July 19, 1938. J. McNAMEE 2,124,508

WEFT KNIT FABRIC

Filed June 26, 1937

Fig. 3

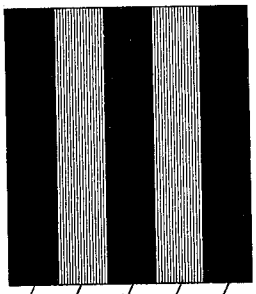


Fig. 4.

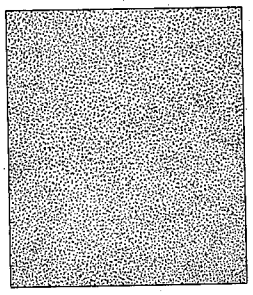
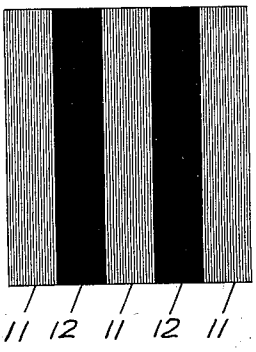


Fig. 5.



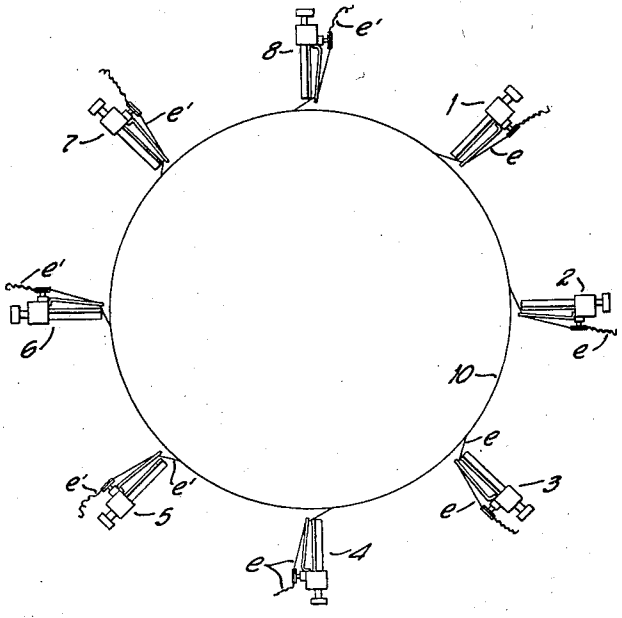


Fig. 1.

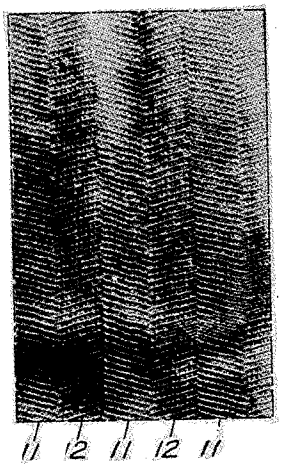


Fig. 2.

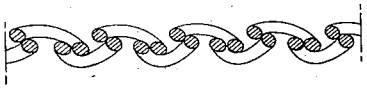


Fig. 6.

INVENTOR
JAMES McNAMEE
BY HIS ATTORNEYS
Howson and Howson

Patented July 19, 1938

2,124,508

UNITED STATES PATENT OFFICE

2,124,508

WEFT KNIT FABRIC

James McNamee, Ballston Spa, N. Y.

Application June 26, 1937, Serial No. 150,612

8 Claims. (Cl. 66—201)

My invention relates to weft knit fabrics and more specifically to such fabrics in which patterns appear by light reflection. It has been known for decades that twist in the ordinary knitting yarn causes the knitted stitches to lean to one side or the other according to the direction of twist. This has been universally regarded as objectionable because the fabric tends to twist and shrink, and the amount of twist in such yarns is ordinarily kept low or soft. It was suggested many years ago that these objections might be overcome if a yarn with a twist in one direction were used for one or two courses and then a yarn twisted in the opposite direction for one or two courses, either with or without the interspersion of one or two courses of a balanced twist yarn.

I have discovered that under certain conditions it is possible to make use of certain twists of yarn to produce a pattern effect in weft knit fabric due to light reflection.

In the drawing, Figure 1 is a diagrammatic plan view of a needle circle and yarn feeds of an eight-feed circular knitting machine suitable for making my novel fabric;

Fig. 2 is a photographic plan view of the face of a piece of balbriggan fabric made in accordance with my invention;

Figs. 3, 4 and 5 are diagrams illustrating the light-reflection patterns seen when viewing the fabric of Fig. 2 from the side (i. e. at an angle) at various points around the fabric, Fig. 3 showing the appearance of the fabric when the alternate bands are dark and the intervening bands light, Fig. 4 showing the entire fabric neutral, and Fig. 5 showing the alternate bands light and the intervening bands dark; while

Fig. 6 is a view in vertical section through a few of the stitches of the fabric of Fig. 2 showing how the stitches are tipped up on one leg.

If a yarn of sufficiently high twist is used in knitting, I have observed that when the fabric is viewed from the side, the amount of light reflected varies as the source of light or the observer moves around the fabric. I have discovered that if yarns of this high degree of twist, but in opposite directions, are used to knit a row or band of at least four courses in succession so that straight lines are produced in the wales, and the two opposite yarns used in alternation, a highly novel light-reflection pattern is obtained. I find that under these circumstances the knitted herringbone construction produces contrasting bands reflecting lustrous fabric and bands of darkness showing no substance. I further find that as the observer or the source of light is moved about the fabric, the bands merge into a neutral appearance where the entire fabric has a uniform slightly matte appearance, and then as the movement continues the bands that were dark suddenly become light and the ones that were light become dark. This appears to be controlled by the straight lines forming the wales, and to vary from a shade of darkness where the substance of the fabric is lost to a highly lustrous appearance.

Apparently not only are the lines of the wales reversely sloped in the fabric, giving a line direction similar to a woven herringbone pattern, but it also appears that each stitch is tipped up on one side. Thus one leg or side of each stitch is vertically above the other as it lies in the fabric and the direction of twist determines which leg is up (Fig. 6). This gives a straight line herringbone effect in a vertical dimension and the light-reflected pattern apparently is due at least partly to this upstanding linear arrangement. Possibly the light goes into the tipped-up openings of the stitches when approaching from one angle, but cannot enter and is reflected off when approaching at another angle. The crests appear more as continuous lines than valleys. The shapes of the trough and crest are somewhat like waves preparing to break on the shore. Fig. 6 is merely diagrammatic to show troughs and crests generally.

I have found that the pattern is not produced if the number of courses of the same twist yarn is so low that no appreciable straight lines of wales are present. Furthermore, the tipping up of the stitches does not seem to occur to any extent. Thus with two courses, each stitch is partially bent by its interlooping with the adjacent stitch of opposite twist and there are no consecutive stitches in a straight line to unite and give a band of light reflection or absence of light and substance as may be called for by the angles of incidence and reflection leading to the observer, and the collective effect of tipped stitches.

It is also impossible to produce a light-reflection pattern unless there is a comparatively high twist in the yarn. Thus in 30's cotton the minimum twist would be about twenty turns to the inch (the ordinary cotton yarn has only 14 or 15 turns per inch). The minimum number of turns necessary decreases in proportion as the bulk, i. e. weight, per unit length increases, and vice versa. Yarns other than cotton need the same number of turns, size for size, to be equivalent.

Expressed another way, the proportion of the diameter of the yarn to the number of turns should never be less than the diameter of 30's cotton to twenty turns. I prefer to use about 26 or 27 turns per inch in 30's comb peeler cotton yarn. At the minimum twist mentioned the yarn first assumes substantially uniform roundness. In the claims the phrase "hard twisted" is intended to denote a twist of the above-mentioned minimum or higher.

This light-reflection pattern from the ordinary weft plain knitting is quite novel. I find that whereas when the fabric is viewed from above, the face of the fabric merely shows the interlooping of the yarns, there is an entirely different appearance when viewed from the side, i. e., at a considerable or low angle. When viewed thus the fabric will have any one of three appearances according to the angle relative to the length of the courses of stitches from which it is viewed. At certain angles relative to the length of the courses the fabric shows an absolutely uniform, slightly matte appearance in which the structure of the stitches is not apparent and there is no visible distinction between the portions knit of yarn of one direction of twist and portions knit of yarn of the opposite twist. If, however, the source of light or the observer or both should change their circumferential position, i. e., their position in the plane of the fabric, the opposite twist portions at once begin to differentiate themselves. Thus if the observer should move about the fabric about 90° from the neutral position, he would find a striking contrast. Assuming that the fabric is knit with alternate bands of say ten courses of one twist and of ten courses of the opposite twist, the bands of one twist will now have a lustrous sheen, and, while the stitch structure will not be visible, the surface will have a slight character or substance. On the other hand, the bands of opposite twist will have become very dark and smooth, and totally without substance, due, apparently, to the uniform absence of light reflection. The surface of woven herring-bone fabrics does not exhibit this patterning despite the straight effects which they contain, and presumably this is so because of their smooth surface.

Referring to the drawing, 10 indicates the needle circle of a multifeed circular knitting machine (Fig. 1) which is adapted to produce my novel fabric (Fig. 2). While I have illustrated a circular knitting machine it will be obvious that the fabric can be produced on a straight or circular machine, independent or united needle. I have illustrated eight feeds of yarn, though it is to be understood that this number of feeds is merely illustrative of my invention and not a limitation on the number of feeds. My fabric may be made on a four feed machine or on a machine having only a single feed, by means of automatic yarn changing devices such for instance as are common on circular hosiery knitting machines and other types. In the machine shown in Fig. 1, the four yarns *e*, *e*, *e*, *e*, which are fed from feeds 1, 2, 3 and 4 are yarns twisted in one direction while the four yarns *e'*, *e'*, *e'*, *e'*, which are fed from feeds 5, 6, 7 and 8 are yarns twisted in the opposite direction. The twists are at or above the minimum specified above and the yarns are therefore termed hard twisted.

In Fig. 2 the herringbone appearance of the fabric is apparent. It will be seen that the fabric is composed of bands 11, 12 of reversely sloped wales in which each band contains a multiplicity of courses. In Fig. 2 there are about 10 courses in each band. For the sake of the description, I will assume that the yarns *e* are twisted left compose the alternate bands 11 while the yarns *e'* are twisted right and compose the intervening bands 12.

It will be noted that even in the machine of Fig. 1 which knits bands only four courses wide, there are a multiplicity of stitches of the same twist not interlaced with stitches of opposite twist. This length of line of wales produces a linear or straight line effect which is essential to my light-reflection pattern. It will be noted that in the fabric of Fig. 2 one leg of each stitch is tipped up producing a depth and a linear appearance not ordinarily present. Furthermore, it will be noted that the leg which is lifted depends on the direction of twist. Thus the stitches knit of yarn *e* appear to raise their first leg, while stitches knit of yarn *e'* appear to lift their opposite leg. When one looks at the cloth from the edge one can see tiny holes in the tipped stitches and the holes appear dark. From any one position the holes can be seen in one band only and the holes in the other band are tipped away or turned. The latter band appears as a solid fabric and is light. When the eye is placed laterally to one side of the fabric and a slight distance above it, the novel light-reflection pattern appears. There are three kinds of maximum effects to be seen. These are seen as the observer or the source of light moves around the fabric, maintaining the angle above the fabric. As one moves around one observes shades or jumps from one maximum effect to another as the case may be. Thus at certain points the change is abrupt while in others it is gradual. The three maximum effects are shown somewhat diagrammatically in Figs. 3, 4, and 5. In Figures 3 and 5 there are striking light-reflection contrasts between the successive bands 11 and the intervening bands 12. In the two figures the contrast is reversed or alternated. In Fig. 3 the alternate bands 11 appear dark and all the substance of the fabric has disappeared. These alternate bands 11 are smooth and appear to be masses or areas where there is no light reflected. On the other hand, the intervening bands 12 when viewed from the same point appear lustrous and bright. In Fig. 5 it is the intervening bands 12 which appear dark and without substance while it is the alternate bands 11 which appear lustrous. The horizontal angle relative to the fabric through which the observer must move to change from the contrast where one band is dark and without substance to the contrast where the other band is dark and without substance, is affected by the source of light. If this does not move relative to the fabric, then apparently the observer must move 180° to make the full change. Half way between the two positions, however, the observer will find a strikingly different light effect. At this intermediate position the fabric assumes a uniform appearance all over and there is no contrast left between the bands. This position may be termed a neutral position. The fabric appears slightly matte and the actual stitch structure is not apparent. At positions between the neutral and the contrasts, the structure of the stitches in one set of bands or the other is apparent.

While I have shown the invention embodied in plain fabric, it can also be embodied in rib fabric.

It will be obvious that the invention is not limited to continuous bands all across the fabric but that it would be within the scope of the invention to knit areas several wales long and at least four courses wide in succession with the successive areas of opposite twist yarns, thus giving a checkerboard effect. Also patterns due to other stitch or yarn changes may be combined with my light-reflection pattern. Other variations not departing from the scope of the invention will occur to those skilled in the art.

This application is a continuation in part of my application Serial Number 101,604, filed September 19, 1936.

What is claimed is:

1. A plain weft knit pattern fabric of hard twist yarn, having one area of a plurality of wales and at least four courses knit of yarn twisted in one direciton, in combination with an adjacent similar area knit of oppositely twisted yarn, the fabric showing a light-reflection contrast when viewed from the side, one area being dark.

2. A plain knit weft pattern fabric of hard twist yarn, having one area of a plurality of wales forming straight lines, the area having at least four courses and being knit of yarn twisted in one direction, in combination with an adjacent similar area knit of oppositely twisted yarn, the lines of the wales in the areas being sloped reversely to each other and the areas showing a light reflection contrast when viewed from the side, with one area dark and the other lustrous, and vice versa with a change of angle.

3. A weft knit pattern fabric of yarns of opposite hard twists, each stitch having one leg tipped up, the stitches of one direction of twist being tipped up on one side and the stitches of the opposite twist on the opposite side, the fabric having one area of a plurality of wales and at least four courses knit of yarn twisted in one direction, in combination with an adjacent similar area knit of oppositely twisted yarns, whereby the fabric in the areas appears alternately lustrous and dark when viewed from the side.

4. A weft knit pattern fabric of yarn twisted the equivalent of at least 20 turns per inch for 30's cotton, yarn twisted in one direction being used in a plurality of wales for four or more courses, in combination with four or more courses adjacent thereto in said wales knit of oppositely twisted yarns, the portions knit of the two yarns appearing lustrous and dark, respectively, or of slightly matte neutral appearance when viewed from the side.

5. A plain knit patterned fabric having bands of four or more courses of yarn hard twisted in one direction alternating with bands knit of four or more courses of yarn hard twisted in the opposite direction, the wales in said bands being straight line and reversely sloped in adjacent bands, the bands appearing alternately as lustrous and of smooth darkness when viewed from the side.

6. A weft knit patterned fabric in which bands of four or more courses of yarn twisted in one direction to substantial roundness are alternated with bands of four or more courses knit of yarns twisted the same amount in the opposite direction, the resulting straight lines of the wales being reversely sloped in adjacent bands, and reflecting contrasting bands of luster and of darkness when viewed from the side.

7. A weft knit fabric having a light-reflection pattern therein knit of yarns hard twisted in opposite directions, a plurality of adjacent courses at least four in number being knit of yarn twisted in one direction, and a similar plurality of adjacent courses being knit of oppositely twisted yarns, whereby the tipped-up wale lines sloping reversely in adjacent groups of courses reflect lustrous bands and bands of darkness without substance when viewed from the side, said groups of courses appearing alternate and opposite to each other when viewed at certain angles and the entire fabric appearing neutral and slightly matte at another angle.

8. A weft knit fabric having a light-reflection pattern therein, knit of hard oppositely twisted yarn, the fabric containing areas of a plurality of wales four or more courses in extent knit of yarn of one direction of twist, and adjacent areas knit of yarn of the opposite twist, the wales in the two areas being sloped reversely to each other, but forming straight parallel lines in their own area, the stitches in each area being tipped up on the side opposite from the tipping of the adjacent area, whereby when viewed from the side the fabric will have a neutral, slightly matte, uniform appearance, or the areas will have contrasting lustrous or dark and without substance appearances in alternation according to the angle from which viewed.

JAMES McNAMEE.