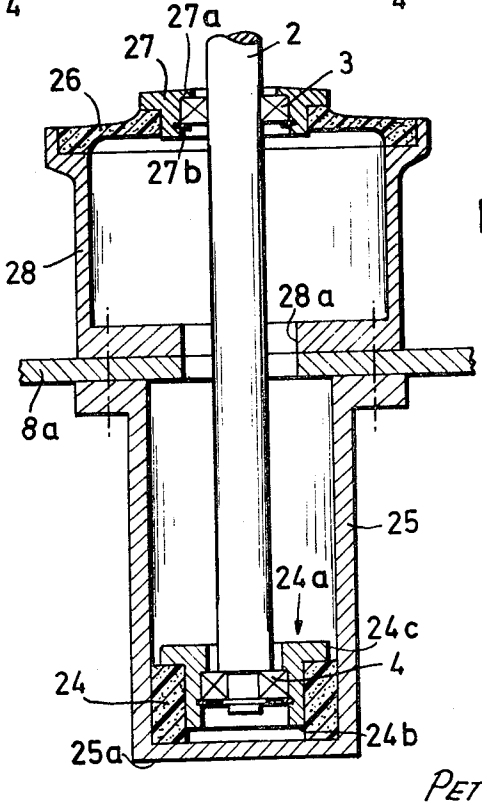

FIG.5

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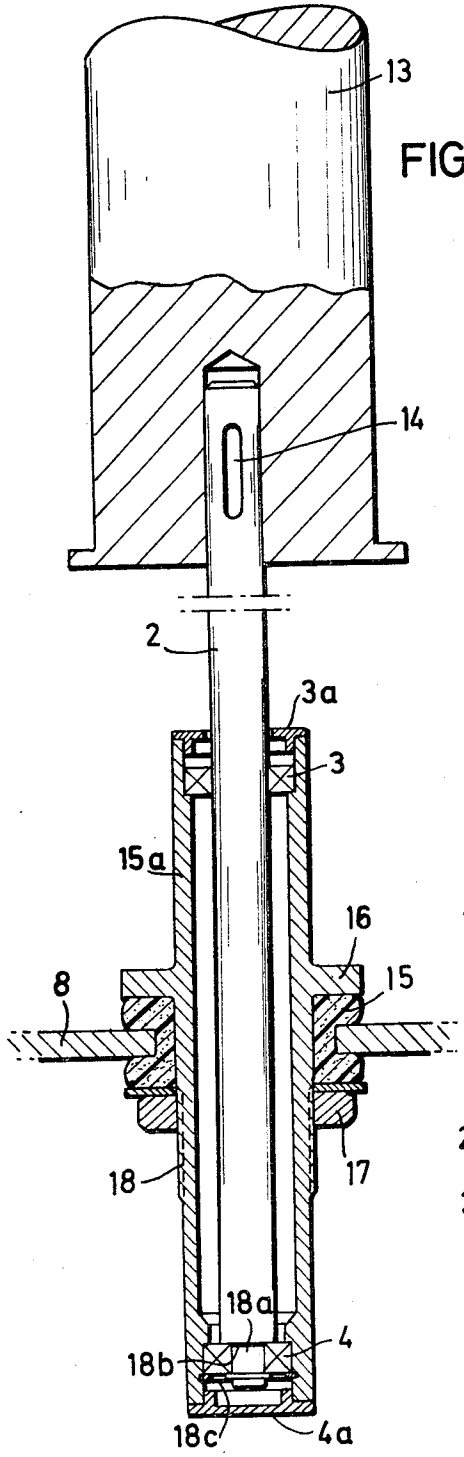

FIG.3

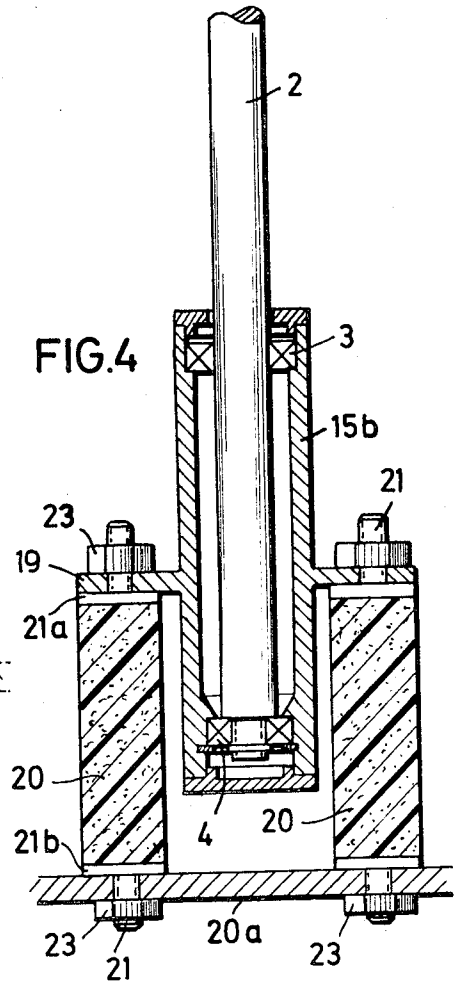

FIG.4

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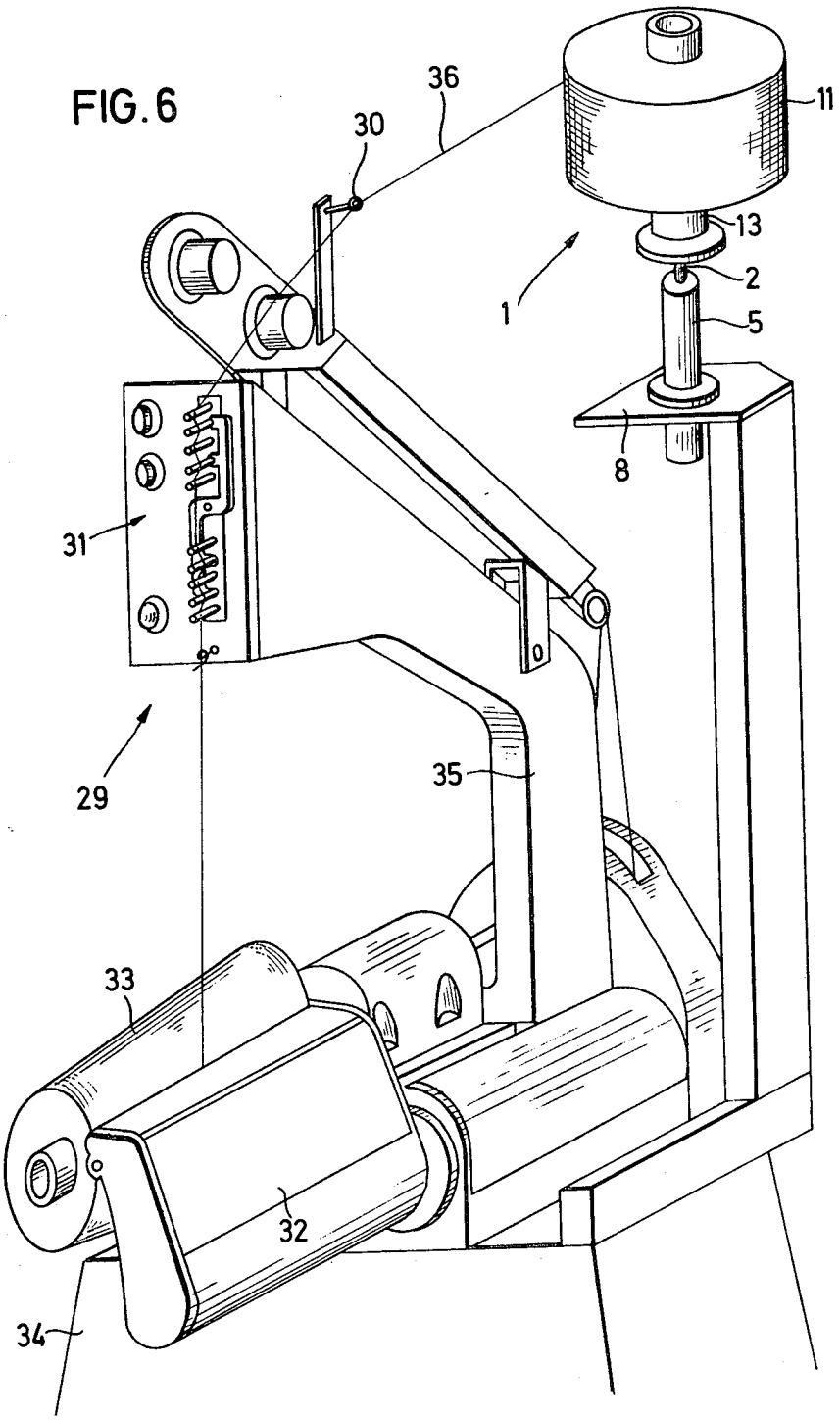
FIG. 6



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UNWINDING DEVICE FOR YARN SPOOLS

This invention relates to a device which permits rapid unwinding of yarn from a spool.

In the textile industry it is frequently necessary to wind yarn and thread from one spool to another to improve the unspooling characteristics of the yarn, which unspooling characteristics are of utmost importance for further processing of the yarn. Such rewinding is particularly necessary where the yarn or thread is further processed by dyeing or bleaching after the yarn is wound on a spool. As a result of such processing, the yarn has very poor unwinding characteristics and it is necessary to rewind the yarn onto another spool before further processing.

To rewind the yarn onto another spool, several techniques are presently employed. In one device known as a "transverse winding frame," the yarn is drawn off the spool axially over one end of the spool and is wound onto another spool. In this device the spool is fixed and does not usually rotate. While this device is satisfactory for unwinding some types of yarn, problems are encountered with set yarns and dyed yarns since these yarns do not unwind properly in an axial direction. In addition, where the yarn is unwound axially additional twists are formed in the yarn which are frequently undesirable. Hence, in many instances, auxiliary unwinding apparatus is required such as release plates. Alternatively, the yarn can be drawn from the spool tangentially in which case the spool is fixed to a spindle and the spool rotates with the spindle as the yarn is unwound.

Where yarn is drawn tangentially from the spool, the spindle for the spool is usually supported by bearings for rotation about a horizontal axis. Thread tension forces can be maintained at the necessary low value only if the bearings are quite efficient and have low friction characteristics. Even with efficient bearings, however, it has been found that the maximum attainable thread speeds are on the order of only 700 meters per minute. The reason for this speed limitation is not because of the friction in the bearings but because of rotational unbalance of the spool and the yarn wound thereon. Although the magnitude of the unbalance decreases as the thickness of the yarn on the spool decreases during unwinding, the speed of revolution of the spool increases with the result that bearing friction and vibration raise the tension in the thread to an unacceptable level.

An object of this invention is to provide an apparatus in which yarn can be withdrawn from a spool at a very rapid rate while maintaining the withdrawal tension in the yarn at an acceptably low level so the yarn can be rewound at a relatively high speed.

In accordance with this invention, the unwinding device includes a rotatable spindle on which the yarn spool is readily mounted for rotation with the spindle, and the spindle is so mounted that the spool and spindle can rotate about the common center of gravity of these bodies, at the high unwinding speeds, rather than about the geometric center of the spindle. In the preferred embodiment the spindle is so mounted that it can tilt gyroscopically to permit rotation about the center of gravity of the combined mass of the spindle and spool.

As is well known, an unbalanced body rotating at high speed tends to rotate about its center of gravity. In a thread unwinding apparatus, the unwinding spindle and and spool mounted thereon have a common center of gravity axis which is frequently not the same as the axis of rotation of the spindle. When the spool and spindle rotate at high speeds during unwinding the rotating parts attempt to rotate about this common center of gravity axis. Where the mounting of the spindle is such that the spindle can move to permit rotation about this common center of gravity, the spool and spindle become gyroscopically balanced. As a result of this balancing no jamming occurs and the spool can be unwound at far higher thread withdrawal speeds than were possible with the previous spindle arrangements while maintaining the thread withdrawal tension within acceptable low limits. With this arrangement it is no longer necessary to use the auxiliary devices required in the past and the stresses on the bearings of the unwinding spindle as well as vibrations transmitted to the machine frame are vastly reduced.

In accordance with this invention, the spindle is elastically supported for movement in a radial direction. Advantageously, such elastic suspension includes a deformable elastic component such as rubber or plastic.

Normally, the unbalance of the spool and spindle occurs primarily as a result of unbalance in the spool and the thread wound on the spool. On the other hand, the spindle itself can be precisely constructed so its center of gravity precisely corresponds to its axis of rotation. In order to keep the fluctuations of the spindle axis as small as possible relative to the elastic suspension, the unwinding spindle is as large and as heavy as is possible in relation to the spool mounted thereon. With such an arrangement where the spindle is relatively heavy in relation to the spool and thread, the common center of gravity will be quite close to the geometrical axis of the spindle. Correspondingly, at least that portion of the spindle which extends into the spool is of substantial mass.

It has also been found that the effect of the unbalance forces can be maintained at a minimum by maintaining the tilting axis of the spindle at a substantial distance from the spool. If the distance between the tilting axis of the spindle and the spool were very small, the angle of tilt would correspondingly be greater. However, as this distance is increased, the angle of tilt of the spool decreases with the result that the displacement of the center of gravity from the axis of rotation of the spindle becomes progressively smaller as the distance between the center of gravity of the spool and spindle and the tilting axis of the spindle increases. Correspondingly, the extent of tilt of the mounting for the spindle becomes smaller as this distance is increased.

Advantageously, the unwinding spindle is mounted on two spaced apart bearings for example, roller bearings, which are mounted in a common sleeve. Advantageously, the sleeve is pivotally mounted elastically at a location between its ends. The elastic mounting can take the form of a readily deformable ring of elastic material, or alternatively, the bearings themselves can be elastically mounted for radial movement.

Numerous other features, objects, and advantages of the unwinding device according to this invention will become apparent with reference to the accompanying drawings which form a part of this specification and in which:

FIG. 1 is a diagrammatic view of the device of this invention for unwinding yarn spools;

FIG. 2 is a view corresponding to FIG. 1 and showing the displacement of the axis of rotation of the spindle and spool when the unwinding device is in operation;

FIG. 3 is an enlarged view in partial section showing a first embodiment of an elastic mounting for the spindle;

FIG. 4 is an enlarged partial view in section showing a second embodiment of the elastic mounting for the spindle;

FIG. 5 is a partial view in section showing a third embodiment of the elastic mounting for the spindle; and

FIG. 6 shows the unwinding spindle arrangement of this invention in use with a rewinding device of the transverse winding frame type.

With reference to FIGS. 1 and 2, there is shown one embodiment of an unwinding device in accordance with this invention and which can be used with the transverse winding frame of FIG. 6. Unwinding device 1 includes an elongated spindle assembly including a shaft 2 which is mounted for rotation in spaced apart bearings 3 and 4 mounted within a hollow cylindrical sleeve 5. Sleeve 5 has spaced apart exterior flanges 6 and 7 which are disposed respectively on opposite sides of a support plate 8. Interposed between flange 6 and support plate 8 is an elastic element in the form of a rubber ring 9. Interposed between the upper surface of flange 7 and the lower surface of support plate 8 is a second elastic element in the form of a rubber ring 10.

A yarn spool 11, full of thread, is mounted on a spindle or mandrel 13 which is secured to the upper end of shaft 2 for rotation with the shaft. Shaft 2 and spindle 13 have an axis of rotation 12 which is along the center of gravity of these elements. As a result of the manner in which thread is wound on the spool 11 and because of subsequent processing the center of gravity 12a of the spool is usually not along the axis of the spool 11, but is, for example, offset to one side of the axis. As a result, the common center of gravity S of the spool 11 and spindle 13 is offset from the axis 12 of the spindle by a distance e. When the spool is rotated very slowly spindle 13 and shaft 2 also rotate, and the entire assembly rotates about the axis 12 on bearings 3 and 4. However, during an unwinding operation where thread or yarn is drawn tangentially from spool 11 at a rapid rate, the spool, spindle, and shaft rotate at high speed, the entire assembly rotates about the center of gravity S in a manner similar to a gyroscope, and such rotation is around the axis 13a which passes through the center of gravity S of the mass of the assembly. During such rotation, the axis 12 traverses a conical path about the center of tilt 13*b* of shaft 2 where axis 12 intersects axis 13*a*. Such tilting and precessing movement of the spindle assembly is permitted by the resilient rings 9 and 10 which permit axis 13 to swing and tilt as a result of the unbalance of the spool 11. By virtue of the resiliency of the rubber rings 9 and 10, return forces are constantly acting on the spindle assembly and tend to return the assembly to the position of FIG. 1.

In order to reduce to a minimum the effects of the unbalanced spool 11, the weight of the spindle assembly is relatively great in relation to the weight of the mounted spool. Advantageously, such weight is provided by using a spindle 13 of substantial mass such as a solid bar of heavy material like steel, copper or even lead. The spindle 13 and shaft 2 are each carefully balanced so their centers of gravity lie along the axis 12. Advantageously, the weight of the spindle 13 is at least several times that of the filled spool 11.

As will be observed with reference to FIGS. 1 and 2, spindle 13 is mounted on the upper end of shaft 2 and the lower end of shaft 2 is supported in the bearings 3 and 4 so the spindle assembly can swing around the center of tilt 13b which is substantially co-planar with plate 8. Hence, it will be apparent that the spool 11 is a substantial distance from the tilt point 13*b* of the spindle assembly. It has been found that a distance between the center of gravity of the spool and the center of tilt 13*b* which is at least equal to 1 ½ times the height of the spool works satisfactorily whereas in some instances this distance can be substantially greater for example, more than twice the height of the spool, as shown at FIGS. 1 and 2.

In the embodiment of FIG. 3 the spindle 13 is seen to be of solid metal construction and is mounted on the upper end of shaft 2 for rotation with the shaft by a keyed or splined connection 14. A supporting sleeve 15*a* for the lower end of shaft 2 is hollow and elongated and includes an integral outwardly projecting flange 16 which is vertically above the mid-point of the sleeve. The lower portion of sleeve 15*a* is provided with external threads 18 to receive a nut 17 which, when it is tightened, axially clamps against the resilient element 15. The resilient element has annular portions 16a and 16b which project between the upper surface of plate 8 and the lower surface of flange 16 and the lower surface of plate 8 and the lower surface of flange 16 and the lower surface of plate 8 and the upper surface of washer 17*a*, respectively. The annular portions are joined by a tubular body 17*b*.

The respective ends of the sleeve 15*a* are recessed to receive the bearings 3 and 4 and suitable dust covers or end caps 3*a* and 4*a* are mounted on the ends of the sleeve to minimize the entry of foreign matter into the bearings. The lower end 18*a* of shaft 2 is turned to a reduced diameter so shoulder 18*b* of the shaft seats on the top surface of bearing 4. Shaft 2 and bearing 4 are held in position against axial movement relative to the sleeve by a retaining clip 18*b*, which engages suitable grooves in the inside of the sleeve and the outside of the lower end 18*a* of the shaft.

FIG. 4 shows a second embodiment of the mounting arrangement for the spindle assembly. The bearings 3 and 4 and the configuration of the lower end of the shaft are the same as in the embodiment of FIG. 3. However, the sleeve 15*b* only has one radially extending circular flange 19 which is integral with the sleeve. While only two resilient support elements 20 are shown at FIG. 4, three such elements are advantageously provided in equally circumferentially spaced relation to each other. Sleeve 15*a* is resiliently connected to support plate 20*a* by resilient assemblies including a resilient cylindrical element 20 bonded at its opposite ends to the securing elements 21*a* and 21*b*. The elements 21*a* and 21*b* each have a threaded stud 21 secured to same and projecting therefrom. Suitable nuts 23 are threaded on the several stud portions 21 to mount support sleeve 15*b* on support plate 20*a*.

In the embodiment of FIG. 5 the bearings 3 and 4 are each resiliently mounted for radial movement. As

shown at FIG. 5, shaft 2 extends through bearing 3 and has its lower end seated in bearing 4 in the manner explained for the embodiment of FIG. 3. However, bearing 4 extends into a suitable recess in the lower end of a flanged collar 24*a*. Collar 24*a* is resiliently mounted in a hollow cylindrical resilient element 24 which surrounds the body 24*b* of the collar and on which the lower surface of flange 24*c* of the collar seats. The resilient element 24 is so dimensioned that collar 24*a* is free floating and is spaced from the bottom 25*a* of a cylindrical sleeve 25 which is secured to the plate 8. Hence, the bearing assembly including the bearing 4 and collar 24*a* are resiliently mounted for movement in a radial direction.

Bearing 3 is positioned in a collar 27 and is retained against axial displacement by an inwardly projecting flange 27*a* of the collar and a snap ring 27*b*. A cup shaped support 28, fixed to support plate 8*a*, surrounds collar 27. Connecting collar 27 with support cup 28, adjacent the upper end of the cup, is a flexible diaphragm 26 formed from a resilient or elastic material. Advantageously, diaphragm 26 is formed from soft rubber and is connected to collar 27 and the upper end of cup 28 by vulcanization or by a suitable adhesive. The hollow resilient element 24, while elastic, is more rigid than the diaphragm 26 so shaft 2 can tilt at a location offset toward the lower end of the shaft. A distinct advantage of the resilient mount arrangement of FIG. 5 is that collars 27 and 24*a* have a mass which is substantially less than the mass or weight of the sleeves and flanges of the embodiments of FIG. 1–4. By maintaining the non-rotating movable portions of the unwinding device at a minimum weight, the spindle assembly and spool has more freedom to seek an axis of rotation which corresponds to the axis extending through its center of gravity. The cup shaped element 28 which forms a support for upper bearing 3 is secured to support plate 8*a* and has an opening 28*a* through which the shaft 2 extends. Both the opening 28*a* in the cup and the opening through plate 8a are sufficiently large that shaft 2 can tilt or oscillate without engaging the sides of these openings during an unspooling operation.

FIG. 6 shows the unwinding device mounted on a transverse winding frame 29, which represents one form of rewinder with which the unwinding device of this invention can be used. The transverse winding frame 29 includes a thread guide 30 in the form of an eye through which thread 36 from spool 11 extends. In addition, there are a plurality of spaced-apart pins which form a thread braking and tensioning device 31 through which thread 36 travels prior to being rewound on the spool 33 which rotates about a horizontal axis. The braking and tensioning device 31 are mounted on a suitable arm 35 secured to the base 34 of the transverse winding frame. Advantageously, the arrangement includes a guide 32 for insuring that thread is wound on spool 33 in the desired predetermined pattern.

When the unspooling device 1 is used with the transverse winding frame 29 the shaft 2 and spindle 13 are arranged to rotate about a vertical axis and thread 36 is drawn tangentially from spool 11. However, it is to be understood that the transverse winding frame 29 is only exemplary of a rewinding apparatus with which the unwinding device 1 of this invention can be used.

In the several embodiments of the mounting for the shaft and spindle the respective resilient elements 15, 20, 24 and 26 are formed from elastic or resilient material such as rubber or a resilient plastic material. For example, these elements can be formed from a foam or cellular rubber, or a soft foam cellular material such as a polyurethane.

In each of the embodiments, the spindle 13 is so dimensioned that the spool 11 is merely thrust onto the spindle and is frictionally held thereon for rotation with the spindle during the thread unwinding operation.

While several preferred embodiments of an unwinding device according to this invention have been shown and described in detail, it is to be understood that numerous changes can be made without departing from the scope of this invention as set forth herein and as defined in the appended claims.

What is claimed is:

1. Apparatus for rapidly unwinding yarn from a spool comprising, in combination,
   a. a spindle having an axis and including means to mount a spool of yarn thereon for rotation with the spindle, and
   b. mounting means mounting said spindle for rotation, said mounting means comprising bearing means and means mounting said bearing means for movement in a direction transversely of the axis of the spindle to allow said spindle and spool to rotate about an axis passing through the common center of gravity of the spindle and spool.

2. Apparatus according to claim 1 wherein
   said bearing means includes
      a first bearing, and
      a second bearing spaced from said first bearing and in a direction along the axis of the spindle; and
   said means mounting said bearing means for transverse movement includes
      resilient means.

3. Apparatus according to claim 2 wherein
   said resilient means comprises
      first resilient means mounting said first bearing for transverse movement, and
      second resilient means mounting said second bearing for transverse movement.

4. Apparatus according to claim 3 wherein
   one of said resilient means is a resilient diaphragm secured between a bearing and a fixed support.

5. Apparatus according to claim 2 wherein said first and second bearing are mounted in a rigid sleeve in axially spaced relation to each other; and
   said resilient means mounts said sleeve for limited transverse movement.

6. Apparatus according to claim 5 wherein
   said resilient means comprises
      an annular resilient element surrounding said sleeve and mounting the sleeve on a rigid support.

7. Apparatus according to claim 5 wherein
   said resilient means comprises
      a plurality of elongated resilient elements in circumferentially spaced relation around the sleeve and connected between the sleeve and a rigid support.

8. Apparatus according to claim 5 wherein

said sleeve has an external flange intermediate its ends;

a fixed support plate has an opening therethrough;

said sleeve extends through said opening;

said resilient means has a portion thereof engaging one face of said plate and another portion engaging the other face of said plate; and

clamp means on said sleeve in spaced relation to said flange and clamping said first resilient portion between said flange and plate and said second resilient portion between said clamp means and said plate.

9. Apparatus for rapidly unwinding yarn from a spool comprising, in combination

a. a shaft,

b. a spindle connected to said shaft for rotation with the shaft and including means to mount a spool of yarn thereon for rotation with the spindle, and

c. mounting means for mounting said shaft for rotation at a location spaced from said spindle, said mounting means including means to allow said shaft and spindle to tilt gyroscopically to enable said shaft, spindle, and spool thereon to rotate about an axis passing through their common center of gravity.

10. Apparatus according to claim **9** wherein

said mounting means mounts said shaft at a location spaced from said spindle a distance at least as great as the height of a spool on the spindle.

11. Apparatus for rapidly unwinding yarn from a spool comprising, in combination

a. a spindle having an axis and including means to mount a spool of yarn thereon for rotation with the spindle, said spindle including a weight having its center of gravity along the axis of the spindle, said weight having a mass several times the mass of the spool and thread on said spindle, and

b. mounting means mounting said spindle for rotation, said mounting means including means for allowing said spindle and spool to rotate about an axis passing through the common center of gravity of the spindle and spool.

12. Apparatus for rapidly unwinding yarn from a spool comprising, in combination

a. a spindle having a longitudinal axis,

b. mounting means supporting said spindle in a generally vertical position and at a first location along its axis below its upper end, and

c. means to mount a spool of yarn on said spindle at a second location along its axis above said first location, said mounting means including means for allowing said spindle and spool to rotate about an axis passing through the common center of gravity of the spindle and spool.

13. Apparatus according to claim **12** wherein said mounting means comprises resilient means.

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