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Butzow et al.

[11] **3,804,479**

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[54] **LOW FRICTION FABRIC-LINED BEARINGS AND IMPROVED FABRIC THEREFOR**

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[73] Assignee: **Rexnord Inc.**, Milwaukee, Wis.

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[21] Appl. No.: **317,210**

[52] **U.S. Cl.** ..... **308/238**, 139/420 A, 161/91

[51] **Int. Cl.** **F16c 33/18**

[58] **Field of Search** ..... 308/238, DIG. 7, DIG. 8; 139/420, 426; 161/91

[56] **References Cited**

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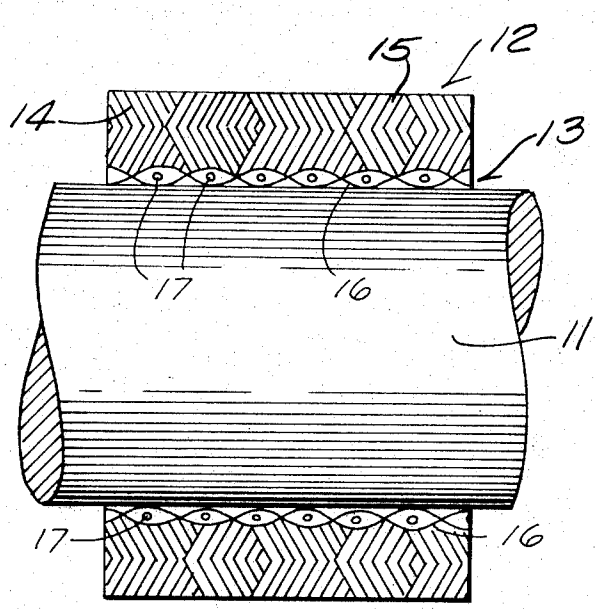
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Primary Examiner—Charles J. Myhre
Assistant Examiner—Barry Grossman

[57] **ABSTRACT**

Unblended yarns are constructed and woven with other yarns to form a mixed fabric which is particularly suitable for use as the liner for resin bodied annular bearings which are subject to reversing loads, that is where one bearing element oscillates relative to the other or relative rotation or movement of the bearing elements regularly reverses in direction. More particularly, yarn of Teflon filaments and yarn of bondable filaments are woven in a 1 × 1 plain weave so that the filaments are just sufficiently loose to allow the capillary action of the liquid resin to thoroughly impregnate the fabric in the manufacture of the bearing and anchor the Teflon filaments to prevent their being worked loose from the resin by the reversing loads.

7 Claims, 6 Drawing Figures



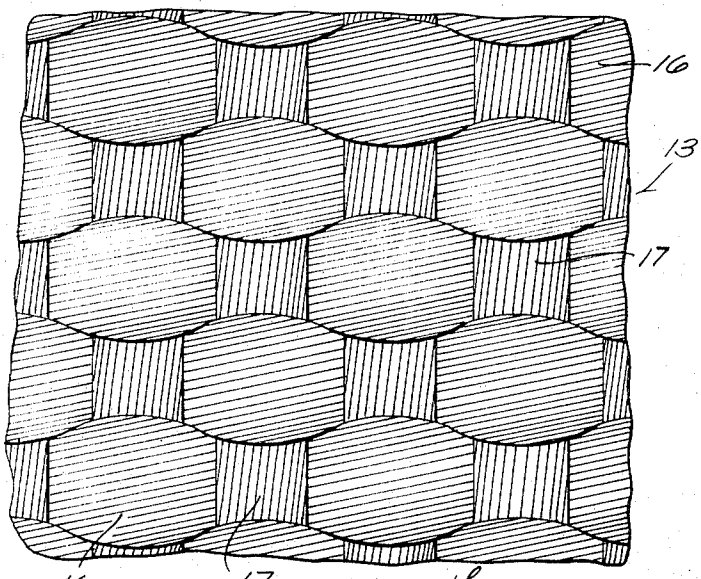


Fig. 2

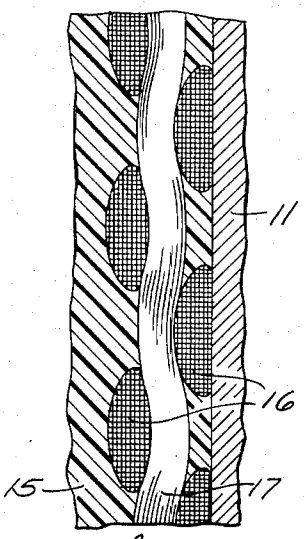


Fig. 4

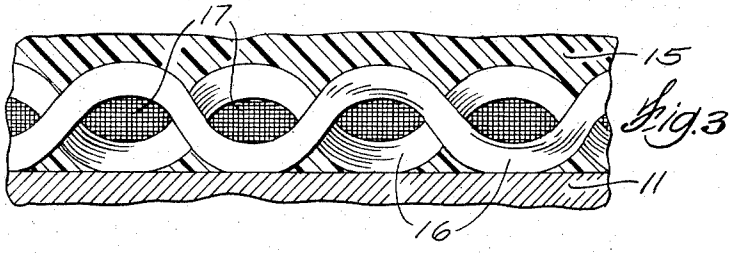


Fig. 3

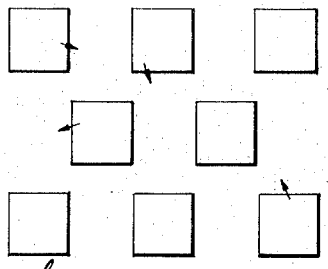


Fig. 5

Fig. 6

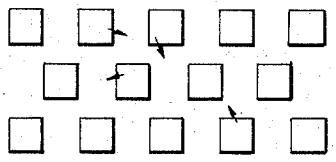
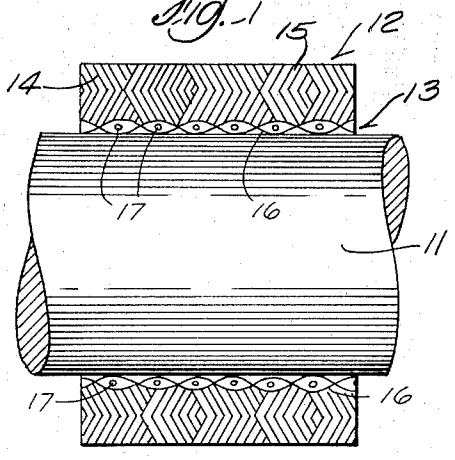


Fig. 1



LOW FRICTION FABRIC-LINED BEARINGS AND IMPROVED FABRIC THEREFOR

CROSS REFERENCE TO RELATED APPLICATION

The bearing disclosed and claimed in the copending application filed Dec. 4, 1970 by the present inventors, Ser. No. 95,363 and entitled Seamless Fabric Lined Bearing of Multiple Length Construction is particularly intended for use with the fabric of the present invention. The method of making the bearing is the subject of U.S. Pat No. 3,616,000.

BACKGROUND OF THE INVENTION

1. Field of Invention

The present invention involves the selection of the fiber content of the yarns, the counts and picks of the warp and filler and weaving specifications for a fabric for use as the liner of a low friction bearing. The fabric of the present invention is adapted for use for example in the construction of bearings in accordance with the disclosure of U.S. Pat. No. 3,616,000 of the present inventors.

2. Description of the Prior Art

For some time a number of polymers have been available for use as a low friction bearing liner in the form of a fabric of woven monofilament yarns. British Pat. No. 698,611 published Oct. 21, 1953 describes improvements in anti-friction materials including the use of filaments of polyethylene made on an extruding machine and cold-stretched if desired. Each yarn is doubled with a textile yarn and woven into a fabric, impregnated with resin, and moulded under heat and pressure to a structure of one or more plies.

A polytetraflouroethylene resin, presently marketed under the trademark "Teflon," is a more recently developed polymer of outstanding low-friction characteristics. According to the disclosure of U.S. Pat. No. 2,885,248, Teflon threads are interwoven into a cloth and this cloth is resin impregnated and located in the resin body so that substantially all of the threads forming the front face of the Teflon cloth are exposed to form the face of the bearing and the entire rear side of the cloth is embedded in the resin. However, this fabric is unsuitable because thermosetting resins are incapable of bonding to Teflon.

Subsequently, Teflon cords or threads were woven with bondable cords or threads such that the face of the cloth to be exposed comprised substantially all Teflon material and the face to be bonded comprised substantially all bondable material. U.S. Reissue Pat. No. 24,765 shows such a compound fabric having a three-float twill weave. The patent suggests also that a satin weave might be used.

Bearings of especially high quality in terms of load capacity, low break-away torque, and wear resistance can be made using such a compound fabric. However, such bearings are serviceable only under relatively clean conditions and with an especially well-finished steel mating element. Any slight imperfection in the surface of the mating element or any intruded sand or grit particles will quickly snag a Teflon filament and pull the cord or thread from the face of the bearing and as a result destroy the bearing. It has also been found that reversing movements normal to the filaments particularly accelerate the wear and failure of the bearing. This is because in providing a compound fabric of such

description, it is necessary that the Teflon warp yarns float or skip over some number of the filling yarns. These "floats" tend to be more readily broken away from the backing by imperfections or foreign particles in the bearing. While this tendency is reduced in a fabric of a plain or 1 × 1 weave, a bearing with a plain fabric of whatever proportion of Teflon might be selected, generally appears comparatively secure but fails quickly due to overheating because of too little Teflon on the bearing face or appears to be a comparatively good bearing but fails quickly due to loosening of the fabric because of inadequeate bonding of the reverse side. These mutually exclusive considerations of course, led to the development of the compound fabric some years ago.

The present invention is based upon the discovery in a bearing of a certain manufacture that a plain fabric of Teflon and bondable yarns of certain relative dimensions can provide a bearing comparable to or better than a bearing having the compound fabric referred to. It is believed that the improvement is the result of 1) reducing the amount of the bondable yarns which reach to the bearing face and 2) assuring adequate looseness of the bondable filaments so that the entire fabric is assuredly filled with resin in the manufacture of the bearing.

In the type of bearing to which the present invention appears limited, the fabric is woven in the form of a sleeve having longitudinal Teflon warp yarns and circumferential filling yarns of such as Dacron and is held against a mandrel by the tension of the filling yarns upon heat-shrinking such that at spaced points the filling yarns extend between alternate warp yarns and the resin-mandrel face of the bearing. According to the present invention the relative sizes and spacing of the warp and filling yarns are selected so that between said spaced points the filling yarns bridge the alternate warp yarns and support themselves some distance from the resin-mandrel face of the bearing.

Any suitable material for the filaments of the filling yarn might be employed. Dacron is the trademark used for a commercially available polyester of a dihydric alcohol and terephthalic acid. This material is heat-shrinkable and is especially suitable for use as the filaments of the bondable yarns of the fabric of the present invention.

The commercial availability of the Teflon and Dacron yarns should be noted because the Teflon yarns in particular are not to be doubled or tripled. Doubling is mentioned in the British Pat. No. 698,611, above noted and must be avoided in carrying out the present invention because doubled or tripled yarns cannot be consistently pressed against the mandrel to form the bearing face.

At present, Teflon yarns of 30, 60 and 180 filaments each are available. Such yarns of unbleached Teflon have Deniers of 200, 400 and 1200 respectively. While these specifications are arbitary, they indicate that the Teflon monomer has an optimum filament diameter which was arrived at empirically and is now standardized.

The fabric of the present invention utilizes the 400 Denier, 60 filament Teflon yarn because the other two available selections are respectively too fine and too coarse. According to the explanation of the invention which is offered, the finer yarn would be preferable, but are too fine for available looms for weaving seam-

less tubing, as required, and, because the filling yarns must be even finer, they cannot be woven readily. Most importantly, they would then not have sufficient tensile strength for conforming the face of the fabric to the mandrel and to hold the fabric in the resin. It should or will be readily understood that the 1200 Denier, 180 filament Teflon yarn is far too coarse for the purposes of the present invention.

A wider selection of Dacron yarns is available and the selection of the filling yarn size is made with reference to the size of the 60 filament, 400 Denier unbleached Teflon warp yarn which essentially here, is the only choice available.

The twist of any woven yarn is generally required to some degree for handling of the yarns in weaving. In the fabric of the present invention a minimum of twist is desired because, in general, twisting increases the resistance of the yarns to the crimping which is required of the relatively much stiffer Teflon yarns and, twisting in effect bundles the Dacron filaments too tightly and prevents entry of the liquid resin into the interstices of the yarns as is required for bonding of these yarns.

Notwithstanding the desireability of unplied Teflon yarns with a minimum of twist, one difficulty in weaving must be noted and which, so far has required blending the warp yarn with about 5 percent of filaments of other than Teflon so that the tension of the warp yarns can be maintained. This tension is maintained by drawing the yarns over a number of pegs and the 5 percent blended yarn need not be of a bondable material. In fact, filaments of polyethylene is recommended and preferred. This material is lubricious and non-bondable as was indicated by British Pat. No. 698,611 but provides the desired tensioning effect in weaving. A polypropylene is also recommended.

SUMMARY OF THE INVENTION

The fabric of the present invention is intended for providing the Teflon face of a hardened resin backing which is to form one part of a low-friction bearing. The fabric is of a plain 1 × 1 weave for durability and comprises Teflon warp yarns and bondable or Dacron filling yarns of such size and number which are selected so that rather than providing as great an area of Teflon at the bearing surface as possible, the maximum practicable number of relatively much smaller areas of Teflon are provided. The fabric is still adequately bondable on either side, or possibly more so, depending upon the comparison; the synergistic effect in providing many small Teflon areas is a bearing of uniquely high capacity and durability for this type of fabric and is believed to be associated with the slight tendency for some of the Teflon molecules to be rubbed off from the filaments and over the adjoining non-Teflon surfaces. By reducing the size of the Teflon areas and effecting a corresponding increase in their number, the distance across the non-Teflon areas is thus reduced and maximum utilization of the rubbed-off Teflon is believed to provide the improvement noted. While this conjecture has not yet been verified, it seems to be justified by actual tests of bearings with several different fabrics having only slightly larger and fewer areas. The warp comprises commercially available unbleached Teflon yarns of 400 Denier having a minimum of twist allowing maximum crimping, thewarp end count being in the order of 85 and thus relatively near the maximum allowed with such yarns and such that the filling yarns are allowed a minimum of crimp. The filling yarns are of Dacron and of about a 200 Denier such that the cross-section of each yarn is about two-thirds that of each Teflon warp yarn, the filling pick count being about 56 and thus also about two-thirds that of the end count.

DESCRIPTION OF VIEWS OF THE DRAWING

FIG. 1 shows in section a typical bearing using the fabric as the lining for the outer glass-reinforced resin body in which the inner member turns.

FIG. 2 is greatly enlarged plan view of the fabric of the present invention for the bearing of FIG. 1.

FIG. 3 is a similarly enlarged section of the bearing showing one of the Teflon yarns in elevation.

FIG. 4 is a similarly enlarged cross-section of the bearing showing a portion of the Dacron filling yarn in elevation.

FIGS. 5 and 6 are representations of larger and smaller areas of the Teflon at the bearing surface with arrow indicating the Teflon which is rubbed onto the intermediate adjacent areas.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The cylinder **11** shown in FIG. 1 represents both the mandrel on which the bearing **12** is made and the shaft which is turnable relative to bearing **12.** As described in the related application referred to, bearing **12** is manufactured in multiple as a long tube which is cut to the desired lengths of the individual bearings. The face of bearing **12** is formed by the seamless fabric sleeve **13** which is first heat-shrunk on the mandrel (**11**) and is then spirally wrapped with a resin-carrying tape of parallel roves of glass filaments **14.** The resin is then cured to form the resin body **15** of bearing **12.**

Sleeve **13** includes the longitudinal warp yarns **16** which are comprised of Teflon filaments having a nominal twist. Because the fabric is of a plain 1 × 1 weave and in the form of a seamless sleeve, the circumferential filling is comprised of a single yarn **17** which extends in a spiral or circumferentially and from one end to the other end of the bearing face. Yarn **17** is of a size or number of filaments which is critical to carrying out the present invention. The filaments of yarn **17** are of Dacron which shrinks upon heating and also provides strength and bonding.

FIGS. **2–4** show a section of fabric sleeve **13** enlarged about 60 times and are believed to illustrate the physical characteristics of the fabric which provide the unexpected results observed in testing bearings of identical manufacture with similar fabric sleeves but merely different yarn sizes and spacing.

As shown, the filling yarn **17** is about two-thirds the size of the warp yarns **16**; the warp yarns **16** are closely spaced and sharply crimped over and under the parallel well-spaced turns of the filling yarn **17** which has practically no crimp; a part of each crimp of the warp yarns **16** is pressed against the mandrel (**11**) by the heat-shrunk circumferential filling yarn **17** which bridges the warp yarns so that the filling yarn positively spaced from the bearing face; the warp yarns **16** are flattened against mandrel (**11**) to form a large number of Teflon bearing areas in a uniform, closely spaced pattern.

FIGS. **5** and **6** represent the larger and smaller patterns which were provided by several of the tested fabrics. The larger pattern shows relatively larger squares

of Teflon with larger intermediate resin areas although both patterns include the same overall percentage of Teflon and intermediate areas of resin. As is known, some amount of Teflon is rubbed by the moving bearing part (11) from the Teflon areas and over the ajoining portions of the resin areas. However, in the smaller pattern this effect provides a significantly greater total area of Teflon and a significantly improved bearing wear life. That is, with the greater area of Teflon, both the enlargement of the bearing and the deterioration of the bearing due to wear and overheating is reduced so that a bearing of substantially greater load capacity and wear life is provided.

The exact specifications of the fabric shown and described are:

Warp: 87 ends per inch; 400 denier unbleached Teflon yarns of 60 filaments with the producer's twist; each yarn may include some polypropylene filaments for tensioning in weaving.

Filling 56 ends per inch; 220 denier type 52 Dacron yarns of 50 filaments with Z twist of 5 per inch.

Another aspect of the invention respects the side of the fabric over which the glass filaments are wound. Also as shown in FIGS. **2–4**, the warp yarns **16** protrude beyond the filling yarn **17** but are not flattened as on the bearing side of the fabric and significant depressions appear where each two adjoining warp yarns **16** cross each other. The first layer of glass filaments **14** which are spirally wound over sleeve **13** include a significant number which lie in these depressions so that the fabric is especially well anchored by the glass filaments **14** as well as by the resin body **15.**

We claim:

1. In a low-friction bearing having a filament reinforced thermoset resin body and a fabric having one face embedded therein and the other face substantially exposed to form the bearing surface, the improved fabric which comprises warp and filling yarns woven with a 1 × 1 weave, the warp yarns comprising Teflon filaments and having a denier in the order of 400, the filling yarns comprising bondable filaments such as Dacron and having a denier in the order of 200, said fabric having in the order of 90 end and 60 pick counts, all of said yarns having a twist of no more than one per inch, the area of each face of said fabric being in the order of 55 to 60 percent Teflon to provide on either selected side a durable bearing surface, 40 to 45 percent of the remaining area of each side comprising said bondable filaments which are adequately spaced to and interlocked by the intersticial resin.

2. A fabric sleeve for shrinking over a mandrel and embedding in a hardenable material to form the bearing face of a low-friction device, said fabric being of a 1 × 1 weave and comprising between 80 and 90 ends and between 50 and 60 picks per inch, each warp yarn being of Teflon filaments with minimum twist in the order of 400 denier and each filling yarn being of Dacron filaments and in the order of 200 denier.

3. In a journal bearing which comprises a thermoset resin body having wound filaments for internal reinforcing and a fabric embedded therein at and to form the bearing face, said fabric being of a 1 × 1 weave and woven in the form of a sleeve and having longitudinal warp yarns of low-friction filaments of a material such as Teflon and a circumferential filling yarn of filaments of a heat-shrinkable and bondable material such as Dacron, the cross-section and spacing of said filling yarns being about two-thirds that of the warp yarns whereby the filling yarns are substantially uncrimped and the warp yarns forming the bearing face appear as ros of relatively small squares of nominal spacing.

4. In a journal bearing which comprises a thermoset resin body having wound filaments for internal reinforcing and a fabric embedded therein at and to form the bearing face, said fabric being of a 1 × 1 weave and woven in the form of a sleeve and having longitudinal warp yarns of low-friction filaments of a material such as Teflon and circumferential filling yarns of filaments of a heat-shrinkable and bondable material such as Dacron, said bearing of the type wherein the fabric is held against a mandrel by the tension of the filling yarns upon heat-shrinking such that at spaced points the filling yarns cross-over and press alternate warp yarns against the mandrel and at intermediate points the filling yarns extend between alternate warp yarns and the resin-mandrel face of the bearing, the relative sizes and spacing of the warp and filling yarns being such that between said spaced points the filling yarns bridge the alternate warp yarns and support themselves some distance from the resin-mandrel face of the bearing.

5. The bearing of claim **3** which is in the form of a cylinder and wherein the Teflon yarns on the other face of the fabric form similar rows of diagonally arranged projections and the reinforcing filaments are wound in a spiral so that a significant number of said filaments lie between such projections to firmly anchor the fabric in the resin body of the bearing.

6. The bearing of claim **4** which is in the form of a cylinder and wherein the warp yarn forming the other face of the fabric includes projections which are spaced axially and circumferentially on parallel diagonal lines and the internal reinforcing filaments are wound in a spiral so that a significant number of said filaments lie between such projections to firmly anchor the fabric in the resin body of the bearing.

7. In a journal bearing which comprises a reinforced thermoset resin body and a fabric embedded therein at and to form the bearing face, said fabric being woven with a 1 × 1 weave and having longitudinal warp yarns of low-friction filaments of a material such as Teflon and a circumferential filling yarn of filaments of a bondable material such as Dacron, the cross-section and spacing of said filling yarns being about two-thirds that of the warp yarns whereby the filling yarns are substantially uncrimped and the warp yarns forming the bearing face appear as rows of relatively small squares of nominal spacing.

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