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[54] **JOINTLESS PACKING RING AND METHOD OF MAKING SAME**

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[58] **Field of Search** 277/203, 204, 227–230, 277/DIG. 6

[56] **References Cited**

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[57] **ABSTRACT**

Jointless packing rings are made by passing one or more ends of yarn through a bath of heat-curable polymeric binder, winding the yarn in the form of an annular helix, coating the exterior surfaces of the yarn helix with additional polymeric binder, and subjecting the yarn helix to heat and pressure to consolidate the yarn convolutions upon each other and to set the binder.

6 Claims, No Drawings

JOINTLESS PACKING RING AND METHOD OF MAKING SAME

BACKGROUND OF THE INVENTION

Reinforced packing rings are used in various types of hydraulic and pneumatic apparatus. Such packing rings generally have been made by one or the other of two methods, each of which involves coating cloth with a polymeric material, and drying the coated cloth. In one method, known as the roll-up method, the dry cloth is cut into narrow strips which are jointed together at their short edges to form a long continuous band. This band is then formed into a long tube similar to a hose by wrapping the band about a mandrel so that the long edges of the band extend along the axis of the mandrel, and then joining the long edges. The resulting tube is cut into lengths to provide preform rings which are subjected to heat and pressure to produce the desired packing ring. This procedure requires the use of a combination of manual manipulations and specific machinery, and therefore is costly to carry out.

In the other process, referred to as the click-out method, a plurality of superimposed layers of the coated cloth are cut by an annular die to form a preform, which is subsequently molded under heat and pressure. This latter method is also costly since it involves the production of a large amount of waste material from the punched-out centers and edges.

An object of the present invention is to provide an improved method for making jointless reinforced packing rings.

Another object of this invention is to provide jointless reinforced packing rings of improved quality.

Still another object of this invention is the provision of a novel method for forming jointless reinforced packing rings at reduced cost since the method produces little or no scrap and does not involve costly hand lay-up work.

These and other objects of this invention will become further understood by a consideration of the following specification and claims.

THE INVENTION

According to the present invention, there is provided a novel method for making jointless reinforced packing rings which comprises passing one or more ends of yarn through a bath of polymeric binder, forming the yarn into an annular helix, coating the exterior surfaces of the yarn helix with additional polymeric binder, and subjecting the yarn helix to heat and pressure to consolidate the yarn convolutions upon each other and to set the binder.

In a preferred form of the invention a plurality of yarn ends, e.g. two to five ends, are passed through a bath of polymeric binder and wound on a cylindrical mandrel to form one individual preform. This preform is ejected from the mandrel, coated with additional polymeric binder, and then subjected to heat and pressure to obtain the desired packing ring. The invention also contemplates an alternative method in which a plurality of yarn ends after being passed through a bath of polymeric binder are wound about a cylindrical mandrel to form a tube-like structure. The tube is then cut into a plurality of annular preforms which are subsequently coated with additional polymeric binder and molded under heat and pressure.

The packing rings of this invention generally will contain from about 10 to about 60 percent, by weight of binder, based on the combined weight of binder and yarn. Preferably the rings contain from about 30 to about 50 percent of binder. A particularly preferred yarn for use in making the jointless packing rings comprises asbestos fibers.

The method of this invention has a number of distinct advantages over the hose roll-up and click-out methods heretofore employed in making packing rings. By level winding the yarn ends after they have been passed through the bath of polymeric binder, truely jointless annualar preforms are obtained with no waste. Various types of yarns and polymeric binders can be used. There are no costly hand lay-up operations or splicing of joints. Raw yarns can be used in place of more expensive woven cloth, and the usual cloth treatment steps, such as calendering and tower coating, can be avoided.

In making the jointless packing rings of this invention a great variety of different types of yarns of both natural and synthetic fibers can be used. Examples of suitable yarns formed of natural fibers are yarns formed of cotton, wool, hemp, jute and asbestos fibers. Typical of the synthetic fibers which can be used in the yarns are polyamide (nylon), polyester, rayon, cellulose acetate, acrylic, polyolefin such as polypropylene, vinyl, and glass. Yarns of the above materials containing one or more strands of such metals as copper, brass, and the like, may also be used. Preferred yarns for use in the jointless packing rings of this invention are formed of either cotton or asbestos fibers, or a combination thereof.

In the yarns, the fibers may be in the form of staple fibers, as would be the case with natural fibers, or in the form of continuous filaments, as is generally the case with synthetic textile materials.

Yarns of various dimensions may be used depending upon the size, configuration and use of the desired jointless packing rings. In the case of cotton yarns, those having yarn numbers from 1 to 10 and multiple plies of the same yarns are satisfactory for most purposes. The yarn numbers set forth herein are from ASTM D1907, Appendix A1 entitled "Test for Yarn Nos. (Skein Method)," 1969. Asbestos yarns having yarn cut from three to 52 may be used. In the case of yarns composed of continuous filaments of a synthetic material, those having a filament count of from about 44 to about 980 and a denier of from about 210 to about 10,000 have proved satisfactory. Glass yarns having a filament count of 37 to 1,800 and from 51 to 408 filaments per yarn end are also useful.

As stated, in making the jointless rings, one or more ends of yarn are passed through a bath of a polymeric binder material. The term "polymeric" as used in this specification and claims, means a substance, generally synthetic, composed of large molecules that have been formed by union of a considerable number of simple molecules with one another. This is the generally accepted definition of this term (see The Condensed Chemical Dictionary, Reinhold Pub. Co., 1961). The polymeric materials may be thermosetting, thermoplastic, elastomeric, etc., depending upon the particular physical and chemical properties the jointless rings are required to have. Among the useful thermosetting materials are the phenol aldehyde, particulary phenol formaldehyde resins, urea formaldehyde resins, epoxy and

polyurethane resins. Among the thermoplastic resins are the polyolefins such as polyethylene and polypropylene, the polyamide (nylon) resins, alkyd and polyester resins. Suitable elastomers may be both natural and synthetic, such as butadiene polymers, copolymers of butadiene and styrene or acrylonitrile, chloroprene, polyacrylic rubber, butyl rubber, polysulfide rubber, etc. The fluorocarbons are also particularly useful polymeric materials. These include polytetrafluoroethylene (TFE), polychlorotrifluoroethylene, poly (vinyl fluoride), poly (vinylidene fluoride), fluorinated ethylene propylene polymers (FEP), and fluoroelastomers.

Depending upon the particular yarn type and polymeric binder selected, the bath of the binder may comprise a solution or dispersion of the polymeric material. Solutions of both thermosetting and thermoplastic resins in organic solvents in which the particular resin is soluble find particular application. The solvent for the polymeric binder, however, should not be a solvent for synthetic fibers if the yarn to be impregnated with binder comprises synthetic fibers or filaments. In the case of certain of the fluorocarbons, such as polytetrafluoroethylene, aqueous dispersions of the polymer particles may be used.

The baths generally will contain from about 10 to about 75 percent by weight of polymer solids. The bath may also contain various curing agents, vulcanizing agents, catalysts, plasticizers, heat and light stabilizers, accelerators, fillers, etc. These are all well known materials and have been used for many years in the compounding of polymeric binders. The present invention is not limited to the use of any particular polymeric binder composition, and those which heretofore have been used in providing packing rings may be employed.

After the yarn ends have passed through the bath of polymeric binder, they are wound about a cylindrical mandrel to form an annular helix. As stated above, according to the preferred method, single preforms are prepared by forming one or more yarn ends into individual helices. However, a plurality of yarn ends may be wound about a mandrel in side-by-side relation to form a tube. The tube is then cut into the desired lengths to produce a plurality of packing ring preforms.

In applying yarn ends to a mandrel according to the alternative method in which a tube is first formed followed by cutting the tube into individual preforms, the yarn convolutions preferably lie in a plane substantially perpendicular to the axis of the mandrel. However, satisfactory results can be obtained even if the convolutions lie in a plane which forms an angle of only about 15° with the mandrel axis. Regardless of the angle, it is necessary that adjacent yarn convolutions be in parallel, side-by-side relation. In preparing individual preforms according to the preferred method, adjacent yarn convolutions are in side-by-side relation, and lie in a plane which is substantially perpendicular to the axis of the mandrel.

In order to provide the packing rings with the desired surface characteristics, the helical yarn preforms, prepared by one or the other of the above-described methods, are coated with additional polymeric binder. In this step, generally the same type bath used in impregnating the yarn ends can be employed, the polymeric binder used to coat the exterior surfaces of the preforms being the same as was used to impregnate the yarn ends. However, a different coating binder can be used provided it is compatible with the binder employed to impregnate the yarn ends.

In the final jointless packing rings, the amount of polymeric binder can vary from about 10 to about 60 percent, based on the combined weight of yarn and binder. These percentage amounts of binder refer to polymer solids after removal of solvent or liquid dispersing medium. Preferably the rings contain from 30 to 50 percent binder.

The preforms coated with additional binder are then placed in suitable molds where they are subjected to heat and pressure to consolidate the yarn convolutions upon each other and to set the binder.

The expression "set the binder" as used in this specification and claims refers to causing the polymeric binder to be placed in the final form required for providing a usable packing ring. During the application of heat and pressure there may be some redistribution of binder within the preform. In addition, where the binder is of the heat-curable type, e.g. a thermosetting resin or an elastomer, the term "set" includes curing. In the case of some fluorocarbon polymers, the term "set" can mean sinter, as would be the case with polytetrafluoroethylene.

The temperatures and pressures employed in the final molding step will depend upon both the composition of the yarn fibers and the polymeric binder. With elastomeric binders, pressures on the order of 1,000 to 2,200 psi and temperatures of from 220°F. to 400°F. are generally satisfactory. In the case of fluorocarbons, such as tetrafluoroethylene, temperatures sufficiently high to cause sintering of the polymer particles are required. Generally such sintering can be carried out at a temperature of about 680°F. to 900°F., typical sintering conditions being 850°F. for 6 minutes. Curing temperatures for most thermosetting binders will run in the neighborhood of 250° – 350°F.

In many instances it may be desirable to subject the rings to post-molding heat treatment. Here again, the temperatures and times used in this post-molding heat treatment will depend upon the particular polymeric binder. Such post-molding heat treating conditions are well known to those skilled in the art. In the case of elastomeric binders, for example, post baking is generally carried out stepwise at increasing temperature. A typical post baking is 4 hours at 250°F., followed by 4 hours at 300°F., and finally 16 hours at 350°F.

The jointless packing rings produced according to this invention can vary both in size and surface configuration. For example rings can be produced which vary in diameter from 1 to 16 inches, and in thickness from ⅛ to 1½ inches. The side surfaces of the rings may be flat and substantially parallel, v-shaped, or have other configuration. Rings having a fluorocarbon binder are particularly suitable for service against commercial chemicals, alkali, acids and solvents, and for high temperature use.

The following examples will serve to further illustrate the practice of the present invention and the benefits to be derived therefrom.

EXAMPLE I

A bath of polymeric binder having the following composition and containing 30 percent solids in methyl ethyl ketone was prepared:

Constituent	Amount (Parts by weight)
Fluoroelastomer*	100
MgO (activator)	15
Furnace black	20
N,N'-dicinnamylidene-1,6 hexanediamine (vuncanizing agent)	3

*An elastomer terpolymer composed of tetrafluoroethylene, vinylidene fluoride and hexafluoropropylene units as described in U.S. Pat. No. 2,968,649 issued January 17, 1961.

Three ends of 12 cut asbestos yarn were let off bobbins and passed through a dip tank containing the above-described binder solution. After passing through the solution, the yarn ends passed over a wiper bar to a mandrel of short length where the yarn ends were formed into a helix to produce a single ringshaped preform. The preform was removed from the mandrel, and coated with elastomer solution used to impregnate the yarn ends.

After drying overnight, the preform was compression molded for 10 minutes at a temperature of 320°F. and a pressure of 2,200 psi.

The ring was post-baked for a period of 18 hours at temperatures varying from 250°F. to 400°F.

EXAMPLE II

A bath of polymeric binder (30 percent solids) having the composition of the binder used in Example I was prepared. Six bobbins of 12 cut asbestos yarn were placed on a creel behind a level winding device which was adjacent a TFE coated cylindrical mandrel having a 2 inch O.D. The ends of yarn were let off the bobbins and passed through a dip tank containing the binder solution. After passing through the solution, the yarn ends passed through a wiper die and through a traversing guide onto the rotating mandrel. A tube of reinforced elastomer having a thickness measured in the radial direction of ⅜ inch was produced. In the tube the lay of the yarns was parallel to each other and at 90° to the axis of the mandrel. The mandrel was removed and the solvent evaporated from the tube.

⅜ inch thick rings were cut from the tube using a parting tool and lathe. The ring-shaped preforms were dipped a plurality of times in the elastomer solution used to impregnate the yarn ends. The preforms contained 45 percent elastomer binder and 55 percent yarn.

After drying overnight, the preforms were compression molded for 10 minutes at a temperature of 320°F. and a pressure of 2,200 psi.

The rings were post-baked for a period of 18 hours at temperatures varying from 250°F. to 400°F.

The packing rings produced in this manner were of a 80±5 Shore D durometer hardness.

EXAMPLE III

Polymeric binder having the following composition prepared on a mill was dissolved in xylene to provide a 25 percent solids bath:

Constituent	Amount (grams)
Ethylene-propylene-diene elastomer*	400
Zinc oxide (activator)	12
Stearic acid	12
Carbon black	240
Napthenic oil (plasticizer)	40
Sulfur (vulcanizing agent)	6
2-Mercaptobenzothiazol (accelerator)	3
Dipentamethylenethiuram-tetrasulfide (accelerator)	3

*Elastomeric copolymer of ethylene, propylene and 1,4 hexadiene containing 50 to 75 weight percent of ethylene units, 1 to 10 weight percent of hexadiene units and the remainder propylene units, prepared by polymerization of the monomers in the presence of a catalyst, for example by the method of U.S. Pat. No. 2,933,480.

Twelve bobbins of No. 5 cotton yarn were placed on a creel behind a level winding device which was adjacent a TFE coated cylindrical mandrel having a 2 inch O.D. The ends of yarn were let off the bobbins and passed through a dip tank containing the binder solution. After passing through the solution, the yarn ends passed through a wiper die and through a traversing guide onto the rotating mandrel. A tube of reinforced elastomer having a thickness measured in the radial direction of ⅜ inch was produced. In the tube the lay of the yarns was parallel to each other and at 90° to the axis of the mandrel. The mandrel was removed and the solvent evaporated from the tube.

⅜ inch thick rings were cut from the tube using a parting tool and lathe. The ring-shaped preforms were dipped a plurality of times in the elastomer solution used to impregnate the yarn ends. The preforms contained 35 percent elastomer binder and 65 percent yarn.

After drying overnight, the preforms were compression molded for 10 minutes at a temperature of 320°F. and a pressure of 2,200 psi.

The rings were post-baked for a period of 45 minutes at a temperature of 280°F.

EXAMPLE IV

A bath of polymeric binder having the following composition and containing 30 percent solids in a toluene/methyl ethylene ketone mixture was prepared on a mill:

Constituent	Amount (grams)
Acrylonitrile elastomer (medium-high acrylonitrile content)*	100.0
Zinc oxide (activator)	5.0
Sulfur (vulcanizing agent)	1.5
Stearic acid (activator)	1.0
Furnace black (reinforcer)	65.0
Di(2-ethyl-hexyl) phthalate (plasticizer)	15.0
Tetramethylthiuram monosulfide (accelerator)	0.4

*A copolymer containing 33%, by weight, of acrylonitrile and 67% of butadiene.

Twelve bobbins of 15 cut asbestos yarn were placed on a creel behind a level winding device which was adjacent a TFE coated cylindrical mandrel having a 2 inch O.D. The ends of yarn were let off the bobbins and passed through a dip tank containing the binder solution. After passing through the solution, the yarn ends passed through a wiper die and through a traversing guide onto the roating mandrel. A tube of reinforced elastomer having a thickness measured in the radial direction of ⅜ inch was produced. In the tube the lay of the yarns was parallel to each other and at 90° to the axis of the mandrel. The mandrel was removed and the solvent evaporated from the tube.

⅜ inch thick rings were cut from the tube using a parting tool and lathe. The ring-shaped preforms were dipped a plurality of times in the elastomer solution used to impregnate the yarn ends. The preforms contained 45 percent elastomer binder and 55 percent yarn.

After drying overnight, the preforms were compression molded for 10 minutes at a temperature of 320°F. and a pressure of 2,200 psi.

EXAMPLE V

A bath containing 35 percent urethane resin solids (isocyanatoterminated prepolymer prepared substantially by the procedures disclosed in U.S. Pat. No. 3,188,302) in solvent was prepared. Six bobbins of 6 cut asbestos yarn were placed on a creel behind a level winding device which was adjacent a TFE coated cylindrical mandrel having a 2 inch O.D. The ends of yarn were let off the bobbins and passed through a dip tank containing the binder solution. After passing through the solution, the yarn ends passed through a wiper die and through a traversing guide onto the rotating mandrel. A tube of reinforced urethane resin having a thickness measured in the radial direction of ⅜ inch was produced. In the tube the lay of the yarns was parallel to each other and at 90° to the axis of the mandrel. The mandrel was removed and the solvent evaporated from the tube.

⅜ inch thick rings were cut from the tube using a parting tool and lathe. The ring-shaped preforms were dipped a plurality of times in the urethane resin solution used to impregnate the yarn ends.

After drying 2 hours, the preforms were compression molded for 10 minutes at a temperature of 320°F. and a pressure of 2,200 psi.

EXAMPLE VI

A commercial aqueous emulsion containing 60 percent polytetrafluoroethylene solids was placed in the bath. Six bobbins of 10 cut asbestos yarn were placed on a creel behind a level winding device which was adjacent a TFE coated cylindrical mandrel having a 2 inch O.D. The ends of yarn were let off the bobbins and passed through a dip tank containing a PTFE aqueous emulsion. After passing through the emulsion, the yarn ends passed through a wiper die and through a traversing guide onto the rotating mandrel. A tube of reinforced PTFE having a thickness measured in the radial direction of ⅜ inch was produced. In the tube the lay of the yarns was parallel to each other and at 90° to the axis of the mandrel. The mandrel and tube were placed in a 280°F. oven overnight for drying.

⅜ inch thick rings were cut from the tube using a parting tool and lathe. The ring-shaped preforms were dipped in the PTFE emulsion used to impregnate the yarn ends and dried. The preforms were then cold formed in a mold under a pressure of 2,200 psi, and redipped in the emulsion for a finish coating.

The cold formed rings were sintered at a temperature of 850°F. for 6 minutes.

The rings were then coined in a cold mold and trimmed.

What is claimed is:

1. A jointless packing ring comprising an annular helix formed of a plurality of convolutions of a yarn comprising asbestos fibers impregnated with a polymeric binder selected from the group consisting of fluorocarbon, urethane and acrylonitrile polymers, the adjacent yarn convolutions within said helix being in substantially parallel side-by-side relation, and said helix having been subjected to heat and pressure to consolidate the yarn convolutions upon each other and to set said binder, the exterior surface of said ring being coated with said polymeric binder, said ring containing from about 10 to about 60 percent of binder, based on the combined weight of yarn and binder.

2. A jointless packing ring according to claim **1** containing from about 30 to about 50 percent of binder, based on the combined weight of yarn and binder.

3. A jointless packing ring according to claim **1** in which said polymeric binder comprises a fluoroelastomer.

4. A jointless packing ring according to claim **1** in which said polymeric binder comprises polytetrafluoroethylene.

5. A packing ring according to claim **1** having a thickness measured in the radial direction of from ⅛ to 1 ½ inches.

6. A packing ring according to claim **1** in which the side surfaces thereof are substantially V-shaped.

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