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RADIALLY COMPRESSED TEXTILE YARN CARRIER AND METHOD OF FORMING SAME

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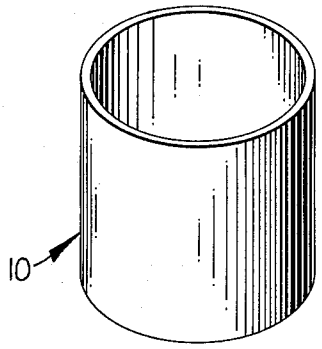


Fig-1

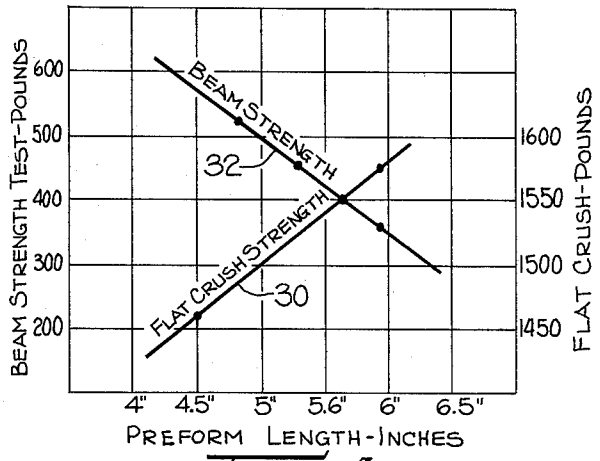


Fig-4

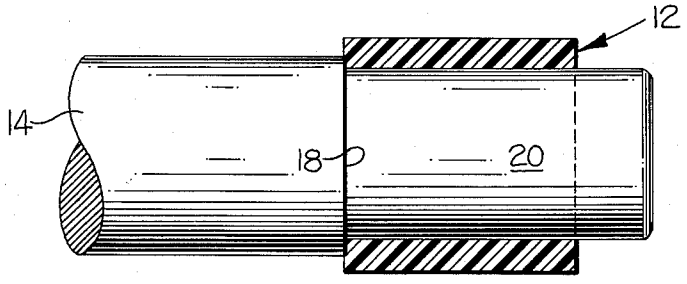


Fig-2

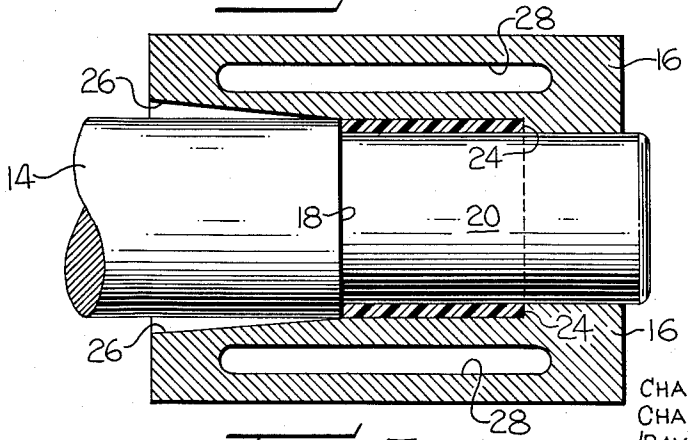


Fig-3

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RADIALLY COMPRESSED TEXTILE YARN CARRIER AND METHOD OF FORMING SAME

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This invention relates to textile yarn carrier structures and more particularly to an improved bobbin structure having exceptional strength and density, and the method by which this bobbin is formed.

The bobbin structure of the present invention is especially suited for handling synthetic yarns, such as nylon and Dacron, that have elastic properties which result in imposing very severe compressive stresses on a bobbin as they are wound into a package. Wooden bobbins, for example, are permanently deformed quite readily by these compressive stresses even when reinforced. Certain other bobbins, such as paper-covered, metal reinforced bobbins, will satisfactorily withstand the compressive stresses developed, but bobbins of this type tend to be unusually heavy when constructed with adequate strength. Also, bobbins made out of plastic materials have not proved successful, since the plastic materials do not provide adequate strength to withstand the compressive stresses and are relatively fragile when subjected to the normal rough treatment during use.

According to the present invention a textile bobbin is provided that is suitable for handling yarn that builds up excessive compressive stresses when wound into packages. The textile bobbin of the present invention is characterized generally as comprising a tubular body of laminated, fibrous, sheet material, such as paper, impregnated with a thermosetting resin such as phenol-formaldehyde resin and compressed into a dense mass.

In order to form a bobbin structure having an unusually high strength, it is necessary to compress the sheet material after it is initially wound into a preform. The preform of the present invention is compressed radially or both radially and axially and this compression is only accomplished after the preform has been impregnated. In regard to an axially compressed textile bobbin without any radial compression of diametric dimensional change, reference is made to copending application, Serial No. 314,002, filed October 10, 1952, now abandoned.

The finished bobbin has exceptional resistance to impact. It easily withstands the standard service test of being dropped on a hard surface from a height of 3 feet when loaded with a 3 pound yarn. In addition, an excellent winding surface is provided on the outer surface of the textile bobbin, which may be buffed or sanded in order to give a rough or smooth surface, as desired.

These and other features of the present invention are described in further detail below in connection with the accompanying drawing, in which:

FIG. 1 is a perspective view of a conventional type of bobbin embodying the present invention;

FIG. 2 is a side elevational view showing the preform in section and illustrating a mandrel with the preform placed thereon;

FIG. 3 is a fragmentary sectional detail illustrating the bobbin forming operation of the present invention; and

FIG. 4 is a graph illustrating the strength of the finished textile bobbin produced from various types of compression.

A conventional type of bobbin such as is commonly used for synthetic yarn in package form is illustrated in

FIGURE 1 of the drawing and indicated generally by the reference numeral 10. The bobbin 10 shown in FIG. 1 according to the prefered embodiment of the invention, has a length of 4 inches, an outside diameter of 4⅛ inches, and a wall thickness of ¼ inch.

In forming a preform denoted by numeral 12 in FIG. 2 from which the finished textile bobbin 10 is constructed, paper sheet material is preferably used, although other fibrous materials can be used. The sheet material is dried slowly to about a 3% moisture content using a temperature of about 200° F. to prevent blistering or delamination, which occurs more readily in paper sheet material having a relatively high moisture content. After the paper sheet material is dried it is then trimmed to the desired width which will vary from 4" to 9" depending on the particular type of strength desired, as will be explained in detail later.

After drying and cutting the paper sheet material to the desired width, the material is preferably impregnated by immersion in a solution of treating resin. For the impregnation, a thermoactive resin is used, and preferably a thermosetting resin such as a phenol-formaldehyde resin.

Various types of treating chambers may be employed for immersing the paper sheet material, but one type from which we have obtained good results is a closed treating chamber in which the sheet material is subjected to a vacuum of 15 inches Hg for less than one minute. Of course, the times and vacuums will differ with different types of impregnants and sheet materials used.

After the paper sheet material has been immersed, it is then passed through rubber rolls to remove the excess resin, although it will be understood that other means can be employed for removing the excess resin.

Following the above step, the sheet material is air dried for a short period of time and then finally dried by passing through drying rolls that are heated to a temperature of approximately 212° F., remaining in contact with these drying rolls for approximately two minutes.

During the impregnation with the resin and the subsequent drying and other treatment, the paper sheet material increases in weight by approximately 30%. It increases about 100% when immersed in the resin solution, but when dried, 70% of this increased weight is removed so that a total of approximately 30% increase in weight results from the resin impregnation.

The sheet material is next heated to approximately 150° F. for a short period of time in order to make it temporarily flexible or pliable. This facilitates the subsequent winding of the material into the preform 12.

After the impregnation, drying and heating treatments, the paper sheet material is wound in tubular form, an adhesive being applied to bind the plies as they are being wound so that a laminated tubular body results. It has been found that a convolutely wound preform is preferable although a spirally wound structure can be used to advantage, if desired. There are many types of adhesives that are suitable for use in binding the plies and practically any adhesive can be used that does not interfere with the subsequent polymerization of the resin impregnation during molding of the preform.

In certain instances, it may be desirable to impregnate the preform itself with the treating resin instead of treating the sheet material with resin before it is wound into the preform, although we have found it preferable to impregnate the sheet material first, as described above.

The number of plies or wraps will vary according to the thickness desired in the preform and of course, the thickness of the sheet material. When using a paper sheet material of the thickness of .020" and when the de-

sired thickness of the finished textile bobbin is ¼", the number of plies will be generally within the range of 13 to 18. Further, if a greater radial compression is desired, an increased number of plies will be used in the preform than if a lesser radial compression is desired, but care must be taken in drying the preform after it has been wound to insure that the temperature is sufficiently low to keep the resin from polymerizing. One method which has been found effective is vacuum drying at a temperature of approximately 150° F. for a period of approximately 5 hours. Another method is air drying, but this requires a much longer period of time such as one week or more, and is therefore commercially less desirable.

After winding, the preform is weighed and if there is an excessive weight the preform is ground to the desired weight or shape.

Compression of the preform is next carried out as illustrated in FIGURES 2 and 3 of the drawing by placing the preform **12** on a mandrel **14** slidably or reciprocably arranged for entering a mold or die **16**. Mandrel **14** is formed with an annular shoulder **18** beyond which its diameter is reduced as at **20** to correspond with the inside diameter of preform **12**. It is noted that the outside diameter of preform **12** in FIG. 2 is considerably larger than the outside diameter of mandrel **14**. The die **16** has a cavity to receive mandrel **14** which is of the same diameter as the outside diameter of mandrel **14** and an annular shoulder **24** is provided on the interior of die **16** to abut the end of preform **12**. Also, die **16** has a tapered opening **26** at one end for radially compressing the preform **12** as will be explained in detail later.

In operation preform **12** is placed on mandrel **14** and is moved into the cavity of die **16**. As the preform **12** enters die **16** the tapered opening **26** presses against the outside of preform **12** and compresses preform **12** radially to the diameter of the cavity. The mandrel **14** is pressed or moved into die **16** rapidly, and remains there a short period of time. A period that we have found to be effective is 5 minutes. The preform is compressed axially between mandrel shoulder **18** and die shoulder **24** and the amount of axial compression depends, of course, on the amount of penetration of mandrel **14** into the cavity of die **16** and the original length of preform **12**. In instances where no axial compression is desired the penetration of mandrel **14** will be such as not to compress preform **12** axially. Die **16** is arranged so that it may be heated, as from a steam jacket at **28** or by electric heating elements (not shown) installed in jacket space **28**, and thereby cause the resin impregnant to flow and polymerize during the axial and radial compressions. The mandrel **14** may also be heated, for the same purpose, if desired.

Inasmuch as the amount of radial compression and axial compression will determine the strength of textile bobbin **10**, data obtained from strength tests performed on the bobbins is used to interpret the strength from various proportions of axial and radial compressions. Two types of fracture tests are employed in the testing of the bobbins, one in which pressure is applied at right angles to the longitudinal axis of bobbin **10** by squeezing it between two parallel platens, and another in which longitudinal segmented strips are formed from textile bobbin **10** with the ends of these strips being placed on separate supports and pressure applied at a point at or near the center of the strips. The first test, in which bobbin **10** is placed between two parallel platens, determines the "flat crush strength" and the other test determines the "beam strength" of bobbin **10**. The flat crush strength is indicated by line 30 on the graph shown in FIGURE 4 and the beam strength is indicated by line 32 on the graph. Various lengths of preforms were used depending on the type of strength desired, and all of the preforms used in these tests were compressed to a final length of 4 inches. However, as the length of the preform is increased, the number of plies or number of wraps of paper sheet material is decreased, and the density of the final bobbin **10** remains substantially constant, regardless of the original length of preform **12**.

According to the tests performed on the completed bobbin **10** the amount of axial compression is increased with an increase in length of preform **12** since all of the preforms that are employed in these tests are compressed to a length of 4 inches. Also, as the length of preform **12** is decreased the thickness of preform **12** is increased so that a substantially constant density is imparted to final bobbin **10**. For instance, a preform of 6" in length is compressed axially to a length of 4" while a preform 4½" in length is also compressed axially to a length of 4". In order to maintain a substantially constant density the thickness of preform **12** is increased as the length is decreased.

The amount of axial compression will therefore increase with an increased length of preform while a decreased length of preform will result in an increased original thickness of preform and a corresponding increased radial compression since the thickness and density of the final textile bobbin is uniform.

Referring now to the graph of FIGURE 4, it will be noted that the flat crush strength of the finished textile bobbin increases proportionately to the increased length of preform and corresponding increased axial compression. The beam strength increases as the length of preform is decreased and the radial compression is correspondingly increased.

If a textile bobbin with a high flat crush strength is desired as is required when high stresses are created by yarn wound on textile bobbins, then the preform should be subjected to a high axial compression; and correspondingly, if a high beam strength is desired, the preform should be subjected to a high radial compression.

As a specific example of the embodiment of my invention, plies of a thickness of .020" formed of paper manufactured from about 40% clean corrugated boxes and cuttings and about 60% clean news print are dried slowly to about a 3% moisture content at a temperature of 212° F. Next, the paper material is cut to a width of 5⅝ inches and is impregnated by immersing in a bath of phenolic resin in a closed treating chamber and subjecting this paper material to a vacuum of 15 inches Hg for less than one minute. The material is next passed through rubber rolls that remove the excess of the treating resin, is then air dried for a short period of time, and finally dried by passing through drying rolls heated to a temperature of approximately 212° F. Further, the paper material is convolutely wound by conventional apparatus to a thickness of 15 plies or wraps with a phenol-formaldehyde resin being applied as an adhesive during the winding. After winding, the preform is vacuum dried at a temperature of 150° F. for 5 hours. The preform is placed on the mandrel and the mandrel is pressed inside the heated die for a period of 5 minutes. The textile bobbin is then removed from the die and its edges are trimmed. Following the trimming, the bobbin is dipped in a finishing chemical, such as 3% butyl Cellosolve stearate in toluene, for a pleasant appearance. The finished textile bobbin formed by this specific example should have a flat crush strength of approximately 1550 pounds and a beam strength of approximately 400 pounds.

This resulting strength of the textile bobbin is considerably larger than that obtained by axial compression without any radial compression and is a simple solution to the problem of dealing with the compressive stresses met in handling synthetic yarns.

Although the bobbin disclosed in the drawings is a textile bobbin, it is obvious that the same type of procedure can be used with various other bobbins or carrier structures where great strength is necessary, such as pirns, spooler sleeves, take-up tubes and the like.

The above described structures and procedures are subject to variations and modifications within the scope of this invention as defined by the appended claim.

We claim:

A method of forming a textile yarn carrier comprising the steps of, forming a tubular, thermosetting resin impregnated preform of wound fibrous sheet material, compressing said preform axially to reduce its length a selected amount as much as one-third smaller than its original length before compression, simultaneously compressing said preform radially throughout its entire peripheral surface to reduce the wall thickness of the preform uniformly throughout and to a predetermined degree to thereby produce a carrier of uniform density and wall thickness with an interrelated predetermined beam strength and flat crush strength, and simultaneously applying heat to said preform during said compression steps to activate said resin.

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