This invention relates to a new and novel apparatus and method of knitting more particularly to a system to automatically maintain a pre-selected loop size in the material being knitted.

Prior to the invention the knitting of fabric into cloth material was subject to many disadvantages which caused imperfections in the cloth due to variation in size of the loops in the material. These variations in loop size were caused by the change of rate that the knitting machine took the material being supplied thereto, the change of rate of the knitting machine being due to such factors as bent needles, stretch of the yarn being knit, imperfections in the knitting machine, moisture content of the yarn being knit, etc. In an attempt to maintain a constant feed rate in order to obtain constant pre-selected loop sizes in the yarn being knit, various prior art devices were employed to maintain the tension constant in the yarn being knit. These prior art devices worked to some satisfaction but were still objectionable due to the abovementioned disadvantages.

Therefore, it is an object of this invention to provide a feed system for a knitting machine which will automatically maintain the loop size in the cloth being knit by controlling the feed rate of the yarn being supplied to the knitting machine. A second object of the invention is to provide a feed system for a knitting machine which will automatically vary the yarn consumption rate of the knitting machine in response to a change in the rate of yarn take-up by the knitting machine.

A further object of the invention is to provide a feed system for a knitting machine which will automatically maintain a pre-selected loop size in the material being knit by controlling the feed rate of the yarn to be knit in response to the rate of the yarn being taken by the knitting machine. A still further object of the invention is to provide a feed system for a knitting machine which will automatically maintain a pre-selected loop size in the material being knit by controlling the position of the yarn with respect to the needles in response to the rate of the yarn take-up by the knitting machine.

Another object of the invention is to provide a continuous in-line operation in which material from a roll can be continuously slit, compacted, and knit into a cloth material in which the loop size is substantially constant providing a quality knit material. A still further object of the invention is to provide a high quality knit material in which the loop size is maintained substantially constant.

Other objects and advantages of the invention will be clearly apparent as the specification proceeds to describe the invention with reference to the accompanying drawings in which:

FIGURE 1 is a schematic representation of a knitting system employing the herein disclosed yarn feed control system;

FIGURE 2 is an exploded view of the sinker burr shown schematically in FIGURE 1;

FIGURE 3 is a graphic representation of the sinker burr shown in FIGURES 1 and 2; and

FIGURE 4 is a modification of the yarn feed device of FIGURE 1.

For the purpose of illustration and explanation the herein disclosed invention describes the knitting of paper in a circular type knitting machine such as a Tompkins spring beard needle type employing a sinker burr. It is to be understood that other yarns such as cotton, wool, synthetics, etc., can be employed if desired. Furthermore, other types of knitting machines, such as a latch needle type employing a stitch cam, can be used within the scope of the invention.

Looking now to FIGURE 1 the reference numeral 10 represents a circular spring beard knitting machine employing a sinker burr assembly 12 to supply paper yarn Y thereto. As shown, the process of knitting the paper yarn is continuous in that an unlitt roll of paper 14 is fed through a pair of slitting rolls 16 by a pair of feed rolls 18 to slit the paper roll into a plurality of strips 20. Each of the strips 20 is delivered to a compaction means 22 through a pair of guide pins 24 on guide member 26. From the compaction means 22 the paper yarn Y is delivered to the sinker burr assembly 12 to be knit into a paper fabric. Only one compacting member 22 and one sinker burr assembly 12 are shown for the sake of illustration, but it is understood that such devices will be provided for each strip of paper 20 slit by slitting rolls 16. It is further understood that the paper strips 20 slit from the paper roll 14 can all be supplied to one knitting machine or can be supplied to a plurality of knitting machines.

In the preferred form of the invention shown in FIGURE 1, it is necessary to correlate the operation of the slitting rolls 16, the compaction means 22, the sinker burr assembly 12 and the circular knitter 10. This correlation can be accomplished in any suitable manner schematically represented by drive connections 28 and 30 geared to the circular knitter 10 by gears 32 and 34 which is driven at a constant rate by a drive means (not shown). The speed of feed rolls 18 is correlated to the speed of gears 36 and 38 through proper selection of 40, 42, 44, 46, 48, 50, 52 and 54 to provide a pre-selected fixed tension in the paper strip 20 between the slitting rolls 18 and the compaction means 22. The speed of drive gears 36 and 38 is also correlated to the rate of take-up by the circular knitter so that the tension in yarn Y between the compaction means and the sinker burr assembly 12 is within a pre-selected range. A slip clutch 56 is provided in the drive to gears 36 and 38 so that if an excessive torsional force is exerted on the drive to the gears 36 and 38 the slip clutch will slip and thereby not transmit the excessive force on the gears 36 and 38 and cause breakage of the paper strip 20 being compacted due to increased pull on the paper being compacted.

In the preferred form of the invention the compaction means 22 is a paper folder for converting the paper strip into flat, folded twistless paper yarn. Folder 22 is similar to that disclosed in copending Serial No. 264,375, supra. Briefly, the paper strip is passed consecutively over a guide roll 58, a first folding roll 60 which folds the edges of the paper inward to the centerline of the strip 20, a second folding roll 62 which folds the strip double on the centerline thereof, a pair of creasing rolls 64 to crease the final fold, and drive years 36 and 38 which impart a transverse edge-to-edge crease across the twice folded strip 20 to provide a folded twistless paper yarn Y.

As pointed out previously compaction means provide a constant positive feed of yarn to the sinker burr assembly 12. The folder herein described is merely illustrative since it is preferred to knit paper yarn but the only basic criteria of the invention is that the means 22 provide a substantially constant positive feed of the yarn to the sinker burr assembly.

Looking now at FIGURES 1 and 2 and more par-
particularly to FIGURE 2, the sinker burr assembly is shown in detail. The overall sinker burr assembly 12 is supported on sinker burr support member 66 and is supported in any suitable manner adjacent to the collar member 10. In FIGURE 2, the sinker burr assembly is shown in detail. The overall sinker burr assembly 12 is supported by collar member 10 and secured thereto by setscrews 90. Collar member 88 abuts sinker burr 68 and secures same against the circular flange 92 of the sleeve member 76. Welded or otherwise secured to the collar member 88 is an arm 94 with a pulley 96 mounted at the end thereof in a manner so as to be capable of rotation separate from the rotation of the lever arm 94.

It should be noted that sleeve member 76, sinker burr 68, collar member 88 and lever arm 94 can be rotated eccentrically as a unit on spindle 74 and at the same time sinker burr 68 is free to rotate concentrically on the conical sleeve member 76 independent of the unit rotation on the spindle. Looking at FIGURE 1 the paper yarn Y is fed to the sinker burr 68 from the compacting means 22 through a guide member 96. From the guide member the yarn Y passes through a guide member 98, around the pulley 96 and through guide member 100 to form a slack loop L for reasons hereinafter described. From the guide member 100, the yarn is delivered to the sinker burr 68 through a further guide member 102.

In normal operation the sinker burr assembly 12 is adjusted to provide an approximate desired loop size. The sinker burr 68 operates in a manner well known in the art in that the yarn Y is carried by the sinker burr 68 and is forced up into the spring beard of the needles 70 as the needles move past the sinker burr 68 on rotation of the circular knitter. In normal fashion the beard part of the needles 70 will move between the burrs of the sinker burr to form the knitting loop. It can be seen under normal tension that the relative position of the sinker burr to the axis of rotation of the circular knitter will determine the size of the loop being knit. In other words the greater the projection of the sinker burr into the path of rotation of circular knitter the larger the loops being knit and the more yarn being used and vice versa.

Looking now to FIGURES 1–3 and in particular at FIGURE 3 the new and improved automatic feed back control will be explained. In FIGURE 3 the circle 104 represents the axis of rotation of the conical sleeve member 76. The dot 106 represents the axis of rotation of the sinker burr 68 on the conical sleeve member. The normal path of rotation of the sinker burr 68 and the normal position of the lever arm 94 are represented in solid lines by the reference numbers 108 and 110 respectively. The normal path of the needles on the circular knitting machine which may be due to imperfections in the yarn being knit, stretchiness of yarn, bent needles on the knitting machine, change of atmospheric conditions in the work area, or other conditions affecting the characteristics of the yarn which cannot readily be controlled.

Inherently in the use of the herein disclosed feed back compensator a better quality of knitted fabric will be obtained because of the constant and even loop sizes. Furthermore, the herein disclosed control system provides a system which eliminates waste and excess cost since the loop size can be controlled much closer allowing the tightening of specifications, thereby eliminating the need for adjustments on the size of any desired fabric to insure that the end product completely fulfills the desired conditions.
Further, the herein disclosed knitting system operates exceptionally well in in-line operation since the feed back compensator will automatically adjust for variations in the yarn being knit. Such in-line operation provides the advantage that all the strips of yarn being knit will run out at the same time. This is true whether all the yarn being knit is from one original supply roll or whether it is from a single roll mounted on a common mandrel with other yarn being knit.

Furthermore, the herein disclosed knitting system allows the knitting of novelty fabrics without drastic changes in the system to knit such fabrics the relative speeds of the constant feed device and the knitter can be altered to provide different loop effect and the feed rate compensator will automatically maintain this desired effect until the relative speeds of the constant feed device and the knitter are again altered.

Although I have described specifically the preferred embodiments of my invention, I contemplate that changes may be made without departing from the scope or spirit of my invention and I desire to be limited only by the scope of the claims.

That which is claimed is:

1. Apparatus for knitting fabric comprising: a knitting machine, said knitting machine including means to form loops of predetermined size, means supplying yarn to said knitting machine at a substantially constant rate, means forming an elongated loop of yarn in said yarn between said knitting machine and said constant yarn supply means and means to vary the loop size in the fabric being knit in response to the rate of take-up of yarn by the knitting machine, said loop varying means including a lever arm, one portion of said lever arm being connected to said loop forming means, another portion of said lever arm engaging and being moved by said elongated loop whereby a change in depth of said elongated loop will change the position of said loop forming means.

2. The structure of claim 1 wherein said loop forming means is eccentrically mounted.

3. The structure of claim 2 wherein said knitting machine has a circular row of needles and said loop forming means is a sinker burr.

4. The structure of claim 3 wherein said sinker burr is eccentrically mounted adjacent said row of circular needles, said elongated loop rotating said sinker burr on the eccentric axis to vary the position of said sinker burr in relation to said row of circular needles.

5. The structure of claim 4 wherein the eccentric mounting of said sinker burr is an eccentrically drilled sleeve member, said sinker burr being rotatably mounted on said sleeve member, said one portion of said lever arm being connected to said sleeve member.

6. The structure of claim 5 wherein a pulley member is located on said another portion of said lever, said elongated loop engaging said pulley member.

7. The structure of claim 6 wherein said means supplying yarn to said knitting machine is a positively driven yarn compacter.

8. The structure of claim 7 wherein said yarn compacter is a paper folding machine.

9. A sinker burr assembly for a circular knitting machine comprising: an eccentrically drilled sleeve member, a sinker burr rotatably mounted on said sleeve member, a lever arm connected to said sleeve, and yarn engaging means on said lever member remote from said sleeve member.

10. Apparatus for knitting fabric comprising: a knitting machine, said knitting machine including means to form loops of predetermined size, means supplying yarn to said knitting machine, said knitting machine having a plurality of needles, said yarn supplied to said knitting machine having an elongated loop therein between said knitting machine and said yarn supply means and means varying the position of said loop forming means in response to the change of length of said elongated loop to vary the amount of yarn being supplied to said needles to vary the loop size in the fabric being knit.

11. The structure of claim 10 wherein said loop forming means is a sinker burr assembly.

12. A process for forming knit material on a knitting machine having a circular row of needles comprising the steps of supplying yarn at a substantially constant rate to a loop forming member of a knitting machine, supplying yarn from said loop forming member to said row of needles of said knitting machine and forming a loop thereat and changing the position of said loop forming member relative to said knitting machine in response to a change of rate of yarn take-up by the knitting machine to vary the size of loops subsequently being formed by said loop forming member.

13. The process of claim 12 wherein an elongated loop is formed in the yarn being supplied to said knitting machine, the position of said loop forming member being changed in response to the length of said elongated loop.

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