United States Patent

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[54] **PILE FABRIC METHOD AND PRODUCT**

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[52] **U.S. Cl.**.....**273/61 R,** 28/72 P, 28/72.2 R, 156/148, 161/67, 161/81, 161/154, 161/167, 273/61 B

[51] **Int. Cl.**...**A63b 39/06,** D03d 27/00, D04h 11/00

[58] **Field of Search**.....161/62, 67, 80, 81, 154–156, 161/167; 28/72 P, 72.2 R; 66/202; 156/148; 273/61 R, 61 B

[56] **References Cited**

UNITED STATES PATENTS

2,018,559	10/1935	Horner	273/61 R
3,167,941	2/1965	Rab	66/202
2,952,063	9/1960	Bukalders et al.	273/61 R
3,074,144	1/1963	Reed	28/72.2 R
3,396,970	8/1968	Fraser, Jr. et al.	273/61 R
3,442,101	5/1969	Plock et al.	28/72.2 R

FOREIGN PATENTS OR APPLICATIONS

279,254	9/1964	Australia	273/61 B
1,152,240	5/1969	Great Britain	273/61 B

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[57] **ABSTRACT**

A pile fabric designed particularly for use as a cover of a tennis ball. The fabric has a base structure comprising knitted cotton yarns, preferably in two layers laid back-to-back. A pile surface is provided on one side of the base structure by a fleece preferably composed of a plurality of carded webs having synthetic components including polyester, acrylic, polypropylene fibers. The webs are integrated with one another and with the base structure by the fibrous components of the webs passing substantially perpendicular to the plane of the webs through the adjoining webs and the base structure. When the disclosed fabric is used as a tennis ball cover, it is cut into blanks of conventional configuration and applied to the core structure of the tennis ball by suitable adhesives. The integration of the webs and base structure into a unitary fabric is effected by a series of needling operations, selected ones of which provide full penetration of the assembled layers with fine needles, and others of which provide only partial penetration of the assembled layers by course needles.

7 Claims, 10 Drawing Figures

FIG. 1.

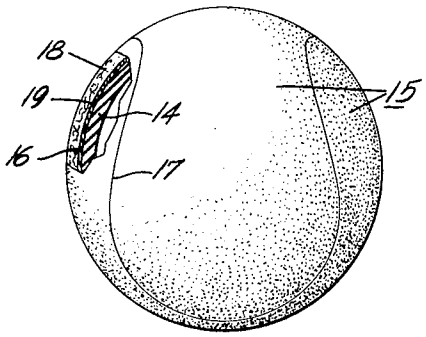


FIG. 2.

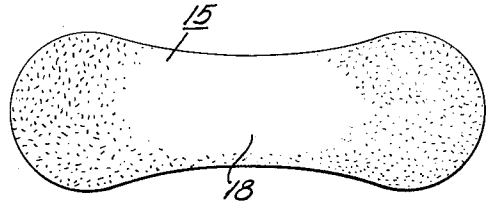


FIG. 3.

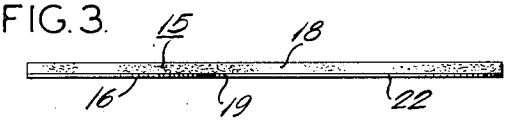


FIG. 4.

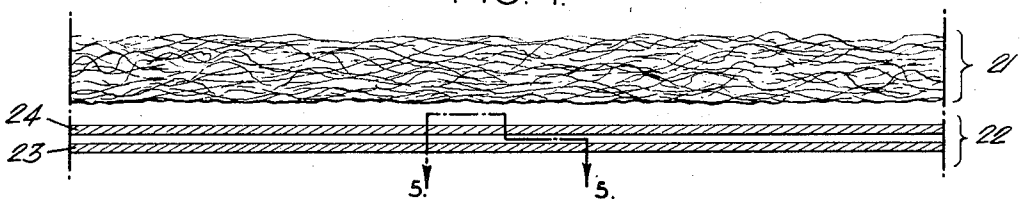


FIG. 5.

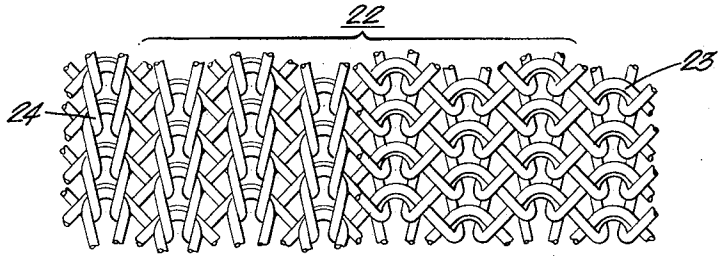
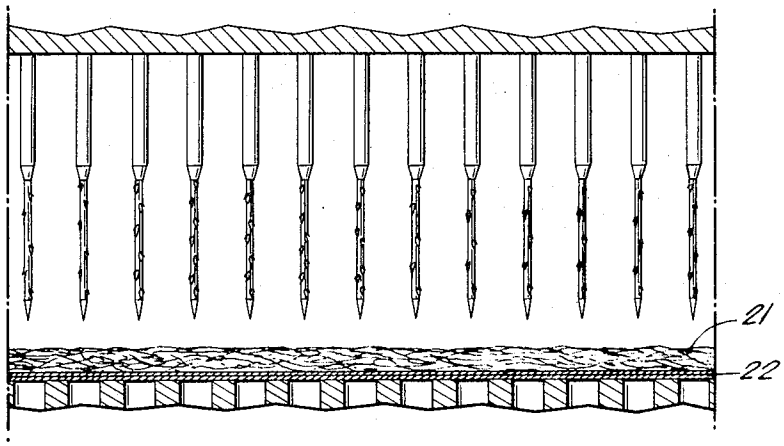


FIG. 6.



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FIG. 7.

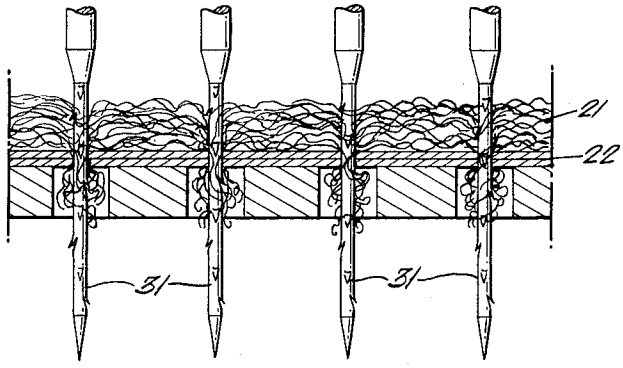


FIG. 8.

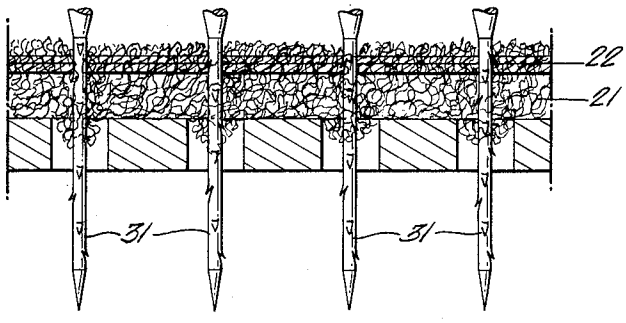


FIG. 9.

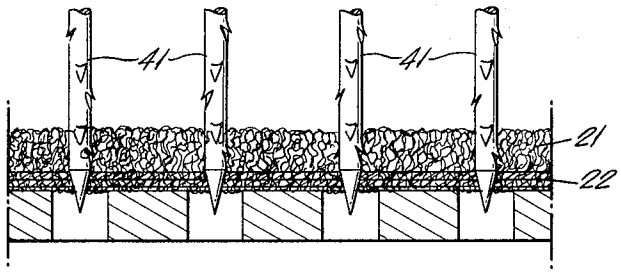
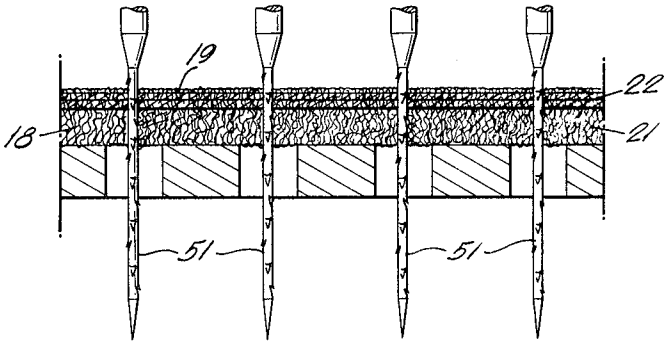


FIG. 10.



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PILE FABRIC METHOD AND PRODUCT

The present invention relates to a novel pile fabric and a method of making the same, and has particular application to a fabric for use as the outer covering of a tennis ball.

Prior to the present invention the major manufacturers of tennis balls employed a woven fabric having a pile formed thereon by a napping operation. The fabric is normally supplied in continuous lengths and the typical blanks which are applied to the spherical core of the ball are cut from the continuous lengths of woven material on the bias so that the stretch and conformability of the blanks along the longitudinal and transverse axes of the blank are affected substantially equally by the characteristics of the warp and the weft of the woven structure.

The production of tennis balls using such fabrics has required the use of skilled hand workers for applying the blanks to the core without having wrinkles or other defects present in the finished ball, and considerable waste has been tolerated because of fraying along the edges of the blanks and by the wastage in the cutting operations due to the need for orienting the blanks on the bias.

Previous attempts to improve the tennis ball cover material have not proved commercially acceptable for one reason or another. The cost of the cover material cannot be substantially higher than the cost of the previously-used material. The durability of the material cannot be reduced, and the material must be possessed of good aesthetic properties.

With the foregoing in mind, the present invention provides an improved fabric which has particular application for covering tennis balls which has properties substantially improved over the properties of the conventional cover material.

More particularly the present invention provides a fabric structure which has improved formability when compared with a conventional woven structure, and is produced on apparatus which is more economical to own and operate than the equipment used for the manufacture of conventional tennis ball cover material.

More particularly the present invention contemplates a fabric composed of a double layer of knitted yarns having on one side of the double layer a pile surface composed of fibrous webs needled into an integrated fabric having a pile on one surface and being substantially smooth on the other surface.

The present invention also contemplates a novel method of forming such a structure wherein the needling operations are controlled to correlate the penetration of the needles with the gage of the needles and the construction of the knitted layers so as to avoid rupture of the yarn components of the knitted layers during the needling operation.

All the objects of the invention are more fully set forth hereinafter with reference to the accompanying drawing wherein:

FIG. 1 illustrates a tennis ball with a portion broken away to illustrate the construction embodying the fabric of the present invention. FIG. 2 is a plan view of a blank of the form used in covering a tennis ball with fabric of the present invention.

FIG. 3 is a side elevation of the blank shown in FIG. 2.

FIG. 4 is an enlarged fragmentary transverse sectional view showing the components of the fabric used in the blank of FIG. 3 separated from one another.

FIG. 5 is a greatly enlarged sectional view taken on the line 5—5 of FIG. 4 illustrating the orientation and arrangement of the two knitted layers in the base structure of the fabric.

FIG. 6 is a diagrammatic illustration of a needling operation illustrating the components of the fabric in position between the needles and the base plate of a needling machine; and

FIG. 7 to 10 inclusive illustrate the needling action which occurs in sequential steps during the integration of the webs and the knitted base structure in the fabric.

Referring now to the drawing, FIG. 1 illustrates a tennis ball embodying a fabric made in accordance with the present invention. Apart from the novel fabric, the tennis ball is of conventional construction. As shown in FIG. 1, the ball comprises a resilient spherical core 14 of elastomeric material. In the present instance the core 14 comprises a hollow sphere of rubber or the like which is pressurized to provide the desired degree of resiliency in the finished product. The spherical core 14 is covered with a pair of blanks 15,15 identical in outline, as shown in FIG. 2 so as to completely enclose the spherical core 14 when abutted along their margins to form a seam as shown at 17 in FIG. 1. The blanks 15 are cemented to the core 14 as diagrammatically illustrated at 16 in FIG. 1 by a suitable adhesive compound, which is coated on the undersurface of the blanks to form an intimate surface-to-surface bond firmly anchoring the blanks 15 when they are applied to the core 14. The adhesive material, or another adhesive compound, is applied along the peripheral margins of the blanks to assist in preventing raveling of the material of the blank and to insure against separation of the two blanks along the seam line 17 after the blanks are applied to the core. The line of adhesive material 17 also may be pigmented to serve as decorative ornamentation, as for example when it is of a color contrasting with the color of the exposed surfaces of the blanks 15. As indicated in FIG. 3, the blanks 15 comprise a fibrous outer pile surface 18 constituting the pile of the fabric and a smooth undersurface 19 on which the adhesive coating 16 is applied prior to application of the blanks to the core 14.

As illustrated diagrammatically in FIG. 4, the fabric from which the blank 15 is made includes a layer of substantially untwisted fibers of textile material which forms the pile surface 18 and a base structure 22 of fabric formed from yarns or filaments which comprises the major element of the undersurface 19.

In accordance with one feature of the present invention, the base structure 22 comprises a double layer of knitted fabric. As shown in FIG. 5, the knitted structure is a flat knit in each layer wherein all of the needles loops project from the same side of the fabric. As shown, the lower layer 23 of the structure is reversed relative to the upper layer 24 so that the needle-loop surfaces of the two fabrics are remote from one another leaving the smooth back surfaces disposed face-to-face. In the present instance, the stitch construction embodies two yarn systems which knit and tuck alternately and in alternation on the needles of a weft knitting machine. By this arrangement, a dense base structure is

obtained by the imtimate contact between the confronting backs of the two fabrics.

In the illustrated embodiment of the invention, the layers **23** and **24** comprise integral parts of a single fabric knitted as a tube on a circular knitting machine and thereafter folded flat with the smooth surface of the knitted fabric on the interior of the tube. It is understood that other knitting operations will produce comparable results wherein by reason of the knitted construction of the fabric, the inherent stretch and recovery in substantially all directions provides a balanced knit structure which is highly conformable to curved surfaces such as the spherical surface of the core **14**. In the present instance the knitted fabric embodies 18/1 carded cotton yarn knitted with a density of approximately 16 wales per inch and 30 courses per inch. The use of cotton in the base structure provides good compatibility with the adhesive coating **16** and the adhesive along the seam **17**, as well as good strength characteristics.

The fibrous layer **21** preferably comprises randomly oriented individual fibrous filaments having a fiber length of at least 1 1/2 inches. A blend of synthetic fibrous components has been found to be highly successful to provide the desired wear characteristics and aesthetic properties, without detracting from the attributes of the knitted base structure. Blends of acrylic, polypropylene, and polyester fibers have been found particularly suitable, and a preferred blend comprises 35 per cent by weight of 3 denier, 2 inch staple acrylic fibers, 5 per cent by weight of 6 denier, 1 7/8 inch staple polypropylene fibers, and 60 per cent by weight of 6 denier, 2 1/2 inch staple polyester fibers. The fibrous components of the fabric preferably comprise between 30 and 40 per cent of the total fibrous content of the fabric structure.

The preferred material provides not only competitive pricing of the fabric, but also improved abrasion resistance, better formability, improved soil resistance, reduced moisture absorbency when compared to the conventional fabric cover of a woven hand napped construction, all without impairing the bounce efficiency of the core. Examination of the finished fabric shows a random orientation of the fibers in the pile surface coupled with a high portion of fibers disposed substantially perpendicular to the pile surface penetrating through the layers composing the pile surface and the base structure. The fiber segments which penetrate through the base structure are looped around the yarn components in the base structure and penetrate back through into the pile surface so that the undersurface of the finished fabric does not exhibit any substantial number severed ends of fibers but presents a substantially smooth surface which is highly receptive to the coating **16** of adhesive material used for applying the blanks to the core.

The novel fabric of the present invention is produced by needling webs of substantially untwisted fibers into the knitted base structure with predetermined control of the thickness of the needle and of the penetration of the needle into and through the composite structure both in relation to the fabric construction of the base structure. FIG. **6** illustrates a needling machine for producing the novel fabric of the present invention, and FIGS. **7** through **10** illustrate needling operations which occur sequentially in the production of the fabric in accordance with the present invention.

As discussed above, the fibrous layer **21** of the fabric preferably consists of a blend of synthetic fibers. In the preferred method of producing the composite structure in accordance with the present invention, the components of the layer **21** are blended in conventional manner and in a final operation, are carded to produce a loose fibrous bat. The bat is cross-lapped and is run through a needle-tacker to give the carded web sufficient integrity to permit handling thereof in the subsequent operations. The tacked web might be produced with sufficient density and weight to be used alone as a sole component of the fibrous layer **21**, but is is preferred to utilize a plurality of less-dense tacked webs in combination to produce the desired weight of the layer **21** in relation to the base structure **22**. For the purpose of illustration, the relative thicknesses of the layers **21** and **22** in the various stages of production of the composite structure have not been reproduced in the drawings.

It should be noted that the tacked webs used in the preferred process of the present invention provide a lightly consolidated web which is free from the dense consolidation of a thoroughly needled structure so that the individual fibers within the lightly consolidated web are free to be displaced through the structures substantially independently of one another without bunching and clumping. Thus it is preferred to use a plurality of lightly consolidated webs and to build up the desired weight ratio between the fibrous component and the knit component of the composite structure by adding additional lightly consolidated webs until the proper ratio is obtained.

Referring now to FIGS. **7** through **10**, the function of the sequential needling operations is illustrated diagrammatically therein.

In accordance with the invention, the fibrous web from the tacking machine is initially united to the base structure by needling operations which cause the barbed felting needles to enter composite structure from the side of the layer **21** and penetrate through the base structure **22**. This needling function operates to carry individual fibers of the layer **21** downwardly through both the layer **21** and the base structure **22** and to project down beyond the lower surface of the base structure **22**. Repeated needling functions operate to firmly interlock the layers **21** and **22** by the fibers from the layer **21** which penetrate through the base structure **22**. In accordance with the invention, the coarseness of the needles **31** used in this needling function is selected relative to the openness of the knitted construction in the base structure **22** so as to avoid rupture of the yarns in the knitted structure by the barbs which penetrate through the knitted structure as shown in FIG. **7**. With reference to FIG. **5**, it is apparent that by selecting a needle with a sufficiently fine diameter, it is possible to pass a barbed needle through the knitted structure without tearing or otherwise rupturing the yarns which compose the knitted structure. The fine needles **31** used in the first needling function operate to carry individual fibers downwardly through the composite structure so that the fibers project below the undersurface of the structure.

The next needling function operates to further integrate the composite structure, and to this end the structure is needled from the opposite surface again with fine needles. This is illustrated in FIG. 8 wherein the composite structure has been reversed and passed through the second needling operation utilizing identical felting needles 31. The fine gage needles 31 penetrate the knitted base structure without substantial rupture of the yarns in the structure and the barbs of the needles 31 carry the fibers from the undersurface (which is now uppermost) of the composite structure in a reverse path through the structure. Obviously, the needles do not retrace the identical path so that the fibers which previously passed through one interstice of the knitted structure will in most cases return through another interstice thereby forming a bight which interlocks with the yarns of the knitted structure. The reverse needling function is repeated until the undersurface (which is uppermost) is substantially free of downwardly projecting fiber ends and the knitted structure of the base layer 22 is predominant on this surface.

The needling of the composite structure with the fine needles effects a degree of consolidation of the lightly consolidated tacked webs which are now integrated with he base structure; however, for the end use of this fabric a denser consolidation of the fiber structure is desirable. In order to obtain the denser consolidation of the fibrous layer 21, coarser felting needles 41 have been found necessary. However, to avoid damage to the yarns of the base structure 22, the depth of penetration of the heavier needles 41 must be controlled to avoid the passage of the barbed portion of the needles 41 through the knitted base structure. To this end the fabric is again reversed so that the fibrous layer 21 is uppermost and the base structure 22 is lowermost. The composite structure is passed through a needling operation wherein the heavier needles 41 are caused to penetrate downwardly into the fibrous layer 21 of the composite structure without penetrating sufficiently far to cause the barbs to engage in the knitted base structure 22 (see FIG. 9). In this manner, damage to the structure by the barbs of the needles 41 is avoided and the structural integrity of the base structure is maintained. The needling function with heavy needles 41 is repeated until the desired consolidation of the fibrous layer 21 is obtained.

The consolidation of the fibrous layer 21 by the heavy needles 41 has a tendency in many constructions, depending upon the characteristics of the components of the composite structure produced by the present invention, to produce needle marks or tracking throughout the exposed pile surface 18 of the composite pile fabric. To eliminate or mask the tracking or needle marks produced in the previous needling functions, the present invention provides a further needling function in which extremely fine needles 51 are employed to erase the needle marks. In the present instance, this needling function is performed with the base structure 22 uppermost overlying the fibrous layer 22 and the needles 51 are selected so as to be at least as fine as the needles 31 used in the first two needling functions. The finest gage needles 51 serve to smooth out the exposed pile surface 18 and furthermore tend to eliminate fuzz from the smooth undersurface 19 of the pile fabric structure. This smoothing function of the needles 51 is accomplished without substantially affecting the heavy consolidation of the fibrous material which was previously accomplished by the heavy needles 41 and furthermore the finest needles 51 avoid damage to the yarns of the base structure 22. Although the needles of the final needling function are illustrated as being finer than the needles of the first two functions, it is possible to use the same thickness of needles for all of these functions. Furthermore it is apparent that other variations will be apparent to those skilled in this art, both as to the selection of needles, and the selection of the components which make up the layers 21 and 22. The correlation of the needle fineness to the construction of the knitted base structure is paramount.

A specific example of the needling operations used and subsequent finishing used to produce a fabric with the knitted base structure indicated above has been performed on a Hunter Fiber-Locker needling machine with 46-density needle boards and a feed of 15 strokes per inch. The needles for the first, second and final needling function were No. 40 (15 × 18 × 40 × 3½ RB felting needles) and the needles for the third needling function were No. 32 (15 × 18 × 32 × 3½ RB felting needles). The fibrous layer 21 was needled to the base structure 22 with No. 40 needles in two webs using three passes to obtain adequate, even, overall fiber distribution and back coverage. The fabric was reversed and was again needled with No. 40 needles for two passes until the back fiber coverage was returned to the face side so that the knit cotton backing material was clearly evident.

The machine was then adjusted to install the No. 32 needles and the height of the needle board was adjusted to insure that no barbs pierced the backing material. This needling was done for a sufficient number of passes to obtain an overall thickness in the range desired (0.145 inches to 0.155 inches) and the final needling step was omitted.

The composite fabric was then scoured for 15 minutes at 212° F with detergent, and the water was extracted by running the fabric through squeeze rolls. The fabric was tumble dried and then heat set in open width on shelves in an oven at 350° F. The heat set fabric was then passed through squeeze rolls to reduce the finished thickness to the desired range (0.110 inches to 0.120 inches). It should be noted that in this example the heat setting in the oven was above the melting point of the polypropylene component of the fibrous layer and it is believed that the heat setting operation serves to provide a firm bond within the integrated structure.

This composite fabric exhibited good formability when applied to the cores of tennis balls both manually and in mechanized operation. This was manifested by the absence of wrinkles and puckering at the seams. Following vulcanization, the completed ball was subjected to wear testing and the results of the test showed a marked improvement in the wear characteristics of the completed ball. The cover material does not ravel or fray at the seams. The pile surface retains the pile for a period of use which is substantially longer than the period of use considered acceptable for balls made in accordance with the conventional prior art processes.

Although the foregoing example utilized a weft-knitted two-layer fabric base, it is anticipated that other knitted fabric constructions may be embodied in a cover construction to obtain results which are improved over the present conventional cover construction. For example, warp-knitted fabrics may be substituted and flat-knitted fabrics may be used in lieu of the circularly-knit fabrics. Likewise the specific components of the fibrous layer set forth above are not deemed to be restrictive, and as fiber technology makes additional fibers available at economical costs, such additional fibers may be substituted to provide properties which are found desirable.

While a particular embodiment of the present invention has been herein described and set forth in detail, it is not intended to limit the invention to such disclosure but changes and modifications may be made therein and thereto within the scope of the following claims.

I claim

1. A blank for covering a tennis ball comprising a segment of a composite felted fabric structure having a felted pile surface on one side and a smooth surface on the other side, and a coating of adhesive material applied to the smooth surface of the blank for adhesively attaching said blank to the core of a tennis ball, said fabric comprising a layer of fibrous material in the form of discrete fibers of determinate length, said fibrous layer being densely consolidated through entanglement of the individual fibers of the character produced by needling operations, and a base structure comprising two layers of a fabric knitted with coherent yarns, the fibrous layer and the base structure being thoroughly integrated throughout by at least a major proportion of fibers penetrating through all of said layers and being looped around the yarns in the knitted structure of the layer on the smooth side of the composite fabric.

2. A product according to claim 1 wherein said two layers knitted base fabric comprise flat knits in which all of the needle loops are positioned on one face of the fabric, the back face being relatively smooth, said two layers oriented with the smooth back faces confronting one another in face-to-face engagement.

3. A product according to claim 2 wherein said layers are integral parts of a knitted tubular structure which is flattened with the smooth face of the knitted structure on the interior of the tube.

4. A product according to claim 2 wherein each knitted layer comprises two yarn systems which knit and tuck alternately and in alternate wales so that the yarns of one system tuck when the yarns of the other system knit.

5. A tennis ball comprising a resilient core of elastomeric material and a covering comprised of two blanks made in accordance with claim 1 and securely bonded to said core by said adhesive coating.

6. A method of producing a pile fabric having a pile on one surface and being smooth on the opposite surface comprising the steps of supplying a web of fibrous material having staple lengths in the range of at least 1 ½ inches supplying a base structure of knitted fabric from yarns of a predetermined size in a given knitted construction, needling said web through said base structure by penetrating felting needles downwardly through said web and then through said base structure, thereafter needling said composite structure from the opposite surface to project the felting needles through said base structure and thereafter through said fibrous layer to remove the major portion of loose fiber ends from the undersurface of said composite structure, selecting felting needles in the aforesaid needling operations having a fine thickness relative to the knit construction of said base structure so that said felting needles may penetrate through said base structure without rupturing the yarns of said knitted structure, thereafter needling said composite structure from the fibrous face thereof to consolidate the web of fibrous structure in the composite fabric structure, selecting coarser felting needles for said consolidating needling operation, and controlling the penetration of said coarser felting needles so as to avoid engagement of the barbs of said coarser needles with the knitted yarns of the knitted base structures, thereby avoiding rupture of the yarns by said consolidating needling operation.

7. A method according to claim 6 including an additional step of needling said consolidated web with fine felting needles which penetrate through the entire consolidated structure, the fineness of the needles being selected to avoid rupture of the yarns of the knitted structure by the barbs of said fine needles.

* * * * *