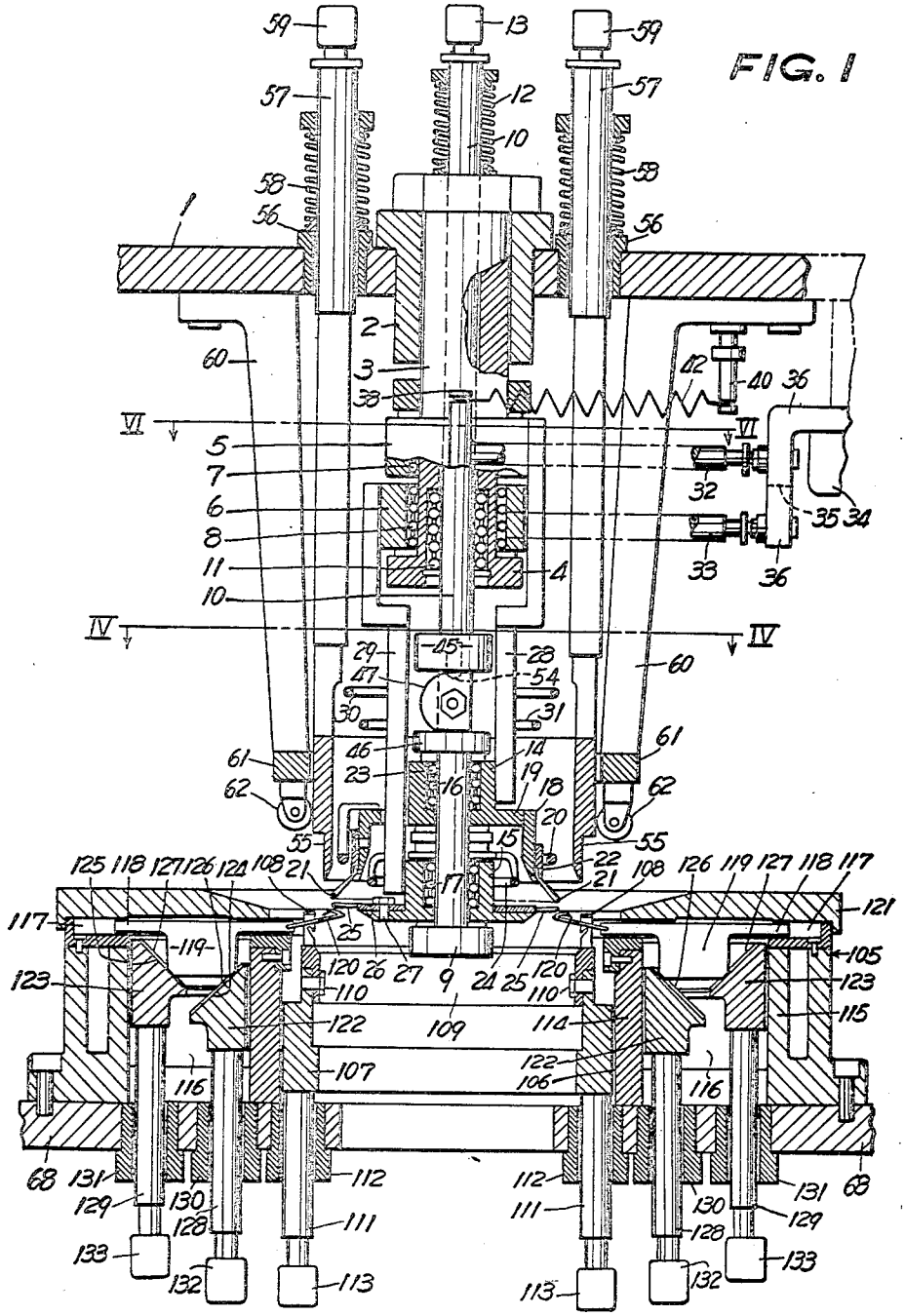
Nov. 25, 1969 NAOTAKE KITAHARA ET AL 3,479,841

CIRCULAR TRICOT KNITTING MACHINE

Filed Sept. 28, 1967 7 Sheets-Sheet 1

FIG. 1



INVENTORS:
Naotake Kitahara
Teruo Yoshida
BY
Michael S. Striker
Attorney

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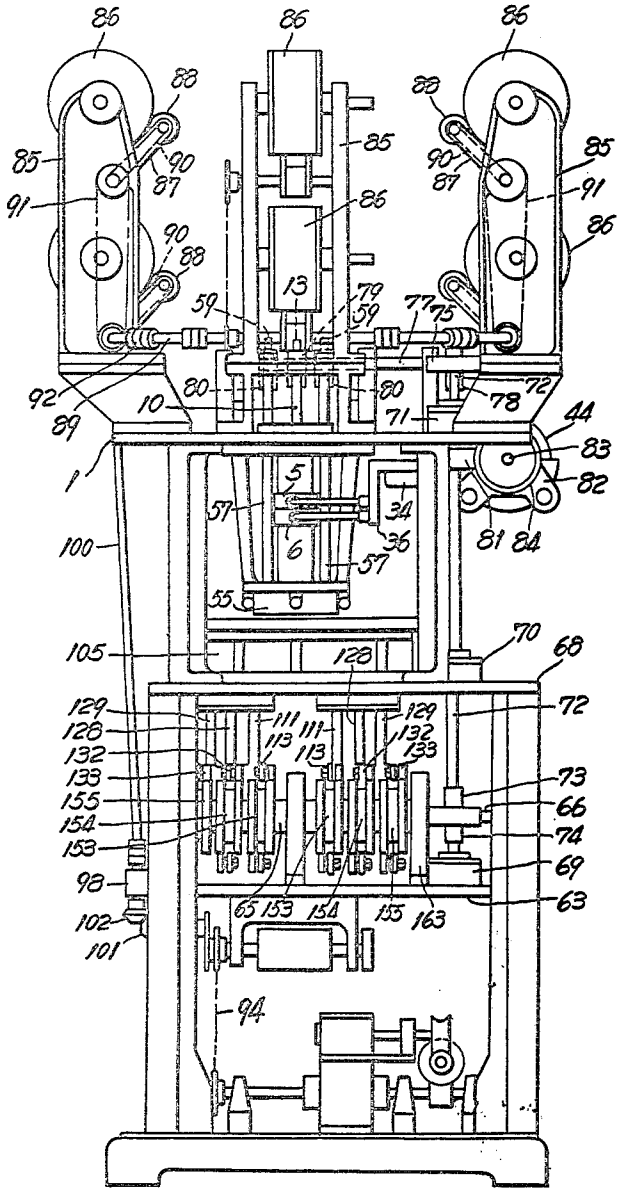
CIRCULAR TRICOT KNITTING MACHINE

Filed Sept. 28, 1967 7 Sheets-Sheet 2

FIG. 2



INVENTORS:
Naotake Kitahara
BY Ferne Yoshida
Mohan S. Shirsker
Attorney

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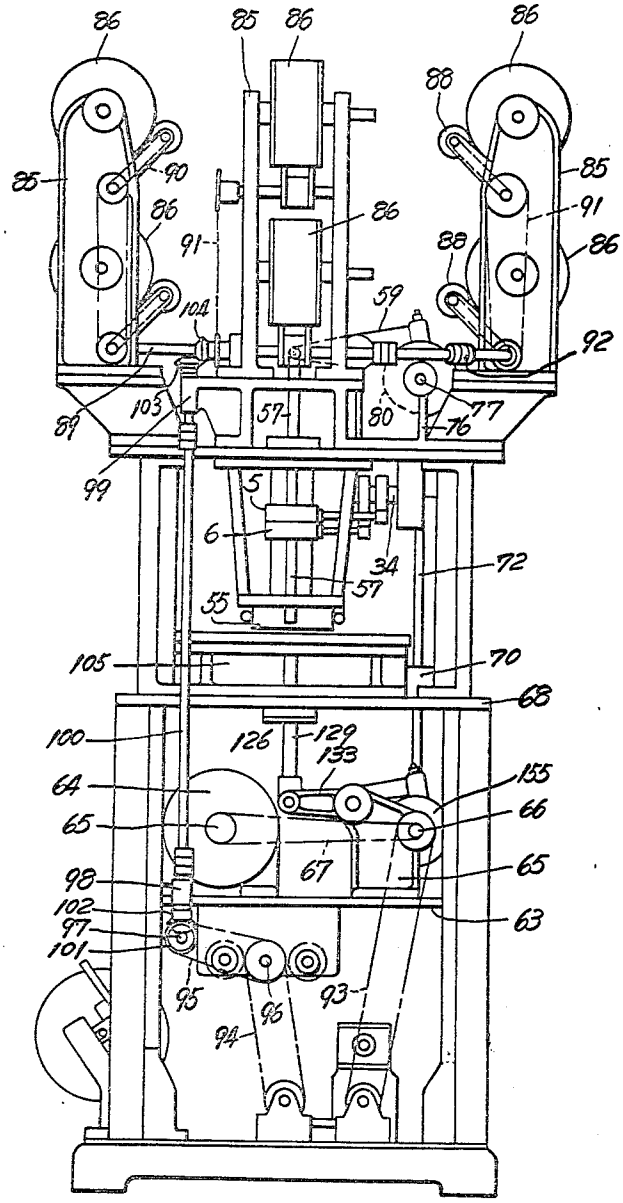
CIRCULAR TRICOT KNITTING MACHINE

Filed Sept. 28, 1967 7 Sheets-Sheet 3

FIG. 3



INVENTORS:
Naotake Kitahara
Teruo Yoshida
BY Michael S. Striker
Attorney

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CIRCULAR TRICOT KNITTING MACHINE

Filed Sept. 28, 1967 7 Sheets-Sheet 4

FIG. 4

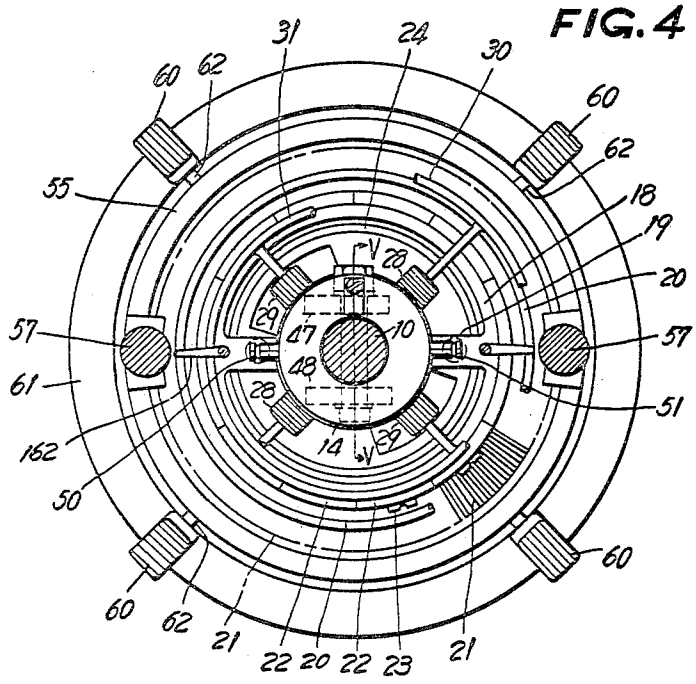
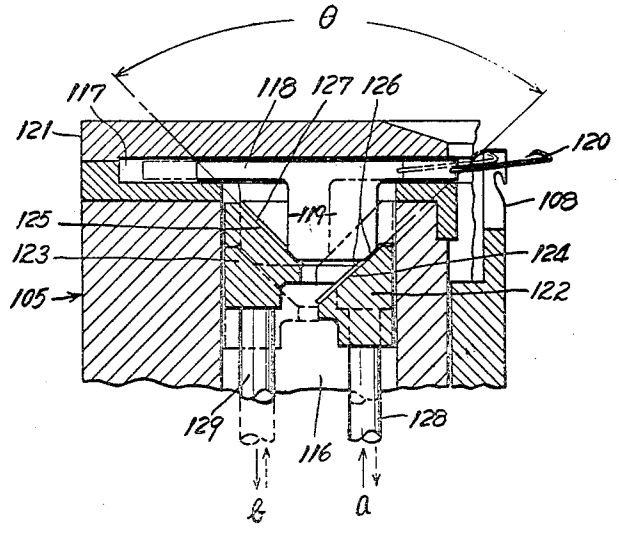


FIG. 7



INVENTORS:
Naotake Kitahara
BY Teruo Yoshida
Michael S. Striker
Attorney

Nov. 25, 1969 NAOTAKE KITAHARA. ET AL 3,479,841

CIRCULAR TRICOT KNITTING MACHINE

Filed Sept. 28, 1967 7 Sheets-Sheet 5

FIG. 5

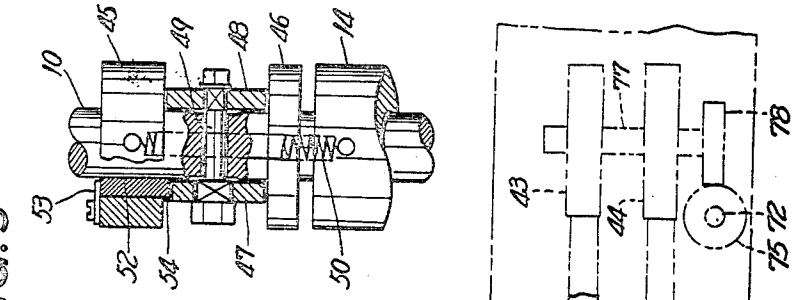
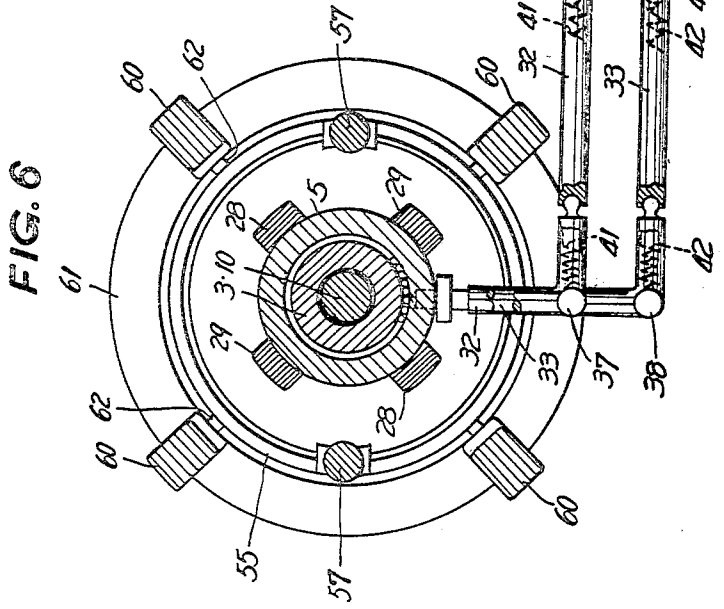


FIG. 6



INVENTORS.
NAOTAKE KITAHARA
TERUE YOSHIDA

Nov. 25, 1969 NAOTAKE KITAHARA ET AL 3,479,841

CIRCULAR TRICOT KNITTING MACHINE

Filed Sept. 28, 1967 7 Sheets-Sheet 6

FIG. 8

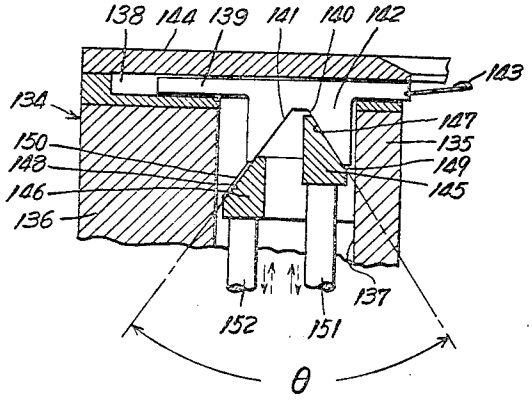
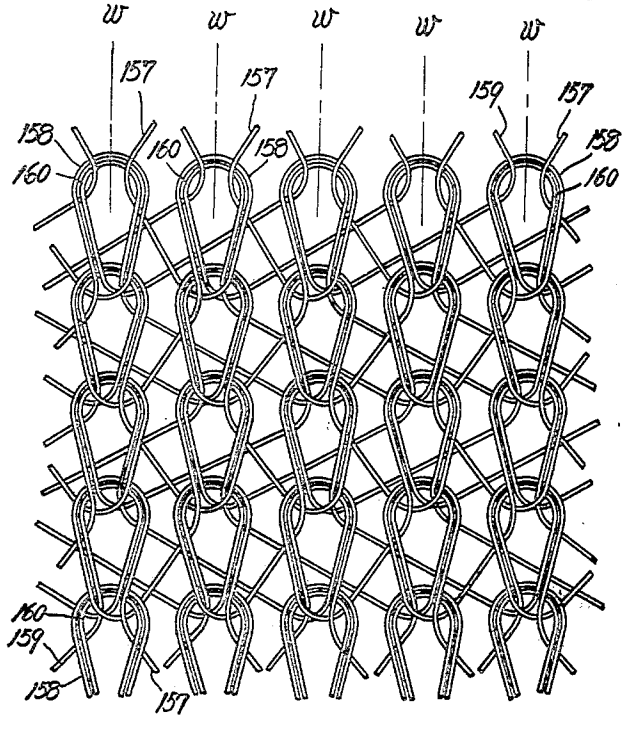


FIG. 9



INVENTORS.
Naotake Kitahara
BY Isamu Yoshida
Michael S. Striker
Attorney

Nov. 25, 1969 NAOTAKE KITAHARA ET AL 3,479,841

CIRCULAR TRICOT KNITTING MACHINE

Filed Sept. 28, 1967 7 Sheets-Sheet 7

FIG. 10

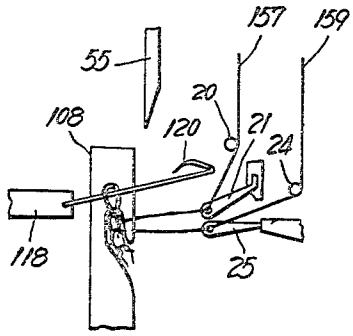


FIG. 13

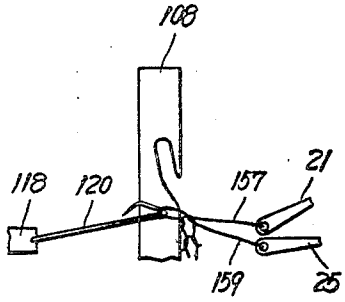


FIG. 11

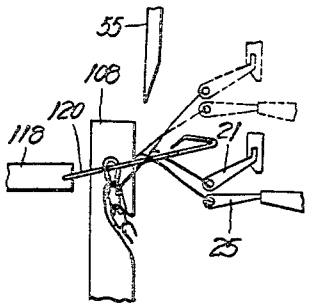


FIG. 14

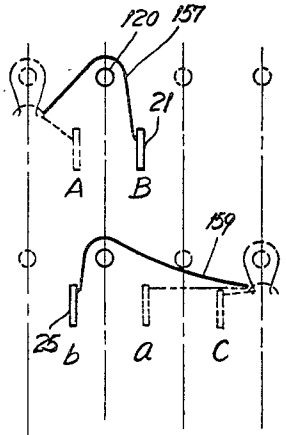


FIG. 12

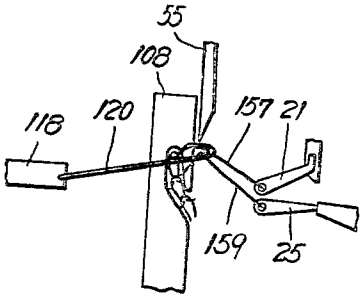
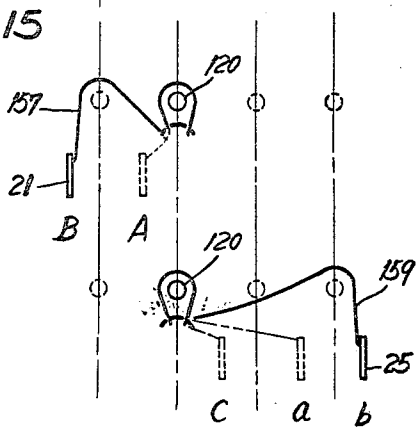


FIG. 15



INVENTORS;
Naotake Kitahara
Ferne Yoshida
BY Michael S. Striker
Attorney

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Patented Nov. 25, 1969

3,479,841

CIRCULAR TRICOT KNITTING MACHINE

Naotake Kitahara, Tokyo, and Terue Yoshida,, Yokosuka-shi, Japan, assignors to Tokyo Kulsushita Kabushiki Kaisha, Tokyo, Japan, a corporation of Japan

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Claims priority, application Japan, Dec. 8, 1966, 41/80,024
Int. Cl. D04b 9/06
U.S. Cl. 66—31 2 Claims

ABSTRACT OF THE DISCLOSURE

The invention relates to a circular tricot knitting machine in which improved knitting needles, yarn guides, a presser, and sinkers are arranged in a circle. All needles move horizontally toward the center, while the yarn guides, positioned above the same, and reciprocating in circumferential direction, feed the yarns. The presser and the sinkers make up and down strokes, crossing the needles.

BACKGROUND OF THE INVENTION

The present invention relates to a circular tricot knitting machine which produces a circular tricot efficiently.

Various flat tricot knitting machines have so far been known, and yet no circular tricot knitting machine has been devised. The present invention aims at providing a circular tricot knitting machine equal in basic function to a flat tricot knitting machine by radically improving the needles, reeds, sinkers, presser, etc. of the flat tricot knitting machine so as to arrange them circularly. Especially an improvement of the implement for operating the needles and the reed equipment for feeding yarn has led to the development of a circular tricot kniting machine embodying the present invention.

SUMMARY OF THE INVENTION

The knitting machine of this invention is characterized as follows: A cylindrical shaft vertically directed is received by a bearing at the center of a bedplate constituting a top portion of a frame. Two rings are rotatably fitted to the lower portion of the cylindrical shaft. A main shaft is loosely passed through the cylindrical shaft and supported at its upper end by a spring. Two annular bodies independent of each other are fitted to the main shaft firmly in the axial direction and movably in the peripheral direction. A plurality of reeds are radially projected from the lower peripheral edge of the lower annular body. A cylindrical body is firmly connected to the peripheral side surface of the upper annular body through arms. The same number of reeds as that of the reeds attached to the lower annular body are radially extended from the peripheral side surface of the upper annular body closely above the lower reeds. The upper annular body thus equipped with the upper reeds is connected through a pair of rods to the upper one of said two rings rotatably fitted to the cylindrical shaft, while the lower annular body carrying the lower reeds is connected through another pair of rods to the lower ring independently of the upper annular body. The two rings mounted on the cylindrical shaft are each linked with a rod horizontally directed, that is, perpendicular to the cylindrical shaft. The two horizontal rods are supported by the frame bedplate and to be horizontally reciprocated by means of cams and springs so as to move the respective rings back and forth along the periphery of the cylindrical shaft, thereby causing the reeds connected to both rings to swing around the main shaft. The main shaft is moved up and down at the extremes of the swing of the reeds by means of a cam and a lever to raise and

lower the reeds for guiding yarn. On either side of the main shaft, a rod is engaged with a bearing and supported by a spring at an upper spot thereof, the pair of rods carrying a cylindrical presser. The presser is moved up and down on the outside of the circularly arranged reeds, by moving the pair of rods simultaneously by means of cams and springs. Below the presser and the reeds, a cylindrical needle bed is set on a bedplate coaxially with the main shaft. Grooves are horizontally and radially cut in the upper surface of the cylindrical needle bed to receive stems loosely. Each of the stems is equipped with a needle projecting from its inner tip and has a butt at its bottom center. The inner and outer edges of the butt are loosely received by grooves cut in slopes constituting the top surfaces of two push rings. The push rings are fitted in an annular opening provided in the needle bed and each fastened, at the bottom, to a pair of rods. The two pairs of rods are vertically moved by means of cams and levers so as to move the two push rings vertically in mutually opposite directions, thereby reciprocating all the stems and the needles at the tips of the stems simultaneously in the radical directions inside the inner peripheral wall of the needle bed. A plurality of mutually separate sinkers extend from the top annular surface of a ring slidable along the inner cylindrical wall of the needle bed. The ring is supported at the bottom by a pair of rods. The rods and the ring connected to the rods are moved up and down by means of cams and levers to move the sinkers up and down between the needles and perpendicularly thereto. During every reciprocation of the needles in the radial directions, each of the reeds swings in the right or left direction in respect to the corresponding needle, the right and left swings taking place alternately, and rises and falls at the extremes of the swinging motion to pass over the needle for feeding yarn. Immediately after the feeding, the sinkers and the presser are vertically moved. Thus a circular tricot can be produced.

This invention also contemplates replacing the equipment included in the circular tricot knitting machine for horizontal reciprocation of the needles and the stems, with another equipment. The alternative equipment is characterized as described below: A stem equipped with a projecting needle is loosely fitted in each of the grooves radially cut in the upper surface of the cylindrical needle bed, with the needle directed toward the center of the needle bed. The stems are covered with a holding plate and each equipped, at the bottom center, with a butt having the bottom side notched in a V-shape so as to form a pair of inclined surfaces facing each other. The butt of each of the stems extends in the annular opening made in the needle bed. Two stem push rings are loosely fitted in said annular opening. One of the push rings has an outwardly facing annular slope while the other has an inwardly facing annular slope, both slopes matching the inclined surfaces of the butt. Grooves are cut in both of said annular slopes to engage loosely with the inclined surfaces of the butts. The two push rings are vertically moved in mutually opposite directions to alternately push up the butts received by the grooves cut in the two ring slopes, thereby simultaneously reciprocating all the stems together with the needles horizontally and radially inside the inner cylindrical wall of the needle bed.

The present invention will be more fully understood by reference to the following detailed description taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a side view in vertical section of the knitting machine of this invention, partly taken away to show its main structure.

FIG. 2 is a front view which schematically shows the principal construction of the tricot knitting machine.

FIG. 3 is a side view of the schematic structure shown in FIG. 2.

FIG. 4 is a view in horizontal section taken along the line IV—IV in FIG. 1.

FIG. 5 is a side view partly in vertical section taken along the line V—V in FIG. 4.

FIG. 6 is a view in horizontal section taken along the line VI—VI in FIG. 1.

FIG. 7 is a side view partly in section illustrating the action of needle moving members in a needle bed.

FIG. 8 is a side view partly in section illustrating another needle moving structure.

FIG. 9 shows the texture of a circular tricot knitted by the knitting machine of this invention.

FIGS. 10 to 15 illustrate the manner in which the tricot knitting machine operates for knitting.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. 1 showing a side view in vertical section of the principal mechanism of the tricot knitting machine according to this invention, a cylindrical shaft **3** vertically directed is supported by a bearing **2**, at the center of a bedplate **1** constituting a top portion of a circular frame. The cylindrical shaft **3** is equipped, at the bottom, with a collar **4**. Two rings **5** and **6** are rotatably fitted above the collar **4** to the cylindrical shaft **3** through bearings **7** and **8** respectively. A main shaft **10** is loosely passed through the cylindrical shaft **3** with the provision of a bearing **11** between both shafts. The main shaft **10** is equipped with a collar **9** at its lower end. supported by a spring **12** at an upper spot thereof and connected with a crank lever **13** at the top end. Two annular bodies **14** and **15** are mounted on the main shaft **10** through bearings **16** and **17** above the collar **9**. As shown in FIG. 4 also, a pair of arms **19** extend from the peripheral side surface of the annular body **14** and support a cylindrical body **18**. A guide ring **20** is fastened to the peripheral side surface of the cylindrical body **18** by means of a pair of supporting bars **162**. Several support pieces **22** are continuously fitted to the lower periphery of the cylindrical body **18** by means of rivets **27** so as to be easily removable, and each of the support pieces **22** carries a multiplicity of reeds **21**. A guide ring **24** is fitted to the peripheral side surface of the annular body **15**. Several support pieces **26** are continuously fixed to the lower peripheral edge of the annular body **15**, and carry the same number of reeds **25** as that of the reeds **21** close to the latter reeds.

The annular body **14** is connected through a pair of vertical rods **28** to the ring **5** rotatably fitted to the cylindrical shaft **3**, while the annular body **15** is connected through another pair of vertical rods **29** to the ring **6** independently of the former connection. Yarn guide rings **30** and **31** are fixed to the pairs of rods **28** and **29** respectively by means of arms so as to surround the rods.

As shown in FIG. 6, horizontal L-shaped rods **32** and **33** are respectively fixed at one end to the rings **5** and **6** rotatably mounted on the cylindrical shaft **3**, in perpendicular relationship to the main shaft **10**. The other ends of the rods **32** and **33** are connected to two slide rods **35** and **36** respectively. The rods **35** and **36** are set on a slider support **34** located under the bedplate **1**. Rods **37** and **38** vertically projecting from the bends of the rods **32** and **33** are respectively connected by springs **41** and **42** to rods **39** and **40** hanging from the bedplate **1**. Thus, the rods **32** and **33** are pulled by the springs **41** and **42** so that the slide rods **35** and **36** connected with the rods **32** and **33** have their ends pressed to cams **43** and **44**. By rotating the cams **43** and **44**, the slide rods **35** and **36** in contact with the cams are respectively set in horizontal reciprocation. By the resulting horizontal reciprocation of the rods **32** and **33**, the two rings **5** and **6** mounted on the cylindrical shaft **3** are moved back and forth along the periphery of the cylindrical shaft **3** with the result that the reeds **21** and **25** connected with the rings **5** and **6** as described before swing around the main shaft **10**. The main shaft **10** is moved up and down at the extremes of the swing of the reeds **21** and **25** by the rocking of the crank lever **13** linked to the top end of the main shaft **10** and the elastic force of the spring **12** supporting the main shaft **10**, so that the reeds **21** and **25** fitted to the main shaft **10** fixedly in the axial direction are moved up and down. The motion of the reeds **21** and **25** about the main shaft **10** relates to the texture of a knitted material as will be described later. By changing the cams **43** and **44** in contact with the rods **35** and **36** according to the texture of a desired tricot, the horizontal reciprocation of the rods **35** and **36** can be optionally changed in amplitude and direction.

The distance between the annular body **14** carrying the reeds **21** and the annular body **15** located just below the annular body **14** and supporting the reeds **25** can be changed by sliding the annular body **14** in the axial direction of the main shaft **10** in the following manner: As seen in FIG. 5, two rings **45** and **46** are mounted on the main shaft **10** above the annular body **14**. The upper ring **45** is fixed to the main shaft **10**, while the lower ring **46** is freely fitted to the shaft **10** and set on a seat plate which is in contact with the annular body **14**. A pair of holding cams **47** and **48** are provided between both rings **45** and **46**, sandwiching the main shaft **10** and fastened thereto by means of a bolt **49** rotatably passing through the main shaft **10** and a nut. Cams **47** and **48** are fixedly secured to bolt **49** and turn when the same is manually turned. The holding cams **47** and **48** press the lower ring **46** to fix the annular bodies **14** and **15** in the axial direction of the main shaft **10**. The upper fixed ring **45** is connected to the annular body **14** by springs **50** and **51** located on opposite sides of the ring **45** and the annular body **14**. An arresting pawl **52** is put inside an axial groove in the fixed ring **45** and held at the top by a spring plate **53**. The lower tip of the pawl **52** projects into a pawl receiving recess **54** of the cam **47** to prevent the holding cams **47** and **48** from undesired angular displacement. When bolt **49** is manually turned with cams **47** and **48**, the slanted wall of recess **54** in the periphery of cam **47** urges pawl **52** upward against the resiliently yielding spring plate **53**. When the cams **47** and **48** are further forced to rotate by bolt **49** until the vertical extension of the cams becomes a minimum, the annular body **14** connected to the fixed ring **45** by the springs **50** and **51** is pulled up by the springs, so that the reeds **21** supported by the annular body **14** becomes more distant from the lower reeds **25**, thus making it easy to supply yarn to the reeds **21** and **25**. Upon manual return rotation of bolt **49** with cams **47** and **48**, the lower tip of pawl **42** falls again into recess **54** of cam **47** to arrest the same, and thereby bolt **49** and cam **48** so that cams **47**, **48** cannot turn to a position in which annular body **14** is pulled up.

A cylindrical presser **55** is located over and outside the circularly arranged reeds **21** and **25**, as shown in FIGS. 1, 4 and 6. A pair of vertical rods **57** arranged on opposite sides of the main shaft **10** is engaged with bearings **56** set in the upper bedplate **1** and supported by springs **58** provided over the bearings **56**. The rods **57** are connected at the lower ends with the upper edge of the presser **55** and linked at the upper ends with crank levers **59**. By rocking the crank levers **59**, the pair of rods **57** are moved up and down to raise and lower the presser **55**. A number of support bars **60** are hung from the bottom of bedplate **1** on the outside of the pair of rods **57** holding the presser **55**. The lower ends of the support bars **60** are positioned just outside the cylindrical presser **55** and connected to a ring **61**. The bottom of the ring **61** carries a number of support rollers **62**, which are in contact with the peripheral surface of the presser **55** to ensure the vertical motion of the presser **55**.

The reeds **21** and **25** and the presser **55** are driven by a prime mover. FIGS. 2 and 3 show a mechanism associated with the driving. The prime mover **64** is installed on the lower bedplate **63** of the frame. The rotary shaft **65** of the prime mover **64** is connected through a belt or

chain 67 to a cam shaft 66 received by a bearing 163. The cam shaft 66 and a vertical driven shaft 72 perpendicular to the former and received by bearings 69, 70 and 71 fitted to the lower bedplate 63, a middle bedplate 68 and the upper bedplate 1 respectively are engaged with helical gears 73 and 74 so that the rotation of the prime mover 64 can be transmitted to the driven shaft 72. A helical gear 75 fitted to the top end of the driven shaft 72 is engaged with a helical gear 78 fastened to a horizontal cam shaft 77 perpendicular to the shaft 72 and received by a bearing 76 mounted on the upper bedplate 1. The cam shaft 77 carries an eccentric cam 79 which causes the crank lever 13 to rock, with the resultant vertical movement of the main shaft 10 and the reeds 21 and 25. The cam shaft 77 also carries a pair of eccentric cams 80 on both sides of the cam 79. The eccentric cams 80 rotate to rock the crank levers 59 connected to the top ends of the pair of rods 57 holding the presser 55, thus causing the rods 57 and the presser 55 to rise and fall.

A helical gear 81 is mounted on the driven shaft 72 just below the upper bedplate 1 and rotates in engagement with a helical gear 84 mounted on a rotary shaft 83 received by a bearing 82 under the bedplate 1. The rotary shaft 83 carries the cams 43 and 44 represented by the dotted lines in FIG. 6. The cams 43 and 44 are rotated to cause the slide rods 35 and 36 in contact with the cams to slide horizontally, with the consequent swing of the reeds 21 and 25 around the main shaft 10.

The yarn guided by each of the reeds 21 and 25 which move as already mentioned is fed to the reed from one of bobbins supported above the frame. As seen in FIGS. 2 and 3, the horizontal shafts of several bobbins 86 which are at different levels (two bobbins in FIGS. 2 and 3) are removably supported by each of supports 85 arranged along the periphery of the upper bedplate 1 of the frame. Arms 87 project from a side of each of the supports 85 and carry rollers 88 at the tips. The rollers 88 are pressed to the peripheral surfaces of the bobbins 86. A rotary shaft 89 is received by a bearing at the lower portion of the support 85 and extends from sides of the support 85. The rollers 88 are each connected to the shaft 89 directly or indirectly, that is, by means of chains 90 and 91. Thus, when the shaft 89 is rotated, the rollers 88 and the bobbins 86 revolve. The rotary shafts 89 supported at the lower portion of the supports 85 carrying the bobbins 86 are connected together in a line along the periphery of the upper bedplate 1 by means of universal joints 92, so that by rotating one of the rotary shaft 89, all bobbins 86 are turned at the same time for supply of yarn.

The power for rotating the shafts 89 is supplied from the prime mover 64: The rotation of the shaft 65 of the prime mover 64 is transmitted to auxiliary shafts 96 and 97 through chains 67, 93, 94 and 95. The auxiliary shaft 97 is connected to a rotary shaft 100 through bevel gears 101 and 102. The rotary shaft 100 is perpendicular to the auxiliary shafts 96 and 97 and received by bearings 98 and 99 fitted to the bedplates 63 and 100 respectively. The rotary shaft 10 carries, at the top end, a bevel gear 103 which meshes with a bevel gear 104 mounted on one of the rotary shafts 89. Thus, the revolution of the shaft of the prime mover 64 is transmitted to the rotary shafts 89.

As illustrated in FIG. 1, a cylindrical needle bed 105 is installed on the middle bedplate 68 coaxially with the main shaft 10 below the reeds 21 and 25 and the presser 55. A cylindrical body 107 is loosely fitted inside the inner circular wall 106 of the needle bed 105. A ring 109 is removably fastened, at its lower edge, to the upper edge of the cylindrical body 107 by means of bolts 110. A multiplicity of sinkers 108 are firmly erected like comb teeth on the upper peripheral edge of the ring 109. A pair of rods 111 vertically directed are fixed to the bottom of the cylindrical body 107 symmetrically in respect to the center of the cylindrical body 107 and received by bearings 112 set in the bedplate 68. The lower ends of the rods 111 are connected to a pair of crank levers 113. By moving the pair of rods 111 up and down simultaneously, the ring 109 equipped with the sinkers 108 also rises and falls inside the inner circular wall 106 of the needle bed 105. When raised, the sinkers are positioned outside the lower portion of the presser 55. The needle bed 105 has an inner cylinder 114 and an outer cylinder 115, both cylinders defining an annular opening 116. Stem grooves 117 are cut in the upper peripheral surfaces of the inner and outer cylinders 114 and 115 radially with regard to the center of the needle bed 105, with the extentions of the groove center lines passing between the sinkers 108.

Each of stems 118 has a rectangular butt 119 at the bottom center. Two parallel corners of the butt 119 are chamfered. A needle 120 having a hook is projected from one end of the stem 118, inclining slightly upwards, wih the hook positioned on the upper side of the needle 120, that is, on the side opposite to the butt 119. The stems 118 are loosely set in the stem grooves 117, with the hooked needles 120 directed to the center of the needle bed 105 and the butt 119 extending in the annular opening 116 of the needle bed 105. The stems 118 are covered with a holding plate 121. Two push rings 122 and 123 for shifting the stems 118 are loosely fitted in the annular opening 116 receiving the butts 119. The outer diameter of the push ring 122 is slightly smaller than the inner diameter of the push ring 123. Both push rings 122 and 123 are triangular in sectional configuration and equal in sectional area, having respective slopes 124 and 125 facing each other. Thus, the peripheral slopes 124 and 125 have a V-shaped section taken along a vertical and radial plane.

Grooves 126 and 127 are cut in the slopes 124 and 125 respectively in radial directions and loosely receive the chamfered corners of the butts 119 of the stems 118. A pair of rods 128 are fixed to the bottom of the push ring 122 symmetrically in respect to the center of the ring 122, while another pair of rods 129 are likewise fastened to the bottom of the push ring 123. Both pairs of rods 128 and 129 are respectively received by bearings 130 and 131 set in the bedplate 68. The lower ends of the rods 128 and 129 are connected to crank lever 132 and 133 respectively. By moving both push rings 122 and 123 vertically in mutually opposite directions, the slopes 124 and 125 of the push ring 122 and 123 push up the butts 119 alternately, thus setting all the stems 118 together in horizontal reciprocation.

Referring now to FIG. 7, the rods 128 and 129 can be moved up and down in mutually opposite directions. When the rod 128 is raised as indicated by the letter *a* and the rod 129 is lowered as represented by *b* at the same time and the same speed as the former, the two push rings 122 and 123 move accordingly, and the corners of the butts 119 which are in contact with the grooves 124 cut in the push ring 122 are pushed up, shifting the stems 118 horizontally in the stem grooves 117 as indicated by the dotted line in the figure. Next, by moving the rods 128 and 129 in the directions reverse to those mentioned above, the corners of the butts 119 which are in engagement with the grooves 127 of the slope of the push ring 123 are forced up, with the result that the stems 118 move horizontally in the reverse direction to that in the former case and return to the original position represented by the solid line. By repeating the abovementioned vertical movement of the rods 128 and 129, the needles 120 projecting from the tips of the stems 118 can be reciprocated horizontally and radially inside the inner circular wall of the needle bed 105.

FIG. 8 shows in part another exemplary structure for horizontal movement of the stems and the needles. A cylindrical needle bed 134 has an inner cylinder 135 and an outer cylinder 136, both cylinders defining an annular opening 137. Stem grooves 138 are cut in the upper peripheral surfaces of the inner and outer cylinders 135 and

136 radially with regard to the center of the needle bed 134. Each of stems 139 has a butt 142 notched in a V-shape at the bottom center so as to form mutually facing inclined surfaces 140 and 141. A needle 143 is projected from one end of each stem 139. The steams 139 are loosely set in the stem grooves 138, with the needles 143 directed toward the center of the needle bed 134 and the butts 142 extending in the annular opening 137. The stems 139 are covered with a holding plate 144. Two push rings 145 and 146 for shifting the stems 139 are loosely fitted in the annular opening 137. The outer diameter of the push ring 145 is slightly smaller than the inner diameter of the push ring 146. The push rings 145 has an inwardly facing annular slope 147, while the push ring 146 has an outwardly facing annular slope 148, both slopes 147 and 148 matching the inclined surfaces 140 and 141 of the butts 142. Grooves 149 and 150 are cut in the slopes 147 and 148 to engage loosely with the inclined surfaces 140 and 141 of the butts 142. A pair of rods 151 vertically directed are fixed to the bottom of the push ring 145 symmetrically in respect to the center of the ring 145, while another pair of rods 152 are likewise fastened to the bottom of the push ring 146. The lower ends of the rods 151 and 152 are connected to crank levers (not shown). By moving the rods 151 and 152 vertically in mutually opposite directions, both push rings 145 and 146 move accordingly and set all the stems 139 in horizontal reciprocation.

When the angle θ formed between the slopes of both push rings for pushing the butts of the stems shown in each of FIGS. 7 and 8 is an acute angle, the reciprocating motion of the stems can be carried out smoothly and yet the amplitude of the horizontal reciprocation is small so that the motion required for loop knitting is also small. Meanwhile, if the angle θ is extremely obtuse, not only excessive pressure is applied to the butts, which may then be damaged, but also the horizontal reciprocation of the stems is not smooth. Hence, it is preferable that the angle θ be about 80 to 100 degrees.

The power for the horizontal and radial reciprocation of the needles on the stems horizontally arranged on the needle bed and the power for the vertical motion of the sinkers located inside the inner circular wall of the needle bed are supplied from the aforesaid prime mover. As shown in FIGS. 2 and 3, the cam shaft 66 connected to the shaft 65 of the prime mover 64 through the belt or chain 67 carries three pairs of eccentric cams 153, 154 and 155 corresponding respectively to the three pairs of vertical rods 111, 128 and 129 supporting the stem pushing rings and the sinker-carrying cylindrical body and received by the bearings set in the middle bedplate. The outer ends of the crank levers 113, 132 and 133 connected to the rods 111, 128 and 129 are in contact with the cams 153, 154 and 155. The crank levers 113, 132 and 133 are rocked with their middle points as fulcrums by the rotation of the cams 153, 154 and 155, causing the rods 113, 132 and 133 to move vertically. Consequently, the sinkers move up and down and the needles are all together reciprocated vertically and radially.

The knitting machine of the present invention operates to knit a circular tricot as described below.

FIG. 9 shows part of a tricot knitted in a cylindrical shape by the knitting machine. There are twice as many reeds than needles, and two reeds feed two lines of yarn to one needle. Each line of yarn 157 for forming the exterior texture of the tricot takes two mutually opposite courses alternately to form loops 158 at adjacent wales W, while each line of yarn 159 for making the interior texture of the tricot follows another pair of opposite courses alternately so as to form loops 160 staggered reversely to the loops 158, inside the latter loops at wales W next but one to each other.

FIGS. 10 to 15 illustrates the loom operation for knitting the circular double tricot. Each needle 120, after forming loops, projects inside the sinker 108 as shown in FIG. 10, when the sinker 108 is lowered and the presser 55 is higher than the needle 120. At the time, the reels 21 and 25 for supply of yarn to the needle 120 are positioned a little below the needle 120, carrying different lines of yarn 157 and 159. As shown in FIG. 11, when the needle 120 is projected to form new loops, the two reeds 21 and 25 feed the two lines of yarn 157 and 159 simultaneously to the needle 120. The movement of the reeds 21 and 25 is as shown in FIG. 14. Prior to supply of yarn to the needle 120, the reeds 21 and 25 are respectively at positions A and *a* with regard to the needle 120. When the needle 120 projects, the reeds 21 and 25 rise at the same time on both sides of the needle 120, guiding the two lines of yarn 157 and 159. Having risen slightly above the needle 120, the reeds 157 and 159 are swung in mutually opposite directions. As soon as the reeds 157 and 159 pass over the needle 120, both reeds 157 and 159 lower on both sides of the needle 120 and return to the positions A and *c* (indicated by dotted line) via positions B and *b* respectively, thus feeding yarn to the needle 120. As shown in FIGS. 12 and 13, the needle 120 fed with yarn moves back. Then, the presser 55 lowers to press the hook of the needle 120, while the sinker 108 rises so that the loops formed at the hooked portion of the sinker 108 are removed from the needle 120. When the needle 120 is projected again to form new loops, the presser 55 and the sinker 108 return to their initial positions, and the reeds 21 and 25 are moved in the reverse directions to those described above, that is, the reeds 21 feeds yarn to a needle next to the needle 120, while the reed 25 supplies yarn to a needle second next to the needle 120 on the other side. Again, when the needle 120 juts out to form newer loops, the reeds 21 and 25 return to the first needle 120 and feed the needle with yarn. In this manner, each of the reeds 21 and 25 reverses its swing direction for every other loop so as to form a series of staggered loops. Thus, a circular tricot is knitted up.

Besides the above-mentioned typical circular tricot produced by the present knitting machine, a circular single-loop tricot can be knitted by the same operation, only by feeding either of the reeds 21 or the reeds 25 with yarns. Further, any optional type of tricot can be obtained by adequately changing the swing of the reeds 21 and 25 in amplitude and direction, that is, by optionally altering the cams for controlling the swing amplitude and direction of the rods 21 and 25.

What is claimed is:

1. A circular tricot knitting machine characterized in that: a cylindrical shaft vertically directed is received by a bearing at the center of a bedplate constituting a top portion of a frame; two rings are rotatably fitted to the lower portion of the cylindrical shaft; a main shaft is loosely passed through the cylindrical shaft and supported at its upper end by a spring; two annular bodies independent of each other are fitted to the main shaft firmly in the axial direction and movably in the peripheral direction; a plurality of reeds are radially projected from the lower peripheral edge of the lower annular body; a cylindrical body is firmly connected to the peripheral side surface of the upper annular body through arms; the same number of reeds as that of the reeds attached to the lower annular body are radially extended from the peripheral side surface of the upper annular body closely above the lower reeds; the upper annular body thus equipped with the upper reeds is connected through a pair of rods to the upper one of said two rings rotatably fitted to the cylindrical shaft, while the lower annular body carrying the lower reeds is connected through another pair of rods to the lower ring independently of the upper annular body; the two rings mounted on the cylindrical shaft are each linked with a rod horizontally directed, that is, perpendicular to the cylindrical shaft; the two horizontal rods are supported by the frame bedplate and to be horizontally reciprocated by means of cams and springs so as to move the respective rings back and forth along the periphery of the cylindrical shaft, thereby causing the reeds

connected to both rings to swing around the main shaft; the main shaft is moved up and down at the extremes of the swing of the reeds by means of a cam and a lever to raise and lower the reeds for guide of yarn, on either side of the main shaft, a pair of rods is engaged with a bearing and supported by a spring at an upper spot thereof, the pair of rods carrying a cylindrical presser; the presser is moved up and down on the outside of the circularly arranged reeds, by moving the pair of rods simultaneously by means of cams and springs; below the presser and the reeds, a cylindrical needle bed is set on a bedplate coaxially with the main shaft; grooves are horizontally and radially cut in the upper surface of the cylindrical needle bed to receive stems loosely; each of the stems is equipped with a needle projecting from its inner tip and has a butt at its bottom center; the inner and outer edges of the butt are loosely received by grooves cut in slopes constituting the top surfaces of two push rings; the push rings are fitted in an annular opening provided in the needle bed and each fastened, at the bottom, to a pair of rods; the two pairs of rods are vertically moved by means of cams and levers so as to move the two push rings vertically in mutually opposite directions, thereby reciprocating all the stems and the needles at the tips of the stems simultaneously in the radical directions inside the inner peripheral wall of the needle bed; a plurality of mutually separate sinkers extend from the top annular surface of a ring slidable along the inner cylindrical wall of the needle bed; the ring is supported at the bottom by a pair of rods; the rods and the ring connected to the rods are moved up and down by means of cams and levers to move the sinkers up and down between the needles and perpendicularly thereto; during every reciprocation of the needles in the radial directions, each of the reeds swings in the right or left direction in respect to the corresponding needle, the right and left swings taking place alternately, and rises and falls at the extremes of the swinging motion to pass over the needle for yarn feeding; and immediately after the feeding, the sinkers and presser are vertically moved.

2. An equipment for horizontal reciprocation of stems in a circular tricot knitting machine according to claim 1, characterized in that: a stem equipped with a projecting needle is loosely fitted in each of grooves radially cut in the upper surface of the cylindrical needle bed, with the needle directed toward the center of the needle bed; the stems are covered with a holding plate and each equipped, at the bottom center, with a butt having the bottom side notched in a V-shape so as to form a pair of inclined surfaces facing each other; the butt of each of the stems extends in an annular opening made in the needle bed; two stem push rings are loosely fitted in said annular opening; one of the push rings has an outwardly facing annular slope while the other has an inwardly facing annular slope, both slopes matching the inclined surfaces of the butt; grooves are cut in both of said annular slopes to engage loosely with the inclined surfaces of the butts; and the two push rings are vertically moved in mutually opposite directions to alternately push up the butts received by the grooves cut in the two ring slopes, thereby simultaneously reciprocating all the stems together with the needles horizontally and radially inside the inner cylindrical wall of the needle bed.

References Cited

UNITED STATES PATENTS

2,004,260 6/1935 Welch et al. ---------- 66—8

FOREIGN PATENTS

821,735 8/1937 France.

WM. CARTER REYNOLDS, Primary Examiner

U.S. Cl. X.R.

66—8