United States Patent [19]

Blood et al.

[11] **3,729,955**

[45] **May 1, 1973**

[54] STRAIGHT BAR KNITTING MACHINES

[75] Inventors: **Raymond Blood,** Shepshed; **Colin Barry Strong,** Syston; **Alan John Pearson,** Loughborough, all of England

[73] Assignee: **William Cotton Limited,** Loughborough, England

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[21] Appl. No.: **26,028**

[30] **Foreign Application Priority Data**

Apr. 16,1969 Great Britain.....19,387/69

[52] **U.S. Cl.**.....**66/89,** 66/88

[51] **Int. Cl.**.....**D04b 11/06**

[58] **Field of Search**.....66/89, 88

[56] **References Cited**

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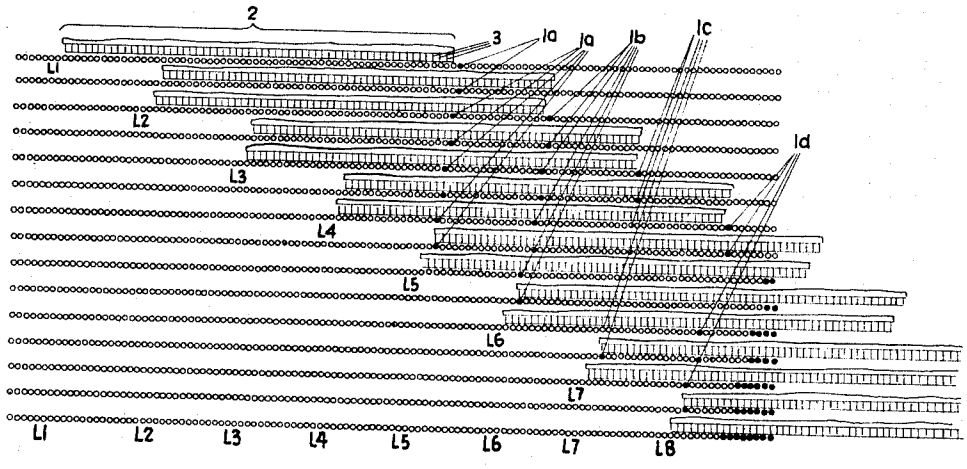
Primary Examiner—Ronald Feldbaum

Attorney—Larson, Taylor & Hinds

[57] **ABSTRACT**

Straight bar knitting machine method and means of loop doubling in the last course of rib fabric to be followed by knitting non-rib fabric onto the rib fabric, by the use of controlled fashioning mechanism using two wide point bars with means providing for single and plural inward needle loop transfer motions of the point bars, plural needle outward re-set motions of the point bars including adjustable ratchet control means, and single and plural selvedge stop inward motions, under control of a punched chart programming means, including fashions counting means, which is pre-arranged with reference to available information, so that loop doublings at any required frequencies can be formed automatically.

7 Claims, 27 Drawing Figures



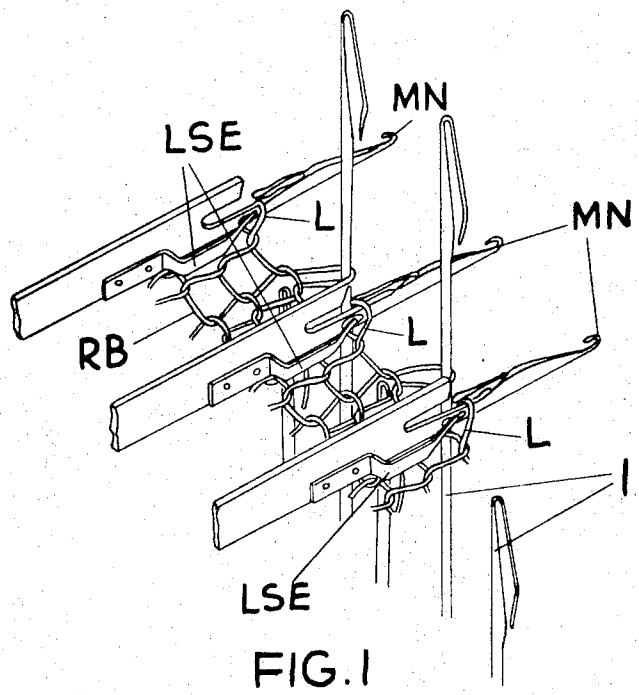


FIG. 1

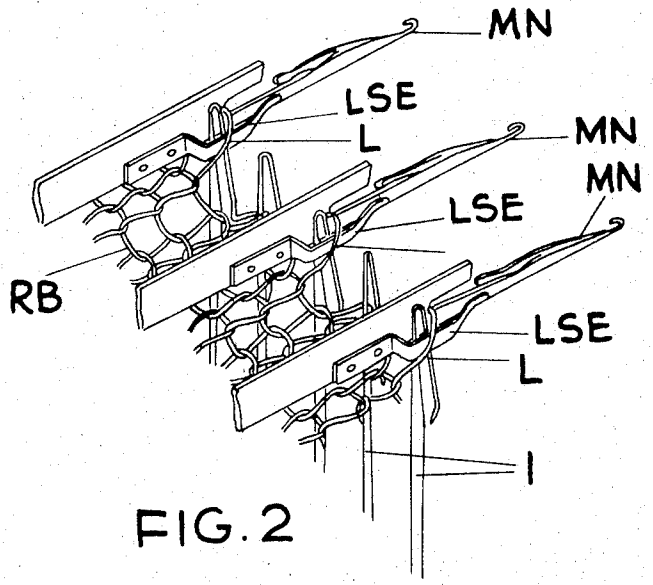
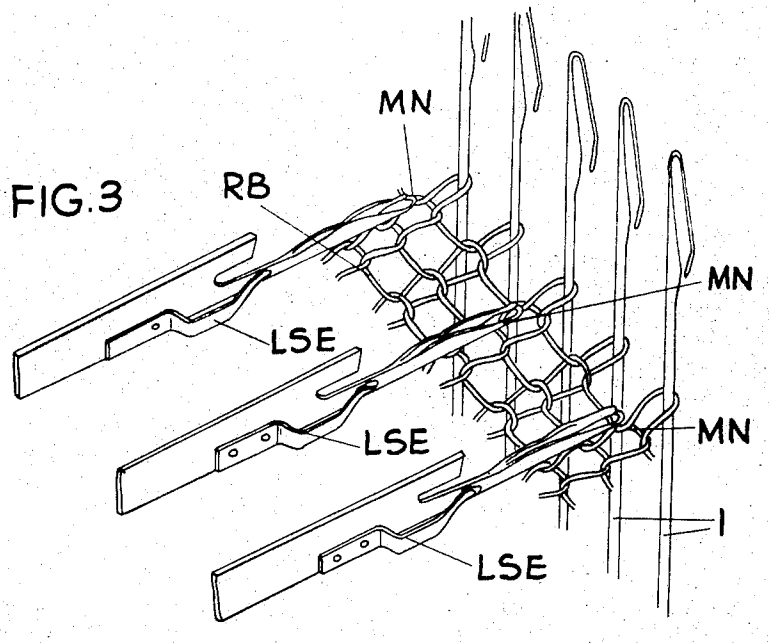


FIG. 2

FIG.3



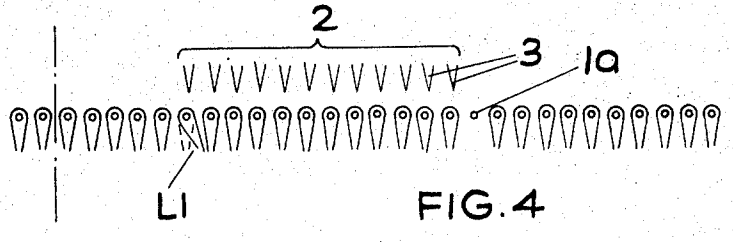


FIG.4

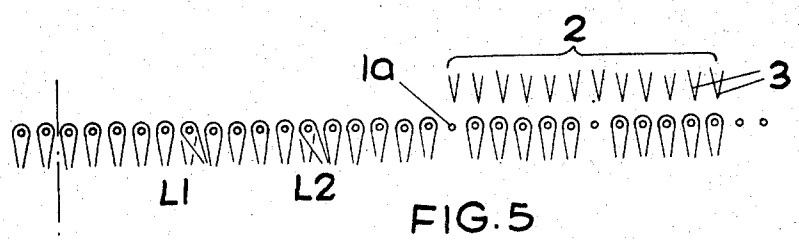


FIG.5

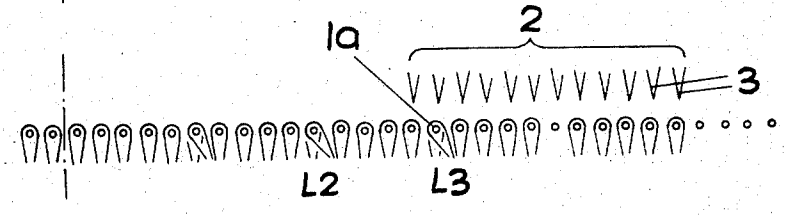


FIG.6.

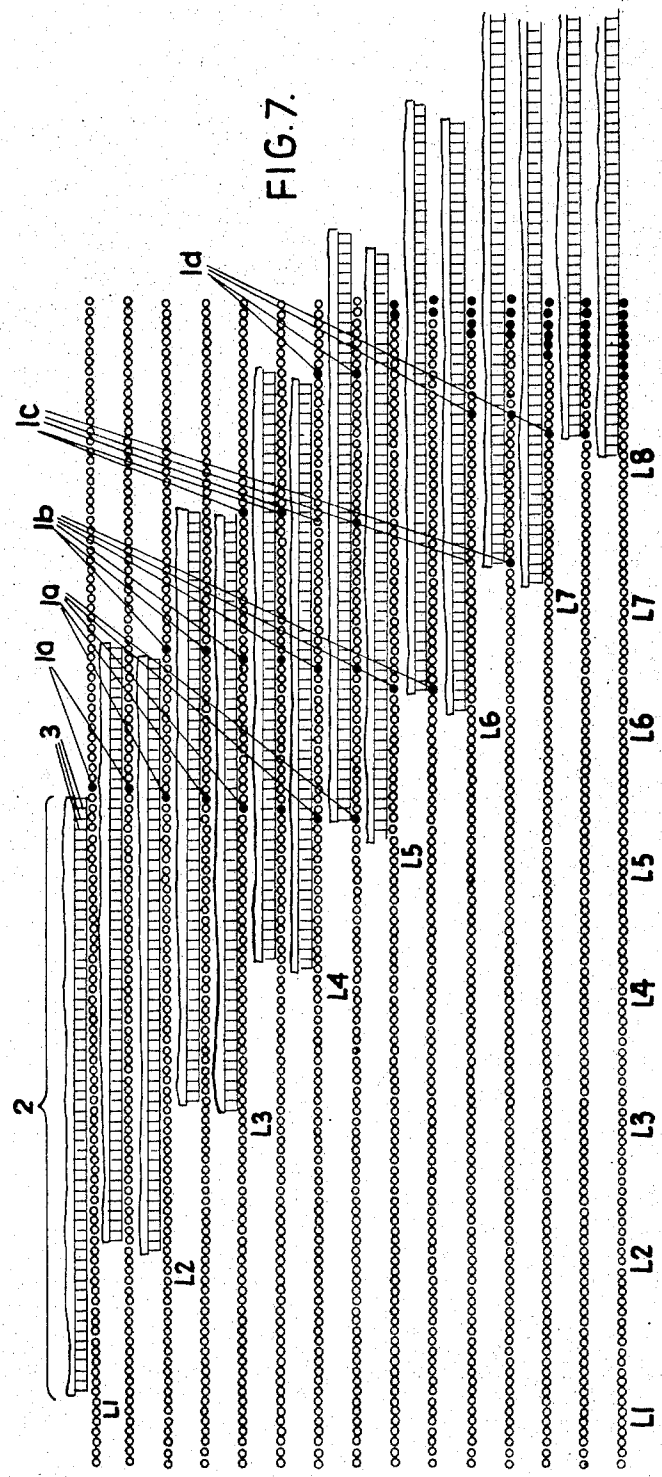


FIG. 7.

FIG.8

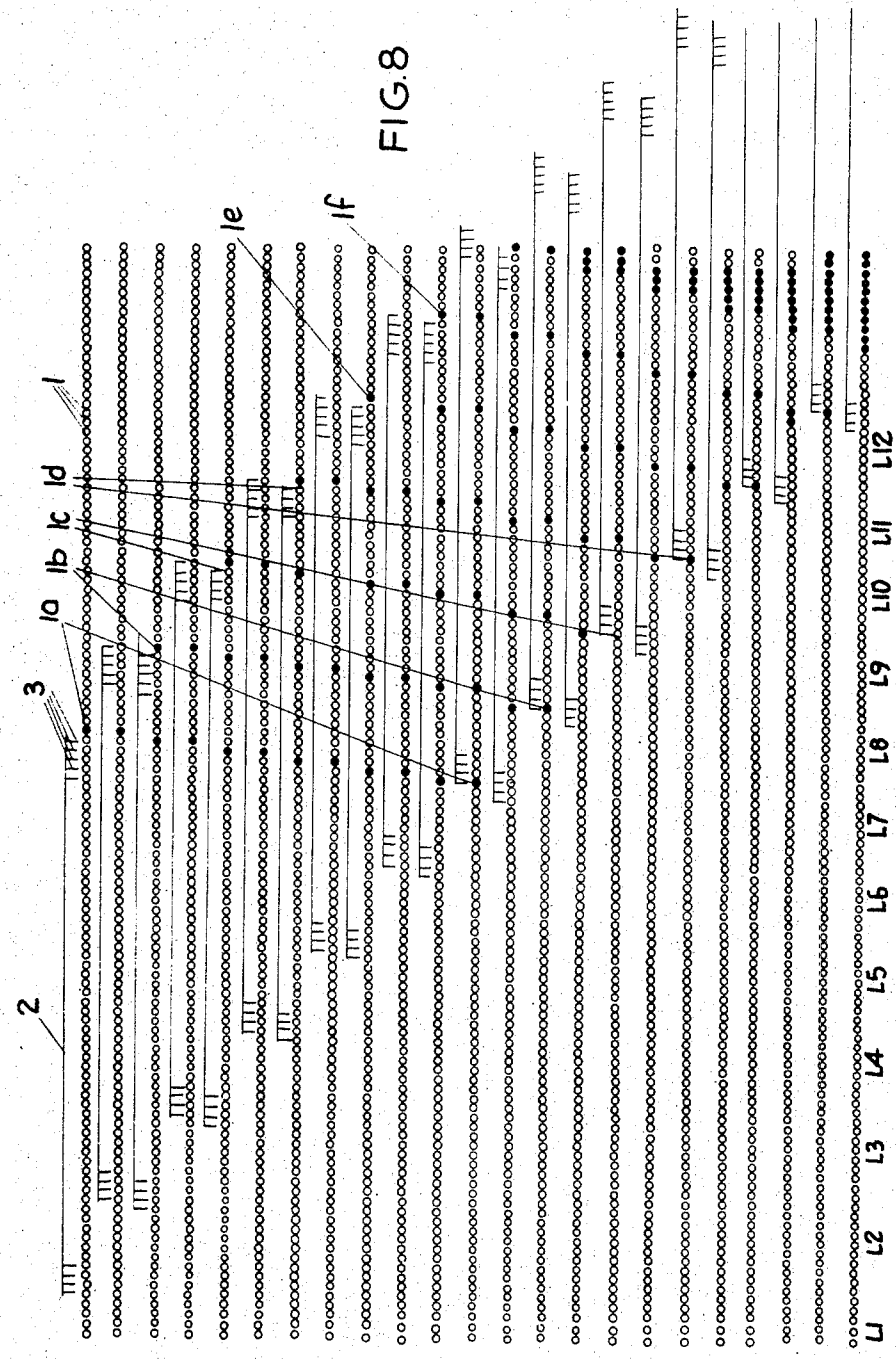
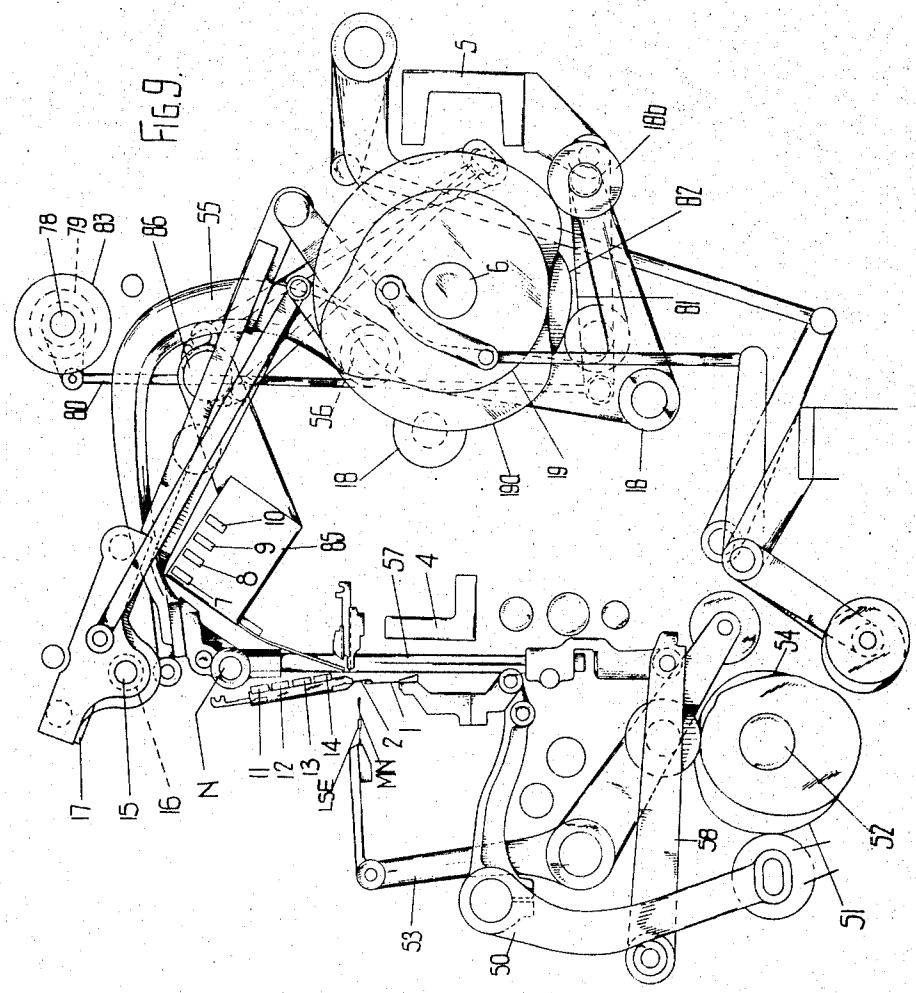


FIG. 9.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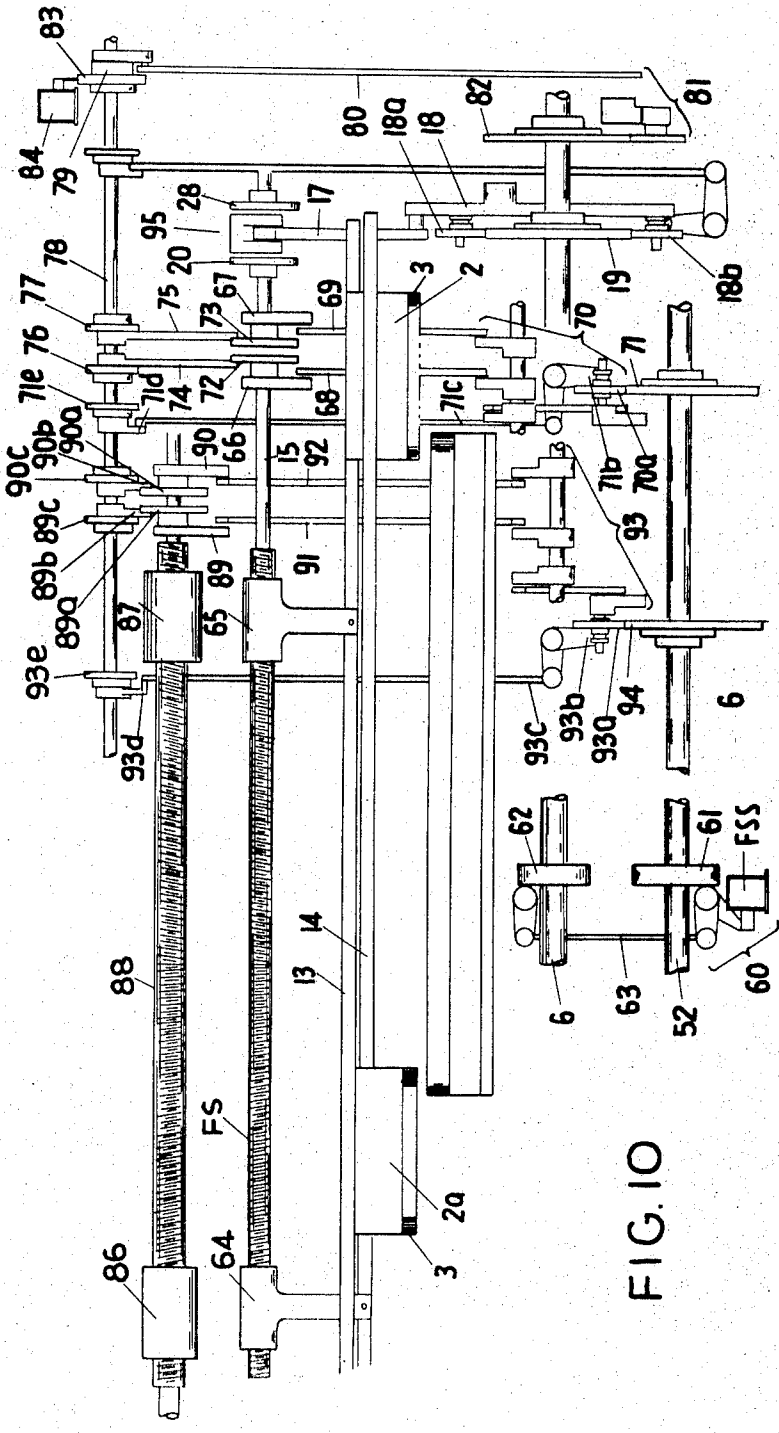
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71c
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90c
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89c
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FIG. 10

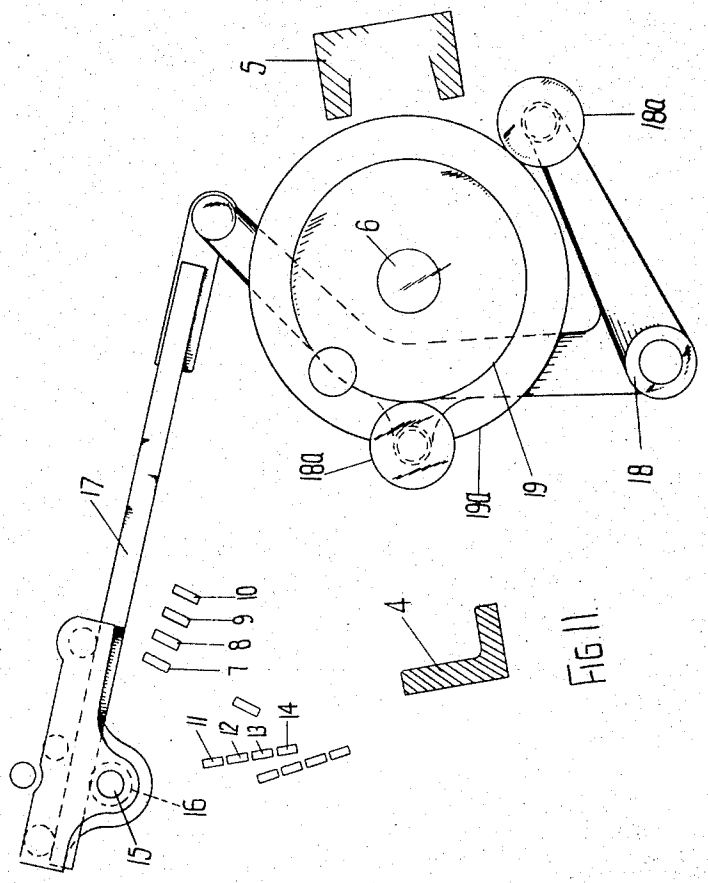

FIG 11

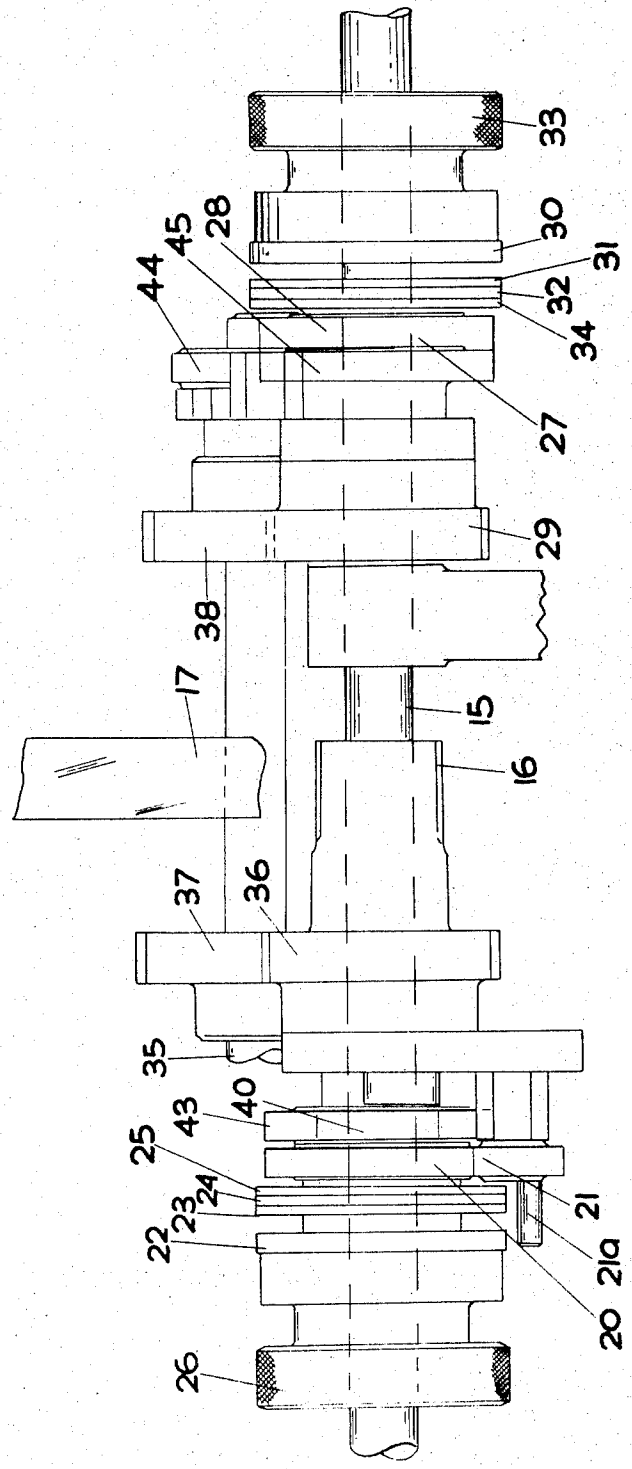
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FIG. 12

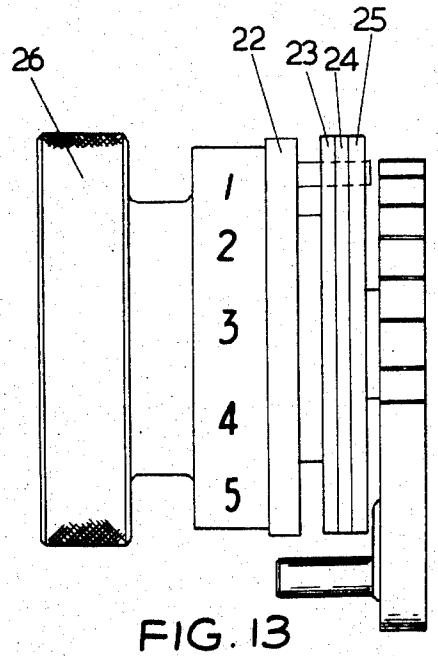

FIG. 13

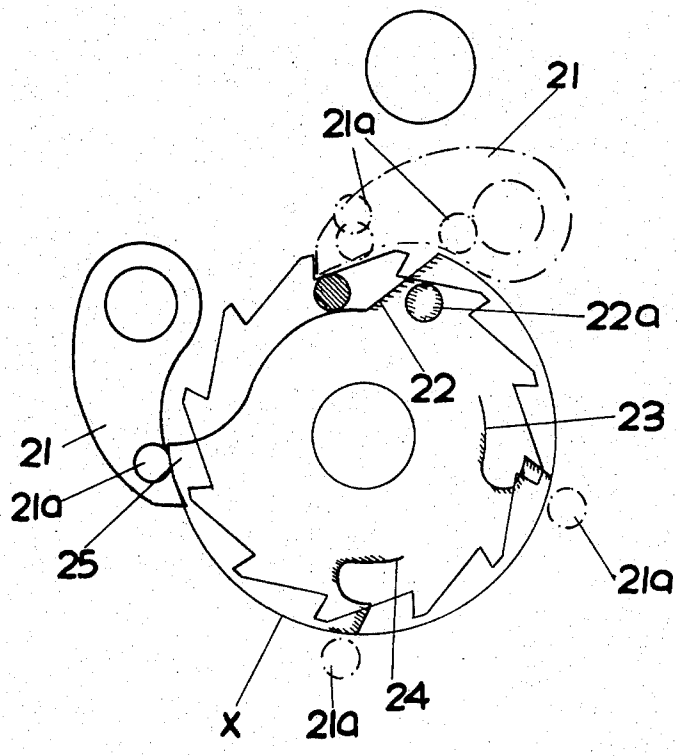

FIG. 14.

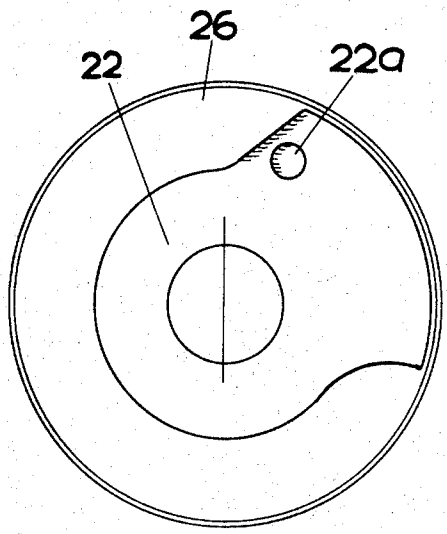

FIG. 15

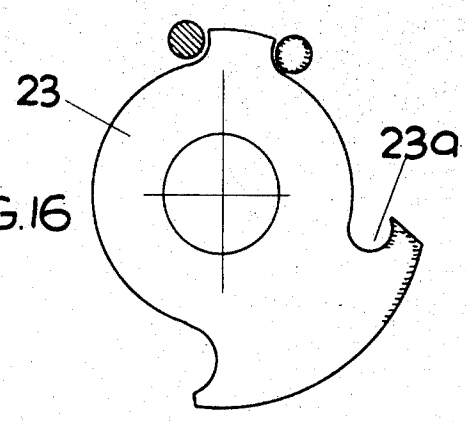

FIG. 16

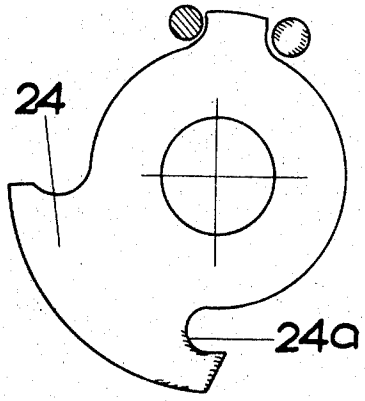

FIG. 17.

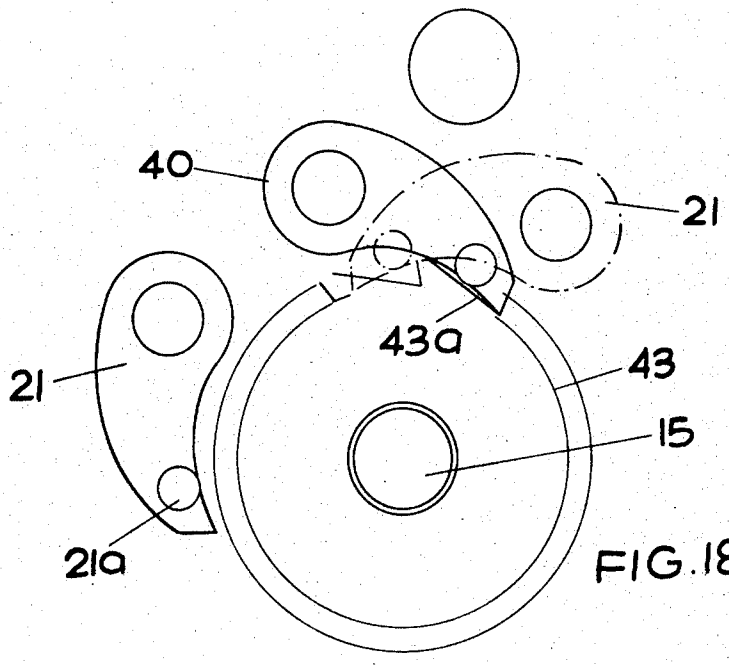

FIG. 18

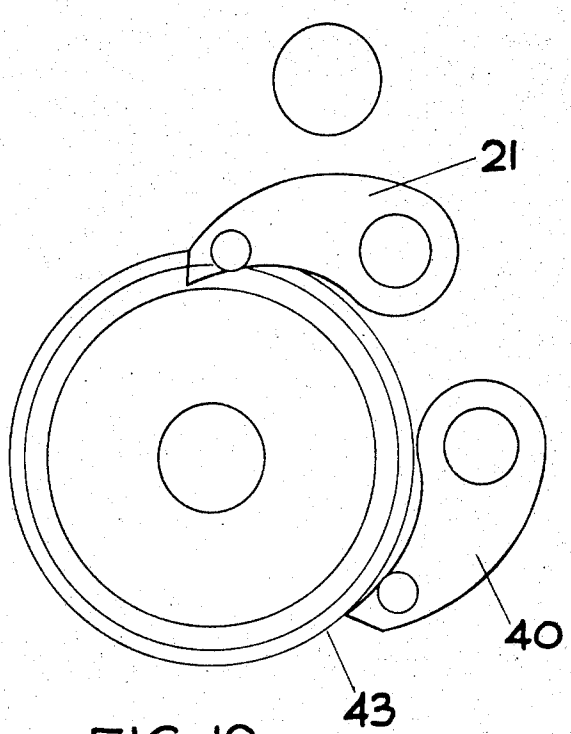

FIG. 19

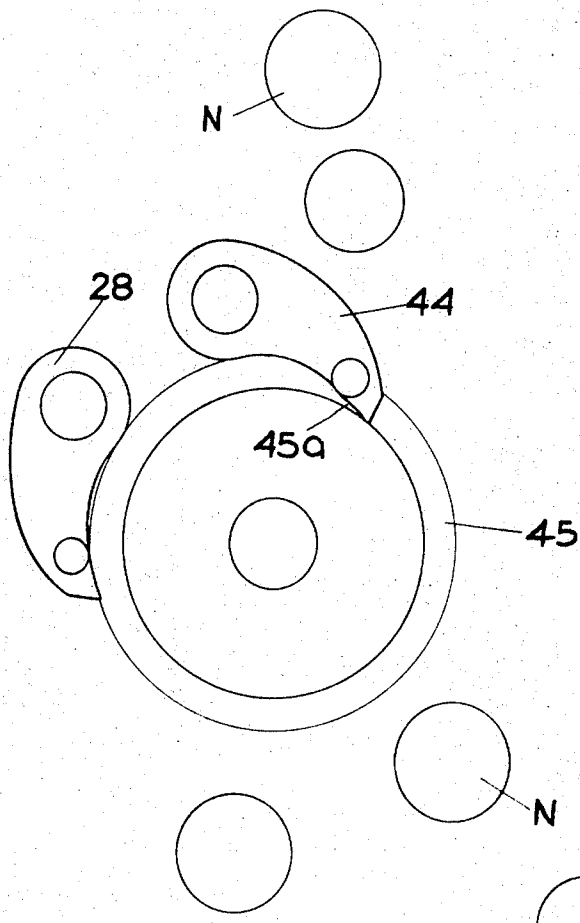

FIG. 20

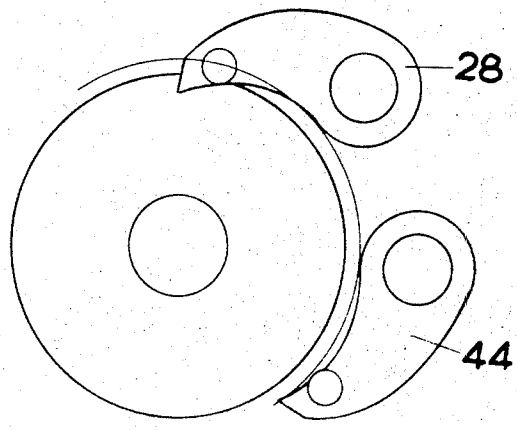

FIG. 21

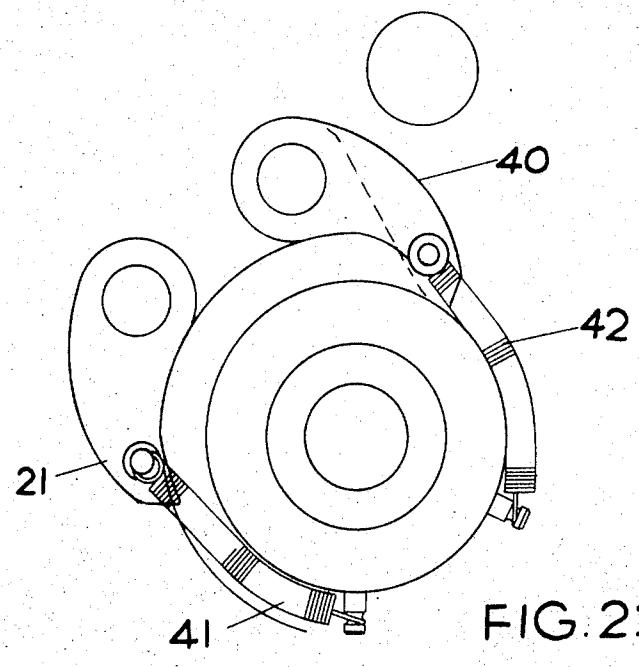

FIG. 22

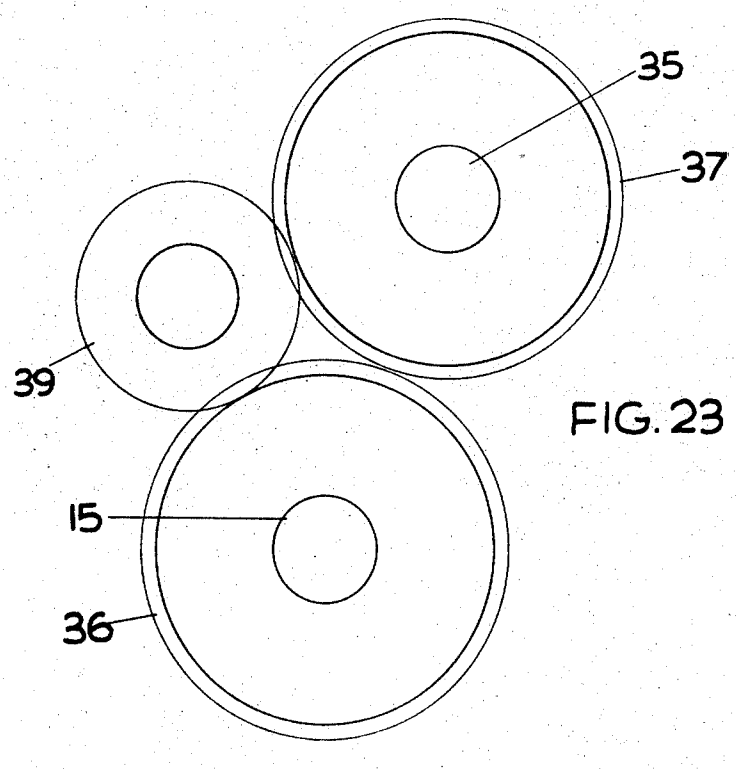

FIG. 23

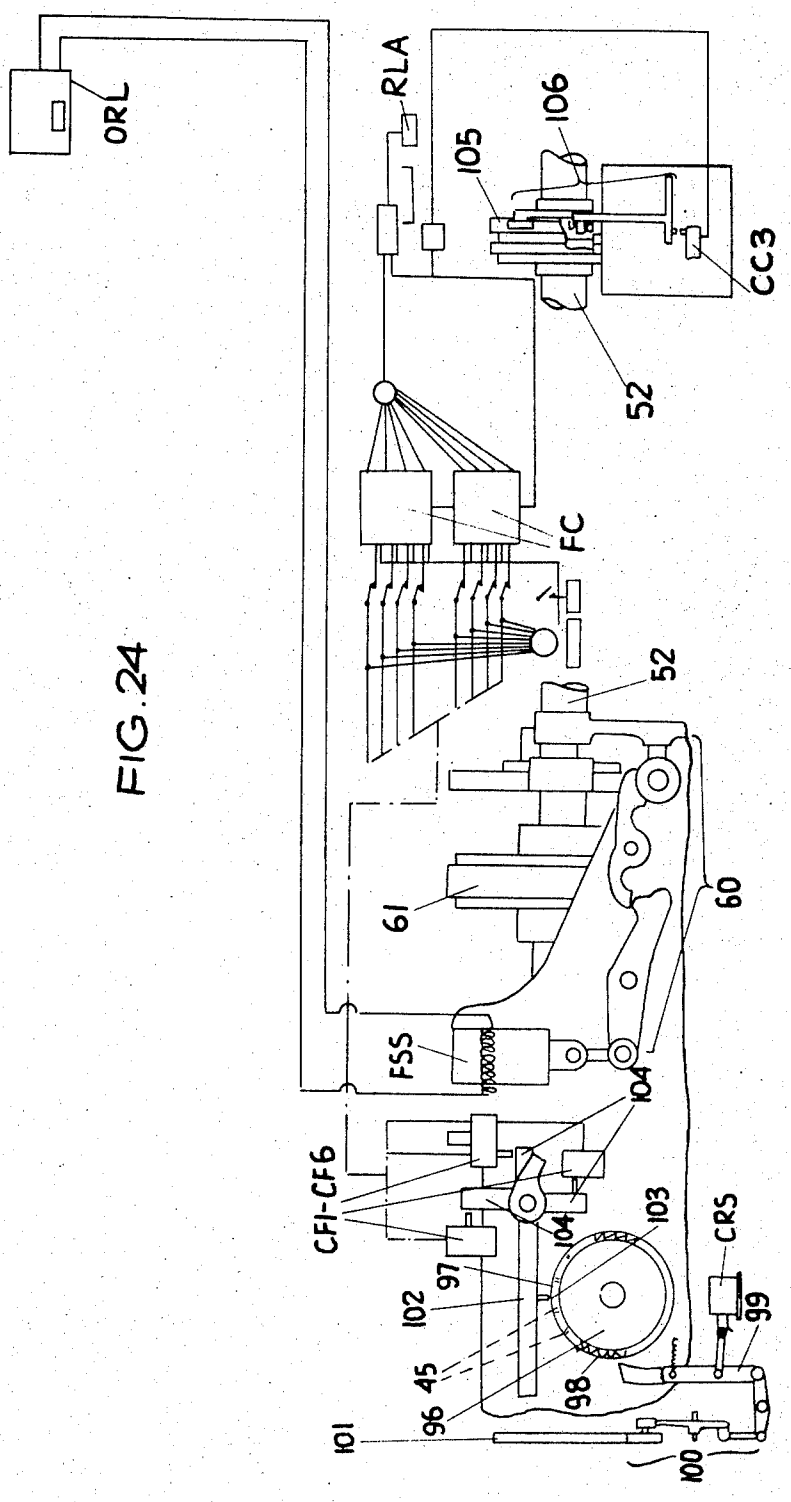
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FIG. 24

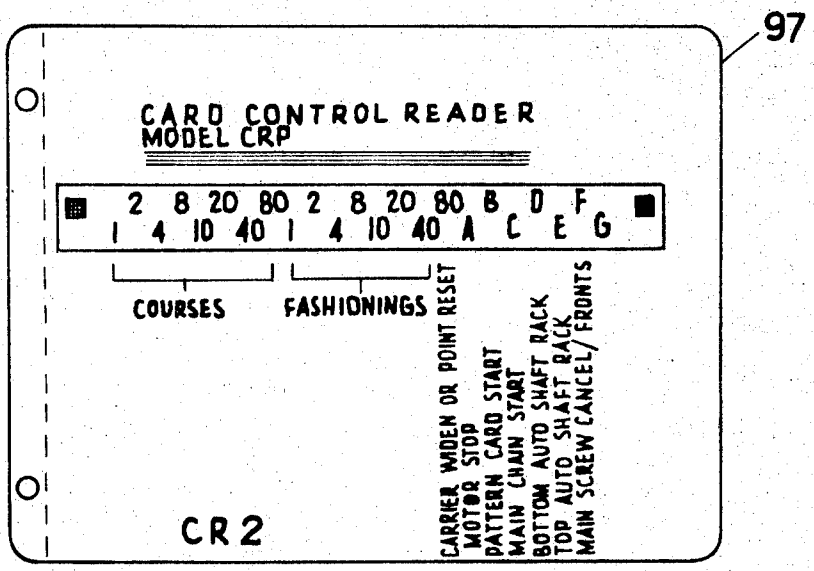
97
CARD CONTROL READER
MODEL CRP
2 8 20 80 2 8 20 80 B D F
1 4 10 40 1 4 10 40 A C E G
COURSES
FASHIONINGS
CARRIER WHEN OR POINT RESET
MOTOR STOP
PATTERN CARD START
MAIN CHAIN START
BOTTOM AUTO SHAFT RACK
TOP AUTO SHAFT RACK
MAIN SCREW CANCEL/FRONTS
CR 2

FIG. 25

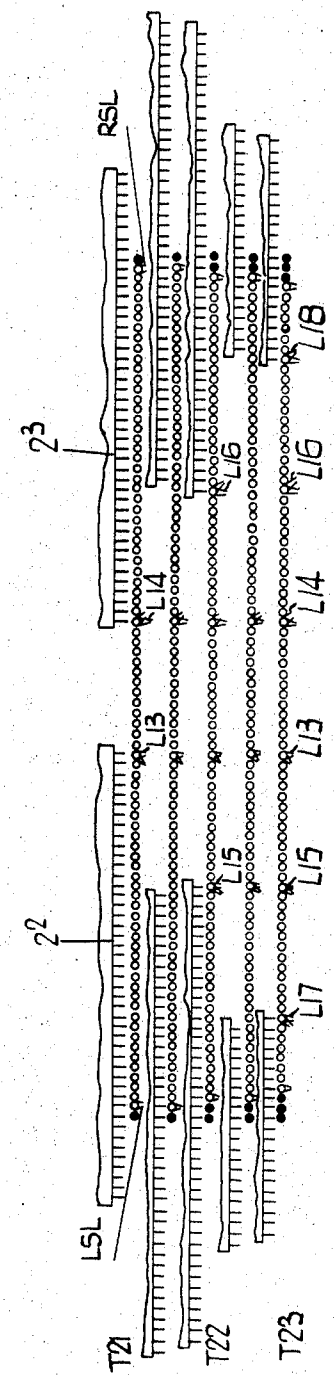

FIG. 25.

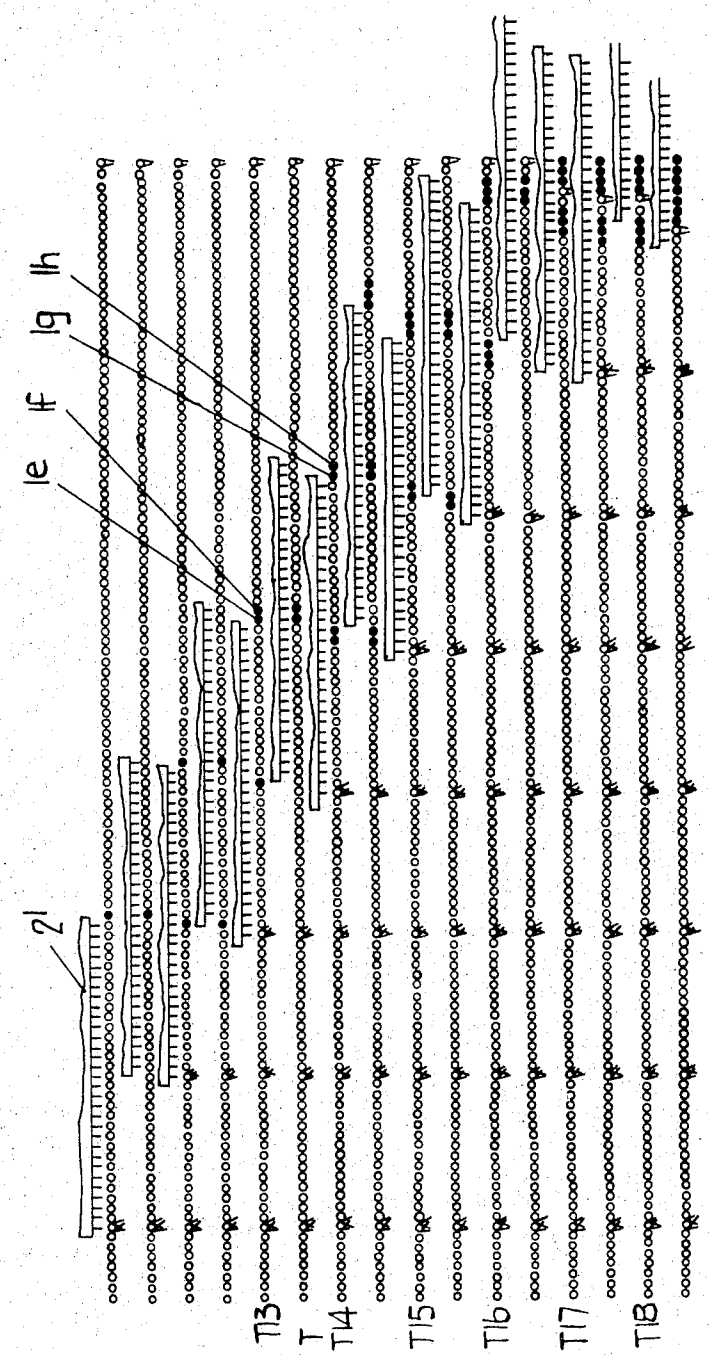

FIG. 27.

STRAIGHT BAR KNITTING MACHINES

CROSS REFERENCES TO RELATED APPLICATIONS

Reference is made to British Pat. application No. 19387/69 of Apr. 16, 1969, William Cotton Limited, from which priority is claimed.

This invention is for improvements relating to the production of rib fabric in straight bar knitting machines, and is concerned with the production of knitted blanks for which the knitting of rib fabric, as for a rib border for a knitted garment, is to be followed by non-rib fabric being knitted onto the rib fabric. It is usual for the rib fabric to have a greater number of wales than the non-rib fabric, and therefore it is usual for the last course of rib fabric to be subjected to an operation known as loop doubling in which, at each of a multiplicity of predetermined substantially equally spaced positions in the length of the course, a loop is doubled with the next adjacent loop, the frequency of the loop doubling along the course being governed by the difference in the number of wales in the rib and non-rib fabric and by customers requirements.

Prior proposals have been made for effecting the loop doubling by automatic means in different instances (a) before the rib fabric is removed from a rib knitting machine to be transferred to a plain knitting machine, or (b) after the rib fabric has been removed from the rib knitting machine and before it is transferred to a plain knitting machine, or (c) after the rib fabric has been produced on a modified machine capable of knitting rib and non-rib fabric and before non-rib fabric is knitted onto the rib fabric in the same modified machine.

Certain of these prior proposals have been of somewhat complex nature such as to be undesirably costly. In another prior proposal for using wide bars of fashioning points in a straight bar knitting machine, loop doublings can be formed equally spaced in a course but only throughout a course length having the same number of loops as there are points in the wide bars of fashioning points. Therefore either the length of the course is limited by the width of the bar of points, or loop doublings can be formed only in a part length of a course. The width of the point bar is limited by space available between knitting heads which it is not desirable to increase.

An object of the invention is to provide for loop doubling in such improved manner as not to be undesirably costly and yet enabling loop doubling to be effecting at any required frequency throughout the length of a last rib course of any possible length.

The invention provides a method of producing by a knitting machine, rib fabric having spaced loop doublings in its last-formed course to prepare it for non-rib fabric to be knitted onto the rib fabric, which method includes forming the loop doublings by operating a pair of adjacent loop transfer point bars with single-needle type inward transfer motions alternating with plural-needle type outward re-set motions, changing when required the single-needle type transfer motions of the point bars to plural-needle type transfer motions, imparting to selvedge stops when required single-needle type and plural-needle type inward adjustments, and setting up control means for controlling the operations of the point bars with reference to available

information of at least different course lengths in terms of numbers of loops, different numbers of points in the point bars, different needle spacings between the point bars in their adjacent position, and different loop doubling frequencies, so that different arrangements of loop doublings can be formed to suit different requirements. The method may include using the point bars each with a number of points equal to or greater than half the total mumber of loops in the course, forming the loop doublings by only the single-needle type transfer motions of the point bars, and imparting to the selvedge stops only the single-needle type adjustments. The method may alternatively include using the point bars each with a number of points less than half the total number of loops in the course, forming a first fractional number of the loop doublings, including forming holes spaced from the loop doublings, by only the single-needle type transfer motions of the point bars, forming a second number of the loop doublings, including filling up the holes, by only plural-needle type transfer motions, and imparting to the selvedge stops the single-needle type adjustments when required and the plural-needle type adjustments when required. If and when required, the plural-needle type transfer motions and selvedge stop adjustments are of two-needle type, and a third number of the loop doublings, including filling up the holes, is formed by three-needle type transfer motions and selvedge stop adjustments. The method may include re-adjusting the selvedge stops for selvedge fashioning, the re-adjustment being made with reference to available information of the number of points remaining in registry with selvedge groups of needles at the end of forming the loop doublings. Conveniently the available information is in the form of numerical charts the details of which have been obtained by use of formulae. In one arrangement the method includes setting up the control means to provide for a number of single-needle transfer motions without selvedge stop adjustments, a number of the single-needle type transfer motions with single-needle type selvedge stop adjustments, a number of two-or-more-needle type transfer motions with two-or-more-needle type selvedge stop adjustments, and a two-or-more needle type transfer motion without a selvedge stop adjustment.

The invention also provides a straight bar knitting machine having means for producing rib fabric to be followed by knitting non-rib fabric onto the rib fabric, a narrowing head carrying a pair of loop transfer point bars each having a multiplicity of loop transfer points, means for changing the mode of the machine from knitting to fashioning, adjustable lead screw means for controlling the point bars to provide when required for single and plural-needle inward loop transfer motions alternating with plural-needle outward re-set motions of the point bars for loop doubling at spaced locations along the length of the course, selvedge stops adjustable to provide when required for single-and-plural-needle inward adjustments thereof, and pattern or programme control means which is variably pre-set with reference to course length in terms of loops in the course, number of points in the bars, number of needles between the bars in an innermost starting position, and frequency of loop doubling, so that loop doublings can be formed at any required frequency automatically.

Conveniently the number of points in the bar is a calculated maximum or minimum number. Conveniently the adjustable lead screw means for the point bars to provide plural-needle outward re-set motions is under control of cam-operated ratchet means having pawl control plates which are adjustable to provide for the re-set movements of the point bars being to variable plural-needle extents. Conveniently the machine includes punched chart programming control means for controlling machine operations including fashioning motions of the machine and having counting means under control of punched hole information from the chart for controlling the number of fashioning motions or loop doublings required prior to changing from single-needle transfer motions to plural-needle transfer motions and prior to single-and-plural-needle adjustments of the selvedge stops.

The foregoing and other features of the invention set out in the appended claims are incorporated in the construction which will now be described, as a specific embodiment, with reference to the accompanying drawings in which:

FIG. 1 is a perspective view of needles and rib fabric in a straight bar knitting machine, according to the invention.

FIG. 2 is a similar view to FIG. 1 showing transfer of rib loops to frame needles.

FIG. 3 is a similar view to FIGS. 1 and 2 showing all the fabric loops on frame needles.

FIG. 4 is a detail view of a first loop doubling stage.

FIG. 5 is a similar view to FIG. 4 showing a later loop doubling stage.

FIG. 6 is a similar view to FIG. 5 showing a further loop doubling operation.

FIG. 7 is a view showing diagrammatically all the loop doubling stages necessary to suit one set of requirements.

FIG. 8 is a similar view to FIG. 7 showing all the loop doubling stages necessary to suit modified requirements.

FIG. 9 is a cross sectional view of relevant parts of a straight bar knitting machine according to the invention.

FIG. 10 is a diagrammatic front view of part of the machine.

FIG. 11 is a detail view of part of FIG. 9.

FIG. 12 is a detail view of part of FIG. 10.

FIG. 13 is a detail view of part of FIG. 12.

FIGS. 14 to 17 are detail views of control plates of FIG. 12.

FIG. 18 is a diagrammatic illustration of first clawker mechanism of FIG. 12.

FIG. 19 is a similar view to FIG. 18 at a later stage.

FIG. 20 is a similar view to FIG. 18 of a second clawker mechanism of FIG. 12.

FIG. 21 is a similar view to FIG. 19 showing the second clawker mechanism at a later stage.

FIG. 22 is a further detail view of the first clawker mechanism.

FIG. 23 is a detail view of gearing of FIG. 12.

FIG. 24 is a diagrammatic illustration of part of the machine mechanism and associated electrical control means.

FIG. 25 is a detail view of a punched chart used in the mechanism of FIG. 24.

FIG. 26 is a diagrammatic view similar to FIG. 8 showing loop doubling stages to suit further modified requirements.

FIG. 27 is a similar view to FIG. 26 showing loop doubling stages to suit still further modified requirements.

The illustrated examples of the invention will be hereinafter described with particular reference to a straight bar knitting machine of the kind disclosed in our U.S. Pat. No. 1,121,143, to which reference is directed for full details.

Referring to FIG. 1 this kind of machine has bearded frame needles 1 and spaced machine needles MN which in this instance are latch needles. Rib fabric RB is knitted on the spaced machine needles MN and on spaced ones of the frame needles as shown. Loop transfer mechanism, comprising in this instance loop spreader elements LSE on the machine needles MN is provided. The machine needle loops L of the last rib course are transferred, by advancing the machine needles MN as in FIG. 2 and raising the frame needles as shown, to the intervening frame needles which have been inactive during the rib knitting. This forms a non-rib course on the frame needles 1, FIG. 3, onto which non-rib fabric is to be knitted, either in the same machine or in a plain knitting machine.

The machine is equipped with at least two loop transfer devices 2, 2*a*, FIG. 10, each having a group of loop transfer points 3 for fashioning purposes but which are modified as hereinafter fully described for loop doubling in the last course of the rib fabric. The machine is further equipped with the usual narrowing head having a narrowing shaft N, FIG. 9, carrying the loop transfer devices 2, 2*a* including the usual mechanism including an adjustable lead screw FS FIG. 10 for effecting single needle loop transfer motions of the points and re-setting motions of the points, the latter involving modified mechanism as hereinafter fully described for the required loop doubling.

The machine is still further equipped with punched chart programming mechanism which may be a main punched chart programming mechanism, partly shown in FIG. 24, for controlling shaping of a garment and modified for control of the required loop doubling, or there may be a separate punched chart programming mechanism for controlling the loop doubling.

Each of the loop transfer devices 2, 2*a* may have either a predetermined variable number of points or a predetermined standard number of points, to be hereinafter more fully referred to, and the programming means for the loop doubling is adapted for causing the points 3 of each loop transfer device 2, 2*a* to have a predetermined number of single needle loop transfer motions and a predetermined number of plural needle reset motions to provide a plurality of loop doublings in the last rib course at any required given frequency, and if necessary also to impart to the points 3 a predetermined number of following two or more needle loop transfer motions and further a predetermined number of plural needle reset motions to provide a further plurality of loop doublings substantially at the same given frequency, so that loop doublings can be formed at any required frequency in a series extending substantially throughout the whole length of the course. For this purpose the holes in the punched chart

of the programming mechanism are provided with reference to predetermined formulae in such manner, as hereinafter more fully described, that the holes can be arranged in any one of a multiplicity of arrangements to provide for the loop doublings being formed, at any one of the given frequencies.

In one arrangement it is required to use the minimum number of points, in each transfer device, that will produce the required result. In order to determine this minimum number of points in relation to any length of course, any desired frequency of loop doubling and other incidental considerations, use is made of a formula $(H - N)/2 = B + (FB/R)$ where B is the unknown number of points, H is the known length of the course before loop doubling, F is the known frequency of loop doubling, R is the known rate of re-setting and is $F + 1$, N is the known needle pitch spacing of the two innermost loop doublings and is $F + 2$ or another given number, and the resultant number is increased, if necessary, to the nearest number to be wholly divisible by R. In one example, shown in FIG. 7 to be hereinafter more fully described, the known length of the course is 234 needles and there is required a loop doubling frequency of 14 so that $H = 234$, $N = 14 + 2 = 16$, $F = 14$ and $R = 15$. Now applying the formula,

$$(234 - 16)/2 = B + (14B/15)$$

$$109 = 29B/15$$

$$B = 1635/29 = 56$$

Since the number is not divisible by the reset frequency, i.e. 15, there must be added to it the smallest number necessary to rectify this. This added number is 4 since 60 is divisible by 15 four times.

Thus 60 is the minimum number of points necessary for a loop doubling frequency of 14 as in the example of FIG. 7.

Taking the example of FIG. 8 in which the frequency required is 9.

$$(234 - 11)/2 = B + (9B/10)$$

$$111{\cdot}5 = 19B/10$$

$$B = 1{,}115/19$$

$$= 58$$

add two to be divisible by $10 = 60$

In other instances the number of points will be different from 60. For example for a doubling frequency of 6.

$$(234 - 8)/2 = B + (6B/7)$$

$$113 = 13B/7$$

$$B = 791/13$$

$$= 60$$

add 3 to be divisible by 7 — 63.

Accordingly for each of these three examples, only those particular numbers of points are employed in the machine, but it will be understood how for other course lengths and other loop doubling frequencies, the minimum number of points can be calculated.

In an alternative arrangement there is employed a predetermined standard number of points which is found in practice to be a maximum number of points that it is practical to use in the machine in each loop transfer device. In one example of a 21 gauge machine the maximum length for each loop transfer device is about 9 inches and the maximum number of points in this example will be 126 but this number would be decreased in certain instances to provide that it is equally divisible by the reset frequency R. For example for a doubling frequency of 2, the value of R would be 3 and the number of points could be the maximum of 126 since this is equally divisible by 3, whereas in another example where the doubling frequency is 3 so that the reset frequency is 4 the number of points would be 124 being the nearest number less than 126 that is equally divisible by 4. For other machine gauges the maximum length of bar and number of points will be to suit these machine gauges.

Whether or not the number of points in each loop transfer device is a variable minimum number, or is a predetermined maximum number, holes are provided in the punched chart governing the instigation and number of the required loop transfer and reset motions of the points in any particular instance, and the number is predetermined by different formula according to whether the length of the last rib course is on the one hand equal to or less than $N + 2B$ or on the other hand greater than $N + 2B$. In the first of these instances the formula is

$$x = \left(\frac{H - N}{2} + R\right) + 1$$

where x is the required number, and in the second instance thie formula is $B/R = x$.

In the first of these instances as shown in FIG. 26 all the loop doublings L13 to L18 will be by single needle loop transfers T21 to T23, and for each of these by each loop transfer device 2^2, 2^3, the selvedge stops will be racked in one needle distance, since for each loop transfer each selvedge loop LSL, RSL will always have a point associated with it to simultaneously lessen the overall length of the course.

In the second of said instances however a stage is reached where, for a reason to be hereinafter fully explained, it is required to have two needle loop transfers. The formula $B/R = x$ already referred to for these instances will determine the total number required of the single needle loop transfers. In the example of FIG. 7 this is $60/15 = 4$. If the calculated minimum number of points is to be used, the number of single loop transfers before selvedge stops are racked in with two needle racks is the same as said total number, i.e., in this example 4. Similarly this same number 4 indicates the number of two needle transfers to follow the single loop transfers. In other instances e.g. where the maximum number of points is to be used and/or where it is required to know the number of needles finally covered by some of the points, the number of single loop transfers before racking and the number of two needle transfers is found by the formula:

$$S = \left(\frac{H - N}{2} - B\right) + 1$$

where S is the required number.

In one example a rib 292 needles wide is to be doubled at a frequency of 8 using a point bar of 126 points.

Then

$F=8$

$R=9$

$H=292$

$N=12$ (minimum possible in this instance)

$B=126$

$x = B/R = 126/9 = 14$ = number of doublings by $1N$ transfer

$$S=\left(\frac{\left(\frac{H-N}{2}\right)-B}{F}\right)+1=\left(\frac{\left(\frac{292-12}{2}\right)-126}{8}\right)+1$$

$$=\frac{14}{8}+1=1+1 \text{ (with remainder of 6)}=2$$

Number of doublings prior to selvedge stops racking being started = 2.

Also the number of doublings by 2 needle transfer = 2.

Also points coverage after doubling = the remainder from the calculation for S, $+1=6+1=7$ points.

Therefore, number of doublings by $1N$ transfer = 14

number of doublings by $2N$ transfer = 2

total number of doublings = 16

Selvedge stops to be racked after 2 doublings.

Points coverage after doublings = 7 points

NOTE: All calculations are over the centre line and must therefore be doubled with the exception of the points coverage.

In such loop doubling arrangements as the latter one the punched chart will have holes for governing the calculated number of single and two-needle transfers.

The chart information will also be used to provide that while the S number of single needle transfers are being effected, the selvedge stops will be controlled not to rack-in. Then while the $x - S$ number of single needle transfers are effected the selvedge stops will be controlled to rack-in single needle stages, and thereafer the selvedge stops will be controlled to rack-in in two needle stages since the course of loops is being shortened by two needle increments.

It will be understood from the foregoing particular description that by reference to the formulae the machines control means can be set up to provide such variable relationships between the points, the length of the last rib course, and the loop doubling frequency, that the series of loop doublings can be formed at any of a multiplicity of lengths to extend throughout any multiplicity of lengths of the last course of rib fabric.

In practice the groups of points are started at inner locations such as indicated for the group **2** in FIG. **4**, the loop doubling transfers are inwardly as indicated by the loop doubling L1 made by a single-needle transfer and the re-set motions are outwardly.

In instances where H is greater than $N + 2B$, each pair of single needle loop transfers, such as for loop doublings L1, L2, FIG. **5**, that are made before the outermost points extend beyond the selvedges, is accompanied by the outermost points denuding a needle **1***a* at the outer end of each group of points of its loop. Because of such holes the system would not normally be acceptable. However an important factor of the invention is that the system is made to be acceptable by following the series of single-needle loop transfers with a series of two-needle loop transfers whereby, during the consequent formation of further loop doublings, such as L3, FIG. **6**, the denuded needles are re-supplied with loops.

In further explanation of the system, more detailed description will now be given of the examples of FIGS. **7** and **8**.

The needles of the right hand half of the needle row in the straight bar knitting machine are indicated at **1**, and co-operating with this right hand half of needles **1** is the one group **2** of 60 loop transfer points **3**, and it will be understood that the group **2** of loop transfer points together with the group **2***a* are operable, as for fashioning points, by existing narrowing mechanism of the machine, for transference of loops in a course of stitches on the needles, and modified narrowing mechanism hereinafter fully described is provided for re-setting the points at progressively further outwards locations.

It is also to be understood that there will be associated with the left hand half row of needles the second group **2***a* of loop transfer points similar to the group **2** and operable in mirror image manner in relation to operation of the group **2** of points now to be fully described.

It will be assumed that the machine control means has been set up as before and hereinafter more fully described for loop doubling at a frequency of 14, the re-set frequency being 15, in a course of loops on 234 needles; also that the minimum number of points has been calculated as before described to be 60 in each group, and further that it has been calculated as before described for the points to have four single-needle loop transfer motions and four two-needle transfer motions.

In this example all the needles **1** have loops on them of the last course of rib fabric, and the group **2** of points **3** is first located over a group of 60 needles which are spaced from the left hand end of the row of needles, i.e., spaced from the middle of the complete course, by seven needles, i.e., half the loop doubling frequency. The group of points is then operated to transfer all the loops of their opposite needles one needle distance to the left thereby to form the loop doubling L1 at the left hand end of the group of points. It is important to note that at the right hand end of the group of points one needle **1***a* has, because of the loop transfer operation, been denuded of its loop. This stage of operations can be referred to as transfer stage T1.

The next stage of operations is a reset stage indicated at R1 and it comprises resetting the group of points a distance of fifteen needles to the right ready for a second loop transfer operation.

This second loop transfer operation is indicated at transfer stage T2 where it will be seen that a second loop doubling L2 is formed at the left hand end of the reset group of points and at the desired fourteen needle frequency. The needle **1***a* remains denuded of its loop, and at the right hand end of the displaced group of points a second needle **1***b* is denuded of its loop.

At the next reset stage R2 the group of points is reset a further 15 needles to the right, and at the following transfer stage T3 a third loop doubling L3 is formed at the left at the desired 14 loop frequency, the needles

1*a*, 1*b* remain denuded of their loops and a third needle 1*c* becomes denuded of its loop.

At the next reset stage R3 the group of points is again displaced 15 needles to the right, followed by the stage T4 whereat a fourth loop doubling L4 is formed, the needles 1*a*, 1*b* and 1*c* remain denuded of their loops and a fourth needle 1*d* becomes denuded of its loop.

At the next reset stage R4 the group of points is again displaced fifteen needles to the right. It will be observed that at this stage the left hand point is disposed opposite the denuded needle 1*a*, and that a few of the points at the right hand end project beyond the selvedge needle.

At the next transfer stage T5 the group of points is operated to effect a two-needle transfer so that not only is a fifth loop doubling L5 formed but the needle 1*a* receives another loop. The needles 1*b*, 1*c* and 1*d* remain denuded of their loops. In addition, since the group of points projects beyond the selvedge, two selvedge needles will become denuded of their loops so that the fabric is correspondingly narrowed. Consequently the selvedge stops are adjusted at this stage inwardly two needles to reset the thread carriers to the narrowed width of fabric.

At the next reset stage R5, the group of points is displaced fifteen needles to the right so that the left hand point is opposite the denuded needle 1*b*, and the group of points projects to a further extent beyond the selvedge.

At the next transfer stage T6 the group of points is given a two-needle transfer motion thereby to form a sixth loop doubling L6 and to provide a loop on the needle 1*b*, the loops 1*c*, 1*d* remaining denuded of their loops. Also two additional selvedge needles are denuded and the selvedge stops are consequently further adjusted.

At the next reset stage R6 the group of points is again displaced fifteen needles to the right so that its left hand point is opposite the denuded needle 1*c*.

At the next transfer stage T7 the group of points is given a two-needle transfer motion to form a seventh loop doubling L7 and to provide a loop on the needle 1*c*. Two further selvedge needes are also denuded and the selvedge stops are still further adjusted.

On the next reset stage R7 the group of points is further reset fifteen needles to the right so that its left hand point is opposite to the denuded needle 1*d*.

At the last transfer stage T8 the group of points is given a two-needle transfer to form an eighth loop doubling L8 to provide the needle 1*d* with a loop.

It will be understood from this example how the one group of points, with its counterpart, is used to provide loop doublings at the required frequency throughout the length of the course of rib fabric.

FIG. 8 shows the successive stages of operation of the group of points to form loop doublings at a frequency of nine. Assuming that machines control means to have been set up with reference to the appropriate formulae, the system of operation of the group 2 of points 3 is basically the same as in FIG. 7, the only exceptions being that whereas in FIG. 7 the reset motions are to the extent of 15 needles, the reset motions in FIG. 8 are to the extent of 10 needles, and whereas in FIG. 7 there are eight transfer stages and seven reset stages to provide for eight loop doublings at the required frequency of 14, in FIG. 8 there are 12 transfer stages T1 to T12 and 11 reset stages R1 to R11 to provide 12 loop doublings L1 to L12 at the required frequency of nine.

It will be observed from these two examples that when changing from single to two-needle transfers, the loop doubling and reset frequencies are reduced by one.

It will be further observed that at stages T5 to T8 in FIG. 7 and stages T7 to T12 the length of the course is lessened, and the invention provides for corresponding inward adjustment of the selvedge stops, in a manner hereinafter described, at each of said stages.

In the machine, FIG. 9, the frame needles 1 are operable by usual cam operated mechanism including the cam follower lever 50 and cam 51 on a lower cam shaft 52. The spaced machine needles MN are operable by cam operated mechanism including cam follower lever 53 and cam 54 on the shaft 52. The two groups of points are carried by point carrier bars 13, 14 respectively which are mounted in the narrowing head represented by the narrowing shaft N, arms 55 pivoted thereto and at 56, link 57 connecting the shaft N to a cam follower lever 58, and a cam 59 acting on the lever 58 for operating the narrowing head up and down in known manner during fashioning motions of the machine. For changing to fashioning motions, shogging means 60, FIG. 10, is provided for shogging the two cam shafts in known manner and comprises side face cams represented at 61, 62 on the respective shafts, with rollers interconnected by a link 63 for co-operating with the cams and which are displaceable by a solenoid FSS into operative position in which they act as abutments against which the cam faces ride so that the cams and the shafts become sideways displaced in the known manner.

The adjustable lead screw FS, FIG. 10, for the single and plural loop transfer motions of the points is oppositely screw threaded and connected to the point bars by screw nuts 64, 65 respectively. For adjusting the screw FS it carries ratchet wheels 66, 67 and co-operating pawls which in known manner are operated through links 68, 69 connected to cam follower means 70 having a roller 70*a* which is acted on by cam 71 on the shaft 6.

The pawls are under selective control of control plates 72, 73 which are selectively displaceable by pattern bits represented at 74, 75 on discs 76, 77 on a top disc control shaft 78.

This shaft 78 is racked round when required through a ratchet wheel 79 and a pawl which is operated through a link 80 connected to cam follower means 81 acted on by a cam 82 on the shaft 6 in known manner, the pawl being under control of a control plate 83 operated by a solenoid 84.

There are also usual selvedge stops such as 85, FIG. 9, which control the amplitude of traverse of the thread carrier bars 7 – 10 and which are connected by screw nuts 86, 87, FIG. 10, to a usual selvedge stop screw 88. This screw 88 is oppositely screw threaded and for its adjustment has ratchet wheels 89, 90 and co-operating pawls which in known manner are operated through links 91, 92 connected to cam follower means 93 which is acted on by cam 94.

The pawls are under selective control of control plates 89*a*, 90*a* which are selectively displaceable by

pattern bits represented at 89*b*, 90*b* on discs 89*c*, 90*c* on the top disc control shaft 78.

Cam follower rollers 70*a*, 93*a* of the cam follower means 70, 93 are displaceable from the cams 71, 94 when required. For this purpose the rollers 70*a*, 93*a* are connected by shifting forks 71*b*, 93*b* and links 71*c*, 93*c* to the top disc control shaft 78 where the links are displaceable by pattern bits represented at 71*d*, 93*d* on control discs 71*e*, 93*e*.

The adjustable lead screw FS, FIG. 10, for the plural-needle reset motions of the point bars, has an extension shaft 15 to which adjustable re-set racking mechanism is connected. This mechanism is shown diagrammatically at 95 in FIG. 10 and in detail in FIGS. 9 and 11 to 23. FIG. 12 shows that the mechanism comprises on the shaft 15 a loose pinion 16, also FIG. 11, engaged by a rack 17, and the latter is movable in opposite directions by an attached cam follower lever 18, FIG. 11. The lever 18 has rollers 18*a*, 18*b* engaging cams 19, 19*a* respectively for the opposite movements of the rack 17 to be positive in both directions.

Secured on the shaft 15 is a ratchet wheel 20, FIG. 12, to be racked round by a clawker 21 which is secured to said loose pinion 16 so that movements of the rack 17 moves the clawker 21 to rack the ratchet wheel 20 and consequently turn the shaft 15. The extent of racking has to be variable to suit the frequency of re-setting required. For this purpose there are three sector control plates 22, 23, 24, also FIGS. 13 to 17, for the clawker 21 which has an overlying peg 21*a* and these can be fanned out to limit the racking to say two needle distances or they can be closed together to provide for racking say for eight needle distances, and they can have any desired intermediate positions for racking for any distance between two and eight needle distances.

The control plates are shown in detail in FIGS. 14 to 17 from which it will be seen that a first plate 22 carries a peg 22*a* which after a movement of it can first engage a part 23*a* of a second plate 23 to move the latter, and then engage a part 24*a* of a third plate 24 to move this plate, for closing the plates together.

There is also a fixed control plate 25, FIG. 14.

The first plate 22 is secured to a manually adjustable knob 26, FIGS. 12, 13 which has index numbers indicating various possible settings for the various possible numbers of racks.

Conveniently the motion of the rack 17, FIG. 11, in forward direction to effect say anti-clockwise rotation of shaft 15 is timed to take place while the narrowing head is rising following a loop doubling transfer so that the re-setting thus takes place to the desired extent.

To provide for re-setting to any further extent required, there is a second racking mechanism comprising a ratchet wheel 27, FIG. 12, a clawker 28 secured to a pinion 29, three sector control plates 30, 31, 32 adjustable by a manually controlled knob 33, and a fixed control plate 34. This mechanism is arranged, by a lay shaft 35 and pinions 36 to 38, a pinion 39 FIG. 23, is an idler pinion, for the clawker 28 to ride backwards over the ratchet wheel 27 while the first ratchet mechanism is operating. Thereafter while the narrowing head is next lowering, the return of the rack 17 will cause the first clawker 21 to ride backwards over its ratchet wheel 20 while the second clawker 28 will effect, if suitably set by the second knob 33, movement of its ratchet wheel 27 such as to further rotate the shaft 15 in its original anti-clockwise direction thereby to add to the re-setting of the point bar to desired extent, such for example as to add from two to eight needle distances to the original eight, making from 10 to 16 in all.

The control of the sector control plates 22, 23, 24 can be appreciated from reference to FIG. 14. The clawker 21 is shown at a left hand starting position, where it is held clear of the teeth by the fixed control plate 25, and at an upper stopping position. The arc line X indicates the joint peripheries of the sector plates 22, 23, 24 when fully fanned out, the result being that in the anti-clockwise movement of the clawker 21 it rides over the control plates for most of its movement, but near the end it engages the ratchet wheel to produce say a two needle re-setting rack if the knob 26 has been set at 2. For other settings of the knob 26 the joint periphery of the control plates 22, 23, 24 will be shortened to expose more teeth where the clawker 21 is passing through the latter part of its movement so that the re-setting rack will be for correspondingly greater needle distances. This explanation applies equally well to the second racking device.

In order to avoid over-racking, the second racking device has a check pawl which co-operates with a notched disc to control the first clawker, and the first racking device has a check pawl which co-operates with a notched disc to control the second clawker, as illustrated in FIGS. 18 to 22. Referring first to FIG. 18 the racking clawker 21 of the first racking device has coupled to it a check pawl 40, with suitably attached springs 41, 42 as shown in FIG. 22. In FIG. 18 the rack clawker 21 is shown at the left in its starting position and at the top in its finish position. At the start the narrowing head is in its lowermost position as indicated by the position of the narrowing machine shaft N which is disposed below the racking mechanism as shown.

FIG. 19 shows the first racking device at the end of a rack during which the check pawl 40 has trailed over its control plate 43, the narrowing head with its shaft N has been raised and the rack bar 17 FIGS. 9 and 10 has had an advance stroke to the left in relation to FIGS. 18, 19.

FIG. 20 shows that the second racking device has coupled to its clawker 28, which is shown in its start position, a check pawl 44 which at the stage of FIG. 19 engages a notch 45 in a control plate 45 to prevent over-racking of the first device.

FIG. 21 shows the finish position for the second racking device after a rack during which the narrowing head with its shaft N has lowered and the rack bar 17 has had a return stroke to the right in relation to FIGS. 20, 21. Overracking of this second device is prevented by the check pawl 40 of the first racking device engaging notch 43*a* in the control plate 43.

FIG. 23 shows the pinions 36, 37 and that they are interconnected by the pinion 39. Between the pinions 29, 38 FIG. 12 is an idler pinion and this is a counter part of the pinion 39, FIG. 23. This provides for the opposite motions of the rack bar 17 producing rotation of the first and second ratchet wheels in the same direction for the purpose hereinbefore described.

The programming control means, which is substantially as that disclosed in our G.B. Pat. No. 960,816 and our U.S. Pat No. 3,141,316 to which reference is directed for full details, for the machine is shown diagrammatically in FIG. **24**. There is a control drum **96** for a punched chart **97** represented in FIG. **25**. The chart **97** is adapted having punched holes in selected rows and columns, there being a group of columns for courses holes, a group of columns for fashioning holes and a group of columns for a plurality of other machine operations, as shown, and one of which labelled "Top auto shaft rack" is particularly relevant to the invention and relates to the top disc control shaft **78** FIG. **10**. Holes in the courses and fashions columns can be provided to have numerical coded values on the Binary system through the medium of the binary numbers on the chart and reader means. Referring to FIG. **24** the drum **96** is adapted for being racked on, for different readings, by a ratchet wheel **98** and a pawl **99** which is operable through cam operated mechanism **100** and a cam **101**, and the pawl is under control of a solenoid CRS.

The reader means comprises a series of feelers **102** having pegs **103** for engaging the chart and holes therein, the feelers having tail portions **104** for acting on electric switches CF1 – CF6. These switches are connected to different stages in a fashions counter FC in a manner to set the counter according to the numerical value of a hole or holes in the fashions columns of the chart, such holes being predetermined with reference to the formulae as hereinbefore described. For example if eight fashioning motions are required for eight loop doublings as in FIG. 7, a hole is provided in the **8** fashionings column. This will set the counter FC to a count of 8, and a pulse signal will be sent from the counter to a relay RLA which, through the medium of relay logic ORL, will cause energizing of a solenoid FSS. This solenoid FSS is connected to the cam shaft shogging means **60** so that the cam shaft is shogged to put the machine into a fashioning motion. Another pulse signal will be received back by the counter FC, to reduce the count set up by 1 to 7, from an electric switch CC3 which is operated by a cam **105** on the cam shaft **11** through the medium of cam operated mechanism **106**.

In the same row as the fashions hole there will be a hole in the "Top auto shaft rack" column, and through its associated feeler switch, this hole causes energizing of the solenoid **84** FIG. **10** which results in racking of the top disc control shaft **78** by the cam **82**. The arrangement of the pattern bits on the discs on the shaft **78** are such that the cam follower roller **70***a* is shifted onto its cam **71** which causes a single needle rack of the lead screw FS by the pattern bit **74** rendering the ratchet wheel **72** operative for this purpose.

This takes place after the narrowing head has lowered and raised and this is followed by a second lowering of the narrowing head in the known manner which forms the first loop doubling. As the narrowing head again rises the cam follower rollers **18***a*, **18***b*, which have been shifted onto the cam by shifting fork means **18***c* by a pattern bit **18***d* on a control disc **18***e*, are acted on by the cam **19** to operate the ratchet mechanism **95**. This will have been in this instance preset by hand setting of the knob **26** to the number **14** so that the lead screw FS will have a 14-needle rack for re-setting the point bars **2**, **2***a* a distance of 14 needles as required for FIG. **7**.

Since the counter FC still has a count of 7, the loop doubling and re-setting operations continue in repeat as described for FIG. **7** until the stage **T5** at which time the pattern bit **75** renders the ratchet wheel **67** operative to impart to the lead screw FS the two-needle motion required to form the loop doubling **L5** and close the hole **1***a*. At the same stage the pattern bit **93***d* will act to shift the cam follower roller **93***a* onto its cam **94** and the pattern bit **90***b* will act to render the ratchet wheel **90** effective, so that a two-needle rack will be imparted from the cam **94** to the selvedge lead screw **88** thereby to adjust the selvedge stops **86**, **87** the required two needles inwardly. Each loop doubling from **L1** to **L5** has in the meantime been counted off by the fashions counter FC.

Since there is still left a count of **3** in the fashions counter FC, the two-needle loop doubling and selvedge adjustments continue in repeat until the fashions counter is reduced to zero, each loop doubling being followed by re-setting operations of the cam **19** on the ratchet mechanism **95** and the single needle control means being rendered ineffective by the top disc shaft control.

At the zero stage of the fashions counter FS it causes de-energizing of the relay RLA and of the fashions solenoid FSS to discontinue the fashioning motions, and the cam follower rollers **93***a*, **70***a* and **18***a*, **18***b* are shifted by the top disc shaft control off their cams to render the lead screws, point bars and selvedge stops inoperative. The counter FS also causes energizing of the solenoid CRS for racking on of the punched chart by rendering the pawl **98** operative.

It is to be understood that modifications may be made to the arrangement as hereinbefore particularly described without departing from the invention. For example, as shown in FIG. **27**, in certain instances the point bars **2'** may so narrow compared with the length of the course that each two-needle transfer **T13**, **T14** is accompanied by denuding needles **1***e*, **1***f*, **1***g* **1***h* of their loops at the outer ends of the point bars, and in this event the racking mechanism is modified to provide for ensuing loop transfer motions **T15** to **T20** and selvedge stop adjustments being of three-needle type.

In order to assist customers in setting up the machine's control mechanism there may be compiled from the formulae a series of comprehensive charts to be supplied to customers, such charts showing numerical values of which the following are a few given by way of example where:

F = Doubling Frequency
R = Doubling Bar Reset Frequency
B = Number of Points in Doubling Bars
N = Number of Needles Between the Doubling Bars at the Centre of the Head
H = Starting Width, In Needles Prior to Doubling
Hi = starting Width Index Reading Prior to Doubling
X = Number of 1 Needle Transfers
X = Number of 2 Needle Tansfers and the Number of Doubling Dips Prior to the Selvedge Stops being Transferred, i.e., the Selvedge Loops Commence to Move Inwards
W = Finishing Width in Needles After Doubling
Wi = Finishing Width Index Reading After Doubling

C = Number of Fashioning Points Inside the Selvedge After Doubling
T = Total Number of Doublings
DOUBLING FREQUENCY = 3
F = 3 R = 4 B = 124 N = 13
* N = 15

H	Hi	X	S	W	Wi	C	T	H	Hi	X	S	W	Wi	C	T
448	112	31	31	324	81	3	124	264	66	31	1	200	50	2	64
444	111	31	31	320	80	2	124	260	65	30	----	200	50	3	60
440	110	31	30	318	79½	3	122	256	64	30	----	196	49	1	60
436	109	31	30	314	78½	1	122	252	63	29	----	194	48½	3	58
432	108	31	29	312	78	2	120	248	62	29	----	190	47½	1	58

What we claim is:

1. A method of producing, by a knitting machine having needles, fashioning mechanism including loop transfer points, and patterning means, a rib fabric having spaced loop doublings in its last-formed course of prepare it for non-rib fabric to be knitted onto the rib fabric; which method comprises: initially disposing the two groups of loop transfer points inwardly and spaced by a distance equal to a required pitch distance for the loop doublings in terms of a number of said needles, said points being of a predetermined number registering with a number of said needles which, jointly with said pitch distance number of needles, is in predetermined relation to the number of said needles forming said last-formed course, performing an operation of imparting to said points narrowing motions to form a spaced pair of loop doublings by the inner end points of said groups of points and causing at the outer ends of the groups of points to become loop-less needles, and re-setting the points by outward re-set motions for a distance under control of the patterning means equal to said required pitch distance for the loop doublings, and performing a succession of operations similar to the first said operation and in outwardly progressing manner for the points until loop doublings are formed at required spaced locations throughout the length of the course.

2. A method of producing, by a knitting machine having needles including selvedge needles, fashioning mechanism including loop transfer points, thread carrier selvedge stops, and patterning means, a rib fabric having spaced loop doublings in its last-formed course to prepare it for non-rib fabric to be knitted onto the rib fabric; which method comprises: initially disposing two groups of the loop transfer points inwardly and spaced by a distance equal to a required pitch distance for the loop doublings in terms of a number of the needles, the points being of a predetermined number registering with a number of the needles which jointly with said pitch distance number of needles is not less than the number of needles forming the last-formed course, performing a first operation of imparting to the points single needle narrowing motions to form first spaced loop doublings by the inner end points of the groups of points and causing a pair of selvedge needles to become loop-less needles, racking-in the selvedge stops one-needle distance, and re-setting the points by outward re-set motions for a distance under control of the patterning means equal to said required pitch distance for the loop doublings, and performing a succession of operations similar to the first said operation and in outwardly progressing manner for the points until the loop doublings are formed at required spaced locations throughout the length of the course.

3. A method of producing, by a knitting machine having a row of needles including selvedge needles, fashioning mechanism including loop transfer points, thread carrier selvedge stops, and patterning means, a rib fabric having spaced loop doublings in its last-formed course to perpare it for non-rib fabric to be knitted onto the rib fabric; which method comprises initially disposing two groups of the loop transfer points near the middle of the row of needles and spaced apart for a relatively small distance in terms of a small number of middle needles, the points registering with a number of the needles which jointly with the small number of middle needles is less than the number of the needles forming the last-formed course, performing a first operation of imparting to the points single needle narrowing motions to form first spaced loop doublings by the inner end points of the groups of points and causing needles at the outer ends of the groups of points to become first loop-less needles, and re-setting the points by outward re-set motions for a distance under control of the patterning means equal to said required pitch distance for the loop doublings, performing a succession of operations similar to the first operation in outwardly progressive manner for the points until the inner end points of the groups of points register with the first loop-less needles, performing a second operation of imparting to the points two-needle narrowing motions to form a further pair of spaced loop doublings by the inner end points of the groups of points and causing the first loop-less needles to receive loops and two pairs of selvedge needles to become first loop-less selvedge needles, racking-in the selvedge stops two-needle distances, and re-setting the points by outward re-set motions for a distance under control of said patterning means substantially equal to said required pitch distance for the loop doublings, and performing a succession of operations similar to said second operation in outwardly progressing manner until required loop doublings are formed at required spaced locations.

4. A knitting machine having a combination a row of needles, fashioning mechanism including means for changing the mode of the machine from knitting mode to fashioning mode and loop transfer points, two groups of said points being initially disposed near the middle of said row of needles and spaced apart for a relatively small distance in terms of a small number of said needles, said points being of a predetermined number registering with a number of said needles which jointly with said small number of said needles is in predetermined relation to the number of said needles forming the last-formed rib course, limited selection means operably connected to said points to provide for at least one-needle and two-needle loop transfers, multi-selection means operably connected to the points to provide for re-set motions of the points to variable extents, and pattern control means operably connected

to said limited and multi-selection means for variably determining the transfer and re-set motions of the loop transfer points with reference to a numerical chart.

5. A machine as claimed in claim 4 having selvedge stops and means for adjusting them, and punched chart programming control means for controlling machine operations including fashioning motions of the machine and having counting means under control of punched hole information from the chart for controlling the number of fashioning motions or loop doublings required prior to changing from single-needle transfer motions to plural-needle transfer motions and prior to adjustments of the selvedge stops.

6. A method of producing, by a knitting machine having needles including selvedge needles, fashioning mechanism including loop transfer points, thread carrier selvedge stops, and patterning means, a rib fabric having spaced loop doublings in its last-formed course to prepare it for non-rib fabric to be knitted onto the rib fabric; which method comprises employing two small groups of the loop transfer points which are initially spaced by a distance equal to a required pitch distance for the loop doublings in terms of a number of the needles, the points registering with a number of the needles which jointly with said pitch distance number of needles is appreciably less than the number of needles forming the last-formed course, performing a first operation of imparting to the points single needle narrowing motions to form first spaced loop doublings at the inner ends of the small groups of points and causing first needles at the outer ends of the small groups of points to become first loop-less needles, and re-setting the points by outward re-set motions for a distance under control of the patterning means equal to said required pitch distance for the loop doublings, performing a succession of operations similar to said first operation in outwardly progressing manner for the points until the inner end points of the small groups of points register with the first loop-less needles, performing a second operation of imparting to the points two-needle narrowing motions to form further spaced loop doublings at the inner ends of the small groups of points and causing the first loop-less needles to receive loops and two pairs of needles at the outer ends of the groups of points to become first pairs of loop-less needles, and re-setting the points by outward re-set motions for a distance under control of the patterning means substantially equal to said required pitch distance for the loop doublings, performing a succession of operations similar to said second operation in outwardly progressing manner for the points until the inner end points of the small groups register with the first pairs of loop-less needles, performing a third operation of imparting to the points three-needle narrowing motions to form further spaced loop doublings at the inner ends of the small groups of points and causing the first pairs of loop-less needles to receive loops and second needles at the outer ends of the groups of points to become second loop-less needles, re-setting the points by outward re-set motions for a distance under control of the patterning means substantially equal to said required pitch distance for the loop doublings, and performing a succession of operations similar to said third operation in outwardly progressing manner for the points until required loop doublings are formed at required spaced locations throughout the length of the course.

7. A method of producing by a knitting machine having a row of needles, fashioning mechanism including two groups of transfer points, and patterning means, rib fabric having spaced loop doublings in its last-formed course to prepare it for non-rib fabric to be knitted onto the rib fabric, which method consists in initially disposing said two groups of loop transfer points inwardly of said row of needles and spaced by a relatively small number of needles, said two groups of points being of a predetermined number registering with a number of said needles which jointly with said small number of needles is in predetermined relation to the number of needles forming said last-formed course, imparting to each group of points a first narrowing motion to form a pair of spaced loop doublings by the inner end points of said groups of points, and then performing a reset and narrowing operation, by imparting to each group of points an outwards re-setting motion for a distance under control of said patterning means substantially equal to a required pitch distance for the loop doublings and a further narrowing motion to form a second pair of spaced loop doublings by points at inner ends of the groups of points, said operation being repeated if required, for loop doublings to become formed at required spaced locations throughout the length of the course.

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