

Nov. 27, 1923.

1,475,325

I. SPRINGTHORPE

KNITTED FABRIC AND METHOD FOR ITS PRODUCTION

Filed Nov. 19, 1918

7 Sheets-Sheet 1

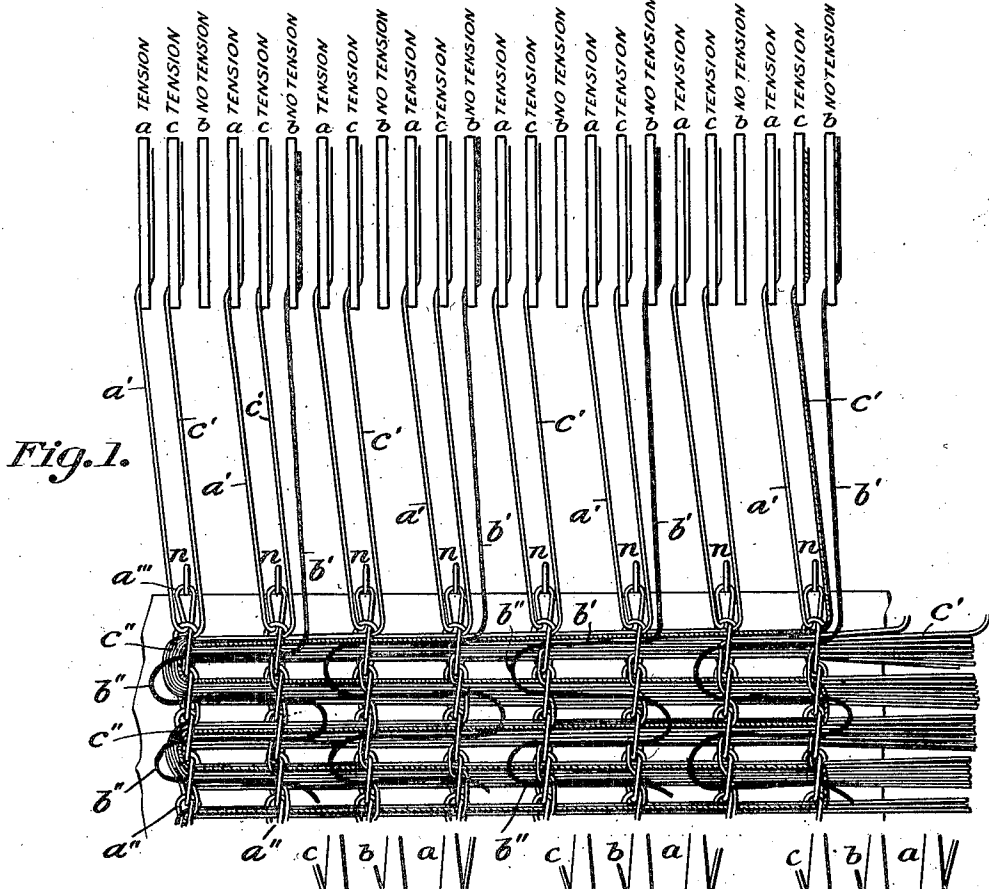


Fig. 1.

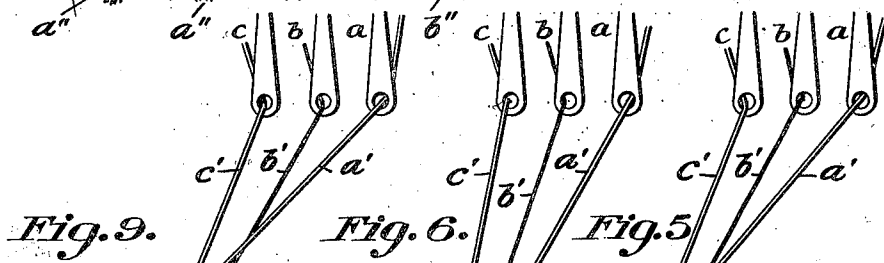
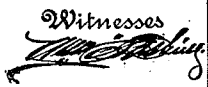
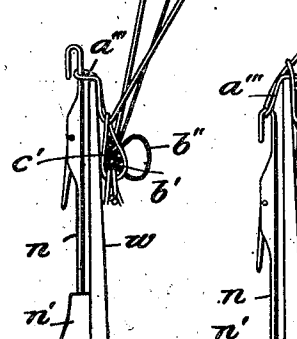


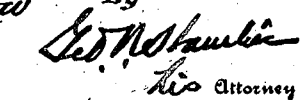
Fig. 9.

Fig. 6.

Fig. 5.

Witnesses  
  
 W  
 n'

  
 W  
 n'

Inventor  
 Isaac Springthorpe  
 By  
  
 His Attorney

Nov. 27, 1923.

1,475,325

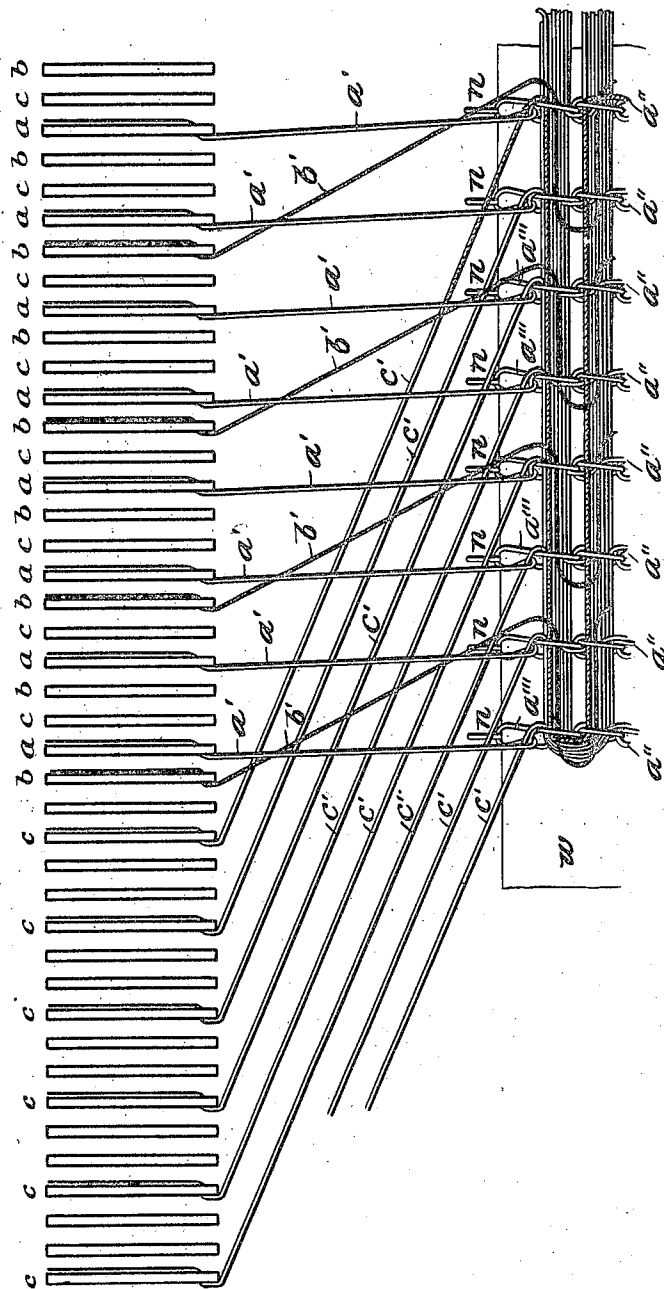
I. SPRINGTHORPE

KNITTED FABRIC AND METHOD FOR ITS PRODUCTION

Filed Nov. 19, 1918

7 Sheets-Sheet 2

Fig. 2.



Witnesses

*[Handwritten signature]*

Inventor

Isaac Springthorpe

By

*[Handwritten signature]*  
his Attorney

Attorney

Nov. 27, 1923.

1,475,325

I. SPRINGTHORPE

KNITTED FABRIC AND METHOD FOR ITS PRODUCTION

Filed Nov. 19, 1918

7 Sheets-Sheet 3

Fig. 3.

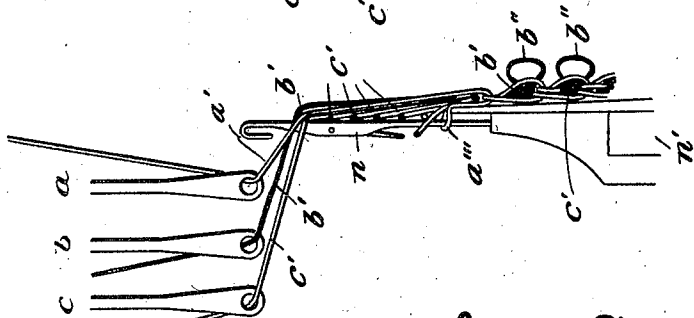
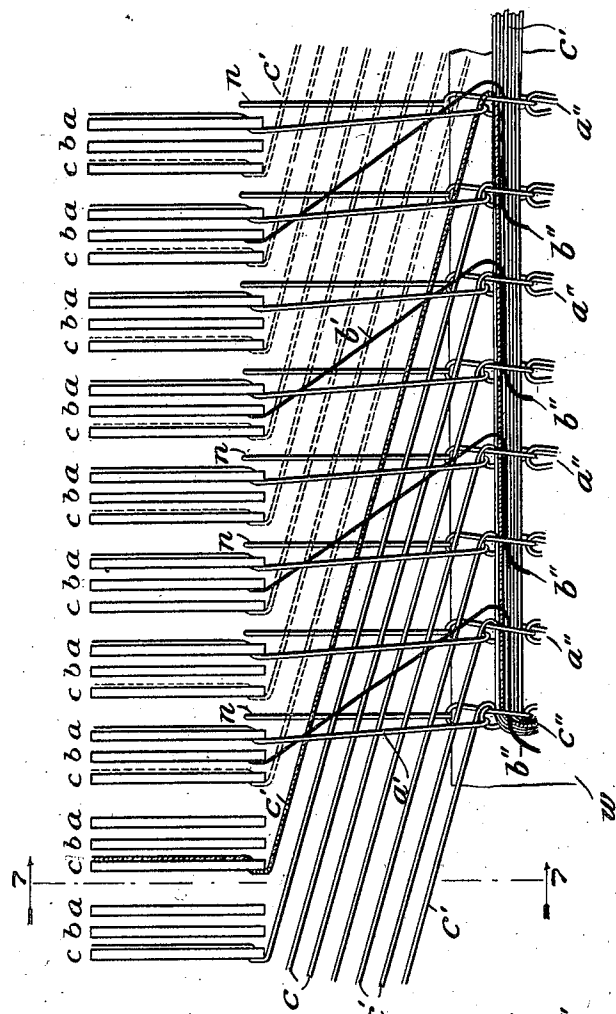
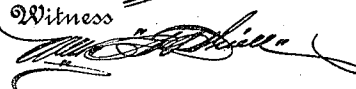



Fig. 7.

Witness  


Inventor  
 Isaac Springthorpe  
 By   
 his Attorney

Nov. 27, 1923.

1,475,325

I. SPRINGTHORPE

KNITTED FABRIC AND METHOD FOR ITS PRODUCTION

Filed Nov. 19, 1918

7 Sheets-Sheet 4

Fig. 4

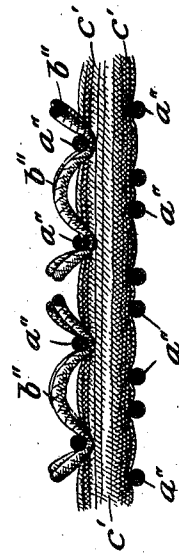
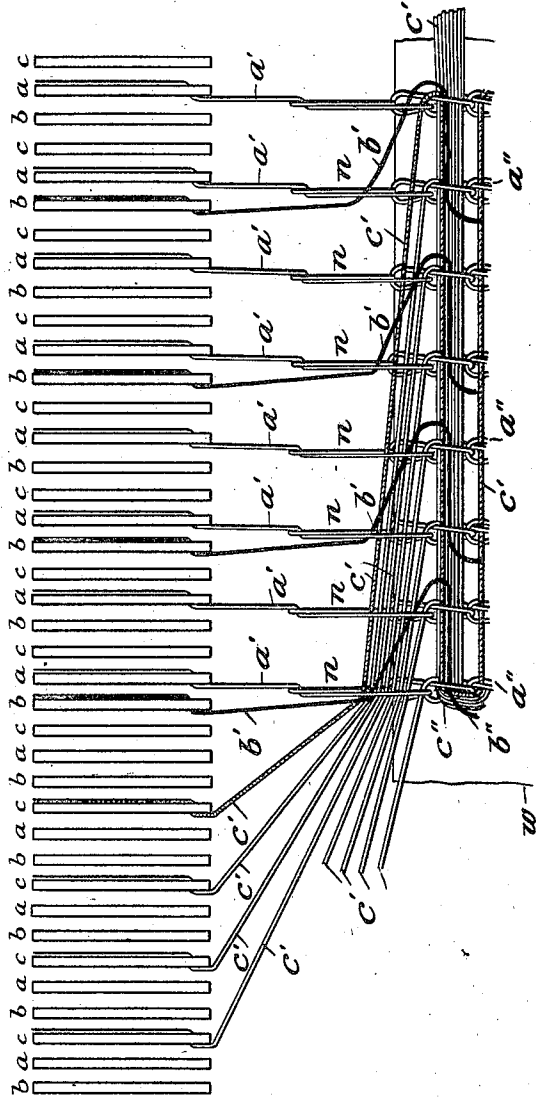
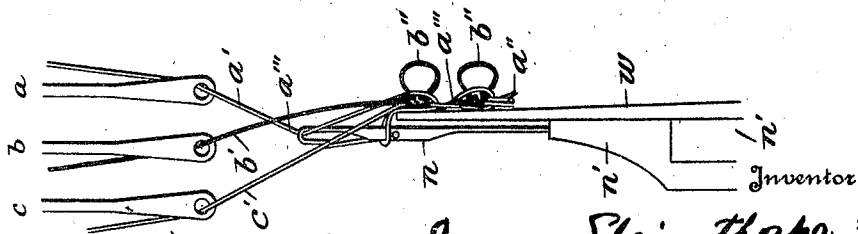


Fig. 10.



Witness  
*[Signature]*

Fig. 8.

Isaac Springthorpe,

By *[Signature]*  
 his Attorney

Nov. 27, 1923.

1,475,325

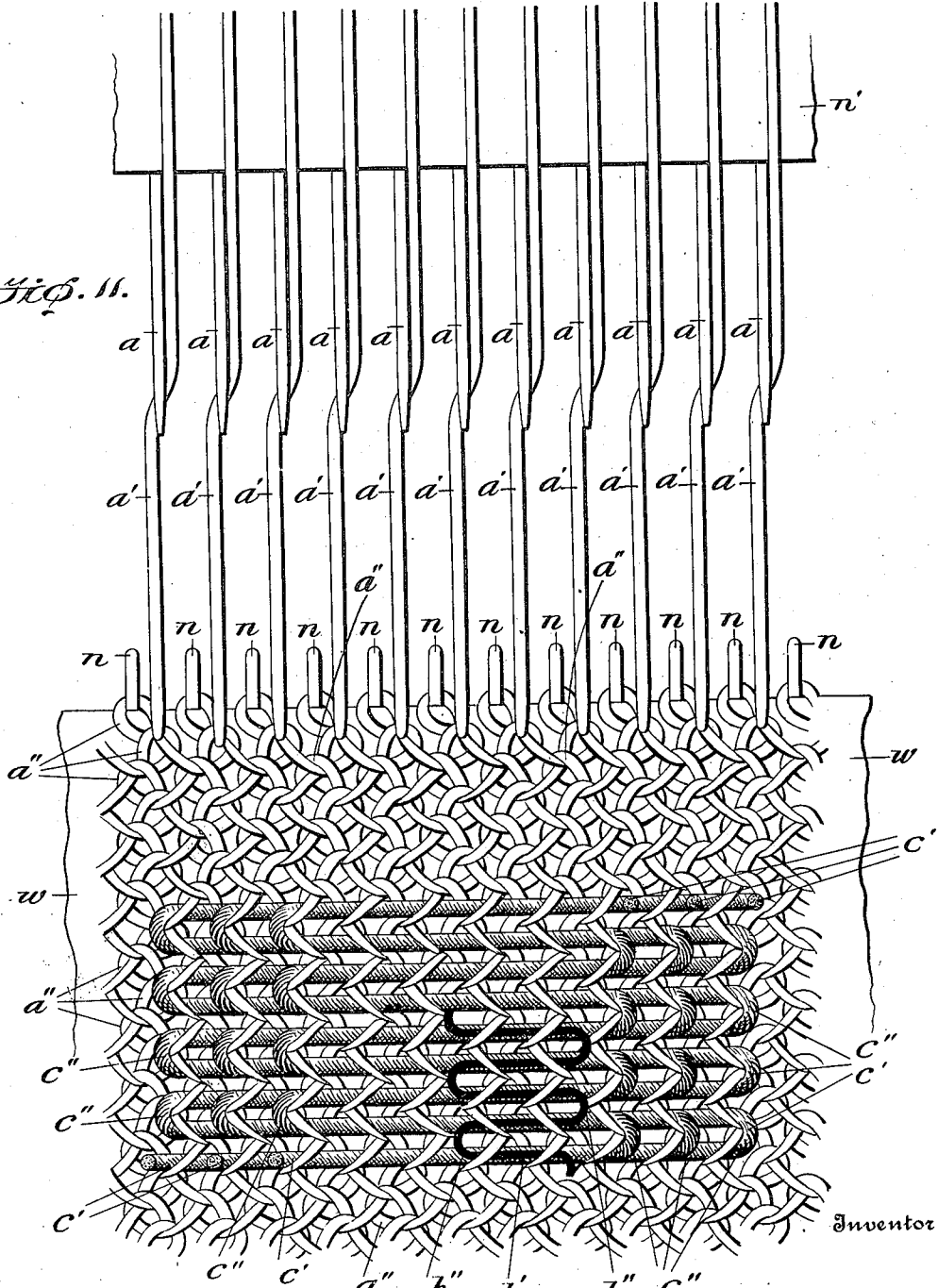
I. SPRINGTHORPE

KNITTED FABRIC AND METHOD FOR ITS PRODUCTION

Filed Nov. 19, 1918

7 Sheets-Sheet 5

Fig. 11.



Inventor

Witness

*[Handwritten signature]*

By

Isaac Springthorpe

*[Handwritten signature]* his Attorney

Nov. 27, 1923.

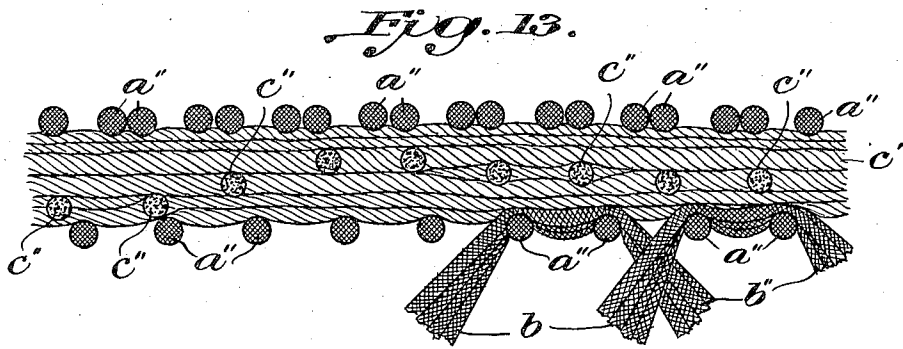
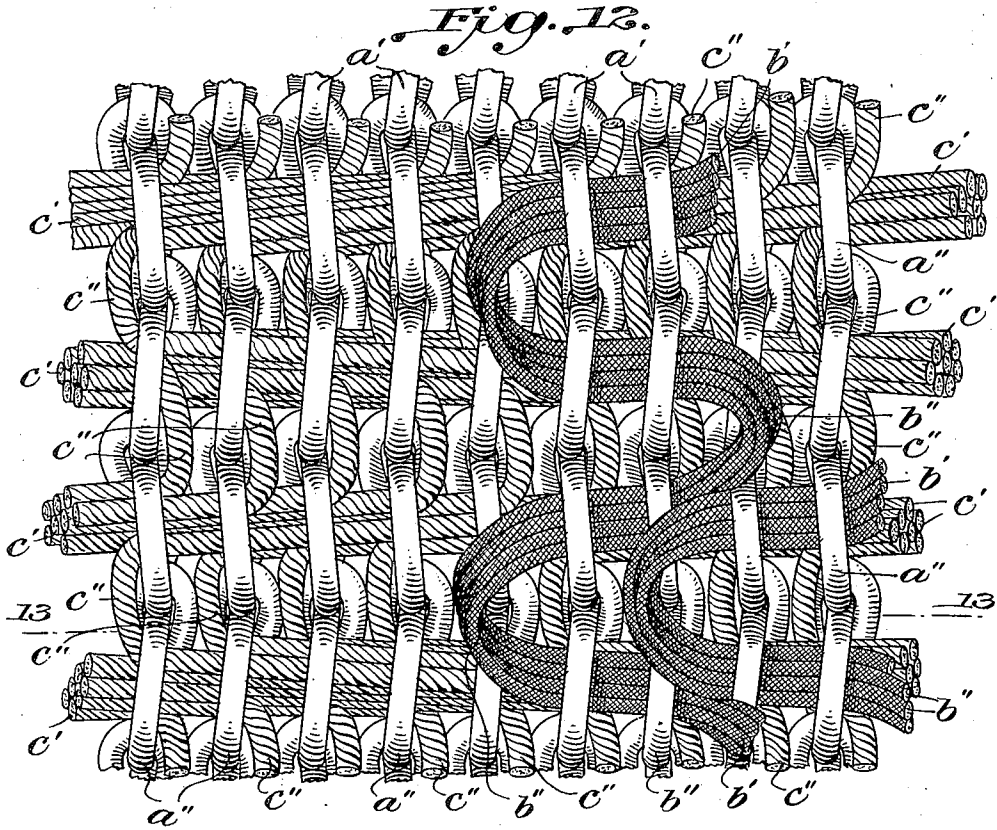
1,475,325

I. SPRINGTHORPE

KNITTED FABRIC AND METHOD FOR ITS PRODUCTION

Filed Nov. 19, 1918

7 Sheets-Sheet 6



Inventor,  
Isaac Springthorpe  
By *J. N. Whulji*  
his Atty.

Nov. 27, 1923.

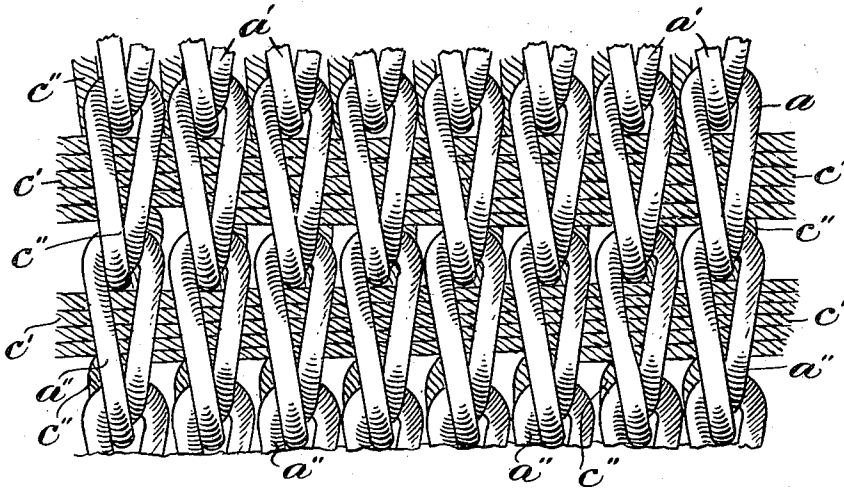
1,475,325

I. SPRINGTHORPE

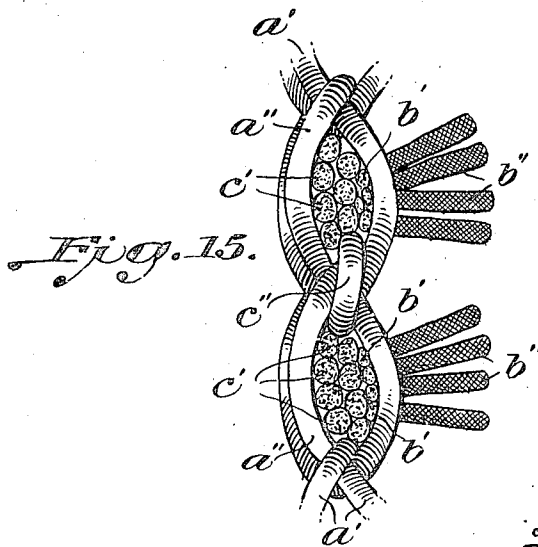
KNITTED FABRIC AND METHOD FOR ITS PRODUCTION

Filed Nov. 19, 1918

7 Sheets-Sheet 7



*Fig. 14.*



*Fig. 15.*

Inventor,  
Isaac Springthorpe  
By *H. H. Haulin*  
his Atty.

# UNITED STATES PATENT OFFICE.

ISAAC SPRINGTHORPE, OF GERMANTOWN, PENNSYLVANIA, ASSIGNOR, BY MESNE ASSIGNMENTS, TO SPRINGTHORPE TEXTILE MACHINE COMPANY, OF PHILADELPHIA, PENNSYLVANIA, A CORPORATION OF DELAWARE.

## KNITTED FABRIC AND METHOD FOR ITS PRODUCTION.

Application filed November 19, 1918. Serial No. 263,165.

*To all whom it may concern:*

Be it known that I, ISAAC SPRINGTHORPE, a citizen of the United States, residing at Germantown, Philadelphia, in the county of Philadelphia and State of Pennsylvania, have invented certain new and useful Improvements in Knitted Fabric and Methods for Its Production, of which the following is a specification.

The object of this invention is to provide a new method of knitting and a new fabric produced thereby having the characteristics and appearance of woven fabrics, either with, or without, a nap or pile, at greatly lessened cost of materials, time and labor with a vastly increased rate of production.

My new method of knitting, and fabric are, respectively, susceptible of such variation without departing from their novel principles so that fabrics of different appearance may be produced at different times.

My invention may also be practiced to produce either a relatively smooth-faced fabric, or, on the other hand, one having a nap or pile.

In any instance, however, my invention may be practiced to produce a knitted fabric which has the minimum tendency to stretch either warpwise or weftwise.

When the invention is practiced to produce a knitted pile fabric, a solid substantially non-stretchable body or back is formed with which is interknit weft threads having loose, free parts which constitute a nap that can be left as such, or, subsequently combed or brushed up as desired without injury to the body, and scoured, dyed, and fulled, or otherwise treated as desired.

When the invention is practiced to produce a substantially flat-faced fabric the weft pile-threads may be omitted.

The principal object of my invention is, however, to produce a knitted fabric having a substantially non-stretchable body and a free, high pile outstanding therefrom.

Whether the invention be practiced to produce a flat-surfaced fabric, or, on the other hand, a pile fabric, the body of the fabric produced is filled substantially solid with weftwise extending ribs. The body comprises tightly knit warps whose loops

are interknit with, and tightly bind, groups or bundles of weftwise extending threads. Each weft thread is laid in sinuous form relative to the lengths of the warps, and successive weft threads of the respective groups or bundles have their turns or bends arranged in progressively advanced position, weftwise of the fabric, and tightly interknit with the loops of successive courses of the warps at said turning points. The invention contemplates tensioned warp threads and tensioned weft threads for the formation of the body of the fabric. Consequently, each loop of each warp is subject to the opposing weftwise acting tensions of the bends or turns of the weft threads and, during the incorporation of the weft threads, the loops of the warps are alternately pulled to the left and right, weftwise of the fabric being produced.

When the invention is practiced to produce a fabric having a pile or nap, the body is formed as previously outlined and, simultaneously with the placing of the relatively heavily tensioned weft threads, there are laid, in a sinuous form, other weft threads which are, however, only lightly tensioned. These lightly tensioned weft threads are laid alongside the relatively heavily tensioned weft threads and are incorporated with the bundles or groups of the latter into the loops of the warps and tightly bound by them. Being lightly tensioned, however, these weft threads are pulled by the knitting action into relatively deep, loose, free loops at the bends or turns of the said lightly tensioned weft threads. Consequently, when the needles complete their work, these deep, loose, free loops remain as such. The tension on the warp threads causes the loops of the warps and the bundles or groups of relatively heavily tensioned weft threads to exert a pressure or constricting action on the lightly tensioned weft threads to hold them in position, and the frequency with which the loops are laid causes them to stand outwardly from the face of the body and constitute a nap or pile. This nap or pile being composed of free surface loops, may be subsequently combed, brushed up, or treated in any manner to give the fabric the appearance of a woven fabric.

To produce either a flat surfaced, or a pile, fabric, the weft threads are first laid



in groups or bundles across the backs of as many of the needles as may be predetermined. The warp threads are then laid so as to be positioned for engagement by the  
 5 hooks of the needles. The needles then knit the tensioned weft threads into the loops of the warp threads, said loops surrounding and tightly embracing the bundles of weft threads which have been laid. Another  
 10 course of weft threads is then laid in the opposite direction weftwise across the backs of a corresponding number of the needles and the warp threads are again laid across the hook sides of the needles. The needles  
 15 then form additional loops in the warp threads and tightly knit in the new bundles of weft threads thus laid.

The needles form the warps into a series of tight loops, tightly binding in such weft  
 20 threads as have been previously laid across the backs of the needles. There are thus knitted tightly into the loops of the warps, bundles, sets, or groups of weft threads, each thread proceeding in regular sinuous form  
 25 warpwise of the fabric being produced and all the weft threads collectively constituting bundles or groups which, due to progressive weftwise advanced arrangement of their loops or bends, interlock with the loops of  
 30 the warps and tightly bind the fabric together against other than minimum lateral of weftwise stretching. The tightly knitted warps prevent other than minimum warpwise stretching of the fabric produced by  
 35 my method.

To produce a pile fabric, other weft threads, under only light tension, are laid across the needle backs along with the binding weft threads and proceed in sinuous  
 40 form warpwise of the fabric. Preferably, these lightly tensioned weft threads will be laid across the backs of fewer of the needles than those crossed by the more heavily tensioned weft threads which form the body of  
 45 the fabric. The knitting action on the lightly tensioned weft threads forms deep loops in them, which remain, free and loose, due to the relative lack of tension on these threads.

The method may be practiced, and the fabric produced, on a knitting machine having independently movable thread guide  
 50 bars and movable needles. The warp and weft thread carriers should be subject to suitably heavy braking action to afford the requisite tension for said threads. The carriers for the weft threads whose loops  
 55 are to form the nap or pile, should be subject to only very light braking action.

In an application for a knitting machine filed June 28, 1918, Serial No. 242480 I have disclosed a machine which may be adapted  
 60 to carry out the present method.

While my method and fabric are not restricted to placing the weft threads across  
 65

any given number of needles, I have found in practice that the relatively heavily tensioned weft threads may, with highly satisfactory results as to character and rate of  
 70 production of the fabric, be laid to and fro across the backs of eight needles, and the relatively lightly tensioned weft threads which provide the nap may be laid to and fro across two needles.

In the accompanying drawings:

Figure 1 is an enlarged elevational diagrammatic view, looking toward the work  
 75 plate, a portion of the latter and a few of the needles and thread guides and a part of the knitted fabric being shown, the thread guides being shown as displaced laterally from their true position to enable the showing to be made diagrammatically, the  
 80 needles being slightly elevated and the cycle of knitting about to begin;

Fig. 2, a similar view, showing the "b"  
 85 thread guides actually displaced two units to the left to lay each nap or pile thread in position to cross the backs of two needles, and the "c" thread guides actually displaced eight units to the left to lay each  
 90 weft binding thread in position to cross the backs of eight needles;

Fig. 3, a similar view, the needles having risen and moved crosswise in traversing  
 95 relation to the "a", "b" and "c" thread guides as shown in Fig. 7, the "a" thread guides having not yet moved across the hook sides of the needles;

Fig. 4, a similar view, the thread guides  
 100 "a" having been shifted one unit to the right from their position in Fig. 3 to lay the respective warp threads across the hook sides of the needles, the needles having partially  
 105 descended to begin the binding in of the "b" and "c" threads in the warp thread loop being formed, as shown in Fig. 8;

Fig. 5, is a side elevation showing the true  
 110 arrangement of the "a", "b", "c" thread guides, that is, in front of one another, the needle being down and in initial position for starting the cycle;

Fig. 6, a view like Fig. 5, showing the  
 115 needle slightly elevated above the work plate, the cycle having begun, as in Fig. 1;

Fig. 7, a view like Fig. 5, on line 7-7. Fig. 3, the "b" and "c" threads having  
 120 been laid across the backs of two and eight needles, respectively, the needle being in its farthest advanced position and its cycle half completed;

Fig. 8, a view like Fig. 5, the "a" thread  
 125 guide having been previously shifted to lay the "a" or warp thread across the hook side of the needle, the needle now being on the return part of its cycle, its hook being engaged with the warp thread and pulling it down as shown in Fig. 4;

Fig. 9, a view like Fig. 5, showing the  
 130 needle nearly at the completion of the cycle

and about to pull the warp of "a" thread through the previously formed loop of that thread for the purpose of locking the "b" and "c" weft threads in the warp loop to bind the warp to the "c" threads to form the body of the fabric;

Fig. 10, an enlarged detail weftwise sectional view of a portion of the fabric produced by the method, the "a" warp threads being shown in section;

Fig. 11, an enlarged elevation view, looking toward the work plate, disclosing a few needles and "a" thread guides, illustrating a net or nubia fabric which may be produced by the method, there being only three weft threads and one pile thread laid in, to better disclose the nature of the net foundation.

Fig. 12 is an enlarged fragmentary detail view looking toward the front of a portion of a nap or pile-fabric made according to the present invention, numerous body-forming and nap or pile-forming threads being omitted for the sake of clearness;

Fig. 13 is a weftwise-section on line 13—13, Fig. 12;

Fig. 14 is an enlarged fragmentary detail view looking toward the back of the fabric of Figs. 12 and 13, numerous body-forming threads being omitted for the sake of clearness; and

Fig. 15 is an enlarged fragmentary vertical or warpwise section showing all the body-forming and pile-forming weft threads in section, a warp chain in full lines, and the nap or pile loops.

While my method is not limited to being practiced on any particular knitting machine, I have shown in the drawings in a diagrammatic manner, the general arrangement and movements of the thread guides, needles, and work plate of the machine of my application Serial No. 242480 by way of illustration.

The layout of the thread guides is necessarily distorted in Figs. 1, 2, 3, 4 to illustrate the steps of the method; the true arrangement of the thread guides *a*, *b*, *c*, is that shown in Figs. 5 to 9 inclusive. The showing of the threads *a'*, *b'*, *c'* and the warp chains *a''* is greatly exaggerated in the matter of spacing and proportions. A large number of thread guides corresponding, respectively, to *a*, *b*, *c*, are carried by bars which are timed and actuated as to frequency and amplitude according to the requirements of the practice of the method. The timing and characteristics of the cycle of travel of the needles *n* and the needle bar *n'* which carries them cause the needles to have a general crosswise traversing movement in relation to the thread guides *a*, *b*, *c*. The warp threads *a'* correspond in number to the needles *n* and their guides *a* have a movement of but one unit, that is, to lay the thread across the hook side of but one needle,

in each instance. The respective needles *n* knit the threads *a'* into parallel warp chains *a''* which pass down the face of the work plate *w* as the warp loops are cast from the needles after the body-binding weft threads *c'* and nap or pile weft threads *b'* have been first laid, and then bound in by said warp loops. The warp threads *a'* are under relatively heavy tension which may be provided by suitably weighted brake straps acting on the beam from which these warp threads are taken.

The body-binding weft threads *c'* are also under relatively heavy tension which may be applied by weighted brake straps acting on the beam from which they are taken.

The nap or pile weft threads *b'* are subject to relatively light tension; in practice, they are relatively loose, as shown, for instance, in Figs. 1 and 8. The tension on the threads *b'* is so light that it is just sufficient to allow them to be taken off from their beam and properly drawn down for incorporation in the fabric.

The threads *b'*, *c'*, are themselves not knitted into loops or chains, as are the warp threads *a'*, and are not engaged by the hooks of the needles. These threads *b'*, *c'* are, by first shifting the thread guides *b*, *c*, laid in position to be engaged by the backs of the needles *n* when the latter subsequently rise, as shown in Fig. 6, and as the needles traverse the thread guides *c*, *b*, *a*, in the order stated, the backs of the needles engage and pull upon the threads *b'*, *c'*, as shown in Fig. 7. Being under relatively heavy tension, the body-binding weft threads *c'* become very taut but the nap or pile forming weft threads *b'*, being under only light tension, are formed by the knitting action into free, loose, deep loops *b''*, such loops remaining at the bends or turns of the *b'* threads as they are not taken up by any subsequent tension.

After the needles have assumed the position shown in Figs. 3 and 7 and carried out the step just described, thus completing one half of their cycle, the thread guides *a* are shifted a distance of one unit, that is, sufficiently to lay each warp thread *a'* across one needle *n* on the hook side thereof. The needles are then shifted to re-traverse the thread guides in the order *a*, *b*, *c*, the warp threads *a'* entering the needle hooks and successively assuming the positions shown in Figs. 8, 9, 5. The loop *a'''* formed by the needle hook in each warp thread *a'* is thus finally pulled through the previous loop of the given chain *a''* and the previous loop of the given chain cast to the position shown in Fig. 5.

The thread guides *a*, *b*, *c* remain where shifted until the needles complete the cycle. During the succeeding cycle the thread guides *b*, *c*, and *a*, again act as before ex-

plained but now move in the opposite direction to their previous travel, thus laying the next course opposite to the previous one. Consequently, the threads  $b'$  and  $c'$  are laid in regular sinuous form throughout the length of the fabric.

The tension on threads  $a'$ ,  $c'$ , is sufficiently heavy to insure a very firm compression of the bundle or group of threads  $b'$ ,  $c'$  by the loop  $a'''$ ; this compression, with the pressure exerted by the  $c'$  threads on the  $b'$  threads within the loops  $a'''$  holds the loose, free pile or nap threads  $b'$  firmly in position on the face of the fabric, as shown in Fig. 10. The relative arrangement of the thread guides  $b$  and  $c$ , the former being in front of the latter, contributes to position the  $b'$  threads on the surface of the fabric. In Figs. 5 to 9, the loops  $b''$  appear as they are in the knitted fabric. They may be left in that form, or, they may be brushed, combed, or otherwise treated.

The relatively heavy tension to which the weft threads  $c'$  are subject causes their bends or turns  $c''$  to draw tightly weftwise on the loops  $a''$ . The method of laying the threads  $c'$  in sinuous form, a given number of units one way (eight in the present instance) in one course, then rising and returning in the opposite direction in the succeeding course a distance embracing the same number of units, places the threads  $c'$  in bundles or groups whose bends  $c''$  are arranged in successively progressing position in both directions weftwise of the fabric. This results in subjecting each loop  $a'''$  of each warp chain  $a''$  to opposite pulls by oppositely turning or facing bends  $c''$  and tightly binds the fabric together weftwise. The tension on the warp threads  $a'$  causes them to be knitted as tight chains  $a''$ . Consequently, the possibility of stretching warpwise or weftwise in a fabric produced by my method is reduced to a minimum.

My method may be practiced to produce a fabric having a smooth or flat body by the use of only the threads  $a'$  and  $c'$  and in that respect the method is complete. If a knitted pile fabric is to be produced, which is a particular object of the invention, the  $b'$  threads under relatively light tension are laid in the manner heretofore described.

The weftwise travel or lay of both the binding threads  $c'$  and the nap threads  $b'$  may cover a greater or lesser number of units than eight and two, respectively.

The method may be considered as commencing when the conditions are as disclosed in Fig. 5. The first step in the cycle of knitting is to move the thread guide bars  $b$ ,  $c$  the distances which have been determined for them, such as two and eight units, respectively. The needle bar  $n'$  is then shifted to cause the needles to rise and traverse the thread guides  $c$ ,  $b$ ,  $a$ , in the

order stated. When the needles rise through the previously formed loops  $a'''$ , a V is defined between the loops and the warp threads  $a'$ ; the latter running direct from the thread guides  $a$  to the finished fabric in front of the work plate, as shown in Fig. 6. Threads  $b'$ ,  $c'$  are thus laid across the backs of their respective number of needles and in the V thus formed. This step is illustrated in Figs. 2 and 6, where a group of eight weft threads  $c'$  and four nap threads  $b'$  are shown as having been moved weftwise in the same direction to assume diagonal positions.

The needles moving in the first half of their cycle finally reach the positions shown in Fig. 7, meanwhile contacting with and positioning the portions of  $b'$  and  $c'$  threads which are to be incorporated into the fabric, i. e., those which were previously deposited in the V of warp threads  $a'$ .

The thread guide  $a$  is now moved to lay each warp thread across its needle, as shown in Fig. 7.

The needles next re-traverse the thread guides in the order  $a$ ,  $b$ ,  $c$ , and during such re-traverse assume the position shown in Figs. 4 and 8, where the hooks of the needles are shown as engaged with the threads  $a'$ . The descent of the needle finally causes the previously formed loop  $a'''$  to close the needle latch and the newly formed loop  $a'''$  to be pulled through the formed loop, as shown in Figs. 9 and 5. The newly formed loop is thus retained by the needle hook. The completely knitted loop  $a'''$  in the chain  $a''$  now tightly binds the bundle of threads  $b'$ ,  $c'$ , and the pile loops  $b''$  are automatically, as it were, positioned on the face of the fabric.

The fabric produced is substantially filled with weftwise running ribs formed by the bundles or groups of threads  $c'$ .

Fig. 11 disclosed a non-stretchable net or nubia pile fabric which may be produced by my method. In producing such a fabric the steps previously described are followed. Instead, however, of forming foundation warp chains, the relatively heavily tensioned warp threads  $a'$  running from the guides  $a$  to the needles  $n$  are knitted into loop units  $a''$  which collectively constitute a net or nubia body.

The relatively heavily tensioned weft threads  $c'$  are laid in regular sinuous form a given number of units one way (eight in the present instance) in one course, then rising and returning in the opposite direction in the succeeding course a distance embracing the same number of units. This method places the threads  $c'$  in bundles or groups whose bends  $c''$  are arranged in successively progressing position in both directions weftwise of the fabric. This results in subjecting the loop units  $a''$  to opposite pulls

by the oppositely facing bends  $c''$ , as previously explained at length, and tightly binds the loop units  $a''$  of the net or nubia foundation together weftwise.

When forming a net fabric my method may be practiced to produce a fabric having a smooth or flat body composed of the net foundation loop units  $a''$  and the weft binding threads  $c'$ . If a pile net or nubia fabric is to be produced, the sinuous, lightly tensioned  $b'$  threads are laid, and bound in by the loop units  $a''$ , in the manner heretofore described. The bends or turns  $b''$  remain as free, loose, deep loops, as previously described.

In Fig. 11 I have shown only three weft threads  $c'$  and one nap or pile thread  $b'$  but it will be understood that these threads are incorporated throughout the fabric in suitable numbers, as previously set forth.

My method is susceptible of producing fabrics whose foundation of  $a'$  and  $c'$  threads is formed of other stitches than the warp chains and net loops heretofore described and its product is not limited to warp chain and net foundations.

The fabric shown in Figs. 12 to 15, inclusive, has warp threads  $a'$  which are knitted into parallel chains composed of successive loops  $a''$  in successive courses. Extending through, and tightly bound by, the loops  $a''$  are groups or bundles of body-forming, binding weft-threads  $c'$  each of which runs in regular sinuous form throughout the fabric. Each thread  $c'$  extends a given number of units weftwise of the fabric, that is, it is enclosed by and crosses the loops  $a''$  of a given number of the warp chains. Each thread  $c'$  then rises and bends or turns into the next course of the loops  $a''$  and extends weftwise in the opposite direction the same number of units as in the preceding course, then rising, bending and returning in the following course. The bends or turns  $c''$  of the threads  $c'$  thus interlock with two loops  $a''$  in successive courses of the fabric (Fig. 12). As the threads  $c'$  are spaced weftwise prior to being knitted into the fabric, and are moved equal distances in the operation of knitting, the bends or turns  $c''$  of the individual threads  $c'$  are arranged in progressively advanced position weftwise of the fabric and interlock with the loops  $a''$  of the warp chains. The threads  $c'$  being laid, first in one direction and then in the opposite direction, successive loops  $a''$  of the warp chains are pulled alternately in opposite directions weftwise of the fabric, as shown in Fig. 12, and the body formed of the threads  $a', c'$  is thus tightly bound together against weftwise stretching.

I do not limit myself to threads  $c'$  which extend weftwise any given number of units, but I have found that eight units produce a highly satisfactory body.

The warp threads  $a'$  being tightly knit, the fabric will have only a minimum tendency to stretch warpwise.

The nap or pile-forming threads  $b'$  are arranged in sinuous form in successive courses of the fabric and are enclosed in, and bound by, the loops  $a''$ , but form no part of the body. Their bends or turns are free and form loose, deep loops  $b''$  which constitute the nap or pile of the fabric. These loops may be left complete, or, they may be brushed up, combed, or, otherwise finished.

I do not limit myself to the pile threads  $b'$  as extending weftwise any given number of units, but I have found that two units extent, with the loops  $b''$  extending freely beyond in each direction, weftwise of the fabric as shown in Fig. 12, produces a highly satisfactory pile.

During the operation of knitting the present fabric the warp threads  $a'$  and the body-forming weft threads  $c'$  are under relatively heavy tension, which may be provided by suitably weighted brake straps acting on the beams from which the respective warp threads are taken, or by other means.

When knitting the present fabric, the nap or pile weft threads  $b'$  are subject to relatively light tension; in practice, they are relatively loose. The tension of the threads  $b'$  is so light that it is just sufficient to allow them to be taken off from their beam without danger of tangling or snarling.

Because of their relatively heavy tension and the method of knitting, the body-forming weft threads  $c'$  are taut in the knitted fabric. The nap or pile-forming weft threads  $b'$ , being under only light tension during the knitting of the fabric, the knitting action pulls them into deep loops  $b''$  at the bends of turns and as they are not taken up by any subsequent tension or needle pull, these loops  $b''$  remain free and loose and constitute a nap or pile.

When knitting the fabric, the tension on threads  $a', c'$  is kept sufficiently heavy to insure a firm compression of the bundles or groups of threads  $b', c'$  by the loops  $a''$  of the chains of warp threads  $a'$ . This compression, with the pressure exerted by the body threads  $c'$  on the pile threads  $b'$  which are enclosed within the loops  $a''$ , causes the pile threads to remain permanently fastened, even when the high, loose loops are subjected to severe finishing processes. In Fig. 12, the loops  $b''$  appear as they are in the knitted fabric. They may be left in that form, or, they may be brushed, combed, or otherwise treated.

The relatively heavy tension to which the weft threads  $c'$  are subject causes their bends or turns  $c''$  to draw tightly weftwise on the loops  $a''$  of the warp chains  $a'$ . The sinuous form of the body-threads  $c'$ , a given number of units one way (eight in the pres-

ent instance) in one course, then rising and returning in the opposite direction in the succeeding course a distance embracing the same number of units, disposes the threads  
 5  $c'$  in bundles or groups, the turns or bends  $c''$  of each individual thread  $c'$  being arranged in successively progressing position in both directions weftwise of the fabric. This results in subjecting each loop  $a''$  of  
 10 each warp chain  $a'$  to opposite pulls by oppositely turning or facing bends  $c''$  of the body threads  $c'$  and tightly binds the fabric together weftwise. The tension on the warp threads  $a'$  causes them to be knitted as tight  
 15 chains. Consequently, the possibility of stretching warpwise or weftwise in a fabric made like my invention is reduced to a minimum.

By using only the warp threads  $a'$  and  
 20 body-forming threads  $c'$  in the manner specified, there is produced a fabric having a smooth flat body which is filled in with closely arranged parallel ribs as shown in Figs. 12 and 14. By incorporating the nap  
 25 or pile threads  $b'$  under relatively light tension, but bound in by the loops  $a''$ , a nap or pile fabric is provided, which is a particular object of my invention.

The frequency of the  $c'$  threads at the  
 30 back of the fabric assists in automatically forcing the nap or pile threads  $b'$  toward the front while the fabric is being knitted.

A furry or woolly surface is so desirable on a certain kind of fabrics that special machinery and processes have been used to  
 35 produce this appearance, prior to my invention. In an effort to simulate fur or wool it has been a common practice to tear the body strands or fibres of the fabric with  
 40 wire combs and brushes, in addition to the usual scouring, dyeing and fulling processes. Such processes of combing are, of course, injurious to the fabric in several ways. The threads may be pulled out of their proper  
 45 position in the fabric; the strands of thread may be weakened or severed, thus opening rents in the fabric or leaving the wearing surface or body of the cloth unable to withstand wear for any great length of time.

My new method of knitting provides a fabric having a special nap or pile surface composed of free loops which are held  
 50 tightly in place in the main fabric and may, or may not, be combed, in addition to the scouring, dyeing and fulling. In any event, the body of the fabric is tightly knitted, substantially equivalent to what weaving  
 55 would produce, and is not affected unfavorably by any surface treating process to which the nap or pile loops may be subjected.

Fabrics produced by the present invention, wherein the nap or pile loops  $b''$  have merely  
 65 been scoured, dyed and fulled, have been found to have a surface which is far superior

to any which can be made by using the combing process on ordinary fabrics heretofore produced. When the combing treatment is applied to a fabric produced by my  
 70 present method, an extremely long and furry nap or surface is produced, composed solely of the surface or nap loops  $b''$ . The body of the fabric, being unharmed by the surface treating processes applied to the pile or nap  
 75 threads, remains as strong and firm as in any untreated woven cloth, while the surface presents the beautiful napped appearance so desirable in certain commercial fabrics. I have thus produced by my new  
 80 method a fabric of great wearing qualities and attractiveness.

This application is, in part, a continuation of application Serial No. 242,479, filed June 28, 1918, knitted fabrics.

What I claim is:

1. The method of knitting a fabric which is substantially non-stretchable and is of substantially uniform and regular formation warpwise and weftwise throughout its extent, which consists in forming a body  
 90 composed solely of tensioned warp threads and tensioned weft threads, the warp threads being knitted into tight loops while knitting into said loops uniformly and regularly laid tensioned sinuous weft threads in  
 95 a manner insuring the enclosure and tight binding of the weft threads at different points of their lengths and at their bends or turns by the loops of the warp threads and the exertion of weftwise tension by the  
 100 bends or turns of the weft threads on the warp loops where they interlock with the loops of the warp threads, the weft threads being repeated in regular and corresponding formation warpwise throughout the fabric in groups or bundles, the bends or  
 105 turns of the individual weft threads of each group or bundle being regularly progressed weftwise throughout the fabric being knitted.

2. The method of knitting a fabric which is substantially non-stretchable and is of substantially uniform and regular formation warpwise and weftwise throughout its extent, which consists in forming a body  
 115 composed solely of tensioned warp threads and tensioned weft threads, the warp threads being knitted into tight loops while knitting into said loops uniformly and regularly laid tensioned sinuous weft  
 120 threads in a manner insuring the enclosure and tight binding of the weft threads at different points of their lengths and at their bends or turns by the loops of the warp threads and the exertion of weftwise tension  
 125 by the bends or turns of the weft threads on the warp loops where they interlock with the loops of the warp threads, the weft threads being repeated in regular and corresponding formation warpwise throughout  
 130

the fabric in groups or bundles, the bends or turns of the individual weft threads of each group or bundle being regularly progressed weftwise throughout the fabric being knitted, and each bend of a weft thread being interlocked with two loops of a given warp thread for the purpose of subjecting each loop of a warp thread to opposite tensions by the weft threads laid in different courses of the fabric.

3. The method of knitting a fabric having a nap or pile, which consists in laying sinuous weft body-forming threads and sinuous nap or pile-forming threads across tensioned warp threads and knitting the tensioned warp threads into successive loops which enclose and tightly bind the body-forming threads and nap or pile-forming threads.

4. The method of knitting a fabric having a nap or pile, which consists in laying relatively heavily tensioned weft body-forming threads and relatively lightly tensioned nap or pile-forming threads across tensioned warp threads and knitting the tensioned warp threads into successive loops which enclose and tightly bind the body-forming threads and nap or pile-forming threads.

5. The method of knitting a fabric having a nap or pile, which consists in laying body-forming weft threads and nap or pile-forming threads in sinuous form in successive courses across tensioned warp threads and knitting the warp threads into successive loops which enclose and tightly bind the body-forming and nap or pile-forming threads, while applying a degree of tension to the body-forming threads such as will cause their bends or turns to draw tightly weftwise on the warp loops with which they interlock, and forming the nap or pile-forming threads into loops which are free or loose from the body of the fabric.

6. The method of knitting a fabric having a nap or pile, which consists in laying body-forming weft threads and nap or pile-forming threads in sinuous form in successive courses across tensioned warp threads and knitting the warp threads into successive loops which enclose and tightly bind the body-forming and nap or pile-forming threads, while applying a degree of tension to the body-forming threads such as will cause their bends or turns to draw tightly weftwise on the warp loops with which they interlock, and a lighter tension to the nap or pile-forming threads and by such difference of tension providing the nap or pile-forming threads at their bends or turns with free, loose loops on the body of the fabric.

7. The method of knitting a fabric having a nap or pile, which consists in laying body-forming weft threads and nap or pile-forming weft threads in groups or bundles in sinuous form in successive courses across

tensioned warp threads with the bends or turns of different ones of said body-forming weft threads in progressively weftwise-advanced arrangement, and knitting the warp threads into successive loops which enclose and tightly bind the body-forming weft threads and nap or pile-forming weft threads, while applying a degree of tension to the body-forming weft threads such as will cause their bends or turns to draw tightly weftwise in opposite directions on successive warp loops with which they interlock, and a lighter tension to the nap or pile-forming threads and by such difference of tension providing the nap or pile-forming threads at their bends or turns with loops which are free or loose on the body of the fabric.

8. A knitted fabric which is of substantially uniform and regular formation warpwise and weftwise throughout its extent comprising warps composed of successive loops, and pluralities of tensioned weft threads arranged in bundles or groups in regular and uniform sinuous form in successive courses warpwise and weftwise throughout the fabric with the bends or turns of different ones of said weft threads in progressively weftwise-advanced arrangement and enclosed within, and tightly bound by, said loops the successive progressively weftwise-advanced bends or turns of said tensioned weft threads drawing tightly weftwise on the successive loops of the warp chains with which they interlock in a manner to exert alternately opposite tensions or pulls on each loop of a warp.

9. A knitted fabric of uniform structure having warps comprising successive loops, relatively taut weft threads arranged in regular sinuous formation throughout successive courses and enclosed within, and tightly bound by, said loops, the bends or turns of said weft threads drawing tightly weftwise on the warp chains with which they interlock, and nap or pile threads arranged in regular sinuous form in successive courses and enclosed within, and tightly bound by, said loops, the nap or pile threads having their bends or turns free and loose and constituting a nap or pile, the parts of the nap or pile threads intermediate their bends or turns being secured to the body by the pressure of the weft threads and the binding action of the loops of the warp chains.

10. A knitted pile fabric having warp chains, composed of successive loops, pluralities of relatively taut weft threads arranged in bundles or groups in sinuous form in successive courses with the bends or turns of different ones of said weft threads in progressively weftwise-advanced arrangement and enclosed within, and tightly bound by, said loops, the progressively weftwise ad-

vanced bends or turns of said weft threads drawing tightly weftwise on the warp chains with which they interlock, and nap or pile threads arranged in groups or bundles in  
 5 sinuous form in successive courses and enclosed within, and bound by, said loops of the warp chains, the nap or pile threads having their bends or turns free and loose and constituting a nap or pile standing out-  
 10 wardly from the body of the fabric.

11. A knitted fabric which is of substantially uniform and regular formation warpwise and weftwise and is non-stretchable, consisting of warp threads having loops, and  
 15 relatively taut sinuous weft threads, repeated in uniform sinuosity warpwise and weftwise of the fabric, each bend or turn of a weft thread being interlocked with a loop of a warp thread, and sinuous nap or pile  
 20 threads bound by the loops of the warp threads and repeated in uniform sinuosity warpwise and weftwise of the fabric and having their bends or turns free and loose.

12. A knitted fabric consisting of independent warp chains having loops and tensioned sinuous weft threads extending warpwise and weftwise of the fabric whose bends or turns interlock with the loops of the warp chains, binding the warp chains together,  
 25 the sinuous weft threads being regularly repeated warpwise of the fabric and arranged in weftwise extending groups or bundles, each tensioned weft thread crossing a plurality of warp threads, the bends or turns of successive weft threads being regularly  
 30 progressed weftwise of the fabric.

13. A knitted fabric which is of substantially uniform and regular formation warp-

wise and weftwise throughout its extent and is non-stretchable warpwise and weftwise,  
 40 consisting of warp threads having loops, and tensioned weft threads of sinuous and uniform formation having their bends or turns interlocked with the loops of the warp threads and exerting alternately opposite  
 45 tensions or pulls on the various warp threads in successive courses of the fabric, the weft threads being repeated uniformly warpwise and weftwise throughout the fabric, and arranged in weftwise extending groups or  
 50 bundles, each tensioned weft thread crossing a plurality of warp threads, the bends or turns of successive weft threads being arranged progressively weftwise of the fabric.

14. A knitted fabric which is of substantially uniform and regular formation warpwise and weftwise and is non-stretchable warpwise and weftwise, consisting of independent warp chains each composed of loops, and tensioned weft threads of uniform  
 55 sinuous formation having their bends or turns interlocked with the loops of the warp chains and exerting opposite tensions or pulls on the various warp chains in successive courses, the weft threads binding the  
 60 warp chains together and being repeated uniformly warpwise and weftwise throughout the fabric and arranged in weftwise extending groups or bundles, each tensioned weft thread crossing a plurality of warp  
 65 threads, the bends or turns of successive weft threads being progressed weftwise of the fabric.

In testimony whereof I affix my signature.

ISAAC SPRINGTHORPE.