

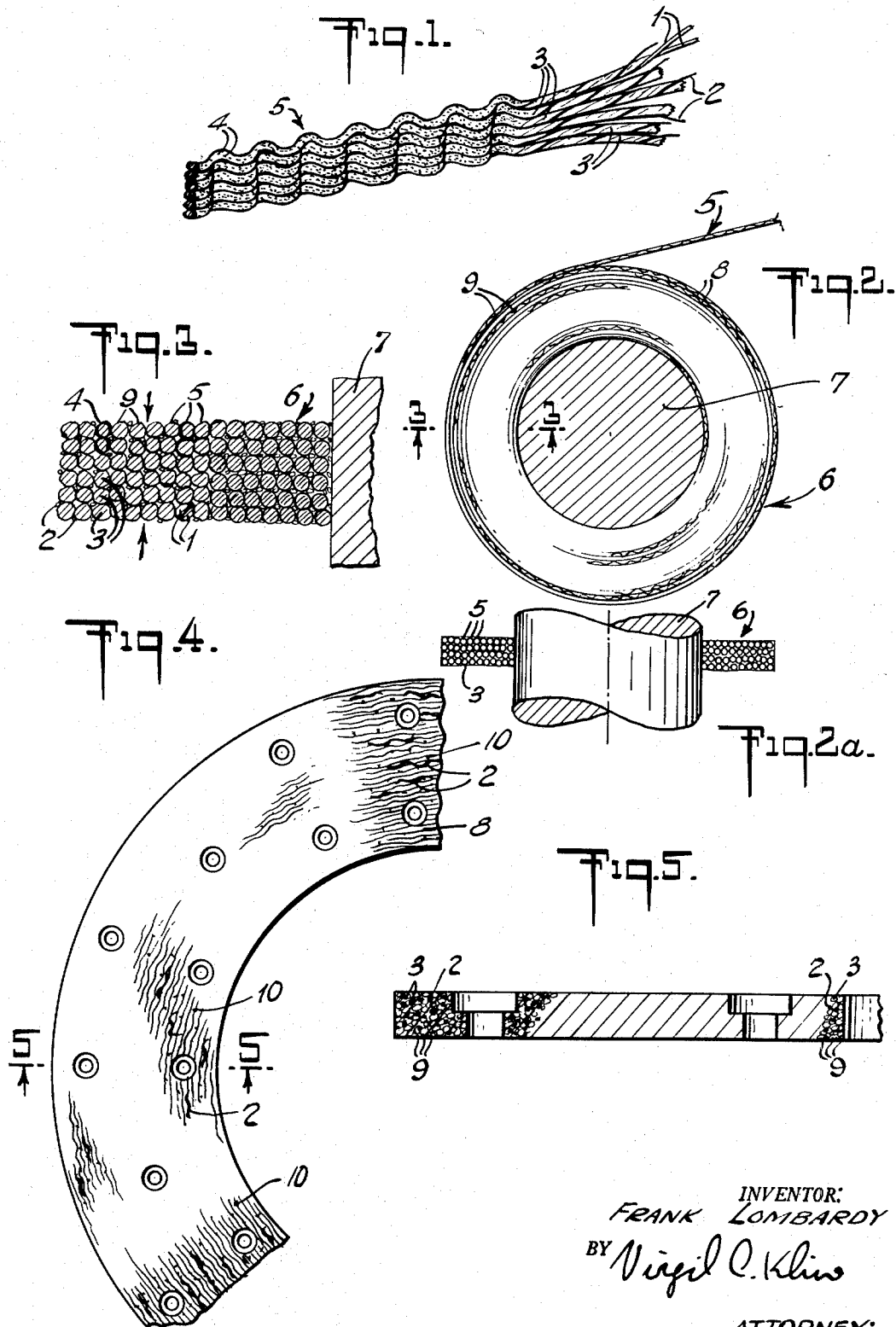
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FRICTION ELEMENT AND METHOD OF MAKING THE SAME

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FRICION ELEMENT AND METHOD OF MAKING THE SAME

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This invention relates to improvements in friction elements for use as clutch facings and the like. The invention relates particularly to clutch facings known in the art as the circular-wound or spiral-wound type.

One object of this invention is to provide a friction element of the type specified having high hot spin strength, a highly uniform resistance to, and low rate of, wear over its entire friction faces, even at high temperatures, and a torque level at least comparable to conventional spiral-wound facings. It is a further object of the invention to provide a method of making such a friction facing.

Another object of the invention is the provision of a method of producing large-size, warp-free friction discs of the circular-wound type employing wire-reinforced fiber yarns.

A still further object of the invention is to provide a method of making friction discs of the circular-wound type in which the friction characteristics or coefficient of friction of the friction faces of the finished product may be varied widely by the application of different types of friction treatment at different stages in the production of the disc and in various combinations.

In making clutch facings it has been found extremely difficult to successfully employ the circular-winding method for large-size facings, of 15" in diameter and up, where wire-reinforced yarns in their conventional, relatively straight form are used. When wire-reinforced yarns of a conventional type are wound in convolutions, as they are in the circular-winding method, to form discs in this large-size range, warping is frequently encountered in the finished disc, apparently because the straight wire does not permit the yarn or yarns to yield under the play of forces that come into effect during the processing of the disc, especially during the curing phase. I have found that by using a crimped yarn in accordance with the instant invention, this tendency to warp can be eliminated. This is believed to result from the fact that the crimps or corrugations in the yarn impart a yielding characteristic thereto so that the yarn will yield under the forces developed rather than cause the disc to be twisted or warped.

I have also found that by using crimped wire-reinforced fiber yarn in this circular-wound type of facing I can obtain a finished product having the metal and other friction imparting materials distributed more widely and uniformly over the friction faces than in the case of conventional facings of this type. This results from the retention in a large measure of the crimps or corrugations in the finished product, so that instead of having the wire and fiber arranged as conventionally in regular, even layers defined by the successive convolutions, the convolutions have generally radial undulations, which produce a somewhat random but, in total effect, wide and uniform distribution of the metal and fiber content. Various friction filler materials can be added at different stages in the processing of the discs, as will be described hereinafter, in which case these materials will be similarly randomly and more effectively distributed over the friction faces, to occupy the pattern of voids established by the undulations.

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By employing different combinations of binders and filler materials, different friction characteristics can be obtained in the finished discs. Friction discs embodying crimped wire-reinforced yarn as described have been found to satisfy the requirements set forth in the statement of objects as to high hot spin strength, highly uniform resistance to wear, low rate of wear, and a favorable torque level.

The invention will be more readily understood by reference to the following detailed description and to the drawing, in which:

Fig. 1 is a side view of a crimped composite strand in the form of an undulated tape made up of individual strands of fiber yarn reinforced with metallic strands and impregnated with a binder, one of said individual strands being separated from the others at one end and shown in detail;

Fig. 2 is a face view of an annulus formed by arranging on a mandrel, shown in cross-section, a composite strand or tape such as shown in Fig. 1 in relatively loose convolutions, prior to compression and curing;

Fig. 2a is a view showing the annulus of Fig. 2 in cross-section, with the mandrel partly in elevation and partly in section.

Fig. 3 is a partial section on a larger scale of the annulus shown in Fig. 2 taken on the line 3—3, looking in the direction of the arrows;

Fig. 4 is a partial face view on a larger scale of the final friction facing resulting from the further processing of the annulus shown in Figs. 2 and 3; and

Fig. 5 is a partial section of the final facing, taken on the line 4—4.

My invention involves the use of wire-reinforced fiber yarn in the production of a friction element, particularly a clutch disc of the circular-wound type. The fiber employed for the yarn preferably is asbestos fiber having sufficient cotton or other fiber content to give it the required strength. However, any suitable fiber or combination of fibers may be employed. In any case, it is essential to include a wire reinforcement, in order to achieve the desired results, as will become more apparent as the description proceeds. A preferred yarn for effectively practicing the instant invention can be obtained by twisting together two strands 1 of asbestos yarn, having a suitable cotton content for strength, with one strand of wire 2, as shown in Fig. 1. While the resulting individual wire-reinforced fiber strand 3 is exemplary of the type of yarn that may be employed, other combinations can be used, in which the number of strands of wire or fiber, or the types of wire or fiber may be varied. The wire may suitably be brass, but other wire or combinations of wires may be used in place of, or in conjunction with, the brass wire.

In accordance with the preferred method of the invention, a plurality of strands of a wire-reinforced fiber yarn of the type described above are impregnated with an appropriate binder represented by the stippling at 4 in Fig. 1 (see also Fig. 3), as by running them through a vat containing the impregnating solution. The impregnating solution may comprise any of the well-known binders such as thermo-setting resins, natural or synthetic rubber, drying oils, or inorganic binders such as calcium silicate, or combinations of the above, and also friction particles of metal, ground hard rubber, or the like. The impregnated strands are then dried, as by air drying, and brought together, conveniently by passing them through a ring of appropriate size, in a relatively loose bundle to form a composite strand, in which the individual strands extend generally in the direction of the length of the composite strand. The number of individual wire-reinforced strands which are collected to form the composite strand may vary, depending upon the thickness of the friction disc that is desired. Suit-

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ably 8-16 such impregnated individual strands may be collected to form the composite strand. Or the impregnating step could be carried out after the collection of the individual strands to form the composite strand, though not as effectively.

In the preferred and much more simple and satisfactory method, the crimping of the yarn is carried out after the composite strand is formed to produce an undulated tape, shown generally at 5 in Fig. 1, but the individual wire-reinforced strands could be crimped after impregnation and drying and before they are collected to form the composite strand. It is necessary in any case to perform the crimping step after the impregnating and drying steps so that the crimps will not flatten out too easily in subsequent handling. The crimping operation may be performed by passing the composite strand, or the individual strand, as the case may be, through two gears in mesh, or a hemp break, or in any other suitable manner. A preferred number of crimps or corrugations per unit length has been found to be about five per inch. In order to obtain satisfactory results, the number of corrugations should not be reduced below two per inch.

In the preferred method, a crimped composite strand 5, formed in accordance with the above, is arranged in convolutions to form a disc or annulus of the desired size, such a disc being shown generally at 6 in Fig. 2. This may be done advantageously by first storing lengths of the crimped impregnated composite strand in its undulated tape form on spools, from which a suitable length of the undulated tape may be drawn and wound upon itself on a mandrel 7 to form the disc 6 having the desired diameter, with the width of the tape extending generally axially of the disc, and the crimps defining generally radially extending undulations 8 in the convolutions 9. Alternatively, the composite strand may be fed directly from the crimping operation to the winding operation. By the selection of the proper number of individual wire-reinforced fiber strands in the formation of the composite strand, only a single composite strand in the crimped tape form need be wound spirally or circularly upon itself to form the disc on the mandrel, the axial thickness of the disc being determined by the diameter of the composite strand or, more proximately, by the width of the tape. The winding operation is thus greatly simplified, since the undulated tape can simply be wound between two guide plates on the mandrel to form a disc of the desired diameter and axial thickness without the necessity of using special winding techniques in order to obtain a level wind or other suitable winding pattern.

However, instead of collecting the impregnated and dried individual wire-reinforced fiber strands to form the composite strand, as described above, the wire-reinforced impregnated and dried individual strands could be crimped individually and thereafter wound directly on the mandrel in substantially side-by-side spiral or circular fashion, with the crimps defining the generally radially extending undulations 8 in the convolutions 9, the axial thickness of the resulting disc or annulus being determined by the number of such strands selected.

Care should be exercised in winding either the composite strand or the individual strands to use enough tension to cause the resulting blanks to stick together, but with as little flattening of the crimps as possible.

However formed in accordance with the foregoing, the resulting annulus or disc 6 comprises a suitable amount of the selected crimped wire-reinforced yarn arranged upon itself in convolutions to form a preform of the desired size in which the crimps or corrugations in the yarn define the generally radial undulations 8 in the convolutions 9. As exemplary of the amount of yarn that may be employed, approximately 1,000 grams of impregnated, crimped, wire-reinforced fiber yarn was successfully used in making an FMS 1618 clutch facing having,

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as final dimensions, 16 $\frac{1}{8}$ " outside diameter by 10" inside diameter by .135" thick.

After forming the disc or preform of the impregnated, dried and crimped yarn as described above, the preform may be finished in a number of ways to arrive at a final friction element having a corresponding variety of friction characteristics. Preferably, the preform is placed in a bump mold and compressed in an axial direction as indicated by the arrows in Fig. 3 to provide a densified blank, after which the binder is cured. The compressed and densified blank has characteristics as indicated in the cross-sectional detail at the left side of Fig. 5. Either before or after compressing the disc, but before cure, the disc may be redipped in the impregnating solution, or otherwise impregnated with the same or a different solution, drained, and allowed to dry. As in the first impregnating step, various friction imparting filler materials may be added to the solution, in which case the second impregnation should be performed before compressing the disc. These friction filler materials, as in the first instance, may include metal, hard ground rubber, or other well-known friction particles. By selecting different combinations of friction treatments for the first and second impregnating steps, the friction characteristics of the resulting product can be widely varied.

In compressing the impregnated, dried, and crimped preforms, the preforms are usually reduced in thickness about a third, as from .200" to .140". The blanks thus formed may be reduced further in thickness to, for example, .125" by grinding after cure.

The cured blanks made in accordance with the above may be finished in any of the usual ways as by subjecting them to baking, grinding, drilling, and counter-boring operations. In the final friction discs, as shown in Figs. 4 and 5, the crimps or corrugations in the yarn are largely retained, the yarn being disposed in the convolutions 9, in which the crimps in the yarn define the generally radial undulations 8. The yarn is held in the disc form in the hard, cured binder matrix, which, as illustrated at 10, fills the spaces surrounding the wire and fiber, it being understood that the binder matrix thus referred to includes such friction particles as may have been incorporated in the friction treatment. Part of the wire (2) and fiber (1) content of the yarn is exposed at the friction surfaces (the axial end faces) of the disc to render visible at these surfaces the generally radial undulations defined in the convolutions by the crimps or corrugations in the yarn. As a result of the undulations, the exposed fiber and wire content is distributed somewhat randomly but widely and, in total effect, uniformly over the friction surfaces, and the remainder of the fiber and wire is similarly distributed in the body of the disc in a manner exemplified in Fig. 5. The friction treatment 10, filling the spaces between the fiber and wire to form the binder matrix, of course is also very effectively distributed throughout the disc, including its friction faces, as a result of the described distribution of the fiber and wire.

Friction discs of the type described above, and made in accordance with the described method, which is very simple and economical to practice, have the desirable properties already discussed. It will thus be seen that the stated objects of my invention have been attained.

Having thus described my invention in rather full detail, it will be understood that these details need not be strictly adhered to and that various changes and modifications may suggest themselves to one skilled in the art, all falling within the scope of the invention as defined by the subjoined claims.

What I claim is:

1. In a method of making a friction element which includes spirally winding wire-reinforced hardenable binder impregnated and dried fiber yarn in convolutions, the step of crimping said yarn after impregnation and drying but before winding.

2. A method of making a friction element comprising,

impregnating wire-reinforced fiber yarn with a binder, drying and crimping the impregnated yarn, arranging a desired quantity of the crimped yarn in convolutions to form a disc of the desired size, compressing said disc, and curing the binder.

3. In a method of making a friction element, the steps of impregnating wire-reinforced fiber yarn with a binder, drying and crimping the impregnated yarn, arranging a quantity of the crimped yarn in convolutions having radial undulations defined by the crimps, to form a disc, compressing said disc, and curing the binder.

4. A method of making a friction element comprising impregnating wire-reinforced fiber yarn with a binder, drying and crimping the impregnated yarn, arranging a desired quantity of the crimped yarn in convolutions to form a disc of the desired size, compressing said disc, impregnating said disc with additional binder, and curing the binder.

5. A method of making a friction element comprising, impregnating wire-reinforced fiber yarn with a binder, drying and crimping the impregnated yarn, arranging a desired quantity of the crimped yarn in convolutions to form a disc of the desired size, impregnating said disc with additional binder, compressing said disc, and curing the binder.

6. In a method of making a friction element, the steps of arranging a composite strand of crimped hardenable binder impregnated wire-reinforced fiber yarn in convolutions upon itself to form a disc, compressing the disc, and curing the binder.

7. In a method of making a friction element, the steps of forming a composite strand of hardenable binder impregnated and dried fiber yarn including asbestos and wire reinforcement, crimping said composite strand, arranging said composite strand in convolutions upon itself to form a disc, compressing the disc, and curing the binder.

8. In a method of making a friction element, the steps of forming a composite strand of hardenable binder impregnated and dried wire-reinforced fiber yarn, in which composite strand the strands of wire and fiber are bundled together and extend generally in the direction of the length of the composite strand, crimping said composite strand to form an undulated tape, arranging said tape in convolutions to form a disc having the undulations in the tape disposed as generally radial undulations in the convolutions, compressing the disc, and curing the binder.

9. A method of making a friction element comprising, impregnating strands of wire-reinforced fiber yarn with a binder, drying and collecting together a plurality of said impregnated strands to form a composite strand, crimping said composite strand, arranging said crimped composite strand in convolutions to form a disc of the desired size, compressing the disc, and curing the binder.

10. A method of making a friction element comprising, impregnating strands of yarn including asbestos and wire reinforcement with a binder, drying and collecting together in a bundle a plurality of said impregnated strands to form a composite strand in which said impregnated strands extend generally in the direction of the length of the composite strand, crimping said composite strand to form an undulated tape, arranging said

tape in convolutions upon itself to form a disc having the undulations in the tape disposed as undulations in the convolutions and in which the width of the tape extends generally axially of the disc, compressing the disc, and curing the binder.

11. In a method of making a friction element, the steps of forming a composite strand of wire-reinforced fiber yarn, impregnating said composite strand with a binder, drying and crimping the impregnated composite strand, arranging said composite strand in convolutions to form a disc of the desired size, compressing the disc, and curing the binder.

12. A friction element comprising crimped wire-reinforced fiber yarn disposed in convolutions defining a disc, said yarn being held in the form of said disc by a hard, cured binder matrix.

13. A friction element comprising crimped wire-reinforced fiber yarn arranged in convolutions defining a disc, the crimps in the yarn defining undulations in the convolutions, said yarn being held in the form of said disc by a hard, cured binder matrix.

14. A friction element comprising crimped wire-reinforced fiber yarn arranged in convolutions defining a disc, the crimps in the yarn defining undulations in the convolutions, said yarn being held in the form of said disc by a hard, cured binder matrix, part of the fiber and wire content of said yarn being exposed at the friction surfaces of the disc.

15. A friction element comprising crimped yarn including asbestos and wire reinforcement arranged in convolutions defining a disc, said yarn being held in the form of said disc by a hard, cured binder matrix, part of the fiber and wire content of said yarn being exposed at the friction surfaces of the disc and forming thereat a visible pattern of radial undulations in the convolutions.

16. A friction element comprising corrugated wire-reinforced fiber yarn disposed in convolutions defining a disc, the corrugations in the yarn defining generally radial undulations in the convolutions, said yarn being held in the form of said disc by a hard, cured binder matrix, part of the fiber and wire content of said yarn being exposed at the friction surfaces of the disc to render visible thereat the generally radial undulations defined in the convolutions by the corrugations in the yarn.

17. In a method of making a friction element, the steps comprising forming a tape of hardenable binder impregnated and dried fiber strands including wire-reinforcement, crimping said tape, arranging said tape in convolutions to form a disc, compressing the disc, and curing the binder.

18. The method defined in claim 17, in which said tape is crimped transversely and arranged lengthwise in convolutions to form the disc.

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