

July 3, 1945.

M. NEBEL

2,379,649

KNIT FABRIC AND METHOD OF MAKING THE SAME

Filed Sept. 16, 1937

17 Sheets-Sheet 1

Fig. 1

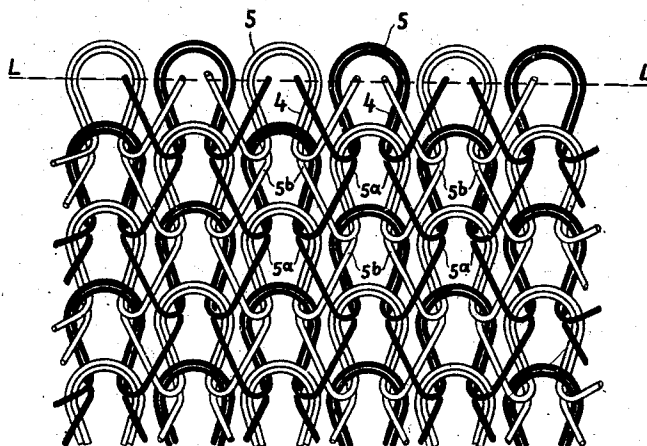
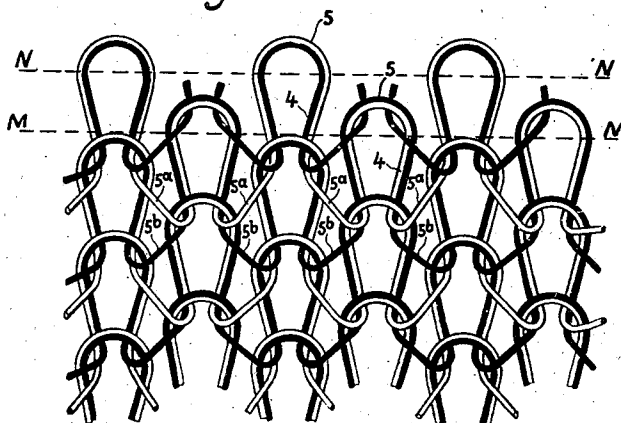


Fig. 2



Inventor:
M. Nebel

July 3, 1945.

M. NEBEL

2,379,649

KNIT FABRIC AND METHOD OF MAKING THE SAME

Filed Sept. 16, 1937

17 Sheets-Sheet 2

Fig.3

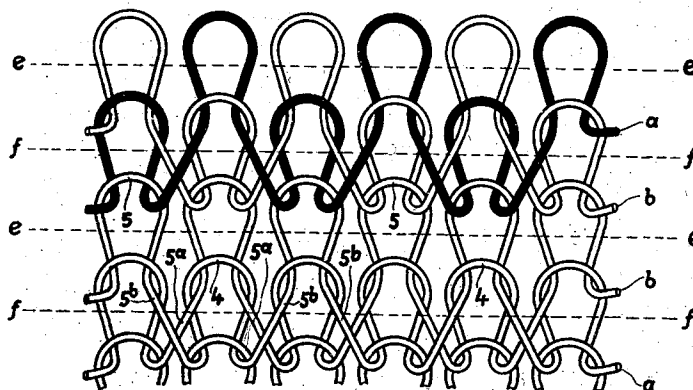
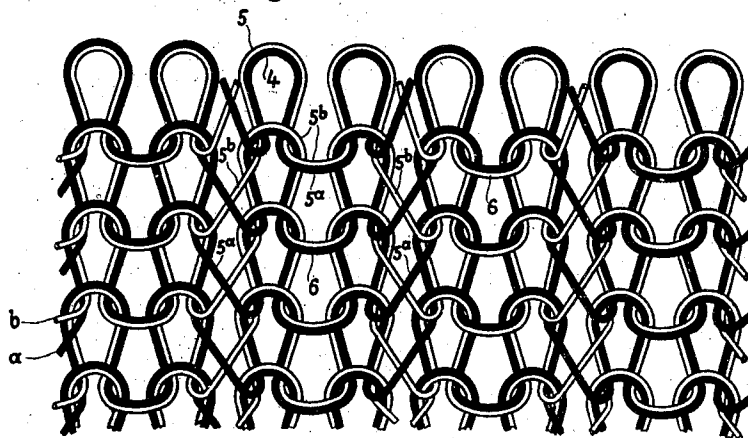


Fig.4



Inventor:
M. Nebel

July 3, 1945.

M. NEBEL

2,379,649

KNIT FABRIC AND METHOD OF MAKING THE SAME

Filed Sept. 16, 1937

17 Sheets-Sheet 3

Fig. 5

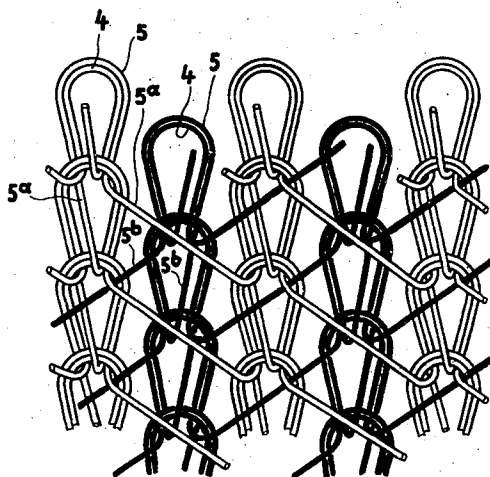
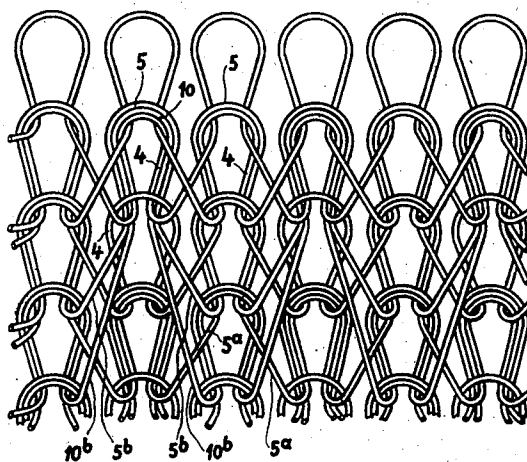


Fig. 6



Inventor:
Max Nebel

July 3, 1945.

M. NEBEL

2,379,649

KNIT FABRIC AND METHOD OF MAKING THE SAME

Filed Sept. 16, 1937

17 Sheets-Sheet 4

Fig. 7

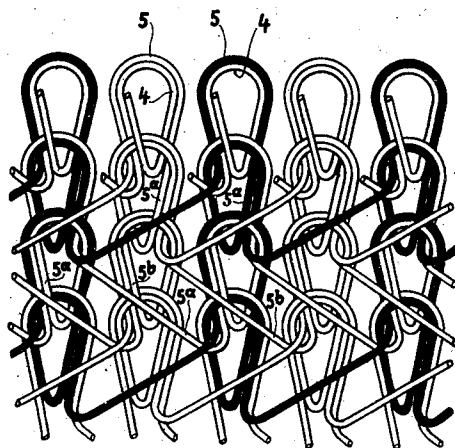
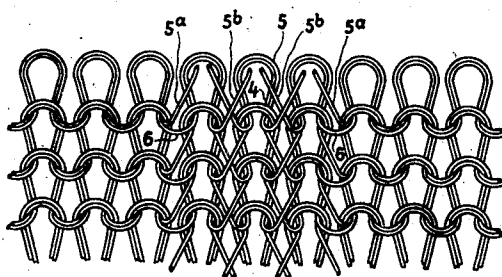


Fig. 8



Inventor:
Max Nebel

July 3, 1945.

M. NEBEL

2,379,649

KNIT FABRIC AND METHOD OF MAKING THE SAME

Filed Sept. 16, 1937

17 Sheets-Sheet 5

Fig. 9

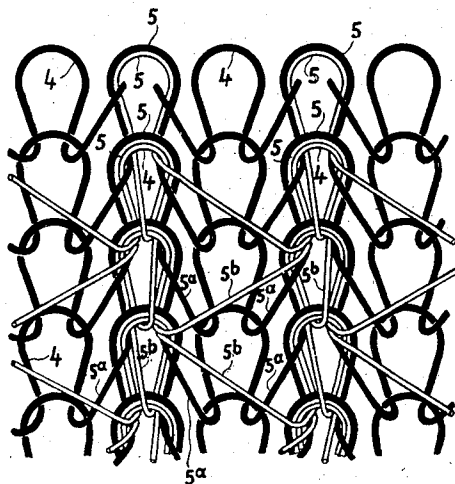
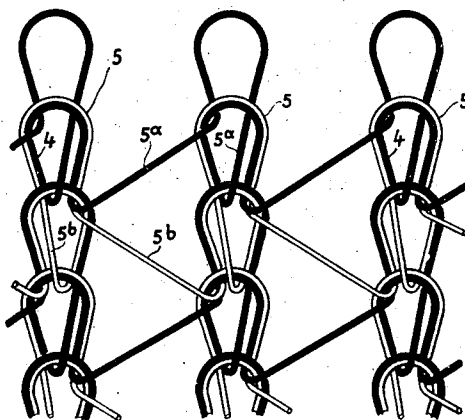


Fig. 10



Inventor:
M. Nebel

July 3, 1945.

M. NEBEL

2,379,649

KNIT FABRIC AND METHOD OF MAKING THE SAME

Filed Sept. 16, 1937

17 Sheets-Sheet 6

Fig. 11

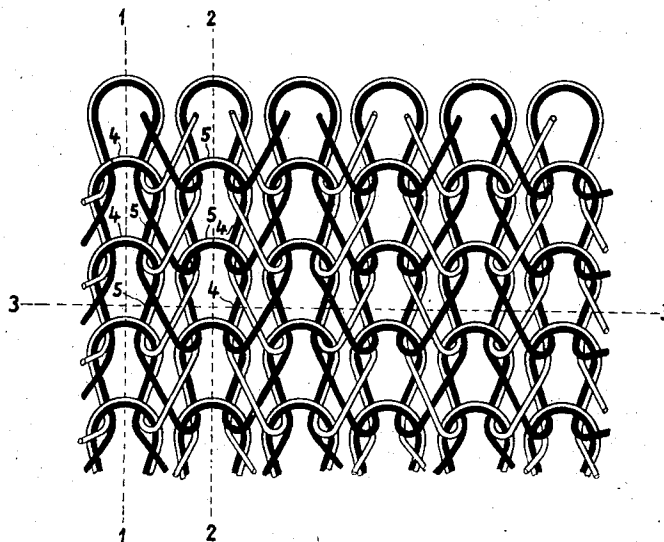


Fig. 12

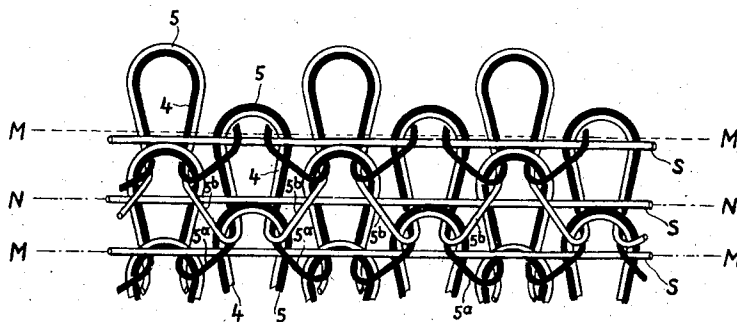
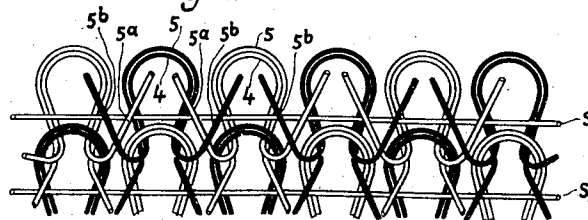


Fig. 13



Inventor:
M. Nebel

July 3, 1945.

M. NEBEL

2,379,649

KNIT FABRIC AND METHOD OF MAKING THE SAME

Filed Sept. 16, 1937

17 Sheets-Sheet 7

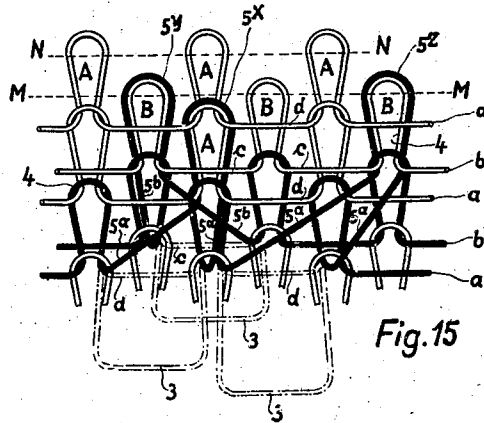


Fig. 15

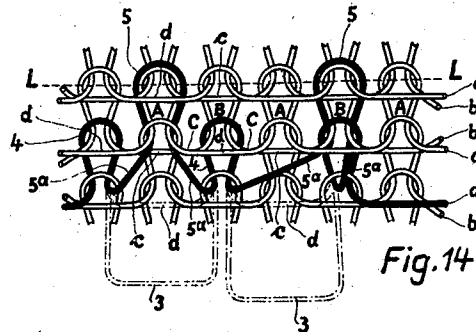


Fig. 14

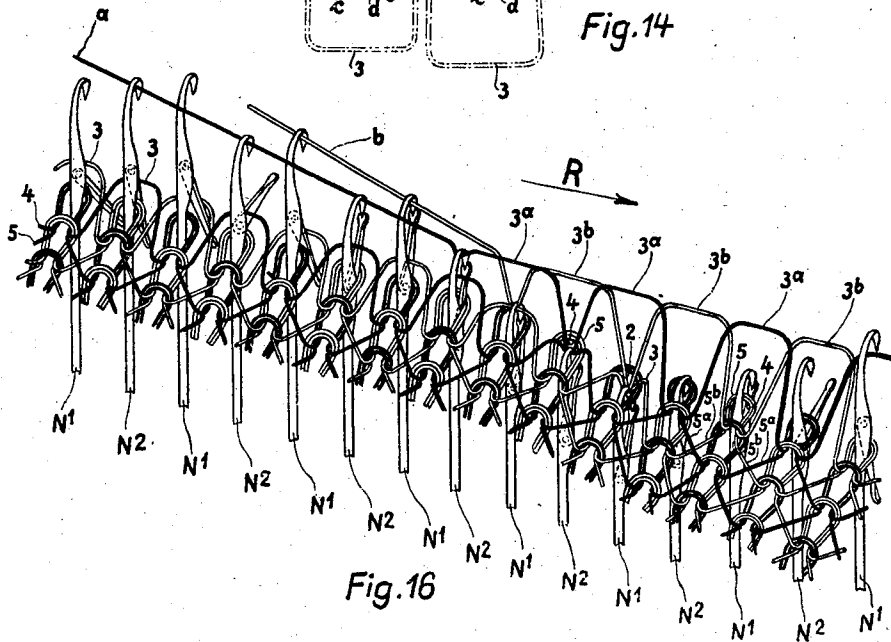


Fig. 16

Inventor:
Max Nebel

July 3, 1945.

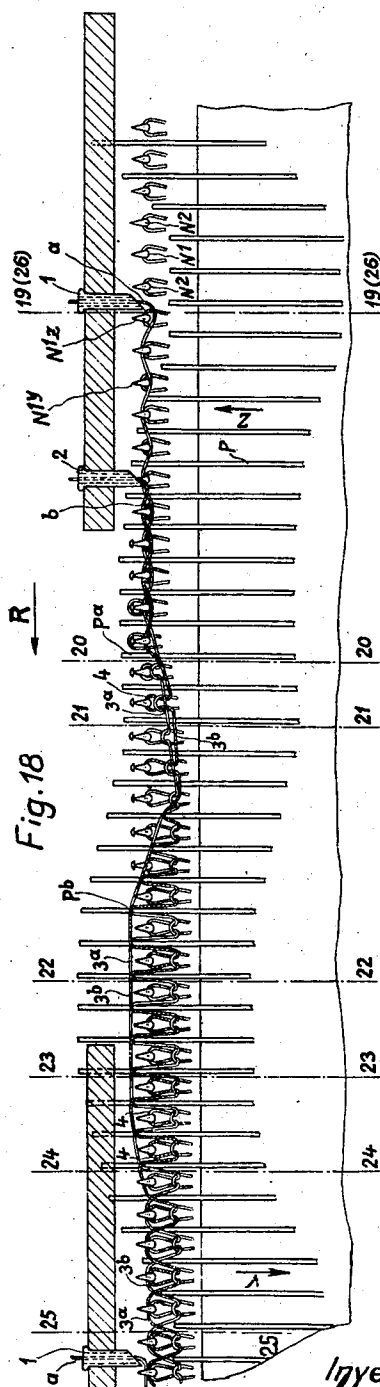
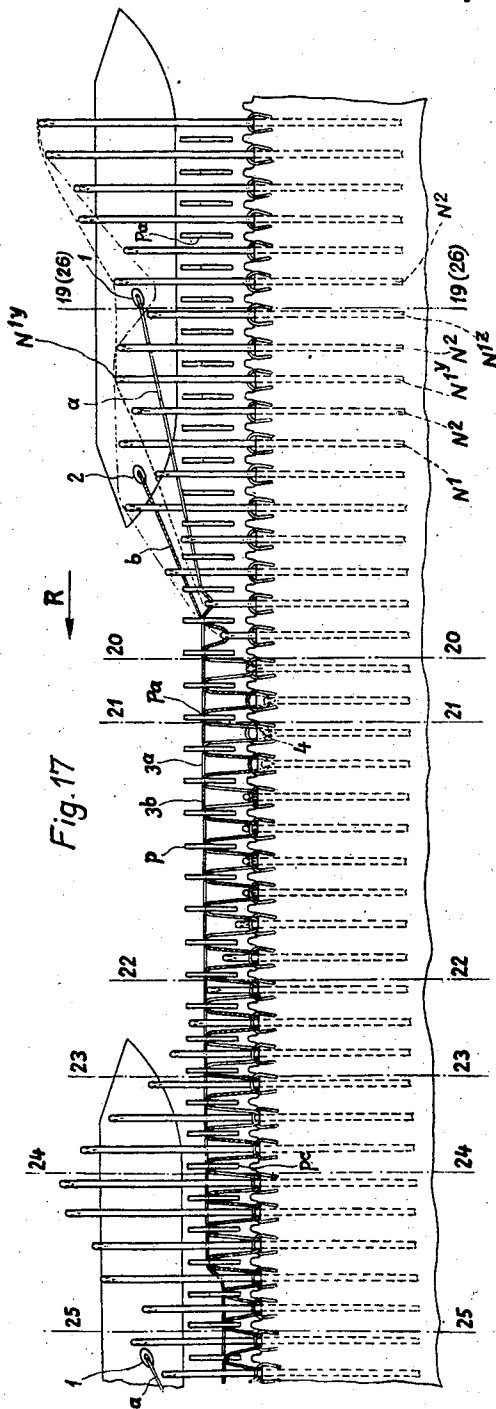
M. NEBEL

2,379,649

KNIT FABRIC AND METHOD OF MAKING THE SAME

Filed Sept. 16, 1937

17 Sheets-Sheet 8



Inventor:
M. Nebel

July 3, 1945.

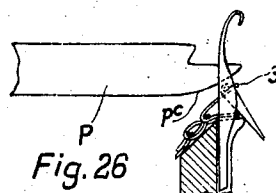
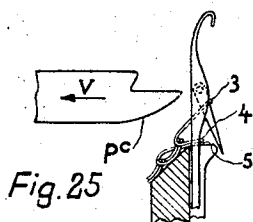
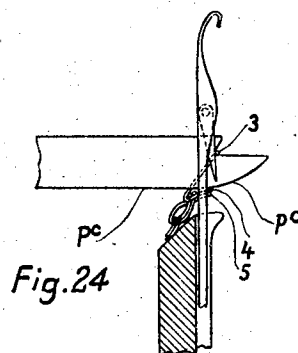
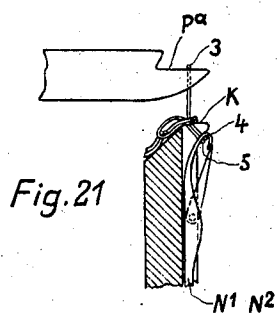
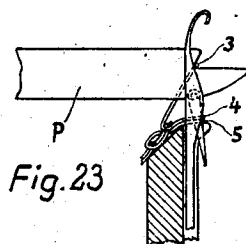
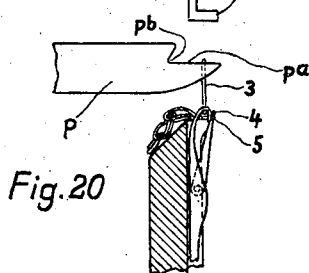
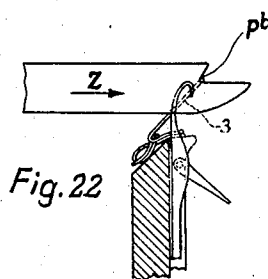
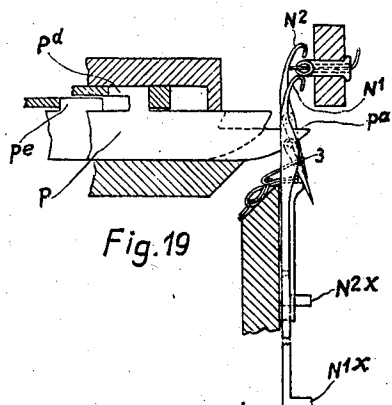
M. NEBEL

2,379,649

KNIT FABRIC AND METHOD OF MAKING THE SAME

Filed Sept. 16, 1937

17 Sheets-Sheet 9



Inventor:
M. Nebel

July 3, 1945.

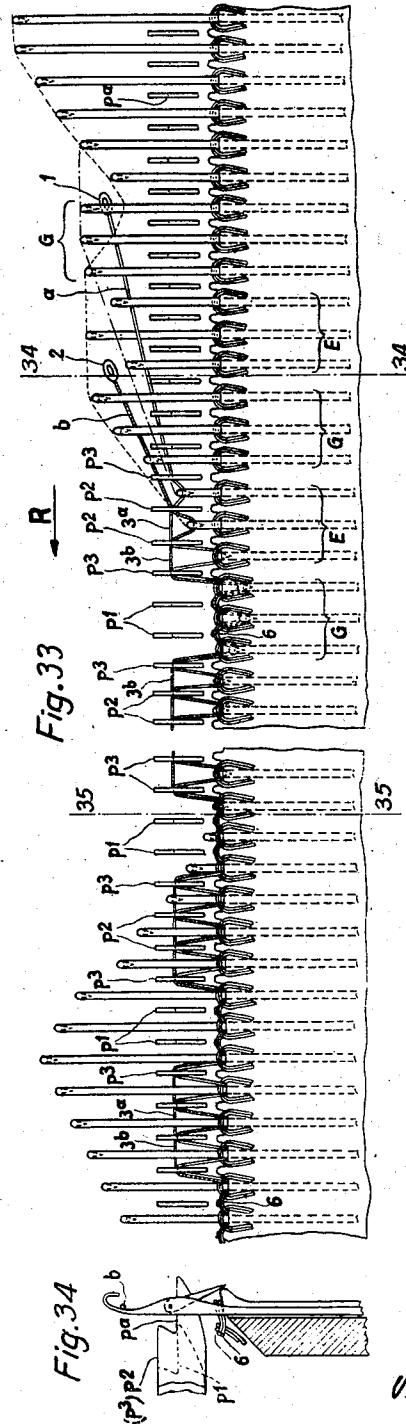
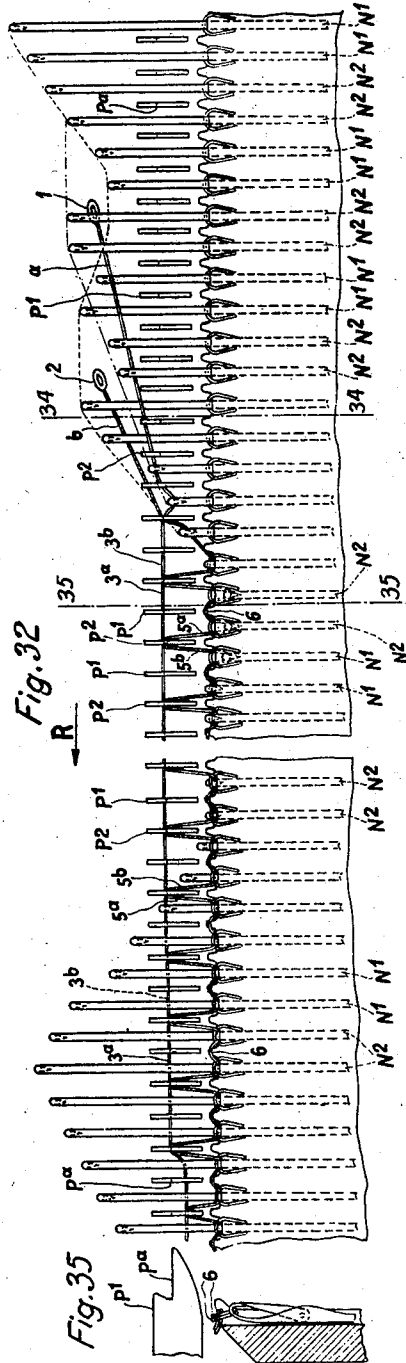
M. NEBEL

2,379,649

KNIT FABRIC AND METHOD OF MAKING THE SAME

Filed Sept. 16, 1937

17 Sheets-Sheet 11



Inventor:
Max Nebel

July 3, 1945.

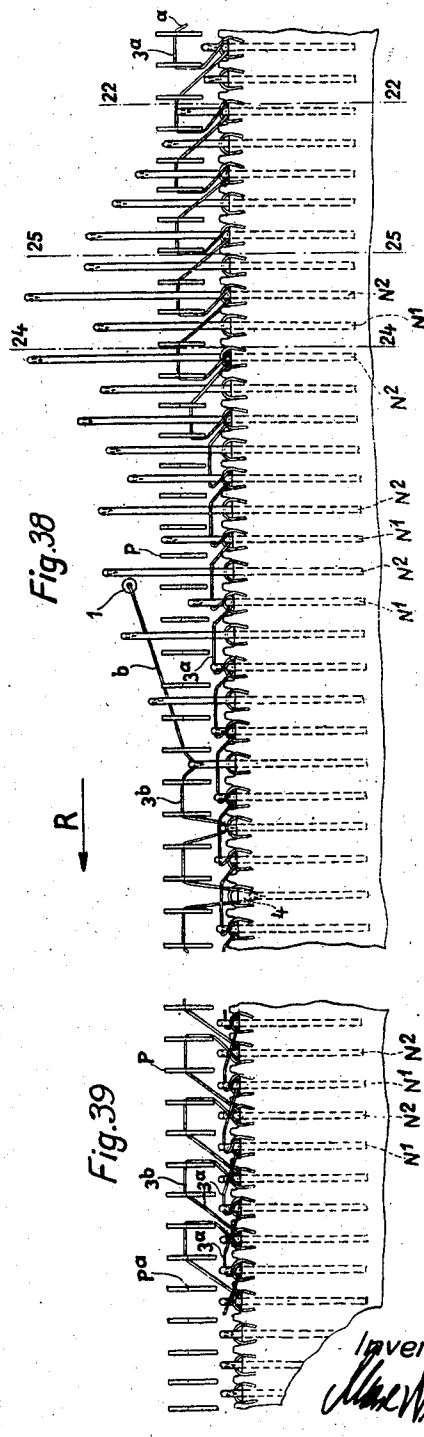
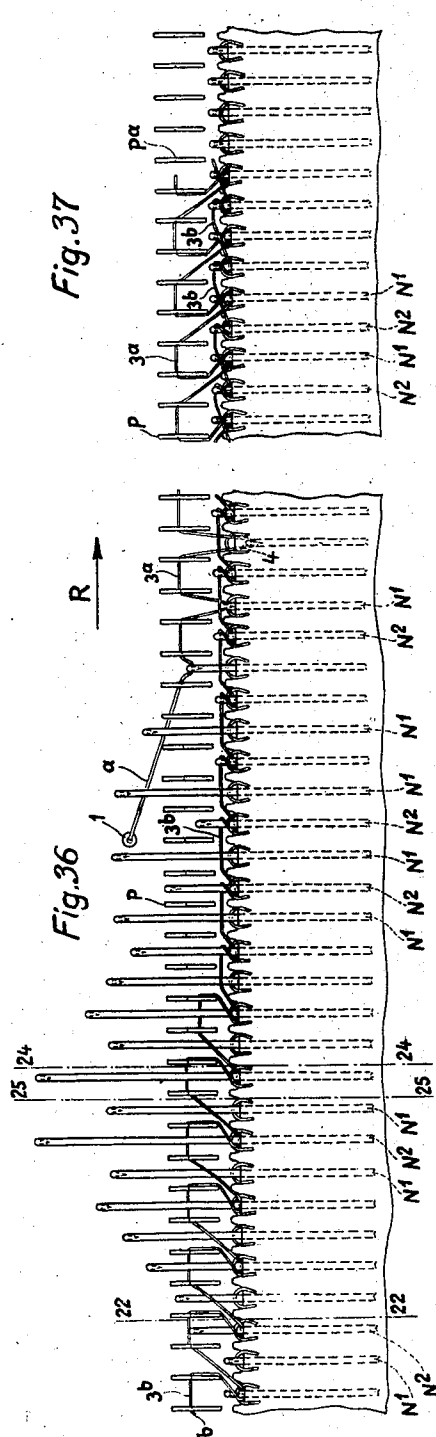
M. NEBEL

2,379,649

KNIT FABRIC AND METHOD OF MAKING THE SAME

Filed Sept. 16, 1937

17 Sheets-Sheet 12



Inventor:
M. Nebel

July 3, 1945.

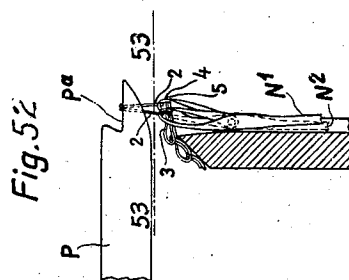
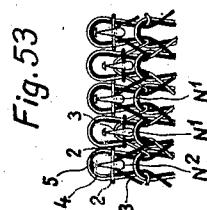
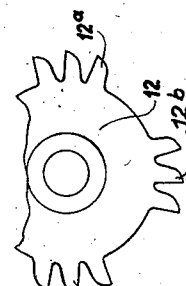
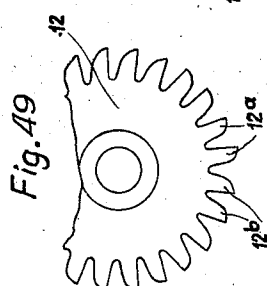
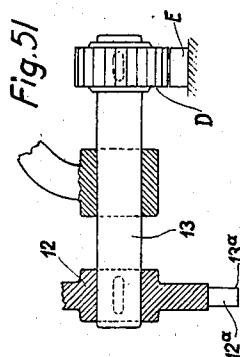
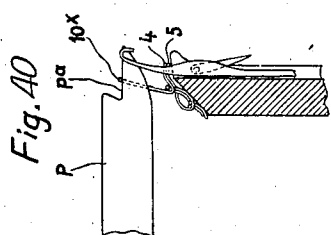
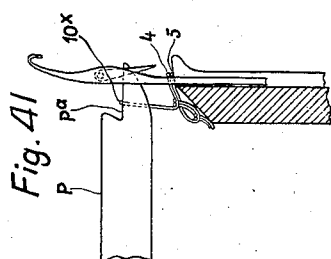
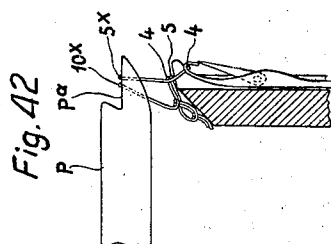
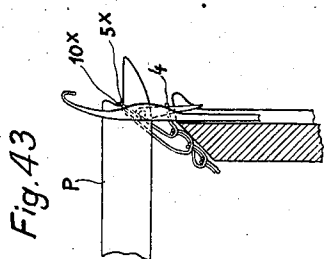
M. NEBEL

2,379,649

KNIT FABRIC AND METHOD OF MAKING THE SAME

Filed Sept. 16, 1937

17 Sheets-Sheet 13



Inventor:
M. Nebel

July 3, 1945.

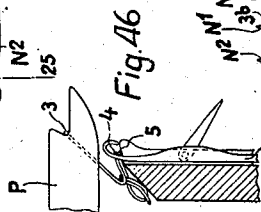
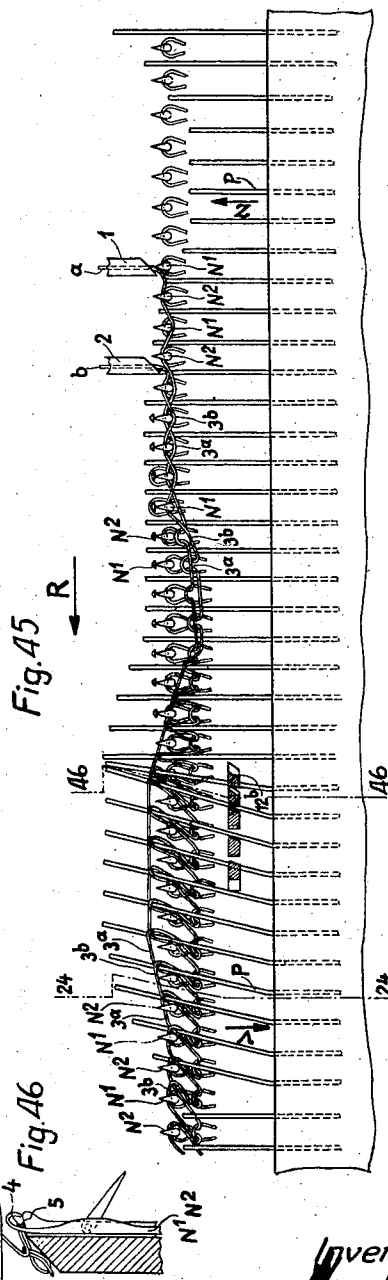
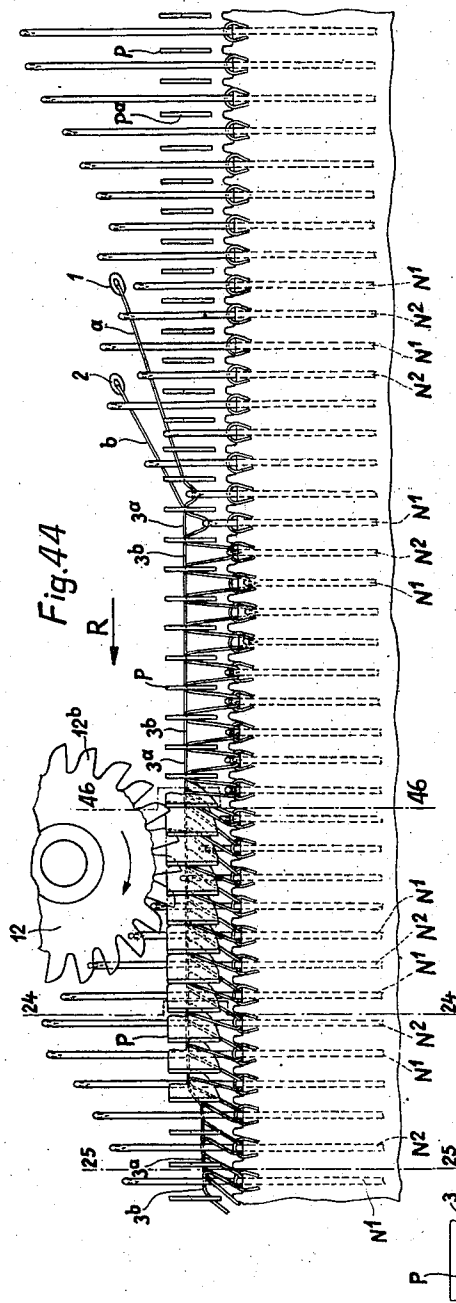
M. NEBEL

2,379,649

KNIT FABRIC AND METHOD OF MAKING THE SAME

Filed Sept. 16, 1937

17 Sheets-Sheet 14



Inventor:
Max Nebel

July 3, 1945.

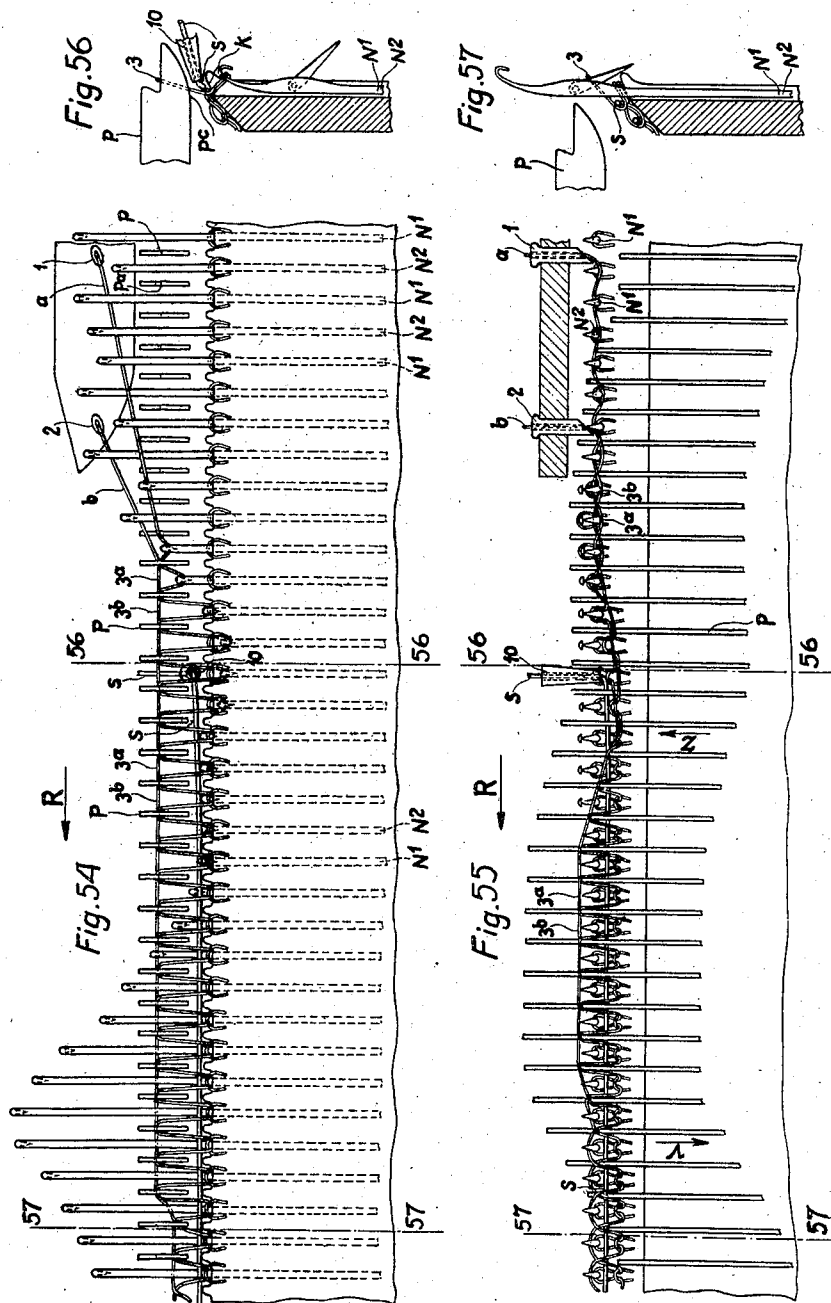
M. NEBEL

2,379,649

KNIT FABRIC AND METHOD OF MAKING THE SAME

Filed Sept. 16, 1937

17 Sheets-Sheet 16



Inventor:
Max Kheel

UNITED STATES PATENT OFFICE

2,379,649

KNIT FABRIC AND METHOD OF MAKING
THE SAMEMax Nebel, Chemnitz, Germany; vested in the
Alien Property CustodianApplication September 16, 1937, Serial No.
164,119½. In Germany September 14, 1936

7 Claims. (Cl. 66—169)

This invention relates to a knit fabric and a method of knitting such fabric.

An object of the invention is to combine the principal advantages of warp goods and hosiery and to produce a new fabric having characteristic features of warp goods, as well as hosiery.

In accomplishing the above and other objects of this invention, it was found advisable to provide a fabric wherein, as in hosiery, the thread extends in the transverse direction of the fabric, that is, in the direction of the courses. This makes it possible to attain in the new fabric the high degree of extensibility, ladder-proofness and other advantageous properties of hosiery. On the other hand, sinker loops are eliminated in the new fabric and, as in warp goods, are substituted by thread crossings or shanks which extend from a needle loop situated in one course to a needle loop situated in a following course. Due to this arrangement the great elasticity, ladder-proofness and other advantageous properties of the warp goods are retained in the new fabric.

In accordance with the present invention, each course or certain courses of the new fabric contain needle loops having short shanks and other needle loops having elongated shanks. The loops with elongated shanks are formed into a needle loop either by themselves or together with a needle loop with short shanks in the same wale or in a laterally-spaced wale situated in a following course, while one of the two elongated shanks is formed into one of the needle loops preceding the needle loop having short shanks.

In order to produce the fabric made in accordance with the present invention, the thread portions disposed between and above the needle loops are worked longer than usual and longer than the top loop portions, so that during looping in a following course these thread portions can be drawn through the needle loops of the course in which they are formed or through the needle loops of a following course, and in the next course they can be made into needle loops in the same wale or in a wale spaced laterally therefrom. The needle loops with elongated shanks may be formed into a needle loop either alone or together with the needle loop having short shanks of the course concerned. The thread portions located between the needle loops are worked in the width over one or more divisions.

The invention will appear more clearly from the following detailed description when taken in connection with the accompanying drawings showing, by way of example, preferred embodiments of the inventive idea.

In the drawings:

Figure 1 is a diagram illustrating a fabric having loops provided with short and elongated shanks;

Figure 2 illustrates diagrammatically a fabric wherein the loops are arranged along straight lines;

Figure 3 illustrates diagrammatically a fabric wherein each needle loop consists of a single thread;

Figure 4 illustrates diagrammatically a fabric wherein sinker wales alternate with cross-wales;

Figure 5 illustrates diagrammatically a fabric wherein needle loops with elongated shanks are provided in different wales;

Figure 6 illustrates diagrammatically a fabric, the elongated shanks of which are twice as long as the short shanks;

Figure 7 illustrates diagrammatically a fabric wherein loops with elongated shanks are worked into a needle loop;

Figure 8 shows a fabric substantially similar to that shown in Figure 4;

Figure 9 illustrates diagrammatically a fabric having two partial courses provided with overhanging thread portions;

Figure 10 shows a fabric which is substantially similar to that illustrated in Figure 5;

Figure 11 illustrates diagrammatically a plated fabric manufactured in accordance with the principles of the present invention;

Figures 12 and 13 are diagrams illustrating fabrics with tied-in wefts.

Figures 14 and 15 are diagrams illustrating hosiery of a type known in prior art for the purpose of explaining the development of the loop connection in the fabrics made in accordance with the present invention;

Figure 16 is a diagram illustrating the fundamental principle of loop connection in fabrics made in accordance with the present invention;

Figures 17 to 60 are diagrams illustrating sections through parts of circular knitting machines for the purpose of illustrating the operation of sinkers and needles in carrying out the methods of the present invention. For clarity's sake, the rows of sinkers and needles are shown as extending along straight lines and not circularly, or in the form of an arc, in both the top and front views. Throughout the following specification the front views are assumed to be taken in the direction of the back of the needles, i. e., in circular knitting machines looking from the inside of the needle cylinder. The front views and

top views show a complete looping process from beginning to end and up to the beginning of the next looping process. In these figures:

Figures 17 and 18 are a front view and a top view, respectively, of a section of the needle and sinker plate of a circular knitting machine for producing fabrics according to the present invention, the sinkers moving in the direction of the back of the needles and both partial courses being formed during a looping operation.

Figures 19 to 26 are side-views illustrating various positions of needles and sinkers, these figures being sections along the lines 19—19, 20—20, 21—21, 22—22, 23—23, 24—24, 25—25, 26—26 respectively, in Figures 17 and 18.

Figure 27 is a diagram illustrating a circular knitting machine in front view and showing the application of the method to this machine, wherein the sinkers move in the direction of the back of the needles and two courses are simultaneously formed.

Figures 28 to 31 are sectional side views taken along the lines 28—28, 29—29, 30—30, 31—31 of Figure 27.

Figure 32 is a diagram illustrating a circular knitting machine in front view and showing a method wherein the sinkers move toward the needle backs and both courses are formed during one looping process.

Figure 33 is also a front view of a circular knitting machine and shows another application of the method in accordance with the present invention, wherein the sinkers move toward the needle backs and both partial courses are also formed during a looping process.

Figures 34 and 35 are sectional side views taken along the lines 34—34 and 35—35 in Figures 32 and 33.

Figures 36 to 39 are diagrams showing the application of a method in accordance with the present invention to a flat or straight bar knitting machine, wherein the sinkers move toward the needle backs. Figures 36 and 37 show the looping in one working direction, and Figures 38 and 39 show the looping in the other working direction, only one partial course being formed during each looping.

Figures 40 to 43 are side views illustrating needles and sinkers in different positions for carrying out another knitting method constituting a part of the present invention.

Figures 44 and 45 show diagrammatically a front view and a top view, respectively, of a knitting machine and illustrate a method in accordance with which both partial courses are formed in one looping operation and the sinkers are moved against the needle backs.

Figure 46 is a section along the lines 46—46 in Figures 44, 45, 47 and 48.

Figures 47 and 48 are a front view and a top view, respectively, of a knitting machine and illustrate the application of another method.

Figures 49 and 50 show pattern wheels.

Figure 51 shows a drive for a pattern wheel.

Figure 51a is a sectional view taken along lines 51a—51a in Figures 47 and 48.

Figure 52 shows a needle and a sinker and illustrates the relative position of these parts during a reverse plating of a fabric.

Figure 53 is a sectional plan view taken along the line 53—53 of Figure 52.

Figures 54 and 55 are a front view and a top view, respectively, of a part of a knitting machine and illustrate a method in accordance with which

both partial courses are formed during one looping operation.

Figures 56 and 57 are sectional side views along the lines 56—56 and 57—57, respectively, of Figures 54 and 55.

Figure 58 is a diagram illustrating a fabric manufactured in accordance with the present invention and provided with plush loops.

Figures 59 and 60 show in front view and top view, respectively, a part of a knitting machine and illustrate the application of a method of producing a loop-plush fabric illustrated in Figure 58, whereby both partial courses are formed during a looping operation.

In accordance with the principles of the present invention, the knitting proceeds from two ground connections of the fabric. In the first place, as shown in Figure 14, there are two threads *a* and *b* in a course, all loops of which lie in two partial courses on a straight line L—L, and the two threads *a* and *b* are formed into needle loops A and B, while the sinker loops C are formed partly by the thread *a* and partly by the thread *b*. In this type of fabric the needle loops of a course always consist of one thread, alternately *a* and *b*, and the thread portions *c* and *d* of the threads *a* and *b* which have not been formed into loops A and B, are so arranged behind the needle loops A and B, alternately formed of the thread *a* or *b*, as unfinished loops *c* and *d*, that every second loop *d* of a course covers the ends of the loops *c* laterally spaced therefrom. This change 1+1 in the formation of the needle loops from one of the threads *a* and *b* and this relative position of the loop portions *d* and *c* occur in every wale.

Another starting connection is illustrated in Figure 15. The fabric also consists of two threads *a* and *b*, but all loops A formed out of the thread *a* lie on the straight line N—N, and all loops B formed of the thread *b* lie on the line M—M which line extends parallel to the line N—N representing the partial course of the loops A.

In the partial courses N—N and M—M both threads *a* and *b* are made into needle loops A and B and into partial loops *d* and *c* respectively, in such manner that the parts *d* and *c* do not cover each other and the change in forming loops A and B from threads *a* and *b*, which takes place when both partial courses are considered together, does not occur in the wale.

Fabrics, made in accordance with the present invention, are developed as follows from these fabrics.

In accordance with the present invention, the two incomplete loops *c* and *d* are made longer than in the prior art fabrics; the approximate new length of the loops being indicated by broken lines in Figures 14 and 15 and being designated by the references 3, 3a and 3b in Figure 16. These loops 3 having elongated shanks are made in the next course together with a needle loop A or B, which as a needle loop with short shanks is subsequently designated by the numeral 4, into a needle loop 5 with elongated shanks.

In the prior art arrangement shown in Figure 14, wherein the partial courses formed by the loops A and B extend along the line L—L, the positions of the thread constituting a part of the present invention are indicated by solid black lines. One loop 5 of the thread, represented by the solid black line, is made into this needle loop 5 together with the needle loop A or B of the following course, in the wale. In the prior art fabric the loop 5 would lie above it as the thread portion *d* or *c*.

This manner of knitting may be described as follows:

The loops 3 with elongated shanks are made into long needle loops 5 together with a needle loop 4 with short shanks in the same wale and in the following course or in the next but one course.

The other loop 5 indicated by a heavy black line in Figure 14 is not worked in the same wale into a needle loop in the next course, but in a wale which is laterally spaced therefrom. It is obvious that, in view of the overhanging of the long loops 5, more length of thread is required than is necessary for the long needle loop 5 which is worked into a needle loop in the same wale in the next course, as indicated by the unfinished loop 3d of the laterally overhanging loop 5 (shown by broken lines) which is somewhat longer than the other loop 3. In accordance with the present invention, the thread portions 3 can be formed only into needle loops 5 with elongated shanks in a following course.

In the diagram shown in Figure 15, wherein the two partial courses formed of the loops A or B extend along two straight lines N—N and M—M, the arrangements of the thread in accordance with the present invention, are also indicated by two threads a and b shown in solid black. The arrangement shown by solid black lines in Figure 14 may be also used in connection with the fabric illustrated in Figure 15, and vice versa.

Figure 15 illustrates by solid black lines a thread b forming a loop c, the loop c or 3 being longer than in prior art and being worked in the following partial course in the adjacent wale of the loops A into the longer needle loop 5 together with the loop A. For better distinction this loop is designated as 5x in Figure 15. In the other partial course of the thread a designated by solid black lines and having a loop d which in the prior art arrangement is formed into a longer loop 3, this loop 3 is formed in a direction different from that of the loop 5x in the adjacent wale B into the long needle loop 5y together with the loop B of the following partial course.

The loop 5z with elongated shanks which is also shown in Figure 15 and is indicated by solid black, is situated in the following partial course and in a wale which extends laterally of the original wale; it is made into a loop with the loop B and is subsequently referred to as the loop 4. In the prior art arrangement shown in Figures 14 and 15, the shanks which produce crossings in accordance with the present invention are formed of the thread portion which extends from the needle loop 5 with elongated shanks to its associated needle loop 4 with short shanks, the needle loops made of the thread a being designated as loops 5a, and the loops made of the thread b being designated as the loops 5b. As indicated in Figure 15, loop shanks 5a or 5b extend from the ordinary loops of a course formed of the threads a or b as portions of the needle loops with elongated shanks made of the same thread to a following course.

These various ways of laying the thread while starting from different initial connections may be combined at will. Examples of such combinations will be described hereinbelow. For each described connection an equivalent warp fabric connection is available. However, in the fabrics, made in accordance with the present invention, the thread extends in a transverse direction.

The general procedure is that the thread portions lying between the needle loops and worked

longer than usual, are drawn during the looping of a following course through the needle loops of the course in which the loops are formed, or through the needle loops of a following course, and are then formed into needle loops in the next course in the same wale or in a wale laterally spaced therefrom.

The loop formation shown in Figure 14 is produced as follows:

1st looping step

As shown in Figure 16, the thread a is placed behind the head of needle N1 and under the hooks of needles N2, whereas the thread b is placed behind the head of the needles N2 and under the hooks of the needles N1.

Both threads are sunk to form longer loop portions 3 and needle loops of ordinary length (Fig. 14). As each thread is sunk from every other needle, the loop portions 3 have the width equal to twice the length of the needle division. The loop portions 3 are drawn out to such an extent, as compared to loops of the usual size, that enough thread is available for finishing the loops 5 with elongated shanks in the next course, the elongated shanks being twice as long, or even longer, than the shanks of the ordinary needle loops 4. The loops formed of the threads a and b are designated as loops 3a and 3b in Fig. 16.

After the completion of the sinking step and when the needles ascend again, the loops 3, 3a and 3b are again brought over and beyond the needle head under the hook. This is possible, since each of the loops 3a and 3b extends over a division in width.

As shown in Figure 16, the loops 3a hang over the needles N1, while the loops 3b hang over the needles N2.

The thread portion 2 which is drawn from the long drawn-out loop through the old loop 4, 5 becomes the ordinary loop 4, while the other thread portion which, due to the higher sinking point, has more thread, forms the loop 3 with elongated shanks. The device has two sinking edges, namely, the ordinary one and a second one located above the ordinary edge, the higher edge serving for sinking and the ordinary edge serving for finishing and knocking over.

After the hanging over, the needles N1 and N2 ascend farther into the pressing position. The pressing is carried out as follows:

The loops 4 and 5 which were already on the needles before the hanging-over took place, are pressed off in the usual manner, namely, these old loops are placed below the latch on the needle shank to be knocked over during the next looping operation by sliding during the following sinking step over the closed latch and being thrown off the needles. The overhanging loops 3 are not pressed and remain below the hook on the latch until the next sinking operation.

2nd loop formation

The next sinking operation begins by placing the thread a from the needles N2 under the hooks of the needles N1. The thread b is placed from the needles N1 under the hooks of the needles N2.

The loops 3 drawn from the threads a and b are worked into needle loops 5 with elongated shanks during the sinking operation together with loops 3 formed in the first sinking operation, which are not pressed off under the hook, and together with the new needle loops 2 which are made into ordinary loops 4.

It follows from both looping steps that loop portions or shanks 5a or 5b extend from the

ordinary loops 4 of a course, formed of the same thread *a* or *b*, to the long needle loops 5 of the following course and connect needle loops of one course with the needle loop of a following course, instead of the ordinary sinker loops in fabrics in which the needle loops of a course are connected by sinker loops. In this way, cross threads are formed instead of a sinker loop, as illustrated in Figure 16.

3d looping step

During the next sinking operation, the thread *a* is placed behind the head of the needles N2 and under the hooks of the needles N1, while the thread *b* is placed behind the head of the needles N1 and under the hooks of the needles N2.

4th looping step

During the fourth sinking operation the thread *a* is placed behind the head of the needles N1 and under the hooks of the needles N2, while the thread *b* is placed behind the head of the needles N2 and under the hooks of the needles N1.

The fifth looping step is similar to the preceding one, and the sixth step is similar to the second one.

The described method is used to produce a fabric, the loops of which are positioned as in the basic connection shown in Figure 14.

The following method is utilized to produce a fabric of the type shown in Figure 15:

The first sinking operation is as described above in connection with the first looping step. The second sinking operation is similar to that described in the second looping step; then again as in the first sinking operation, followed by the second sinking operation, and so on.

In the fabrics shown in Figs. 1 and 2, each loop has two threads *a* and *b* and short shanks and elongated shanks, the loop 5 having elongated shanks being worked together with the loop 4 having short shanks to form a needle loop.

In the fabric shown in Fig. 1, all loops lie along straight lines such as L—L in accordance with the fundamental connection shown in Fig. 14, in the manner of an ordinary knit fabric. In Fig. 2, the loops lie on two straight lines N—N and M—M, according to the fundamental connection shown in Fig. 15.

In both fabrics, thread crossings are produced instead of sinker loops, and thus the two fabrics somewhat resemble the diagram of the known traverse warp fabrics.

The method used for manufacturing these fabrics is indicated in Figs. 17 to 26.

These figures show two needle groups N1 and N2 guided in two cams, the needles N1 being longer than the needles N2. The heel of the long needles N1 is designated as N1x and the heel of the shorter needles N2 is designated as N2x. As is shown more clearly in Figs. 19, 20 and 21, both needle groups are moved differently. Two threads *a* and *b* issuing from the thread guides 1 and 2 are worked at each sinking operation. The needles N1 move below the thread guide 1 and past it and ascend so high that their heads move above and past the guide 2. In order to insure a reliable placing of the threads behind the needle heads, the latter preferably, are bent somewhat toward the thread guide, as indicated in Fig. 19. Due to this needle motion, the thread *a* is brought behind the heads of the needles N1 and the thread *b* is brought under the hooks of the needles N1. The needles

N2 move with their heads above and past the thread guide 1 and then descend to pass below the thread guide 2. In this way, the thread *a* is brought under the hooks of the needles N2 and the thread *b* is brought behind the heads of the needles N2. Figure 24 shows the pressing position. Preferably, the needles of both groups are moved down to a certain extent out of their elevated position, before moving into their operating position relatively to the thread guides, so that when the sinkers leave the needle row (Fig. 25) the loop 3 lying on the open latch cannot slip off the latch, since it would then hang upon the needle shank without the necessary distance from the old loops 4, 5. Furthermore, the needle heads must pass as closely as possible above and below the thread outlet of the guides, so that the latch always operates as a separating member between the loops 3 and the old loops 4, 5, as shown in Figure 19. The sinkers P, moved by cams of known type, enter between the two thread guides 1 and 2 (Fig. 18) and move in the direction Z toward the needle back through the needle row and under the threads *a* and *b* to such an extent that, as indicated in Fig. 19, the threads are placed on the sinking edge Pa of the sinkers P during the sinking of both needle groups N1 and N2. As shown in Figure 17, this edge Pa is situated higher than in prior art to such an extent that the loop is drawn out as required to provide the longer loops between the needle loops 4 with so much more thread that they can be worked in the next course into the loop 5. The loop 3 will then be so positioned that the loop 3a of the thread *a* will lie above the two sinkers P between the needles N1 and above the needles N2, and the thread 3b will lie above the sinkers between the needles N2 and above the needles N1, as shown in Figures 17 and 18.

During this sinking of the loops on the edge Pa, the finishing of the loops on the ordinary sinking edge (Figs. 21 and 24) takes place, the edge K lying underneath the lower sinker edge Pc. The thread portions hanging on the needles lie on the edge K.

The sinking depth can be adjusted by vertically adjusting the sinker bar, or by correspondingly sinking the needles, or, which is particularly advantageous, by varying the relative positions of the two loop-forming tools, namely, sinkers and needles, in such manner that the needles move down to a lower level below the ordinary sinking edge K (Fig. 21), and the sinking point for the loop portions is raised by raising the sinkers P and, consequently, their edge Pa.

As indicated in Figures 17, 18, 20 and 21, the sinkers P move further in the direction Z toward the needle backs after the sinking of the long loops and prior to the ascent of the needles, until the long unfinished loops 3, each of which is carried by two sinkers, are brought forward by the throat Pb (Fig. 22) to such an extent, that the ascending needle passes through the loop, as shown in Figure 23. The long loop is thus transferred to the needle and lies below the hook. After this transfer, the sinker moves back somewhat in the direction V to permit the loop to lie within the range of the needle hook, as shown in Figures 18 and 23.

To permit the placing of the overhanging loop 3 under the hook, care must be taken that the latch of the needle is open already at the time when it moves out of the sinking position (Figs.

21 and 29) into the overhanging position (Fig. 22).

This opening of the latch can be carried out by any known means, for instance, by using a latch-opening brush in machines in which the sinkers are moved toward the needle back, or by employing latch needles wherein the latch-guide slot does not extend toward the needle back, so that when a loop passes over the latch, it is elastically held in the closed position and opens when pressure ceases to be exerted upon it.

The usual procedure is to have the latch opened by the old loop, when the needle is moved up after the sinking, and this method can be utilized for the purposes of the present invention, provided that the latch is so short that it will be opened by the old loop 4, 5 before the needle head passes through the loops 3 pushed in the front of the head on the sinkers P during the motion of the needle from the sinking position into the overhanging position.

When the needle moves into its highest position, namely, the pressing position (Figs. 17, 18 and 24), the sinker is still in the needle row to such an extent that the long loop still lies on the edge Pa and on the open latch, and the old loops 4, 5 are separated by the lower edge Pc from the overhanging loops 3, so that the new loop 3 is not placed below the opened latch on the needle shank during the pressing, when the old loop slides from the open latch onto the needle stem owing to the ascent of the needle. This pressing position is the highest needle position from which it moves down again, while the sinker moves out of the needle row in the direction V (Figs. 17, 18 and 25). When the sinker separating the old and new loops is moved out of the needles, the latch separates the old loop from the new loop, even if at the beginning of a new sinking operation the sinker moves again between the needles (Fig. 26). To prevent damage to or displacement of the loops 3 by the sinker, the lower edge Pc of the sinker P is bevelled at the free end of the sinker in such manner that the lower edge Pc forms a point with the upper edge Pa.

The next sinking operation begins in the same manner as the first one, with this difference, however, that the thread a is brought under the head of the needles of the group N1 and behind the head of the needles of the group N2, while the thread b is brought under the head of the needles of the group N2 and behind the head of the needles of the group N1 (Fig. 19). During the sinking operation, the loop 3 lying on the open latch together with the newly sunk needle loops is drawn through the loops 4, 5 of the preceding course and formed into a new loop 3, the old loop 4, 5 remaining on the needles, as shown in Figures 20 and 21.

The old loop 4, 5 is thrown off over the needle head, as indicated in Figures 20 and 21. Then the loop 3 is hung over again, so that it lies in front of the head below the hook (Figs. 22 and 23). In this manner, the fabric shown in Figure 1 is produced.

The making of the fabric shown in Figure 2 involves the same operations, the only difference being that the motions of the needle groups N1 and N2 are not changed from one sinking operation to another. It is, therefore, essential that, as in the above described method relating to Figure 1, two threads should be alternately brought in front of and behind the heads of the

needles of both needle groups N1 and N2 during a sinking operation and, further, that the needles of the group in which the thread issuing in the working direction is to be brought behind the needle head, ascend rapidly behind the first thread guide to insure the safe placing of the thread, particularly since the thread issues in the form of a curve toward the needle which thus has to move up behind this curving thread. This is shown in Figures 17 and 18, wherein one needle path is designated by dotted lines and the other by dash-and-dot lines. The needle group N1 places the thread a and sinks the thread b, while the needle group N2 places the thread b and sinks the thread a.

The needle N1z moves directly behind the thread guide 1 having the thread a which is to pass behind the heads of the needles N1, and rapidly moves into the position of the needle N1y (Fig. 17). As is clearly shown in Figure 18, the thread a issues in the form of a curve from the guide, so that the needles N1z can safely push up from behind.

The needle group N2 used for placing the thread b, moves slowly down into the sinking position, after having placed the thread a under the needle hook, and thus moves below the thread outlet of the guide 2 and beyond the latter, as indicated by a dotted line. Therefore, the thread b which is taken under the hook by the ascended needle of the other group N1, cannot be caught by the needles N2 and is thus placed behind the needle head.

The thread tube is bevelled in the known manner toward the operating direction R (Figs. 17 and 18), so that the thread outlet can be brought as closely as possible to the needles, and in order to facilitate the curve-like issuance of the thread from the guide.

The described method does not depend necessarily upon the motion of the sinkers in the direction of the needle backs. It is possible to utilize the better known and more customary motion of the sinkers in the direction of the needle breast.

Figure 3 shows a fabric which has one thread in every needle loop, but which is otherwise similar to fabrics shown in Figures 14 and 15.

In this fabric two superposed courses are formed of two threads a and b. Each thread is alternately worked into loops 4 having short shanks and needle loops 5 having elongated shanks. As distinguished from other fabrics, such as fabrics shown in Figures 1 and 2, the loops 5 with elongated shanks are formed alone into needle loops, and not together with the loops 4 with short shanks, so that they form a needle loop by themselves.

The shanks 5a of the loop 5 which are close to the loops 4 with short shanks, form a thread crossing which replaces the sinker loop. For this reason there are no sinker loops in the row of loops with elongated shanks.

A method of producing this fabric is shown in Figures 27 to 31.

The machine has two needle groups N1 and N2 which are moved by different cams. Furthermore, there are two thread guides 1 and 2 for the threads a and b. The two needle groups N1 and N2 get the thread, sink it, hang over the longer drawn-out loops 3 under the needle hook and press the old loops while not pressing the hanging loops 3, in the same manner which was previously described. The new feature is that the overhanging loop 3 which lies under

the needle hook on the latch while the short loop 4 lies below the latch (Fig. 28), is drawn through the old loop 4 during the further descent of the needles. The old loop 4 closes the latch (Fig. 29) and is thrown off, so that only the loop 3 is made into a needle loop 5 with elongated shanks. In accordance with this modification, the loop 5 is made without the short loop, which is the case in the fabrics shown in Figures 1 and 2, since during the further motion into the sinking position, namely, the motion behind the line 28—28 of Figure 27, no thread is fed. Then the needle moves into the pressing position (Figs. 24 and 31), and the loop 5 which alone hangs on the needles is placed below the open latch on the needle shank. The thread is obtained by both needle groups only during the following sinking operation. Then the thread is worked into loops 3 with elongated shanks and loops 4 with short shanks, whereupon the next row is sunk without the feeding of the thread by working out the long loops, and so forth.

Thus, by working the two threads *a* and *b*, the double-threaded course *f—f* (Fig. 3) is formed, which consists of the loops 4 with short shanks and the intersections of the elongated shanks 5*a* and 5*b*, whereupon the course *e—e* is formed by the threadless sinking and working of the loops 5 with elongated shanks.

During the sinking operation in the course of which the thread is supplied, shown to the right of the line 28—28 in Figure 27, the sinkers move relatively to the needles in exactly the same manner as that described with reference to Figures 17 and 18. During the sinking without the supply of thread, the sinker remains in a position outside of the needle row in which it must be placed before the beginning of that sinking operation, during which the thread is supplied, as indicated in Figures 28 to 30. Figure 31 shows the beginning of the sinking operation during which the thread is supplied, after the pressing of the loops 5. The sinker is again in the same needle row.

Figure 4 shows a fabric wherein the sinker wales alternate with cross wales. Each course and each needle loop consist of two threads *a* and *b*. The elongated shanks of the loops 5, which are indicated by references 5*a* and 5*b*, form toward one side an ordinary sinker loop 6 together with the adjacent loop 4 with short shanks. Toward the other side the loops 5 form a crossing together with the shanks 5*b* or 5*a*.

This fabric is produced in the following manner:

The two needle groups N1 and N2 are movable independently of each other, but each group comprises two needles disposed side by side. The needle groups operate in the same manner which was previously described, with that difference, however, that the first two needles of the group N1 move below the thread guide 1 disposed in the operating direction R and immediately go up behind this guide, so that the thread *a* is placed behind the head of two needles N1, while two needles of the group N2 move under and pass the other guide 2, so that the thread *b* is not brought under their head. Furthermore, the sinker also comprises two groups *p1* and *p2*, as shown in Figure 34. The sinkers *p1* are located between the adjacent needles of a group N1 and N2 (Fig. 32) and do not move like the sinkers *p2* between the needles and under the threads *a* and *b*, but remain outside of the

needle row in an inactive position (Fig. 34). This is attained in a manner known per se by providing sinker feet of different lengths and by actuating them with two cam members which are also different in length.

As the thread *a* is sunk by two adjacent needles N2 into long loops and is not caught by two needles N2, each loop of one or the other thread lies over two needles of both needle groups and extends from a sinker P2 to the next sinker P2 (Fig. 32), so that each loop 3 is brought over two needles under the hook in such manner that it is worked together with new loops into a needle loop only in the next course. In this manner a crossing is formed between two needles of the group N1 and two needles of the other group N2, while the thread between two adjacent needles of a group N1 or N2 is worked into ordinary sinker loops 6 (Fig. 35), since there is no sinker in the row between these two needles N1 and N2, or N2 and N2. Thus a longer sinking of this thread portion does not take place.

When the loops 3*a* and 3*b* are worked together with the new loop into a needle loop 4 and 5, the long loop is drawn through two old loops and the thread portion between the two needles is also worked into an ordinary sinker loop together with the already formed sinker loop, so that all ordinary sinker loops are double-threaded, as shown in Fig. 4.

As previously indicated, the operation of the needle groups relatively to the thread guides may vary from course to course and from one sinking operation to the other; one needle group may alternately be operated and the other one may be eliminated.

By means of the new group formation, it is possible to make a change in the association of the needles with the various groups, so that, for instance, the first and second, fifth and sixth, ninth and tenth needle of the group N1 and the third and fourth, seventh and eighth, eleventh and twelfth needle of the group N2 work in one row, and the next course is formed by the second and third, sixth and seventh, tenth and eleventh needles of the group N1 and the fourth and fifth, eighth and ninth, twelfth and first needles of the group N2, and so forth. The operation of the two sinker groups must change accordingly. When in one row the sinkers P2 are situated between the needles, the sinkers P1 must remain outside in the next row during the change of the groups.

The fabric shown in Figure 8 is similar to the fabric shown in Figure 4. Here a known plain fabric alternates with loops of a fabric made in accordance with the invention, in groups or according to a pattern. Any other known fabric, such as 1:1, interlock, and the like, may be substituted for the plain fabric.

An ordinary sinker loop 6 and a shank 5*a* or 5*b* are located at the point where the usual fabric extends into the new fabric.

A method of manufacturing the fabric shown in Fig. 8 is illustrated in Figure 33.

The needles are divided into two groups in accordance with their motions, namely, a group E and a group G. In the example illustrated, each group has three needles. The group E operates in accordance with the method shown in Figure 16, while the group G operates normally, so that both threads *a* and *b* are caught by all needles and worked into ordinary double-threaded loops. The sinkers P1 between the needles of the group

G remain inoperative during the sinking (Fig. 34), so that the threads are not made into long loops on the upper edge Pa. The sinkers P2 between the needles of the group E and the sinkers P3 which lie between every group G and E move in the manner hereinbefore described (Fig. 18) below the range of the two thread guides 1 and 2 into the needle row, so that the threads are sunk by the needles of the group E to form long loops 3 which in accordance with the present invention (Figs. 17 and 18) are brought under the needle hooks and are worked into needle loops in the next course. After the sinking operation the sinkers P1, as well as the sinkers P2 and P3, move in the direction Z toward the needles, but they do not carry loops (Fig. 35).

Figure 6 shows a fabric having loops 10 with elongated shanks which are approximately twice as long as the shanks of the long loops 5. The longer loops of this course in the next course but one are worked into needle loops together with the loops 5 of the intermediate course and the ordinary loops 4. In this way single-threaded, double-threaded, and triple-threaded loops 4, or 4, 5 or 4, 5, 10 are produced, as well as the crossings of the shanks 5a and 5b, or 10a and 10b, 5a or 5b and 10a or 10b, etc.

This fabric has an extraordinary close Jersey-like or crepe-like character.

Figures 40 to 43 illustrate a method of producing this fabric.

The procedure is practically the same as that previously described with reference to Figures 17 and 18, with this difference, however, that if a three-threaded needle loop is to be worked into the fabric, the sunk long loop 10x, which is then made into the long loop 10, lies on the sinker edge Pa after the sinking, as shown in Figure 40, and is not hung over and placed under the needle hook, since the sinker does not advance any further toward the needles, but retains the sinking position, as described in connection with the main method illustrated in Figures 18 and 21. During the further upward motion of the needles into the pressing position the old loop is pressed off (Fig. 41) and the loop 10x remains behind the needle back on the sinker edge Pa. During the next sinking operation long loops 5x (Fig. 42) are sunk near the loop 10 lying on this edge. Since during the sinking of the thread to form long loops 5x, no loop 10x of the preceding sinking operation is positioned under the hooks, the needles form only single-thread loops 4 of regular length. The sinkers move toward the needles after the sinking operation, and this is necessary to bring the loops over the needle head under the needle hook, so that both loops 10x and 5x (Fig. 43) are jointly worked into a three-threaded needle loop 4, 5, 10 during the following sinking operation together with the regular loop 4.

Figure 7 shows a fabric wherein the long loop is worked into a needle loop together with the regular loop, not in the same wale but in the adjacent wale, so that a thread arrangement resembling warp goods is produced. The shanks of the long loops do not cross each other, but one shank 5a or 5b crosses the needle loop and the other shank surrounds the head of the double needle loop which in the same wale precedes the loop through which the long loop is drawn.

The method of producing the fabric shown in Fig. 7 is indicated in Figures 18, 36, 44 and 45. The lateral racking of the loops can be carried out before the sinkers move in the direction Z

into the hanging-over position (Fig. 21), or after the sinkers are in that position (Fig. 22).

The mode of operation is the same as described with reference to Figure 18. The only difference is that the long loops 3a or 3b are laterally racked one or two divisions after the sinking and before the needles have moved up between the sinkers.

There are several devices which can be used for racking the loops into the range of the adjacent needle.

In circular knitting machines presser wheels 12 (Fig. 51) may be employed. The wheels 12 are driven by a rack E and a tooth D mounted upon the shaft 13 carrying the presser wheels 12. The presser wheels 12 have teeth which are bevelled on one side or the other, depending upon the side to which the sinkers are to be pressed, and the bevelled side of the teeth acts upon the sinkers. Differently bevelled teeth are designated by references 12a and 12b in the drawings. A presser wheel is provided with either the teeth 12a or the teeth 12b and can be hung over only towards one side. If a loop is to be hung over once in one direction and in the next course in another direction, a presser wheel 12 may be provided with teeth 12a and 12b, as shown in Figure 49. If certain loops should not hang over laterally in a predetermined course, the teeth are eliminated along that portion of the wheel 12 which is intended to actuate the sinker (Fig. 50).

Figures 44 and 45 show the manner in which the presser wheels 12 are pushed sideways into the adjacent division, at the time when, after the completion of the sinking operation, the sinker has brought the loop 3a or 3b lying in its throat Pb in front of the needle head. This lateral pressing must take place, of course, before the needles move between the sinkers. The relative position of the sinkers and needles at the time when lateral pressure begins is shown in Figure 46, and this position corresponds to an intermediate position situated between those shown in Figures 21 and 22. The sinkers are pushed laterally by the teeth 12a or 12b of the presser wheels 12 to the extent of a needle division only until the needle has ascended far enough to be between the sinkers and when it holds back the laterally pressed sinkers from snapping back into the normal position. The sinker retains the advanced position (Fig. 24) in the adjacent division up to the pressing operation. After the pressing operation the sinkers move out of the needle row into the inactive position and resume again the normal straight position (Fig. 25). The presser wheels exert pressure upon the sinkers in the foremost position of the latter, while they are in a position of rest (Fig. 46).

The presser wheel 12, shown in Figure 44, is provided only with teeth 12b and presses the sinker in a direction opposite to that of the working direction R, so that the long loops of the fabric shown in Figure 7 are racked to the right. In the next course, in which the racking is to the left, a presser wheel 12 is used which has only the teeth 12a. As shown in Figures 47 and 48, the teeth 12a are so formed that the sinkers enter the adjacent division in the operating direction R.

To permit the pressing of the sinkers without causing deformation, they must be made of highly elastic steel.

Another way of laterally racking the loops is indicated in Figures 36 and 37 and is used in flat machines having a sinker bar plate and one or two needle beds, one of which carries the sinkers

besides the needles, since after the working of one course the needle bed or the sinker bed is racked one or two divisions in one direction and in the next course is racked in the other direction. Otherwise, the mode of operating the needles and sinkers is similar to the methods shown in Figures 56 and 57.

The fabric shown in Figure 5 has the fundamental connection of Figure 15 in which the long loops 3a and 3b are worked into needle loops in one course in the wale on one side and in the following course in the wale on the other side.

The method of producing this fabric is indicated in Figures 36 to 39, 47 and 48. While the machine is operated, work is carried on in double division at each sinking operation, so that the needle group N1 forms the thread a into loops with short shanks and long loops, and the other needles N2 are eliminated from the sinking operation. During the following sinking operation the interposed needles of the group N2 work the second partial course out of the thread b, and the needles of the group N1 are cut off from the sinking operation. In the first partial course (Figs. 36 and 37) which is worked with the needles N1, the long loop 3a is hung over toward one side and in the next partial course which works the thread b into loops 3 with the needles N2, the racking is effected toward the other side.

Figures 36 to 39 show the working method in flat knitting machines in which the racking is carried out by the lateral displacement of the needle or sinker bed.

Figure 36 shows the sinking of the first partial course from the needles N1, and Figure 37 shows the finished partial course with all needles in the elevated position shown in Figure 21, the needles N2 being in the catching position. The long loops on the sinkers are racked to the left by the lateral displacement of the needle or sinker bed (Fig. 21), prior to being hung over to one side, as shown in Figure 37. Figure 38 shows the sinking of the next partial course made of the thread b by the needles N2, and Figure 39 shows the sunk partial course with all needles in the catching position. In the position according to Figure 21 the long loops on the sinkers are racked to the right by a lateral displacement of the sinker or needle bed. The long drawn-out loops are always hung over before the needles go up out of the position shown in Figures 37 and 39 into the pressing position and before sinking (as seen in the working direction). The change in the working direction in flat machines, as indicated in Figures 36 and 38, has no influence upon this procedure. The same is true as far as the co-operation of the sinkers and needles is concerned. In the described method, wherein both loops 3a and 3b hang over laterally, both partial courses are worked in one sinking operation and, therefore, it is possible to work the laterally transferred loop together with the new regular loop into a needle loop, since both needle groups N1 and N2 participate in the following sinking operation.

In accordance with the new method, the groups of the needles N1 (Fig. 37) over which the long drawn-out loops are hung have participated in the sinking operation. After the transfer of the loops (Figs. 22 and 23), these needles move into the pressing operation shown in Figure 24. During the next sinking operation the needles N1 do not operate and the needles of the other group N2 are operating. The long drawn-out loops hanging on the needles N1 which are not cut off during this sinking operation, cannot be worked

out during the following sinking operation, and therefore, the needles in their disengaged condition must pass up through the sinking point or position, to prevent the old loop from being thrown off over the needle head and the hung-over loop from being under the needle hook.

The loops drawn out by the needles N2 are now hung toward the other side. After the lateral hanging-over of the loops, the needles N1 go up into the pressing position (Fig. 24) while the needles N1 which now participate in the sinking operation go up only to the extent shown in Figure 25 prior to the sinking step, so that the loops are not placed below the open latch, but remain under the head up to the sinking step and are worked into a needle loop, together with the newly sunk regular loops.

This signifies the following:

The needle which has worked a short loop 4 and a loop 3 and to which the interposed long loop has been transferred, goes into the pressing position, presses off the old loops (Figs. 22, 23 and 24), and the loops remain on the open latch; then this needle is eliminated from the following sinking operation, whereupon this needle goes up into the position shown in Figure 25, then again into the sinking position, etc.

While the other needles form short loops 4 and the loops 3, the interposed needles pass through this sinking operation into the position shown in Figure 25, and then into the sinking position; after this sinking operation the needles and sinkers move again into the position shown in Figures 22, 23 and 24, so that the same position is reached again.

The method shown in Figures 47 and 48 can be applied also to circular frames or circular knitting machines, with the difference that then the sinker or needle bar is not racked laterally, but the sinkers are pressed into lateral divisions by the presser wheels 12 having teeth 12a and 12b.

The fabric can be also worked in accordance with Figure 14 with the lateral racking of the long loops, which changes from course to course. Such a fabric is of a pronounced charmeuse type.

As shown in Figures 47 and 48, in the manufacture of this fabric one needle group, namely, the loop N1, forms short loops 4 and loops 3 in two successive sinking operations, namely, in one operation from the thread a and in the other operation from the thread b. In this way the needles of the group N1 form short loops 4 and loops 3a and 3b in two successive sinking operations. The needles of the group N2 are eliminated from these two sinking operations.

After the sinking operation the needles N1 which first form short loops 4 and loops 3a from the thread a, receive again their own loop 3a, due to the fact that the sinkers in the overhanging position shown in Figure 46 are pressed in the working direction R into the adjacent division by a presser wheel 12 having teeth 12a. Then the needles move into the pressing position shown in Figure 24 and start the next sinking operation, in which they participate again to work the thread b into loops 4 and long loops 3b, and the transferred loops 3a into long needle loops 5. After the sinking of the long loops 3b and when they are again in the overhanging position (Fig. 46), the sinkers are pressed by a presser wheel 12 having teeth 12b in a direction opposite to the working direction and into the adjacent division, and the loops 3b are hung over the needles N1. After this transfer the needles N1 move into the pressing position shown in Figure 24 and then into the

catch position which the needles N2 have occupied during the two sinking operations; the needles N2 ascend only far enough to prevent their loops from passing under the latch and the needles N2 do not move into the pressing position.

The same working cycles are repeated during the next two sinking operations, with the difference that the needles N2 carry out the motions of the needles N1 and the latter those of the needles N2. The mode of operating the two needle groups N1 and N2 changes uniformly after every two sinking operations.

The fabric shown in Figure 10 resembles the fabric shown in Figure 5. The only difference between the two fabrics is that in the fabric shown in Figure 10 only one partial course is worked on the needles of only one group N1 or N2 like a regular course from one thread and that, changing from course to course, the loops 3 located between the needle loops or the sinker loops are hung over the needles N1 or N2 alternately to the left and to the right, and are worked in the next courses into needle loops.

The hanging-over may also take place toward one side of a course.

The fabric shown in Figure 10 may be manufactured in the manner indicated in Figures 36, 38, 44, 45, 47 and 48, with this difference, however, that only one thread is worked during the sinking and only one needle group is operated, while the other needle group is eliminated all the time from the sinking operation by passing without any change in its vertical position and therefore forming no loops.

The lateral transfer of the loops is carried out in the manner previously described, so that the needle which sinks the thread, for instance, the needle N1 in Figure 36 always receives the loop 3 situated above this needle (Fig. 37).

Figure 9 shows another variation of overhanging thread portions in a fabric worked with two partial courses in one row and with two threads.

In this example, all the loops of one partial course which may have the fundamental arrangement shown in Figures 14 or 15, are worked in the following loop of the same wale into loops 5 and 5a, while the loops of the other partial course, changing from course to course, once to the right and once to the left, are worked in the following course of the adjacent wale located to the right or to the left, into the needle loops 4 or 5 with the shanks 5b.

It follows that a three-threaded wale with the loops 5, 5 and 4 always alternates with a single-thread wale formed of loops 4. Of course, it is possible to change from a three-threaded loop to a single-threaded loop not only in the courses but also in the wales.

In the manufacture of the fabric shown in Figure 9, each partial course may be worked in a separate sinking operation (Fig. 36).

For instance, a partial course may be formed from the thread b by the needles N2, and then the loops 3b are hung over the needles N2 and the latter pass into the elevated position through the sinking point, where the needles N1 operate and work the thread a into loops 4 and 3a above the needles N2, as indicated by the first sinking operation (looking in the working direction R in Figure 36). These loops 3a are formed without a lateral racking, that is, they are hung again over the needles N2 over which they are formed. Therefore, the needles N2 carry the loops 3b of one partial course and the loops 3a of the other partial course. During the following sinking op-

eration and when the needles N2 are moving, the loops hanging on them are worked into long double loops 5, 5 together with the newly sunk loops 4. The loops 3b formed during the sinking from the thread b are hung again over the needles N2, etc.

Therefore, the needle groups operate from one sinking operation to the next one in the following order:

Group N2.—The loops are hung over the needles N2 by lateral racking.

Group N1.—The loops are hung over the needles N2 without lateral racking.

Group N2.—The loops are hung over the needles N2 by lateral racking.

Group N1.—The loops are hung over the needles N2 without lateral racking, and so forth.

Therefore, the long loops 3a and 3b are always worked in the wale of the needles of a group into double long loops 5, 5 together with the loop 4.

If, for instance, the needle groups are to operate in the order N1 N1, N2 N2, etc., the needles which are to form the double loops 5, 5, namely, the needles N2, move into another position not only after the transfer of the laterally racked loops 3b during the sinking operation of the needles N1, but also after the transfer of the loops 3a formed by the needles N1 during the following sinking of the needles N1. During the next sinking of the needles N1, the needles N2 also move into that position, but both loops 3a and 3b are now under the head of the needles N2 and the old loops 4 and 5, 5 lie on the closed latch. In the next two sinking operations the needles N1 operate in the same manner as the needles N2 and move into the same position, so that they form the loops 4, the long loops 5, 5 and the loops 3a and 3b.

In some of the fabrics made in accordance with the present invention, for instance, in fabrics shown in Figures 5, 7, 9 and 10, all or some of the long loops 3 are worked in a laterally disposed wale together with the newly formed regular loops 4 into a long needle loop 5. This may also be accomplished in the manner shown in Figures 27 to 31, in accordance with which only the laterally transferred loops 3 are made into long needle loops 5 in the following courses. However, the motion of the needles must be always such that that needle which is to form single-thread loops, moves into the sinking position without any thread feed, and so that only the loop 3 which is formed thereon during the preceding sinking operation, is worked out to form the long loop 5. This method can be used when both partial courses are formed in the same sinking operation or in two successive operations.

Figure 11 shows a fabric which is plated in a manner constituting a part of the present invention.

It will be necessary to use four-threaded loops in order to plate the fabrics illustrated in this specification in the manner known in prior art.

In order to plate with double-threaded loops, that is, in order to arrange the two threads present in the illustrated fabrics in a plating manner, if they are different from each other in color and the like, care must be taken that the overhanging long loop is not alternately placed on the front side, as indicated in Figure 11. It follows from the described examples that the overhanging long loops 3, as well as the long needle loops 5, always lie on the outside of the face side, and the short loops 4 always lie on the outside of the

back. Each needle loop in the wale 2 and the course 3 (Fig. 11) comprises a long white loop 5 and a black loop 4 of ordinary length. The white loop 5 lies in the next loop on the outside of the front side (wale 1, course 3). The short loop 4 lies outside on the face side and the long loop 5 which is formed of the loop 3, is so laid that it lies outside on the back. In accordance with the present invention, this may be done in the manner shown in Figures 52 and 53 by pressing back the needle N1 on which the long loop 3 hangs; the loop 3 is worked into the long loop lying on the back at the moment when the newly sunk loop 2 meets the overhanging loop 3 in the needle head. By depressing the needle N1 the overhanging loop 3 is caused to change its position in the needle head in such manner that it is placed in the form of loop 5 before the newly sunk loop 2, which then becomes the loop 4 situated outside on the back, while the loops 3 lie behind the newly sunk loops 2 on the needles N2 which are not pressed back, in the needle head. Thus the loop 3 formed into a loop 5 is placed outside on the face side and the loop 4 which is formed out of the loop 2, is situated outside on the back.

A fabric made in accordance with the present invention may be worked also with a plush loop lining, as shown in Figure 58. In this fabric in which the plush loops are formed in the manner of a loop-plush fabric, the arrangement shown in Figure 1 has been chosen as basis. The plush loop F is tied up between the long loops 5 and the regular short loops 4 are tied into needle loops 7 and long sinker loops 8.

Figures 59 and 60 illustrate a method of producing the fabric shown in Figure 58. The sinkers and the needles for working the ground fabric are operated in the same manner as that shown in Figures 17 and 18, with that difference that another thread F is fed to both needle groups N1 and N2. The guide L1 for the thread F is arranged much lower in relation to the needles, in order to eliminate the necessity of varying the needle motions; the extent to which this guide is situated lower than the needles corresponds to the arrangement of the two other thread guides 1 and 2 with respect to the threads a and b, so that the thread F is always brought under the hook of the needles of both groups. While the thread a is worked into needle loops 4 and long loops 3a by the needles N2 during the sinking, and while the thread b is worked into needle loops 4 and long loops 3b by the needles N1, the thread F is worked by all needles N1 and N2 (Figures 59 and 60) as a second thread over the edge Pa of the sinker P into long sinker loops 8 and needle loops 7. Since the thread F is formed only on one sinker into a loop-plush loop 8 and is not worked like the loops 3a or 3b on two adjacent sinkers P over and beyond a needle division, the plush loops are not brought upon the needles during the motion of the sinkers for the hanging of the loops 3a or 3b over the needles (Fig. 60), but remain only on the sinkers P until they move in the direction V out of the needle row and are thrown off (Figs. 59 and 60). Due to the position of the thread guide, the plush thread F occupies the position taken by the ground thread during plating and thus lies before the threads a and b on the face side. The plush thread F is covered by the overhanging loops 3a and 3b, or the long loops 5 formed therefrom, which are always on the face side of the goods,

so that the needle loop 7 is placed between the loops 4 and the needle loops 5 (Fig. 58).

Figure 12 shows a weft fabric with a ground fabric as shown in Figure 2. In this fabric, as indicated for instance in Figure 15, every other course consists of a partial course M—M and the interposed courses are worked out of the other partial course N—N. In this weft fabric each partial course M—M is provided with a weft thread S in such manner that it lies in the partial courses M—M between the needle loops 4, 5 and the shanks 5a of the long loops 5 which extend from the loop 4 of the preceding partial course to the loops of the next partial course. In the other partial course a—a the weft thread 5 is placed between the needle loops 4, 5 and the shanks 5b of the long loops 5.

This type of weft fabric is quite close, since each total course comprises two partial courses M—M and N—N, so that two weft threads lie over each loop, each of which is separately tied and lies closely to the next one.

Figures 56 and 57 illustrate a method of producing the fabric shown in Figure 12. In accordance with this method, only one needle works a thread a into loops and long loops 3a, and the other needles N2 are eliminated by passing into the low position shown in Figure 56. When the needles have reached this low position, a weft thread guide 10 is disposed between the lower sinker edge Pc and the upper edge K of the needle bed, which lays the weft thread S (Fig. 56) in such manner that it is placed behind the needles which go up again after the thread passes to the needles N2. In the next course, the weft thread is placed again behind the needles N1, so that by this change of operation of the needle groups N1 and N2 and due to the placing of the weft once behind the needles N1 and then again behind the needles N2, the weft thread S will have the position shown in Figure 12. The weft thread S will have this position, since it is placed between the loops 5a or 5b of the loops 3 and the loops 4 hanging on the needles (Fig. 57), after it has been inserted behind the ascending loops and the long loops 3 have subsequently been hung over these needles.

The weft fabric shown in Figure 13 comprises two partial courses in a course and corresponds to the fabric shown in Figure 1; the fabric has only one weft thread S for each course, which lies between all loops 5a or 5b of the long loops 5 and the needle loops 4, 5 of the course concerned.

As indicated in Figure 57, both partial courses are worked simultaneously to produce this fabric. The same method is shown in Figures 17 and 18, although without working in weft threads. Both needle groups N1 and N2 sink the thread a and b and the weft thread is inserted when they have reached their lowermost position, as described above. It follows that, as shown in Figure 13, the two partial courses worked into one course have only one weft thread which lies between all loops 5a, 5b of the long loops and all loops 4, 5. All loops 3a and 3b of both partial courses are hung after and during the rising of the needles N1 and N2 over all the needles, after the weft thread has been laid (Fig. 56), so that the weft thread lies behind all needles between the loops 3a and 3b and the needle loops 4, 5 (Fig. 57).

The described motion of the weft thread can be applied to all other fabrics which have weft threads.

The described methods can be carried out by means of knitting machines having two rows of

needles. Preferably, one of the two needle beds is fitted then with hang-over sinkers in addition to the needles. These sinkers correspond in form and operation to the sinkers P shown in Figures 19 to 26. In order to prevent the annular projection T which is situated on the cam of such machines and which holds the ribbing needles in their guide, from interfering with the motion of the sinkers, the upper edge Pk of the sinkers which faces the projection T, is provided with a recess Pu which is equal in length to the path of the sinkers from the inoperative position into the operative position plus the width of the projection T.

Whenever a fabric in accordance with the present invention is to be made, the needle or needles of the row in which the hang-over sinkers are arranged, are cut off from their loop forming work and for each eliminated needle two sinkers on either side of the needle are actuated (Figs. 19 to 26).

The fabrics and methods constituting the subject matter of the present invention may be combined with each other or with prior art fabrics and methods in many different ways.

I claim:

1. A knit fabric, comprising compound needle loops formed from threads extending in a coursewise direction of the fabric, each of said compound loops formed from a first loop having at least one comparatively short shank, and a second coinciding loop having at least one elongated shank; the apices of the compound loops being alined in a coursewise direction along successive parallel straight lines, the long shanks of adjacent compound loops which are disposed along the same line intersecting each other, said intersecting shanks respectively forming continuations of laterally disposed short shank loops situated along a preceding straight line.

2. A knit fabric, comprising compound needle loops formed from threads extending in a coursewise direction of the fabric, each of said compound loops formed from a first loop having at least one comparatively short shank, and a second coinciding loop having at least one elongated shank; the apices of the compound loops being alined in a coursewise direction along successive parallel straight lines, the long shanks of adjacent compound loops which are disposed along the same line intersecting each other, said intersecting shanks respectively forming continuations of short shank loops situated in adjacent wales along a preceding straight line.

3. A knit fabric, comprising compound needle loops formed from threads extending in a coursewise direction of the fabric, each of said compound loops formed from a first loop having at least one comparatively short shank and from a plurality of coinciding loops each having at least one elongated shank; the apices of the compound loops being alined in a coursewise direction along successive parallel straight lines, the long shanks of adjacent compound loops which are disposed along the same line intersecting each other, said intersecting shanks forming continuations of lat-

erally disposed short shank loops respectively situated along preceding straight lines.

4. A knit fabric, comprising compound needle loops formed from threads extending in a coursewise direction of the fabric, each of said compound loops formed from a first loop having at least one comparatively short shank and from a plurality of coinciding loops each having at least one elongated shank; the apices of the compound loops being alined in a coursewise direction along successive parallel straight lines, the long shanks of adjacent compound loops which are disposed along the same line intersecting each other, said intersecting shanks forming continuations of short shank loops respectively situated in adjacent wales along preceding straight lines.

5. A knit fabric, comprising compound needle loops formed from threads extending in a coursewise direction of the fabric, each of said compound loops formed from a first loop having comparatively short shanks, and a second coinciding loop having elongated shanks; the apices of the compound loops being alined in a coursewise direction along successive parallel straight lines, the long shanks of adjacent compound loops which are disposed along the same line intersecting each other, said intersecting shanks respectively forming continuations of laterally disposed short shank loops situated along a preceding straight line.

6. A knit fabric, comprising compound needle loops formed from threads extending in a coursewise direction of the fabric, each of said compound loops formed from a first loop having comparatively short shanks, and a second coinciding loop having elongated shanks; the apices of the compound loops being alined in a coursewise direction along successive parallel straight lines, the long shanks of adjacent compound loops which are disposed along the same line intersecting each other, said intersecting shanks respectively forming continuations of short shank loops situated in adjacent wales along a preceding straight line.

7. The method of knitting a fabric from two threads, which comprises working one of said threads between alternate wales into shanks of needle loops which are longer than the usual shanks of needle loops while forming loops from both of said threads at said alternate wales, and working the other of said threads between the remaining wales into shanks of needle loops which are also longer than the usual shanks of needle loops while forming second loops from both of said threads at said remaining wales; then passing the first named loop shanks through said second loops while working the other of said threads between the remaining needles into shanks longer than usual and passing the latter loop shanks through said first loops while working said first thread between alternate wales into loops longer than usual; and then repeating said thread working, loop forming and loop passing steps to form a fabric.

MAX NEBEL.