Oct. 25, 1949. R. F. W. KRUEGER 2,485,746

KNITTING PROCESS

Filed Sept. 23, 1946 2 Sheets-Sheet 1

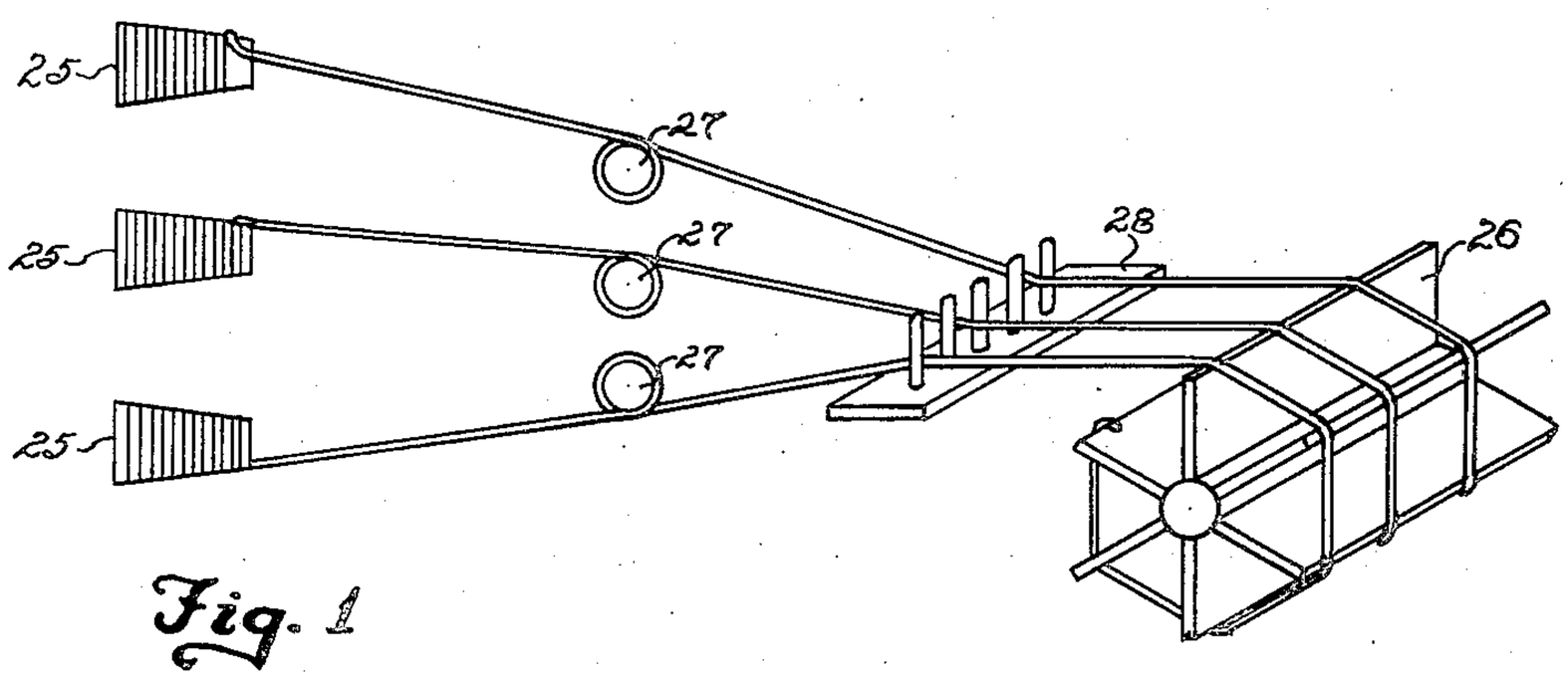

Fig. 1

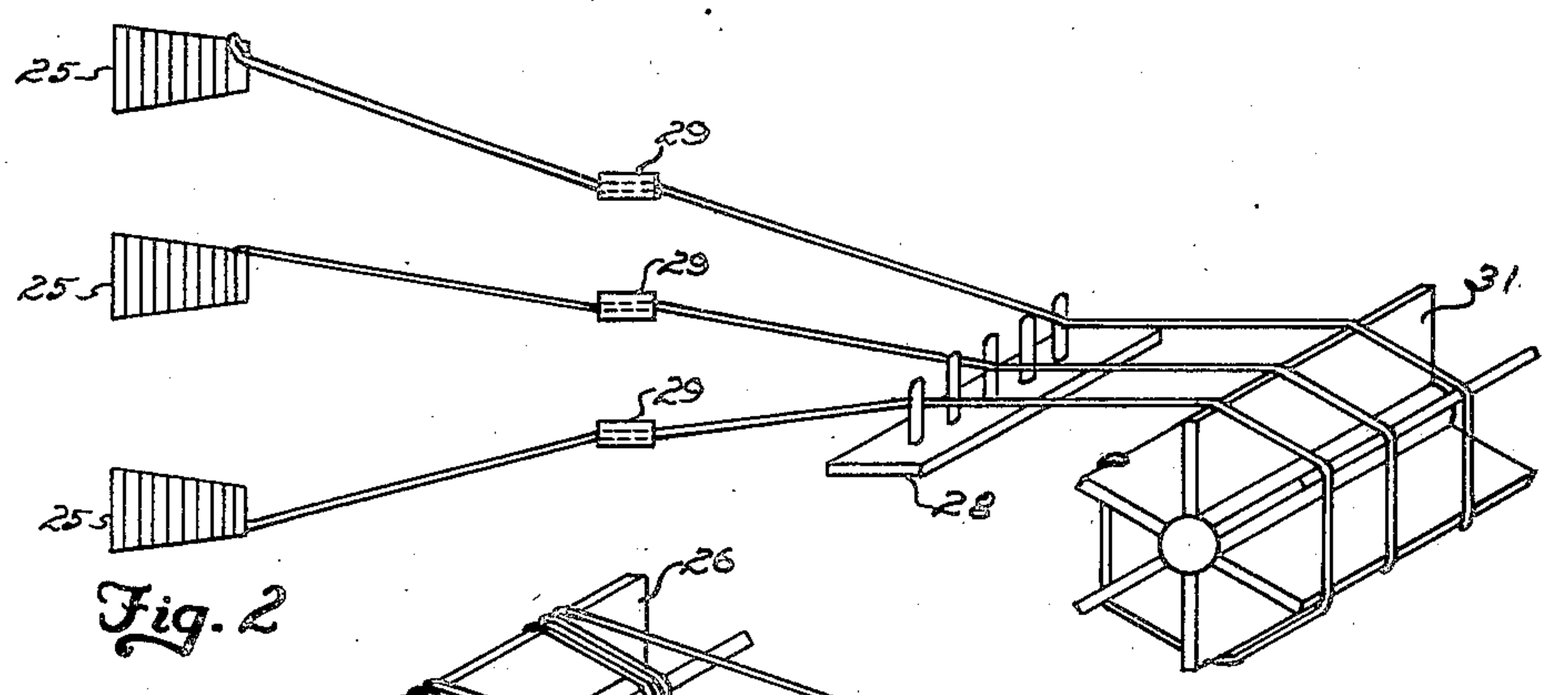

Fig. 2

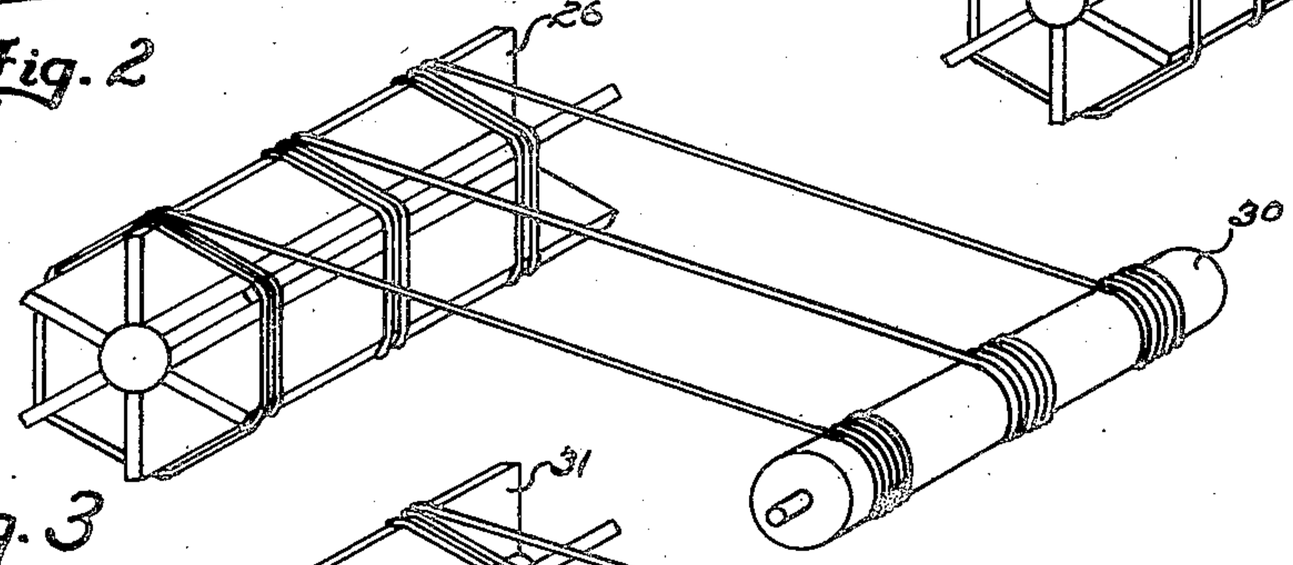

Fig. 3

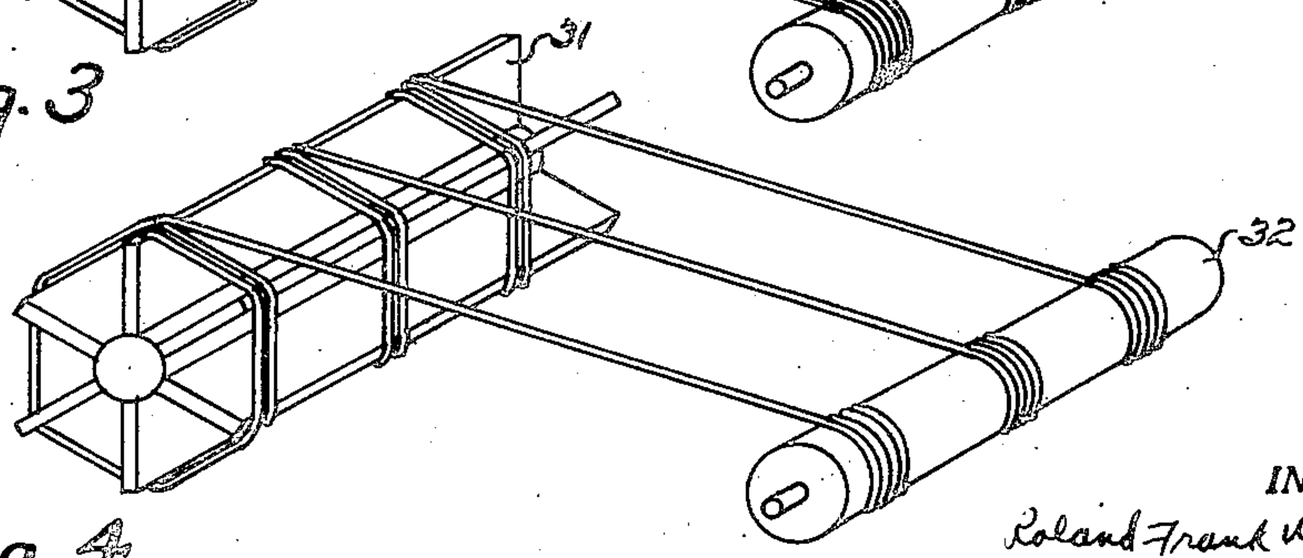

Fig. 4

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Filed Sept. 23, 1946 2 Sheets-Sheet 2

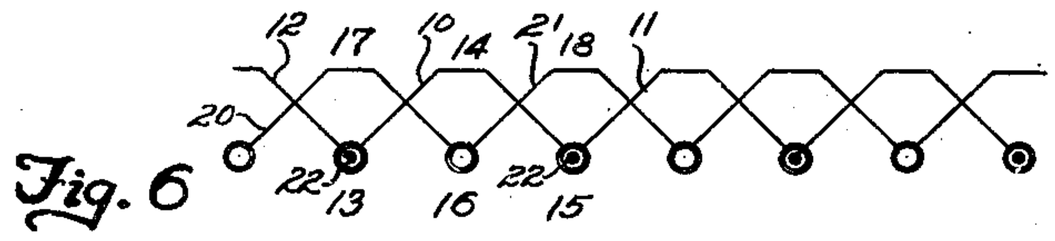

Fig. 6

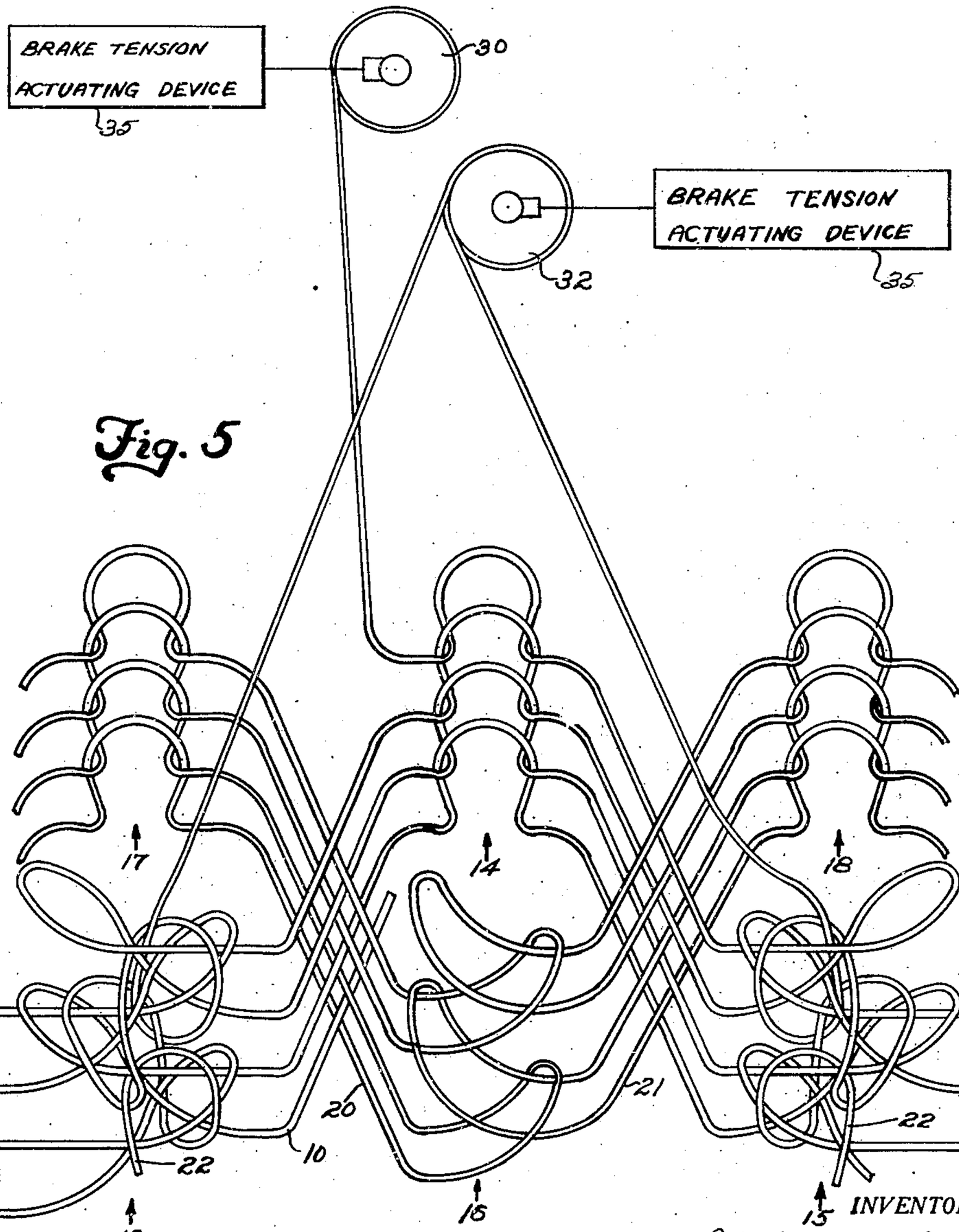

Fig. 5

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UNITED STATES PATENT OFFICE

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KNITTING PROCESS

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3 Claims. (Cl. 66—87)

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My invention relates to knitting practice in general, and more particularly to the practice of knitting elastic and inelastic yarns into a fabric.

An object of my invention is to control the degree of tension on the elastic yarn of a knitted fabric produced from the combination of elastic and inelastic yarn.

Another object of my invention is to provide an improved method of feeding yarn to a knitting machine.

Other objects and a fuller understanding of my invention may be had by referring to the following description and claims, taken in conjunction with the accompanying drawing, in which:

Figure 1 is a diagrammatic view illustrating the method of winding inelastic yarn from spools of the yarn to the reel;

Figure 2 is a view similar to Figure 1 illustrating the method of winding the elastic yarn from spools of the elastic yarn upon a reel;

Figure 3 is a diagrammatic view illustrating the method of winding the inelastic yarn from the reel to the beam;

Figure 4 is a diagrammatic view illustrating the method of winding the elastic yarn from the reel to the beam;

Figure 5 is a diagrammatic view illustrating the separate feeding of elastic and inelastic yarn from individual beams to the knitting machine, and the resulting knitted fabric; and

Figure 6 is a diagrammatic illustration of the relationship of face stitches and cross stitches to produce the double knitted fabric.

In the production of knitted fabrics for sweater waistbands, cuffs, and similar articles, elastic strands and inelastic strands are knitted together to give an elastic characteristic to the fabric. When knitting elastic and inelastic strands together to produce a fabric having a degree of resiliency, the elastic strands are generally fed to the knitting machine under a tension sufficient to stretch the elastic strands somewhat, but not to the limit of their elasticity. Thus, the elastic strands tend to hold the knitted fabric closely compacted, but the knitted fabric can be stretched somewhat because the elastic strands are not fully expanded. The degree of compactness of the resulting knitted fabric, and the amount which it can stretch, is controlled by the amount of tension placed upon the elastic strands at the time they are fed to the knitting machine. It is the feeding and stretching control of the elastic

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strands during the knitting process with which this present invention is concerned.

One particular knitted fabric which may be made by my improved method of feeding, is produced on a knitting machine having guide bars and needles which move alternately to one another; that is, the guide bars move between and around the needles. Such machines are of various makes and are constructed with needle bars comprising long bars having a plurality of needles at regularly spaced intervals therealong. These machines are characterized by guide bars which carry the thread to the needle bars. The needle bars are moved by cams and the guide bars are moved by chains or pattern wheels consisting of links of different heights which through associated mechanism controls the movement of the guide bars and causes the needles to create loops which form the knitted fabric.

Although various types of knitted fabrics may be made on this type of machine, the fabric to which I now refer comprises a plurality of columns each produced by a single strand of yarn. Although the needle bars, comprising a front and a rear needle bar, have a plurality of knitting needles, each strand of yarn is knitted on only one set of these needles. The strand of yarn is first directed to a needle on the front needle bar and knitted; it is then directed to a second needle which is on the back needle bar, and is then knitted; the strand is then directed back to the first needle on the front bar and is then knitted; the yarn is then guided to a third needle on the back knitting bar and is again knitted. This series of operations is repeated indefinitely to the desired length of the fabric being knitted. In other words, the fabric is built up of single strands which are continually looped back and forth between two lateral side limits. The strands are sharply looped at the lateral side limits to return the strands to the opposite side. These lateral side loops are interwoven in a cross-stitch with similar loops of adjacent strands in order to bind the plurality of columns into one continuous fabric. Intermediate the two lateral sides, and produced on the second needle on the front needle bar, each section of the strand, as it proceeds from on lateral side limit to the other, is interlooped with an adjacent section of the same strand in a straight stitch.

Referring now to the Figure 5 of the drawing, I illustrate diagrammatically one basic stitch of the fabric referred to and the two independent beams supplying elastic and inelastic yarns thereto. The two needles on the back needle bar

are spaced apart a predetermined distance to produce a pleasing appearance in the finished fabric. The needle on the front needle bar is of course spaced a lateral distance from the two needles on the back needle bar and is equidistance from the two back needles. The three needles used in producing the basic stitch illustrated in the Figure 5 are in a triangular relationship with the two needles on the back needle bar constituting the base of the triangle, and the one needle on the front needle bar constituting the apex of the triangle. Thus, the needles in sets of triangles are actually overlapping as indicated by the arrangement of the strands in the diagrammatic illustration of Figure 6.

The sets of three needles, as hereinbefore described, constitute a basic three needles for producing the stitch indicated in the Figure 5. This set of three needles may be considered as being repeated along the needle bars to a distance sufficient to produce the desired width of fabric. That is, although the needles on each bar appear to be in straight lines of evenly spaced needles, in their operation they function in sets of three. However, these sets of three are cooperative in their functions. That is, the two needles on the back part to which the threads are directed are also used in the next adjacent strands. For example, referring to the three separate strands of yarn 10, 11 and 12 in the Figure 5, as the strand 10 is directed to the first needle on the back needle bar, it produces a column indicated by the arrow and the reference character 13. As the strand 10 is then directed to the needle on the front needle bar to produce a stitch indicated by the arrow and the reference character 14, the strand 12 is directed to the needle producing the column 13. Thus, the strand 12 and the strand 10 are knitted as indicated in the column 13. The same operation is carried out between the strand 11 and the strand 10 and is indicated by the arrow and the reference character 15. It is to be noted, then, that the columns 13 and 15 are produced by cross stitching adjacent strands together, whereas the column 14 is produced by interlacing adjacent portions of the same strand together. The complete fabric consists simply of two of the fundamental stitches thus far described intermeshed together.

In producing the complete fabric, a third needle is employed on the back needle bar intermediate the needles producing the columns 13 and 15. This needle produces the column 16. Also two additional needles are employed on the front needle bar on either side of the needles producing the column 14, and these needles produce respectively the columns indicated by the arrow and reference character 17 and the column indicated by the arrow and the reference character 18. Thus the needles and sets of triangles are actually overlapping as indicated by the arrangement of the strands in the illustration. This complete fabric amounts to two of the fundamental stitches intermeshed together to form a complete fabric. The strands producing the column 17 is indicated by the reference character 20 and the strand producing the column 18 is indicated by the reference character 21. The strands 20 and 21 are cross stitched to produce the column 16 in exactly the same manner hereinbefore described to produce the column 13 by cross stitching the strands 10 and 12, or the column 15 by cross stitching the strands 10 and 11.

In this type of fabric, a strand of elastic material 22 is directed to one of the needles on the back needle bar forming the cross stitches. That is, whereas the strand 10, for example, is directed to three different needles including the needles forming the column 13 and the needle forming the column 15, the elastic strand is guided to one of these needles only. For example, the elastic strand 22 is guided to the needle forming the columns of cross stitches 13 and 15. Thus, the elastic strands 22 are chain stitched along with cross stitches of the columns 13 and 15.

Referring again to the diagrammatic Figure 6, the relationship of the various strands and stitches is illustrated as they would appear in an end view. The strands are indicated by the reference characters 10, 11 and 12, and the reference characters 20 and 21. The flat portions adjacent the reference characters 14, 17 and 18 on the strands 10, 20 and 21, for example, are the straight stitch area. The concentric circles adjacent the reference characters 13, 15 and 16 indicate the cross stitches between adjacent strands, and the solid inner dot within alternate concentric circles represents the elastic strand 22.

It will be readily apparent from the illustration, that the elastic strand 22 will draw the cross stitches of the columns 13 and 15 tightly together, but this affect on the stitches of the column will not materially affect the stitches of the columns 14, 17 or 18 on the face side of the cloth because of the relatively long strands leading between the column on the face side and those on the rear side. Therefore, when completely relaxed, the columns 13 and 15 will be closely compacted because of the affect on the elastic strand 22 but the face column will not be substantially affected.

In actual practice, for sweater bands and like applications, the elastic material is directed to every alternate column on the rear side of the fabric rather than to every column, because the desirable elastic condition of the fabric is sufficiently brought about by applying elastic strands only to every cross-stitch column. In other words, if the elastic strand 22 were applied to every rear column of cross stitches, the fabric would be too strong in its elastic characteristics for most uses.

The character of the fabric, and the satisfaction it affords to the user, is determined quite largely by the degree of tension applied to the elastic strand 22 when the elastic strand 22 is interwoven into the fabric. If the tension applied to the elastic strand 22 is too great, the amount which the fabric will be able to expand without breaking the elastic strand is unduly limited. On the other hand, if the elastic strand 22 is not stretched a sufficient amount as it is interwoven in the fabric, the desired elastic nature of the fabric will not be accomplished. Further, it is extremely desirable that the elastic strand 22 be evenly stretched throughout the entire fabric in order to avoid spotty effects which produce lumping of the fabric. It is this problem to which the present invention is specifically directed.

Generally, in preparing yarns both elastic and inelastic for use with the knitting machine described, the yarns are fed from spools 25 and wound upon a reel 26. In the Figure 1 of the drawing, I illustrate diagrammatically the winding of the inelastic yarn from the spools 25 to a reel 26. In winding inelastic yarn of this nature, the yarn may be held tight by any suitable method, such, for example as by looping around one or more snubbing pegs 27 and through a guide bar 28 to the reel 26. The reel 26 is power

driven and pulls the strands from the spools **25**. Thus, the yarn is tightly wrapped about the reel **26**.

In the Figure 2 of the drawing, I illustrate the preferred method of winding the elastic yarn about a reel **31**. In the practice of my invention, the elastic strand is placed under tension as it is wound about the reel **31**, in order to stretch the elastic strands as far as they can be safely stretched without approaching too closely to the breaking point. This tension may be applied by any suitable means either mechanical or manual, and is illustrated in the Figure 2 by the snubbing device **29**. Thus, the strands may be stretched to the desired limit as they are wound about the reel **31**. It is not absolutely essential that the strands be stretched to 100 per cent of their elastic limit but they should be stretched reasonably close thereto.

The next step employed in my process is to wind the strands of elastic and inelastic yarn from the reels as described, to a beam. The Figures 3 and 4 of the drawing illustrate, respectively, the winding of a beam for the inelastic and elastic strand. In the Figure 3, a beam **30** is power driven and pulls the strands from the reel **26**. A force resisting rotation, such for example as a braking device, is applied to the reel **26** and therefore the strands are tightly wound around the beam **30**.

The Figure 4 as before stated, illustrates the winding of the elastic strands from the reel **31** to a beam **32**. The operation of winding the elastic strands upon a beam is quite similar to that employed in winding the inelastic strands upon the beam **30**, but I have found that the force resisting rotation which is applied to the reel **31** must be sufficiently great to keep the elastic strands tight, and therefore places considerable strain upon the elastic strands. In order to release the strain upon the elastic strands, I wrap a plurality of dummy inelastic strands upon the reel **31** as the elastic strands are wound thereon. Thereafter, during the wrapping of the beam **32** from the reel **31**, the dummy inelastic strands are wound upon the beam **32** also. The inelastic strands therefore relieve some of the strain from the elastic strands and permit a much more rapid beaming operation than would be possible if the wrapping were done slow enough to carry on the operation without the dummy inelastic strands. These scrap inelastic strands merely fall to the floor from the beam **32** as the elastic strands are fed from the beam **32** to the knitting machine, and therefore do not interfere with the knitting process. However, the use of the inelastic strands is not essential and may be disposed of if the wrapping of the beam **32** from the reel **31** is carried on with care.

When feeding the strands of inelastic yarn from the beam **30** and the strands of elastic yarn from the beam **32** to the knitting machine, the beams **30** and **32** are mounted conveniently with reference to the needles of the knitting machine in order that the strands might be fed from the beam to the machine. The rate of rotation of the beams **30** and **32** is controlled by a force upon the respective beams resisting rotation, such as a suitable braking device as indicated diagrammatically at the reference character **35**. The beams therefore supply the strands as required by the machine. The resistance to rotation applied to the beam **30** carrying the inelastic strands, is just sufficient to keep the strands at the desired

tension and feed a sufficient linear footage of the inelastic strands to the machine as required by the knitting rate of the machine. On the other hand, the resistance to rotation applied to the beam **32** carrying the elastic strands is a predetermined amount less than required to keep full tension upon the beam, and therefore the beam will allow the elastic strands, as measured in their stretched condition, to feed to the knitting machine at a linear rate faster than that required by the knitting machine. Thus, I have provided a means of supplying the elastic strands to the knitting machine under a ratio of tension relative to the inelastic strands which may be accurately controlled to provide exactly the degree of elasticity desired in the finished fabric. Further, if inspection of the knitted fabric as it comes from the machine reveals that the tension should be greater or less upon the elastic yarn, the force resisting rotation of the beam carrying the elastic yarn may be increased or decreased to accurately control the tension of the strand **22**. For example, when the elastic strand is stretched substantially to the elastic limit thereof upon the beam **32**, if the beam **32** is permitted to rotate and feed twice the linear footage of the elastic strand **22**, as measured in its stretched condition, as normally required to supply the machine, half the tension will be removed from the elastic strand **22** in the finished fabric. If the beam is permitted to rotate at just a sufficient speed to feed the linear footage of the stretched elastic strands required to supply the machine, the elastic strands will be stretched to their elastic limit in the finished cloth. Thus, a very even and accurate control of the tension of the elastic yarn as it is fed into the knitting machine, is very easily provided by my improved method of winding the elastic and inelastic yarns upon separate beams, stretching the elastic strands to the limit of their elasticity upon the beam **32**, and thereafter controlling the ratio of feeding speed of the beams **30** and **32** relative to one another.

My improved method of substantially fully stretching the elastic strands upon the beam **32** provides a positive control over the amount of elasticity of the elastic strands in that a positive and ascertainable starting point is provided by substantially fully stretching the elastic strands. This control may be exemplified by an instance wherein the elastic strands are stretched to substantially 90 per cent of their elasticity. Thereafter, as the beam **32** feeds the knitting machine, the elastic strands are allowed to feed at such a linear rate that they may contract substantially 30 per cent of their length, thereby leaving a **60** per cent stretch in the elastic strands.

To illustrate further, an elastic strand may be placed under a slight tension. The strand will pull against the means holding it with a force equal to the tension. If the means holding the strand will resist only a predetermined force, and will then move, then obviously it will be impossible to stretch the strand beyond the tension needed to produce the predetermined force. On the other hand, if the means holding the strand is fixed and the strand is stretched, then the strand may be stretched to its elastic limit, or in other words a maximum force may be exerted on the strand. Thereafter, if the means holding the strand be released to move with a predetermined force, the means will move until the tension of the strand is relaxed to that predetermined force. The holding means will then cease to move and the tension will remain at that predetermined

value. Now, therefore, if the elastic strand is wound upon a spool, or the beam of a knitting machine, and the spool mounted upon a bearing, the resistance which the bearing makes to rotation of the spool will determine the force required to rotate the spool. That is, if the elastic strand is wrapped upon the spool in an unstretched condition and the strand pulled from the spool, the strand will stretch between the spool and the means producing the stretching force to an amount which will produce a tension equal to the force resisting rotation. Therefore, the amount that the strand may be stretched may be determined by controlling the force resisting rotation of the spool. In other words, the strand is fed off of the spool; changes in linear length by stretching to the length sufficient to produce the tension necessary to rotate the spool against the resistance to rotation, and is then fed to the means producing the force.

The converse situation follows readily from this explanation. That is, if the elastic strand is stretched to a predetermined amount, even to its elastic limit, and wound upon the spool, then the strand will be fed off of the spool; will change by contracting in linear length by elastic action to the length which will produce just the tension required to rotate the spool; and will be fed to the means producing the tension. In other words, in the example wherein the elastic strand is tightly stretched upon the spool, the strand will contract and be under a lower tension after leaving the spool. The tension on the strand after leaving the spool is therefore controlled by the resistance to rotation placed upon the spool or beam holding the elastic strands. This is true whether the strand is placed upon the beam in an unstretched or a stretched condition.

An alternate method of controlling the degree of tension upon the elastic strand **22**, I have found, comprises the steps of winding the elastic strand **22** upon the beam **32** with only sufficient tension to hold the elastic strands conveniently upon the beam **32**. That is, the elastic strands are wound upon the reel **31** from the spool **25** very much in the same manner as described in connection with the full stretching method, but the amount of tension applied to the elastic strands is only sufficient to keep the elastic strand snug about the reel **31**. Thereafter, as the elastic strands are wrapped from the reel **31** upon the beam **32**, the degree of tension is again maintained to merely hold the elastic strands snug about the beam **32**.

In this alternate method of controlling the degree of tension upon the elastic strand **22**, the beam is placed in position relative to the machine the same as the beam is placed when the elastic strands are fully stretched. However, the force resisting rotation on the beams carrying the elastic strands to the knitting machine is set to permit the beam to rotate a slow rate in order that the knitting machine is required to stretch the elastic strands as the knitting progresses. That is, the linear footage of the elastic strand allowed to feed from the beam in this unstretched condition is less than that required by the knitting machine. Thus, because the knitting machine requires a greater linear footage of the elastic strand than supplied from the beam, the elastic strands are stretched and thus are placed under a degree of tension. Thus, the ratio of tension between the elastic and inelastic strands may be very accurately controlled by controlling the rate of rotation of the beam carrying the inelastic strand relative to the rate of rotation of the beam carrying the inelastic strand. As an example, the elastic strands may be stretched substantially 10 per cent of their ability to stretch as they are wound snugly upon the beam, and by preventing the beam from rotating freely, the elastic strands may be stretched, say 50 per cent more. Thus, the strands may be stretched 60 per cent as they are knitted into the final fabric.

Although I have described my invention in its preferred form with a certain degree of particularity, it is understood that the present disclosure of the preferred form has been made only by way of example and that numerous changes in the details of construction and the combination and arrangement of parts may be resorted to without departing from the spirit and the scope of the invention as hereinafter claimed.

What is claimed is:

1. The process of producing a knitted fabric from a combination of elastic and inelastic yarns, comprising the steps of winding the inelastic yarn upon a first beam, winding the elastic yarn upon a second beam with a degree of stretching, positioning the wound first and second beams in position to unwind the yarns therefrom to a knitting machine, pulling the yarn from the first beam by operation of the knitting instrumentalities, controlling the removal of the inelastic yarn from the first beam by means resisting rotation of the first beam with sufficient resistance to keep the inelastic yarn to a predetermined degree of tautness and allow the yarn to unwind at a predetermined rate substantially equal to the requirements of the knitting machine, pulling the yarn from the second beam by operation of the knitting instrumentalities, said elastic yarn being in a stretched condition at least between said knitting instrumentalities and said second beam and thereby exerting a rotative force on said second beam to rotate said second beam and unwind the elastic yarn therefrom, and controlling the rate of rotation of said second beam to cause the degree of stretch of the elastic yarn to change between the second beam and the knitting instrumentalities with respect to the degree of stretching of the elastic yarn on said second beam.

2. The process of producing a knitted fabric from a combination of elastic and inelastic yarn, comprising the steps of winding the inelastic yarn upon a first beam, winding the elastic yarn upon a second beam under a tension substantially approaching the elastic limit of the elastic yarn, positioning the wound first and second beams in position to unwind the yarn therefrom to a knitting machine, pulling the yarn from the first beam by operation of the knitting instrumentalities, controlling the removal of the inelastic yarn from the first beam by means resisting rotation of the first beam with sufficient resistance to keep the inelastic yarn to a predetermined degree of tautness and allow the yarn to unwind at a predetermined rate substantially equal to the requirements of the knitting machine, pulling the yarn from the second beam by operation of the knitting instrumentalities, said elastic yarn producing a pulling force between said knitting instrumentalities and said second beam and thereby exerting a rotative force on said second beam to rotate said second beam and unwind the elastic yarn therefrom, and controlling the rate of rotation of said second beam to cause the elastic yarn to relax between the second beam and the knitting instrumentalities to a degree of tautness less than substantially the elastic limit thereof.

3. The process of producing a knitted fabric from a combination of elastic and inelastic yarns, comprising the steps of winding the inelastic yarn upon a first beam, winding the elastic yarn upon a second beam with a degree of stretching, positioning the wound first and second beams in position to unwind the yarns therefrom to a knitting machine, pulling the yarn from the first beam by operation of the knitting instrumentalities, controlling the removal of the inelastic yarn from the first beam by means resisting rotation of the first beam with sufficient resistance to keep the inelastic yarn to a predetermined degree of tautness and allow the yarn to unwind at a predetermined rate substantially equal to the requirements of the knitting machine, pulling the yarn from the second beam by operation of the knitting instrumentalities, said elastic yarn being stretched at least between said knitting instrumentalities and said second beam by said pulling by the knitting instrumentalities and thereby exerting a rotative force on said second beam to rotate said second beam and unwind the elastic yarn therefrom, and controlling the rate of rotation of said second beam to control the degree of stretch of the elastic yarn between the second beam and the knitting instrumentalities.

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