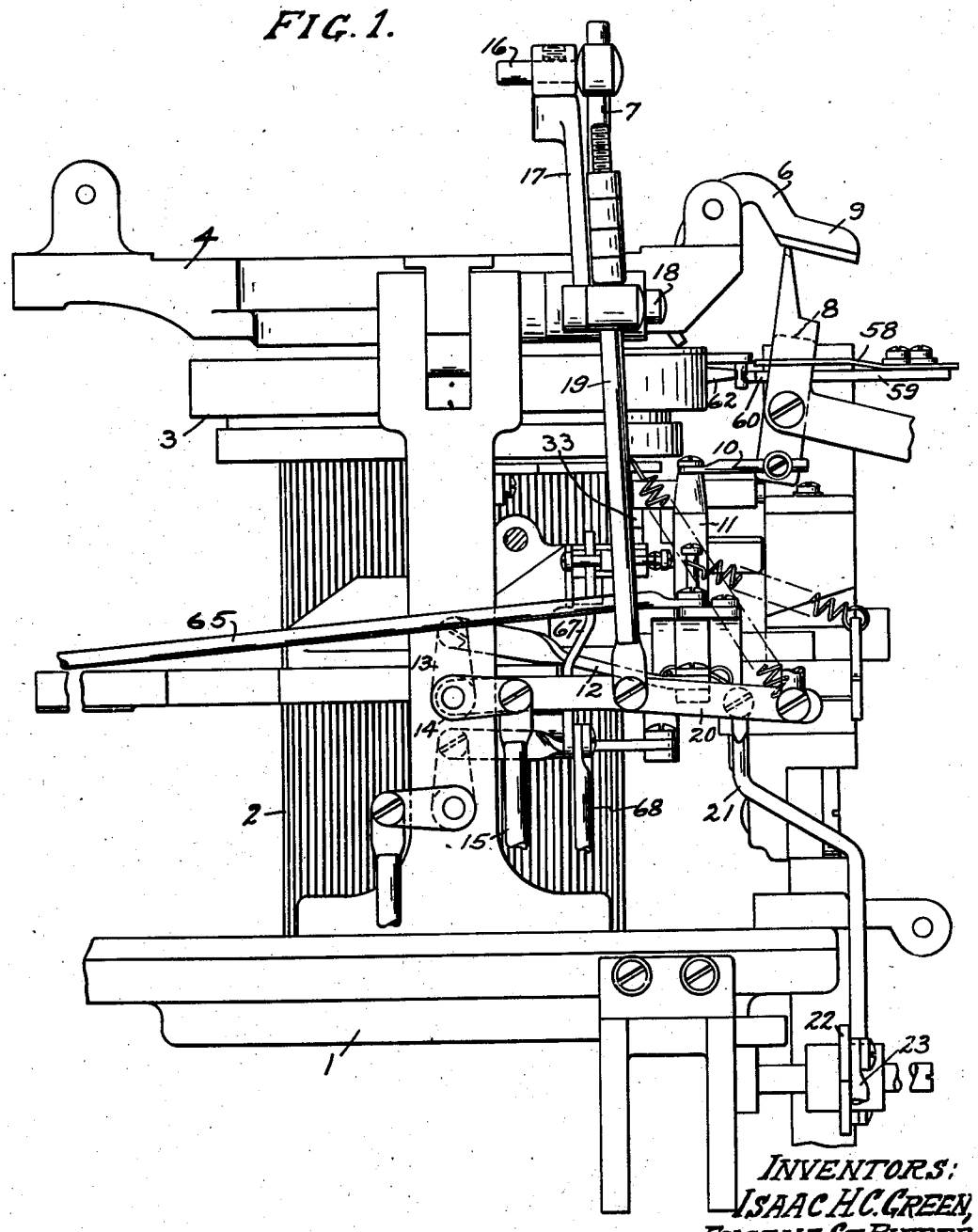
Aug. 7, 1945. I. H. C. GREEN ET AL 2,381,275

KNITTING MACHINE

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FIG. 1.



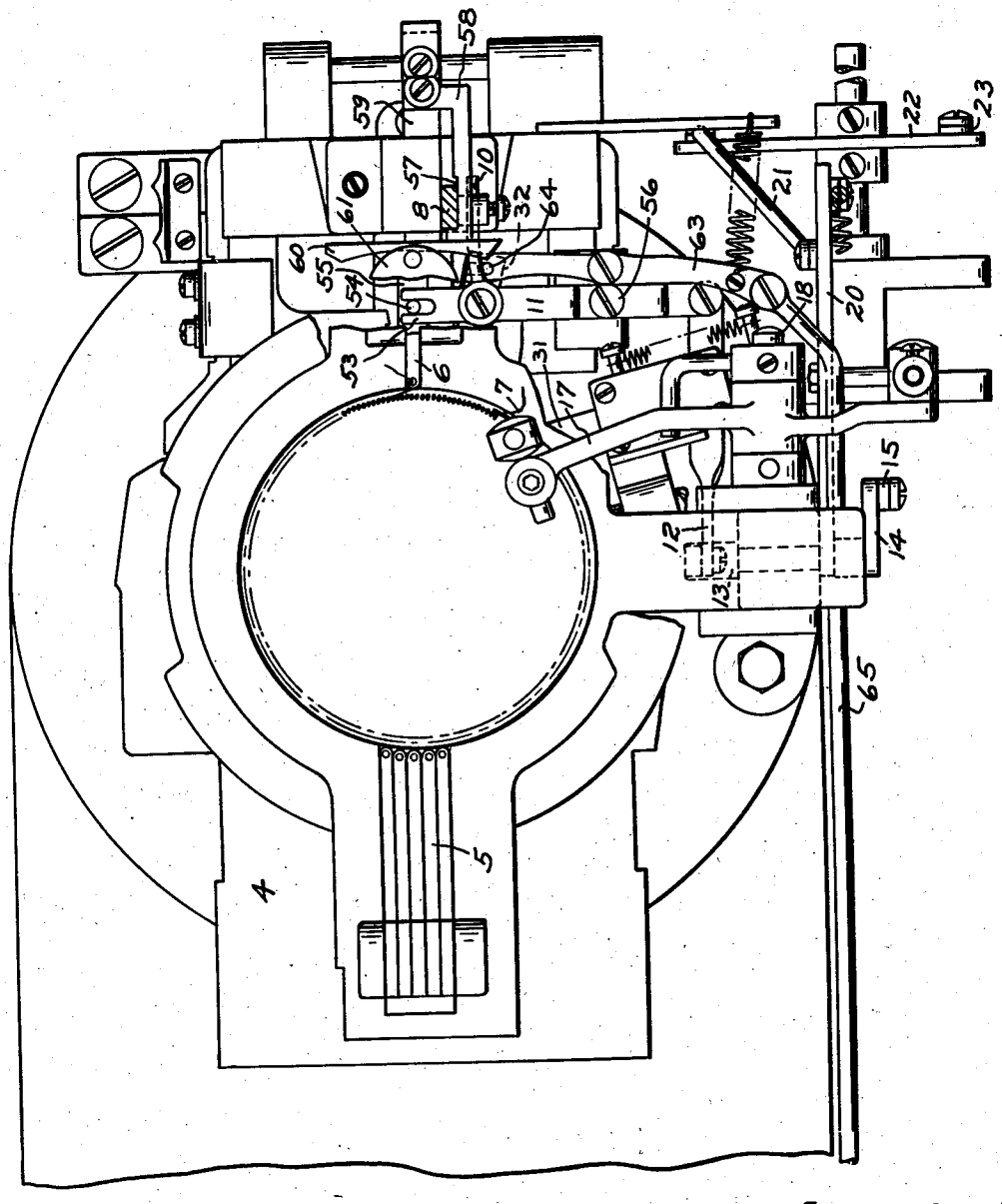
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KNITTING MACHINE

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FIG. 2.



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FIG. 3.

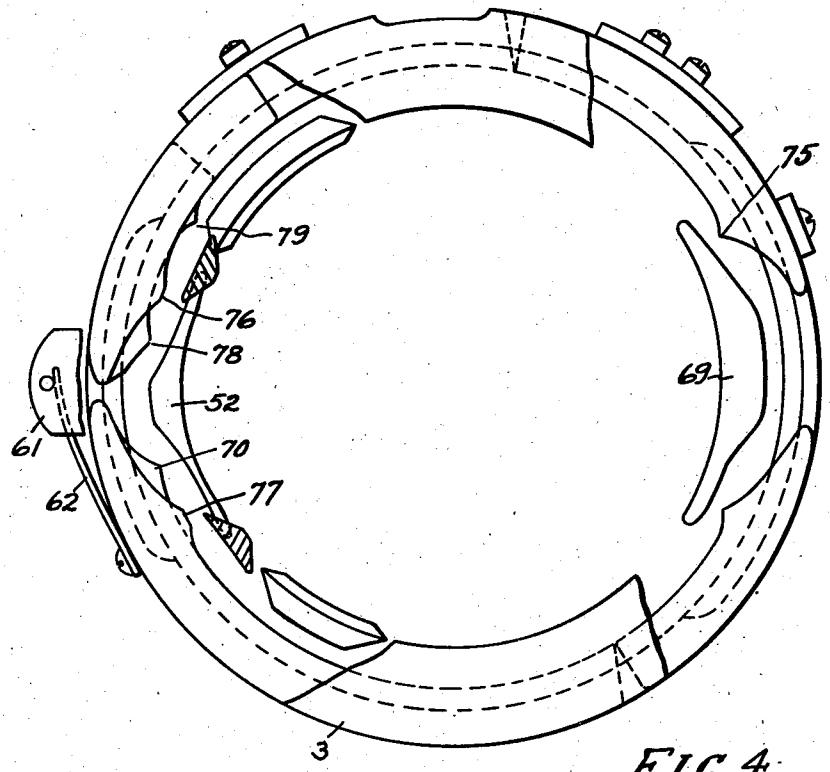


FIG. 4.

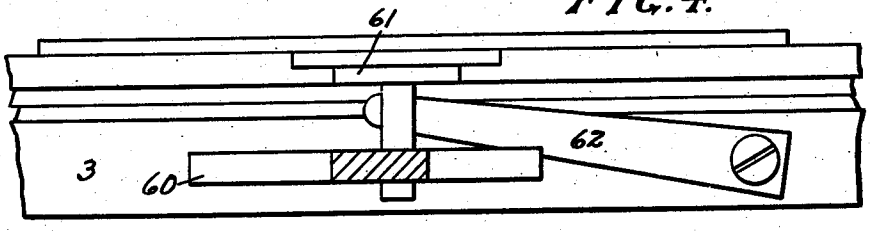
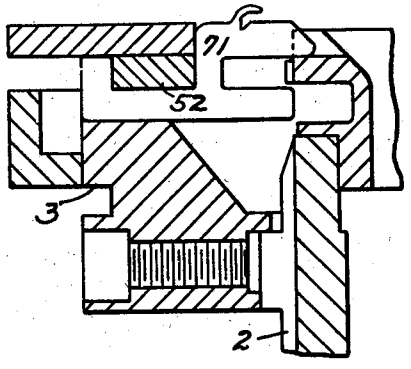


FIG. 5.



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FIG. 6.

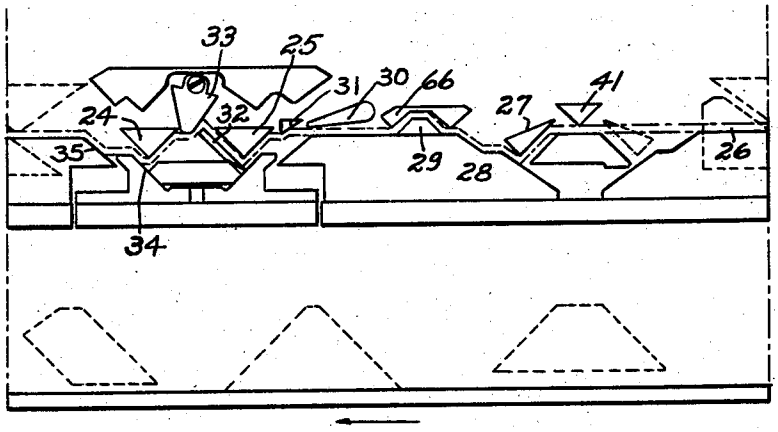


FIG. 7.

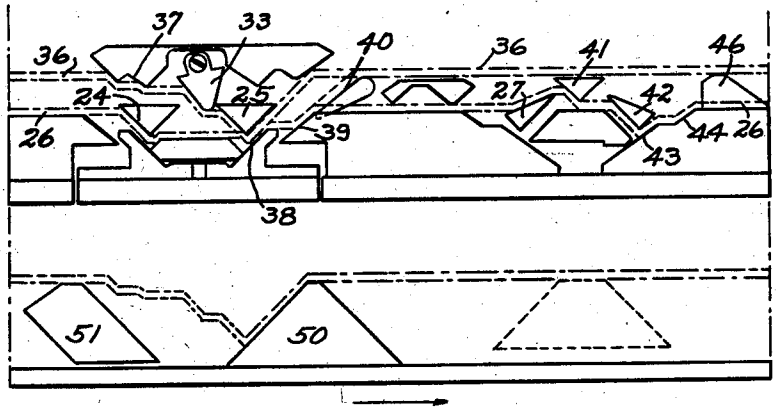
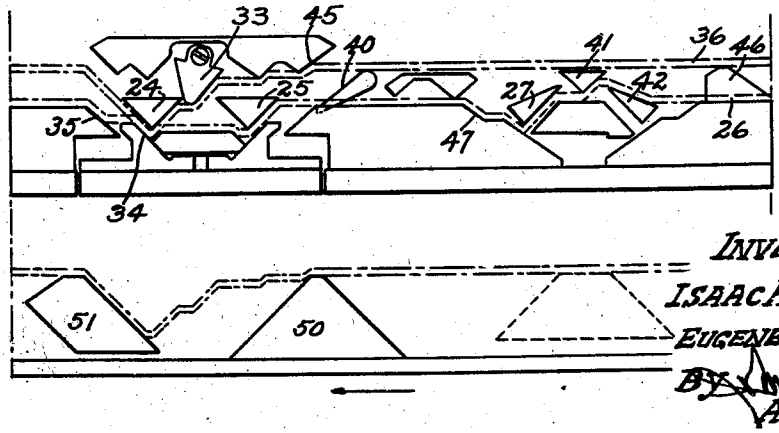


FIG. 8.



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FIG. 9.

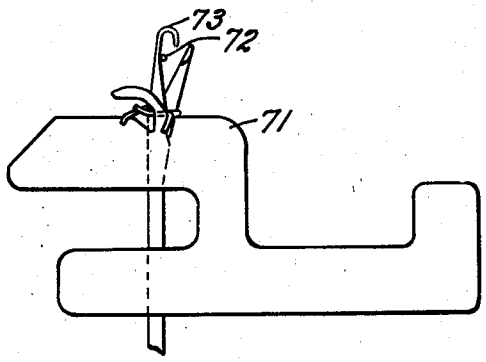


FIG. 10.

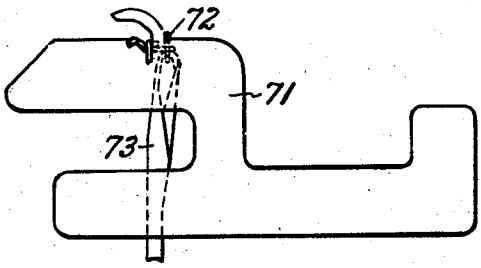


FIG. 12.

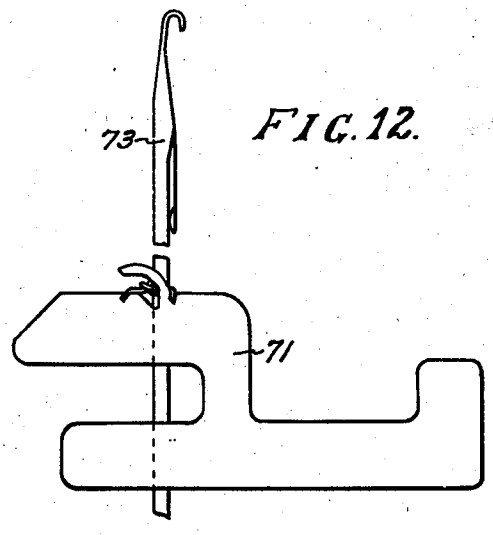


FIG. 11.

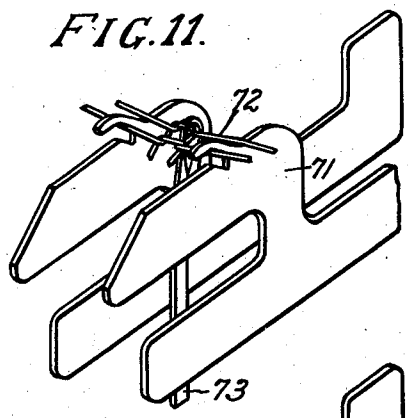


FIG. 13.

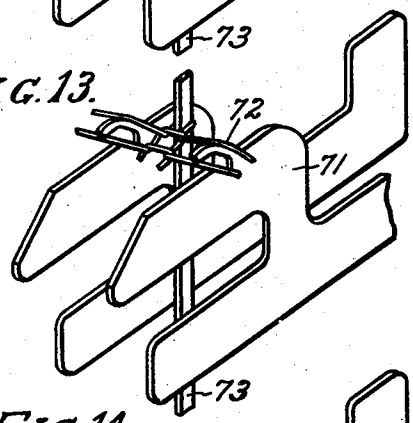
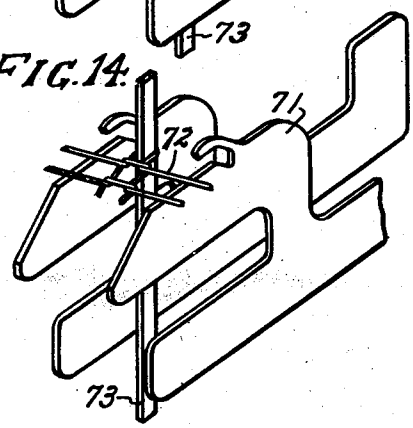


FIG. 14.



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FIG. 15.

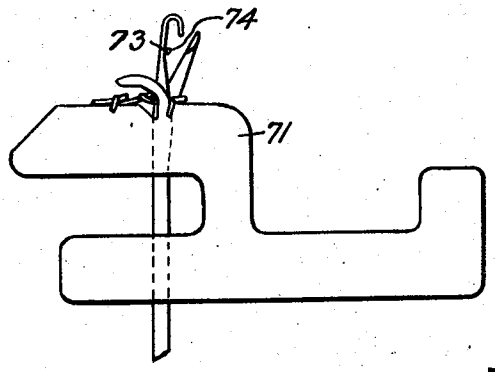


FIG. 17.

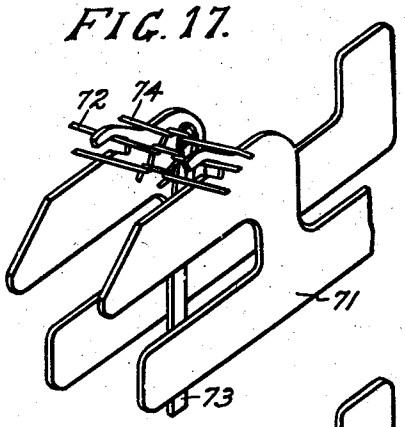


FIG. 20.

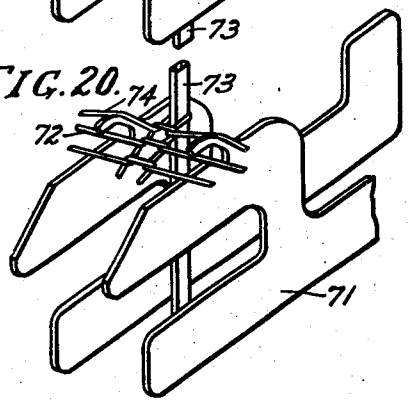


FIG. 16.

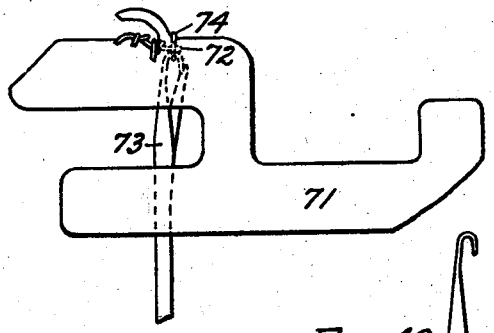


FIG. 21.

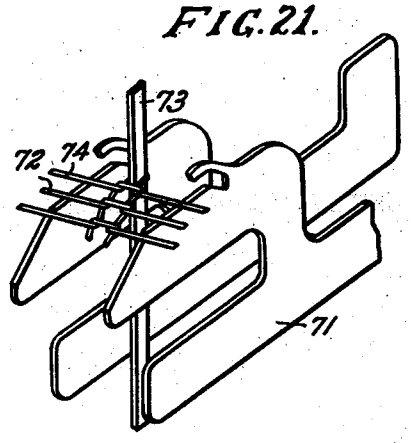


FIG. 18.

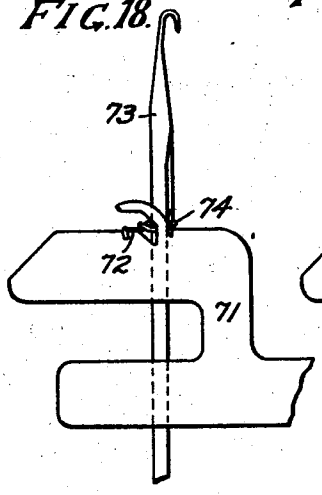
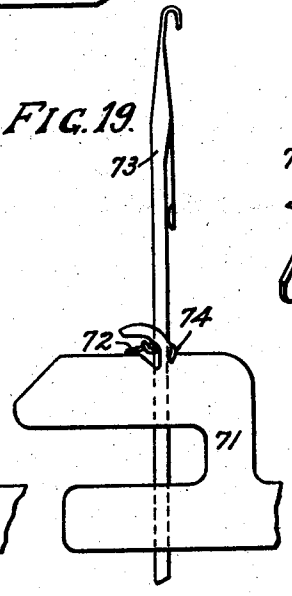


FIG. 19.



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FIG. 22.

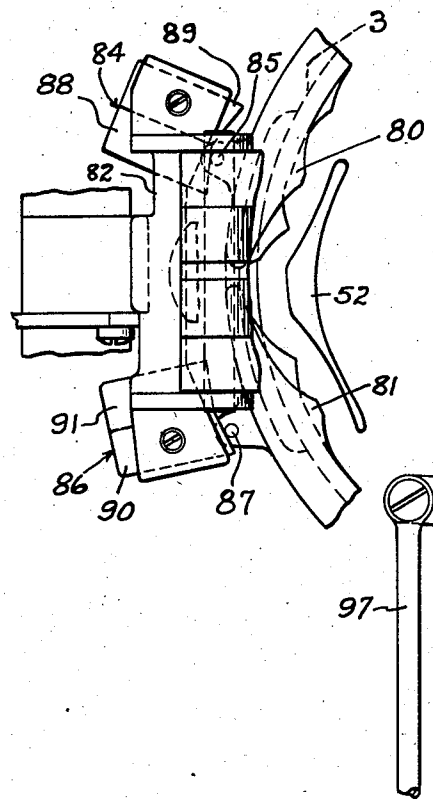


FIG. 23.

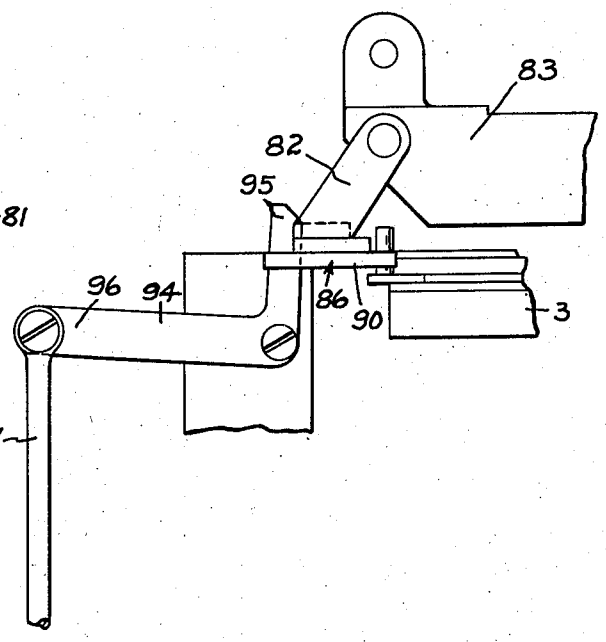


FIG. 24.

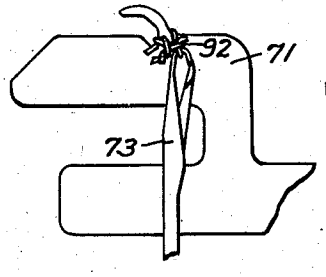
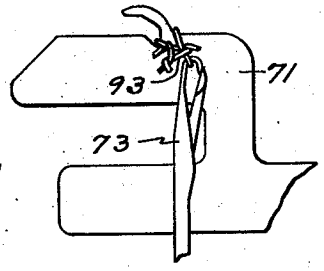


FIG. 25.



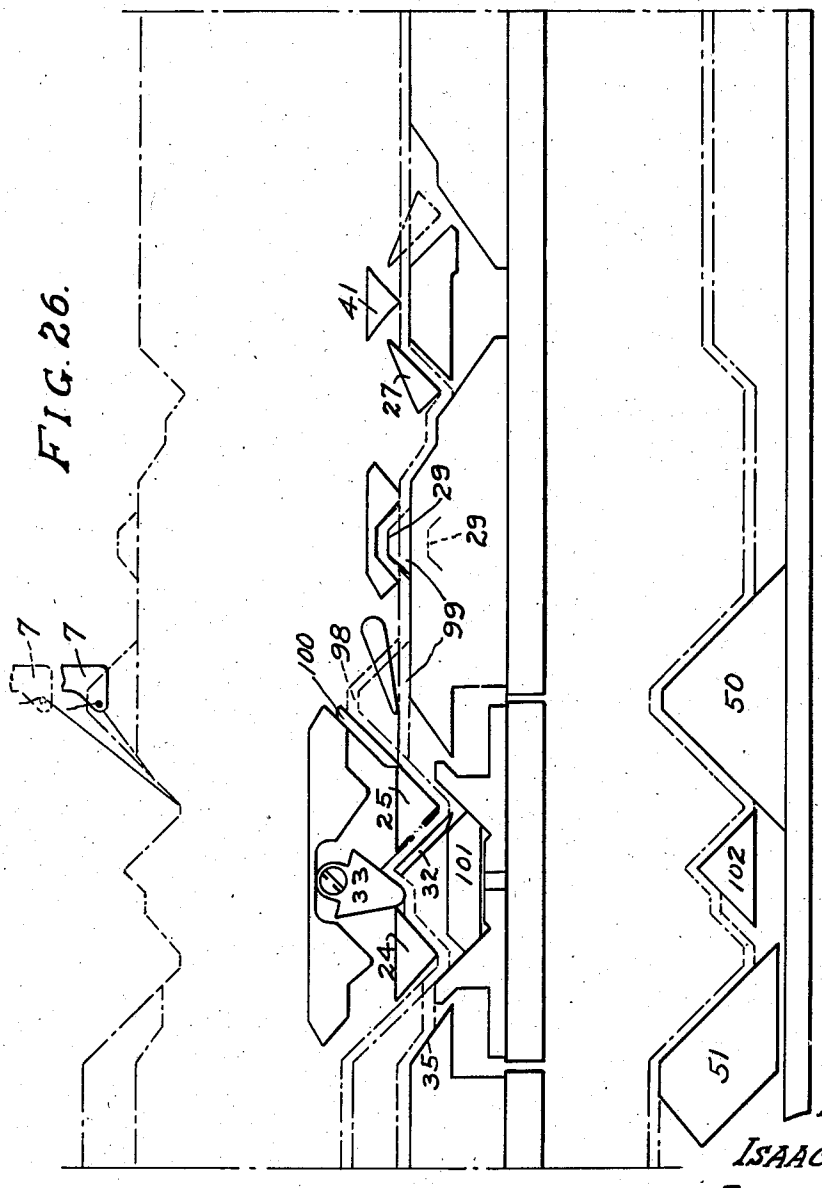
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FIG. 26.



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Patented Aug. 7, 1945 2,381,275

UNITED STATES PATENT OFFICE

2,381,275

KNITTING MACHINE

Isaac H. C. Green and Eugene St. Pierre, Pawtucket, R. I., assignors to Hemphill Company, Central Falls, R. I., a corporation of Massachusetts

Application May 2, 1944, Serial No. 533,744

11 Claims. (Cl. 66—43)

This invention relates to a new and useful improvement in knitting machines, specifically, machines for the production of split foot hosiery and in which the leg is knitted of two yarns both separately fed and separately knitted at the auxiliary side of the machine. The machine is also adapted for the method of knitting in which the yarn or yarns are drawn over the backs of the sinkers at a part or point having a definite height as distinguished from the usual method in which the yarns are drawn in the throats of the sinkers or, in some methods of reverse plating, over the sloping backs of the sinker nibs.

The method of knitting a split foot stocking as carried out on the machine of this invention is fully described and claimed in co-pending application #512,469, filed December 1, 1943. The machine of this invention is designed primarily to function in accordance with that method and, consequently, will be described in relation thereto but it must be understood that the invention is not necessarily restricted to the performance of that method. The invention has been developed for use in a Banner type circular, independent needle, knitting machine. Consequently, a Banner machine is shown in the drawings and described in the specification. However, the invention is not limited to this machine but may be adapted for other machines having generally similar characteristics.

In the drawings:

Fig. 1 is an illustration of part of a Banner type machine showing among other things a circular base, needle cylinder and associated parts to which the invention has been applied;

Fig. 2 is a plan view primarily to illustrate the relative position of the auxiliary yarn levers and the auxiliary yarn levers and the connections for operating certain movable cams which form a part of the invention;

Fig. 3 is a view of the sinker cam cap partly cut away to illustrate the relative positions of the several sinker cams;

Fig. 4 is a fragmentary side elevation of a part of the sinker cam cap of Fig. 3 to illustrate diagrammatically the means whereby the center sinker cam on the auxiliary side of the machine is moved into and out of action;

Fig. 5 is a fragmentary sectional view illustrating the assembly of cylinder, sinker head, sinker cap and stitch ring in the form preferred for this machine;

Figs. 6, 7 and 8 are views illustrating the arrangement of the knitting cams at the main and auxiliary sides of the machine for rotary and reciprocatory knitting and also the paths followed by the needle butts;

Figs. 9 to 14 are views illustrating diagrammatically how knitting is performed by the method in which the yarn or yarns are drawn over the backs of the sinkers instead of in the throats;

Figs. 15 to 21 are also views continuing the steps illustrated by Figs. 9 to 14;

Figs. 22 and 23 are views illustrating a mechanism for variably controlling the casting off cams;

Figs. 24 and 25 are diagrammatic views to further illustrate the purposes of the mechanism of Figs. 22 and 23; and

Fig. 26 is a view illustrating a modification of the knitting cams at the auxiliary side of the machine.

As shown in Fig. 1 the machine is provided with the usual circular base 1 upon which is carried needle cylinder 2 and associated parts. These include sinker head and cap 3 and latch ring 4. The latch ring 4 is also shown in Fig. 2. On the main side of the machine this ring is provided with the usual plurality of yarn fingers 5. On the auxiliary side there is a yarn finger 6 and another yarn finger 7 positioned in advance of yarn finger 6 and also in advance of what is normally the rear stitch cam. Yarn finger 6 is swingable in a vertical plane by a pivoted lever 8 engageable with tail 9 of yarn finger 6 as best shown in Fig. 1 and connected to a suitable cam drum (not shown) through operating linkage generally identified by the numerals 10—15.

Yarn lever 7 is also movable into and out of yarn feeding position. For this reason lever 7 is pivotally mounted upon a stud 16 projecting from one end of a lever 17 adapted to rock upon a pivot 18 and connected to a suitable cam drum or other timing mechanism through linkage shown as rod 19, rocker 20, rod 21, rocker 22 and rod 23 leading to another rocker (not shown) directly operated by the cam drum as shown in U. S. Patent #2,178,911, for example.

This machine is designed for knitting the leg of a stocking in a rotary manner of two yarns separately fed and separately knitted but both fed and knitted at the auxiliary side of the machine. To do this the yarn levers 6 and 7 are both moved into feeding position as shown in Fig. 2 by the mechanisms already generally described. Yarn lever 6 feeds its yarns to the needles just ahead of stitch cam 24 (Fig. 6) of the auxiliary cam block. Yarn lever 7 feeds its yarn just ahead of stitch cam 25 of the same auxiliary cam block.

The paths followed by the needles during rotary knitting is also illustrated by Fig. 6. Since the cams shown in Fig. 6 are viewed from the inside of the needle cylinder the direction of travel is from right to left as indicated by the arrow. Assuming the needle butts to be travelling on the needle support at the level indicated at 26 they pass under stitch cam 27 at the main side of the machine without knitting, then up cams 28 and 29 to transfer the loops from the latches to the shanks of the needles then along the top of cam 28 again, under cam 30 which is adapted to rock to permit the needle butts to pass thereunder, after which they strike guard cam 31 which lowers the butts sufficiently to insure that they will pass under stitch cam 25. Before so doing the needles will receive a yarn fed by yarn lever 7 which will be knitted when the needle butts pass under stitch cam 25. The needles are immediately raised again by raise cam 32 to transfer the newly formed loops from the hooks to the shanks of the needles after which they receive another yarn fed by yarn lever 6 and immediately descend again under guard cam 33 and stitch cam 24 to knit this second yarn. Thereafter they are raised again to the level 26 of the needle support by cams 34 and 35.

In this way, two yarns are separately fed and separately knitted at the auxiliary side of the machine so that two courses are simultaneously in process. Presumably although not necessarily both of the yarns so knitted are identical so that the knitting of a plain leg is speeded up considerably as compared with the rate of knitting when only a single yarn is used. Also the fabric is "ringless" since successive courses of each yarn are separated by a course of the other yarn.

Guard cam 33, which is an important part of the cam assembly on the auxiliary side of the machine, is adapted to rock between the adjacent upper corners of knitting cams 24 and 25. The purpose of this is to provide sufficient space for raising the needles by raise cam 32 to the necessary height to transfer the newly knit loops to their shanks and yet preserve a suitable cam slope for starting them down again upon their next knitting stroke under stitch cam 24. Were cam 33 rigidly mounted in a symmetrical position between stitch cams 24 and 25 it would have to be too thin to be strong and the slope would be too abrupt. By permitting it to swing these difficulties are avoided. During rotary knitting the several cams shown in dotted line in Fig. 6 are not used.

When knitting in a reciprocatory manner as in split foot work, for example, the instep is knitted of a single yarn, that fed by yarn finger 6, and the sole by another yarn fed and knitted at the main side of the machine. This is the usual method of carrying out split work.

The paths followed by the long butt needles to knit the instep and by the short butt needles to knit the corresponding courses of the sole are illustrated in Figs. 7 and 8. Assuming the direction of reciprocation to be from left to right as in Fig. 7, the long butt needles have been raised by the ordinary instep cam to a position indicated by 36 higher than the usual needle support level 26. On the auxiliary side they pass under cam 37 and then under guard cam 33 which is swung to the right, under knitting cam 25 where they knit the yarn previously fed to them by yarn lever 6 after which they are raised again to level 36 by cams 38, 39 and 40 and subsequently pass above the main cam block.

Meanwhile the short butt needles by which the sole is knitted pass from the usual needle support level 26 under stitch cams 24 and 25, raise cam 32 having been previously moved out of operating position, up raise cams 38 and 39 over the stitch cam 27 of the main cam block under guard cam 41 and under stitch cam 42 where they knit and then are immediately raised to needle support level 26 by cams 43 and 44.

In the opposite direction of reciprocatory knitting, illustrated by Fig. 8, the long butt needles starting at the high level 36 to which they have been raised as explained in connection with Fig. 7 pass above the main cam block and above the cams of the auxiliary side until their butts strike cam 45 at which they begin their descent which is continued by guard cam 33 and stitch cam 24 under which they knit. Then they are raised again to level 36 by means of cams 34 and 35 and instep cam 46.

The short butt needles starting at the usual needle support level 26 are first raised by knitting cam 42 high enough to cause previously knit loops to pass from the latches to the shanks of the needles. They then descend again immediately under guard cam 41 and stitch cam 27 under the latter of which they knit. Then they again ascend on cam 47 and along the top of that cam, under stitch cams 25 and 24 after which they are again raised by cams 34 and 35 to their original level 26.

The heel and toe are knitted at the main side of the machine of yarn also fed to them at that side of the machine by one of yarn fingers 5. This is a conventional way of knitting these parts well-known to those skilled in the art, hence requiring no further description.

The several jack cams shown at the bottom of each of Figs. 6, 7 and 8 need be used only when some departure from the usual manner of knitting split work is followed as, for example, when the sole or high heel is made narrower than usual so that some of the short butt needles must be added to the long butt group. This is illustrated, incidentally, in Figs. 7 and 8 by cams 50 and 51 which modify the path followed by those short butt needles which have been added without altering essentially the mode of operation above described. For example, in Fig. 7 the short butt needles which have been added to the long butt group, after they pass under knitting cam 25 instead of being raised by cams 38, 39 and 40 to level 36 are raised directly to that level by jacks controlled by cam 50. When the direction of knitting is reversed as shown in Fig. 8, these short butt needles after passing under knitting cam 24 are similarly raised by cam 51 through the agency of intermediate jacks.

When knitting the heel and toe on the main side of the machine yarn lever 6 (as well as yarn lever 7) must, of course, be out of feeding position. Also swinging guard cam 33 is pulled out of operating position. In addition, center sinker cam 52 (Fig. 3) on the auxiliary side is pushed in so that the sinkers can pass by it without being retracted. These movements are accomplished by the mechanism, shown in Figs. 1 and 2, for swinging yarn lever 6 into and out of feeding position consisting of parts designated by numerals 8, 10—15.

One end 53 of lever 11 is forked and engages a pin 54 which projects from slide 55 upon the inner end of which guard cam 33 is mounted. When the linkage previously described is operated to swing lever 8 to the left (Fig. 1) so

as to permit tail 9 of yarn finger 6 to drop, the motion of lever 11 around its pivot 56 will cause the retraction of guard cam 33.

Lever 11 is also provided with an extension 10 pivotally connected to lever 8 as best shown in Fig. 1. Lever 8 passes through a notch 57 in a plate 58 attached to a slide 59 the inner end of which is provided with a head 60 having an inner face which is shaped as an arc concentric with the cylinder. Center sinker cam 52 (Fig. 3) is mounted upon the end of a slide 61 which is maintained in contact with arcuate head 60 by a spring 62. When lever 11 is rocked as above described to permit yarn lever 6 to swing into inactive position the inward movement of lever 8 will produce a corresponding inward movement of slide 59, head 60, slide 61 and center cam 52 regardless of the position of sinker head 3 which is mounted in the usual way so that it can rotate to a limited extent in either direction. Therefore, the withdrawal of yarn lever 6, guard cam 33 and center sinker cam 52 from their operating positions is effected simultaneously by the same mechanism controlled from the same source which, of course, is so timed as to bring about these movements at the proper point in the knitting.

Cams 31 and 32 (Fig. 6) are used only for two feed rotary knitting. At other times they are withdrawn from action. The mechanism for withdrawing raise cam 32 is also shown in Figs. 1 and 2 as consisting of a rocker 63 one end of which engages a pin 64 projecting from cam 32 and the other end of which is pivotally connected to a rod 65 which is operated from a cam drum or other timing device so that when raise cam 32 is not in use it will be retracted into an inoperative position.

Guard cam 31 is also used only during two feed rotary knitting to insure that the needles which have been raised by cam 29 to transfer the loops carried by them from their latches to their shanks are brought down far enough so that they will not strike the end of stitch cam 25. This might then be the case if guard cam 66 alone were depended upon because of the necessary clearance to insure free passage of the needle butts thereunder. At other times this cam, also, is retracted. The mechanism for this purpose is also shown in Figs. 1 and 2 as consisting of rocker 67, one end of which is connected to the cam and the other end to a lever 68 which is also under the control of a suitable timing device arranged to operate as above indicated.

As mentioned near the beginning of this description, this machine contemplates not only the feeding and knitting in a rotary manner of two yarns at the auxiliary side of the machine, the feeding and knitting of one of these yarns at the auxiliary side to make the instep, the simultaneous feeding and knitting of another yarn at the main side of the machine to form the foot, the two being connected together by sutures and the knitting of the heel and toe in the usual manner but also another variation from the usual method in that the yarns knitted on the auxiliary side are drawn over the backs of the sinkers instead of in their throats.

To accomplish this for the two feed rotary knitting described the sinkers are moved in sooner than usual ahead of points at which the two respective yarns are drawn. This inward movement is sufficient to insure that the yarns instead of being drawn in the throats of the sinkers or over the sloping backs of the nibs will be drawn over the backs of the sinkers behind the nibs or, in other words, on a surface having a definite height. This is shown in Figs. 9, 10 and 11. In Fig. 9 the sinker 71 has been projected inwardly by cam 75 (Fig. 3) so that the yarn 72 fed to needle 73 by yarn lever 7 will be drawn over the back of the sinker as just described. Fig. 10 illustrates the completion of the draw in this way. The sinker shown has a flat horizontal back to provide a drawing surface of definite height. The shape of this sinker may be varied provided a drawing surface having this characteristic of a definite height is retained. Fig. 11 is an isometric view also illustrating the manner in which the yarn is drawn over the back of the sinkers.

After this yarn has been knit by stitch cam 25 (Fig. 6) and the needles have been raised again, as shown in Fig. 12, by raise cam 32 the sinkers are drawn out by center sinker cam 52 which is in its outward, operative position so that the newly drawn loops are transferred from the backs to the throats of the sinkers as shown diagramatically in Figs. 13 and 14. Immediately thereafter, before the yarn fed by yarn lever 6 is drawn, the sinkers are again moved in by cam 70 (Fig. 3) so that this yarn also will be similarly drawn over the backs of the sinkers. In Fig. 15, the sinker 71 is again shown in this position and the yarn 74 as fed to a needle 73. In Fig. 16, the needle has descended under stitch cam 24 drawing this yarn 74 over the back of the sinker and through the previously formed loop of yarn 72 which, as above described, has been transferred to the throat of the sinker and is now cast off. This is also shown in Fig. 17.

Thereafter the needle is again raised to the level 26 at which the newly drawn loop is around the latch as shown in Fig. 18 and subsequently to the position shown in Fig. 19 at which the needle has been further raised by cam 29 to transfer the loop to the shank.

The sinkers are drawn out by center sinker cam 69 on the main side of the machine so that the newly drawn loops of yarn 74 are also transferred from the backs to the throats of the sinkers as shown in Figs. 20 and 21. However, the sinkers are immediately moved in again by cam 75 into position to receive yarn 72 for another course over their backs to be knitted by cam 25 and cast off by cam 76. Cam 78 which corresponds in height to cam 70 is not active. Since the sinkers, after being moved in by cam 75, may retract slightly another cam 79, having a height corresponding to cams 78 and 70, may be positioned ahead of the point at which yarn 72 is fed by yarn lever 7. This will move the sinkers inwardly to the same extent as they are later moved in by 70 before yarn 74 is drawn and thereby insure that both yarns will be drawn under the same conditions. Cam 79 is not essential but is desirable since it insures that the loops of both yarns will be of the same length.

A further desirable, although not essential, refinement of the invention for insuring equal loop length in two feed rotary knitting and in reciprocatory knitting is illustrated by Figs. 22–25. In Fig. 3, casting off cams 76 and 77 are shown as fixed cams. For these there may be substituted flopper cams as shown at 80 and 81 in Fig. 22. These cams are similar to cams 76 and 77 with the exception that they are pivoted in the well-known manner so that they can be moved in and out to vary their height. The mechanism for accomplishing this, shown in Figs. 22 and 23, consists of a yoke 82 pivotally supported by a suitable

bracket 83 and provided with a cam 84 for operating flopper cam 80 through engagement with a pin 85 on the flopper cam and a similar cam 86 for simultaneously operating flopper cam 81 through a pin 87 in that flopper cam. As is well-known, the cam cap 3 is rotatable through a limited arc. Consequently, cams 84 and 86 are so shaped and positioned as to engage the flopper cams in both positions assumed by the sinker cam cap.

The loops knit of the two yarns by rotary knitting should be of the same length and the loops of the single instep yarn should also be of the same length in both directions of reciprocatory knitting. It is also well-known that identical settings of the two casting off cams may not produce this result. For the above reasons operating cams 84 and 86 are each made in two separately adjustable parts, one part of each cam functioning during both rotary and reciprocatory knitting and the other part during reciprocatory knitting in the opposite direction. For example, as shown in Fig. 22, cam 84 consists of two parts 88 and 89 and cam 86 consists of two similar parts 90 and 91. Cams 88 and 90 are positioned so as to engage the flopper cams 80 and 81 to control their radial positions during two feed rotary knitting and reciprocatory knitting in counter-clockwise direction. Cams 89 and 91 are similarly positioned to control the radial positions of the same flopper cams 80 and 81 during reciprocatory knitting in clockwise direction. Since all of these cams are individually adjustable the radial positions of the flopper cams 80 and 81 can be individually set so that the loops of both yarns will be of the same length. Also cam 89 can be set to insure that this loop length is continued in the instep during clockwise reciprocatory knitting. In this instance, cam 91 plays no active part but simply acts as a guard cam to prevent flopper cam 81 from snapping out and, consequently, from colliding with the side of cam 90 when the direction of knitting is reversed.

Another advantage derived from casting off cams of the flopper cam type is that it becomes possible to vary their radial positions simultaneously during the knitting of the different parts of the stocking to correspond with the length of the loops being knit and hence to insure proper casting off and to change the radial position of the cams at any other time when it is desirable to do so.

The effect of varying the radial position of cams 80 and 81 is shown in a general way in Figs. 24 and 25. In Fig. 24 it is assumed that cams 80 or 81 or either of them depending upon the kind of knitting being done has been moved in by the mechanism described to the proper extent for casting off loop 92. In Fig. 25, the loops being drawn are considerably longer and, consequently, the casting off cam has been moved in further to insure that the loop 93 will be cast off. This will serve to illustrate in a general way the manner in which the flopper cams 80 and 81 function and the reason for their use.

A means for controlling cams 84 and 86 as above described is shown in Fig. 23. As already stated, these cams are mounted upon a yoke 82 pivotally suspended from a bracket 83. Behind the bracket and preferably mid-way between its end is a bell crank 94, one end 95 of which is adapted to engage yoke 82 to rock it and, consequently, cams 84 and 86 in and out. The other end 96 of bell crank 94 may be pivotally connected to a rod 97 under the ultimate control of a cam drum or other device (not shown) capable of operating the bell crank in the manner and at the times desired.

During reciprocatory knitting the same general principle of sinker action is followed, the sinkers being projected inwardly soon enough and far enough to receive the yarn over their backs by cam 76 in counter-clockwise direction and by cam 78 in clockwise direction, the old loops being cast off by cams 77 and 76 respectively. In this case, however, the sinkers are drawn out to transfer the loops from their backs to their throats by center cam 52 in both directions with the exception of the few leading sinkers which pass by cam 69.

The simultaneous drawing and knitting of the foot on the main side of the machine is preferably carried out in the usual way, the yarns being drawn in the throats of the sinkers.

The drawing of the leg and instep yarns over the backs of the sinkers and the subsequent manipulation of these yarns produces greatly improved fabric, the loops being more symmetrical in shape and much more uniform in size. This is particularly true of reciprocatory knitting, the characteristic "washboard" effect, heretofore considered inevitable, being practically eliminated. This is clearly shown in Figs. 24 and 25 of U. S. Patent No. 2,360,668 referred to above which are accurate reproductions of directly projected enlargements of fabric knitted in the old and new ways, i. e., in which the loops are drawn in the throats and over the backs of the sinkers respectively.

It is thought that this great improvement in the individual loops and in the general uniformity of the fabric results primarily from the fact that, when the loops are cast off, the sinkers engage only with the sinker loops of the same course, the newly drawn loops being unaffected since they are still riding upon the backs of the sinkers. The loops of the course being cast off are comparatively stable and for this reason and because they are more perfectly drawn in the first place, their shape and proportions are not materially affected by the casting off operation. When the old method of knitting is followed in which not only the old but the new loops are in the throats of the sinkers the casting off operation necessarily disturbs the newly drawn comparatively unstable new loops and upsets their shape and size.

In addition, the transferring of the loops from the backs to the throats of the sinkers tends to tighten them around the needle shanks and thus to bring them to a uniform size. This also results in an equalization of the intervening sinker loops. When the needle loops are cast off and are necessarily stretched somewhat by their passage over the hooks of the needles this stretching is substantially uniform since the loops have already been made uniform. This stretching also places the sinker loops under slightly increased tension which tends to equalize these loops still further. Whether all or only part of these operations are concerned, the net result is a greatly improved fabric produced by both rotary and reciprocatory knitting. The improvement is very evident in any case but appears greater in reciprocatorily knit fabric because the tilt of the loops in such fabric has been in opposite directions in successive courses so that the actual defect in each course is apparently doubled by the oppositely directed defect in the following course.

To these valuable improvements in the fabric should be added the greater knitting speed and "ringless" effect obtained by this invention

through the simultaneous but separate feeding and knitting of two yarns at the auxiliary side of the machine when knitting in a rotary manner which also makes it possible to utilize one of these yarns for the instep of the split foot.

As heretofore stated, the machine is adapted to knit the leg of a split foot stocking of two yarns at the auxiliary side, the yarns being separately fed and separately knitted so that two courses are in course of construction simultaneously. During the knitting of the last course of the leg or, in other words, the last course of rotary knitting before reciprocatory knitting begins at the top of the high splice one of the yarns must be withdrawn. If the high splice is to extend over half the circumference of the stocking so that all the short butt needles are utilized in knitting it there is no difficulty in removing this yarn regardless of whether the yarns are drawn over the backs of the sinkers or in their throats. However, if the high splice is to be narrowed so that some of the short butt needles are added to the long butt needles to function as instep needles there is difficulty in preventing the first few of the remaining short butt needles from catching the yarn in their hooks. When this happens and the yarn is drawn over the backs of the sinkers, the loops will break when the sinkers are pulled out to transfer the loops from their backs to their throats because these particular short butt needles are not raised by raise cam 32 since they do not knit at front stitch cam 24 but cross the cam block at a low level.

To correct this difficulty the modification illustrated by Fig. 26 may be utilized. Beneath the short butt needles adjacent either end of the long butt needles which are to be added to the long butt needles jacks are placed each having a butt adapted to engage cam 50 so as to raise each needle to a high position 98 substantially opposite yarn lever 7. By controlling these needles by jacks in this way, cam 29 may be dropped out of action, as indicated in dotted line, as soon as the last long butt needle has passed over it so that the short butt needles will follow the path indicated by 99 at this point. The following short butt needles, being provided with jacks as above described, will be raised by cam 50 instead of cam 29 to clear the loops from the latches before these needles start downward to knit under stitch cam 25. As soon as the last short butt needle which is to knit the yarn fed by lever 7 has reached the high level 98, yarn lever 7 may be raised above its usual feeding position as shown in dotted line in Fig. 26. Because these short butt needles are high they will take the yarn fed by yarn lever 7 in this position whereas the following short butt needles which follow the low path 99 will not. In this way, the last short butt needle to receive and knit the yarn fed by lever 7 is determined with complete accuracy.

Because of the height to which the short butt needles added to the long butt group are raised by cam 50, guard cam 31, shown in Fig. 6, is modified by lengthening it as shown at 100 in Fig. 26. Cam 100 functions similarly to guide the needles to stitch cam 25 but is simply lengthened to conform to the excessively high position of the needles.

After the long butt needles have knit under stitch cam 25 and have been raised again by raise cam 32, cam 32 must be withdrawn so that those short butt needles which are knitted at the main side of the machine will not be raised but will pass over the top of cam 101. This can only be done while the short butt needles which are serving as long butt needles are being raised, consequently, a cam 102 is provided adapted to function with the jacks associated with these needles to raise them in the same way and to the same height as the long butt needles were raised by cam 32.

Cam 100 must also be withdrawn during reciprocatory knitting. This can be done any time after the last short butt needle which functions as a long butt needle has passed beyond it and before the beginning of the first reciprocatory course in the opposite direction. Jack cam 102 is also withdrawn during reciprocatory knitting after it has served its purpose to elevate the short butt needles as above described.

Jack cams 50 and 51 are also retractable and are withdrawn whenever they are not required. The mechanisms for withdrawing these various cams may be of any form suitable for the purpose and require no description since they are well-known or may be designed by those skilled in the art.

We claim:

1. In a circular, independent needle, knitting machine having main and auxiliary cam blocks, a cam in advance of the stitch cams of the auxiliary cam block for raising needles from a position at which any loops thereon are around the latches to a sufficient height to cause the loops to pass below the latches, a second cam to immediately lower the needles again to substantially their previous position, a third cam between these cams and the stitch cams for guiding said needles so that they will knit under the first stitch cam and a fourth cam for immediately raising the needles again to substantially the same height as that to which they were raised by said first mentioned cam.

2. In a circular, independent needle, knitting machine having main and auxiliary cam blocks, a cam in advance of the stitch cams of the auxiliary cam block for raising needles from a position at which any loops thereon are around the latches to a sufficient height to cause the loops to pass below the latches, a second cam to immediately lower the needles again to substantially their previous position, a third cam between these cams and the stitch cams for guiding said needles so that they will knit under the first stitch cam, a fourth cam for immediately raising the needles again to substantially the same height as that to which they were raised by said first mentioned cam, and a fifth cam for lowering said needles so that they will knit under the other stitch cam.

3. In a circular, independent needle, knitting machine having main and auxiliary cam blocks, means for separately knitting two separately fed yarns at the auxiliary cam block which includes a cam in advance of the stitch cams for raising needles to a height at which any loops thereon are around the shanks, cams for guiding said needles so that they will knit under one stitch cam, another cam for immediately raising the needles again to a height at which the loops knit under this stitch cam will be around their shanks and a cam for guiding the needles to the other stitch cam so that they will knit again thereunder.

4. A circular, independent needle, knitting machine for rotary and reciprocatory knitting according to claim 1 which also is provided with

automatic means for withdrawing the third and fourth cams into inoperative positions at the beginning of reciprocatory knitting and for moving them into their operative positions at the beginning of rotary knitting.

5. In a circular, independent needle, knitting machine having main and auxiliary cam blocks, means for two feed rotary knitting at the auxiliary cam block which includes means for feeding a yarn to the needles in advance of the stitch cams, means for knitting this yarn under one stitch cam, means for feeding another yarn to the needles in advance of the other stitch cam, means for causing the needles to knit this yarn through the loops of the other yarn which were knitted under the first mentioned stitch cam and means for positioning the sinkers during each knitting operation so that the yarn is drawn over the backs thereof.

6. In a circular, independent needle, knitting machine having main and auxiliary cam blocks and sinkers, means for causing the needles to knit different yarns under the front and rear stitch cams respectively of the auxiliary cam block, a sinker cam assembly which includes a cam in advance of the stitch cams for moving the sinkers inwardly sufficiently so that the yarn knitted at the first stitch cam will be drawn over the backs of the sinkers, a casting off cam for casting off the loops knitted at the first stitch cam, a cam for again moving the sinkers inwardly so that the yarn knitted under the other stitch cam is drawn over the backs of the sinkers, a casting off cam for casting off the loops knitted under said other stitch cam said casting off cams being adjustable radially of the cylinder to vary the casting off position thereof and automatic means for so operating said casting off cams.

7. In a circular, independent needle, knitting machine having a cam block and a rotatable needle cylinder provided with groups of needles having long and short butts respectively, means, operative during rotary knitting only, for raising a predetermined number of the short butt needles adjacent the last long butt needle higher than the succeeding short butt needles to engage a yarn fed at a level too high to be taken by the succeeding needles.

8. In a circular, independent needle knitting machine having a cam block and a rotatable needle cylinder provided with groups of needles having long and short butts respectively, means in advance of the first stitch cam for feeding a yarn to all of the needles to be knit under said first stitch cam during rotary knitting, means also operable during rotary knitting for raising a predetermined number of the short butt needles adjacent the last long butt needle higher than the succeeding short butt needles so that they can engage the yarn fed at a level too high to be taken by succeeding needles and means for guiding these short butt needles to the first stitch cam to knit thereunder.

9. In a circular, independent needle, knitting machine having a cam block and a rotatable needle cylinder provided with groups of needles having long and short butts respectively, jacks beneath a predetermined number of short butt needles adjacent the last long butt needle for raising these short butt needles to a higher level than succeeding needles, means for so operating said jacks, and means for so feeding a yarn to the raised short butt needles that it will not be taken by the succeeding short butt needles.

10. In a circular, independent needle, knitting machine having main and auxiliary cam blocks, needles and sinkers, means for causing the needles to knit different yarns under the respective stitch cams of the auxiliary cam block, a sinker cam assembly which includes an adjustable casting off cam for casting off the loops knitted at the first stitch cam, an adjustable casting off cam for casting off the loops knitted at the other stitch cam, means for varying the radial position of each casting off cam independently of the other for rotary knitting, means for varying the radial position of each casting off cam independently of the other for reciprocatory knitting and automatic means operative upon all of said varying means but independently thereof for simultaneously setting each of said casting off cams at any operating radial position in the relation determined by said varying means.

11. In a circular, independent needle, knitting machine having a cam block and a rotatable cylinder provided with needles and means for feeding a yarn to the needles, the combination of means operable during rotary knitting for raising a predetermined number of consecutive needles to a higher level than succeeding needles and means for simultaneously raising said feeding means sufficiently that it will not feed yarn to the succeeding needles but will feed yarn to the hooks of the raised needles.

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