Feb. 24, 1970 MASAHIKO ADACHI 3,497,415
CLOTHING ARTICLES
Original Filed July 2, 1964 3 Sheets-Sheet 1

Fig. 1

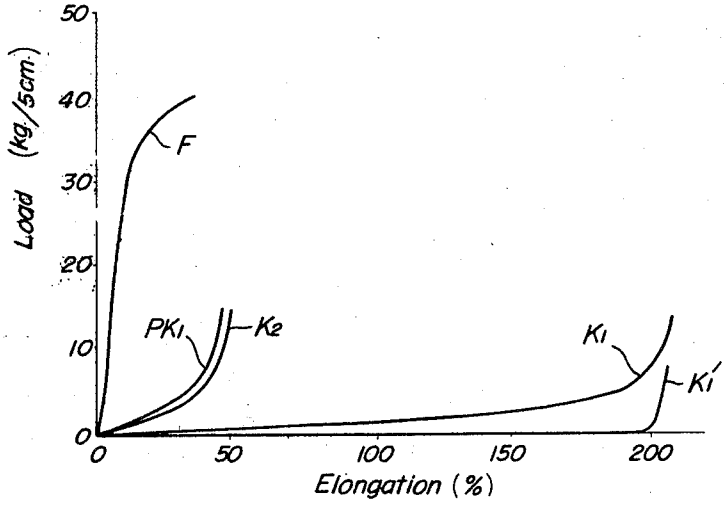


Fig. 2

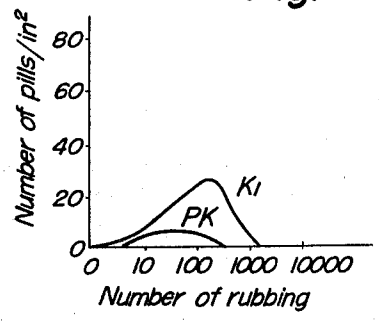


Fig. 3

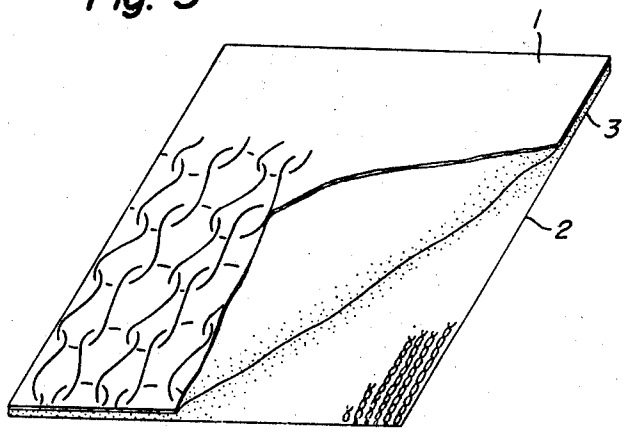


Fig. 4

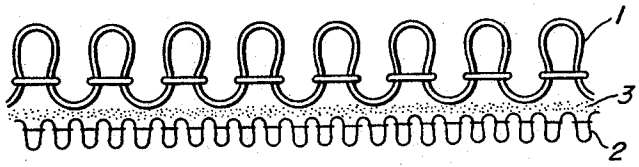


Fig. 5

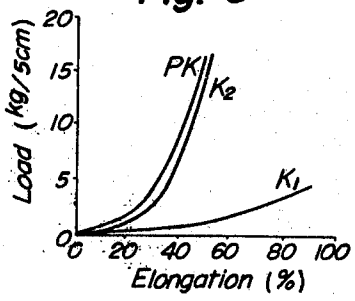


Fig. 6

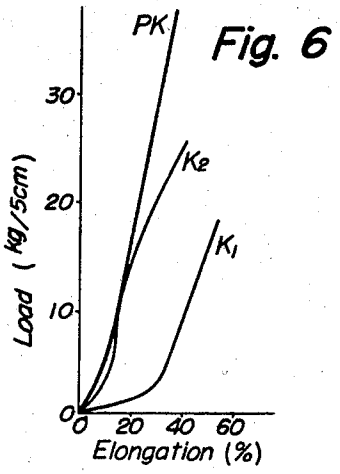


Fig. 7

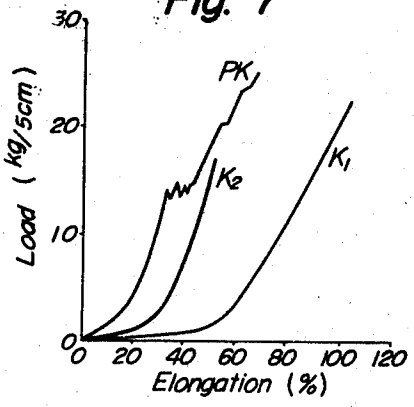


Fig. 8

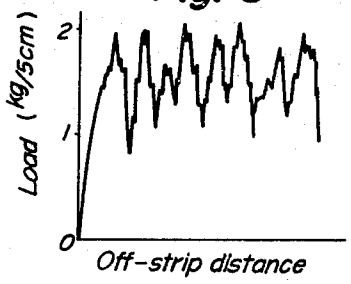


Fig. 9

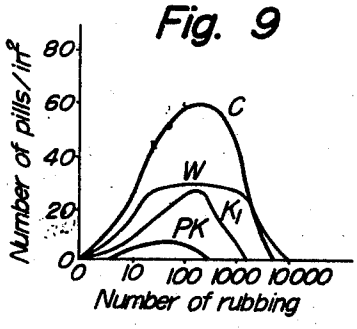
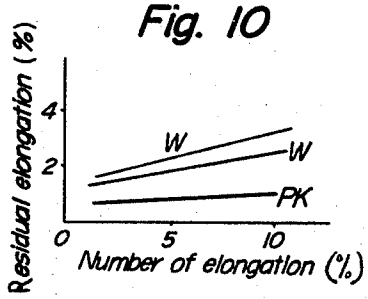


Fig. 10



United States Patent Office 3,497,415 Patented Feb. 24, 1970

3,497,415

CLOTHING ARTICLES

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Continuation of application Ser. No. 380,011, July 2, 1964. This application Aug. 31, 1967, Ser. No. 664,886
Int. Cl. B32b 5/24, 7/12
U.S. Cl. 161—76 1 Claim

ABSTRACT OF THE DISCLOSURE

A composite fabric in which a first knitted acrylonitrile fabric having two faces and being of relatively high elasticity is bonded to a second fabric which is a knitted rayon fabric also having two faces but having relatively low elasticity, by means of an adhesive securing the fabrics together in face to face relationship along the reverse faces thereof.

This invention relates to novel fabric articles and associated methods of manufacture of such articles. This application is a continuation of my earlier application, Ser. No. 380,011 filed July 2, 1964 and now abandoned and which was a continuation-in-part of my earlier application, Ser. No. 229,943 filed Oct. 11, 1962 and now abandoned.

More particularly, this invention relates to novel knitted fabric articles wherein knitted fabrics having slight elasticity are adhered, with suitable adhesives, to the reverse side of various knitting fabrics having large elasticity, to obtain single composite bodies.

As is well known, knitted fabrics are classified as underwear material, sweater material, jersey knit goods, etc., according to purpose. Among them, jersey knit (yard goods) is mostly employed for suits, coats and the like and can be regarded as a textile rather than a knitted article. Hence, knitted fabric for jersey knit (yard goods) should have characteristics, such as ease of sewing, maintenance of original shape when being worn, easy cleaning, etc.

Accordingly, it is required to maintain low elasticity for jersey knit fabric (yard goods), as well as fineness and low density. Knitted jersey fabric which meets the above requirements is therefore quite restricted in properties and is relatively expensive to produce.

It is an object of the present invention to eliminate the above restrictions existing with respect to knitted jersey fabric while simultaneously greatly improving its sewing ability, to thus permit a beautiful appearance therefor with a wide variety of fabrics which has never been known in conventional jersey wool fabrics (yard goods).

The present invention contemplates obtaining a knitted jersey-like article (yard goods) possessing superiority to knitted fabric by applying a jersey-like characteristic to knitted fabric, such as sweater material, to enable the same to be utilized in types of garments which it could not otherwise be used for because of the high elasticity thereof which prevents cutting and sewing the same on a sewing machine. A feature therefore of the present invention resides in producing a novel knitted fabric article wherein knitted fabric having small elasticity is adhesively secured to the reverse side of knitted fabric having large elasticity by means of a suitable adhesive to form a single composite body. A garment may then be prepared from the composite body such that the fabric of large elasticity (sweater material) is the exposed surface while the fabric of low elasticity is the lining. The garment thereby has the surface appearance of knitted fabric of large elasticity whereas the garment is cut and sewn with the same ease as jersey knit material.

As a further feature of the invention the need for a separate lining is avoided when composite body material is employed since the knit fabric of low elasticity which is on the inside of the garment is suitable by itself as lining material.

In the past, attempts have been made to produce laminated products of thermoplastic resin film such as a vinyl resin film and knit fabrics, mats of multilayer or laminar construction fabricated of fibers from mineral material or a composite elastic material consisting of a textile fabric fashioned at least in part from crimped, elastic synthetic yarns and foamed rubbery composition. However, there is no showing of the unique effects resulting from the new fabric of the present invention obtained by adhering together two knit fabrics having respective individual properties which are co-utilized in an unusual manner when the fabrics are adhered together.

In the drawing:

FIG. 1 illustrates a typical load deflection curve of various knitted fabrics and cloth. In the drawing, curve K_1 corresponds to sweaters and knitted fabric; curve K_1' corresponds to knitted freely stretchable fabric; curve K_2 represents warp knitted fabric; curve PK represents composite fabric according to the present invention wherein knitted fabric of the type represented by curve K_1 is adhered with warp knitted fabric; and curve F corresponds to textile material.

FIG. 2 is a pilling curve, wherein K_1 is a pilling curve for sweaters and knitted fabric, PK is a pilling curve for composite fabric material according to the invention wherein knitted fabric such as K_1 is secured to warp knitted fabric such as K_2.

FIG. 3 indicates schematically in a perspective view the structure of the fabric article according to the invention.

FIG. 4 is a cross-sectional view of the fabric material according to the invention.

FIGS. 5–7 are load deflection curves for particular fabrics according to the invention.

FIG. 8 is a curve of load vs. off strip distance for a fabric according to the invention.

FIG. 9 is a representation showing comparison of pilling characteristics of various fabrics, and

FIG. 10 is a representation of residual elongation of various fabrics.

The fabric according to the invention is constituted by knitted fabric **1** of high elasticity which is secured by adhesive **3** to knitted fabric **2** of low elasticity.

Knitted fabric **2** of small elasticity refers to tricot-like knitted fabric shown in the curve in FIG. 1 as K_2.

Suitable tricot fabric, are fabrics having a density of 54±2 C/in., 40 W/in. prepared by dyeing the fabric knitted to half having having density of 61 C/in., 30 W/in. on a warp knitting machine, 28 gauge/in. employing 50 denier cupra filament.

Knitted fabric **1** has large elasticity and corresponds to curve K_1 in FIG. 1. Fabric **1** is adaptable for use in sweaters, or other garments employing elastic knitted fabric and cannot ordinarily be utilized for tailored wear which requires low elasticity. The knitted fabric **1** when adhered with fabric **2**, however, results in material having unique features, as will be pointed out more fully hereinafter.

The knitted fabric **1** may be knitted fabric containing between 30 and 100% acrylic synthetic fiber, the balance being wool, cotton, rayon, cupra, viscose acetate, nylon, propylene fiber. As a substitute for the acrylic fiber, wooly nylon, wooly polyester, wooly polypropylene, wooly polyvinyl fiber and the like are applicable. The

knitted fabric 2 of low elasticity may be, for example, regenerated cellulose, such as cuprammonium rayon, rayon, nylon, polyester fiber, polypropylene fiber, acrylic fiber, rayon-acetate, or the like. The fabric 2 may preferably be warp knitted fabric prepared by weaving one or more varieties of long fiber of synthetic fiber, in a warp knitting machine.

Adhesive 3 for securing the fabric 1 and fabric 2 together may be a solvent type adhesive or an emulsion type adhesive. The solvent type adhesive may be prepared by dissolving into a solvent urethane resin, polyacrylic acid ester, or N-alkoxymethylated nylon. The emulsion type adhesive is polyacrylic acid in a solvent. The solvent may be ethyl acetate, tricrene or the like. The present invention will be further explained with respect to bulky knitted fabric.

As shown in curve K_1 in FIG. 1, it is difficult to cut such fabric or to sew the same with a lockstitch sewing machine due to its large elasticity. Heretofore no attempt has been made to enable sewing these bulky knitted fabrics with a lockstitch sewing machine. This is due to the fact that the extreme elasticity of the fabric causes not only disproportionality at marking and cutting, but the woven mesh is as coarse as net, and is free to be stretched, whereby maintenance of the original shape is very difficult. Hence, use of such fabric 1 is limited only to sweaters, dresses and other typical uses of such knitted goods.

However, when warp knitted fabric 2 as represented by curve K_2 in FIG. 1 which is of low elasticity is adhered to such knitted fabric 1, the load-deflection curve of the composite fabric shows an intermediate curve between textile material F and knitted goods K_2 as indicated by curve PK in FIG. 1. The curve PK slightly deviates towards the axis of load compared to warp knitted cloth alone (K_2) which indicates that there is a slight reduction in elasticity compared thereto.

Such a composite fabric PK can readily be cut, and sewed with usual sewing machines. Moreover, such composite fabrics have ideal properties suitable as a fabric for jersey knit goods, and moreover require no separate fabric for a lining. The composition fabric provides a garment with a beautiful appearance which has never been obtained in conventional jersey knit goods.

Thus, the fabric article of the present invention has remarkable advantages, such as its beautiful appearance as provided by the knitted sweater fabric K_1, while sewing is extremely simplified, and the size of the fabric is stabilized. Furthermore, pilling is minimized, as compared to the case in which only knitted fabric is employed, while deformation of the tailored shape is lessened. Additionally the feel and smoothness of the composite fabric makes the same extremely versatile in use. Moreover, there is no need to employ a lining fabric as has been heretofore generally employed. In general, the composite fabric has the same air-permeability as the knitted fabric 2, and therefore, the composite fabric PK is suitable for outerwear.

As an aid in defining quantitatively the meaning of "low" and "high" elasticity the following table may be taken as representative of ranges of elongation for the various materials.

TABLE I.—ELONGATION

	High (K_1), percent	Low (K_2), percent	PK, percent
Warf	More than 80	30–80	30–80
Do	More than 120	40–120	40–120

EXAMPLE 1

While being vibrated by means of a vibrator, knit fabrics K_1 and K_2 were transferred by rollers under tension-free conditions.

In this example, K_1 is a bulky knit fabric knitted by a raschel knitting machine from an acrylonitrile fiber 2/5 (10 d. x 182 mm., 15 d. x 78 mm.), and having a thickness of 4.45 mm. and a weight of 341 g./m.^{2}. K_2 is a tight knit fabric knitted by a warp knitting machine from a cupro-ammonium rayon fiber (50 d.), and having a density of 52 C/in. and 40 W/in., a thickness of 0.31 mm. and a weight of 105 g./m.^{2}. Spray guns were mounted above the rollers each at a spraying angle of 30° to a respective surface of the fabrics K_1 and K_2, and the spray guns sprayed an adhesive material onto fabrics K_1 and K_2. The adhesive was a mixture of 100 parts of polyurethane resin and 10 parts of an isocyanate derivative, which mixture was dissolved in 4 parts of ethyl acetate. Considering the retention of permeability of air, the amount of the adhesive applied on the surface of each fabric was so adjusted as to be about 1 mg./cm.^{2}. The adhesive was particularly applied onto the bulky projecting part of the fabric K_2, this being advantageous for the subsequent adhering step. The separate fabrics are then pressed together between heated rollers to form a composite fabric. The mechanical property of the thus produced composite fabric is shown in FIGURE 5.

EXAMPLE 2

While vibrating under the action of a vibrator, knit fabrics K_1 and K_2 were transferred by rollers under tension-free conditions.

The surface fabric K_1 is a knit fabric knitted by a raschel machine from an acrylonitrile fiber 2/14 (7 d. x 152 mm.), 2/80 (2 d. x 51 mm.), and having a thickness of 1.88 mm. and a weight of 290 g./m.^{2}. The lining fabric K_2 is a tight knit fabric knitted by a warp knitting machine from a cupro-ammonium rayon fiber (50 d.), and having a density of 52 C/in. and 40 W/in., a thickness of 0.31 mm. and a weight of 105 g./m.^{2}. The adherence of the two fabrics was effected, as in Example 1, by spraying by spray guns mounted each at spraying angle of 30° to the adhering surfaces fabric K_1 and K_2. The composite of the adhering solution was the same as that in Example 1. The mechanical property of the composite of the knit fabrics is shown in FIGURE 6.

EXAMPLE 3

The operation in this example was similar to that in Example 2 except that the surfaces of the fabric were napped beforehand. Adherence of the fabrics was effected by spraying the adhesive as in Example 1, by spray guns mounted each at a spraying angle of 30° to the surface of fabrics K_1 and K_2. The fabric K_1 is a derivative weave of a circular knit from an acrylonitrile fiber 2/14 (7 d. x 152 mm., 7 d. x 152 mm). having a thickness of 297 mm. and a weight of 333 g./m.^{2}. The fabric K_2 is a tight knit fabric knitted by a warp knitting machine from a cupro-ammonium rayon fiber (50 d.) having a knitting density of 52 C/in., a thickness of 0.31 mm. and a weight of 105 g./m.^{2}, which is the same as used in Example 1.

The mechanical property of the composite fabric is shown in FIGURE 7.

EXAMPLE 4

An adhesive solution is obtained by adding 0.5 part of ammonium chloride as a catalyst to 100 parts of reactive acrylate emulsion (solid content 50%) and 10 parts of trimethylol melamine methylether (purity 80%). The adhesive is sprayed onto knit fabric K_1 and knit fabric K_2, which are then adhered together. After drying, the composite material is at 130° C. for 5 minutes. The amount of adhesive sprayed onto the fabrics is 2 mg./cm.^{2}.

The knit fabric K_1 is constituted as follows:

Knitting machine employed	Circular knitting machine 4 gauge.
Thread	Dyed yarn of 2/14 mixed spun yarn consisting of 70% acrylonitrile and 30% mohair.
Knitting structure	Rib stitch.
Thickness	4.3 mm.
Weight	340 g./m.^{2}.

The knit fabric K_2 is constituted as follows:

Knitting machine	Warp knitting machine.
Yarn	Rayon filaments 50 d., nylon filaments 15 d.
Knitting structure	Half of diagonal of rayon and nylon.
Density after finishing	57 C/inch, 39 W/inch.
Weight	174 g./m.^{2}.
Thickness	0.4 m./m.

The properties of the fabric material are given in the following table.

ELONGATION PERCENT

Material	warp		woof	
	strength, (kg./5 cm.)	elongation, percent	Strength	elongation
K_1 alone	15	154	27	186
K_2 alone	12	51	17	97
K_1 adhered with K_2 (PK)	12	48	17	94

NOTE.—The reason why the strength of PK is lower than K_1 is reverse K_2 is initially cut and the value indicates the strength at the time.

The material is easily cut, sewn, has a beautiful appearance, while the original shape is not destroyed by washing.

EXAMPLE 5

Knit fabric K_1 is adhered to knit fabric K_2 in the following manner. An adhesive solution is prepared by adding 0.5 part of ammonium chloride to 100 parts of reactive acrylate emulsion (solid content 50%) and 10 parts of trimethylol melamine methylether (purity 80%). Thereafter, the adhesive solution is thickened by adding 1.5 parts of 28% aqueous ammonia as a thickener to adjust the viscosity of the adhesive solution to 30,000 centipoises. The adhesive is applied to the fabrics K_1 and K_2 by roller coating, and thereafter the fabrics are adhered together. After drying of the adhesive, the composite material is baked at 130° C. for 5 minutes. The amount of adhesive applied to the fabrics is 1.5 mg./cm.^{2}.

Knitted fabric K_1 is characterized as follows:

Knitting machine employed	Same as in Example 4.
Yarn	Dyed yarn of 2/10 bulky yarn obtained from acrylonitrile fiber.
Knitting structure	Tengasa knit.
Thickness	4.2 mm.
Weight	235 g./m.^{2}.

Knitted fabric K_2 is characterized as follows:

Knitting machine	Same as in Example 4.
Yarn	Acetate filaments 50 d., polyester filaments 15 d.
Structure	Twilled half of acetate, polyester.
Density of finishing	56 C/inch, 37 W/inch.
Weight	165 g./m.^{2}.
Thickness	0.3 m./m.

The properties of the fabrics are given in the following table.

ELONGATION

	Warp		Woof	
	strength (kg./5 cm.)	elongation, percent	strength (kg./5 cm.)	elongation, percent
K_1	15.5	160	30	200
K_2	14	45	21	115
PK	14	42	21	110

The strength of the bond between the fabrics K_1 and K_2 as provided by the adhesive was tested and the results indicated in FIG. 8 wherein load is plotted against off-strip distance (elongation). FIGURE 8 is a graph of a power curve recorded by an Instron tensile tester at a temperature of 20±2° C. at a humidity (relative) of 65±2%, on the clothing article PK cut into 5 cm. wide strips in the warp direction. From the figure, it is apparent that the adherence between the fabrics is at spots or lines. This adherence is exceedingly superior to surface adherence, from the viewpoint of "hand."

The characteristics of the composite fabric are shown below.

As the pilling, FIGURE 9 shows the relationship between number of rubbings vs. the number of pills, the rubbing being effected by means of an appearance retention tester. In FIGURE 9, K_1 represents a single knit acrylonitrile fiber, and PK is a composite fabric of the type as shown above wherein K_1 is secured to K_2. On the abscissa is plotted the number of rubbings on a logarithmic scale, and the ordinate represents the number of pills per in.^{2}. C and W are examples of cotton knit and wool knit fabrics respectively. Although the fabric of the acrylontrile fiber K_1 made by Asahi Chemical Ind., Co. (Cashmilon) yields a lower degree of pilling than does wool fabric, the degree of pilling is further lowered by adhering to the fiber K_1, a fiber such as fiber K_2 as above described.

As to abrasion resistance, Table II summarizes the results of abrasion tests. As seen from the table, the abrasion strength of composite fabric PK according to the invention is higher than that of K_1 alone, whereas the abrasion strength at the surface of fabric K_1 of composite fabric PK is higher than that of K_1 alone. This shows that the adhesive securing of the K_1 fabric to fabric K_2 does not lower the abrasion strength of K_1, but serves to increase the abrasion strength of the surface fabric.

As to restoration of the fabric after repeated elongation, it is expected that the composite fabric PK of the present invention is elongated more easily and has better restoration, than the individual fabrics. This has been confirmed by examination of residual elongations at every surface by repeating 10% elongation and restoration using Instron tensile tester at a temperature of 20±2° C. at a relative humidity of 65±2%. FIGURE 10 shows the results of such tests. Wool textile W generally shows 1 to 3% residual elongation but composite fabric PK of the present invention shows less than 1%. After 5 minutes from the restoration, the residual elongation of composite fabric PK of the invention is 0.1 to 0.3%. The force required for 10% elongation is extremely smaller for the PK fabric according to the invention compared to that of textiles. This means, that upon wearing a garment made from the fabric according to the invention the garment will permit easy movement and have a light weight feel.

As to sewing, the composite article shown in the examples has so called Bemberg warp knitted fabrics secured to the knit fabric, and the article can be sewed by means of a sewing machine while the sewing is very smooth. A remarkable characteristic of the composite fabric is the elimination of the cutting and sewing of a lining fabric. The individual fabrics are generally adhesively secured together at their backsides, or reverse sides, but they may be secured together at their face or front surfaces if this is desired. The clothing article shown in the examples may be machine-sewed from the front surface sides also.

With regard to dry and wet cleaning of the fabric, it has been found that clothing articles made from the fabric obtained in the examples is not injured after 10 repeated commercial dry cleanings and is substantially durable to 10 repeated home washings. The fabric of such clothing

is commercially valuable from the viewpoint of "easy care," since they substantially need no ironing.

TABLE II.—ABRASION STRENGTH

Abrasion part	Sample No. 1	No. 2	No. 3	No. 4	No. 5
K_1 alone	15	14	46	41	52
K_1 of PK	31	32	50	70	125
All of PK	85	103	134	157	232

The numbers in the above table represent the number of rubbings (rotations) until the cloth is torn. The conditions for the abrasion test are as follows:

Machine employed for measurement	Shiefer abrasion tester 25 lbs. load for stretching: 1 lb.
Abrasive material	Emery polishing paper No. 600.
Temp. and humidity	20±2° C.
R.H.	65±2%.

What is claimed is:

1. A composite fabric comprising a first knitted acrylonitrile fabric having a front and reverse face and of relatively high elasticity, a second knitted rayon fabric also having a front and reverse face but having relatively low elasticity, and adhesive means adhesively securing the knitted fabrics together in face-to-face relation along the reverse faces thereof.

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U.S. Cl. X.R.

66—196; 161—89, 92, 156, 166