March 20, 1956 T. P. SCOTT, JR 2,738,566

PUCKERED KNIT FABRIC AND METHOD OF PRODUCING SAME

Filed May 17, 1955 6 Sheets-Sheet 1

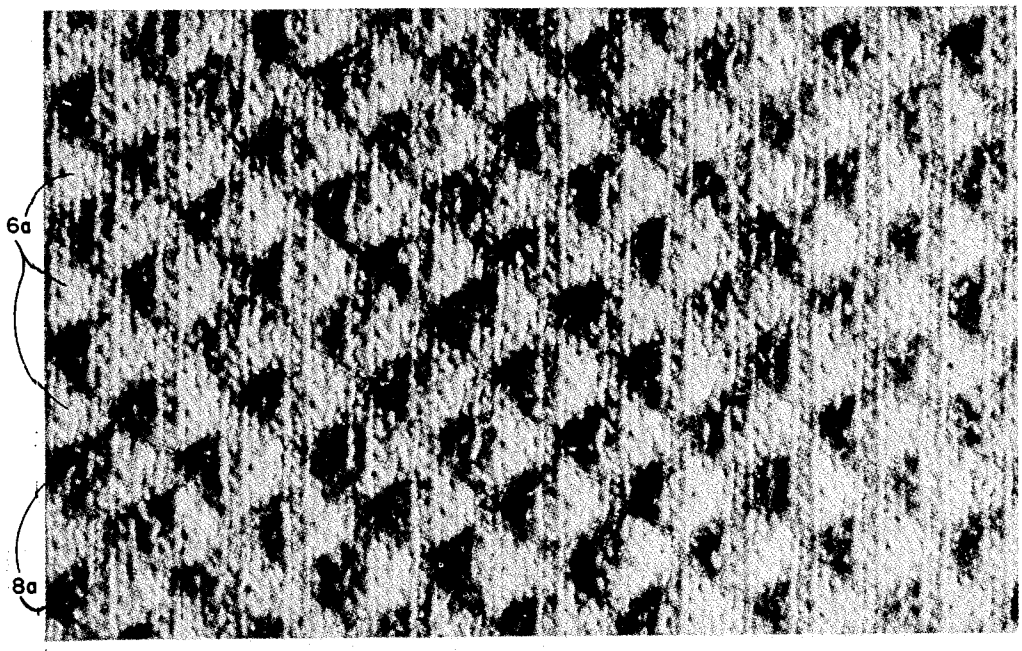


FIG. 1

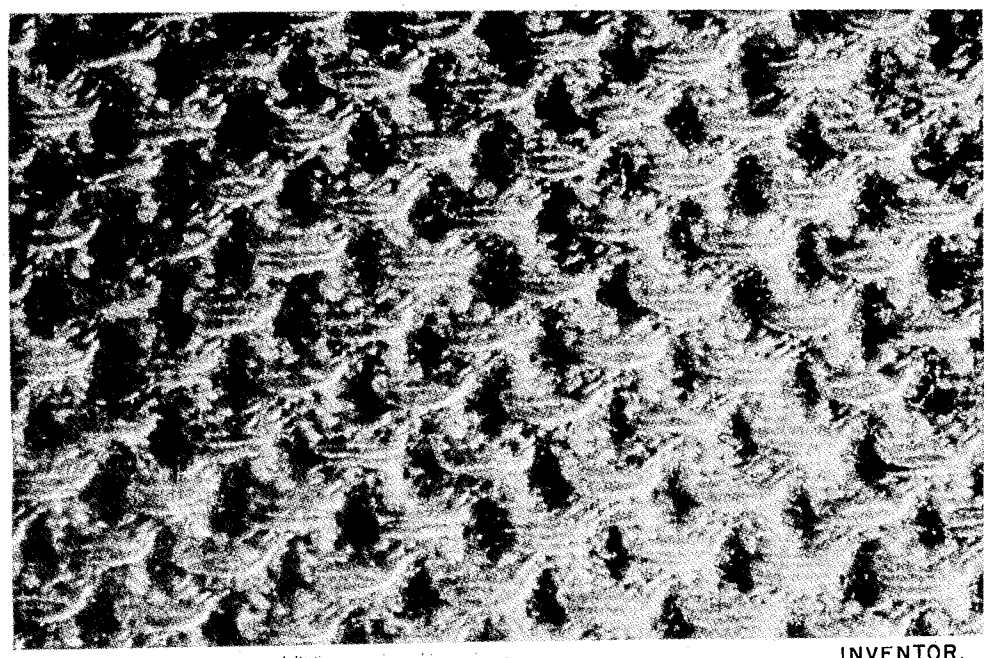


FIG. 2

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PUCKERED KNIT FABRIC AND METHOD OF PRODUCING SAME

Filed May 17, 1955 6 Sheets-Sheet 2

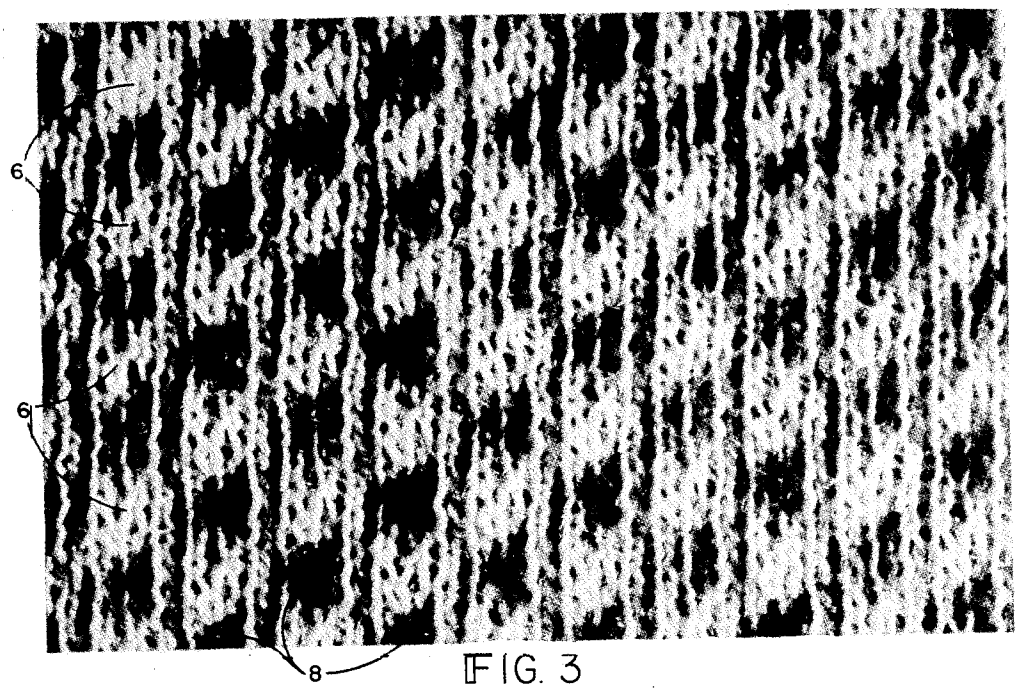


FIG. 3

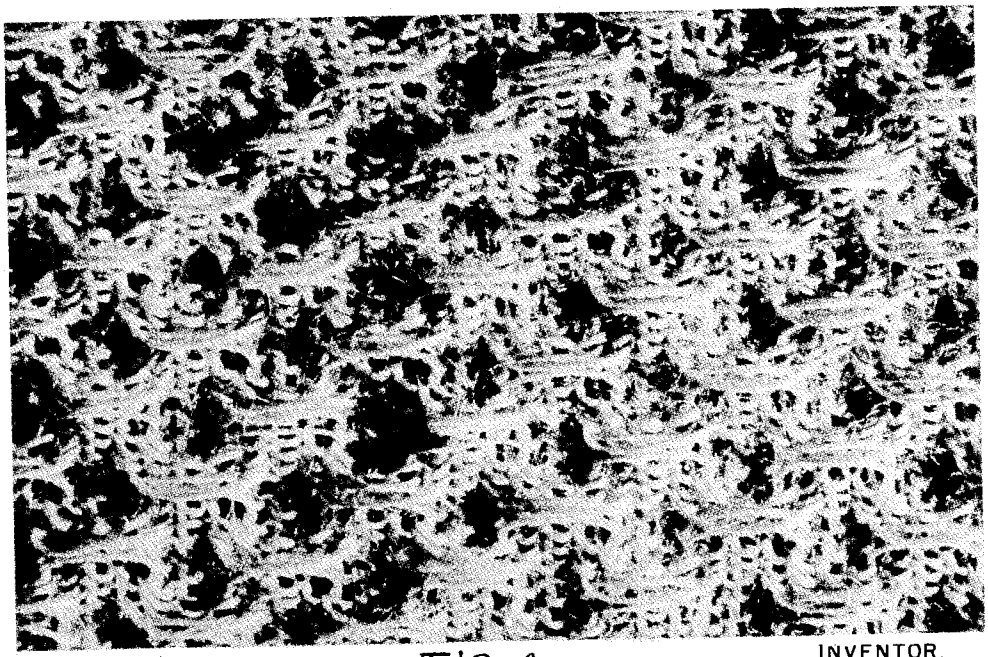


FIG. 4

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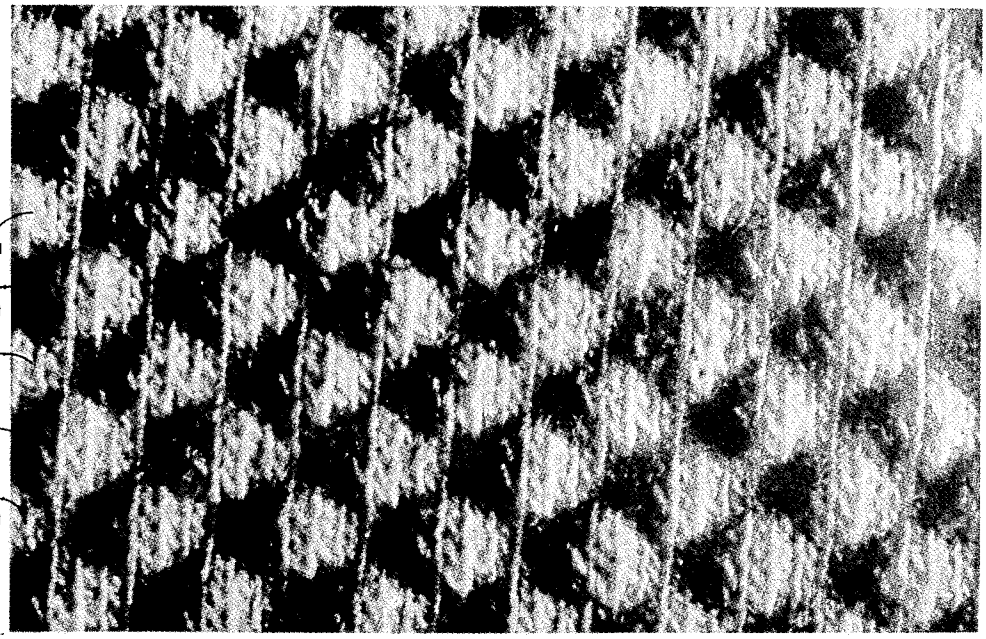


FIG. 5

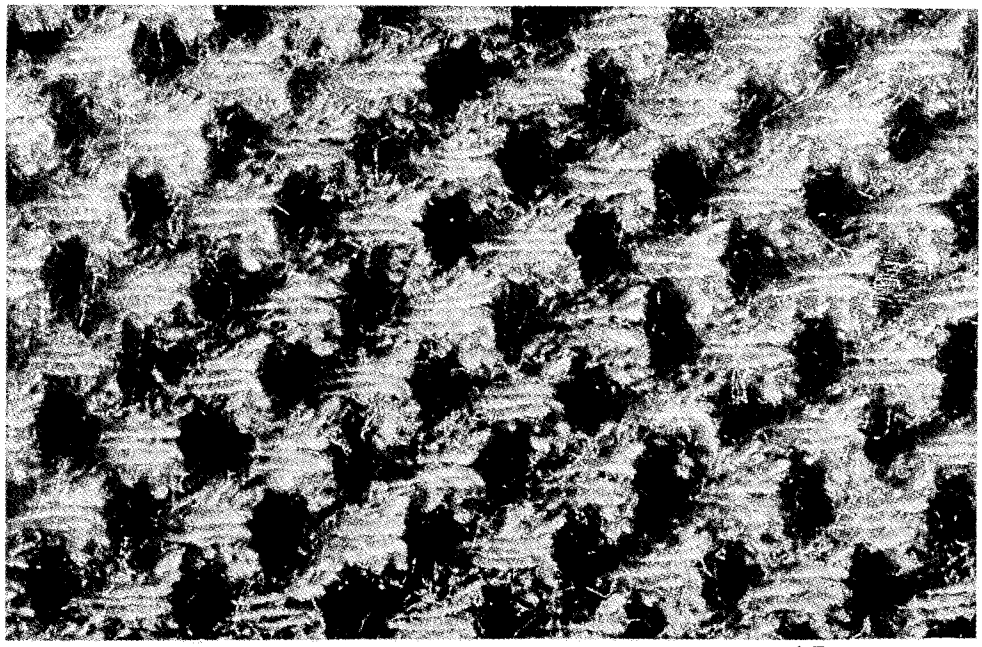


FIG. 6

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PUCKERED KNIT FABRIC AND METHOD OF PRODUCING SAME

Filed May 17, 1955 6 Sheets-Sheet 4

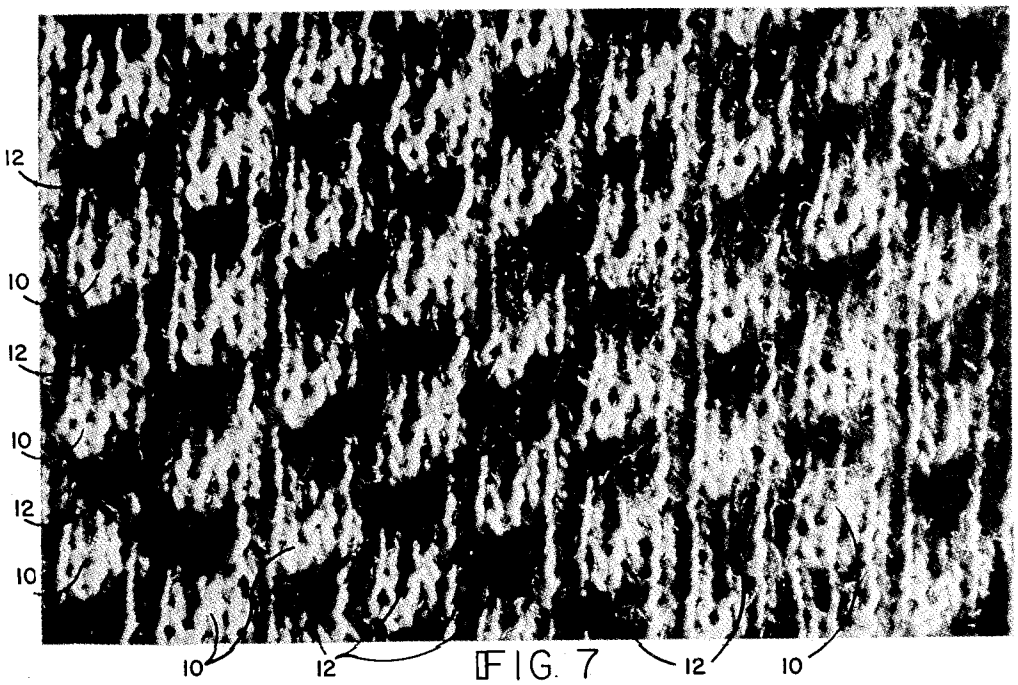


FIG. 7

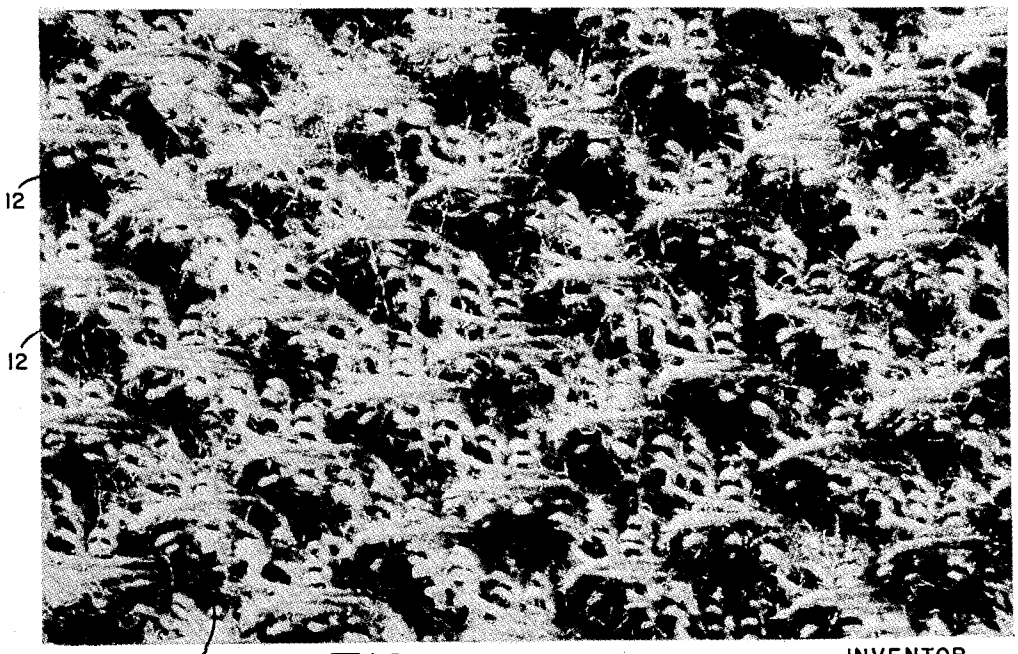


FIG. 8

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March 20, 1956 T. P. SCOTT, JR 2,738,566

PUCKERED KNIT FABRIC AND METHOD OF PRODUCING SAME

Filed May 17, 1955 6 Sheets-Sheet 5

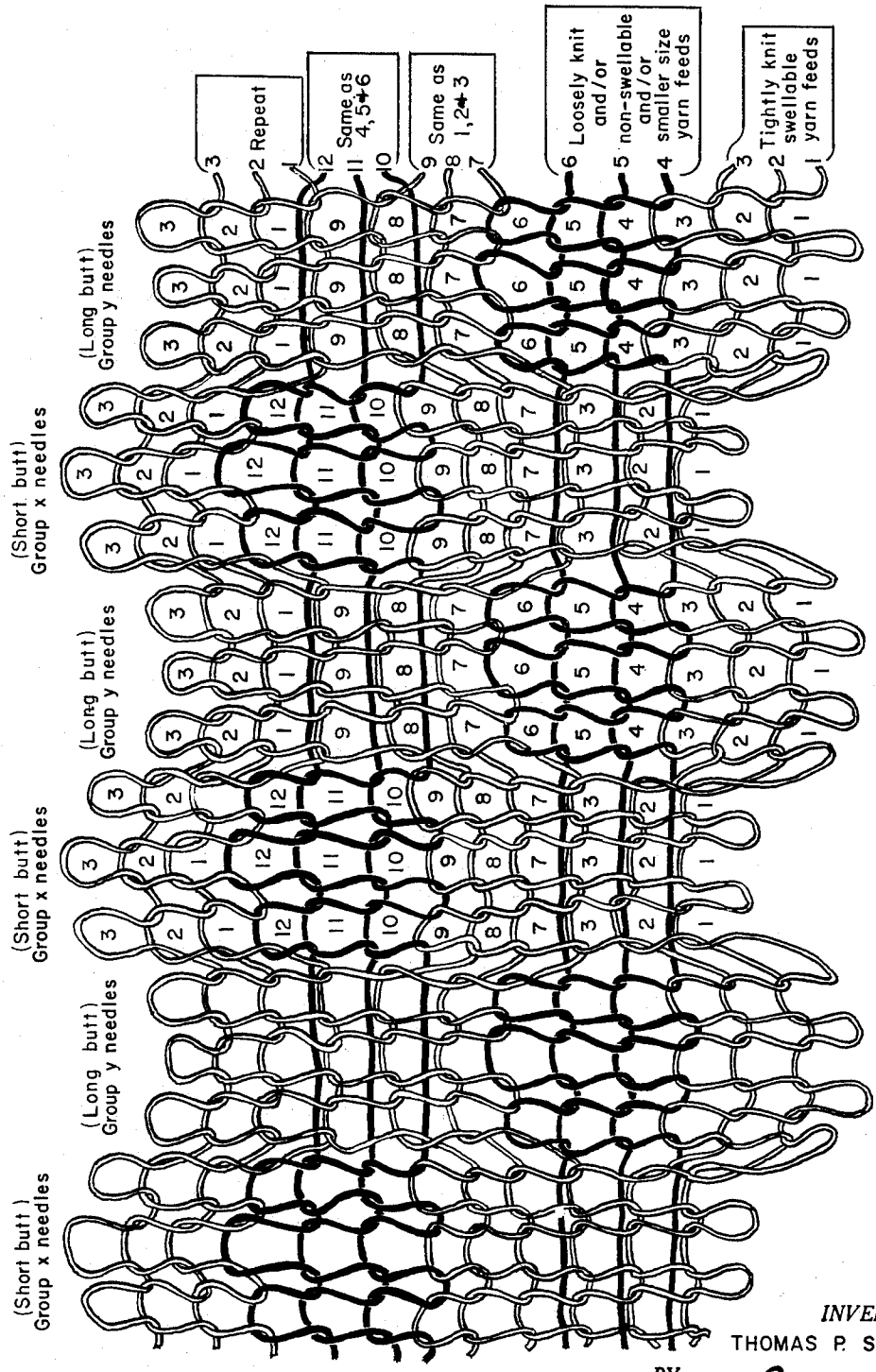


FIG. 9

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Filed May 17, 1955 6 Sheets-Sheet 6

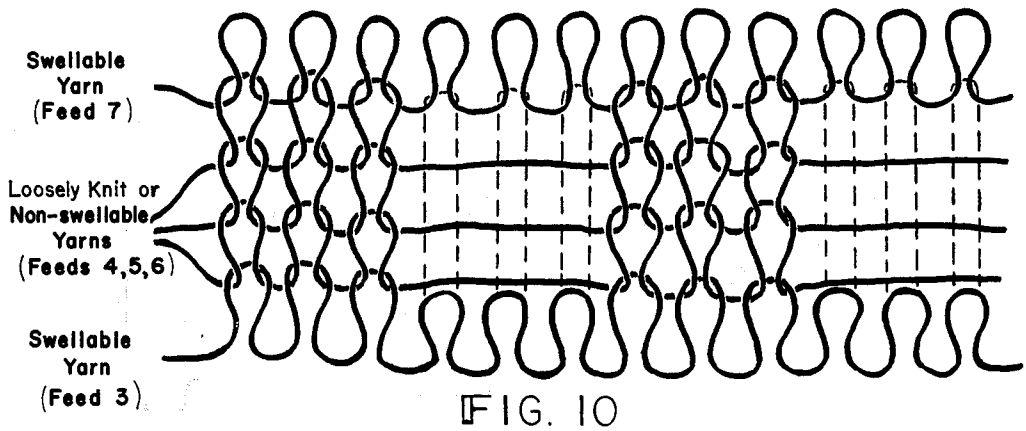


FIG. 10

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United States Patent Office 2,738,566 Patented Mar. 20, 1956

2,738,566

PUCKERED KNIT FABRIC AND METHOD OF PRODUCING SAME

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Application May 17, 1955, Serial No. 508,919

20 Claims. (Cl. 28—76)

This invention relates to the production of plain knit textile fabrics having three-dimensional pattern effects, and specifically to plain knit textile fabrics produced on single cylinder knitting machines and having puckered areas. As hereinafter described, the puckers appear in predetermined areas so as to give the fabric a patterned appearance, either uniformly repeated throughout the fabric to produce, for example, a seersucker, plisse, or pique appearance, or non-uniformly distributed as design areas dispersed on a plain background.

It is the primary object of the invention to produce plain knit puckered fabrics which have stability in the third dimension, i. e., the pucker appearance survives any subsequent manufacturing treatments and is durable under repeated washings. In the preferred form, the fabric simultaneously has greater widthwise and lengthwise stability against shrinkage than that of conventional knitted fabrics. My puckered fabrics are thus particularly suitable for use in the fabrication of garments where it is important that appearance change in the garment as well as any dimensional changes will be minimal upon washing.

Fabrics of this invention may be produced in a variety of manners as hereinafter described but they all have the common feature of having certain plain knit puckered areas which are surrounded or otherwise segregated either walewise or coursewise from each other by intervening plain knit background areas; and wherein the background areas are constituted of interknitted loops which have been subjected, by treatment of the fabric after knitting, to rigid body deformation and wherein the interknitted loops of the intervening puckered areas are so knitted, or their yarns are so pre-treated or are made of such different material that, during such after-knitting treatment, they do not undergo material rigid body deformation but remain free to spatially adjust through rigid body translation and/or rotation. The result is that after such differential treatment the puckered area loops occupy more nearly the same area that they did before the treatment, while the loops of the background areas occupy a smaller area, the puckered areas being displaced out of the plane of the fabric in the direction of the thickness of the fabric. The total projected area of the loops of the puckered areas is, however, substantially less than that of the total projected area of those loops before such treatment.

Such differential effects in the contrasting areas are achieved most simply by knitting the areas with different characteristics of bending stiffness and then subjecting the total fabric to compressional forces (such as occur during conventional caustic shrinkage) which, in the background areas, because of relatively high degree of fabric stiffness, are translated into rigid body deformation; while, in the intervening areas, because of relatively little fabric stiffness, the same forces are either translated into spatial adjustment of the loops, i. e., translation and/or rotation without any great degree of rigid body deformation or better still, the forces are rendered ineffective in the intervening areas, i. e., the intervening areas are knit with

yarns which are individually resistant to the shrinkage forces.

In the latter case, though the yarns may be individually resistant to the compressing forces, they collectively, i. e., as an area, have little resistance to the rigid body deformation developed in the background areas and hence are displaced out of the plane of the fabric in the form of puckers to provide a plisse effect.

According to this invention I utilize contractible yarn in knitting the background areas and I so knit the fabric in those areas as to provide a bending stiffness which, during subsequent treatment of the fabric to contract the yarns, will cause the background areas to exhibit rigid body deformation and exert a displacing pressure in the plane of the fabric against the segregated areas; and to so contrive the loop formation in the segregated areas that they will not exert equivalent displacing pressure and will not even wholly resist the displacing pressure exerted from the background areas, but rather will absorb such exerted pressures by puckering or better remaining puckered out of the plane of the fabric.

Such potential displacing pressure may be imparted to the background areas by interknitting loops of contractible yarn in those areas very tightly, i. e., beyond a minimum threshold value of knitting stiffness and hence producing rigid body deformation during subsequent treatment with a contracting agent. Such a potential condition in a fabric area is to be distinguished from one wherein treatment of a contractible yarn with a contracting agent merely causes the yarn in each loop to adjust spatially by rigid body translation and rotation.

In the latter case, the knit fabric is in an unjammed state, whereas in the former case the loops of the fabric are in an as-knit jammed state or are so near to a jammed state that they reach the jammed state befor the yarn attains its maximum contraction and accompanying diametric swelling consequent to the application of a contracting agent.

Thus, contraction of the yarn in a fabric area knit in a jammed state or in a state closely approaching the jammed state causes a loop-to-loop nudging and rigid body deformation which causes the differential amounts of overall area shrinkage on which I rely to stably maintain puckers in selected areas of my fabric.

Translation and rotation of the loops, as distinguished from rigid body deformation is retained in the segregated areas, by virtue of less body stiffness, either by avoiding the as-knit jammed state in these areas through the use of larger loops, i. e., looser knitting, or of smaller gauge or more flexible yarn; or by restricting the contraction of the yarn in the segregated areas through the use of shrinkage-resistant, non-swellable yarn; or by any combination of these. However, use of markedly different size yarns alone tends to create non-uniformity in the density of the fabric in the contrasting areas with too little coverage for most purposes in the puckered areas and hence I prefer to utilize shrinkage-resistant yarn in the pucker areas and to accentuate the pattern effect by simultaneously utilizing at least slightly larger loops, i. e., less tightly knit loops, in the pucker areas as knit, though for the purposes of illustration I have included in the drawings a representative sample of each, that is, one example where all swellable yarns have been utilized with different sized loops in the contrasting areas and another example where swellable yarn loops have been used in the background areas and non-swellable yarn loops, also of a different size, have been used in the pucker areas.

In any case, in order to separate the pucker areas at least walewise one from another, it is necessary to float the pucker area yarns coursewise between the pucker areas across the background area intervening loops.

A preferred fabric of the invention is shown in Figs. 1–4 of the accompanying drawings, wherein:

Fig. 1 is a photograph (approximately 6½×) of the face of a finished fabric, showing a three-dimensional pucker in the form of pique;

Fig. 2 is a similar photograph of the back side of the fabric of Fig. 1;

Fig. 3 is a similar photograph of the face of the fabric, as knit;

Fig. 4 is a similar photograph of the back side of the fabric of Fig. 3, as knit;

Fig. 5 is a photograph (approximately 7½×) of the face of a similar finished fabric wherein the knit loops in different areas of the fabric are formed of different kinds of yarn;

Fig. 6 is a photograph of the back side of the fabric of Fig. 5;

Fig. 7 is a similar photograph of the face of the fabric of Fig. 5 as knit;

Fig. 8 is a similar photograph of the back side of the fabric of Fig. 5 as knit;

Fig. 9 is a schematic view of the loop structure of fabric of this invention as knit to form the design of the fabrics shown in Figs. 1–8 but with a somewhat arbitrary location of the loops, it being understood that Fig. 9 is not necessarily an accurate representation of the disposition of the loops or their relative size in the fabric as knit, since such characteristics are not particularly susceptible to accurate representation in drawings; and

Fig. 10 is a similar diagrammatic detail introduced solely to clarify the knitting operation with some of the interloopings produced by the knitting being indicated by dotted extension lines.

The fabric shown in Figs. 3 and 4, as knit, comprises isolated areas **6** composed of loosely knit loops in an unjammed state, in adjacent wales and adjacent courses, the areas being segregated from one another both walewise and coursewise in a diamond pattern by intervening background areas **8** of tightly knit loops in or approaching the jammed state, with the yarns of the loosely knit isolated areas being floated coursewise as appears in Fig. 4 from loosely knit pucker area to another. The puckered effect is accentuated and stabilized by treating the fabric after knitting with a contracting agent. The contracting agent also causes some diametric swelling of the yarn. The contracting agent therefore causes the jammed state areas, formed of the tightly knit loops which do not intra se absorb the diameterwise swelling expansion of the yarn accompanying the yarn contraction to exhibit rigid body deformation. The unjammed state areas, formed of the loosely knit loops which better absorb intra se the same diameterwise swelling expansion of the yarn, are thus forced out of the plane of the fabric so that their projections in the plane of the fabric are in total area less than they were prior to treatment.

The accentuation so obtained is shown in the photographs of the treated fabric, Figs. 1 and 2. In these figures the areas **6***a* are the unjammed loosely knit loops and the areas **8***a* are the interspersed continuous areas of tightly knit loops treated after knitting with a swelling agent.

The fabric shown in Figs. 7 and 8 is similar but in this case the yarn forming the loops in the pucker areas **10** is different from the yarn forming the loops in the background areas and is resistant to the contracting agent so that the yarns of the pucker areas **10** are not at all shrunk and swollen or are not as much shrunk and swollen as the yarns in the area **12**. Such resistant yarns may be non-swellable per se or may be a swellable yarn pretreated to resist the action of the contracting agent which effectively acts on the other yarn.

The pucker so obtained, accentuated and stabilized by the treatment, is shown in Figs. 5 and 6.

The fabrics of both Figs. 3 and 4 and of 7 and 8 may be conveniently knit on a single cylinder circular knitting machine having a series of feeds. To form the particular designs shown in Figs. 1–8, the needles are arranged in groups, *x,y, x,y,* etc., the needles of both groups knitting at every tightly knitting feed, and the needles of groups *x* alone knitting at some loosely knitting yarn feeds and the needles of groups *y* alone knitting at the remaining loosely knitting yarn feeds. The group *x* needles hence do not take yarn at the loosely knitting feeds where the needles of group *y* knit and vice versa. It will be understood that where a non-swellable yarn is used, as in Figs. 5–8, it will be fed in at what has above been referred to as the loosely knitting feeds, though in such cases the looser knitting at these feeds, while desirable, is not essential.

Thus a typical needle set-up in a 12-feed spring-needle machine may be —3 long butt needles followed by 3 short butt needles, etc., with all the needles knitting at feeds **1, 2, 3, 7, 8,** and **9,** only the long butt needles knitting at feeds **4, 5,** and **6,** and only the short butt needles knitting at feeds **10, 11** and **12.** This may be accomplished in a manner known to those skilled in the art by properly arranging the needle cams to secure knitting of the long butt needles only at certain feeds, of the short butt needles only at certain other feeds, and of all the needles at still different feeds.

The resulting interknitting is illustrated in Fig. 9. Thus, yarns from feeds **1, 2, 3** at the lower edge of the fabric form the loops **1, 2** and **3,** respectively, of three successive courses. Feeds **4, 5, 6** follow to form the loops **4, 5,** and **6,** respectively, of the next three courses. Feeds **7, 8, 9** follow to form the loops **7, 8,** and **9,** respectively, of the following three courses. Feeds **10, 11, 12** follow to form the loops **10, 11,** and **12,** respectively, of the next three courses; and then feeds **1, 2, 3** repeat loops **1, 2,** and **3,** respectively, of the next three courses. Because of the distortion and/or displacement in the positioning of the floats and loops in Fig. 9, a representation of feeds **3** through **7** is shown in Fig. 10 for the purposes of clarification and indicates how, because of the yarn floats, the loops formed at feed **3** are held, as indicated by the dotted lines, at feeds **4, 5,** and **6** and are directly interknitted over the floats to the yarn fed at feed **7.**

In order to produce the essential tightly knit or jammed state fabric at least at feeds **1, 2, 3, 7, 8** and **9,** etc., the sinker cams are arranged to form only short loops of the swellable yarn on all the needles at these feeds. The sinker cams may and preferably do form longer loops at the remaining yarn feeds **4, 5, 6, 10, 11, 12,** etc., though this is not essential if swell-resistant yarn is fed at these feeds, or if the yarn at these feeds is of sufficiently smaller gauge that even with the same or even smaller size loops, the loops knit at these feeds will not closely approach the jammed state produced at the feeds **1, 2, 3, 7, 8** and **9.**

The length of the loops necessary to approach the jammed state varies with the cut of the machine and the size of the yarn. The fabric shown in the photograph of Figs. 1–4 was produced on a 22 cut spring needle machine using 30/1 C. P. yarn and knitting approximately 52–56 courses per inch; that in Figs. 5–8 using 36/1 C. P. yarn with 57–65 courses per inch. The finer the yarn, the more courses will be required in a given area in order to approach the jammed state on a given cut machine. Such a state can be approached on 22-cut machines with the use of yarns running anywhere from 24's to 36's. Finer yarns may be used successfully on finer gauge machines and the jammed state of coarser yarns may be secured on coarser gauge machines. In general, one should preferably use the coarsest yarn now generally understood in the art to be usable on a given cut machine to secure the jammed state most readily. As previously explained, if the yarn is so tightly knit as to be in a jammed state, the swelling agent action will better force or maintain the pucker areas upwardly to accentuate the pattern effect.

Ordinary scoured absorbent cotton yarn may be used throughout the fabric, as in Figs. 1–4, or solely in the tightly knit areas as in Figs. 5–8, with cotton yarn treated with conventional double waxing treatment being utilized, in the latter case, as the non-swellable yarn. In either case, the fabric may be treated after knitting with conventional caustic of mercerizing strength. Where the absorbent cotton yarn loops are in or close to a jammed state, the diameterwise swelling of the yarn accompanying its contraction will cause the absorbent cotton loops to urge the unjammed or non-swellable loops outwardly from the plane of the fabric to accentuate the three-dimensional effect or pucker, usually already visible but unstable in the untreated fabric, and which, in the case of the needle setup previously described, will have a diamond effect typical of a pique fabric. Preservation of the loose knitting in the pucker areas, even when the waxed cotton is used, provides more yarn to emerge upwardly from the plane of the fabric and helps to give better coverage in the pucker areas.

The caustic treatment will simultaneously, of course, shrink the fabric to dimensional lengthwise and widthwise stability superior to that found in conventional knitted surface effect fabrics, it being understood that the causticization treatment is followed by conventional neutralizing treatment.

Yarns other than cotton yarns may be used for the swellable yarn. For example, rayon yarn, preferably spun rayon yarn, may be used and can be made to swell in a manner similar to cotton. In general, the more swellable the yarn, the less tightly the fabric needs to be knit to reach the jammed state during treatment. Rather than waxing or oherwise rendering a naturally absorbent yarn relatively immune to a swelling agent, a naturally non-swellable yarn may be used such as the naturally hydrophobic yarns, nylon, dacron, or orlon. Any chemical agent known to swell particular yarns may be used with such yarns, and if a yarn resistant thereto is also available it may be then used in the segregated areas, if desired.

It will also be understood that variations may be made from the specific needle setup heretofore described, depending upon the size and/or distribution of the areas desired. Thus, for example, the long and short butt needles may be arranged in groups of 4 and 2, 3 and 5, 4 and 4, etc., or any other arrangement so long as the crosswise or walewise alternation is maintained. A 1,1 needle setup, however, renders the pucker areas undesirably small. Moreover, the feeds may be grouped in 2's, 3's, 4's, or in any other desirable number, according to the type of coursewise alternation desired. For the pique fabric, I find the 12-feed, 3 and 3 needle grouping to produce a highly satisfactory fabric. For a seersucker type fabric it is only necessary in Fig. 9 to omit either the long butt needles and make feeds **10, 11, 12** identical with feeds **1, 2** and **3**, or to omit the short butt needles and make feeds **4, 5** and **6** identical with feeds **1, 2** and **3**. The float courses will then appear only in spaced groups of wales without the diamond pattern of Fig. 5, and there will be only one-half the number of pucker areas which will hence appear in striped array.

I claim:

1. A knit textile fabric having a stable three-dimensional puckered appearance, comprising a plain knit fabric having segregated areas constituted of loops of yarn joined coursewise by floats and separated by intervening areas constituted of tightly knit loops of yarn interknitted walewise with said segregated area loops, the wale loops in said float areas being formed entirely by interknitted tightly knit loops, and said segregated areas visually rising out of the plane of the fabric and producing a three-dimensional puckered appearance.

2. A knit textile fabric having a three-dimensional puckered appearance, comprising a plain knit fabric having segregated areas constituted of loosely knit loops of yarn joined coursewise by floats and separated by intervening areas constituted of tightly knit loops of yarn interknitted walewise with said loosely knit loops except in said float areas, the wale loops in said float areas being formed entirely by interknitted tightly knit loops, and the loosely knit loop areas visually rising out of the plane of the fabric and producing a three-dimensional puckered appearance.

3. A knit textile fabric having a three-dimensional puckered appearance, comprising a plain knit fabric having segregated areas constituted of knit loops of relatively unswollen non-absorbent yarn joined coursewise by floats and separated by intervening areas constituted of knit loops of swollen absorbent yarn interknitted walewise with said unswollen yarn loops except in said float areas, the wale loops in said float areas being formed entirely by interknitted loops of tightly knit swollen yarn, and the unswollen yarn loop areas visually rising out of the plane of the fabric and producing a three-dimensional puckered appearance.

4. A knit textile fabric is claimed in claim 3, wherein the unswollen yarn is more loosely knit than the swollen yarn.

5. A knit textile fabric as claimed in claim 3, wherein the areas of unswollen yarn loops are segregated in a diamond pattern to impart a pique appearance to the fabric.

6. A knit textile fabric as claimed in claim 3, wherein the absorbent yarn is causticized cellulosic yarn.

7. A knit textile fabric as claimed in claim 3, wherein the swollen yarn is causticized cotton yarn and the unswollen yarn is a cotton yarn treated to render it hydrophobic.

8. A knit textile fabric as claimed in claim 3, wherein the swollen yarn is causticized cotton yarn and the unswollen yarn is nylon yarn.

9. A knit textile fabric as claimed in claim 3, wherein the swollen yarn is rayon yarn.

10. A knit fabric ready for caustic treatment to produce a three-dimensional puckered appearance, constituted of an absorbent swellable yarn tightly knit only in selected adjacent courses but at every wale in such courses, and intervening yarns knit only in intervening courses at selected wales and floated across intervening wales, thereby forming the wale loops in the area of the floats solely of tightly knit yarn, and providing fabric constituted of segregated areas of intervening yarn loops surrounded by tightly knit loops, whereby treatment with a swelling agent will swell the absorbent tightly knit loops to displace the yarn loops of said segregated areas and impart a puckered appearance to the fabric.

11. A knit fabric ready for caustic treatment to produce a three-dimensional puckered appearance, constituted of an absorbent swellable yarn tightly knit only in selected adjacent courses but at every wale in such courses, and a yarn loosely knit only in intervening courses at selected wales and floated across intervening wales, thereby forming the wale loops in the area of the floats solely of tightly knit absorbent swellable yarn, and providing fabric constituted of segregated areas of loosely knit yarn loops surrounded by tightly knit loops of absorbent yarn, whereby treatment with a swelling agent will swell the absorbent tightly knit loops selectively to displace the loosely knit yarn loops of said segregated areas and impart a puckered appearance to the fabric.

12. A knit fabric ready for caustic treatment to produce a three-dimensional puckered appearance, constituted of an absorbent swellable yarn tightly knit only in selected adjacent courses but at every wale in such courses, and a relatively non-absorbent and non-swellable yarn knit only in intervening courses at selected wales and floated across intervening wales, thereby forming the wale loops in the area of the floats solely of absorbent swellable yarn, and providing fabric constituted of segregated areas of non-absorbent yarn loops

surrounded by tightly knit loops of absorbent yarn, whereby treatment with a swelling agent will swell the absorbent tightly knit loops selectively to displace the non-absorbent yarn loops of said segregated areas and impart a puckered appearance to the fabric.

13. A knit fabric, ready for caustic treatment to produce a three-dimensional puckered appearance, constituted of a swellable-by-caustic yarn tightly knit only in selected adjacent courses but at every wale in such courses, and a relatively non-swellable-by-caustic yarn loosely knit only in intervening courses at selected wales and floated across intervening wales, thereby forming the wale loops in the area of the floats solely of swellable yarn and providing a fabric constituted of segregated areas of non-swellable yarn loops surrounded by tightly knit loops of swellable yarn, whereby caustic treatment will swell the swellable tightly knit loops selectively to displace the non-swellable loosely knit yarn loops of said segregated areas and impart a puckered appearance to the fabric.

14. The method of fabricating a textile fabric having a three-dimensional puckered appearance, comprising knitting a fabric to produce background areas constituted of plain knit loops of swellable yarn tightly knit substantially in a jammed state, said background areas separating further areas of the fabric which are constituted of plain knit loops knit in an unjammed state, and then treating the swellable yarn of the jammed loops to cause a displacement of the unjammed loop areas in the direction of the thickness of the fabric and impart a stable puckered appearance to the fabric.

15. The method of fabricating a textile fabric having a three-dimensional puckered appearance, comprising knitting a fabric to produce areas constituted of plain tightly knit loops of swellable yarn separating areas constituted of plain loosely knit loops, and then treating the yarn of the tightly knit loops with a swelling agent to displace the loosely knit loop areas in the direction of the thickness of the fabric and impart a stable puckered appearance to the fabric.

16. The method of fabricating a textile fabric having a three-dimensional puckered appearance, comprising knitting a fabric with a swellable yarn and a non-swellable yarn to produce areas constituted of plain tightly knit loops of swellable yarn separating areas constituted of plain knit loops of relatively non-swellable yarn, and then treating the swellable yarn with a swelling agent to displace the non-swellable yarn loop areas in the direction of the thickness of the fabric and impart a stable puckered appearance to the fabric.

17. The method as claimed in claim 16, wherein, in knitting, the swellable yarn is knit only in selected courses but at every wale in such courses and the non-swellable yarn is knit in only the intervening courses at selected adjacent wales, and floats across intervening wales.

18. The method of fabricating a textile fabric as claimed in claim 17, wherein the said selected wales vary diagonally of the fabric to produce a diamond pattern pique appearance.

19. The method of fabricating a textile fabric having a three-dimensional puckered appearance, comprising knitting a fabric with a swellable yarn and a relatively non-swellable yarn to produce areas constituted of plain tightly knit loops of swellable yarn separating areas constituted of plain loosely knit loops of non-swellable yarn, and then treating the fabric with a swelling agent to displace the non-swellable yarn loop areas in the direction of the thickness of the fabric and impart a stable puckered appearance to the fabric.

20. The method as claimed in claim 19, wherein the swellable yarn is scoured cotton yarn and the non-swellable yarn is waxed cotton yarn, and the swelling agent is caustic of mercerizing strength, and wherein the fabric is treated with a neutralizing agent after the caustic treatment.

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