

July 26, 1960

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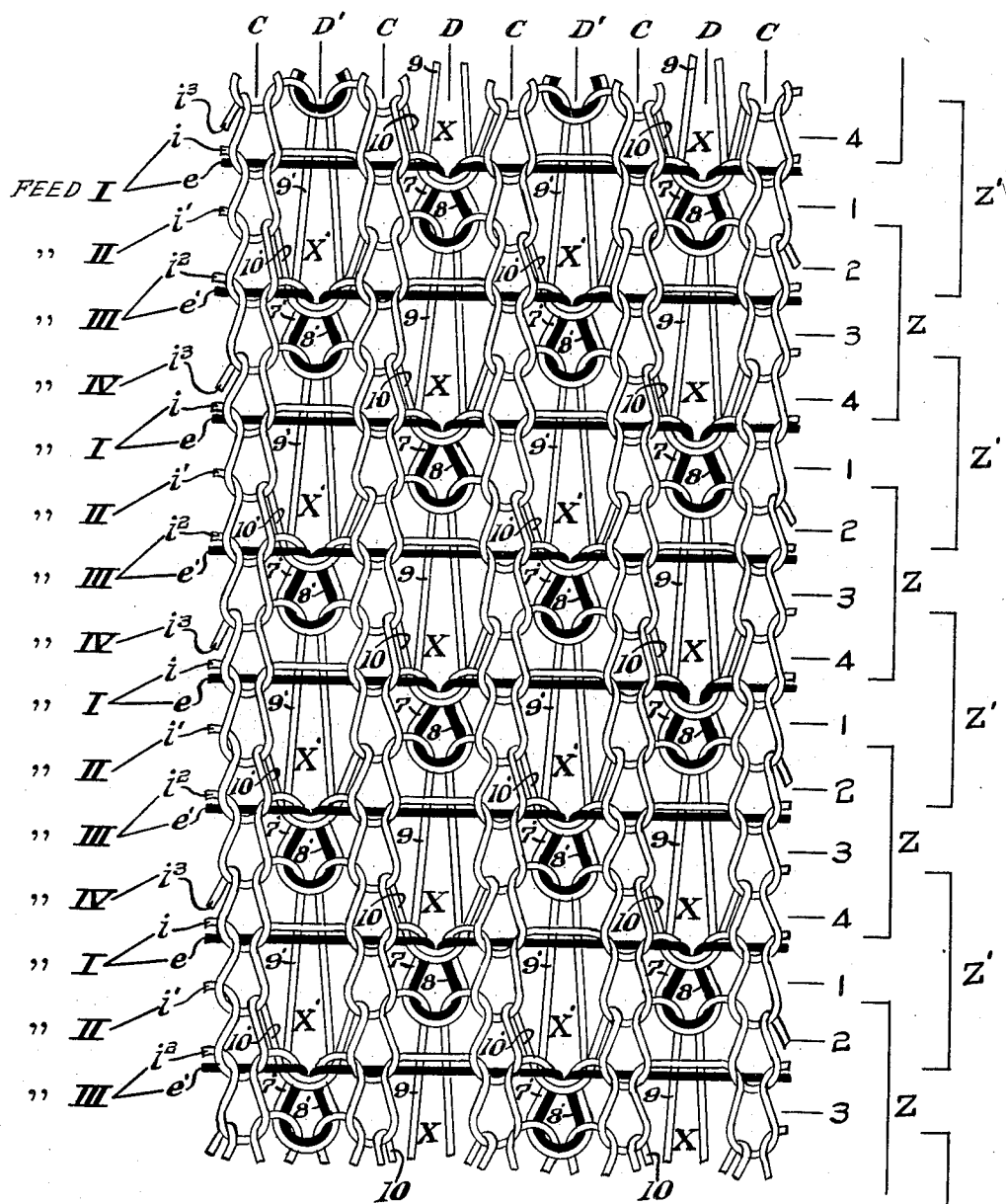
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KNITTED FABRICS

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10 Sheets-Sheet 1

FIG. 1 -



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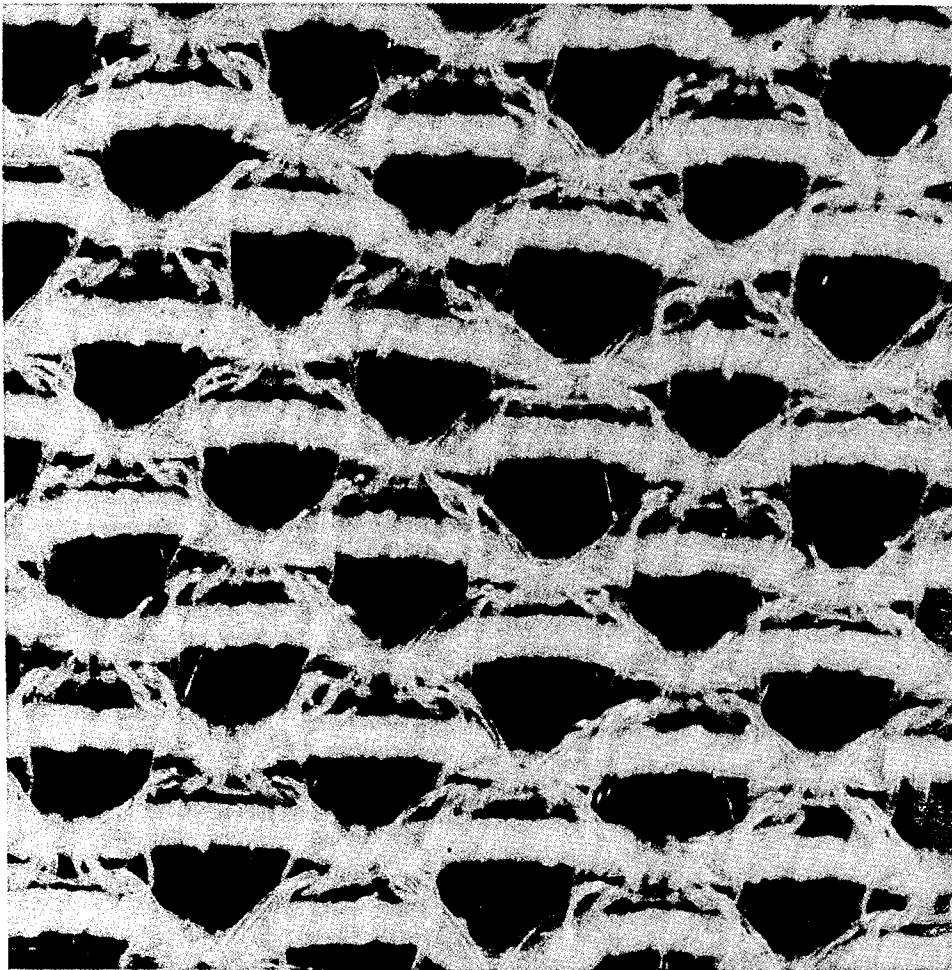
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FIG. 2 -



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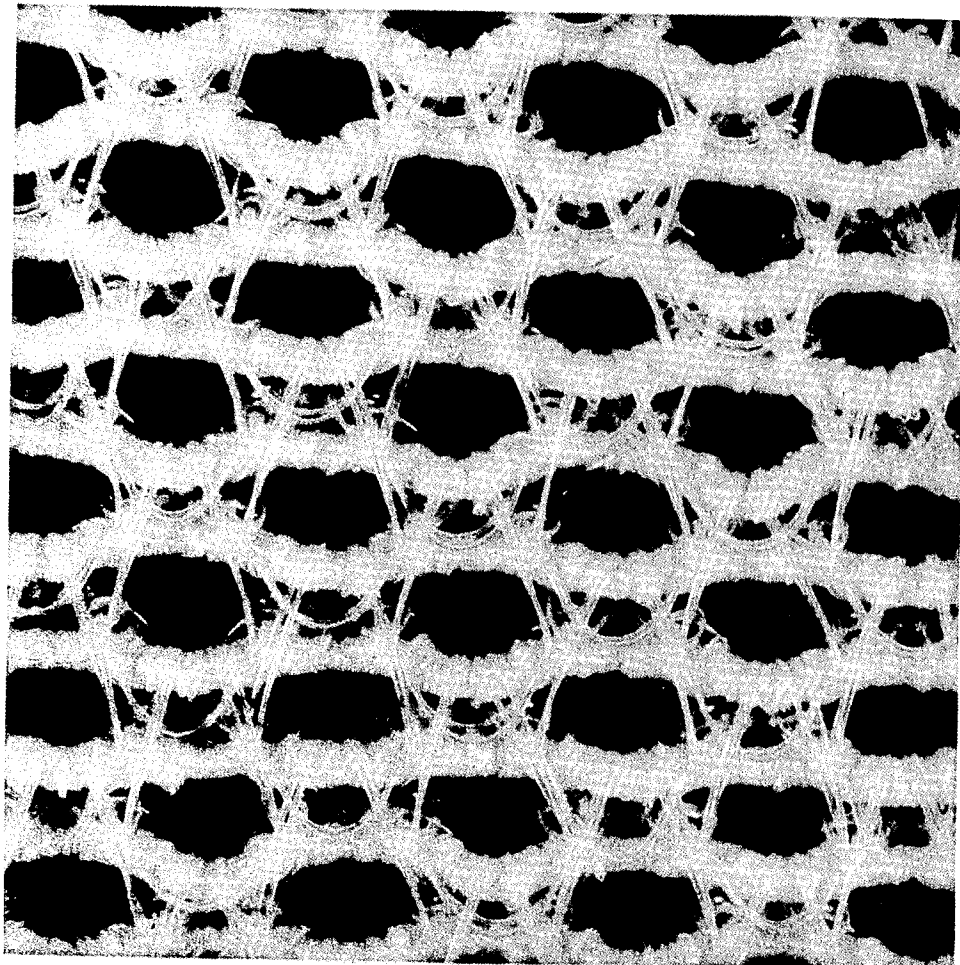
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FIG. 3



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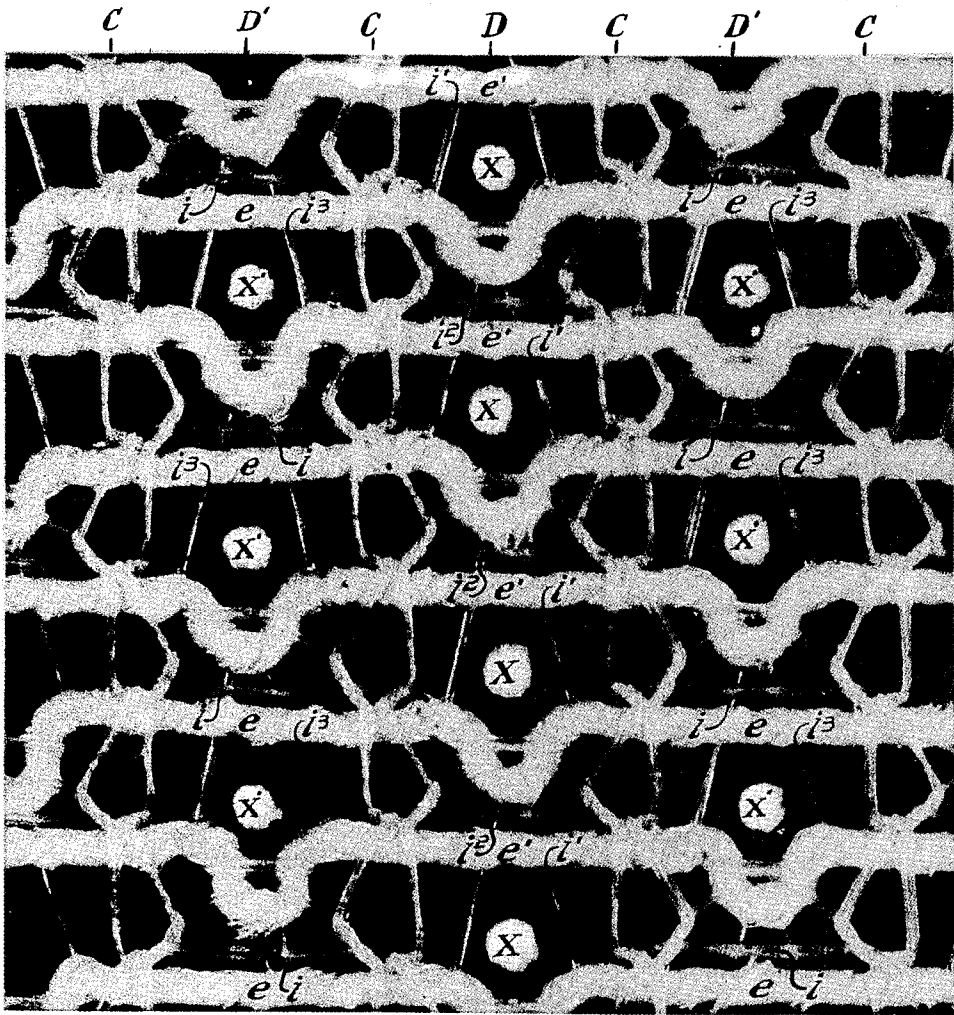
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FIG. 4 -



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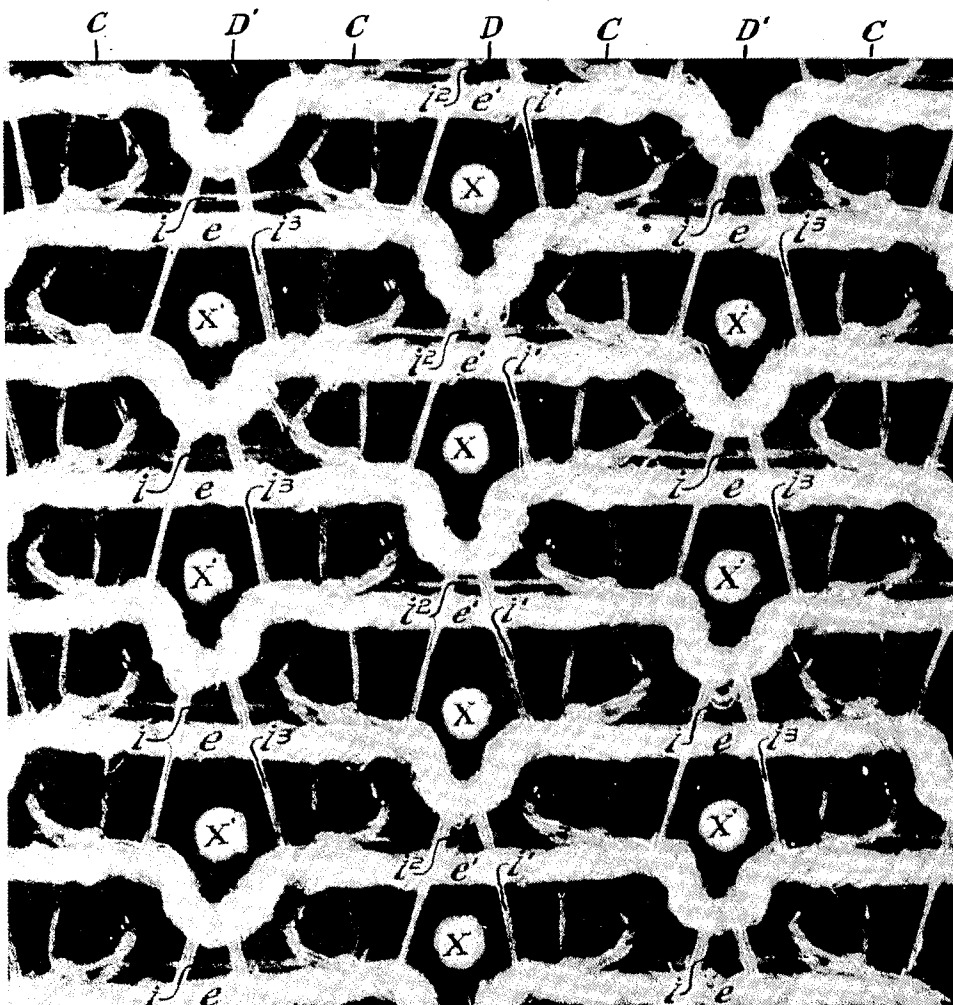
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FIG. 5 -



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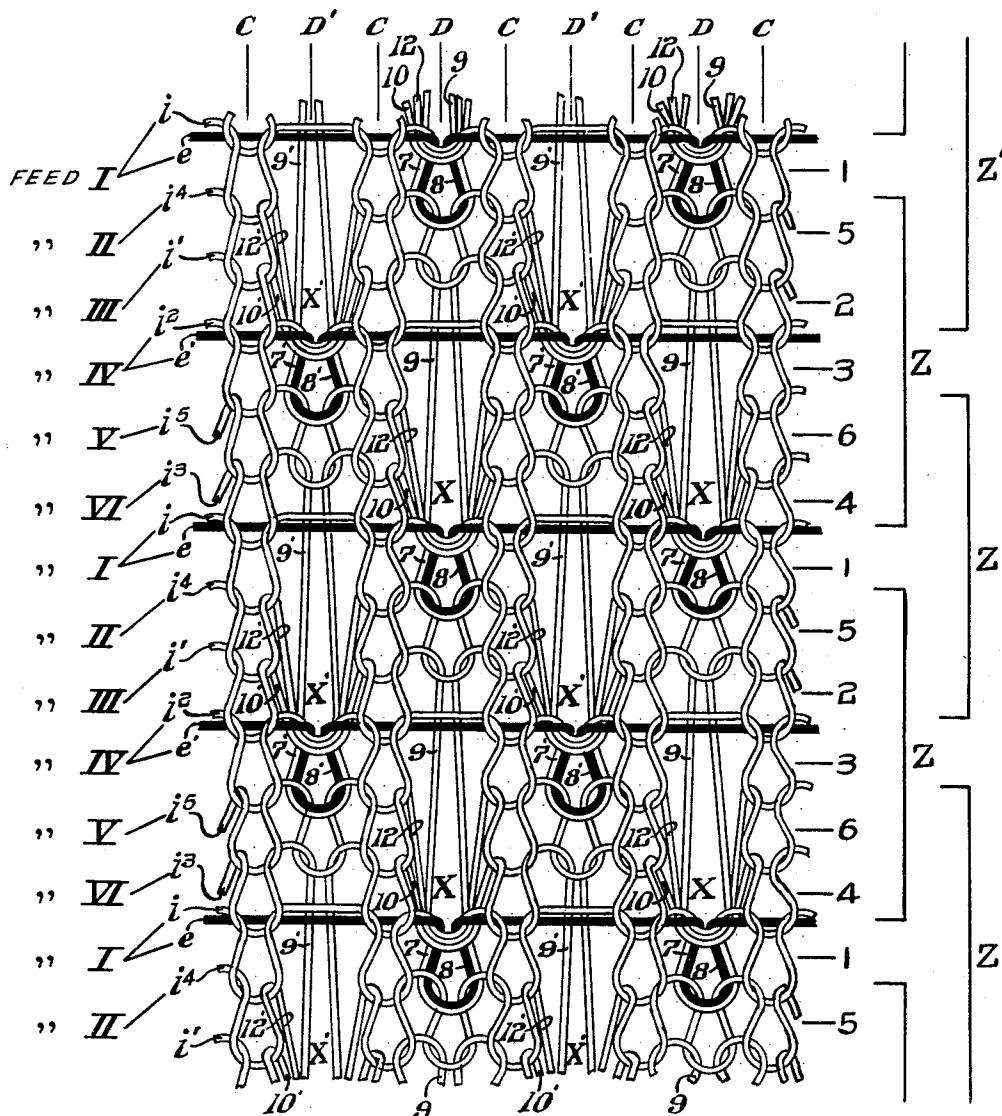
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FIG. 6.



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FIG. 7 -

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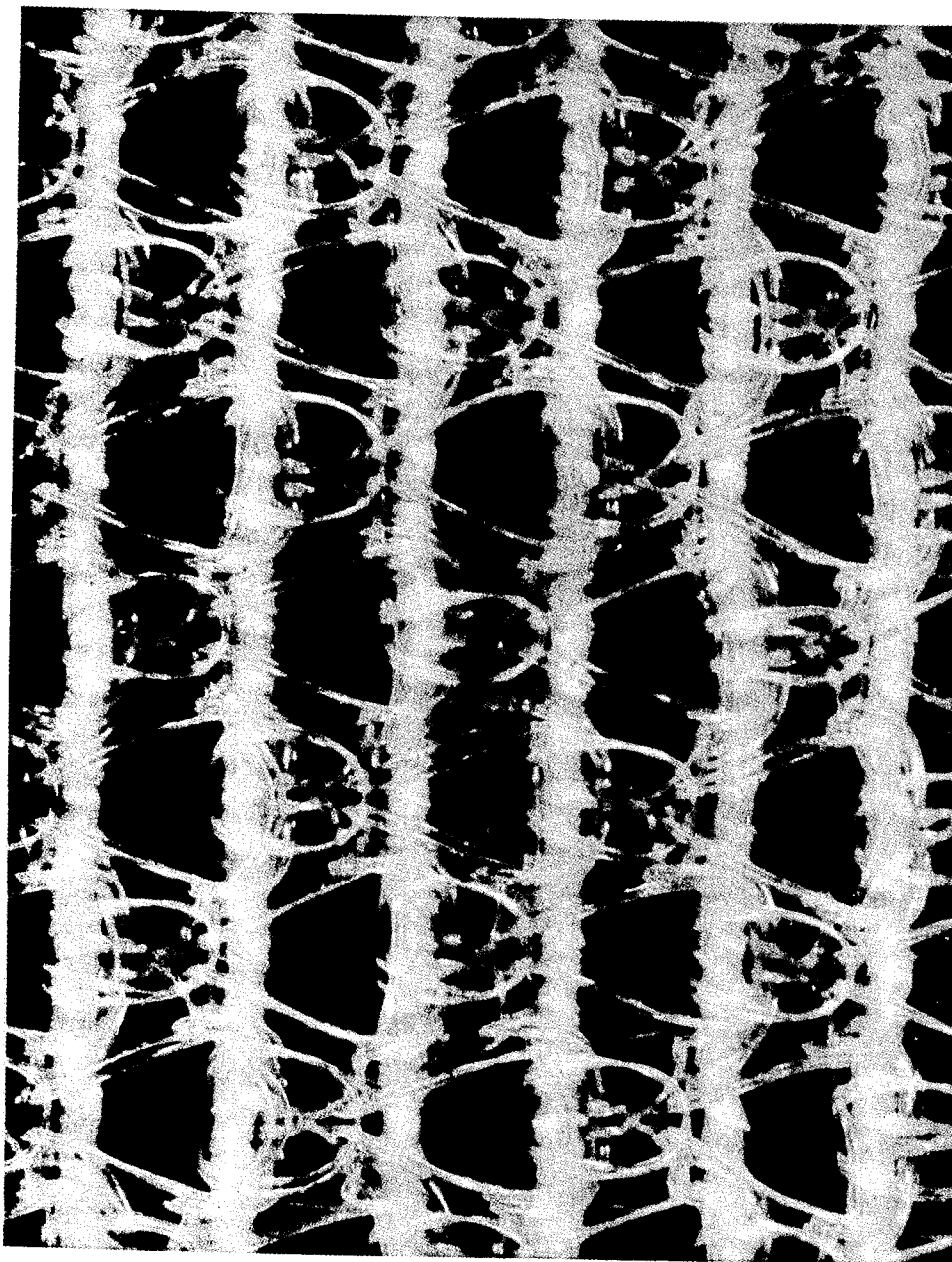


FIG. 8 -

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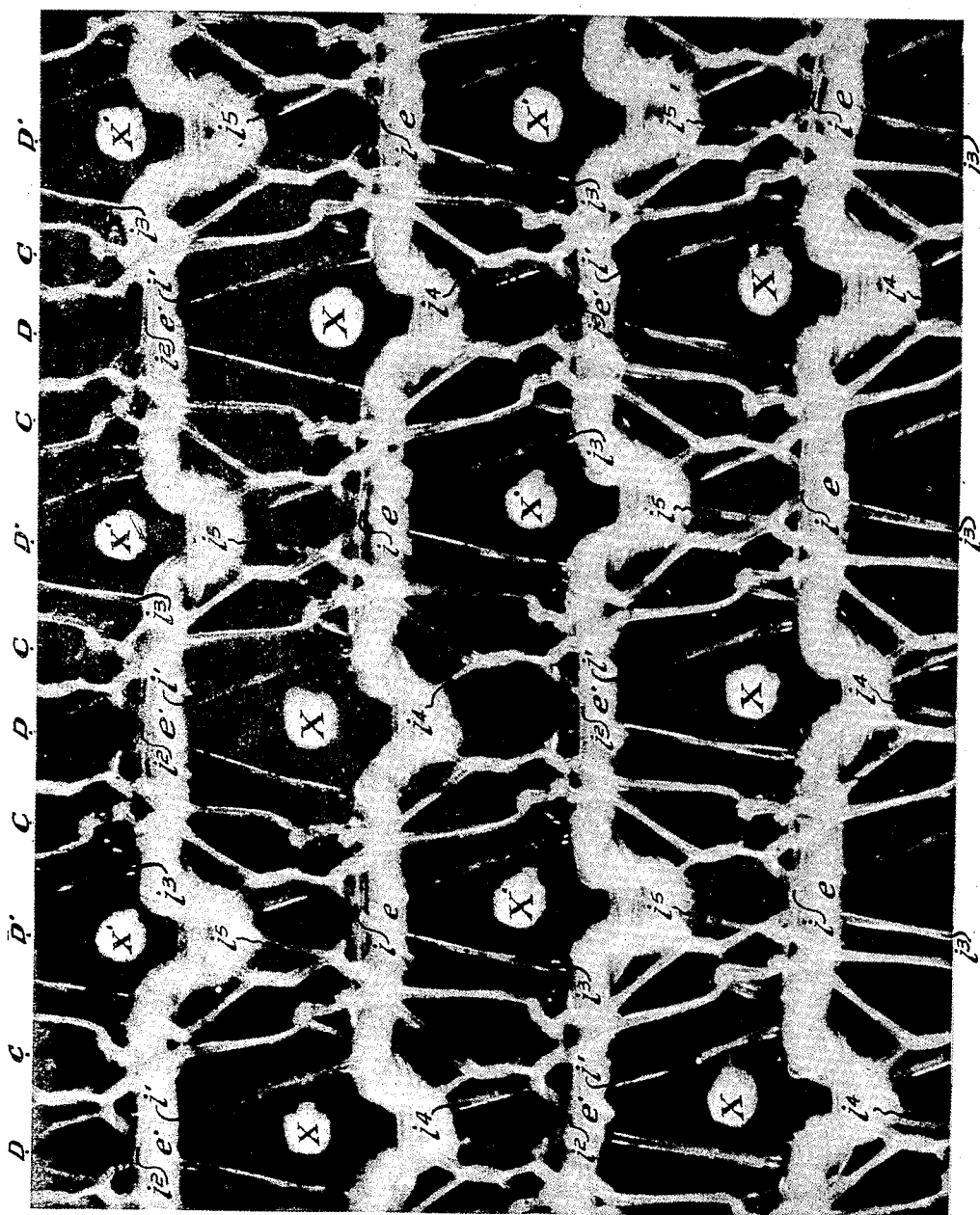
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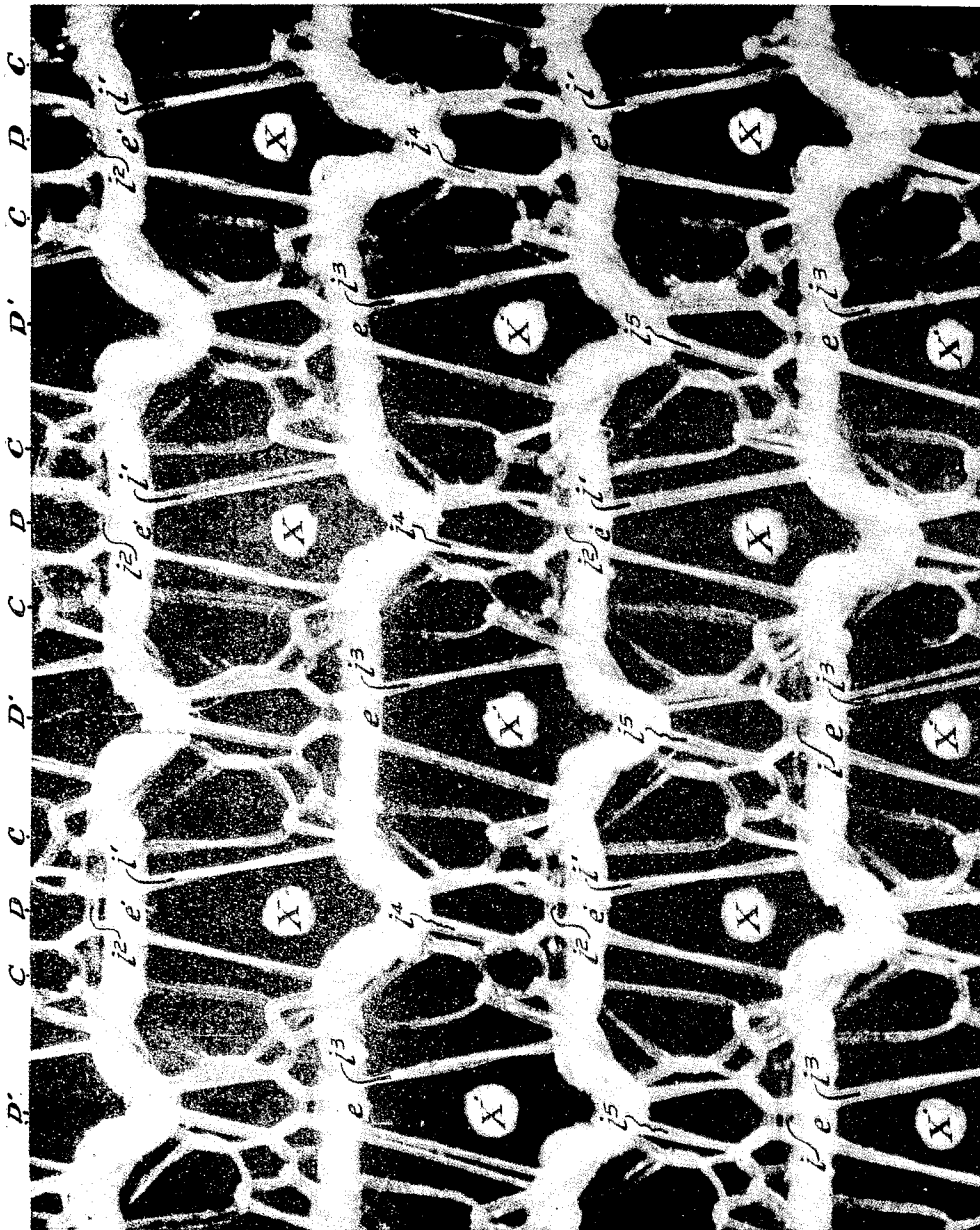


FIG. 10.

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Filed Oct. 8, 1957, Ser. No. 688,953

6 Claims. (Cl. 66—200)

This invention relates to knitted fabrics. More particularly, it is concerned with knitted fabrics primarily intended for use in the manufacture of supporting garments, such as foundation garments, brassieres and the like.

The chief aim of my invention is to provide knitted fabrics suitable for the above purposes which are porous, attractive in appearance, light in weight and elastic so that garments made therefrom will furnish the desired support while conforming comfortably to the contour of the wearer's body.

Another object of my invention is to provide elastic knitted fabrics having the above attributes which lend themselves to economic production in quantity by manufacture in tube form on circular knitting machines.

A further object of my invention is to provide net elastic fabrics which are knitted of inelastic and elastic yarns and which have staggered interstices formed therein.

It is a further object of my invention to provide knitted fabrics composed of monofilament inelastic yarn and having interstices formed therein by the interlooping or tucking loops of spaced courses in spaced wales and having spaced courses containing elastic yarn knit in spaced wales and floated across the wales intervening between said latter spaced wales.

Other objects and attendant advantages will appear from the following detailed description of the attached drawings, wherein:

Fig. 1 is a fragmentary, diagrammatic view showing the front face of a knitted fabric embodying my invention and produced on a circular knitting machine having four feeds or multiples thereof.

Figs. 2 and 3 are photographic views on a magnified scale of the front and back faces, respectively, of an actual, unstretched fabric of the type shown in Fig. 1.

Figs. 4 and 5 are magnified views of the fabric of Figs. 2 and 3 showing the front and back faces, respectively, when in stretched condition.

Figs. 6, 7, 8, 9 and 10 are views corresponding to Figs. 1, 2, 3, 4 and 5, respectively, showing a modified fabric embodying my invention and produced on a circular machine having six feeds or multiples thereof.

The fabric shown in Fig. 1 of the drawings as illustrative of my invention is a one and one rib structure having outer face cylinder needle wales C in alternation, respectively, with inner face dial needle wales D and D' and having staggered interstices X and X' formed, respectively, in overlapping alternate and intervening zones Z and Z'. This fabric can be produced rapidly and economically on any standard circular rib machine, such as a Scott and Williams or a Wildman Jacquard machine having complements of cylinder and dial needles, four feeds or multiples thereof, which are represented in Fig. 1 by the numbers I-IV, and means for variably selecting dial needles for tucking or welting. In knitting the fabric of Fig. 1 on a four feed machine in accordance with my invention, six yarns are employed, these comprising four

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inelastic yarns i , i' , i^2 and i^3 and two elastic yarns e and e' . For convenience of distinction from the inelastic yarns, the elastic yarns e and e' are shown in heavy black lines.

In the embodiment shown in Fig. 1, the inelastic yarn i and the elastic yarn e are fed at feed I, the inelastic yarn i' is fed at feed II, the inelastic yarn i^2 and the elastic yarn e' are fed at feed III, and the inelastic yarn i^3 is fed at feed IV. During formation of the fabric, all of the cylinder needles of the machine knit all of the inelastic yarns. The elastic yarns e and e' are not knitted by any of the cylinder needles, and hence are floated across all the cylinder needle wales C.

At feed I alternate dial needles are moved out to clearing position to take and knit the inelastic yarn i and the elastic yarn e in the spaced wales D, while the intervening dial needles pass in welt position to hold the stitches previously formed by them from inelastic yarn i^3 and miss the yarns i and e , thereby causing the latter yarns to float across the intervening dial needle wales D'. At feed II alternate dial needles are moved out to clearing position to take and knit the inelastic yarn i' in the spaced wales D, while the intervening dial needles are moved out to tuck position to take and hold the yarn i' in the intervening wales D'. Interlooped with the yarn i' in the intervening wales D' are the previously drawn loops of inelastic yarn i^3 which were held on the needles forming wales D' during knitting at feeds I and II. At feed III alternate dial needles are moved out to clearing position to take and knit the inelastic yarn i^2 and the elastic yarn e' in the intervening wales D', while the intervening dial needles pass in welt position to hold the stitches previously formed by them from yarn i' and miss the yarns i^2 and e' , thereby causing the latter yarns to float across the spaced wales D. At feed IV alternate dial needles are moved out to clearing position to take and knit the inelastic yarn i^3 in the intervening wales D', while the intervening dial needles are moved out to tuck position to take and hold the yarn i^3 in the spaced wales D. Interlooped with the yarn i^3 in the spaced wales D are the previously drawn loops of inelastic yarn i' which were held on the needles forming wales D during knitting at feeds III and IV.

Selection of dial needles such that alternate dial needles knit while the remaining dial needles welt or tuck, and reversing the procedure at other feeds, may be accomplished in various well known ways. For example, two lengths of needles may be used in the dial, as in interlock machines, together with double cam raceways. Selection also may be accomplished by use of long and short butt needles using cams in a manner well known to those skilled in the knitting art.

As a consequence of knitting the fabric in the manner just described, the interstices X in the alternate zones Z are staggered relative to the interstices X' in the zones Z'. It will be noted that the elongated and short tuck loops 9 and 10 formed of the inelastic yarns i' and i^3 in the courses 4 are anchored by doubled regular loops 7 and 8 of the inelastic and elastic yarns i and e in the courses 1, and that the elongated and short tuck loops 9' and 10' formed of the inelastic yarns i^2 and i' in the courses 2 are anchored by doubled regular loops 7' and 8' of the inelastic and elastic yarns i^2 and e' in the courses 3. It is to be further noted that in all instances floats of the inelastic and elastic yarns extend across the interstices X and X' at the outer face of the fabric and that the elongate yarn loops 9 and 9' are formed at the inner face of the fabric.

Preferably, the inelastic yarns used in the practice of this invention should comprise "stiff" monofilament synthetic yarns, such as nylon or the like.

The elastic yarns used in the practice of this inven-

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tion should comprise yarns having an inherent capacity to elongate under tension, and having an inherent tendency to contract from an elongated condition with a degree of power in contraction. Such yarns include, but are not necessarily limited to, rubber yarn, covered rubber yarn and elastic polymers of the type disclosed in U.S. Patent No. 2,623,031, one example of which is presently known as DuPont "Lycra," a spandex yarn.

In Figs. 2 to 5 inclusive is shown an actual fabric having the loop and yarn construction of the fabric diagrammatically shown in Fig. 1. The outer face of the fabric is shown in Figs. 2 and 4 and its inner face is shown in Figs. 3 and 5. The fabric is unstretched in Figs. 2 and 3 and stretched in Figs. 4 and 5. In this fabric, the two elastic yarns *e* and *e'* each comprise 100 core nylon covered rubber yarn, and the inelastic yarns *i*, *i'*, *i²* and *i³* each comprise two ends of 20 denier monofilament nylon yarn, rather than a single end of a coarser denier nylon yarn, such as 40 denier. The term "100 core" as applied to rubber yarn indicates a yarn of such diameter that one hundred bare strands thereof may be laid side by side within the space of one inch. Multiple ends of smaller denier nylon yarn may be used in lieu of a single end of a coarser denier nylon yarn for various purposes, such as to reduce stiffness in the fabric, to add to the lengthwise stretch of the fabric, to permit more uniform tensioning and thereby reduce "wash boardiness" when large multiples of yarn feeds are used and to provide a safety factor in the case of yarn breakage, due to the yarn catching on the bobbin or other cause, which normally affects only one end, thereby reducing chances of the fabric being cast off the needles. In addition to the use of two ends of 20 denier nylon yarn in lieu of a single end of 40 denier nylon yarn, it is possible also to use, in the fabric of Figs. 3, 4, 5 and 6, three ends of 12 or 15 denier monofilament nylon yarn or four ends of 10 denier monofilament nylon yarn. Of course, the number of ends of monofilament yarn used in the practice of this invention, and the deniers thereof, may be varied through wide ranges, as is well understood in the art, for the purpose of producing certain desired results in the finished fabric. Similarly, monofilament synthetic yarns other than nylon, such as polyesters (e.g. "Dacron"), acrylics (e.g. "Orlon"), and the like, may be used if desired.

It will be seen from Figs. 4 and 5 that when the fabric is stretched the elastic yarns *e* and *e'* are formed into definite loops wherever they have been knitted into the wales D and D'. When the fabric is relaxed, however, as shown in Figs. 2 and 3, the elastic yarns *e* and *e'* become "unknitted," i.e., due to their inherent tendency to contract, tend to place themselves in a straight line. This result is made possible by reason of the fact that the monofilament nylon yarns in the fabric present a slippery surface and hence offer a very low degree of frictional resistance to the contraction of the elastic yarns. The friction between the elastic and relatively stiff inelastic yarns is sufficient, however, to prevent the elastic yarns from resolving themselves into absolute straight lines, with the result that the elastic yarns take on a sinuous appearance, as is clearly shown in Figs. 2 and 3, the depressions of which comprise the stitches of the elastic yarn which have become "unknitted," i.e. have tended to straighten out. Due to such interaction and interposition of the inelastic and elastic yarns in the fabric when it is relaxed, the fabric acquires a highly attractive and sheer appearance.

When the fabric is unstretched, as shown in Figs. 2 and 3, the elastic yarn loops, due to the contraction of the elastic yarns *e* and *e'*, are pulled back through their anchoring inelastic yarn loops to form substantially straight, but slightly undulating, spaced elastic strands. The tendency of the elastic yarns to form themselves into substantially straight line strands has the effect of also drawing the inelastic yarns in the same courses back through their anchoring loops so that such yarns become

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more wraps about the elastic yarns, thereby adding to the sheerness of the fabric.

As shown in Figs. 2 and 3, the unstretched fabric of this invention presents a net appearance of spaced, substantially straight elastic strands having a slightly undulating character and held in the fabric by nearly invisible inelastic yarn stitches. Thus, the fabric is capable of having both strong elastic qualities and extreme sheerness.

The undulating elastic strands comprise a series of slight crests and depressions in alternation, the depressions, of course, being the loops of the elastic yarns which have pulled back through their anchoring yarn loops into virtual straight line formation. The crests and depressions of each alternate elastic strand are staggered with respect to the crests and depressions of the intervening elastic strands. Thus, the unstretched fabric is formed with a plurality of spaced, walewise extending depressions of elastic yarn with each pair of such spaced depressions separated by an intervening crest of elastic yarn. As will readily be seen in Figs. 2, 3, 4 and 5, when the fabric is unstretched each interstice X and X' is formed by a tucked stitch of inelastic yarn and is framed at its opposite ends, respectively, by a crest and by a depression of elastic yarn disposed in opposing relation.

The modified fabric diagrammatically illustrated in Fig. 6 is made on a machine having six feeds or multiples thereof. It is constructed in the manner of the four feed fabric of Fig. 1, except additional courses 5 and 6 are knit between courses 1 and 2 and 3 and 4, respectively. Courses 5 are formed from inelastic yarn *i⁴* fed at feed II and have their loops 12' in the intervening dial needle wales D' tucked with the loops 9' and 10' of the inelastic yarns *i³* and *i'* in the courses 2. Courses 6 are formed from inelastic yarn *i⁵* fed at feed V and have their loops 12 in the alternate dial needle wales D tucked with the loops 9 and 10 of the inelastic yarns *i'* and *i³* in the courses 4. As a consequence, the interstices X in the alternate zones Z are staggered relative to the interstices X' in the zones Z'. The elongate yarn loops 9 and 9' are formed at the inner face of the fabric, while the floats of the inelastic yarns extend across the loops 9 and 9' at the outer face of the fabric.

In Figs. 7 to 10 inclusive is shown an actual fabric having the loop and yarn construction of the fabric diagrammatically shown in Fig. 6. The outer face of the fabric is shown in Figs. 7 and 9 and its inner face is shown in Figs. 8 and 10. The fabric is unstretched in Figs. 7 and 8 and stretched in Figs. 9 and 10. In this fabric, the inelastic yarns *i*, *i'*, *i²*, *i³*, *i⁴* and *i⁵* each comprise two ends of 20 denier monofilament nylon yarn, while the elastic yarns *e* and *e'* each comprise 100 core nylon covered rubber yarn.

As will be seen from Figs. 7 and 8, when the fabric is relaxed, the elastic yarns *e* and *e'* become "unknitted" and acquire a sinuous appearance. When the fabric is stretched, as shown in Figs. 9 and 10, the elastic yarns *e* and *e'* take on the appearance of definite loops wherever they have been knitted into the wales D and D'.

While the specific illustrations herein shown and described relate to one and one rib knitted fabrics, it is to be understood that such fabrics are merely preferred embodiments of my invention. As will be well understood by those skilled in the art, my invention lends itself to weft knitted fabrics of all types, including plain knitted fabrics and the various rib knitted fabric constructions.

Similarly, feeding of the elastic yarns may be reversed or varied without departing from the spirit of this invention. For example, in the fabric of Fig. 6, elastic yarn may be fed at feeds II and V instead of at feeds I and IV.

Also, where a circular dial and cylinder machine is used, selection of needles for tucking and welting may occur on the cylinder needles instead of on the dial needles, in which event the elongated loops will be formed at the outer face of the fabric. Thus, while the

term "rib wales" is generally understood in the art to denote the needle wales knit by the dial needles of a knitting machine, it is to be understood that such term "rib wales" as used in the claims herein may denote either the needle wales knit by the dial needles or the needle wales knit by the cylinder needles of a knitting machine.

It is to be understood that while in both of the exemplified forms of the fabric shown in the drawings the zones Z and Z' overlap each other, they may be separated by one or more courses, preferably knitted from inelastic yarn, in a manner which will also be readily understood by those skilled in the knitting art.

Having thus described my invention, I claim:

1. In a rib knitted elastic net fabric composed of courses of monofilament inelastic yarn and elastic yarn, a plurality of spaced interstices disposed throughout the fabric, said interstices comprising tucked stitches of said monofilament inelastic yarn, and a plurality of spaced undulating elastic strands formed of said elastic yarn, said elastic strands each having a succession of alternating crests and depressions, said depressions comprising unknitted stitches of elastic yarn when the fabric is unstretched, the depressions of alternate elastic strands being disposed in the same wales as the crests of the intervening elastic strands whereby each interstice in the fabric is framed at its opposite ends, respectively, by a crest and a depression disposed in opposing relation, the total denier of said monofilament inelastic yarn per course being 45 denier or less.

2. In a rib knitted elastic net fabric composed of courses of monofilament inelastic yarn and elastic yarn, a plurality of spaced interstices disposed throughout the fabric, said interstices comprising tucked stitches of said monofilament inelastic yarn, and a plurality of spaced undulating elastic strands formed of said elastic yarn, said elastic strands each having a succession of alternating crests and depressions, said depressions comprising unknitted stitches of elastic yarn when the fabric is unstretched, the depressions of alternate elastic strands being disposed in the same wales as the crests of the intervening elastic strands whereby each interstice in the fabric is framed at its opposite ends, respectively, by a crest and a depression disposed in opposing relation, said inelastic yarn comprising a plurality of monofilament strands of 10 or more denier each.

3. In a rib knitted elastic net fabric composed of courses of monofilament inelastic yarn and elastic yarn, a plurality of spaced interstices disposed throughout the fabric, said interstices comprising tucked stitches of said monofilament inelastic yarn, and a plurality of spaced undulating elastic strands formed of said elastic yarn, said elastic strands each having a succession of alternating crests and depressions, said depressions comprising unknitted stitches of elastic yarn when the fabric is unstretched, the depressions of alternate elastic strands being disposed in the same wales as the crests of the intervening elastic strands whereby each interstice in the fabric is framed at its opposite ends, respectively, by a crest and a depression disposed in opposing relation, said inelastic yarn comprising two monofilament strands of 20 denier each.

4. In a rib knitted elastic net fabric composed of courses of monofilament inelastic yarn and elastic yarn, a plurality of staggered interstices, said interstices comprising tucked stitches of said monofilament inelastic yarn in selected rib wales of the fabric, and a plurality of spaced undulating elastic strands formed of said elastic yarn, said elastic strands each having a succession of alternating crests and depressions, said depressions comprising unknitted stitches of elastic yarn when the fabric is unstretched, the depressions of alternate elastic strands being disposed in the same rib wales as the crests of the intervening elastic strands whereby each interstice in the fabric is framed at its opposite ends, respectively, by a crest and a depression disposed in opposing relation, the total denier of said monofilament inelastic yarn per course being 45 denier or less.

5. In a rib knitted elastic net fabric composed of courses of monofilament inelastic yarn and elastic yarn, a plurality of staggered interstices, said interstices comprising tucked stitches of said monofilament inelastic yarn in selected rib wales of the fabric, and a plurality of spaced undulating elastic strands formed of said elastic yarn, said elastic strands each having a succession of alternating crests and depressions, said depressions comprising unknitted stitches of elastic yarn when the fabric is unstretched, the depressions of alternate elastic strands being disposed in the same rib wales as the crests of the intervening elastic strands whereby each interstice in the fabric is framed at its opposite ends, respectively, by a crest and a depression disposed in opposing relation, said inelastic yarn comprising a plurality of monofilament strands of 10 or more denier each.

6. In a rib knitted elastic net fabric composed of courses of monofilament inelastic yarn and elastic yarn, a plurality of staggered interstices, said interstices comprising tucked stitches of said monofilament inelastic yarn in selected rib wales of the fabric, and a plurality of spaced undulating elastic strands formed of said elastic yarn, said elastic strands each having a succession of alternating crests and depressions, said depression comprising unknitted stitches of elastic yarn when the fabric is unstretched, the depressions of alternate elastic strands being disposed in the same rib wales as the crests of the intervening elastic strands whereby each interstice in the fabric is framed at its opposite ends, respectively, by a crest and a depression disposed in opposing relation, said inelastic yarn comprising two monofilament strands of 20 denier each.

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