July 10, 1934. E. WILDT ET AL 1,965,873

KNITTED ARTICLE

Filed March 23, 1932 2 Sheets-Sheet 1

Fig.1.

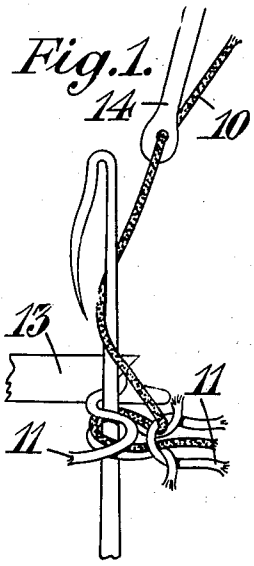


Fig.2.

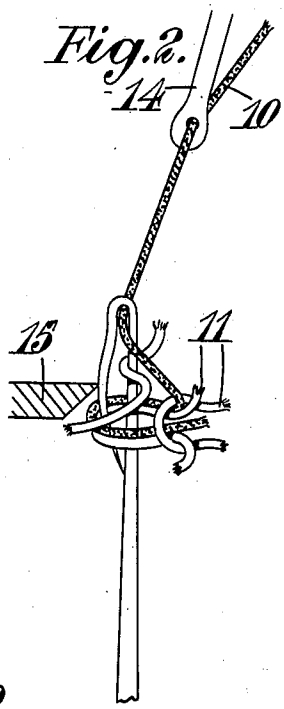


Fig.3.

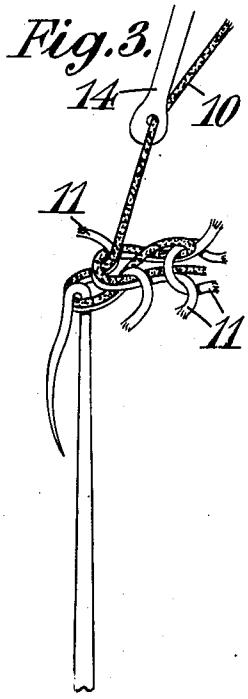


Fig.4.

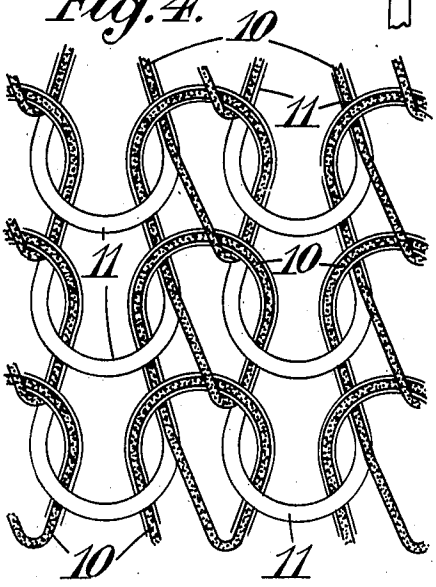
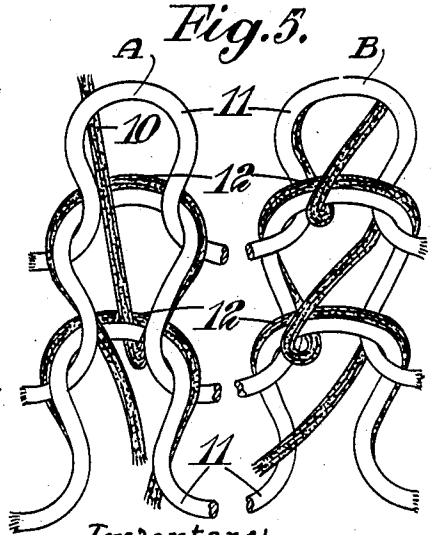


Fig.5.



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Fig. 7.

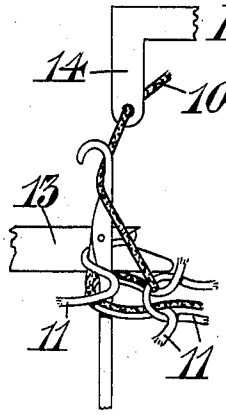


Fig. 8.

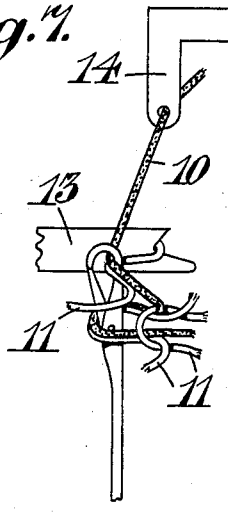


Fig. 9.

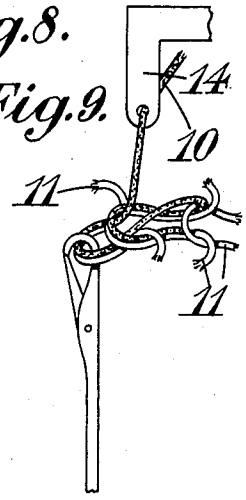
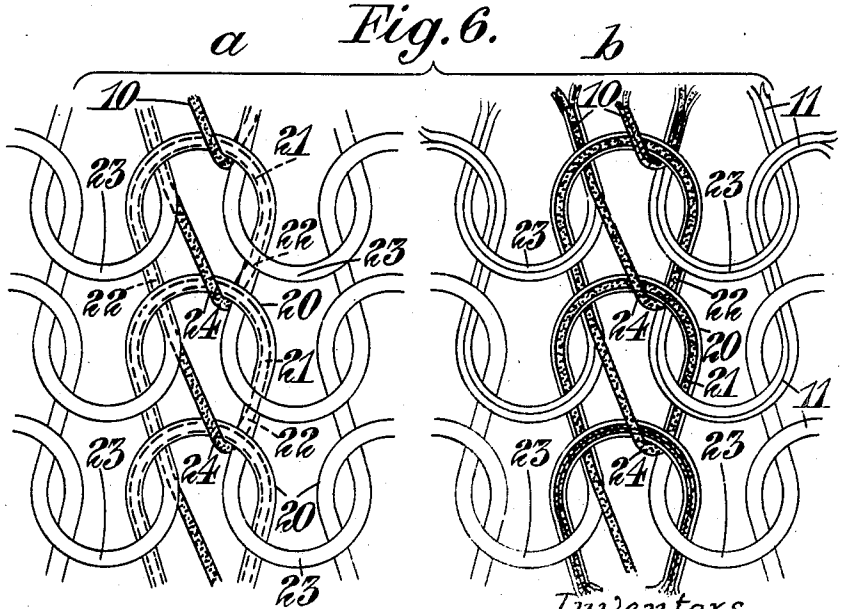


Fig. 6.



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Patented July 10, 1934 1,965,873

UNITED STATES PATENT OFFICE

1,965,873

KNITTED ARTICLE

Edwin Wildt and Henry Harold Holmes, Leicester, England, assignors to Wildt and Company Limited, Leicester, England, a company of Great Britain

Application March 23, 1932, Serial No. 600,780
In Great Britain April 9, 1931

16 Claims. (Cl. 66—201)

This invention consists in improvements in or relating to knitted fabrics and to methods of knitting them and is concerned solely with the production of knitted goods, having what is sometimes termed "non-laddering properties", and includes knitted hose and half-hose. The expression "non-laddering" does not necessarily mean that laddering is wholly prevented but denotes that should a loop of the knitting be broken the stitch or stitches released by the broken loop will not readily run down nor pull out through any considerable length of the knitting.

The invention is limited to articles knitted from silk, artificial silk, mercerized cotton or other yarns having similarly smooth surfaces because it is in connection with goods knitted from such yarns that the problem of preventing laddering becomes a particularly important one.

The invention is also limited to a knit fabric in which the warp-thread is plated at the rear of the face of the fabric. It is not intended to include so called interlocked fabrics in which the warp-thread is laid below the latch of the needles so as to be secured at the back of the fabric. It is to be understood that the plating of warp-thread at the rear of the face of the fabric is to include the so called sandwiching of warp-threads between ground-threads.

Moreover, the invention is applied to non-laddering fabrics knitted from a combination of a ground-thread or threads and warp-threads of a similar type, for instance, to those described in prior British Patents Nos. 327,958, 327,987, 327,988 and 328,026 but is not necessarily limited to the methods and machines therein described and claimed.

An object of the invention is to improve the non-laddering properties of the fabrics and also to improve the appearance of them so that the employment of the wale-threads does not substantially alter the appearance of the fabric from that of a plain knitted fabric. Generally, in non-laddering fabrics produced hitherto from a combination of ground- and warp-threads the appearance of the resultant fabric has not been that of a plain knitted fabric and particularly in the case of hose and half-hose this is objectionable.

The invention described and claimed herein is to be understood to include fabrics, hose and half-hose when those parts only that are normally required in the use of the article to be ladderproof are knitted in the manner and from the yarns above referred to. For instance, in the case of hose and half-hose it may be preferable to form any or all of the following parts, namely, the heel, toe, foot-bottom, welt or ribbed top or portions thereof, and in some instances the high-splice, of the yarns set out above and/or of others not necessarily possessing a smooth surface and some or all of these parts may be knitted in a ladderproof manner or in any other manner. Furthermore, the lower portion of the hose or half-hose comprising essentially heel, toe and foot-bottom need not necessarily be produced on the same machine as the leg portion. Also wales at the back of the article may be involved in the knitting of a mock seam or a substitute therefor, or wales where clocks or similar special patterns are to be produced, may be knitted in any other manner. Again, in cases where embroidered stripes are to be subsequently worked on to the fabric the wale-threads necessary for the ladderproof fabric may be omitted from the needles on which the wales are produced that are to receive the embroidery. Furthermore, articles which are substantially ladderproof owing to being knitted in the manner hereinafter described are not to be deemed outside this invention as described and claimed herein merely because portions of their lengths so short as not seriously to affect the ladderproof quality are knitted in some other manner and/or of some other material.

Where reference is made herein to knitting the major portion of an article in a ladderproof manner it is to be understood that substantially the whole article will be so knitted except for minor or non-essential portions thereof as are exemplified above.

According to the present invention, knitted fabric, hose or half-hose of the kind above specified is so formed that throughout the whole or major portion of the fabric ground- and warp-threads are knitted together with the ground-thread loops plated in front of the warp-thread loops and in which the ratio of the ground-thread diameter to the warp-thread diameter is at least 1.4:1.

Although the minimum ratio of the diameter of the ground-thread to that of the warp-thread has been stated to be 1.4:1, to be more precise in relation to artificial silk and the like the equivalent ratio reckoned in yarn counts is 2:1.

In a preferred form of the said invention the minimum ratio of the diameter of the ground-thread to that of the warp-thread is 1.6:1 and may be as great as 1.73:1 or even greater.

It is to be noted that the maximum coarseness of the warp-threads in accordance with this invention commences at approximately the mini-

mum coarseness used for patterning with plating threads, and that for preference considerably finer warp yarns are used.

It is not necessary that in each wale each warp-thread should be formed into a knitted loop in each course as in some courses the warp-threads may be interlocked in a similar manner to that described in prior British specification No. 313,657.

It is not necessary that each ground-thread be comprised of a single ground-thread, but that it may also be composed of a plurality of threads knitted together in each needle so also the warp-thread may comprise several threads knitted by the same needle at one time.

The "face" of the fabric on which, in accordance with this invention, the ground-thread loops are to appear is that face or surface which will be the outer face or right side of the finished article. In a hose or half-hose the right side of the article is that which is seen when the hose or half-hose is worn and the wrong side or rear face is that which will be next to the skin of the wearer. The warp-loops will thus appear on the wrong side or rear face of the fabric. That is to say, they will appear on that face which, at the time that the loops of the fabric are knocked over the needle-head during the process of knitting, is farthest away from the needle-head.

If preferred, two or more ground-threads can be employed instead of a single ground-thread and the total thickness of the ground-thread can be made up by the use of two or more relatively fine threads.

The mechanism for knitting fabrics, hose or half-hose in accordance with this invention may be similar to that described in any one of the prior patents above mentioned and such mechanism may be modified in the manner described in British Patent No. 331,930.

In a preferred method of carrying out the present invention the warp-threads are knitted so as to appear on the rear face of the fabric by adjusting the relative tensions of the ground- and warp-threads so that they assume the required relative positions above stated. That is to say, the ground-thread will be supplied to the needles under a greater tension than the warp-threads with the result that the ground-thread is laid rearmost in the needle-hook before knocking over and will subsequently come to the face of the fabric (i. e. the outer face or right side) by reason of the overturning of the combined loops during the process of knocking over.

A preferred method of carrying the invention into effect is diagrammatically illustrated in the accompanying drawings, in which—

Figure 1 illustrates a bearded needle and sinker on which both ground- and warp-threads have been laid;

Figure 2 shows the same needle at a later stage of the knitting process known as "landing";

Figure 3 illustrates the same needle at a still later stage of "knocking over";

Figure 4 shows a small section of fabric viewed from the rear face or wrong side in which in each of the wales illustrated and in each course a warp-thread is formed into a knitted loop with a ground-thread, and

Figure 5 is an enlarged view obtained from microscopic examinations showing slight inaccuracies that may occur in the knitting.

Figures 6*a* and 6*b* diagrammatically illustrate portions of the rear faces of two pieces of fabric in which, in Figure 6*a*, the warp-thread is indicated as plated on the ground-thread so as to show on the front or face of the fabric, and in Figure 6*b* the ground-thread is shown as plated, in accordance with the present invention, on the front of the warp-threads so that the latter show on the rear face of the fabric, a portion of the fabric is shown herein as being knitted from a plurality of ground-threads and a plurality of warp-threads, and

Figures 7, 8 and 9 are views respectively similar to Figures 1, 2 and 3 showing a latch-needle in operation instead of a bearded needle.

Like reference numerals indicate like parts throughout the several figures.

In the method illustrated in Figures 1 to 3 a warp-thread 10 shown as a black thread, supplied from a feeder 14, is first wrapped round its needle and subsequently the ground-thread 11, shown as a white thread, is laid on the needle under sufficient tension such that during landing and knocking over the warp- and ground-threads will attain the relative positions shown. A loop-forming sinker is shown at 13 and a presser-verge for closing the beards is shown at 15. This will result in producing a fabric similar to that illustrated in Figure 4 in which the warp-threads, where they are formed into knitted loops with the ground-threads, will be laid substantially wholly or wholly on the rear face or wrong side of the fabric.

This order or sequence of laying the warp-threads on the needles is according to established practice in machines of this class but it is found that the order of feed may be reversed if desired. That is to say, the ground-thread may be the first to be supplied to the needles which are afterwards wrapped with the warp-threads in which case in the diagrammatic illustration above mentioned it is to be understood that the thread 11 is laid on each needle before it is wrapped with the warp-thread 10.

It will be seen from Figures 1 to 3 and 7 to 9 that the normal position of the warp-thread feeder before a wrapping of the needle commences is inside the needle-circle and it is of importance to the present invention that all wrapping operations commence from the inside of the needle-circle then pass round the needles in an outward direction and back again to the inside. Also it is important that the warp-thread feed should be from a position above the lie of the ground-thread feed. With these two essential desiderata the warp-thread loops will be successfully plated entirely in rear of the ground-thread loop provided that proper attention is paid to the relative tensions of the ground- and warp-threads and to the manner of feeding those threads as described herein.

The above diagrams show the formation of loops on a bearded needle as in the case of a machine of the kind known as a "Cotton" patent machine although it will be appreciated that any machine, either flat or circular, employing bearded, latch or sliding latch needles will be suitable subject to slight modifications which will be readily understood by persons skilled in knitting machinery.

In Figures 7, 8 and 9 a latch-needle is shown in operation which may be assumed to be a needle in a circular machine. As in Figures 1 to 3 the warp-thread (black) is indicated by the reference numeral 10, the white ground-thread at 11, the loop-forming sinker at 13 and the feeder at 14. It is thought to be unnecessary further to describe the operation because except for the

change from a bearded to a latch-needle the sequence of operations remains the same as that described with reference to Figures 1 to 3.

When the ground-thread is laid on the needles prior to the wrapping of them with their warp-threads the adjustment of the tension of the ground-threads becomes relatively unimportant, although even in that case it is or may be desirable to supply the ground-thread under a somewhat greater tension than that of the warp-thread.

Fabric knitted in the manner above described is substantially consistent in its formation although sometimes a tendency is shown for the relative positioning or plating of the ground-thread with regard to the warp-thread to become reversed. For example, Figure 5 shows an enlarged view of the knitting obtained microscopically in which the wale A shows the knitting viewed from the front or face of the fabric and the wale B is viewed from the rear. It will be seen at the places indicated by the arrows 12 that the warp-thread loop tends to come slightly forward instead of lying completely in rear of the wale-thread loop.

In the main bulk of the knitting, however, in accordance with this invention, the plating of the warp-thread to the rear of the ground-thread, so that the ground-thread loop overlies the warp-thread loop on the face of the fabric is accurate, although there may be a number of warp-thread loops which appear at the upper part of the ground-thread loops as shown in Figure 5; but, nevertheless, even in such cases the general plane of such warp-thread loops is in rear of the general plane of the corresponding ground-thread loops. It may be remarked also that the twist of the ground-thread appears to remain substantially undisturbed, whereas that of the warp-thread is noticeably released, that is to say, the warp-thread is untwisted to some extent due possibly to the sharp bends through which the thread is turned particularly where it is turned round the upper end of the combined warp- and ground-thread loops. This untwisting of the warp-threads tends to fill up the interstices in the ground-thread loops and gives an appearance of greater fineness of texture to the knitting.

The rear of the fabric knitted in accordance with this invention presents a much more ridged appearance than the face or front surface of the fabric which latter is noticeably smooth.

In Figure 6 a comparison is made between a portion of fabric (*b*) knitted in accordance with the present invention and another portion of fabric (*a*) in which the relative positions of the ground- and warp-threads are the reverse of that in (*b*). In both (*a*) and (*b*) the fabric is to be understood as showing the rear or wrong face thereof. It will be seen that, referring first of all to the fabric (*b*), the top of each loop of the ground-thread 11 in a needle wale, as indicated, for example, by the reference numeral 20, is disposed between a warp-thread loop 21 that is formed together with the ground-thread loop in that course and the shanks 22 of the warp-thread of an adjacent course. The ground-thread loop 20 is indicated in dotted lines and is to be understood as lying behind the warp-thread loop 21. Moreover, the shanks 22 of the warp-thread loops are in direct contact with the ground-thread in adjacent sinker loops 23.

It will be observed that where a warp-thread laps round a combined warp- and ground-thread loop at 24 to pass to the next course of knitting it is in a position to do so without crossing over the shank of a ground-thread loop.

Comparing this form of knitting with that represented in (*a*) it will be clearly seen that in the latter the ground-thread loop 20 is now represented in full lines and the warp-thread loop 21, shown in dotted lines, lies behind the ground-thread loop. In fabric (*a*) therefore it is the warp-thread loop that is disposed between a ground-thread loop of its own course and the shanks of a ground-thread loop in an adjacent course. Moreover, the shanks 22 of the warp-thread loop are not in contact with the ground-thread of adjacent sinker loops 23 as in the fabric (*b*) and the warp-thread in bending round at 24 has now to come from behind the shank of the ground-thread loop.

The fabric sections illustrated in Figures 6*a* and 6*b* and the relative positions of the warp-threads in relation to the ground-thread are only detailed in the case in which the warp-thread is formed into knitted loops. It will be obvious, of course, that where the warp-threads are interlocked at the back of the fabric or are floated, the relative dispositions will naturally be varied from those above described.

It must be understood that a knitted fabric according to this invention and as illustrated in Figure 6*b* is not a mere reversal back to front of the usual form of warp-thread plating in which the warp-thread loops are on the front or face of the fabric as in Figure 6*a*. By a comparison of these two illustrations and by consideration of the differences just described above it will be seen that the interlinking of the warp- and ground-threads in the two cases is different in several respects.

The form of knitting according to the present invention has many practical advantages amongst which the following are of considerable value, namely:—

(*a*) The face of the fabric presents substantially the appearance of a plain knitted fabric, whereas if the warp-threads are to the front this appearance is to some extent marred.

(*b*) Variations in the tension of the warp-threads when they lie at the back of the ground-thread are materially less critical than in the case of the forms of knitting described in the prior patents referred to in which they lie on the front.

(*c*) Fabric containing warp-threads plated on the front is comparatively inelastic, owing to the stiffness imparted by the tension of the warp-threads necessary to produce even plating. In the fabric according to the present invention, the quality of the plating of the warp-threads on the back of the fabric is of relatively less moment than heretofore, and, in consequence thereof, and also of the fact that a more liberal supply of warp-thread for each loop is permissible, and even desirable, the elasticity of the new fabric is materially increased as compared with that of the older fabric.

(*d*) Another advantage also arising out of advantages (*b*) and (*c*) is that as the tension is not quite so critical a factor it may be reduced to an extent that will practically eliminate or at least substantially minimize the risk of breakage in the warp-threads during the knitting.

(*e*) The character of the interlinkage of the warp- and ground-threads as described above is advantageous in producing an improved ladder-proof fabric.

It is advantageous in some cases to use as the

warp-threads, yarns which have superior properties of heat retention and/or tensile strength as compared with the ground-threads. For example, pure silk may be used for the warp-threads and artificial silk for the ground-threads.

Where it is stated herein that the ground-thread loops appear on the face of the fabric, or that the warp-thread loops appear at the back of the fabric, the constancy of the relative positioning of the warp- and ground-thread loops is to be understood as including and modified by the slight inaccuracies which occur in knitting as referred to in connection with Figure 5. Furthermore, as has been already stated, in the major portion of the knitting the warp-threads will be either knitted or interlocked with the ground-threads. The invention is to be understood as existing mainly in connection with those stitches which are formed by combined knitted loops of warp- and ground-threads, but in the case in which a warp-thread is interlocked with ground-thread loops the bight of the warp-thread will in that case also be at the back of the fabric.

In a preferred form of the invention the ground-thread is of a thickness great enough to impart of itself, to the knitted article, the required strength even though the warp-threads are absent.

In one example of the invention the knitted article is produced on a machine of a fine gauge, that is to say, at least a gauge corresponding to twenty needles per inch on a circular machine or its equivalent on a flat machine. Satisfactory results have been obtained when for the ground-thread artificial silk of 125 denier is employed and the warp-threads are each of 50 denier. In another example the ground-thread is 125 denier and the warp-thread is 40 denier; and in a still further example, using pure silk, a ground-thread has been employed of 120 denier and a warp-thread of 30 denier.

While it is a feature of the invention that the ground-threads are coarser than the warp-threads in the manner hereinbefore set out, it is to be understood that when character lines are to be knitted in the fabric coarser warp-threads may be used for this purpose provided that the number of these coarser warp-threads is so small compared with the remainder that the quality of the fabric is not substantially affected.

We claim:

1. Knitted fabric comprising in combination ground-threads and warp-threads knitted together with the ground-thread loops plated in front of the warp-thread loops, and wherein throughout the major portion of the fabric there is one warp-thread in substantially every knitted wale, the warp-threads being smaller in diameter than the ground-threads.

2. Knitted fabric comprising in combination ground-threads and warp-threads knitted together with the ground-thread loops plated in front of the warp-thread loops, and wherein throughout the fabric there is one warp-thread in substantially every knitted wale, the warp-threads being smaller in diameter than the ground-threads.

3. Knitted fabric comprising in combination ground-threads and warp-threads knitted together with the ground-thread loops plated in front of the warp-thread loops, and wherein throughout the major portion of the fabric there is one warp-thread in substantially every knitted wale, and the ratio of the ground-thread diameter to the warp-thread diameter is at least 1.4:1.

4. Knitted fabric comprising in combination ground-threads and warp-threads knitted together with the ground-thread loops plated in front of the warp-thread loops, and wherein throughout the major portion of the fabric there is one warp-thread in substantially every knitted wale, and the ratio of the ground-thread diameter to the warp-thread diameter is at least 1.6:1.

5. Knitted fabric comprising in combination ground-threads and warp-threads knitted together wherein throughout the major portion of the fabric there is a warp-thread in substantially every knitted wale, and in the major portion of the fabric ground-thread loops are plated in front of the warp-thread loops but in relatively small areas the warp-thread loops are plated in front of the ground-thread loops, the warp-threads being smaller in diameter than the ground-threads.

6. Knitted fabric comprising in combination ground-threads and warp-threads knitted together wherein throughout the major portion of the fabric there is a warp-thread in substantially every knitted wale, and in the major portion of the fabric ground-thread loops are plated in front of the warp thread loops but in relatively small areas the warp-thread loops are plated in front of the ground-thread loops, and the ratio of the ground-thread diameter to the warp-thread diameter is at least 1.4:1.

7. Knitted fabric comprising in combination ground-threads and warp-threads knitted together with the ground-thread loops plated in front of the warp-thread loops wherein throughout the major portion of the fabric there is one warp-thread in substantially every knitted wale, the warp-threads being smaller in diameter than the ground threads in most wales, but in the remaining wales the thickness of the warp thread is increased in order to produce shadow effects.

8. Knitted fabric comprising in combination ground-threads and warp-threads knitted together with the ground-thread loops plated in front of the warp-thread loops wherein throughout the major portion of the fabric there is at least one warp-thread, and in each knitted wale a plurality of ground-threads is knitted simultaneously, the aggregate diameter of the ground-threads being greater than the warp-thread diameter.

9. Knitted fabric comprising in combination ground-threads and warp-threads knitted together with the ground-thread loops plated in front of the warp-thread loops wherein throughout the major portion of the fabric there is at least one warp-thread and in each knitted wale a plurality of ground-threads is knitted simultaneously, and the ratio of the aggregate ground-thread diameter to the warp-thread diameter is at least 1.6:1.

10. Knitted fabric comprising in combination a plurality of ground-threads knitted together with a plurality of warp-threads with the ground-thread loops plated in front of the warp-thread loops, wherein throughout the major portion of the fabric there is a plurality of warp-threads in substantially every knitted wale and the aggregate ground-thread diameter is greater than aggregate warp-thread diameter in each wale.

11. Knitted fabric comprising in combination a ground-thread knitted together with warp-threads with the ground-thread loops plated in

front of the warp-thread loops, wherein throughout the major portion of the fabric there is a plurality of warp-threads in substantially every knitted wale, and the ground-thread diameter is greater than the aggregate warp-thread diameter in each wale.

12. Knitted fabric comprising in combination a ground-thread knitted together with warp-threads with the ground-thread loops plated in front of the warp-thread loops, wherein throughout of the major portion of the fabric there is a plurality of warp-threads in substantially every knitted wale, and the ratio of the ground-thread diameter to the aggregate warp-thread diameter in each wale is at least 1.4:1.

13. Circular knitted fabric comprising in combination ground-threads and warp-threads knitted together with each warp-thread loop lying in the rear of the ground-thread loop and wherein throughout the major portion of the fabric there is one warp-thread in substantially every knitted wale, the warp-threads being smaller in diameter than the ground-threads.

14. Circular knitted fabric comprising in combination ground-threads and warp-threads knitted together with each warp-thread loop lying in the rear of the ground-thread loop and wherein throughout the major portion of the fabric there is one warp-thread in substantially every knitted wale, and the ratio of the ground-thread diameter to the warp-thread diameter is at least 1.6:1.

15. Circular knitted fabric comprising in combination ground-threads and warp-threads knitted together in substantially every wale and in every course of the fabric with each warp-thread loop lying in the rear of the ground-thread loop that is knitted together with it, the ground-thread being of greater diameter than the warp-thread.

16. Circular knitted fabric comprising in combination ground-threads and warp-threads knitted together in substantially every wale and in every course of the fabric with substantially the whole of each warp-thread loop lying in the rear of the ground-thread loop that is knitted together with it, the ground-thread being of greater diameter than the warp-thread.

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