Dec. 27, 1955 F. K. STEVENS ET AL 2,728,210

TUCK AND WRAP KNITTING APPARATUS

Filed April 12, 1954 5 Sheets-Sheet 1

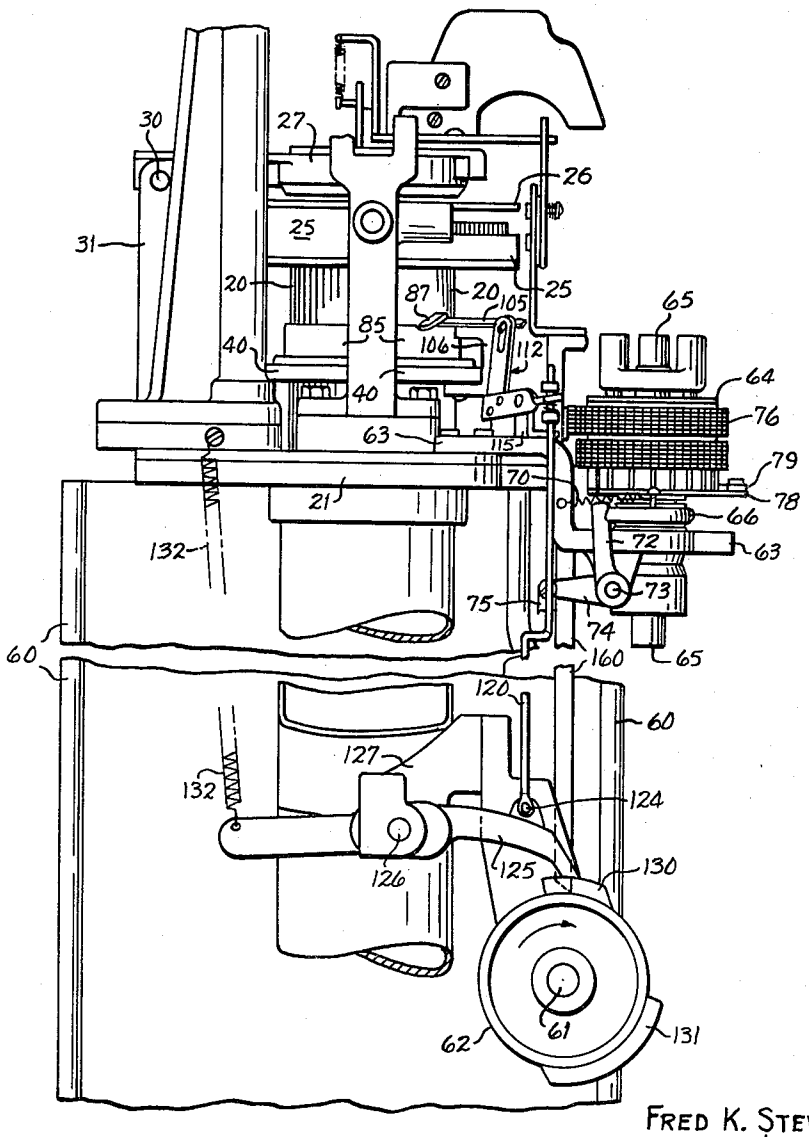


Fig. 1

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TUCK AND WRAP KNITTING APPARATUS

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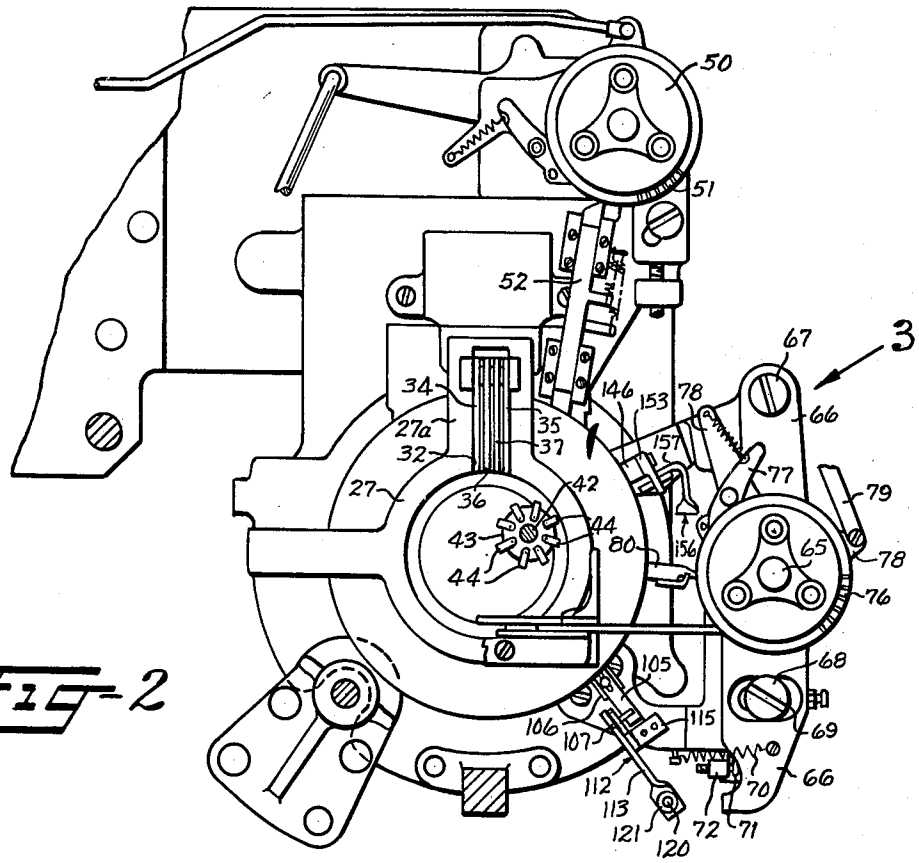
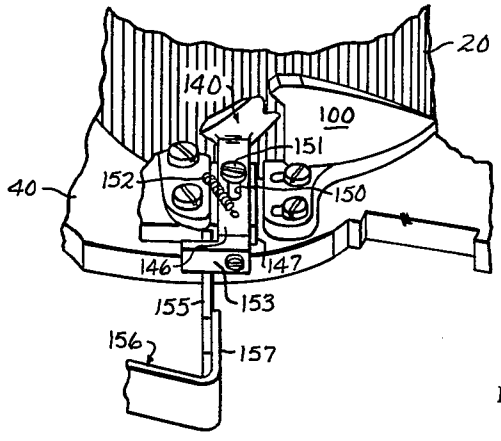


Fig. 2

Fig. 3



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TUCK AND WRAP KNITTING APPARATUS

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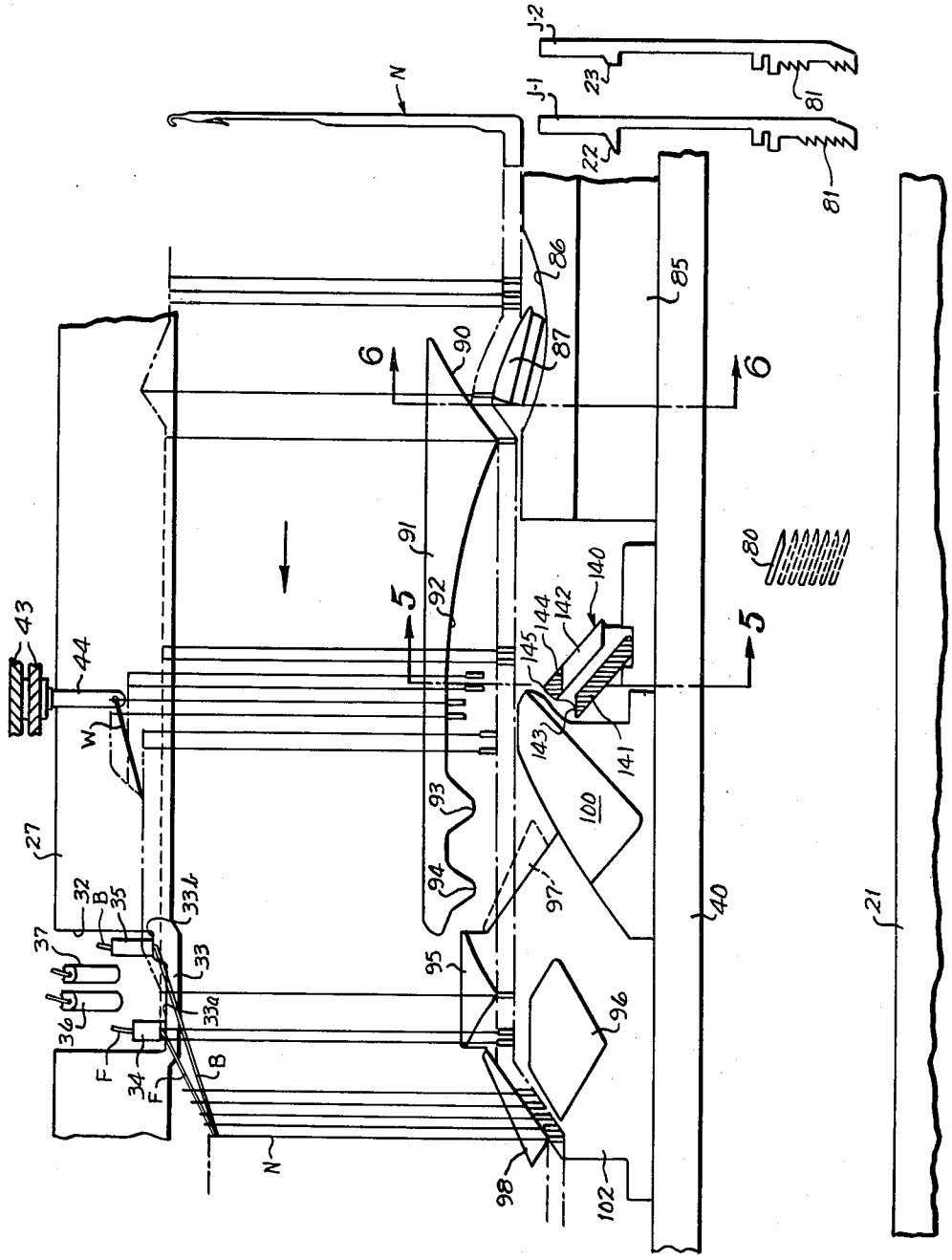


FIG. 4

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TUCK AND WRAP KNITTING APPARATUS

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Fig. 5

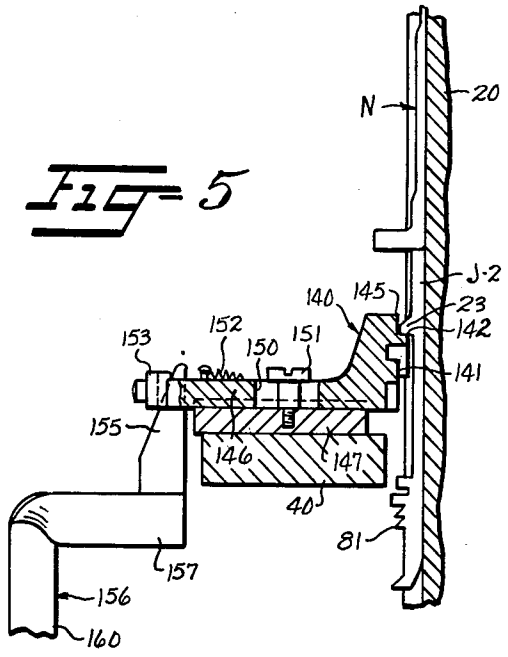


Fig. 5-A

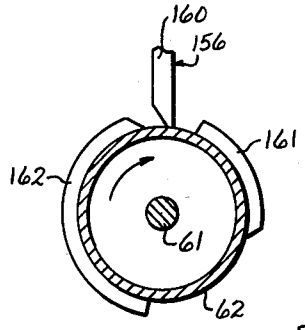
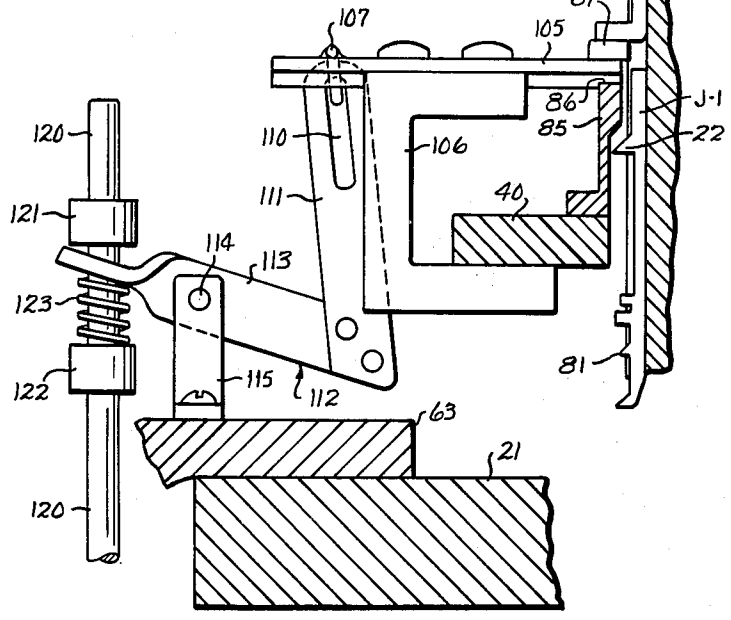


Fig. 6



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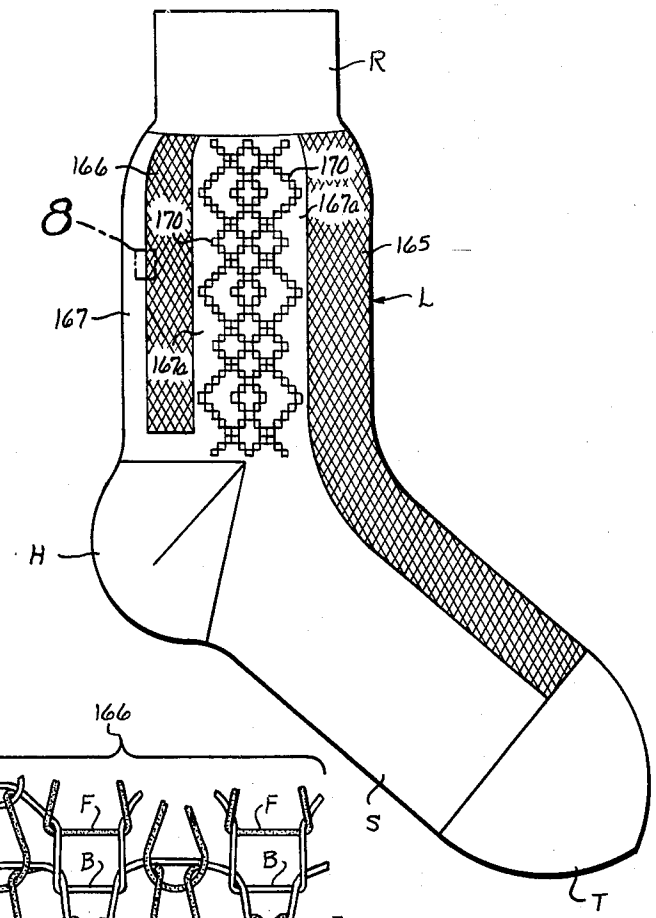
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Dec. 27, 1955 F. K. STEVENS ET AL 2,728,210

TUCK AND WRAP KNITTING APPARATUS

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Fig. 7



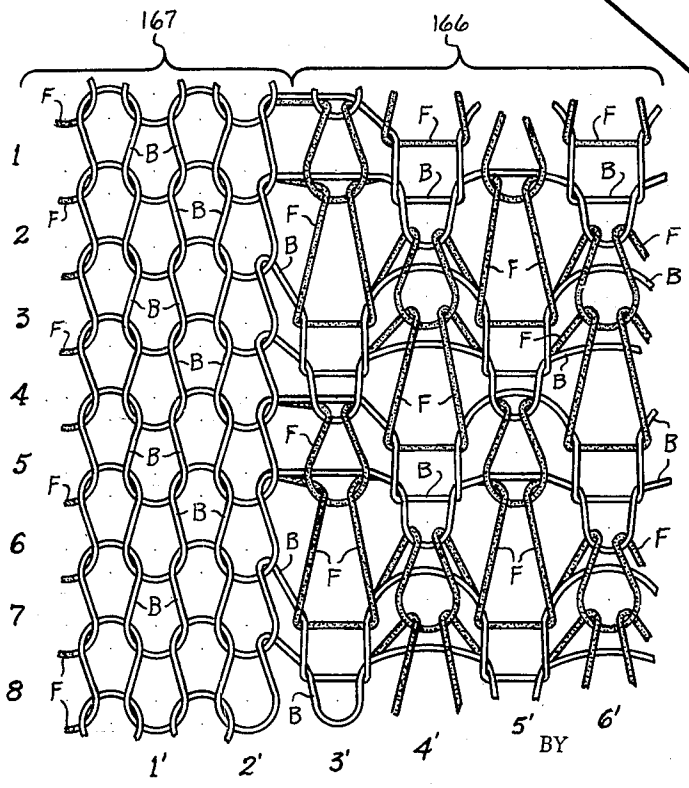


Fig. 8

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ATTORNEYS.

United States Patent Office 2,728,210 Patented Dec. 27, 1955

2,728,210

TUCK AND WRAP KNITTING APPARATUS

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Application April 12, 1954, Serial No. 422,356

11 Claims. (Cl. 66—135)

This invention relates to circular knitting machines and, more especially, to an improved needle control apparatus for producing circularly knit fabrics having circularly arranged areas, one or more of which are formed with tuck or lace stitches and one or more others of which are formed with plain stitches, in which two or more body yarns are knitted in plating relation with wrap yarns interknitted therewith to form true wrap stripes according to a predetermined pattern. The improved needle control apparatus is devised for use with circular knitting machines substantially of a type known as a "Banner Wrap-Reverse Model ESJ Knitting Machine."

It is the primary object of this invention to provide a simple attachment for knitting machines substantially of the character described which may be economically constructed and maintained for controlling the needles to produce a fabric having spaced "diagonal network" or tuck-stitch areas, between certain of which, areas are formed of wrap yarn superimposed over plain knit fabric.

As is well known in the art, Banner Machines of the character described are usually provided with circularly arranged needle cams, including a set of stitch cams and a leveling cam with a main yarn feed station spaced above the stitch cams and a selector mechanism for operating a plurality of selector fingers or plungers spaced between and below the level of the stitch cams and the leveling cam. A wrap head is usually provided for feeding wrap yarns to selected needles in advance of the main yarn feed station, these selected needles being raised to take the wrap yarn from the fingers of the wrap head by means of needle jacks which are operated upon by the selector fingers.

It is therefore a more specific object of this invention to provide an improved duplex or dividing switch cam including first and second superposed inclined needle jack controlling cams which are movable into and out of operative position in unison and are positioned in advance of the vertical plane of the stitch cams and are spaced substantially below the point at which the wrap yarns are fed from the wrap head. The first or lower inclined cam is spaced substantially beneath and slightly subsequent to the second or upper inclined cam and has an upper surface of a given or first level thereon.

The second or upper inclined cam has an intermediate and a relatively high upper surface thereon as compared to the upper surface of the first cam and the portion of the second inclined cam leading up to the intermediate surface is disposed more closely adjacent the periphery of the needle cylinder than the inner surfaces of the first cam and the portion of the upper or second inclined cam which extends from the intermediate level to the upper level.

The selector fingers are disposed in advance of the vertical plane of the improved inclined jack controlling cams and the jacks are formed into groups of long master butt jacks and short master butt jacks. The short butt jacks are provided for controlling those needles which knit the

tuck-stitch or lace areas in the fabric and the long butt needle jacks are provided for controlling needles knitting the plain knit plated areas and those plain knit plated areas in which true wrap stripe designs are formed.

Body yarns are fed at two different levels and the wrap yarns are fed at a higher level than said two different levels so that, in knitting each successive course, some selected needles may take the body yarn from the lowermost level only, other selected needles may take the body yarn from both of said two different levels and still other needles may take the yarn from the wrap yarn feed fingers as well as taking the body yarn from both of said two different levels.

By controlling the selector jacks in this manner, spaced or alternate needles may take the body yarn from one level while the body yarn from the other level is floated in forming spaced or alternate courses and the needles between said alternate or spaced needles may take said body yarn from one level while floating the body yarn on the other level in forming the courses between said spaced or alternate courses thereby forming tuck stitches so the usual needle wales formed by the needles above the short butt jacks are so distorted as to become substantially unrecognizable and the loops or stitches thus formed appear as ribs and may extend diagonally rather than lengthwise of the fabric. Actually, the stitches are then more prominent in the sinker wales than in the needle wales.

Of course, while the needles are forming the tuck stitches or lace areas, those needles positioned above the long butt jacks will take the body yarn from both levels and cooperate with the sinkers in normal plating or reverse plating and selected ones of these last-named needles may take the wrap yarn to form true wrap areas of predetermined configuration over the plain knit fabric knitted from the body yarns taken from said two different levels.

Some of the objects of the invention having been stated, other objects will appear as the description proceeds when taken in connection with the accompanying drawings, in which—

Figure 1 is a fragmentary left-hand side elevation of a knitting machine showing some of the parts of the present invention in association therewith;

Figure 2 is a top plan view, partially in section, of the structure shown in Figure 1;

Figure 3 is a fragmentary perspective view looking in the general direction of the arrow 3 in Figure 2 and showing parts of the means for controlling radial movement of the improved duplex or jack-dividing switch cam;

Figure 4 is a diagrammatic illustration showing the arrangement of the needle and jack control cams and showing some of the needles in different positions;

Figure 5 is a fragmentary vertical sectional view taken substantially along line 5—5 in Figure 4;

Figure 5–A is a fragmentary view showing the cams for controlling radial movement of the dividing switch cam;

Figure 6 is a fragmentary vertical sectional view taken substantially along line 6—6 in Figure 4;

Figure 7 is an elevation of one side of a stocking illustrating designs which may be produced by means of the improved tuck and wrap knitting apparatus;

Figure 8 is a greatly enlarged fragmentary view of the broken line area indicated at 8 in Figure 7 showing the staggered tuck-stitch or lace formations which may be produced by means of the improved apparatus.

Referring more specifically to the drawings, the circular knitting machine illustrated is substantially of the type disclosed in United States Patent No. 2,374,538 of April 24, 1945, with the exception of the improve-

ments in the needle and jack cam arrangements and, of particular importance is the fact that the improved duplex or jack-dividing cam having the three levels thereon adequately controls the jacks in response to only a single set of selector fingers or plungers whereas the apparatus disclosed in said Patent No. 2,374,538 includes two sets of circularly spaced selector fingers or plungers.

The knitting machine is of a type having a needle cylinder **20** rotatable in the usual manner upon a substantially circular base **21**. The needle cylinder has the usually vertically extending slots in the periphery thereof in which conventional latch needles, generally designated at N and corresponding needle jacks are mounted for vertical movement. In this instance, the needle jacks are divided into groups of long master butt jacks indicated at J–1 and groups of short master butt jacks indicated at J–2, the master butts thereon being respectively designated at **22** and **23** (Figure 4).

Sinkers, not shown, cooperate with the needles N in the usual manner of drawing stitches, said singers being carried in a sinker head **25**, above which is a sinker cam cap **26**. A latch ring **27** is disposed above the sinker cam cap **26** and is pivoted, as at **30**, on a post **31**. The latch ring **27** has a throat opening **32** therein whose bottom is closed by a throat plate **33** and in which a plurality of yarn feed fingers are positioned.

The throat opening **32** defines a main yarn or body yarn feed station and, in this instance, there are four yarn feed fingers positioned therein indicated at **34**, **35**, **36** and **37**. For purposes of description, the body yarn feed finger **34** may be termed as a facing yarn feed finger and the body yarn feed finger **35** may be termed as a backing yarn feed finger, which serve to direct a facing yarn F and a backing yarn B, respectively, to corresponding needles N.

In order to produce a knitted structure such as that shown in Figure 8, it should be observed in Figure 4 that the throat plate **33** is provided with stepped upper surfaces **33***a* and **33***b* so that, when the yarn feed fingers **34** and **35** are in operative position, the facing yarn F is fed to the needles on a slightly lower level than the backing yarn B. The yarn feed fingers **34**, **35**, **36** and **37** are pivoted in an extension **27***a* to the latch ring **27** and are controlled in the usual manner to feed and change yarns, such as by the means shown in United States Patent No. 933,443.

The knitting machine is also provided with a cam plate **40** spaced above the bed plate or base plate **21** and on which the usual needle cams are mounted along with the improved duplex jack controlling cam and a needle raising switch cam. The conventional cams are not shown in detail, but will be described more specifically with reference to Figure 4.

Wrap yarns W, only one of which is shown in Figure 4, are fed to selected needles preferably by mechanism such as is illustrated and described in United States Patent No. 2,230,213, and, in this case, only a few of the parts of that mechanism are shown comprising a wrap head spindle **42** (Figure 2) having a pair of disks **43** thereon from which depends a plurality of wrap yarn feed fingers **44** through each of which a wrap yarn W is threaded and fed, only one of said wrap yarn feed fingers being shown in Figure 4. The wrap yarn feeding spindle **42** is driven in a conventional manner to rotate at a one by one ratio with the needle cylinder **20**.

In order to product a stocking of the character shown in Figure 7 and embodying the fabric structure shown in Figure 8, it is necessary that the eyes of the wrap yarn feed fingers **44** are disposed on a higher level than the eyes of both the body yarn feed fingers **34**, **35** as shown in Figure 4. Thus, the yarns F, B and W are fed on first, second and third levels of low, intermediate and high relativity, respectively. The manner in which the spindle **42** is supported and the manner in which the

wrap yarn feed fingers **44** are controlled may be substantially as shown in said Patent No. 2,230,213 and a further detailed illustration and description thereof is thus deemed unnecessary.

It will be observed in Figure 2 that the knitting machine is preferably provided with a pattern drum **50** which controls plating and reverse plating through mechanism in the sinker cam cap **26**. The drum **50** has a series of disks, each of which has a plurality of butts **51** which are removable and whereby a pattern is set up on the drum for controlling the position of a series of plungers **52**. The plungers **52** contact butts on sinker jacks, not shown, for controlling the position of the sinkers substantially as described in United States Patent No. 2,052,777.

The structure shown for controlling the sinkers is also substantially as shown in United States Patent No. 2,374,538 and, therefore, a further description and illustration thereof is deemed unnecessary. As a matter of fact, the pattern drum **50**, plungers **52** and associated parts could be omitted and the sinkers controlled by the usual sinker cams in the usual manner without controlling the plating of the yarns, if desired, without departing from the spirit of the invention.

The substantially circular base or bed plate **21** is supported on the usual frame **60** (Figure 1), and the frame **60** has rotatable in suitable bearings, a main cam shaft **61** upon which a cam drum or pattern drum **62** is fixedly mounted. The cam shaft **61** rotates one revolution for each knitted stocking produced and has the usual cams, along with special cams later to be described, mounted thereon which control the various functions of the machine. Only the cams pertinent to the present invention will be described, later in this context.

The substantially circular base or bed plate **21** has a bracket **63** mounted thereon which carries a pattern drum or selector drum **64** rotatable on a spindle **65** (Figures 1 and 2). Actually, the spindle **25** is supported within an arm **66** pivoted on the bracket at **67** (Figure 2) and guided at its other end by a shoulder screw **68** extending through a slot **69**. A spring **70** is connected to bracket **63** and to the arm **66** and serves to pull that arm inwardly against an adjustable stop screw **71**. A lever **72** pivots at **73** and, by means of a connecting lever **74** and a link **75** (Figure 1), the drum **64** may be moved away from the cylinder when and if desired.

The drum **64** and associated parts, including elements **63** to **75**, inclusive, may be identical to the drum **24** and associated parts shown in United States Patent No. 2,374,538. The selector drum **64** also has a plurality of disks fixed thereto, each of said disks having frangible butts **76** and it being understood that these butts may be broken off according to any desired pattern. The selector drum **64** is ratcheted or racked periodically by mechanism including a pawl **77**, a plate **78** and a link **79**, the link **79** being connected to other mechanism, all of which may be substantially as shown and described in United States Patent No. 1,702,608.

The butts **76** contact the outer ends of a series of selector fingers or plungers **80** for moving the selector fingers **80** inwardly and outwardly to and from the needle cylinder **20** in accordance with the desired pattern. The inner ends of the selector fingers **80** are engaged by selector butts **81** (Figure 4) on the needle jacks J–1 and J–2 and serve to select those jacks by imparting a short vertical movement thereto.

As heretofore stated, the cam plate **40** carries the needle and jack controlling cams and, reading from right to left in Figure 4, there will be observed a segmental needle leveling cam **85** which has means thereon, not shown, for engaging the butts of, and raising, the needles N after they have passed through the stitch cams. The upper edge of the segmental cam **85** has a recess **86** therein in which the inner portion of a novel pattern controlled needle raising switch cam **87** is normally disposed.

The needle raising switch cam **87**, when in operative

position, serves to raise the needles N so the latches thereof are raised above the level of the stitches, thus positioning the stitches on the shanks of the needles or below the latches thereof. Heretofore, this operation has been performed by the right-hand stitch cam, but it must be performed before the needles reach the stitch cams because some needles remain lowered to take yarn F from finger 34 only and this would not be possible if the right-hand stitch cam was in operative position. After the butt of each successive needle N has been raised by the needle raising switch cam 87 it engages a forwardly and downwardly inclined surface 90 of an instep cam 91, the inclined surface 90 serving as a leveling cam for the needles.

The instep cam 91 has a recess 92 in its lower surface intermediate the ends thereof and is formed with a pair of cam projections 93 and 94 at its end remote from the downwardly and forwardly inclined surface 90, adjacent the stitch cams. The stitch cams comprise top and bottom center cams 95 and 96 and right-hand and left-hand stitch cams 97 and 98, the stitch cams 97 and 98 being alternately movable into operative position in the usual manner for deflecting the needles downwardly after having taken the yarn from the main yarn feed station 32, depending upon the direction of movement of the needles N. Any of those needles which are lowered by the left-hand stitch cam 98 in Figure 4 are elevated by the cam 85 and the needles, when moving from left to right in Figure 4, after being lowered by the right-hand stitch cam 97, are elevated by a stationary needle raising cam 100. The top and bottom center cams 95 and 96 are stationary and are supported on a block 102 fixed to the cam plate 40. The cams 100 and 85 are also fixed to the cam plate 40.

It should be noted that cam 100 also functions to lower the jacks J–1 and J–2 after they have passed the vertical plane of the wrap yarn feeding station, indicated by finger 44, as they move from right to left in Figure 4. Suitable conventional means, not shown, may be provided for elevating the jacks to the position in which they are shown in Figure 4 after they have been lowered by cam 100.

The needle raising switch cam 87 forms a part of the present invention to the extent that it is provided because of the fact that the yarn feed fingers 34, 36 and 37, when in operative position, are disposed on a relatively lower level than that normally occupied thereby so the hooks of the needles are barely positioned at a high enough level to take the yarn from the last-named feed fingers and will thereby miss the backing yarn B fed from the yarn feed finger 35, unless prior selection has been made to cause certain needles to be projected to a slightly higher level for taking both the yarns B and F. The means for controlling the needle raising switch cam 87 will now be described.

Referring to Figures 1, 2 and 6, it will be observed that the needle raising switch cam 87 has a shank 105 thereon which is mounted for radial sliding movement, relative to the needle cylinder 20, in the upper horizontal leg of a substantially C-shaped bracket 106. The lower horizontal leg of the C-shaped bracket 106 is suitably secured to the lower surface of the annular cam plate 40. The outer end of the shank 105 of the cam 87 has a laterally extending pin 107 suitably secured thereto, as by welding, which penetrates a slot 110 in the upper end of the substantially vertical leg 111 of a bell crank 112.

The bell crank 112 has an angularly disposed leg 113 (Figure 6) thereon which is pivoted intermediate its ends, as at 114, on a bracket 115 suitably secured to the bracket 63 carried by bed plate or base 21. The slotted outer end of the crank arm 113 is loosely penetrated by a thrust rod or link 120 having a pair of spaced collars or abutments 121 and 122 fixed thereon which straddle the corresponding end of the crank arm 113.

The lower end of a compression spring 123 bears against the upper surface of the lower collar 123 and this spring 123 encircles the upper portion of the thrust rod 120 and its upper end bears against the lower surface of the crank arm 113. The lower end of the link or thrust rod 120 is pivotally connected, as at 124, to a cam follower lever 125 (Figure 1). The cam follower lever 125 is pivoted at 126 on a bracket 127 carried by the frame 60. The nose of the cam lever 125 is urged into contact with a pair of circularly spaced cams 130 and 131, carried by the drum 62, or downwardly on the cam drum 62, by means of a spring 132 which is connected to the lever 125 and a fixed part of the machine.

Whenever the toe of the lever 125 rides on one of the cams 130 or 131, the link 120 occupies the raised position shown in Figure 1, thereby maintaining the needle raising switch cam 87 in operative position against the needle cylinder 20 so that it is engaged by the butts on each successive needle N to raise the same as shown in Figure 4. As is well known, the needles in most circular knitting machines are provided half with long butts and half with short butts for the purpose of knitting the heel pocket and the toe pocket and the spring 123 functions to permit the cam 87 to move into operative position by first engaging the outer ends of the short butts and as it subsequently elevates the long but needles. The cam 87 then moves into fully operative position so as to operate upon both the long butt and short butt needles.

It follows that, when the toe of the cam follower lever 125 is riding against the periphery of the cam drum 62, the needle raising switch cam 87 is then spaced from the needle cylinder 20 sufficiently to permit both the long butts and short butts on the needles N to move past the cam 87 without being engaged thereby. In this instance, the relatively short exposed surface of the pattern drum or cam drum 62 between the cams 130 and 131 in Figure 1 engages the toe of the lever 125 during the knitting of the heel pocket and the relatively long exposed portion of the cam drum or pattern drum 62 between the cams 130 and 131 engages the toe of the lever 125 during the knitting of the toe and the top of the stocking. Thus, the leg of the stocking would be knitted while the toe of lever 125 is in engagement with cam 131 and the foot of the stocking between the heel and toe, would be knit while the cam 130 is in engagement with the toe of the lever 125.

Now, in order to selectively control the needles so they may take the yarn from one, two or three yarn feed fingers, such as fingers 34, 35 and 44 in Figure 4, we have provided a duplex jack-dividing cam broadly designated at 140 which comprises a lower upwardly and forwardly inclined cam 141 and an upper upwardly and forwardly inclined cam 142 spaced substantially above the cam 141.

It will be noted that the cams 141 and 142 are spaced substantially beneath the point at which the wrap yarn is fed from the yarn feed fingers 44, only one of which is shown in Figure 4, and the uper end of the cam 141 is formed with a lower level surface 143 thereon which is disposed forwardly of, or subsequent to, the point at which the wrap yarns are fed to the needles. The cam 142 is formed with an intermediate level surface 144 thereon, above which the cam 142 is cut away to form an upper or third level surface 145 thereon spaced above the level of the surface 144.

The portion of the cam 142 from the lower rear edge thereof to the level 144 projects inwardly toward the needle cylinder beyond the portion of the cam 142 extending between levels 144 and 145 and the inner surface of the cam 141 is disposed in the same vertical plane as the inner surface of the portion of the cam 142 between the levels 144 and 145.

The relative positions of the inner surface of the cam 141 and the inner surfaces of the upper and lower portions of cam 142 are most clearly illustrated in Figure 5. It will be noted that, when the duplex dividing cam 140 is in operative position, with the inner surface of the lower portion of cam 142 disposed closely adjacent

or against the periphery of the needle cylinder **20**, the long master butts **22** on selected jacks J–1 may engage the upper inclined surfaces of both the cams **141** and **142** when selected by the selector fingers **80** while the short butts **23** on selected jacks J–2 will engage the inclined surface of the lower portion of cam **142** only, so these last-named jacks may be elevated only to the intermediate level **144**. This is an important feature of the present invention and its purpose will be more fully described later in this context.

The jack-dividing cam **140** has a shank **146** thereon (Figures 2, 3 and 5) which is guided in a block **147** fixed on the cam plate **40**. The shank **146** is provided with a slot **150** which is penetrated by a shoulder screw **151**, which serves to maintain the shank **146** of the duplex cam **140** in engagement with the grooved block **147**. The jack-dividing cam **140** is normally urged into operative position by a tension spring **152**, one end of which is connected to the shank **146** of cam **140** and the other end of which is connected to a fixed part of the machine (Figure 3).

The shank **146** extends outwardly beyond block **147** and has a laterally projecting arm **153** thereon which is engaged by an upwardly and inwardly inclined portion **155** of a thrust rod **156** (Figure 5). It will be observed in Figures 2, 3 and 5 that the inclined portion **155** is connected to the inner end of an outwardly curving portion **157** of the thrust rod **156** which then extends downwardly at **160** and, as shown in Figure 5–A, the lower end of the portion **160** of thrust rod **156** is adapted to be engaged by a pair of circularly spaced cams **161** or **162** or the periphery of the cam drum or pattern drum **62**, to which the cams **161** and **162** are suitably secured. The cams **161** and **162** have been omitted from Figure 1 for purposes of clarity.

It will be noted that, when the thrust rod **156** is in lowered position against the periphery of the cam drum or pattern drum **62**, the duplex switch cam or dividing cam **140** is then urged into operative position by the spring **152**. Thus, the relatively short space on the periphery of the pattern drum **62** between the cams **161** and **162** engages the lower end of the portion **160** of thrust rod **156** during the knitting of the foot of the stocking, and the relatively long space between the other ends of the cams **161** and **162** on the periphery of the pattern drum **62** engages the lower end of the portion **160** of the thrust rod **156** during the knitting of the leg of the stocking.

When the heel of a stocking is being knitted, the cam **161** is in engagement with the lower end of thrust rod **156** (Figure 5–A) and during the knitting of the toe and top of a stocking, the cam **162** is in engagement with the lower end of the thrust rod **156**. It will be noted that, when the lower end of the thrust rod **156** is engaged by either of cams **161** or **162**, the thrust rod **156** is moved upwardly relative to the position shown in Figure 5 and the inclined portion **155** thereon causes the duplex or dividing switch cam **140** to be withdrawn from operative position.

Referring to Figure 7, a typical men's half hose or stocking is illustrated which includes a plain knit top R, which preferably has an elastic yarn interknitted with or laid in stitches formed from the body yarn. The stocking also has a leg broadly designated at L, a heel pocket H, a foot S and a toe T. The toe is illustrated as though it is looped, but, of course, it is to be understood that the operation of looping the toe is performed after the stocking has been knitted and removed from the machine. Although only one side of the stocking is illustrated in Figure 7, it is to be understood that both sides of the stocking may be identical and the leg L is formed with spaced tuck-stitch, diagonal network or lace areas **165** and **166** at its front portion and adjacent its rear portion and between the areas **166** on opposite sides of the rear portion of the leg of the stocking is a solid plain knit area **167**.

It will be noted that the lace area **165** extends from the top R of the stocking throughout the length of the leg L and throughout the instep of the foot S terminating at the toe T. In the leg of the stocking, between adjacent lace areas **165** and **166**, plain knit areas **167***a* are formed over which irregularly shaped true wrap areas **170** are formed. The wrap areas **170** extend from the top R and terminate adjacent the heel H. The foot S of the stocking is formed from plain knit stitches with the exception of the portion of the instep in which the lace stitch area **165** is present.

The stocking shown in Figure 7 embodies only one of many different lace and wrap designs which may be produced on the present machine and, although it is preferable that the top R, the heel H and the toe T of the stocking shown in Figure 7 are knit while the yarn feed fingers **36** and **37** (Figure 4) are in operative- or lowered position, it is to be distinctly understood that any one or more of the three yarn feed fingers **34**, **36** or **37** may be in lowered or operative position during the knitting of the top R, the heel H and the toe T as desired. Since the elastic yarn may be fed to the needles during the knitting of the top R in the usual manner, a disclosure of the means for feeding the elastic yarn to the needles is omitted from the present drawings.

A greatly enlarged illustration of the portion of the stocking indicated at **8** in Figure 7 is shown in Figure 8 wherein the particular partial courses illustrated are indicated at **1** to **8**, inclusive, and the particular partial wales illustrated are indicated at **1′** to **6′**, inclusive. In controlled plating, it is well known that either of the yarns F or B may appear on the outer face of the fabric as it is knitted and, in Figure 8, the backing yarn B appears on the outer face of the fabric portion **167**. It will also be noted in Figure 8 that the backing yarn B is floated in back of the stitches formed from the facing yarn F in alternate wales in alternate pairs of courses in forming the lace area **166** and, although the backing yarn is also floated in back of the stitches formed from the facing yarn in alternate wales in all of the courses, stitches are formed from both the facing yarn and the backing yarn in the courses between said alternate pairs of courses, but in the same wales in which the backing yarn is floated in back of the stitches formed from the facing yarn in said alternate courses.

In other words, a needle takes both yarns B and F in alternate wales while a needle taking only one yarn knits in the wales between said alternate wales and the wale knit by a needle taking only one yarn is regularly reversed each time two courses are knitted so that the needles which took both yarns then take one only, and the needles which took the single yarn thereafter take both, to form tuck-stitches in alternate wales and in alternate pairs of courses in staggered relationship to form the lace fabric which is referred to as "diagonal network" or "diamond mesh" fabric in the areas **165** and **166**.

This fabric is a one-face or plain fabric and is distinguished by its capacity to stretch in either dimension of the fabric with concomitant contraction in the other direction, and is substantially of the class disclosed in the patent to Smith, No. 1,772,230, dated August 5, 1930.

The illustration in Figure 8 is schematic to the extent that the stitches in the lace area **166** are shown in the order in which they are knit. Due to the alternation of the facing yarn floats, however, the stitches are actually distorted and formed into serpentine or zig-zag sinker wales.

Method of operation

During the knitting of the top R of a stocking such as that shown in Figure 7, the needles N move from right to left in Figure 4 and the needle raising switch

cam 87 and the duplex dividing cam 140 are then in withdrawn or inoperative position while both stitch cams 97 and 98 are in operative position. Thus, the needles move in a straight path from the right-hand portion of Figure 4 until they engage the cam 97 whereupon they are elevated to cause the prior stitches thereon to be slid down the shanks of the needles and below the latches thereof. Thereafter, the top center cam 95 lowers the needles so that they take the yarn from any one or more of the yarn feed fingers 34, 36 or 37, depending on which of these fingers are in lowered position against the upper surface 33*a* of the throat plate 33. Thereafter, the needles cooperate with the sinkers in the usual manner of forming stitches. When the needles are raised by the right-hand stitch cam 97 in Figure 4, they are also raised sufficiently to take the yarn from the yarn feed finger 35 if it then happens to be in lowered position against the shoulder 33*b* on the throat plate 33.

After the ring courses have been knitted between the top R of the stocking and the leg L, the cam 162 (Figure 5–A) moves out of engagement with the lower end of the portion 160 of thrust rod 156 as cam 131 moves into engagement with the toe of the follower lever 125 in Figure 1.

It is apparent that the thrust rod 156 then moves downwardly to permit the spring 152 to move the duplex dividing cam 140 into operative position as shown in Figures 4 and 5 and upward movement of the cam lever 125 in Figure 1 causes the needle raising switch cam 87 to move into operative position as shown in Figures 4 and 6. Since both of the switch cams 87 and 140 are urged inwardly resiliently, it is apparent that the cam 87 moves inwardly while the short butt needles are moving thereby and engages the ends of the short butts and then passes beneath the long butts and thus moves into fully operative position. Also, it is apparent that the duplex dividing cam 140 initially moves into engagement with the short butts 23 on needle jacks J–2 and subsequently moves into fully operative position as the long butts engage and ride up the lower inclined cam 141.

Now, all the needles which knit the lace areas 165 and 166 have corresponding short butt jacks J–2 therebeneath and those needles knitting in the solid or plain knit areas 167 and 167*a* are provided with corresponding long butt jacks J–1 therebeneath.

As the jack dividing cam 140 goes into operative position, it follows that the short master butt needle jacks J–2 continue to move at a given level past the lower inclined cam 141 and, since switch cam 97 is then in withdrawn or inoperative position, those short butt jacks J–2 whose selector butts 81 are not engaged by a selector finger 80 will take the yarn F from the yarn feed finger 34 only, assuming the fingers 36 and 37 to be in raised or inoperative position and assuming the yarn feed finger 34 to be in operative position against the surface 33*a* of the throat plate 33.

However, those short butt jacks J–2 whose selector butts 81 are engaged by corresponding selector fingers 80 are elevated so the short butts 23 thereon engage the upper inclined cam 142 and are raised to the level 144. Accordingly, in knitting the fabric such as that shown in Figure 8, alternate short butt jacks J–2 raise corresponding alternate needles to where the hooks thereof will take the backing yarn B from the yarn feed finger 35 and will also take the facing yarn F from the yarn feed finger 34. Of course, prior to reaching the vertical plane of the selector fingers 80, the butts of all the needles engage and are elevated by the needle raising switch cam 87 to insure that the latches on these needles move upwardly above the stitches then held by these needles.

In the meantime, the long master butts 22 on needle jacks J–1, whose selector butts 81 are not engaged by selector fingers 80, engage the inclined upper surface of the lower inclined cam 141, elevating the same to the level 143 so that such needle jacks J–1 also cause corresponding needles to take the yarn from both of the fingers 34 and 35 such as in knitting the area 167 (Figures 7 and 8) and those portions of the area 167*a* in which the true wrap is not present. Any of the long butt needle jacks J–1 whose selector butts 81 are engaged by corresponding selector fingers 80 are elevated to where they will ride up the inclined upper surface of the upper inclined cam 142, beyond the level 144 to the level 145, thus causing needles corresponding to the last-named selected jacks J–1 to take the wrap yarn in the hooks thereof.

Thereafter, the butts of the latter needles engage and are lowered by the cam projection 93 on the instep cam 91 to where they will move into engagement with the top center cam 95 and will thus take the yarn from both of the fingers 34 and 35 prior to being lowered by the stitch cam 98 in drawing stitches. This operation of the needle jacks and of the corresponding needles is carried out in a plurality of successive courses which, in this instance, includes two successive courses.

Thereafter, the operation of the needle jacks and corresponding needles is the same as that previously described in the formation of alternate pairs of courses, with the exception that the short butt needle jacks J–2 whose selector butts 81 had previously been engaged by corresponding selector jacks 80 then fail to engage corresponding selector jacks and, thus, will only take the yarn F from the yarn feed finger 34 and form stitches therefrom while, on the other hand, those short butt needle jacks J–2 whose butts had previously failed to engage corresponding selector fingers 80 will then be engaged by selector fingers so they are elevated, causing the short butts 23 thereon to ride up the lower portion of upper inclined cam 142 to the level 144 so they will then take the yarn from both yarn feed fingers 34 and 35. Of course, the portions of the courses between said alternate courses in the areas 165 and 166 will be repeated in the manner in which the original description was given as to the operation of the short butt needle jacks J–2 and corresponding needles.

It is thus seen that we have provided a simple and effective means for accurately controlling the operation of the needles so they may selectively take the yarn from the yarn feed finger 34 only or from both the body yarn feed fingers 34 and 35 or from all three of the yarn feed fingers 34, 35 and 44 so the tuck-stitch, diagonal network or lace areas, such as 165 and 166 in Figures 7 and 8, may be formed in portions of courses while plain knit plated fabric may be formed in other portions of the courses and also while the true wrap areas may be formed in still other portions of the courses wherein the wrap yarn is plated over the fabric formed from the same yarns as are employed in forming those plain knit areas in which there are no true wrap designs.

Of course, in knitting the foot S of a stocking such as that shown in Figure 7, it follows that none of the selector butts 81 on any of the long butt needle jacks J–1 would be engaged by corresponding selector fingers 80 whereby none of the corresponding needles would take wrap yarn, but all of the needles corresponding to the long butt jacks would then take the yarn from both yarn feed fingers 34 and 35 in forming the lower portion of the foot S. Also, all those short butt needles which had been knitting in the area 166 in the leg of the stocking would have the selector butts 81 thereon engaged by corresponding selector fingers 80 in order to form a solid plain knit area in the lower portion of the foot S.

It is apparent that this would cause all those needles which had previously been knitting in the area 166 in the leg L to engage the lower portion of cam 142 and elevate the corresponding needles to where they would take both yarns F and B from the fingers 34 and 35. However, the short butt needles which had been knitting in the area 165 in the leg L will continue to function in the manner heretofore described to form the lace or di-

agonal network area in the instep portion of the foot S.

In knitting the heel pocket H and the toe T, any one or more of the yarn feed fingers 34, 35, 36 and 37 may then be in lowered or operative position, the stitch cams 97 and 98 would be alternately moved into operative position during reciprocatory motion of the needle cylinder and the cams 87 and 140 would be in inoperative position, as the lower end of the portion 160 of the thrust rod 156 is engaged by the respective cams 161 and 162 in Figure 5–A and as the portions between the proximal ends of the cams 130 and 131 in Figure 1 are successively engaged by the toe of the cam lever 125.

In the drawings and specification there has been set forth a preferred embodiment of the invention and although specific terms are employed, they are used in a generic and descriptive sense only, and not for purposes of limitation, the scope of the invention being defined in the claims.

We claim:

1. In a circular knitting machine having a circular series of needles, jacks for the needles, a single series of selector plungers for selecting said jacks and a set of stitch cams; the combination of means for feeding first and second body yarns on respective first and second levels, means for feeding at least one wrap yarn on a third level, a jack-dividing switch cam disposed in advance of the stitch cams, means to cause needles corresponding to first non-selected jacks to take the first body yarn only and to draw stitches therewith, means on the dividing switch cam for raising second selected jacks for taking the first and second body yarns and to draw stitches therewith, and means on said dividing switch cam engageable by third selected jacks for raising corresponding needles to take the wrap yarn and the first and second body yarns and to draw stitches therewith.

2. In a knitting machine having a circular series of needles and jacks for the needles, the combination of a main feeding station, means for feeding first and second yarns on respective first and second levels at the main feeding station, a wrap yarn feeding station in advance of said main feeding station, means for feeding at least one wrap yarn at said last-mentioned station, jack dividing means for causing certain needles to take said first yarn only, for raising other needles to take the first and second yarns at the main feeding station and for raising still other needles to take the wrap yarn and the first and second yarns from the main feeding station, and a single selector mechanism having pattern controlled plungers thereon functioning to select jacks prior to their passage through said jack dividing means.

3. In a circular knitting machine having a needle cylinder, a circular series of needles and corresponding jacks mounted for vertical movement in the needle cylinder, a series of needle cams including a set of stitch cams, a stationary leveling cam spaced substantially in advance of the stitch cams for elevating the needles to a predetermined level prior to their reaching the stitch cams, a main feeding station spaced above the stitch cams for feeding facing yarn and backing yarn on a relatively low and an intermediate level, respectively, means for feeding wrap yarns in advance of the main feeding station on a relatively high level, and a single selector mechanism for operating upon selected jacks disposed in advance of the vertical plane of the wrap yarn feeding means; the combination of said jacks being divided into at least two groups, a first of said groups having long butts thereon and a second of said groups having short butts thereon, means engageable by non-selected long butt jacks for elevating the same to a first relatively low level to cause the corresponding needles to take the yarns from the main station on both the lower and the intermediate levels, non-selected short butt jacks being adapted to miss the last-named means to cause corresponding needles to take the facing yarn disposed on the lower level only, means engageable by selected short butt jacks to cause the same to be elevated to an intermediate level to where corresponding needles will also take the facing and backing yarns from both the lower and the intermediate levels, and means engageable by selected long butt jacks to cause corresponding needles to take yarn from the wrap yarn feeding means and the yarns disposed on both the lower and the intermediate levels.

4. In a circular knitting machine having a set of stitch cams, a circular series of latch needles, jacks for the needles and a single selector mechanism for operating upon selected jacks; the combination of a main feeding station, means for feeding first and second body yarns on respective first and second levels, at the main feeding station, means for feeding at least one wrap yarn on a third level disposed higher than the first and second levels, at least one first group of said jacks having relatively long butts thereon, at least one second group of said jacks having relatively short butts thereon, a jack-dividing cam disposed between said selector mechanism and said wrap yarn feeding means, said jacks being so arranged relative to the first yarn feeding means that those jacks having short butts thereon and which are not operated upon by the selector mechanism cause corresponding needles to take the first body yarn only, means on the jack-dividing cam for raising non-selected long butt jacks to a given level to raise corresponding needles for taking the first and second yarns from the respective first and second yarn feeding means, means on the jack-dividing cam for raising selected long butt jacks to another level higher than said given level to cause corresponding needles to take yarn from the wrap yarn feeding means and to take both of the yarns from the main feeding station, and means on the jack-dividing cam for raising selected short butt jacks to still another level lower than said other level and higher than said given level to cause corresponding needles to take the first and second body yarns from the main feeding station.

5. In a circular knitting machine having a set of stitch cams, a circular series of needles, jacks for the needles and a single selector mechanism for operating upon selected jacks; the combination of a main feeding station, means for feeding first and second body yarns on respective first and second levels at the main feeding station, means for feeding at least one wrap yarn on a third level disposed higher than the first and second levels, at least one first group of said jacks having relatively long butts thereon, at least one second group of said jacks having relatively short butts thereon, a jack-dividing cam disposed between said selector mechanism and said wrap yarn feeding means, said jacks being so arranged relative to the first yarn feeding means that those jacks having short butts thereon and which are not operated upon by the selector mechanism cause corresponding needles to take the first body yarn only, means on the jack-dividing cam for raising non-selected long butt jacks to a given level to raise corresponding needles for taking the first and second yarns from the respective first and second yarn feeding means, means on the jack-dividing cam for raising selected long butt jacks to another level higher than said given level to cause corresponding needles to take yarn from the wrap yarn feeding means and to take both of the yarns from the main feeding station, means on the jack-dividing cam for raising selected short butt jacks to still another level lower than said other level and higher than said given level to cause corresponding needles to take the first and second body yarns from the main feeding station, and means disposed between the wrap yarn feeding means and the main feeding station for lowering any of those needles which are raised to take the wrap yarn to where the latches thereof are disposed below the levels at which the first and second body yarns are fed thereto at the main feeding station.

6. In a circular knitting machine having a set of stitch cams, a circular series of latch needles, jacks for the needles and a single selector mechanism for operating upon

selected jacks; the combination of a main feeding station, means for feeding first and second body yarns on respective first and second levels at the main feeding station, means for feeding at least one wrap yarn on a third level disposed higher than and in advance of the first and second levels, at least one first group of said jacks having relatively long master butts thereon, at least one second group of said jacks having relatively short master butts thereon, a jack-dividing switch cam disposed between said selector mechanism and said wrap yarn feeding means, said jacks being so arranged relative to the first yarn feeding means that those jacks having the short butts thereon which are not operated upon by the selector mechanism cause corresponding needles to take the first body yarn only, said switch cam having first, second and third upper surfaces thereon, said first surface on the switch cam being lower than the second surface and said second surface being lower than the third surface, said second surface on the switch cam being closer to the needle cylinder than the first and third surfaces when the switch cam is in operative position, means on the switch cam for directing non-selected long butt jacks to the first surface thereon to raise corresponding needles for taking the first and second yarns from the respective first and second yarn feeding means, means for directing selected long butt jacks to the third surface to raise corresponding needles to take yarn from the wrap yarn feeding means and both of the yarns from the main feeding station, and means for directing selected short butt jacks to the second surface on the switch cam to raise corresponding needles for taking the first and second body yarns from the main feeding station.

7. In a circular knitting machine having a set of stitch cams, a circular series of needles, jacks for the needles and a single selector mechanism for operating upon selected jacks; the combination of a main feeding station, means for feeding first and second body yarns on respective first and second levels at the main feeding station, means for feeding at least one wrap yarn on a third level disposed higher than and in advance of the first and second levels, at least one first group of said jacks having relatively long master butts thereon, at least one second group of said jacks having relatively short master butts thereon, a jack-dividing switch cam disposed between said selector mechanism and said wrap yarn feeding means, said jacks being so arranged relative to the first yarn feeding means that those jacks having the short butts thereon which are not operated upon by the selector mechanism cause corresponding needles to take the first body yarn only, said switch cam having first, second and third upper surfaces thereon, said first surface on the switch cam being lower than the second surface and said second surface being lower than the third surface, said second surface on the switch cam being closer to the needle cylinder than the first and third surfaces when the switch cam is in operative position, means on the switch cam for directing non-selected long butt jacks to the first surface thereon to raise corresponding needles for taking the first and second yarns from the respective first and second yarn feeding means, means for directing selected long butt jacks to the third surface to raise corresponding needles to take yarn from the wrap yarn feeding means and both of the yarns from the main feeding station, means for directing selected short butt jacks to the second surface on the switch cam to raise corresponding needles for taking the first and second body yarns from the main feeding station, and means disposed between the warp yarn feeding means and the main feeding station for lowering any of those needles which are raised to take the wrap yarn to where the latches thereof are disposed below the levels at which the first and second body yarns are fed thereto at the main feeding station.

8. In a circular knitting machine having a set of stitch cams, a circular series of needles, jacks for the needles and a single selector mechanism for operating upon selected jacks; the combination of a main feeding station, means for feeding first and second body yarns on respective first and second levels at the main feeding station, a wrap yarn feeding station spaced in advance of the main feeding station and having means for feeding at least one wrap yarn on a third level disposed higher than the first and second levels, at least one first group of said jacks having relatively long master butts thereon, at least one second group of said jacks having relatively short master butts thereon, a jack-dividing switch cam disposed between said selector mechanism and said wrap yarn feeding station, said jacks being so arranged relative to the first yarn feeding means that those jacks having the short butts thereon and which are not operated upon by the selector mechanism cause corresponding needles to take the first body yarn only, said dividing cam having first, second and third levels thereon, said first level on the dividing cam being lower than the second level thereon and said second level on the dividing cam being lower than the third level thereon, said second level on the dividing cam being closer to the needle cylinder than the first and third levels when the dividing switch cam is in operative position, means on said switch cam for directing non-selected long butt jacks to the first level thereon to raise corresponding needles for taking the first and second yarns from the respective first and second yarn feeding means, means for directing selected long butt jacks to the third level on said switch cam to raise corresponding needles to take yarn from the wrap yarn feed station and both of the yarns from the main feeding station, and means for directing selected short butt jacks to the second level on the switch cam to raise corresponding needles for taking the first and second body yarns from the main feeding station.

9. In a circular knitting machine having a needle cylinder, vertically movable latch needles and needle jacks mounted in the needle cylinder, means for feeding first, second and third yarns on respective first, second and third different levels, a set of stitch cams spaced substantially below the means for feeding the first yarn, pattern controlled selector fingers disposed in advance of the third yarn feeding means, and selector butts on certain of said jacks engageable by corresponding selector fingers for elevating the same to a predetermined level; the combination of a jack-dividing cam unit having lower and upper inclined cams thereon spaced substantially beneath and in advance of the third yarn feeding means, said inclined lower cam terminating on a first relatively low level and being spaced from the needle cylinder when in operative position, said second inclined cam being disposed above the level of the lower portion of the first inclined cam and having its inner surface closely adjacent the needle cylinder for directing selected jacks to an intermediate level, said second inclined cam having a third relatively high level thereon, the inner surface of the second inclined cam between its intermediate and high levels being spaced from the needle cylinder substantially in the same vertical plane as the inner surface of the first inclined cam, said jacks being divided into short master butt groups and long master butt groups whereby the short butt groups will normally continue movement at a normal level as they move past the jack-dividing cam to permit corresponding needles to take the yarn from the first yarn feeding means only and whereby the long butt jacks will normally engage the lower inclined cam to raise corresponding needles to take the yarn from the first and second yarn feeding means, said selector fingers being operable upon selected jacks for elevating the same to where the short butt jacks will be elevated by the second cam to the intermediate level thereon to cause corresponding needles to take the yarn from the first and second yarn feeding means, and said selector fingers being operable for raising selected long butt jacks to where they will also engage the second inclined cam and be elevated to the high level thereon to

cause corresponding needles to take yarn from the first, second and third yarn feeding means.

10. In a circular knitting machine having a needle cylinder, vertically movable latch needles and jacks mounted in the needle cylinder, a single selector mechanism having selector fingers for operating upon selected jacks for elevating the same, a latch ring provided with a throat therein defining a main yarn feed station, said throat being closed at its bottom by a throat plate having upper surfaces of a lower and an intermediate level, at least two yarn feed fingers adapted to engage said lower and intermediate levels, respectively, when in operative position for feeding facing yarn and backing yarn, respectively, to needles, wrap yarn feeding means spaced in advance of the main yarn feed station and disposed at an upper level higher than said lower and intermediate levels, a set of stitch cams spaced substantially beneath the main yarn feed station, and a stationary needle leveling cam disposed in advance of the vertical plane of the wrap yarn feeding means and being spaced from the latch ring a distance slightly less than that of the length of said needles; the combination of long master butts on certain groups of adjacent jacks, short master butts on other groups of said jacks, said other groups of jacks being interspersed with said certain groups of jacks, a needle raising switch cam disposed adjacent the stationary needle leveling cam for elevating the needles to where the latches thereof will pass above the stitches carried by said needles, means for subsequently lowering the needles to substantially the level occupied thereby before being elevated by the needle raising switch cam, a jack-dividing cam spaced substantially beneath the wrap yarn feeding means and having three level surfaces thereon, namely, a lower surface, an intermediate surface and an upper surface, an inclined surface leading to the intermediate and upper surfaces on said dividing cam, an inclined surface leading to the lower level surface on said dividing cam and initiating on a level substantially below the level at which the inclined surface leading to the intermediate and upper surfaces initiates, said inclined surfaces leading to the lower surface and from the intermediate surface to the upper surface being disposed outwardly of the portion of the inclined surface leading to the intermediate surface, and said lower, intermediate and upper surfaces on the dividing cam being so arranged that non-selected jacks having long butts thereon will be elevated to the lower surface to raise corresponding needles to a level for taking the yarn from the yarn feed fingers disposed on the lower and intermediate levels, non-selected jacks having the short master butts thereon will move at a normal level to the stitch cams to cause corresponding needles to take the yarn from the yarn feed finger disposed on the lower level only, selected jacks having the short butts thereon will be elevated to the intermediate surface on the dividing cam to cause the needles elevated thereby to also take the yarn from the yarn feed fingers disposed on the lower and intermediate levels, and whereby selected jacks having long master butts thereon will be elevated to the upper surface on the dividing cam to cause corresponding needles to take yarn from the wrap yarn feeding means and to also take yarn from the yarn feed fingers disposed on the lower and intermediate levels.

11. In a circular knitting machine having a needle cylinder, a circular series of needles and corresponding jacks mounted for vertical movement in the needle cylinder, a series of needle cams including a set of stitch cams, a stationary leveling cam spaced substantially in advance of the stitch cams for elevating the needles to a predetermined level prior to their reaching the stitch cams, a main feeding station spaced above the stitch cams for feeding facing yarn and backing yarn on a relatively low and an intermediate level, respectively, means for feeding wrap yarns in advance of the main feeding station on a relatively high level, and a single selector mechanism for operating upon selected jacks disposed in advance of the vertical plane of the wrap yarn feeding means; the combination of said jacks being divided into at least two groups, a first of said groups having long butts thereon and a second of said groups having short butts thereon, means engageable by non-selected long butt jacks for elevating the same to a first relatively low level to cause the corresponding needles to take the yarns from the main station on both the lower and the intermediate levels, non-selected short butt jacks being adapted to miss the last-named means to cause corresponding needles to take the facing yarn disposed on the lower level only, means engageable by selected short butt jacks to cause the same to be elevated to an intermediate level to where corresponding needles will also take the facing and backing yarns from both the lower and the intermediate levels, means engageable by selected long butt jacks to cause corresponding needles to take yarn from the wrap yarn feeding means and the yarns disposed on both the lower and the intermediate levels, and means for moving said means for elevating selected jacks into and out of operative position according to a predetermined pattern.

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