ABSTRACT

Strand material is dispensed from wound packages under controlled tension conditions by imposing a restraint against rotation of the wound packages as strand material is withdrawn therefrom. The restraint is imposed by controlled coalescence of a body of magnetic particle material subjected to a controllable magnetic flux, with coalesce of the material imposing between a housing and a radially extending rotor forces which resist rotation of the wound package.

10 Claims, 4 Drawing Figures
Many of the industrial processes which make use of strand materials require that one or more strands of such material be dispensed to the process by being unwound from packages typically mounted in a structure called a creel. Such delivery of strand materials is, for example, well known in the tire manufacturing industry and in the textile industry. Particularly in circumstances where the quality of the product produced depends upon consistent tension of the strand materials supplied, tension control is of importance. One specific example of such need for tension control is in the supplying of steel wire used in the tire construction processes which result in so called "steel radial" tires.

Heretofore, tension control in creels of the type described hereinabove has been attempted by the use of friction brakes imposing forces which resist rotation of wound packages from which the strand materials are withdrawn by take-up devices such as a tire building machine, beam winder or the like. Such approaches to controlling the tension in a strand material withdrawn from the wound package have been deficient, in that little or no provision has been made for controllable variation in the friction forces and the forces imposed change between static and rotating conditions of the package, as well as between rotation at varying speeds necessitated by differing take-up speeds of the strand material.

In light of the deficiencies of prior arrangements, it is an object of this invention to control the tension in strand material being withdrawn from a wound package mounted in a creel structure in a manner which will assure an accurately and uniformly maintained tension condition irrespective of the rotational speed or change in rotational speed of the wound package. In accomplishing this object of the present invention, reliance is placed upon a controllable magnetic flux which controls the imposition of forces resisting rotation of a wound package.

A further object of this invention is to arrange in a particularly compact manner a spindle for mounting a wound package of strand material from which material is to be withdrawn and elements of a tension control which impose forces resisting rotation of the spindle and the package mounted thereon. In realizing this object of the present invention, an electromagnetic coil which generates a controllable magnetic flux is arranged concentrically with a spindle which mounts a wound package, a radially extending rotor portion of the spindle, and a housing means cavity which extends about the rotor portion. In particular, the electromagnetic coil is offset from the location of the rotor portion, to facilitate the compact arrangement for the apparatus for this invention.

Some of the objects of the invention having been stated, other objects will appear as the description proceeds, when taken in connection with the accompanying drawings, in which

FIG. 1 is a schematic representation of a creel in accordance with this invention;

FIG. 2 is a perspective view of the tension control apparatus incorporated in the creel arrangement of FIG. 1;

FIG. 3 is a plan view, in section, through the tension control apparatus of FIG. 2; and

FIG. 4 is a perspective view of the rotor portion of the spindle incorporated in the tension control apparatus of FIGS. 1–3.

While a creel and tension control apparatus in accordance with the present invention will be described hereinafter by reference to the accompanying drawing, it is to be noted at the outset that the present invention is susceptible to broad utility and that the specific illustration and description is included here only as the requisite disclosure of the best form presently known to the inventor. Accordingly, the description and drawings are not to be considered as limiting upon the present invention, but only as illustrative thereof.

For purposes of this application, a creel in accordance with the present invention has been illustrated in FIG. 1 by showing only a single wound package (generally indicated at 10) of a strand material 11 which is unwound from the package under the influence of a take-up device (generally indicated at 12). In many typical applications, the creel includes more than a single package 10 and may include a large number of such packages, from each of which a corresponding strand is drawn by the common take-up device. Such creel structures are known to persons engaged in the practice of various manufacturing processes including tire manufacturing processes and textile processes. As is indicated, it is conventional for one or more wound packages 10 to be supported on a framework, indicated in part by a frame member 14 which may form a portion of a larger creel structure so that a plurality of the strands 11 may be supplied.

In accordance with this invention, each of the packages 10 is mounted on an elongate spindle means 15 which forms a portion of a tension control apparatus. Adjacent one terminal end of the spindle means 15 is a radially extending rotor portion generally indicated at 16. The rotor portion preferably is defined by a disk or plate member 18 which has a plurality of openings 19 therein (the purposes of which will be described hereinafter) and which is fixed to a hub member 20. The hub member 20 is fixed to the terminal end of the spindle means 15, as by a press fit thereon. The disk 18 and hub member 20 together form a low inertia means which cooperates with other elements as described hereinafter to resist rotation of a mounted package.

The spindle means 15 is supported for rotation about its longitudinal axis by bearing means which, in the form illustrated, comprise a pair of spaced apart, sealed, antifriction or ball bearings 22, 23. The bearing means formed by anti-friction bearings 22, 23 are enclosed within a housing means generally indicated at 25, which also encloses the inner terminal end of the spindle means 15 and the rotor portion 16 thereof. The housing means 25 additionally defines a cavity 26 (FIG. 3) about the rotor portion 16, for purposes to be described more fully hereinafter, and has a flange portion 28 by which the housing 25 may be secured to a frame member 14 in the creel structure. Preferably, an angled arrangement is provided for the flange portion 28, to permit staggered alignment of a plurality of strand materials 11 being delivered from a corresponding plurality of wound packages 10, as will be understood by persons familiar with the use of creels.

In order to limit end-play of the spindle means 15 and to fix together for rotation the spindle means and a package 10 mounted thereon, a hub 27 is provided and is secured to the spindle means by a lock screw 33A
and a pin 33B. The hub 27 has a drive pin 37 for engaging a mounted package and driving the spindle means in rotation as strand material 11 is withdrawn.

In accordance with this invention, magnetic field means are mounted within the housing means 25 for generating controllable magnetic flux which passes through the cavity 26. In the form illustrated, the magnetic field means takes the form of an electromagnetic coil or winding 29, mounted within the housing 25 in concentric relation with the spindle means 15, the bearing means 22, 23 and the rotor portion 16. As will be noted from FIG. 3, the electromagnetic coil 29 is disposed in such a manner as to encircle the spindle 15 and one bearing 22, while being displaced axially of the spindle 15 from the location of the rotor portion 16. By such an encircling yet spaced relationship, the electromagnetic coil 29 is arranged with the housing 25 and cavity 26 in a particularly compact relationship, yet directs magnetic flux to pass through the housing 25 and the cavity 26.

Disposed within the cavity 26 is a body of magnetic particle material 30, preferably a mixture of fine particles of iron with fine particles of a non-ferrous material such as aluminum. The particular materials chosen, the particle sizes and distribution, and proportions of the materials are not to be considered as subject matter of this invention, which is particularly directed to the structural arrangement of the parts described herein. The body of magnetic particle material 30 is inserted into the cavity 26 through a filler opening in the housing 25, subsequently closed by a threaded plug 31. In accordance with this invention, the cavity 26 is configured to provide a reservoir aligned axially with the spindle 15, which facilitates more uniform distribution of the body of material 30 and makes the desired operation of the tension control independent of attitude or orientation. When the tension control apparatus in this invention is in use, the magnetic particle material 30 is distributed between the surfaces of the housing means 25 which define the cavity 26 and the rotor portion 16. Such distribution is aided by the openings 19 through the rotor disk 18. Entry of material 30 into the bearings is blocked by a seal 43.

In accordance with this invention, the electromagnetic coil 29 may be energized through means of appropriate electrical conductors 40, 41 (FIGS. 1 and 2) so as to generate a controllable magnetic flux passing through the cavity 26. The effect of such flux on the body of magnetic particle material 30 is to coalesce such material to a controllable extent and thereby to impose between the rotor portion 16 in the housing means 25 forces which resist rotation of the spindle means 15 and of the package 10 mounted thereon. Preferably, the coil 29 is protected by a fuse 36 mounted within the housing 25. Additionally, the housing 25 may have a potentiometer 38 mounted therein for aiding in performing control functions as described hereinafter.

In ensuring that the degree of coalescence of the body of material 30 is such as to assure a desired predetermined tension level in the strand material 11 being withdrawn from the package 10 mounted on the corresponding spindle means 15, this invention contemplates the use of control means to govern the electrical energization or excitation of the coil 29. Such control means is illustrated schematically in FIG. 1 as including a control circuit 39 which receives an appropriate line voltage through conductors 40, 41 and determines the level of energization applied to the coil 29 in response to a tension sensor 42 or in view of the setting of the potentiometer 38. The desired one of these alternative controls may be selected by a positioning switch 43. In circumstances where a tension sensor 42 is employed, the tension of the corresponding strand 11 is directly sensed and causes a change in the control circuit 39 as is well known in the art, so that forces resisting rotation of the corresponding package 10 may be increased or decreased as required to restore the desired tension level. In the instance where the potentiometer 38 is employed, it is anticipated that a substantially constant resistance to the rotation of the package 10 would be satisfactory. In most circumstances where accurate tension control is necessary, a closed loop system employing a sensor 42 is to be preferred over an open loop system employing only a set point potentiometer.

In the drawings and specification, there has been set forth a preferred embodiment of the invention, and although specific terms are employed, they are used in a generic and descriptive sense only and not for purposes of limitation.

That which is claimed is:

1. A creel arrangement for delivering strand materials from wound packages to a take-up apparatus under controlled tension conditions and comprising:

- elongate spindle means for mounting a wound package of strand material and having a radially extending rotor adjacent one terminal end,

- bearing means for supporting said spindle means and a package mounted thereon for rotation about the longitudinal axis of said spindle means upon strand material being withdrawn from the package,

- housing means enclosing said bearing means and said one end of said spindle means and defining a cavity about said rotor, said cavity being configured to provide a rotor receiving portion and a reservoir portion aligned axially with said spindle means and disposed to one side of said rotor and having a radial extent less than that of said rotor receiving portion,

- frame means for supporting said housing means in a predetermined spaced relation from the take-up apparatus to which strand material is delivered, a body of magnetic particle material disposed in said housing means cavity for intimate cooperation with said rotor independently of the attitude and orientation of the apparatus, and

- magnetic field means for generating a controllable magnetic flux passing through said housing means cavity and said body of material for coalescing said body of material and thereby for imposing between said rotor and said housing means forces resisting rotation of said spindle means and the package mounted thereon, said magnetic field means encircling said spindle means at a location spaced from said reservoir portion of said housing means cavity and disposed to a side of said rotor opposite the location of said reservoir portion.

2. Apparatus according to claim 1 further comprising means for sensing the tension condition of said strand material being withdrawn from the wound package and control means operatively coupled with said sensor means for responding thereto operatively connected with said magnetic field means for controllably varying the magnetic flux passing through said housing
means cavity in response to sensed variations in strand material tension condition.

3. Tension control apparatus for controlling the tension in a strand material withdrawn from a wound package mounted in a creel structure and comprising:

elongate spindle means for mounting a wound package of strand material and having a radially extending rotor adjacent one terminal end,
bearing means for supporting said spindle means and a package mounted thereon for rotation about the longitudinal axis of said spindle means upon strand material being withdrawn from the package,
housing means enclosing said bearing means and said one end of said spindle means and defining a cavity about said rotor, said cavity being configured to provide a rotor receiving portion and a reservoir portion aligned axially with said spindle means and disposed to one side of said rotor and having a radial extent less than that of said rotor receiving portion,
a body of magnetic particle material disposed in said housing means cavity for intimate cooperation with said rotor independently of the attitude and orientation of the apparatus, and
magnetic field means for generating a controllable magnetic flux passing through said housing means cavity and said body of material for coalescing said body of material and thereby for imposing between said rotor and said housing means forces resisting rotation of said spindle means and the package mounted thereon, said magnetic field means encircling said spindle means at a location spaced from said reservoir portion of said housing means cavity and disposed to a side of said rotor opposite the location of said reservoir portion.

4. Apparatus according to claim 3 wherein said rotor extends radially of said spindle means in spaced relation between opposing walls of said housing means cavity and said body of material is disposed on both radial faces of said rotor for cooperation with both of said opposing faces of said housing means cavity.

5. Apparatus according to claim 4 wherein said rotor defines a plurality of axially directed openings spaced thereabout for distribution of said body of material throughout said housing means cavity.

6. Apparatus according to claim 3 wherein said bearing means comprises first and second anti-friction bearings spaced one from another axially along said spindle means.

7. Apparatus according to claim 6 wherein said first and second bearings cooperate for supporting said spindle means and the package mounted thereon in a cantilever arrangement.

8. Apparatus according to claim 6 wherein said magnetic field means encircles the one of said bearings nearest said rotor and extends axially along said spindle means in spaced relation from said rotor.

9. Apparatus according to claim 3 wherein said magnetic field means includes an electromagnetic coil mounted within said housing means for controlled electrical energization.

10. Apparatus according to claim 9 wherein said electromagnetic coil is concentric with said elongate spindle means.

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