Dec. 27, 1966 M. NEBEL 3,293,885

APPARATUS FOR KNITTING RUN-RESISTANT FABRIC

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FIG. 1

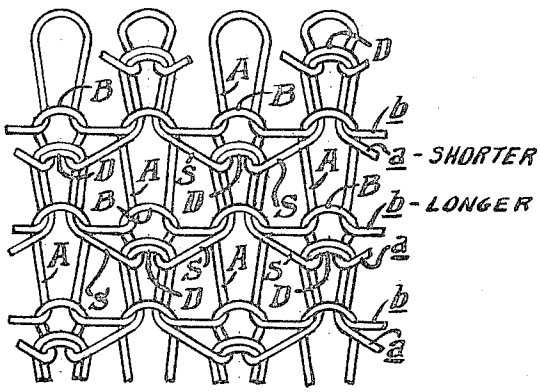


FIG. 2

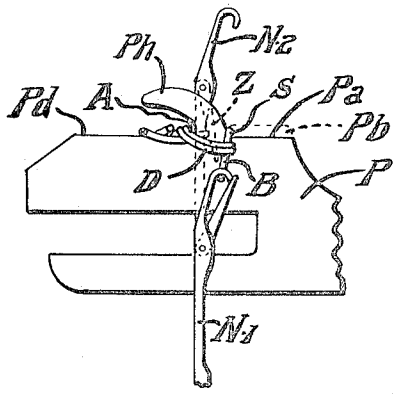


FIG. 3

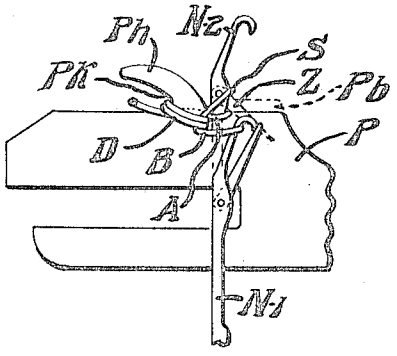


FIG. 4

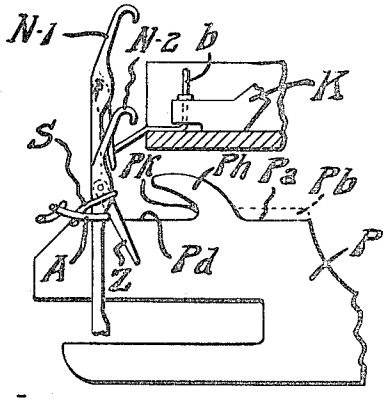


FIG. 5

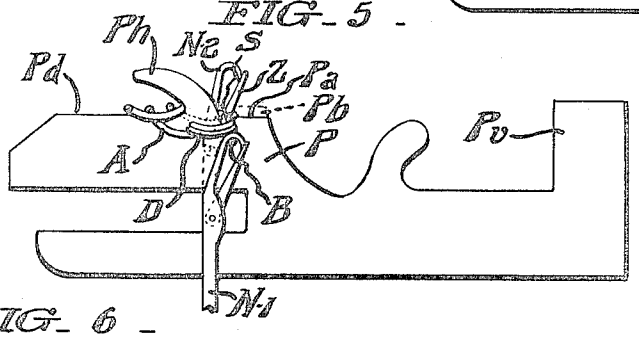
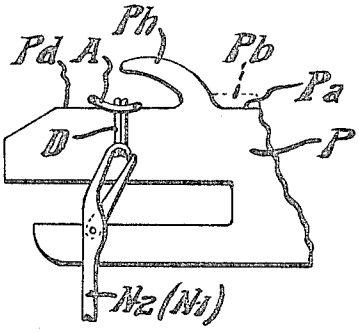


FIG. 6



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FIG. 7

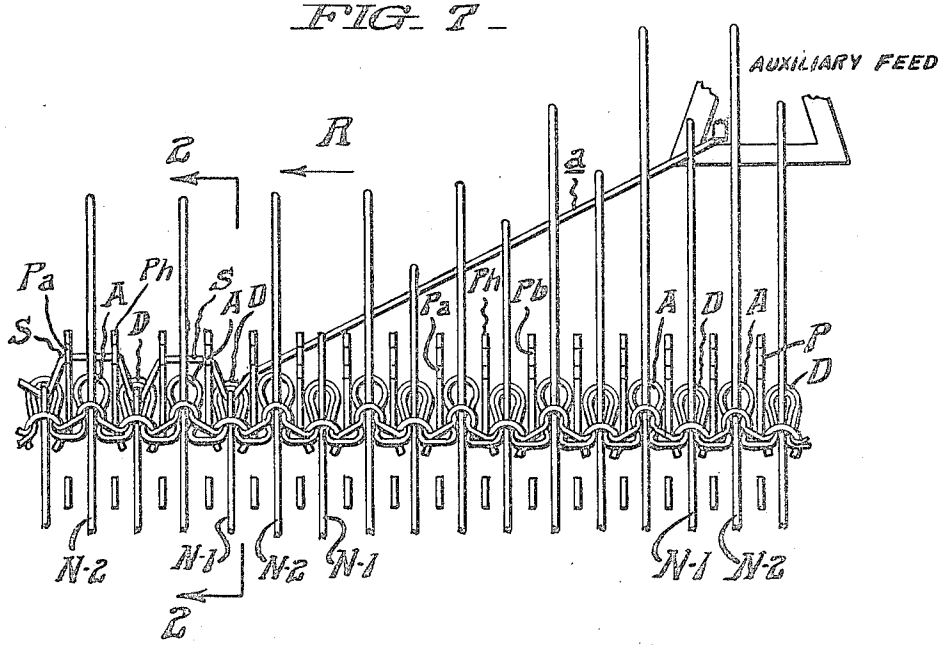
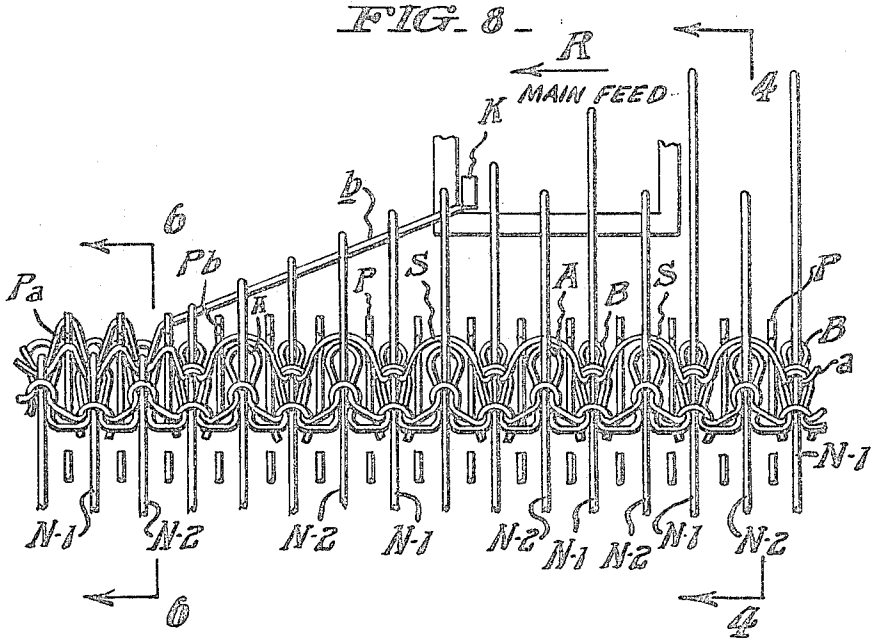


FIG. 8



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FIG. 9

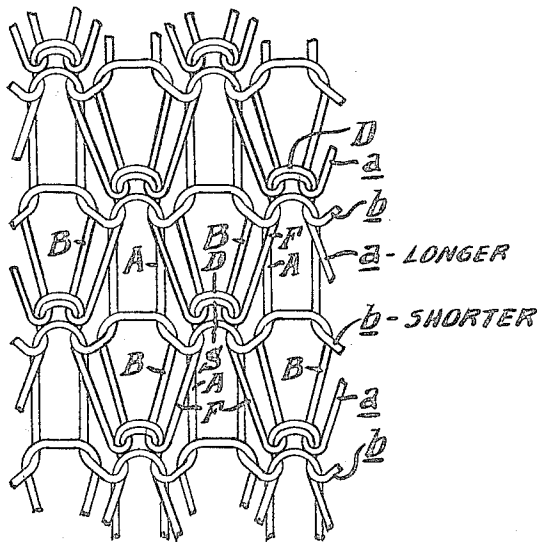


FIG. 10

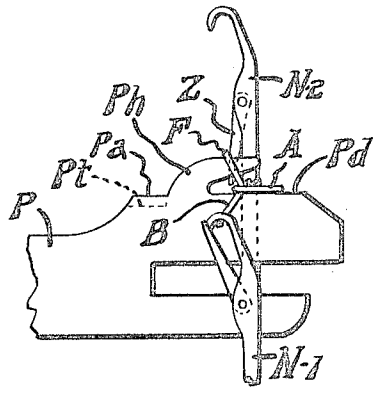
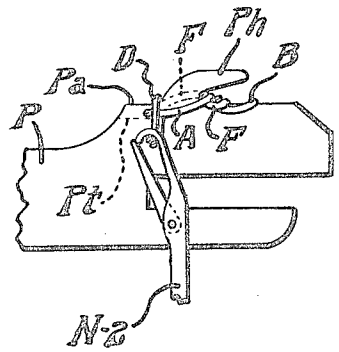


FIG. 11



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FIG. 12

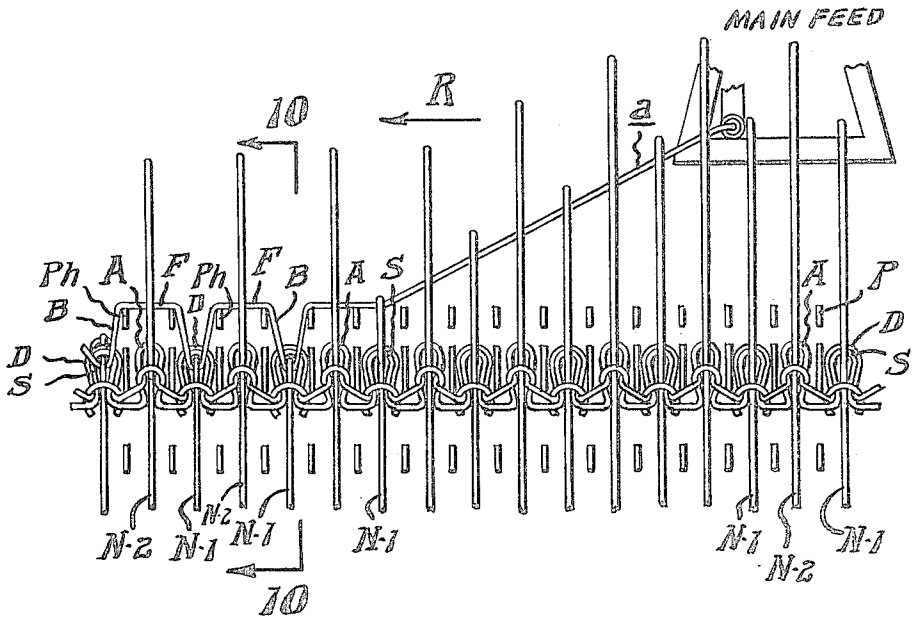
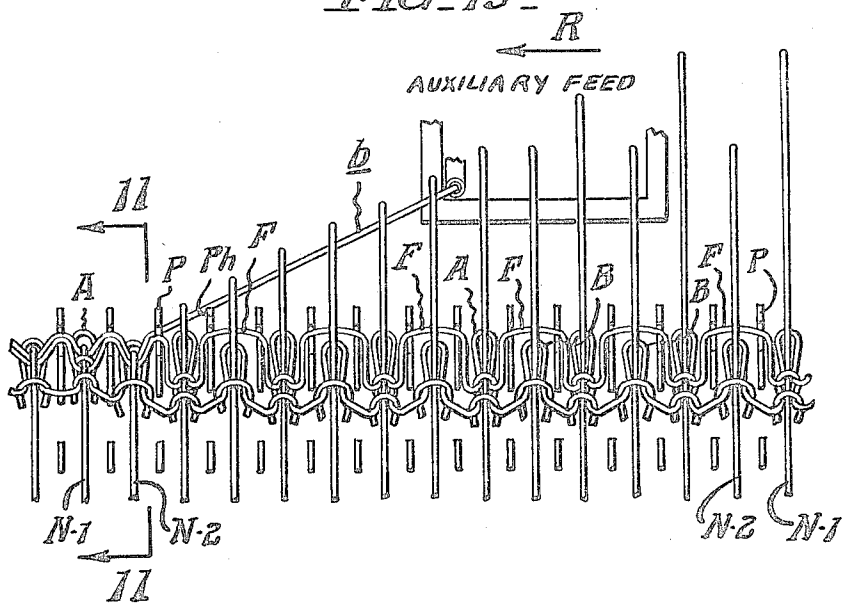


FIG. 13



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FIG. 14

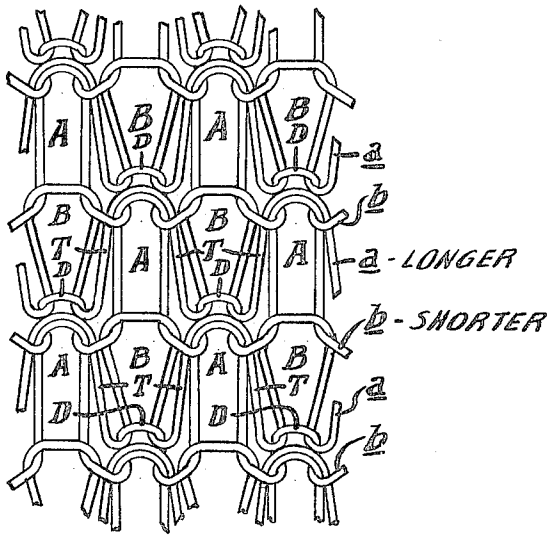


FIG. 15

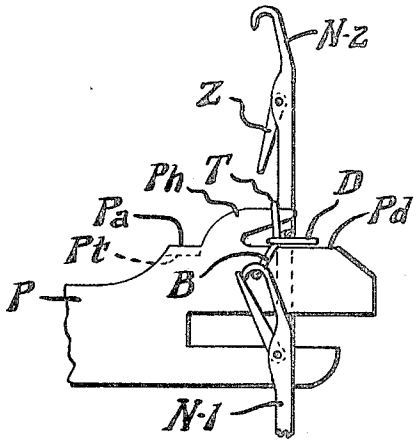
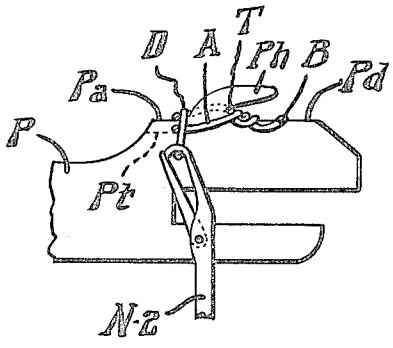


FIG. 16



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FIG. 17

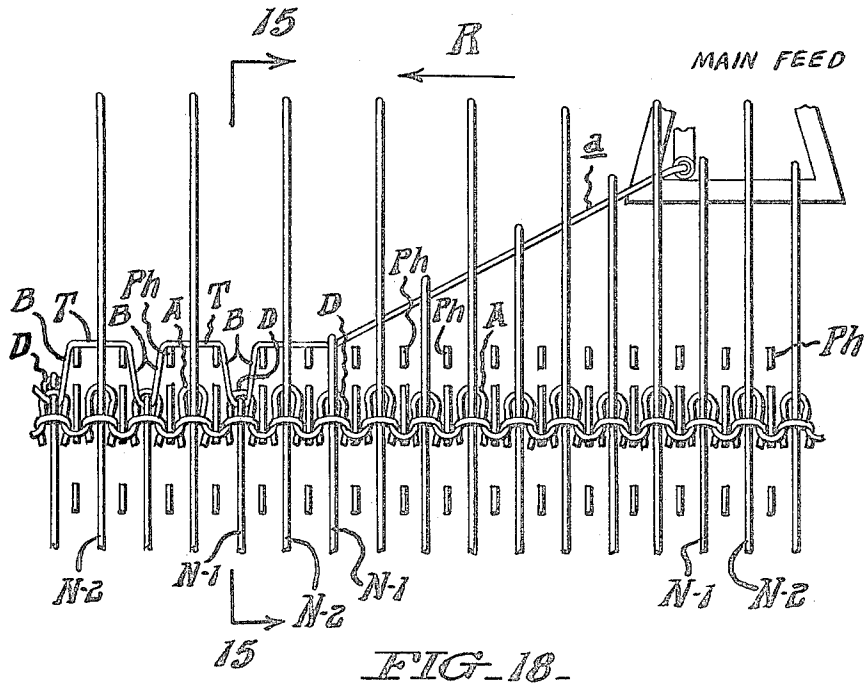
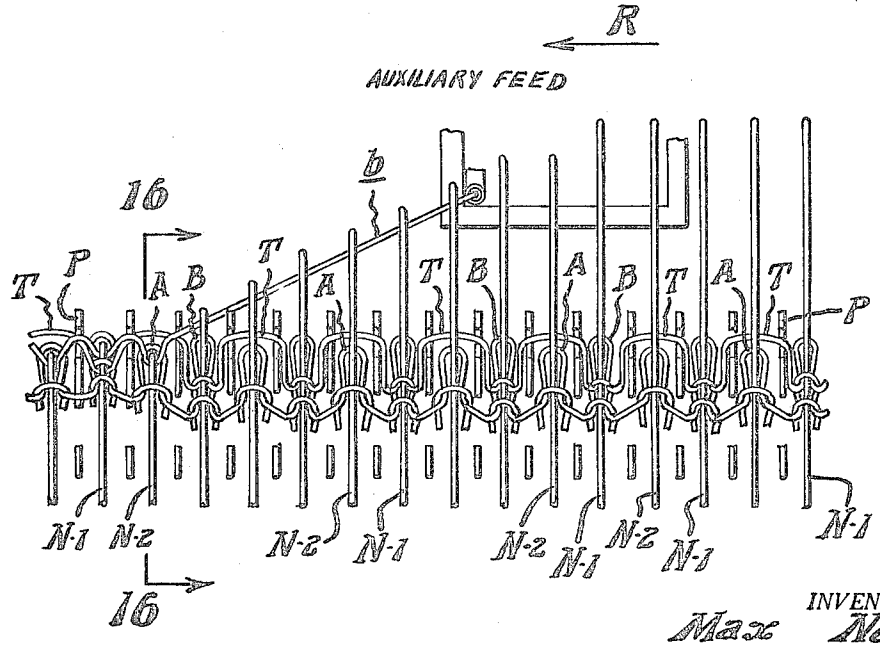


FIG. 18



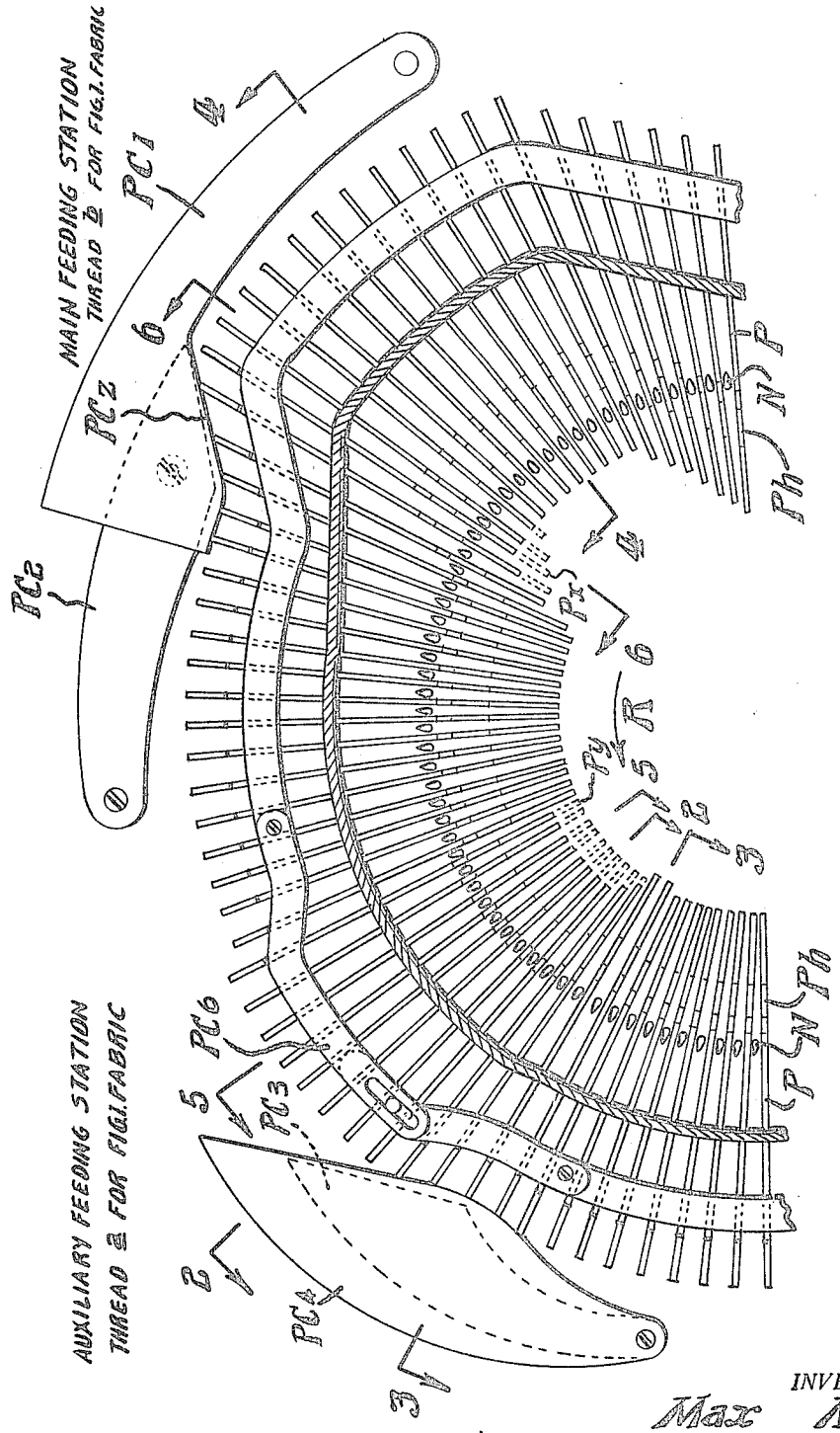
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FIG. 19



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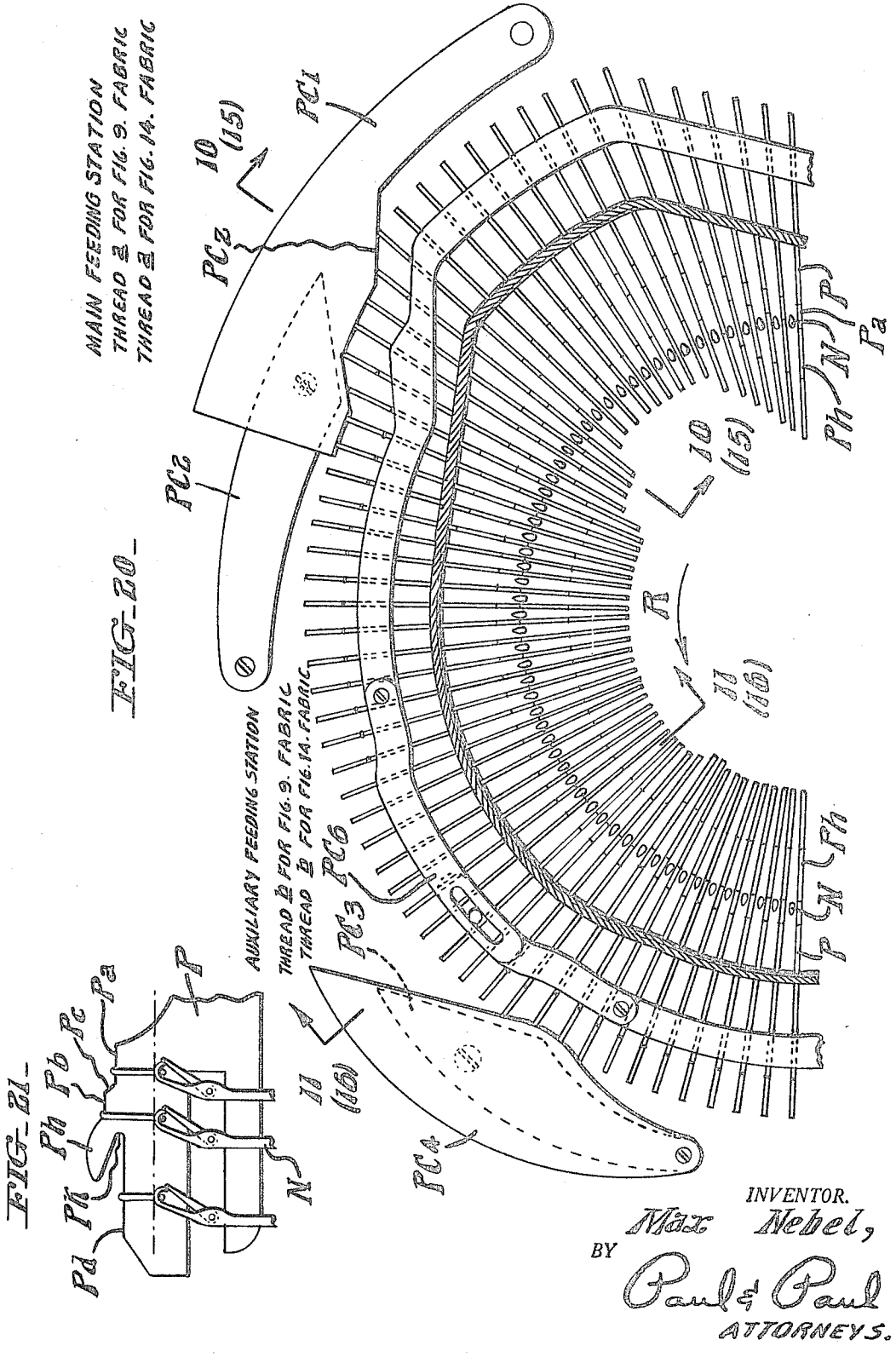


FIG. 20.

FIG. 21.

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United States Patent Office 3,293,885 Patented Dec. 27, 1966

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APPARATUS FOR KNITTING RUN-RESISTANT FABRIC

Max Nebel, Wiesbaden, Germany, assignor to Hanes Corporation, a corporation of North Carolina

Original application Jan. 31, 1962, Ser. No. 170,029. Divided and this application Jan. 5, 1966, Ser. No. 518,906

2 Claims. (Cl. 66—107)

This application is a division of my co-pending application Serial No. 170,029, filed January 31, 1962.

This invention relates to apparatus for knitting run-resistant fabric, the knitted fabric being of the kind in which thread loops of a previous course are knitted together with the threads of an immediately following course to form double-thread stitches therein.

The method and apparatus disclosed herein relate to the production of knitted fabric having run-resistant qualities as generally described above, including variations of the fabric produced by selectively controlling the size and location of the double-thread stitches and controlling the size of the plain stitches. These fabrics are produced by methods which avoid stresses on the thread and needles which were inherent in the prior art processes. Three variations of the fabric are disclosed in detail hereinbelow, along with preferred methods and apparatus for producing the same.

The first fabric comprises courses of plain stitches and thread loops alternating with courses of plain stitches only, the thread lengths of the first mentioned courses being somewhat shorter than those of the intervening courses, and the thread loops thereof being knitted together with stitches of the next subsequent course in the same wales to form double-thread stitches which are staggered by one wale at least after every second course. The knitting of the thread loops in a subsequent course causes the elongation thereof by robbing of thread from the adjacent wales in the same course.

In the second type of fabric, the length of yarn in courses composed of stitches and thread loops is substantially greater than the yarn length in the alternate courses composed of stitches only, the thread loops of the first mentioned courses being knitted together with the stitches of the subsequent courses in the same wales to form double-thread stitches which are staggered by one wale at least after every second course. Similar to the first fabric, the held stitch pulls thread from adjacent knit off stitches and causes them to shrink and lock the wale against runs.

In the third type of fabric, courses of stitches and tuck loops alternate with courses of stitches only, the thread length of the tuck loop courses being greater than the thread length of the plain knit courses, the tuck loops being staggered by one wale at least after every second course.

To produce run-resistant fabrics by this invention, movements of the sinkers and needles are controlled so that loops of different sizes can be drawn over different height sinking levels resulting in courses of different lengths. Needle movement is controlled so that strain on the thread is avoided and the selected pattern advances every course. Sinkers having various yarn sinking levels are provided for the purposes described hereinbelow.

Therefore, it is the primary object of this invention to disclose method and apparatus for producing the fabrics described above avoiding damage to the thread and needles through all knitting stages.

It is a further object of this invention to provide method and apparatus to control loop and stitch size and formation by novel sinker and needle movement so that the desired tension may be created in the selected fabric.

These and other objects and attendant advantages of this invention will become more apparent from the description set forth hereinbelow and from the attached drawings wherein:

FIG. 1 is a schematic view of the first form of the run-resistant fabric of this invention;

FIGS. 2 through 6 are partial views in side elevation of the sinkers and needles during the knitting action of the fabrics of this invention taken along the similar numbered lines and arrows of FIGS. 7, 8, 19 and 20.

FIGS. 7 and 8 are partial schematic views of the needles and sinkers taken from the center of the needle circle at the auxiliary and main feeding stations, respectively, while knitting the fabric of FIG. 1;

FIG. 9 is a schematic view of the second form of the run-resistant fabric of this invention;

FIGS. 10 and 11 are partial views in side elevation of the sinkers and needles and their relative movements for producing the fabric shown in FIG. 9 as taken along the similarly numbered lines and arrows of FIGS. 12 and 13;

FIGS. 12 and 13 are partial schematic views of the needles and sinkers taken from the center of the needle circle at the main and auxiliary feeding stations, respectively, while knitting the fabric of FIG. 9;

FIG. 14 is a schematic view of the third form of the run-resistant fabric of this invention;

FIGS. 15 and 16 are partial views in side elevation of the sinker and needles showing their relative movements while knitting the fabric of FIG. 14 as taken along the similarly numbered lines and arrows of FIGS. 17 and 18;

FIGS. 17 and 18 are partial schematic views of the needles and sinkers taken from the center of the needle circle at the main and auxiliary feeding stations, respectively, while knitting the fabric of FIG. 14;

FIGS. 19 and 20 are partial schematic views in plan of the sinkers and sinker cams during knitting of the fabrics of the invention; and

FIG. 21 is a partial view in side elevation of an alternate type of sinker.

The terms "stitch" and "knitted stitch" as used throughout the specification and claims hereof shall indicate a loop of yarn or thread which has been pulled through a preceding loop of yarn.

The term "casting off" shall indicate the discharge of a loop of yarn from a needle as a newly formed loop of yarn is pulled through the discharged loop to form a stitch.

The term "clearing level" shall indicate the level to which a needle rises to clear yarn from its latch.

The term "tuck level" shall indicate the level to which a needle would rise to take yarn while retaining a loop of yarn on its latch.

The terms "thread" and "yarn" are used as synonyms throughout the specification and claims thereof.

The term "modified tuck loop" shall indicate a yarn loop of a first course which is retained on its needle and knit and cast off with the thread of the first following course.

The stitch structure of the first form of run-proof fabric of this invention is shown in FIG. 1 and is composed of courses *a* having small stitches B and thread loops or modified tuck loops S alternating with courses *b* having large stitches A and double-thread stitches D. During the production of course *a*, only short length stitches are produced on every second needle, and the thread loops S, which are on the intermediate needles, are not formed into stitches but these thread loops, during production of the subsequent course *b*, are knitted together with alternate long length stitches of course *b* thereby forming double-thread stitches D.

Because of the knitting together of the thread loops S in the subsequent long course *b*, thread is pulled or robbed from adjacent stitches B causing said stitches to contract into small locking stitches. In order to obtain spaced locking stitches B in each needle wale, the stitches B from one course *a* to another course *a* are produced in a mesh pattern with one needle step. The resulting fabric consists, in the direction of the wales, of a large stitch A, a double-thread stitch D and a single thread locking stitch B in repetitive succession.

The production of courses composed of stitches of predominantly a large size (course *b*) versus those of a short size (course *a*) results in a stress relation between the stitches which is strongly resistant to runs.

To produce the fabric according to FIG. 1 on a circular knitting machine, the needles are divided into two groups so that every second needle, at one time the needle N–1 and the other time the needle N–2, as identified hereinbelow, follows a particular knitting operation and then the roles of the groups of needles are reversed.

The method of knitting the fabric shown in FIG. 1 is carried out as follows with particular reference being made to FIGS. 7, 8 and 19. Presuppose, according to the schematic representation of needles, sinkers and yarn feed shown in FIG. 7, that the stitches A of the previous course *b* have been formed on the needles N–2 and that the double stitches D have been formed on the needles N–1.

All needles N–1 and N–2, before they take thread for the course *a*, are raised to clear level (while moving in the rotational direction R). Needles N–2 are raised to a higher position (by cam means well known in the art) than the needles N–1 to allow the two groups of needles to be drawn down separately. Then needles N–1 and N–2 pass the yarn feeding station, as shown in FIG. 7, and all take yarn, but only needles N–1 cast off, thus producing stitches B on the needles. Needles N–2 are drawn downward to tuck level so that thread *a* remains adjacent latches Z of the needles N–2 and stitches A remain below the latches. The sinkers P are positioned so that the thread of course *a* is formed by every second needle N–1 into loops B on the sinking ledge P*a* (FIG. 2).

After taking thread *a*, the needles N–2 preferably remain at the tuck height with the thread portions S adjacent the opened latches Z and pass to the second feeding station, as shown in FIG. 8. At this station, the needles N–2 take thread *b* and form, with the thread portions S, the double-thread stitches D. Needles N–1 are raised to clear level (see FIG. 4). Thereafter, needles N–1 and N–2 are pulled downward together while taking thread for the course *b* and all cast off. More specifically, stitches A retained on the needles through the previous feed (FIG. 7) and stitches B are cast off while double stitches D and new stitches A are formed on the needles. Thread *b* may be drawn either in front of or behind the sinker nebs P*h*. The sinking ledges P*d* and P*a*, upon which the threads for the courses *a* and *b* can be drawn, are at the same height, as indicated in FIGS. 2–6. Since course *a* is entirely formed with undrawn straight lengths of threads alternating with stitches, its length of thread is shorter than that of course *b*. If a larger loop length and still longer course thread length is preferred for course *b* than for the stitches of the course *a*, then the thread forming course *b* is drawn on a higher-lying sinking ledge P*b* indicated in broken lines in FIGS. 2 to 6.

The above method of production of the FIG. 1 fabric with the use of latch needles causes a scissors-like pressure on the thread of the large stitch A which lies, during forming of the thread loop S, between the open latch Z and the stem of the needle, and depending upon the strength of that pressure or the quality of the needle may cause damage to the thread. The possibility of thread damage also occurs during casting off of the stitches B of course *a* when the elongated stitch A on the stem of needles N–2 must close the latch Z on which the short thread loop S lies to produce the double thread stitch D as indicated in FIG. 6.

To overcome the above disadvantage, the following method of operating the needles and sinkers to produce the fabric is utilized. FIGS. 19 and 20 show in plan view the movement of the sinkers P and the sinker cams PC relative to the two yarn feeds. Course *b* with stitches A and D of the FIG. 1 fabric is formed at the main feed, and course *a* of loops S and stitches B is produced at the auxiliary feed.

In the preferred method, the sinkers are only partially drawn out of the needle circle at the auxiliary feeding station, as shown in FIGS. 2 and 19 in solid lines, so that the loops B of the course *a* are sunk behind the sinker nebs by the needles N–1 on the sinking ledge P*a*. The sinkers are positioned so that the back curving edge of the neb P*h* is located a little in front of or outward of the open latch 6 of the needle N–2 (FIG. 2), permitting the thread loops S to remain on the sinking point P*a* in front of the open latch, but not lying directly on the open latch.

During sinking of the thread *a* into stitches B, the double stitches D are cast off (FIG. 2). The sinkers P meanwhile are moved by cam PC4 further into the needle circle, and the thread loops S then press on the latches (FIGS. 3 and 19). However, in order that there shall be no pressure on the stitches A lying below the latches, the preferred procedure according to this invention is such that before the needles N–1 (FIG. 2) have reached their lowest sinking position and the sinkers have moved fully into the needle circle, the needles N–2 (FIG. 3) are drawn downward to such a point that the thread loops S arrive or are located opposite the hinge joints of the latches Z. When the sinkers are fully pressed in, the loops S are deposited on or about the hinge joints and thereby do not produce pressure on the lower portions of the latches and on stitches A. The needles N–2 are pulled downward before the sinker edges P*k* begin operating on the double stitches D to cast them off (FIG. 3), thereby facilitating the casting off of stitches D over new loops B.

An alternative arrangement for preventing undue pressure on the latches by the thread loops S during the loop sinking and casting off motions is indicated in FIGS. 5 and 19. In this method, stitches B and thread loops S again are formed behind the sinker nebs P*h* on the sinking point P*a*, but the sinkers P are not withdrawn out of their inward position in the needle circle by cam PC6 while thread *a* is being taken. The sinkers remain in the advanced position shown in dotted lines P*y* in FIG. 19 and as shown in FIG. 5. To effect this, sinker cam PC6 is moved toward the needles at the auxiliary feed, and the sinkers thus are not retracted, but subsequently are pressed further inwardly by means of cam PC4 to knock over the double stitches D.

In the alternative method shown in FIG. 5, the needles N–2 are lowered to the position where their latches are closed by the stitches A without stitches A being cast off, and their hinge-joints pass below the sinking ledges P*a*. When this position of needles N–2 is maintained during the loop sinking and casting off procedure of needles N–1, thread loops S no longer lie adjacent the opened latches, but are located within the hooks of needles N–2 and on the sinking edges P*a* of adjacent sinkers.

Whether the sinkers are retracted as in FIG. 2, or not retracted as in FIG. 5, both needles N–1 and N–2 take thread as shown in FIG. 7.

The needles N–1, after casting off the double stitches D, and the needles N–2, having loops S within their closed hooks and stitches A on the closed latches, are all raised in preparation for passing the next feeding station wherein thread *b* is fed, as shown in FIG. 4. In this position the needles N–2 pass the yarn feeding finger K and take thread *b* (FIG. 8) and form together with the thread loops S, double-thread stitches D on sinker ledge P*d* before the neb.

At the main feed (FIGS. 8, 19), the sinkers are drawn outward so that both stitches D and A are drawn in front of the nebs. The sinkers, subsequently, are moved back into the needle circle to knock over, with their edges P*k*, the stitches being cast off.

In using the above method, it is not absolutely necessary to sink the thread *b* to loops in front of the sinker nebs, P*h*, and so it is not necessary to have a sinker of which the lower portion of the neb between the sinking point P*a* and P*d* is of a very small width. The difference between the length of thread in a course *a* and that in a course *b* can be controlled by the addition of a sinker cam PC1, which together with cam PC6, press the sinkers further and/or earlier towards the needles as indicated in broken lines P*x* in FIG. 19. In this way, the thread *b* is pulled into larger loops on sinking levels P*a* or P*b*.

In addition, by using sinkers with different height sinking ledges, one form of which is shown in FIG. 21, the pressure of thread loop S on the needle latch Z is prevented by the inclined edge P*c* which takes over the function of the back edge of the sinker neb P*h*, as indicated in FIG. 2. Also, by use of the sinker shown in FIG. 21, courses of loops *a* and *b* can be formed into three different loop lengths, on sinking ledges P*a*, P*b* or P*d*. It should be noted that it is advantageous to have the high sinking point P*b* start almost perpendicular above the bottom of the thread P*k* of the sinker, so that it will be necessary to move the sinker only a small distance into the needle circle during sinking of the loops on the sinking point P*b*.

After the production of one course *a* from yarn taken at the auxiliary feeding station, the needles N–1, N–2 interchange their method of operation prior to the production of the following course *a* by needle selection process well known in the art. The method of operation of the needles therefore is that at one time the needles N–1, N–2 carry out their above described motions relative to a particular feeding station and then the motions are reversed.

The second fabric produced by the invention is that shown in FIG. 9 and differs from the FIG. 1 fabric in that the thread of the course *a* composed of stitches B and modified tuck loops F is longer than the thread of course *b* composed of stitches A and double stitches S/D.

For the production of the fabric according to FIG. 9, the thread *a*, feeding now at the arbitrarily designated main feeding station, is drawn by every second needle N–1 (FIG. 12) over the sinker nebs P*h*, forming long loops B and straight portions F. For this purpose, sinker cam PC1 presses the sinkers P inwardly by means of surface PCz at an earlier time, as shown in FIG. 20. Thread loops B are made long without changing the draw depth of the needles N–1 by forming thread of the courses *a* over nebs P*h* of the sinkers (FIG. 12), into stitches B and thread loops F (see FIG. 10). The needles N–2 (FIG. 12), after they have cleared stitches of the previous courses *b* underneath the needle-latches Z and on the stem of the needles, are only partially drawn downward and moved past the loop sinking region as shown in FIG. 12, contrary to the needles N–1 which form loops B and cast off double stitches D. The thread of course *a* (FIG. 12) is laid in front of the opened latches Z of needles N–2. In the following stitch forming cycle for the course *b* (FIG. 13), the sinkers P take the position in relation to the needles and their latches Z as shown in FIG. 11. The thread of the course *b* is then formed by all needles into loops on the sinking points P*a* or P*t* of the sinkers (as shown for point P*a* in FIG. 13).

Knitting the FIG. 9 fabric with latch needles also causes a scissors-like pressure on the thread of the large stitch A, which lies during forming of the thread loops F under the opened latch Z on the stem of the needle, and depending upon the strength of that pressure or the quality of the needle may cause damage to the thread and/or the needle.

This disadvantage also occurs to an even greater extent during casting off of the stitches by the sinkers, when the stitch A must close the latch Z on which the short thread loop F lies, to produce the double-thread stitch D, whereby the thread loop F continuously presses on the latch and also on the stitch A until the thread loop F arrives in the neighborhood of the hinge-joint of the latch. To overcome these disadvantages, the following method of operating the needles and sinkers to produce the FIG. 9 fabric is followed.

Referring to FIG. 20, courses *a* with stitches B and modified tuck loops F are formed at the main knitting system with the sinker cam PC1 along surface PCz with the usual sinker motions, and courses *b* of stitches A and D are produced at the second or auxiliary knitting system. As shown in FIGS. 10 and 20, the sinkers P at the main feed station are only partially drawn out of the needle circle so that the loops F are formed on the nebs P*h* of the sinkers. After needles N–1 form thread *a* into loops B, the sinkers P are moved further into the needle-circle to cast off double stitch D and the thread loops F are pressed on the latches as shown in FIGS. 10 and 20.

To avoid pressure on the stitch A which lies under the latch, before needles N–1 (FIG. 10) have reached their lowest sinking-position, the needles N–2 are drawn downward so that the thread loops F arrive at the hinge joint of the latch Z when the sinkers are moved inwardly to cast off and allow the loop F to come in contact with the latch.

After casting off, needles N–1 rise to clear position and needles N–2 are raised to tuck level as shown in FIG. 13. In this position, the needles N–2 pass the auxiliary yarn feed and take up the thread *b* (FIG. 13) which, with the thread loops F, is pulled through the loops A to form the double thread stitches D (FIG. 11). The needles N–1, with stitch B below the latches, take the thread *b* and form stitches A on the sinking point P*a*.

The sinkers P are moved inwardly by cam PC4 as shown in FIGS. 11 and 20 so that the double loops D are pulled on the sinking ledge P*a* behind the neb, thereby drawing only a small loop or length of thread *b*.

After knitting course *b* at the auxiliary feeding station and before knitting the subsequent course *a*, the needles N–1 and N–2 reverse their operating method so that loops B are formed by needles N–2 and straight yarn portions F are placed in front of the raised needles N–1 at the main feeding station. At the auxiliary feeding station, needles N–1 will then form the double stitches D and needles N–2 form stitches A. As the needles approach the main yarn feeding station, and before yarn *a* is again fed to the needles, the sinkers P are drawn outwardly by cam PC6, as shown in FIG. 20, so as to shed the double loops D and loops A from behind the sinker nebs to the ledges in front of the nebs.

The third fabric produced by the invention is that shown in FIG. 14, and differs from the FIG. 1 and FIG. 9 fabrics in that the tuck loops T of long courses *a* are cast off with the elongated and held tucked stitches A of previous short course *b*.

Referring to FIG. 17, as the needles N–1 and N–2 approach the main feeding station they are divided into two groups, needles N–2 being raised well above clear level and needles N–1 being raised to clear level. As the needles pass the main feed, needles N–2, having loops A of the previous course on their needle stems, are held at their elevated level so that the yarn *a* is laid across the stems of needls N–2, i.e., below the latches, to form straight yarn portions T. Needles N–1, having loops D of the previous course on their stems, are drawn down, take the yarn *a* and form it into loops B while casting off loops D. Needles N–1 draw yarn *a* over sinker nebs P*h*. Needles N–1 are then raised to clear level, while needles N–2 are lowered to clear level.

As the needles N–1, N–2 approach the auxiliary feed, as shown in FIG. 18, needles N–2 are drawn down, take yarn *b* and form loops D, casting off both loops A of the previous course *b* and yarn portions T of the previous

course *a* as tuck loops T. Needles N–1 likewise yarn *b* to form loops A, casting off loops B previously held on the stems of the needles N–1.

It should be noted that the method of forming tuck loops T described above and shown in FIGS. 17 and 18 differs from the conventional method. In prior practices, needles selected to form the tuck loops are lowered to take a first yarn in their hooks and form loops. Then those needles are raised only to tuck level so that the loops remain on the latches of the needles. These needles take a second yarn, pull it into loops and are then raised to clear level, thereby placing two loops on their stems. When these selected needles take a third yarn, the loops of two prior courses located on the needle stems are cast off and form the tuck stitches and held or tucked stitches.

The length of yarn in courses *a* is made longer than that of courses *b* in the FIG. 14 fabric by positioning the sinkers P at the main feeding station so that the yarn *a* is laid on the top of the sinker nebs P*h* (FIG. 17). The sinkers are advanced inwardly to a limited extent by the action of cam PC1 and, specifically, by cam surface PC*z*, so that yarn *a* is laid on top of the sinker nebs as shown in FIGS. 15 and 20. After yarn *a* is formed into loops B and portions T, the sinkers are moved further inwardly to the full inner position (FIGS. 16 and 20) by cam PC4 so that yarn *b* is formed into small loops D and initially small loops A over sinking ledges P*a* located behind the nebs P*h*. Before the sinkers again arrive adjacent the main feeding station, they are drawn outwardly (FIG. 20) so that the loops D and A are shed from behind the sinker nebs to ledges in front of the nebs. The cycle then repeats, but movements of the needles N–1, N–2 as described above are reversed after the needles have passed the auxiliary feeding station. In the next following cycle, needles N–1 are raised above clear level at the main feeding station and receive yarn portions T on their stems, while needles N–2 take yarn in their hooks to form stitches B.

It should be apparent that although the methods of knitting taught by this invention, as described in the specification and defined in the claims, refer to a first and second feed or a two feed knitting machine, this invention can be practiced on a single feed knitting machine. In such a case, the "second" feed or yarn would merely indicate that the machine has made a complete revolution and the single feed is being taken again.

It should be understood that this invention encompasses novel sinker shapes as well as new knitting methods. The nature and advantages of these sinkers, having ledges located at various levels and positions in relation to the nebs, are described hereinabove as part of the description of the novel methods of knitting. The sinkers are shown in various figures of the drawings and especially in FIG. 21 where the sinker P is shown having a lowest ledge P*d* located in front of the neb P*h* and two, progressively higher ledges P*a* and P*b* connected by inclined ledge P*c* located behind the neb.

Although this invention has been described with reference to specific forms and embodiments thereof, it will be apparent to those skilled in the art that various changes other than those referred to above may be made in the form of the apparatus shown, that equivalent elements may be substituted for those illustrated in the drawings, that parts may be reversed, and that certain features of the invention may be used to advantage independently of the use of other features, all such changes being within the spirit and scope of the invention as defined in the appended claims.

I claim:

1. A sinker for a circular knitting machine having
   (a) a neb,
   (b) a yarn drawing ledge behind the neb,
   (c) a second yarn drawing ledge behind the neb at a different height than the first ledge and
   (d) a yarn sinking ledge in front of the neb,
   (e) both yarn ledges behind the neb being at a different height than the ledge in front of the neb, and the two ledges behind the neb being interconnected by an inclined edge.

2. The sinker as defined in claim 1 wherein the yarn sinking ledge in front of the neb is lower than the two yarn sinking ledges behind the neb.

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