July 15, 1941. B. H. FOSTER 2,249,650

ASBESTOS FABRIC

Filed July 27, 1940

Fig. 1

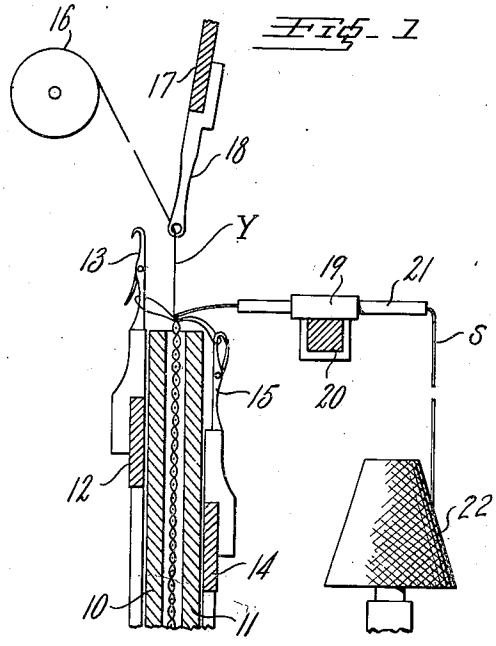


Fig. 2

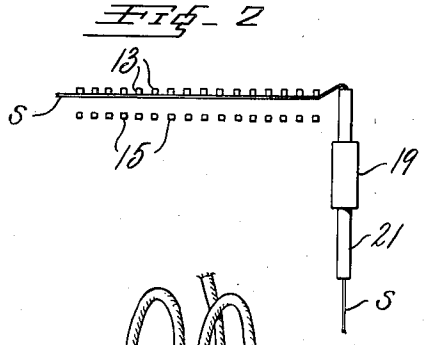


Fig. 3

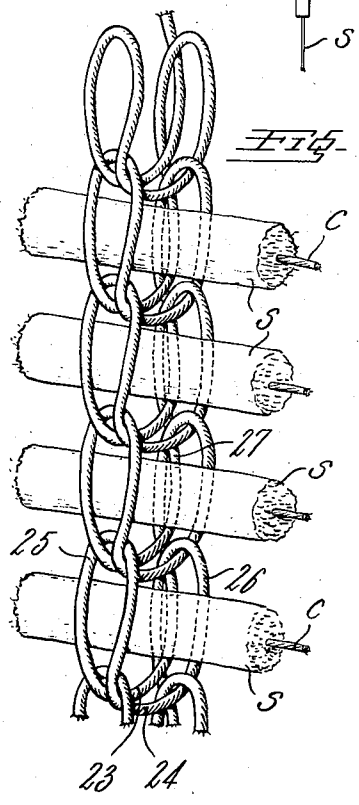
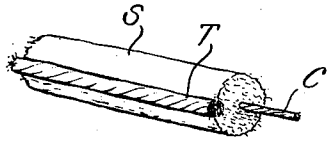


Fig. 6



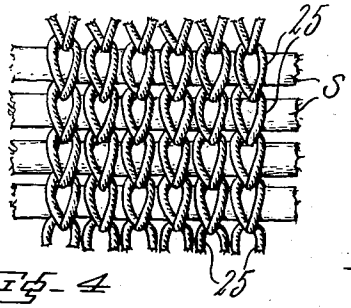


Fig. 4

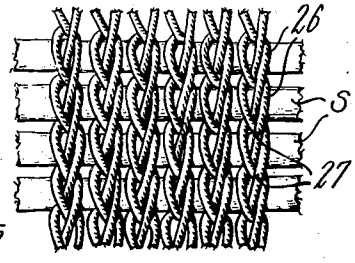


Fig. 5

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ASBESTOS FABRIC

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Application July 27, 1940, Serial No. 347,872

11 Claims. (Cl. 66—193)

The present invention relates to a knitted fire-repellent asbestos fabric which is much softer and more pliable than the woven asbestos fabrics provided heretofore.

Attempts have been made heretofore to provide fire protecting clothing to be worn by firemen, forest fire fighters, welders, steel mill and foundry workers and others, by constructing such clothing of woven asbestos fabric. These prior attempts, however, have been far from satisfactory because when such fire protecting clothing is made of the woven asbestos fabric available heretofore, the clothing has been so harsh and stiff that it is uncomfortable to wear and greatly interferes with the movement of the wearer.

The present invention seeks to provide a fire-repellent asbestos fabric which is more soft and pliable than the asbestos fabrics available heretofore so that clothing formed of this new material will impede the movement of the arms, legs and body of the wearer much less than asbestos fabric employed heretofore, and at the same time will afford a greater degree of resistance to heat than the prior fabrics of corresponding weight.

The asbestos fabrics employed heretofore in fire protecting clothing were usually woven with a plain weave so that each warp yarn passed over one weft yarn or pick and under the next weft yarn. This resulted in a maximum number of intersections of warp and weft yarns which tends to produce a stiff, boardy fabric entirely unsuited for clothing.

The present invention contemplates a knitted fire repellent asbestos fabric formed of knitted asbestos yarns and laid-in asbestos strands which are so assembled that there is no strain or tension upon the finished fabric, with the result that a soft and pliable fabric knitted upon both faces and of good wearing quality and insulating properties is secured.

The fabric of the present invention in its preferred construction comprises a central layer of laid-in asbestos strands which are firmly held in parallel relation to each other by knitted loops of asbestos yarns that form a soft knitted surface upon each face of the fabric. As a result of this construction the fabric is sufficiently thick to afford good heat resisting properties and the knitted face and back cause both surfaces to be soft and smooth.

The present fabric may be produced on different types of knitting machines but is preferably formed on a flat work warp knitting machine which is adapted to produce a fabric having each face thereof constructed so as to closely simulate that of the face of a plain knit fabric, to provide an asbestos fabric having a smooth soft face and back.

The knitted fabric of the present invention when made up into fire repellent clothing wears well and is lighter in weight than woven fire-repellent fabric of corresponding thickness available heretofore. It is also softer and more pliable, can be tailored easily, drapes well and will increase the comfort and efficiency of the wearer. It is also well adapted for use in other fields than wearing apparel.

The above and other features of the present invention will be more fully understood from the following description when read in connection with the accompanying drawing, wherein:

Fig. 1 is a vertical transverse section through the main portion of a warp knitting machine which is well adapted to produce the fabric of the present invention;

Fig. 2 is a top plan view showing the rows of needles diagrammatically and the laying-in mechanism in its forward position;

Fig. 3 is an enlarged perspective view of the present fabric showing how the yarns are knitted about the laid-in strands;

Fig. 4 is a plan view of one face of the fabric of Fig. 3;

Fig. 5 is a plan view of the opposite face of this fabric; and

Fig. 6 is an enlarged perspective view of a modified form of laid-in strand.

While as above stated the fire-repellent asbestos fabric of the present invention may be knitted upon different types of knitting machines, it is believed that a warp knitting machine is particularly well adapted to knit the same because of the ability of this machine to provide a laid-in fabric having smooth knitted faces.

The machine used is preferably a two-needle bar warp knitting machine of well known construction and having one oscillating guide bar provided with the usual thread guides, since this machine is simple in construction and operation to produce upon each face of the fabric a knitted surface closely resembling that of the well known plain knit fabric. Such a machine, however, should be provided with laying-in mechanism for placing the laid-in strand between the front and back rows of needles adjacent the knitting position.

In this preferred knitting machine there are two needles, one front and the other back for each warp end, and each warp end is so manipulated by the oscillating guide bar as to form a

loop first on one face of the fabric and then on the other face thereof. The operation is preferably such that each warp end is confined to a single vertical wale, and the knitted loops of yarns are interlocked about the laid-in strands to thereby firmly hold these strands in spaced parallel relation to each other. These laid-in strands in turn may provide the sole means for retaining the rows of vertical wales in close parallel relation to each other. It will be understood, however, that a much more elaborate knitted construction may be used if desired by employing a warp knit machine having two or more oscillating guide bars and by operating such bars in any one of a number of well known sequences.

The yarn Y to be knitted in accordance with the present invention is an asbestos yarn preferably not heavier than a 20 cut/1 yarn, and the laid-in strand S is preferably formed of one or more asbestos rovings to provide a strand that has a weight at least as heavy as 10 cut, and which is much softer and more bulky than the asbestos yarn.

The knitting machine employed to produce the present fabric may be an 18 gauge machine or finer; that is it may have at least 12 needles to the inch in both the front and rear needle bar.

The warp knitting machine illustrated in the drawing is of well known construction and may be operated in a well known manner, and is shown as provided with two flat vertical plates 10 and 11 spaced a slight distance apart to form a fabric receiving passage therebetween, and they serve also as knock-over plates.

There is mounted adjacent the front plate 10 the front needle bed 12 provided with the needles 13, and adjacent the rear plate 11 is mounted the rear needle bed 14 providing with the needles 15. These needle beds 12 and 14 are supported for vertical sliding movement and are operated by cam mechanism (not shown) so that one set of needles is raised to receive a warp end or yarn in each needle hook and then is lowered, whereupon the other needle bed is similarly operated to receive a warp end or yarn in each needle hook. The warp ends or yarns Y may be supplied by the warped beam 16, there being one yarn Y for each front needle 13.

Above the rows of needles 13 and 15 there is mounted in the construction shown, a single oscillating guide bar 17, provided with the thread guides 18. There is one thread guide 18 for each front needle 13 and its aligned rear needle 15, it being understood that the guide bar 17 serves both sets of needles to present the yarns Y first to the forward set of needles and then to the rear set of needles as each set of needles is raised.

The sequence in which the guide bar is actuated may be varied, but the sequence employed to produce the fabric illustrated in the drawing is or may be as follows which is well known: Assuming that the front needles are raised and the thread guides 18 are back, then the guide bar 17 is rocked to move the guides 18 frontwardly to lay the yarns Y diagonally across these needles. The guide bar 17 is then shifted longitudinally one needle space to lay each yarn in its needle hook. The thread guides are then shifted rearwardly to retain the yarns in the needle hooks while these front needles are lowered, but before the front needles are lowered the laying-in mechanism, to be described, is operated to move the strand S frontwardly against the elevated needles 13 as shown in Fig. 2.

This laying-in mechanism may be of well known construction and as shown comprises a slide 19 mounted on a supporting bar 20 that extends lengthwise of the knitting machine at the rear of the machine and at approximately the level of the knitting position. Means not shown, is provided for reciprocating the slide 19 to carry the strand S back and forth at the rear of the needle beds and frontwardly against the needles. The slide 19 is shown as provided with the tubular guiding finger 21 adapted to move frontwardly to present the strand S in the desired knitting position. The finger 21 is normally held in its rearward position clear of the raised needles by means, not shown, and is moved frontwardly upon reaching the end of its travel lengthwise of the needle bed. In this manner the finger 21 is operated to present the laying-in strand S to the knitting position between the front and rear row of needles without interfering with said needles. The laying-in strand S may be drawn upwardly from a source of supply such as a cone 22.

After the thread guides 18 have been operated as above described to engage the yarns Y with the hooks of the raised front needles 13, they may be similarly operated to engage the yarns Y with the rear needles 15 when the latter are raised. In this case after the thread guides 18 have been moved rearwardly to lay the yarns Y diagonally across the raised rear needles, the guide bar 17 is shifted lengthwise in the opposite direction sufficient to restore it to its original position to thereby place these yarns in the hooks of the rear needles 15.

This sequence of operations may be continued throughout the knitting of the entire fabric and serves to place two strands of yarn, forming the two legs 23 and 24 of a knitted loop 25 between the adjacent laid-in strands S, and to form the loop 26 at the opposite face as will be apparent from Fig. 3 of the drawing. It should be noted, however, that while the loops 25 and 26 at the opposite faces are similar in formation, there is a third strand 27 at the face of the fabric shown in Fig. 5 which pases through the loop 26. This strand 27 bridges two laid-in strands S as shown and extends from one course to another.

The loops thus formed at the opposite faces of the fabric are interlocked about the strands S to prevent slippage between the knitted and laid-in portions of the fabric. The resulting fabric is somewhat similar in construction and appearance at its two faces as will appear from Figs. 4 and 5, and causes each face of the fabric to resemble in appearance the face of a plain knit fabric.

The laid-in strands S may be formed of a single asbestos roving or two or more asbestos rovings, and is preferably provided with a small strengthening yarn or thread C such as cotton disposed near the center of the strands S to facilitate its handling, as shown in Fig. 3. In some cases it may be desirable to further strengthen the strand S by providing along the same an asbestos thread T such as one end of 30 cut 2 or 20 cut 2 asbestos yarn or thread which may become more or less embedded in the roving S as shown in the modified construction of Fig. 6.

In order that the construction of the fabric of the present invention may be further understood, the table that follows gives one good practical

specification for producing the present fabric, and also the analysis of one old woven asbestos fabric for comparison.

TABLE

Asbestos cloths for fire repellent clothing and other uses

	New (knitted)		Old (woven)	
1	Wales per in	13	Warps per in	20.4
2	Courses per in	9.6	Wefts per in	10.4
3	Laid-in strands per in	9.6	Plain weave	1 and 1
4	Knitted yarn material	30 cut/1	Warp material	15.4 cut/2
5	Laid-in material	8½ cut roving 30/2 ply yarn	Weft material	14.5 cut/2
6	Ozs. sq. yd	27.0 wt.	Ozs. sq. yd	28.3 wt.
7	Gauge of fabric [1]	075"	Gauge of fabric	062"
8	Strength lengthwise (Grab test—1")	91 lbs.	Strength warp (Grab test—1")	128 lbs.
9	Strength crosswise (Grab test—1")	38 lbs.	Strength weft (Grab test—1")	54 lbs.
10	Compressibility under a load of 5 lbs./sq. in [2]	19%	Compressibility under a load of 5 lbs./sq. in	16%
11	Yds. of knitted yarn required, in the lengthwise direction of the fabric, to make 1 sq. yd. of fabric	3220	Yds. of yarn in warps to form 1 sq. yd. of fabric	850

[1] The gauge of the fabric was measured by an automatic micrometer having a pressure foot 3/8 of an inch in diameter and actuated with a constant pressure of 6 ounces.

[2] The compressibility was determined by a micrometer provided with a pressure foot having an area of one square inch and adapted to exert an initial pressure on the fabric of 6 ounces, and the compressibility under an added load of five pounds was measured with reference to the thickness under an initial load of 6 ounces.

The fabric of the present invention is much better adapted for use in the construction of fire protecting clothing including gloves and suiting material than the woven asbestos fabrics available heretofore, and possesses pronounced advantages in other fields of use. For example woven asbestos fabric has been used heretofore as a reinforcement for molded products and to produce laminated constructions. It is found that the present knitted fabric will conform to the contour of molds or forms much better than a woven fabric, and that its increased softness and greater compressibility are desirable properties in this molding field.

When the present fabric is employed in laminated constructions such for example as non-metallic gears, to secure a desired thickness, it is found that it provides a saving in asbestos material by weight over a woven laminated construction of the corresponding thickness since the present fabric is less compact than the usual woven asbestos fabric and requires from 25 to 33% less material for a given thickness of fabric. In either laminated or molded constructions the present fabric can be shaped about rounded or irregular objects without the formation of wrinkles, which is a further advantage over woven asbestos fabrics.

A still further advantage of the present soft flexible fabric resides in its improved heat resistant properties over a woven asbestos fabric of corresponding thickness.

It will be apparent from the drawing that the laid-in strands S are disposed in straight parallel relation at the center of the fabric where they form a cushion like layer. They also supply the transverse strength of the fabric. The knitted wales provide the longitudinal strength of the fabric, and as will be apparent from item 11 of the above table the length of yarns forming these wales is nearly four times as great as the length of the warp yarns in the corresponding size of woven fabric. The utilization of this large amount of yarn in the present construction to form the knitted surface of both faces of the fabric and connections therebetween is largely responsible for the desirable features of the present fabric.

It is frequently the practice to mix various fibers or filaments with asbestos fibers to impart increased strength to the asbestos rovings or strands. It is herein contemplated that the yarns Y and strands S will contain at least 70% asbestos fiber.

Having thus described my invention, what I claim and desire to protect by Letters Patent is:

1. A knitted fire-repellant asbestos fabric which is much softer and more pliable than a woven asbestos fabric of the same weight per square yard, comprising a central layer of laid-in asbestos strands, and knitted loops of yarns interlocked about said strands and forming a soft knitted surface upon both faces of the fabric, said knitted loops being formed of asbestos yarns not heavier than a 20 cut/1 yarn and knitted with at least 12 wales to the inch upon each face of the fabric.

2. A knitted fire-repellent asbestos fabric which is much softer and more pliable than a woven asbestos fabric of the same weight per square yard, comprising a central layer of laid-in asbestos strands, and knitted loops of yarns interlocked about said strands and forming a soft knitted surface upon both faces of the fabric, said knitted loops being formed of asbestos yarns not heavier than a 20 cut/1 yarn and together with said laid-in strands forming a fabric over .050" thick.

3. A knitted fire-repellent asbestos fabric which is much softer and more pliable than a woven asbestos fabric of the same weight per square yard, comprising a central layer of laid-in asbestos strands, and knitted loops of yarns interlocked about said strands and forming a soft knitted surface upon both faces of the fabric, said knitted loops being formed of asbestos yarns not heavier than a 20 cut/1 yarn, and said laid-in strands having not less than twice the weight per yard length as said knitted yarn.

4. A knitted fire-repellent asbestos fabric which is much softer and more pliable than a woven asbestos fabric of the same weight per square yard, comprising a central layer of laid-in asbestos strands, and knitted loops of yarns interlocked about said strands and forming a soft knitted surface upon both faces of the fabric, said knitted loops being formed of asbestos yarns not heavier than a 20 cut/1 yarn, and together with said laid-in strands forming a fabric that is over .050" thick and which weighs not over 30 ounces per square yard.

5. A knitted fire-repellent asbestos fabric which is much softer and more pliable than a woven asbestos fabric of the same weight per square yard, comprising a central layer of laid-in asbestos strands, and knitted loops of yarns interlocked about said strands and forming a soft knitted surface upon both faces of the fabric, said knitted loops being formed of asbestos yarns not heavier than a 20 cut/1 yarn, and the compressibility of said fabric being approximately 19 per cent at 5 pound load.

6. A knitted fire-repellent asbestos fabric which is much softer than a woven asbestos fabric of the same weight per square yard, comprising a central layer of laid-in asbestos strands heavier than a 20 cut/2 yarn, and knitted loops of yarns interlocked about said strands and forming a soft knitted surface upon both faces of the fabric, said knitted loops being formed of asbestos yarns not heavier than a 20 cut/1 yarn.

7. A knitted fire-repellent asbestos fabric which is much softer than a woven asbestos fabric of the same weight per square yard, comprising a central layer of laid-in asbestos strands, and knitted loops of yarns interlocked about said strands and forming a soft knitted surface upon both faces of the fabric, said knitted loops being formed of at least 2,000 yards of asbestos yarn per square yard of said fabric.

8. A warp-knit, fire-repellent asbestos fabric which is much softer than a woven asbestos fabric of the same weight per square yard, comprising a central layer of laid-in asbestos strands, and knitted loops of yarn interlocked by a warp knit construction and forming a soft knitted surface upon both faces of the fabric, said knitted loops being formed of asbestos yarns not heavier than a 20 cut/1 yarn.

9. A warp-knit, fire-repellent asbestos fabric which is much softer than a woven asbestos fabric of the same weight per square yard, comprising a central layer of laid-in asbestos strands, and knitted loops of yarn interlocked by a warp knit construction to thereby form a close simulation of a plain knit construction upon each face of the fabric, said knitted loops being formed of asbestos yarn not heavier than a 20 cut/1 yarn.

10. A warp-knit, fire-repellent asbestos fabric which is much softer than a woven asbestos fabric of the same weight per square yard, comprising a central layer of laid-in asbestos strands, and knitted loops of yarn interlocked by a warp knit construction to thereby form a close simulation of a plain knit construction upon each face of the fabric, said knitted loops being formed of at least 2,000 yards of asbestos yarn per square yard of said fabric.

11. A knitted fire-repellent asbestos fabric which is softer than a woven asbestos fabric of the same weight per square yard, comprising a central layer of laid-in soft, compressible strands formed of asbestos rovings reinforced with asbestos yarn, and knitted loops of yarns interlocked about said strands and forming a soft knitted surface upon both faces of the fabric, said knitted loops being formed of asbestos yarns much smaller than said laid-in strands.

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