United States Patent [19]

Kunisada et al.

[11] **3,861,174**

[45] **Jan. 21, 1975**

[54] **APPARATUS FOR KNITTING**

[75] Inventors: **Masaaki Kunisada,** Anjo City; **Mituyoshi Mizutani,** Kariya City, both of Japan

[73] Assignee: **Aisin Seiki Kabushiki Kaisha,** Kariya City, Japan

[22] Filed: **July 30, 1973**

[21] Appl. No.: **383,517**

[30] **Foreign Application Priority Data**

July 31, 1972	Japan	47-76739
Oct. 18, 1972	Japan	47-104652
Aug. 19, 1972	Japan	47-96859[U]
Jan. 30, 1973	Japan	48-13736[U]
Jan. 30, 1973	Japan	48-13737[U]
Jan. 30, 1973	Japan	48-13738[U]

[52] **U.S. Cl.** **66/60**

[51] **Int. Cl.** **D04b**

[58] **Field of Search** ..... 66/64, 60, 64 H, 67, 70, 66/75, 76, 78

[56] **References Cited**

UNITED STATES PATENTS

3,412,582	11/1968	Kitazawa	66/70

FOREIGN PATENTS OR APPLICATIONS

4,532,387	10/1970	Japan	66/72
4,628,706	8/1971	Japan	66/72

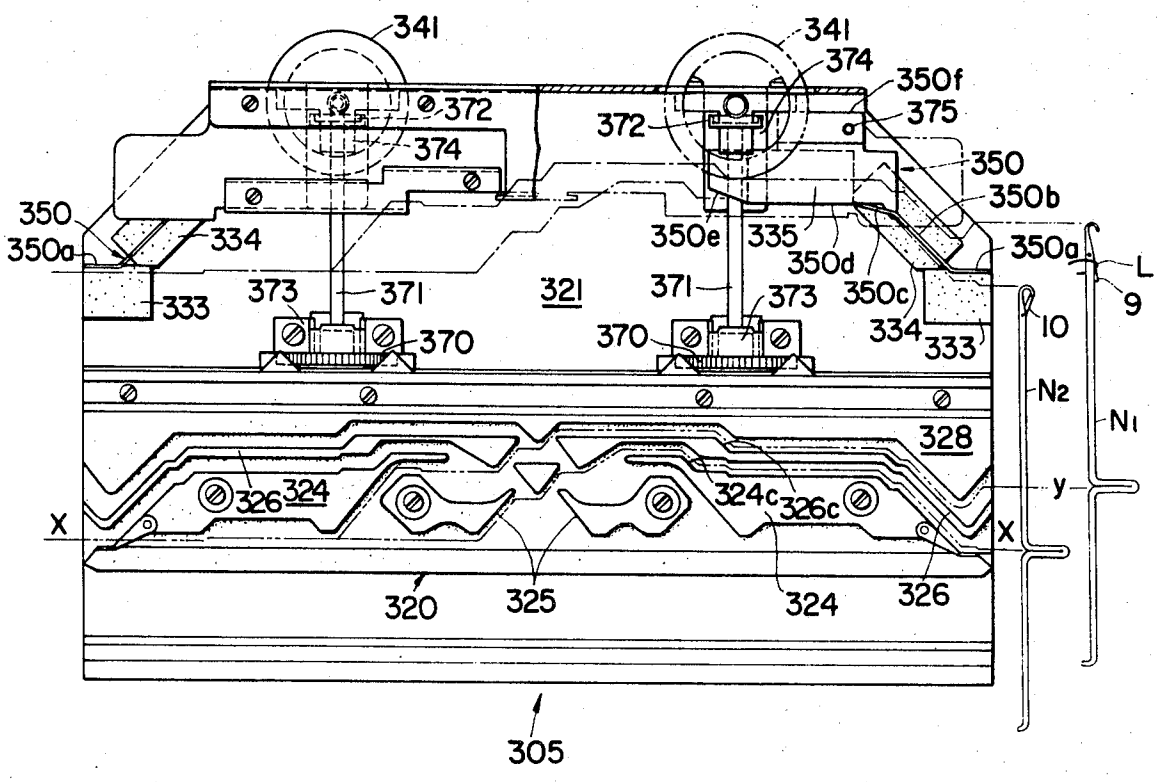
Primary Examiner—Ronald Feldbaum

Attorney, Agent, or Firm—Waters, Roditi, Schwartz & Nissen

[57] **ABSTRACT**

An apparatus for knitting including a needle bed, a plurality of sinkers forwardly protruding from the extremity of the needle bed and arranged in parallel and at regular intervals in a plane, a corresponding number of latch needles alternated with the sinkers and having a free sliding fit on the needle bed so as to project beyond and retract from the neighboring sinkers, a stitch forming actuator movably supported on the needle bed so as to reciprocate along the longitudinal direction of the needle bed and so as to engage with said needles to have the needles project beyond and retract behind the sinkers to form the stitches, and a loop transferring actuator movably supported on the needle bed so as to reciprocate along the longitudinal direction of the needle bed. The loop transferring actuator is characterized by providing laterally shifting means by which axially projecting movement of the needle is translated into a side thrust against the extremity thereof which is developed by engagement of the extremity with an oblique or circular face whereby the needle is enabled to flex with a steeper or smaller curvature than is otherwise obtained.

10 Claims, 30 Drawing Figures



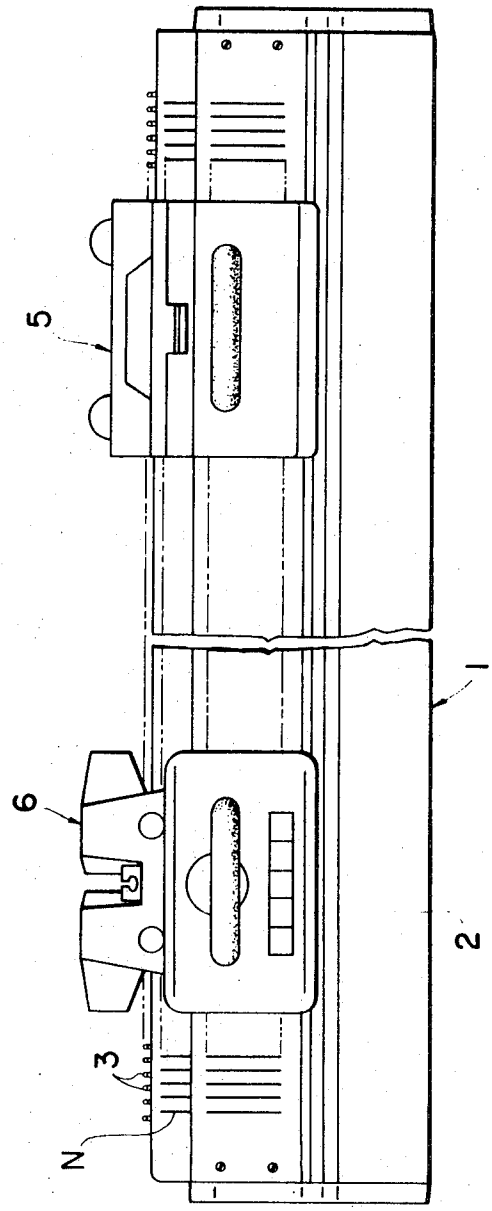
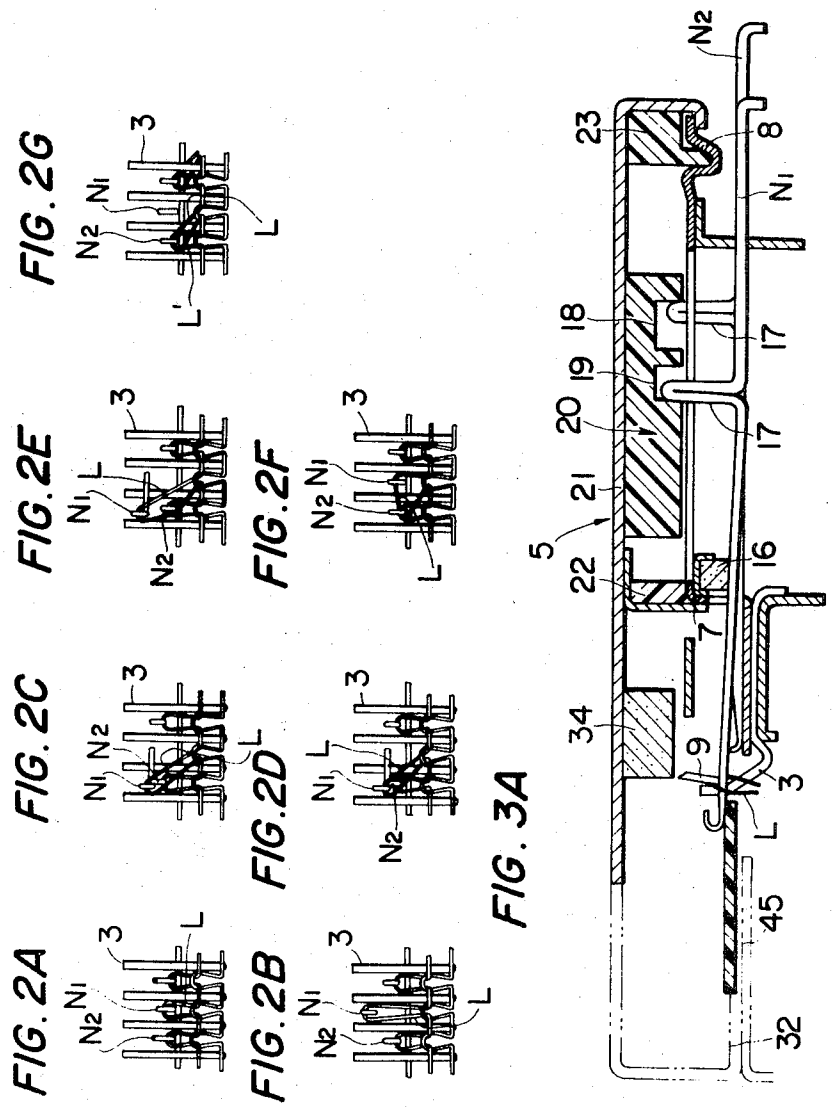


FIG. 1


FIG. 2A
FIG. 2B
FIG. 2C
FIG. 2D
FIG. 2E
FIG. 2F
FIG. 2G
FIG. 3A
N1
N2
L
L'
3
23
8
18
17
19
20
21
5
22
16
7
34
9
45
32

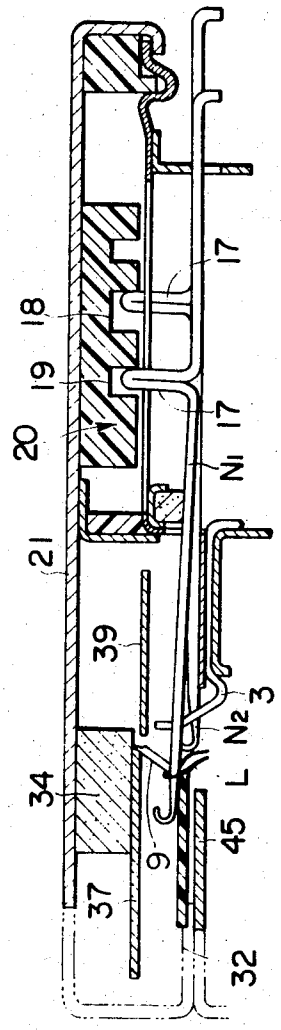

18
19
20
21
17
17
N1
39
3
N2
34
L
45
9
37
32

FIG. 3B

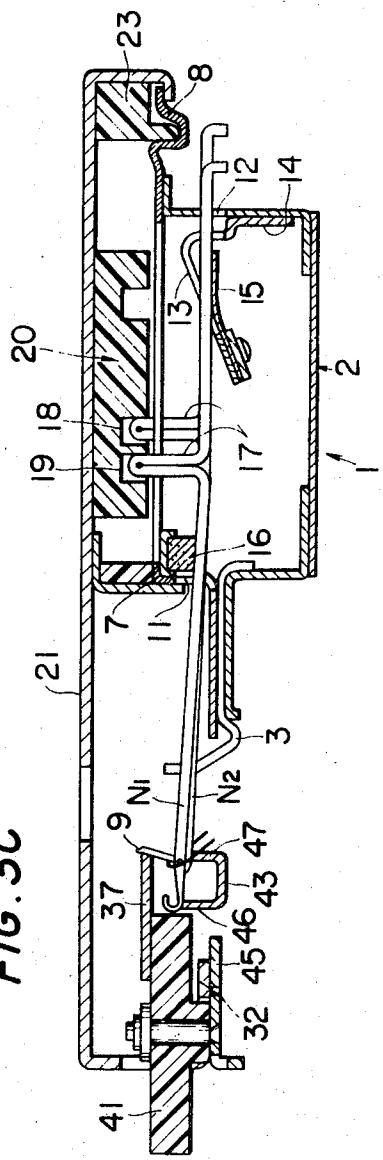

23
8
12
14
13
15
20
2
18
19
17
1
16
7
11
21
3
N1
N2
9
47
37
43
46
45
32
41

FIG. 3C

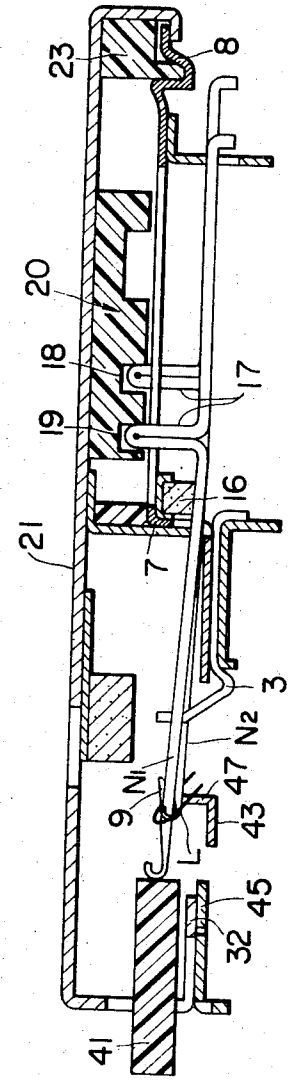

23
8
20
18
17
19
16
21
7
3
N2
Ni
47
9
43
L
45
32
41

FIG. 3D

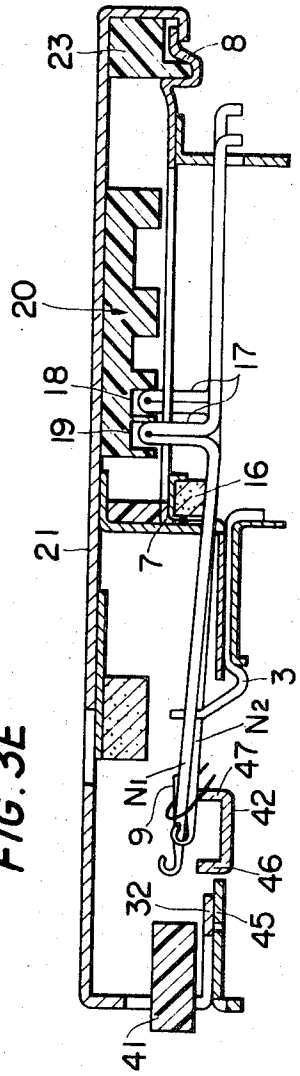

23
8
20
18
17
19
16
21
7
3
N2
Ni
47
9
42
46
32
45
41

FIG. 3E

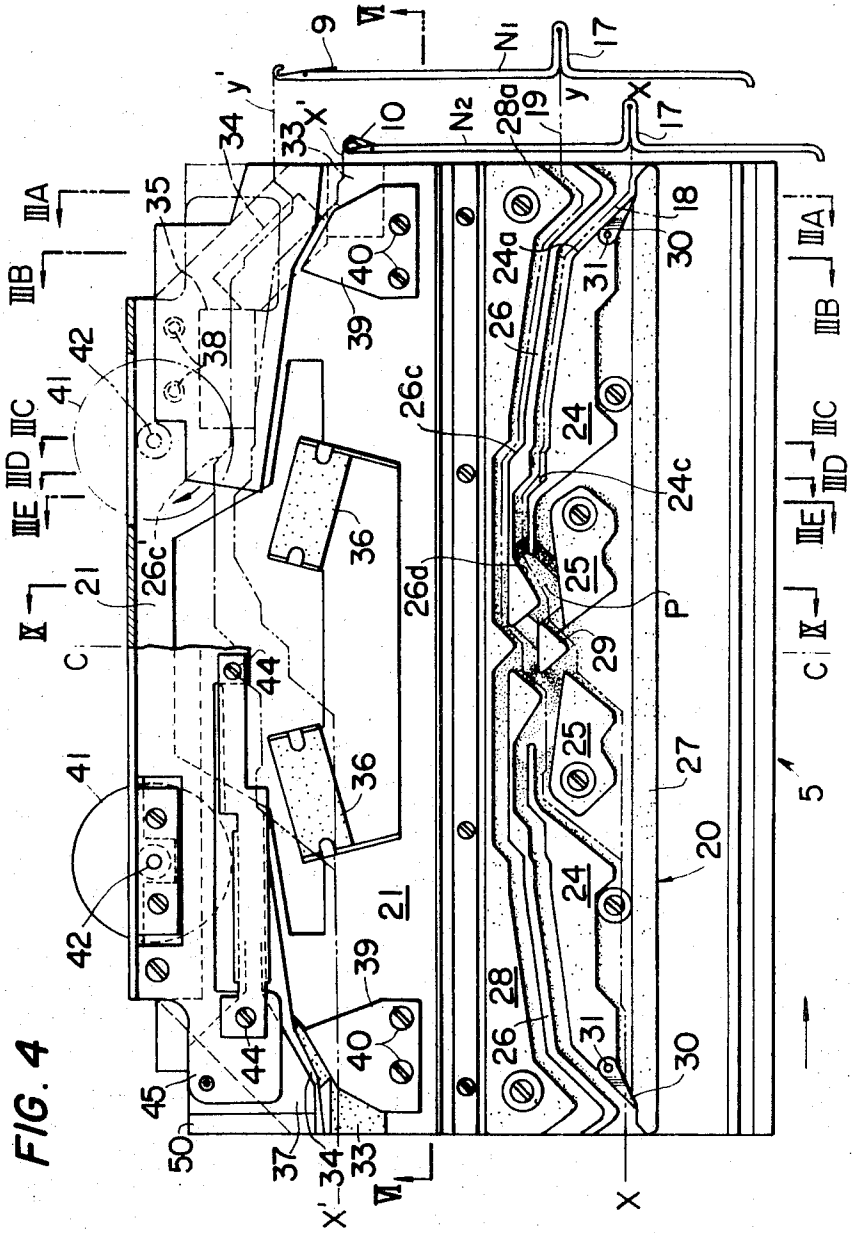

9
VI
N1
17
34
y'
33
X'
10
N2
28a
19
y
X
17
IIIA
35
IIIB
40
39
18
30
31
24a
26
42
41
IIIC
IIID
IIIE
38
26c
24
24c
36
26d
25
P
29
21
IX
26c'
C
44
27
20
5
45
50
37
34
33
VI
X'
X

FIG. 4

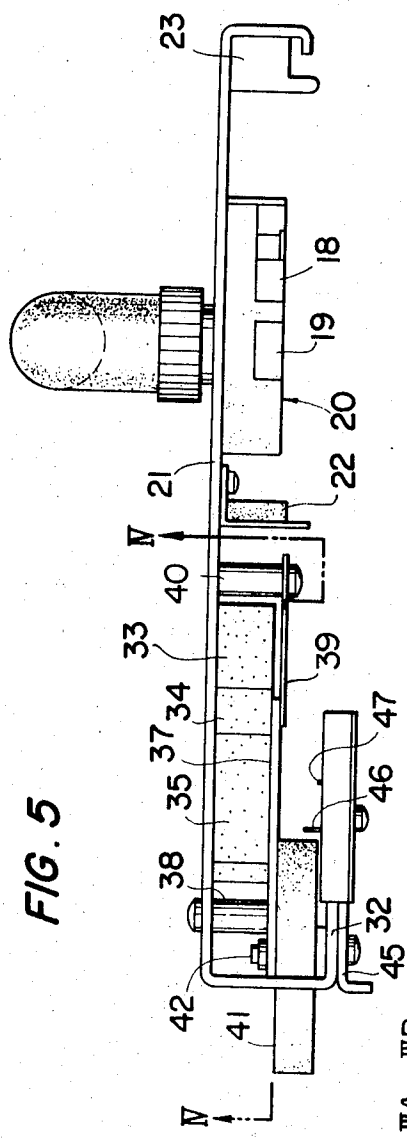

23
18
19
20
22
21
IV
40
33
39
34
37
35
38
47
46
32
45
42
41
IV

FIG. 5

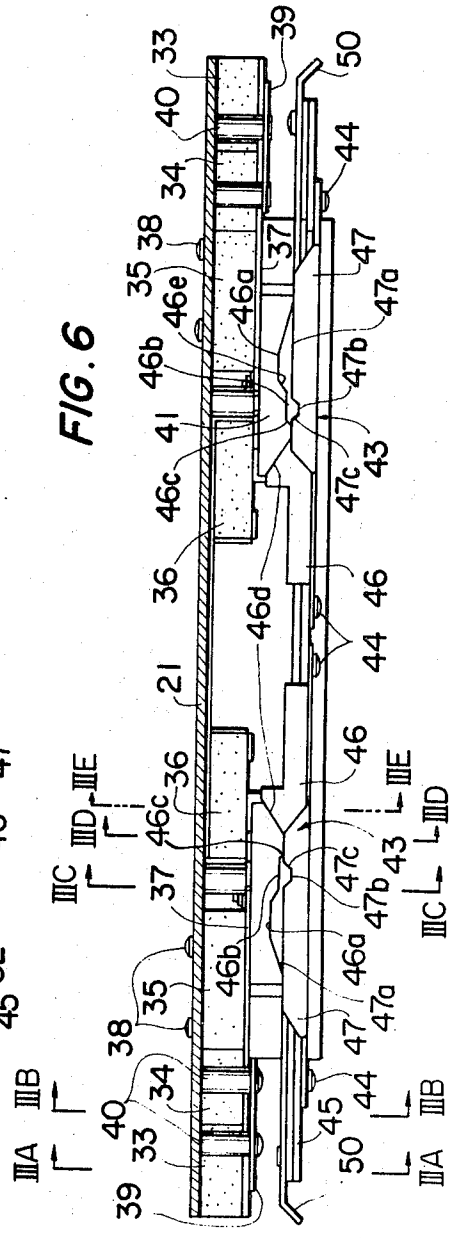

33
39
50
40
44
34
38
37
47
35
46e
46a
47a
46b
47b
41
43
46c
47c
36
46
46d
44
21
46
36
IIIE
IIID
IIIC
46c
37
47c
43
47b
IIIE
IIID
IIIC
46b
46a
35
47a
38
47
34
44
IIIB
40
45
IIIA
33
50
IIIA
IIIB
39

FIG. 6

FIG. 7

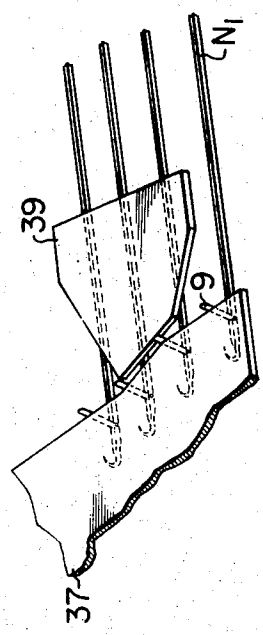
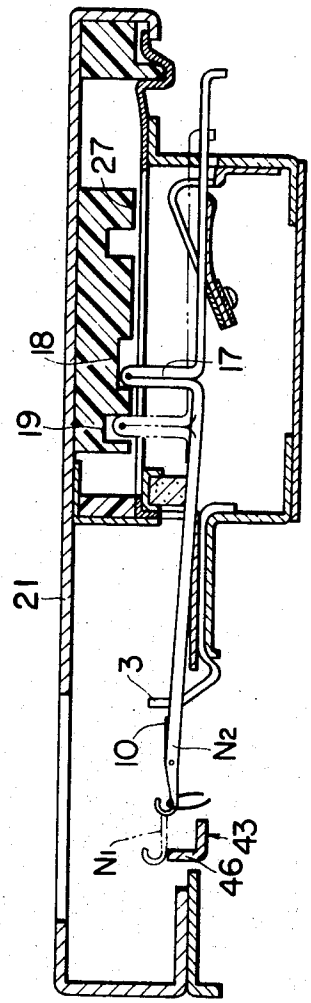


FIG. 9



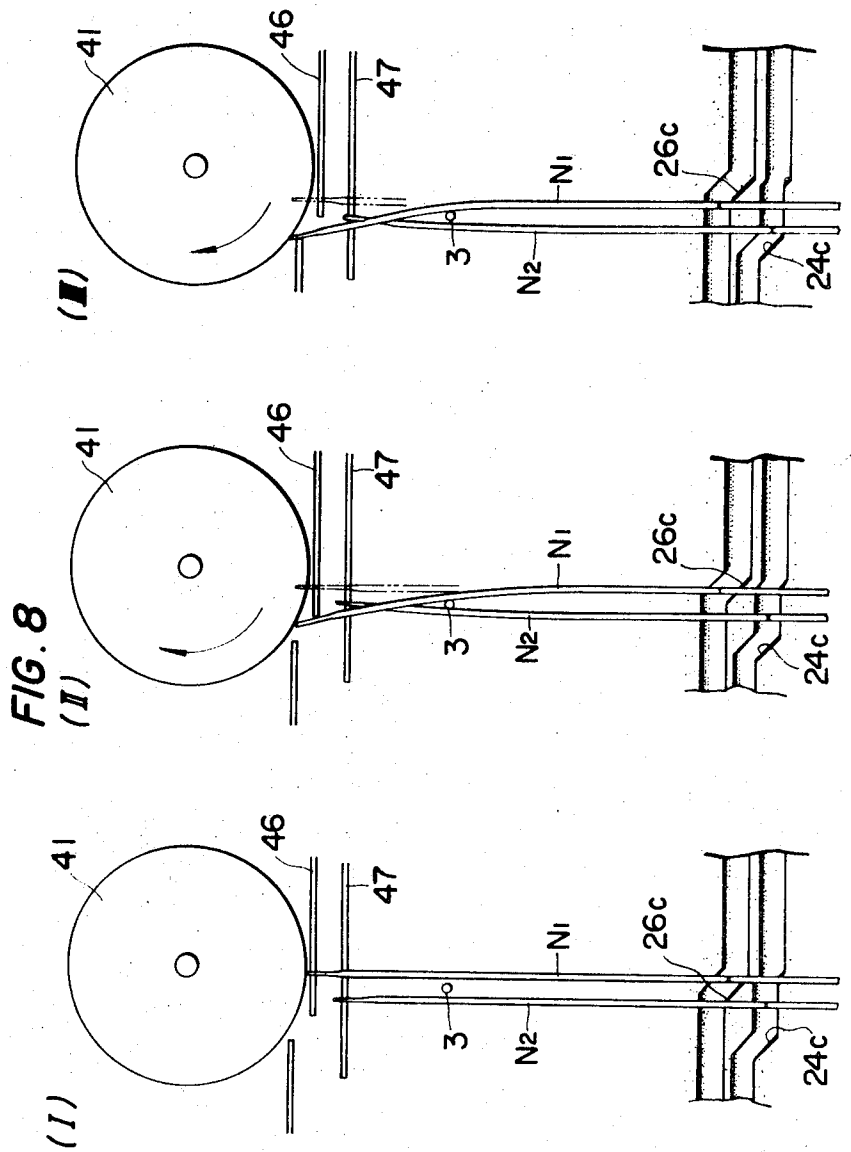

41
46
47
N1
26c
3
N2
24c
(III)
41
46
47
N1
26c
3
N2
24c
(II)
41
46
47
N1
26c
3
N2
24c
(I)

FIG. 8

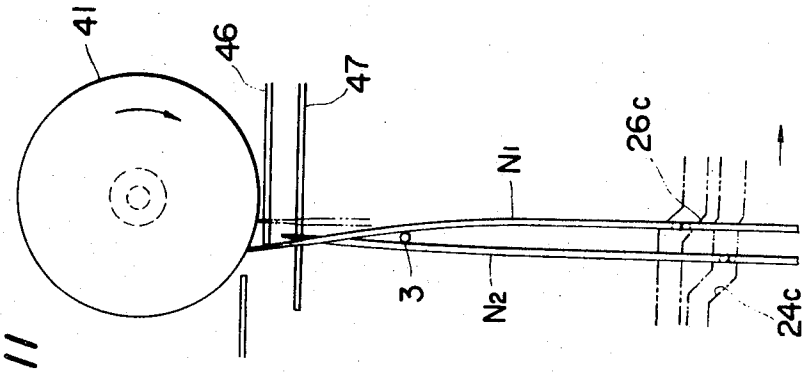


FIG. 11

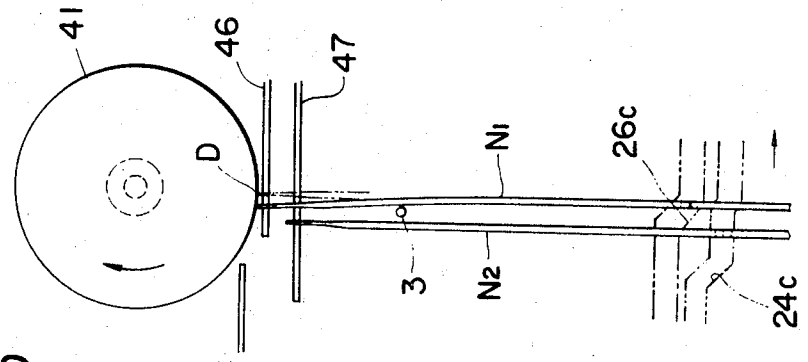


FIG. 10

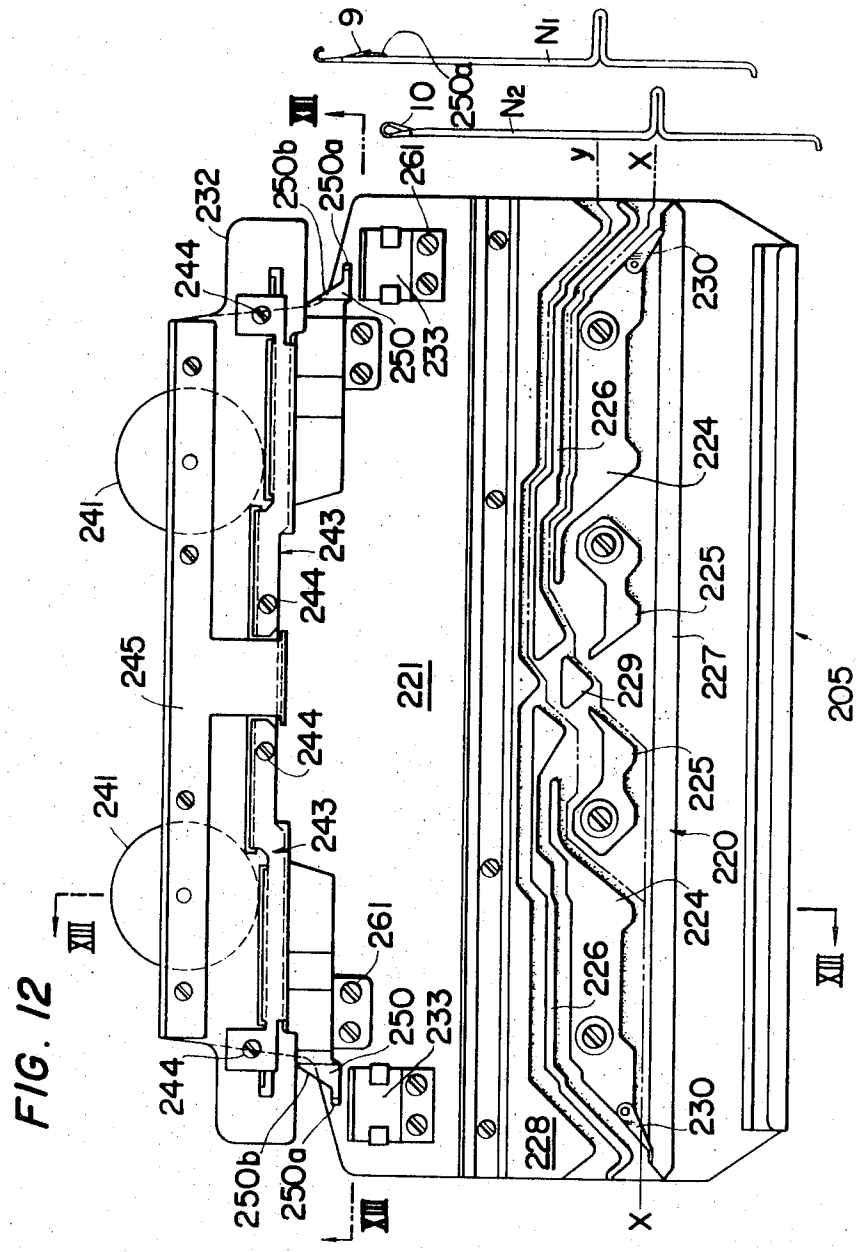

9
N1
10
250a
N2
III
y
X
250b
250a
261
232
244
250
233
230
226
224
241
243
244
225
245
221
229
227
205
244
225
241
243
220
224
261
226
250
233
244
228
230
250b
250a
III
X

FIG. 12

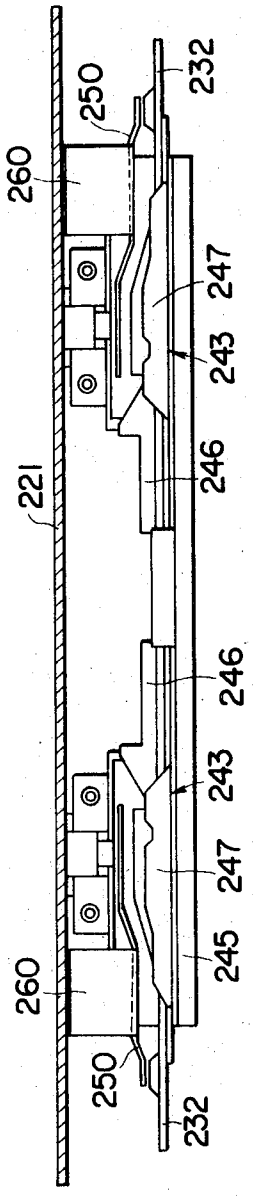

260
250
232
247
243
246
221
246
243
247
245
260
250
232

FIG. 13

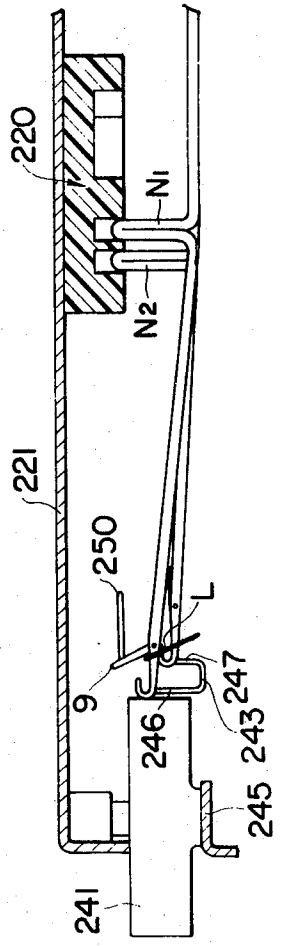

220
N1
N2
221
250
L
9
247
246
243
245
241

FIG. 14

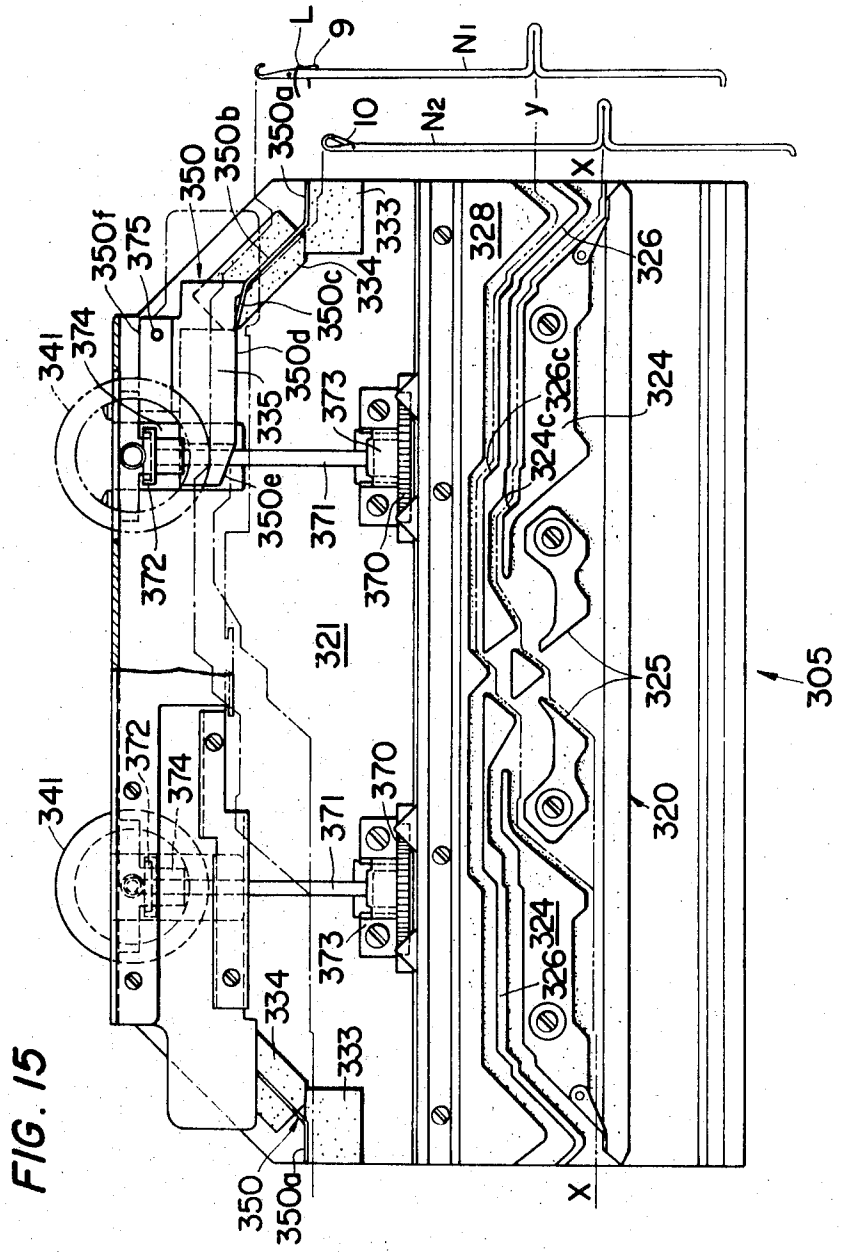

L
9
N1
10
N2
y
X
350a
350b
350
350f
375
333
328
326
334
350c
341
374
350d
373
326c
324
335
324c
350e
371
372
370
321
325
305
320
341
372
374
370
371
373
324
326
334
333
350
350a
X

FIG. 15

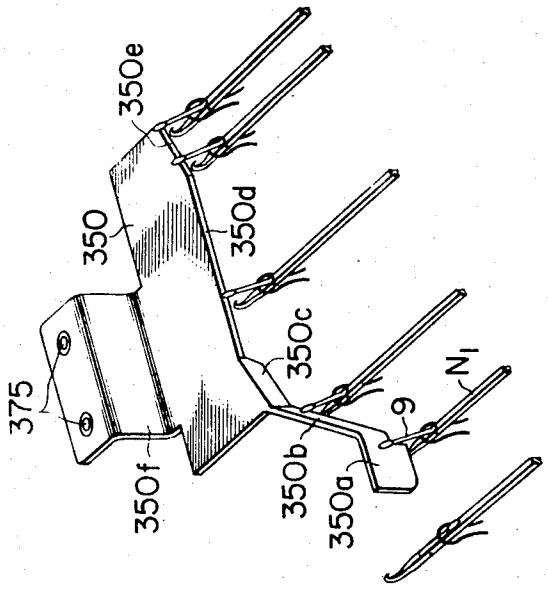

350e
350
350d
350c
375
350f
350b
350a
9
N1

FIG. 16

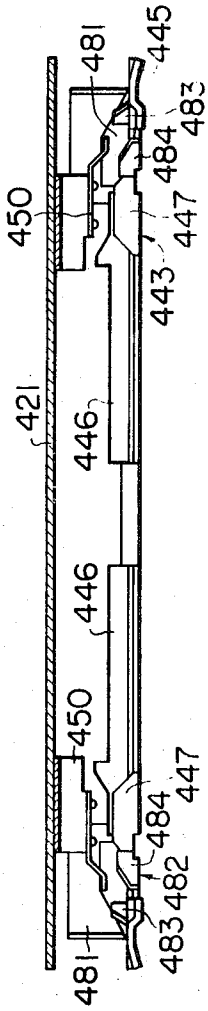

481
445
483
484
450
447
443
421
446
446
450
447
484
482
483
481

FIG. 18

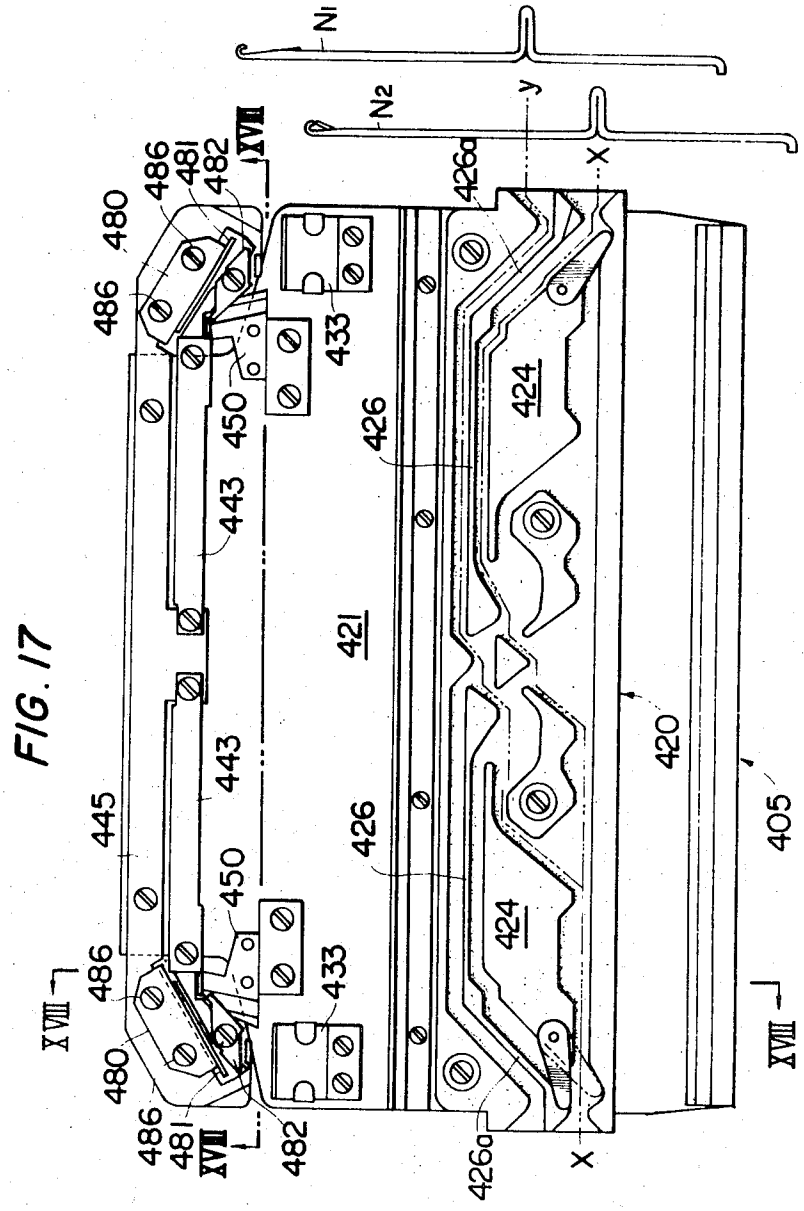

N1
N2
y
x
426a
XVII
486
481
482
480
433
450
426
424
443
421
420
405
445
XVIII

FIG. 17

FIG. 19A

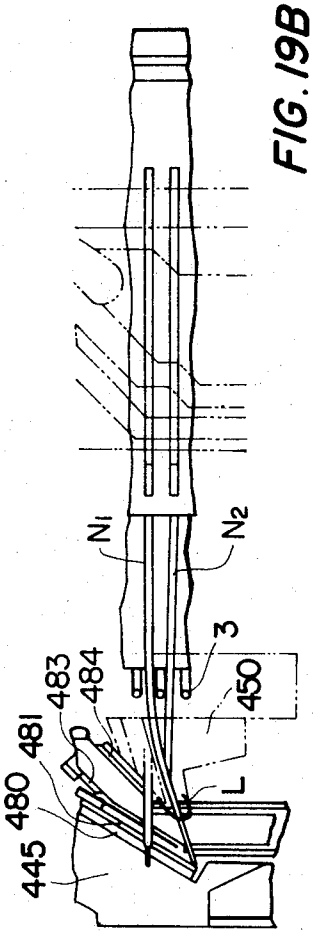
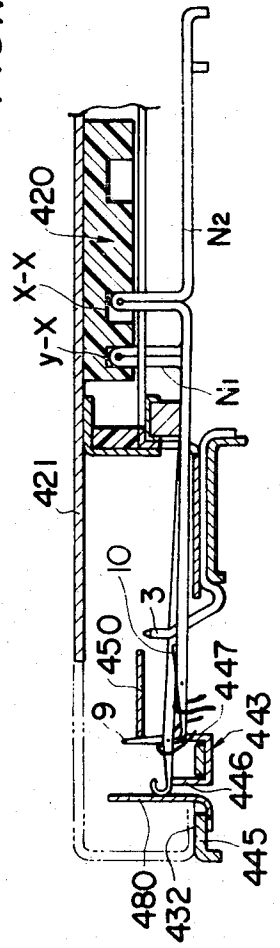


FIG. 19B



APPARATUS FOR KNITTING

BACKGROUND OF THE INVENTION

The present invention relates to knitting and in particular to method and actuating apparatus adapted to the known household type hand knitting machine for changing the knitting pattern. More particularly, the invention is concerned with transferring loops or stitches from the selected needles to the remainder to thereby change the knitting pattern in the character of the product which is needed.

As used herein, the term "loop discharging needle" refers to one from which a loop is transferred to the other needle not selected. The non-selected needle is accordingly referred to hereinafter as "loop receiving needle."

In order to transfer the loops from the loop discharging needles to the loop receiving needles, the loops on the loop discharging needles must be spread to enable formation of a loop having an adequate opening through which the loop receiving needle co-projects. In transferring the loops, such spreading must be restricted to a necessary minimum size of the opening for the sake of avoidance of excessive deformation of neighboring loops in the resultant fabrics. For achieving such spreading of yarn loops, it has heretofore been the usual manner that both loop receiving and discharging needles are flexed to be closely adjacent each other.

However, it has been the practice in the conventional manner that in flexing the loop discharging needle, the loop discharging needle is at first flexed upward beyond uppermost extremities of neighboring alternated sinkers and then the needle is again flexed laterally past the neighboring sinker up to a position immediately above the neighboring loop receiving needle. As a result, the loop yarn on the loop discharging needle is forced to excessively spread to form a loop of uselessly larger size than is really required for co-projecting the loop receiving needle therethrough. This deficiency is considered as a great disadvantage, in that neighboring loops in the resultant fabric will be forced to uselessly reduce for supplying to such spreading loop a length of yarn required to spread. A product of inferior quality will be thus effected.

SUMMARY OF THE INVENTION

A principal object of the present invention therefore is to provide an actuator of the hand knitting machine of household type for preventing the excessive spreading of the transferred loop yarn.

The foregoing object and others are attained according to at least one aspect of the present invention through the provision of means to flex the loop discharging needle out of the vertical plane of the needle but not out of the plane in which lie the sinkers.

Thus, in the disclosed embodiments, there are provided a needle bed, a plurality of sinkers forwardly protruding from the extremity of the needle bed and arranged in parallel and at regular intervals in a plane, a corresponding number of latch needles alternated with the sinkers and having a free sliding fit on the needle bed so as to project beyond and to retract from the neighboring sinkers, a stitch forming actuator movable on the needle bed so as to reciprocate along the longitudinal direction of the needle bed and engage with said needles to have the needles project beyond and to retract behind the sinkers to form the stitches, and a loop transferring actuator movably supported on the needle bed so as to reciprocate along the longitudinal direction of the needle bed. The loop transferring actuator comprises a first cam means to axially move the needles on the needle bed, a second cam means to move the extremities of the selected needles and their neighboring needles in corresponding planes both perpendicular to a plane in which lies said series of needles, and laterally shifting means for forcing the selected needles to flex with their extremities shifted closely toward the neighboring needle past the forward extremity of the neighboring sinker whereby the neighboring needle co-projects through the yarn loop on the selected needle and transferring of the yarn loop is performed from the selected needle to said neighboring needle by having the loop gotten behind the latch of the selected needle and then ridden over the closed latch thereof.

BRIEF DESCRIPTION OF THE DRAWING

Various other objects, features and attendant advantages of the present invention will be more fully appreciated as the same becomes better understood from the following detailed description when considered in connection with the accompanying drawings, wherein like reference numerals are used throughout to designate like or corresponding parts, and which:

FIG. 1 is a plan view of a household type hand knitting machine according to the present invention;

FIGS. 2A to 2G are views from the front side of the machine showing successive steps in the operation of the needles;

FIGS. 3A to 3E are cross sectional views taken along the lines IIIA — IIIA to IIIE — IIIE in FIGS. 4 and 6 showing a series of successive steps in the loop transferring operation of the needles;

FIG. 4 is a bottom plan view of the actuator according to the invention partially cut off along the line IV — IV in FIG. 5;

FIG. 5 is a side view of the actuator according to the present invention;

FIG. 6 is cross sectional view taken along the line VI — VI in FIG. 4;

FIG. 7 is a partially cut off perspective view showing the parts of the actuator of FIG. 4;

FIGS. 8(I) to 8(III) are plan views of a portion of the actuator in FIG. 4 and showing the needles in flexed and unflexed positions which correspond to those at IIIC—IIIC to IIIE—IIIE lines in FIGS. 4 and 6 respectively;

FIG. 9 is a cross sectional view taken along the line IX — IX in FIG. 4;

FIGS. 10 and 11 are both partial views of the needle positions shown in FIGS. 3C and 3D respectively;

FIG. 12 is a bottom plan view of a second embodiment of the invention similar to that of FIG. 4;

FIG. 13 is a cross sectional view taken along the line XIII — XIII in FIG. 12;

FIG. 14 is a cross sectional view taken along the line XIIII — XIIII in FIG. 12;

FIG. 15 is a bottom plan view of an actuator of a third embodiment of the invention;

FIG. 16 is a partial perspective view of the actuator of FIG. 15;

FIG. 17 is a bottom plan view of an actuator of the machine according to a fourth embodiment;

FIG. 18 is a cross sectional view taken along the line XVIII — XVIII in FIG. 17;

FIG. 19A is a pertial plan view of the needle position shown in FIG. 19B; and

FIG. 19B is a cross sectional view taken along the line XVIIII — XVIIII in FIG. 17.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Throughout the drawings, similar numerals refer to similar parts of the machine according to the present invention.

Referring to FIG. 1, the hand knitting machine 1 includes a needle bed 2 and a large number of sinkers 3 forwardly protruding from the forward extremity of the needle bed 2 and being arranged in parallel and at regular intervals in a plane. A corresponding number of latch needles N are alternated with the sinkers in the plane and have a free sliding fit in the respective slots formed in the needle bed as will be described hereinafter in detail. The actuator 5 according to the present invention is provided in addition to the main actuator 6 adapted to the usual plain stitch knitting. The actuator 5 is adapted to production of the figured or patterned knitting such as lace knitting. In actual use of the machine, one of the actuators in acting position is within the acting zone on the needle bed while the other actuator is in the rest position out of the zone. No further description will be made hereinafter with respect to the actuator 6 because the actuator 6 does not form the invention.

The actuator 5 of the present invention is movably supported above the needle bed 2 in a manner such that the actuator may reciprocate along two parallel guide rails 7 and 8 and on the needle bed 2, shown in FIG. 3.

For convenience of understanding the invention, it is thought desirable to briefly set forth the problem to which the invention is directed before commencing detailed explanation of the invention. For such purpose, two courses of resultant stitches are shown in FIGS. 2A to 2G by viewing from the front side of the apparatus.

In FIG. 2A, the loop L is to be transferred from a loop discharging needle N1 to a neighboring loop receiving needle N2 as shown in FIG. 2G where transferring of yarn loop L has been achieved. To accomplish the transferring of the loop L, the extremities, hooked portions, of the needles N1 and N2 are required to move in mutually perpendicular planes in succession to a series of steps of transferring function, as described below.

In FIG. 2A, the both needles N1 and N2 are in the positions immediately before initiation of the transferring. Then, the needle N1 is caused by the first cam means to move forwardly with its hooked portion or extremity protruded beyond neighboring sinkers 3, as shown in FIG. 3A. The latch 9 of the needle N1 is held in raised position to prevent the loop L from being getting behind the latch 9. Means to hold the latch 9 in such position will be described as the discussion proceeds. The hook of the needle N1 is then moved upwardly in slight distance as shown in FIG. 2B while the forward extremity of the other needle N2 is positioned immediately behind the loop L. As a result, the hook of the needle N1 can shift its loop L to a position immediately before the hook of the neighboring needle N2, as shown in FIG. 2C. The hook of the needle N1 is slightly lowered and the hook of the needle N2 thereafter is moved forwardly as shown in FIG. 2D to coproject through the loop L, while the loop being otherwise held not to get behind the latch of the needle N2 as more fully described hereinafter. The hook or extremity of the needle N1 is again rasied as shown in FIG. 2E and is then retracted to the original position as shown in FIG. 2F.

The latch 9 of the needle N1 is then released to fall down so that the loop L may get behind the latch 9 while the loop is held not to get behind the latch 10 (FIG. 9) of the needle N2. Finally the both needles are retracted into their original positions. Such retraction will cause the latch 9 to be closed and the yarn loop L is riding thereover, to thereby cause the needle N1 to be drawn off from the loop L as shown in FIG. 2G whereas the hook of the other needle N2 still holds the loop therein together with its own old loop L'. The transferring of the yarn loop L is thus achieved. From the foregoing, it will be apparent that the hooks of the needles N1 and N2 are also moved during the operation in a imaginary plane normal to the plane in which lies the needle bed 2. The movements in the both planes are in timed relation to each other so that desired transferring operation is completed as shown in FIG. 2G.

The actuator 5 will there be described hereinafter in detail. The actuator has three main parts to move a hooked portion of each needle in mutually perpendicular two planes. One of the three parts includes the first cam means, so to speak, a slide cam mechanism which is reciprocated along the longitudinal direction of the needle bed and is employed for transmitting a straight-line movement to the latch needles N, followed by a dwel to permit the next reverse travel of the actuator 5. The second part includes a different type slide cam mechanism secured on the forward extremity of the actuator adapted to move the hooked portion of each needle in a vertical plane perpendicular to the plane in which lies the series of latch needles N. The both movements are in timed relation with each other so that the desired transferring of the yarn loops may be achieved.

As will be seen in FIG. 3C, the needle bed 2 is provided with a series of slots 11 in the front wall and another series of similar slots 12 in the back wall thereof. Each needle N is free to slide through a pair of corresponding slots 11 and 12. Each needle is further slidably received in a corresponding one of slots 13 formed in the supporter 14 secured on the back wall of the needle bed 2. A leaf spring 15 fixed at one end thereof to the supporter 14 is normally engaged with the needles N to thereby resiliently urge the needles to the upper end of the slots 12 and longitudinal receiving bar 16 secured to the upper inside surface of the front wall of the needle bed 2. It will be understood that the forward extremity of the needle may be raised up against the spring 15, to swing through an angle about the bar 16. This is one of important features of the actuator to move the hooked end of each needle in the vertical plane. Each needle selectively has its butt 17 engage with one of cam tracks 18 and 19, formed in the first cam means generally indicated by the numeral 20 in FIG. 3C.

In the actuator 6, a similar cam mechanism (not shown) is provided for engagement with the buts of the needles N. As conventional, the needles are projected from or retracted into the needle bed 2 for performing

the usual knitting operation, as the actuator **6** is reciprocated laterally on the guide rails **7** and **8** of the needle bed **2**.

Referring now to the actuator **5**, there is provided on the base plate **21** of the actuator **5** two parallel sliding members **22** and **23** which have a free sliding fit on the guide rails **7** and **8** respectively as shown in FIG. **3**. As will be seen in FIG. **4**, the actuator **5** has the first cam track **18** and the second cam track **19** to be traced out by the butt of each needle. Various cam members are secured on the base plate **21** of the actuator **5** to provide the said cam tracks **18** and **19**. It should be noted that most of these cam members are arranged in the actuator symmetrically relative to the center line C — C shown in FIG. **4** to thereby provide similar paths for the needles in whatever direction the actuator may be moved on the needle bed. A first pair of symmetrical cam members **24**, a second pair of symmetrical cam members **25** and a third pair of symmetrical cam member **26** are secured on the internal face of the base plate as shown in FIG. **4**. A first long cam **27** and second long cam **28** are secured on the base plate **21**, between which the said three pairs of cam members are arranged. A single cam member **29** of generally equilateral triangular form is secured on the central portion of the cam **20**. By the arrangement of the cam members, there are provided two paths X — X and Y — X as shown in dot and dash line in the view for the needles to trace. A pair of swinging members **30** are pivoted by upset pins **31** to the corresponding cam members **24** at the outer-most ends thereof. The swinging cam members are normally spring biased toward abutment to the first long cam member to guide the needles into the path X — X while permitting the needles to get out from the path X — X in the reverse stroke of the actuator **5**. It will be seen in FIG. **4**, that the two paths are converged into one path between left-hand cam member **24** and left-hand cam member **25**. It will be noted that the two paths X — X and Y — X are those which are traced when the needles enters from the right-hand side of the actuator **5**. Reverse takes place when the needles enter into the cam **20** from left-hand side of the actuator. From the foregoing, it will be understood that whichever path the needles are passed, every needle getting out of the actuator **5** remains in the same retracted rest position where they are ready for entering into the actuator in the subsequent reverse travel of the actuator **5**.

As shown in FIG. **5**, the base plate **21** is formed of suitabl gauge and is folded back at the forward extremity of the actuator so as to form sub-plate **32**. Within the space formed between the base plate and the sub-plate **32** is received the second cam menas and the laterally shifting means by which the extremity of each needle is moved in the vertical plane. The second cam means and laterally shifting means are particularly shown in FIGS. **5** and **6**. Said laterally shifting means serves to flex the selected needle N1 so as to shift hooked portion thereof to a position closely adjacent to the extremity of the neighboring needle N2 to transfer a loop from the selected needle to the neighboring needle. A pair of sets of magnets **34** and **35** are secured to the internal face of the base plate **21** by firmly clamping thereof by the base plate and supporting plate **37** which are fastened by means of bolts **38** to the base plate. Another pair of magnets **33** are fastened to the base plate **21** by means of different means, such as rivets (not shown). A pair of guide plates **39** are fastened by means of bolts **40** to the base plate **21** as will be seen in FIGS. **4** to **6**. The guide plates **39** are of non-magnetic nature while the other set of supporting or guide plates **37** are of magnetic nature to direct concentrated magnetic flux to the latches of the needles as will be explained as the discussion proceeds. A pair of wheels **41** are free to rotate on shafts **42** extending from the sub-plate **32** as will be seen in FIGS. **4** and **5**.

A pair of hook guiding cams or the second cam means **43** are bolted by means of bolts **44** to a foundation plate **45** which is fastened to the sub plate **32** as will be seen in FIGS. **5** and **6** or FIG. **3C**. The hook guiding cams are of the same U shpaed form as will be seen in FIG. **3** formed of front cam plate **46** and rear or back cam plate **47**. The front cam plate **46** provides a series of cam faces to raise up the front extremity of the loop discharging needles N1. The other cam plate **47** provides another series of cam faces to raise the hooked portion of the loop receiving needle N2.

As shown in FIG. **4**, the needle N1 is selected to occupy a projected position relative to other needle N2 before the actuator **5** initiates the knitting operation.

When the actuator **5** is in use applied to the hand knitting machine, the actuator is reciprocated along the longitudinal direction of the needle bed **2**, as is usual when the other actuator **6** is used in knitting the ordinary plain stitch fabric. Although the actuator **5** is really moved relative to the needle bed, the description with respect to the operation of the actuator will be made hereinafter as if the actuator was held stationary and the needles were advanced or moved relative to the actuator **5**.

It should be noted that an additional device of usual type is used in the application of the actuator **5** in order to allot the selected loop discharging needle N1 to the entrance to the path Y - X in dependency upon a needed charater of the product. However, the additional device is so conventional that description and illustration thereof may be abbreviated.

When the actuator **5** is moved along the needle bed **2** by the operator, the butt **17** of the loop discharging needle N1 follows the path Y - X shown in the FIG. **4** and the loop receiving needle N2 follows the path X — X. The extremity of the needle N1 accordingly follows the path Y' - X' while the extremity of the other needle N2 follows the path X' — X'. It will be seen in the view that the needle N2 leads the other needle N1 in the operation. The needle N1 is first retracted from its selected position by cam face **28***a* shown in FIG. **4** while the other needle N2 is protruded by the swinging member **30** and the cam face **24***a*. The reason why the needle N1 is retracted slightly at the beginning fo the operation, is that the yarn loop L to be transferred is required to shift toward the hooked portion of the needle so that the loop offers no obstruction to the latch **9** to be raised up. The latch is held in its raised up position by the magnet **34** and the guide plate **37** as shown in FIG. **7** until the hook of the other needle N2 becomes co-project through the loop L. The hooked portion of the needle N1 also rides on the guide plate **50** immediately before the latch **9** is raised up by the magnet **34** to ensure a predetermined distance from the magnet and accordingly to ensure a constant magnetic force therefrom. The guide plate **39** serves to prevent the latch **9** from completely falling down apart from the other guide plate **37** in the event of any unexpected

force applied to the latch. The position of the needle N1 shown in FIG. 3A corresponds to that shown in FIG. 4 by line IIIA — IIIA and position of FIG. 3B to that shown in FIG. 4 by line IIIB — IIIB. It will be seen that the needle N1 is so protruded that the loop yarn L is shifted beyond the sinker 3 in FIG. 3B so that loop L can be transferred without obstruction caused by the sinker 3.

During travel from the IIIB position to the IIIC position in FIG. 4, the needle N1 is caused to raise and subsequently lower its hook by the cam face 46*a* shown in FIG. 6 while the other needle N2 remains in engagement with the cam face 47*a*. At the position IIIC, the needle N1 abuts the periphery of the wheel 41 as shown in FIG. 3C and further movement of the actuator 5 causes the further projection of the needle N1 by cam face 26C as shown by the reference character 26C' in FIG. 4 on the path Y' – X'. As a result the needle is forced to restorably flex while the wheel being rotated as shown by the arrow. This will be obvious from the fact that the path Y' – X' crosses with the periphery of the well 41 shown in phantom in FIG. 4. The plan view of the flexed needle N1 is shown in FIG. 8. When the needle N1 is flexed as shown in FIG. 8(II), the extremity thereof engages the cam face 46*b* while the other needle N2 engages the cam face 47*b*. Further travel of the actuator results in crossed condition of the both needles with each other as shown in FIG. 8(III) and FIG. 3D. Immediately after such step, the needle N1 is lowered by decrease of lift of the cam face 46*b* as shown by the numeral 46*c* while the needle N2 is raised by the steep cam face 47*c*. The steep cam face 47*c* on the other hand develops a side thrust against the needle N2 sufficient to slightly flex the needle N2 as shown in FIGS. 8(II) and 8(III). Further projection of the needle N2 results in projection of the extremity thereof through the loop L as shown in FIG. 3E. Further travel of the actuator causes the needle N1 to engage the rising cam face 46*d* while the other needle N2 disengages from the cam 47 as will be seen in FIG. 6. The crossed condition thus ceases as described in the foregoing with reference to FIG. 2F. The latch 9 of the needle N1 thence falls down, disengaging from the magnetic guide plate 37. Getting behind the latch 9 takes place so that further retraction of the needle N1 results in closing the latch and riding of the loop yarn over the latch. The loop L is thus disengages from the needle N1 completely as shown in FIG. 2G, where the Needle N1 is completely retracted and transferring of the loop L has been achieved.

After the completion of the transferring, the extremities of the needles N1 and N2 respectively follow the remainder of the paths Y'–X', and X' — X' as shown in FIG. 4. The magnet 36 serves to raise the latch of the needle N2 so as to prevent the loop L from getting behind the latch 10 of the needle N2.

In FIG. 9, there is shown a cross sectional view taken along the line IX — IX in FIG. 4. As will be seen in the view, the cam track 18 is of lesser depth as compared with the neighboring path or cam track 19. The lesser depth portion is limited in a zone which is shown in FIG. 4 by the reference character P, and faces the cam face 26*d* of the cam member 26. The rising portion P provides means to raise the hooked portion of the needle N2 in the retracting stroke of the needle immediately after the hook has received the loop yarn L with a result that the loop L is ensured within the hook during the stroke without any failure of drawing off. It should be noted that the loop is enlarged during the loop transferring operation and when the transferring is completed the enlarged or spread loop is thereafter slackened. The loop L is apt to escape from the hook of the loop receiving needle N2 during the retracting stroke thereof by reason of the fact that the spread loop is not so promptly reduced as would sufficiently prevent the loop from drawing off from the hook of the needle N2. Thus the provision of the portion P is efficient to obtain the desired result while preventing the misstitching.

As viewed in FIG. 6, the cam plate 46 has a cam face 46*e* sufficiently abrupt to cause a desired side thrust against the extremity of the needle N1 when the butt of the needle N1 is about to engage the cam face 26*c* to be protruded. by the provision of the cam face 46*a*, the needle N1 is slightly flexed immediately before the extremity of the needle N1 abuts the wheel 41 past the bottom dead point on the periphery of the wheel 41. Such abutment of the needle N1 is shown in heavy line in FIG. 10. The needle N1 shown in dot and dash line implies an abutment as would otherwise take place with a danger that the wheel 41 fails to rotate in the direction indicated by the arrow in FIG. 11.

In FIGS. 12 and 14, there is shown a different embodiment of the present invention. Parts which are the same as those shown in FIGS. 3 to 11 are given the same number in a 200 series. The actuator 205 has no more magnet for the needle N1 than it has magnet 233 for raising the latch of the needle N2. In order to raise the latch of the needle N1, guide plates 250 are provided by fastening thereof to the base plate 221 by means of bolts 261 as shown in FIG. 12. Each guide plate 250 has sharp or keen extremity 250*a* as seen in FIG. 12. At the start of operation, the extremity engages the back of the latch 9 of the needle N1 as shown in the view. The latch 9 thereafter is raised as shown in FIG. 14 by the guide plate 250. The latch remains in such position until the other needle N2 projects through the loop L in the same manner as described in the foregoing. The magnet 233 serves to raise the latch 10 of the needle N2 for receiving the loop yarn within the hook of the needle N2. Further function of the embodiment will be obvious from the foregoing and further description will be unnecessary.

There is shown in FIGS. 15 and 16, a third embodiment of the invention. Parts which are the same as those shown in FIGS. 3 to 11 are given the same number in a 300 series.

The most significant feature of the embodiment is that the wheels 341 are drivenly connected to gear 370 which meshes with a series of the stems of the needles in relation of rack and pinion mode each other, through shaft 371 and gear 372. The bevel gear 372 meshes with a circular series of teeth (not shown) on the face of the wheel 341. The shaft 317 is supported rotatably by means of bearings 373 and 374 secured on the base plate 321. A pair of symmetrical guide plates 350 are secured to the base plate 321 by means of bolts through holes 375 formed in the bent portion 350*f*. The magnet 335 is supported within a space defined by the base plate 321 and the guide plate 350. The latch 9 of the needle N1 is raised and guided by a series of edges 350*a* to 350*e* as shown in FIG. 16 under the magnetic force applied by the magnets 334 and 335. Since the wheels 341 drivingly engage the hook of the needle N1, the

needle's exact bending is always ensured, without any danger as would reversely bend when the butt of the needle N1 passes the cam face 326*c*.

In FIGS. 17 to 19, there is shown the fourth embodiment embodying a stationary abutment plates instead of the wheels of the preceding embodiments. Parts which are the same as those shown in FIGS. 3 to 11 are given the same number in a 400 series. The most significant feature as compared with the other embodiment is that a pair of stationary abutting plates 480 are provided instead of the wheels in the preceding embodiments. The abutting plates are placed on the supporting plate 445 by means of bolts 486 at a lesser angle relative to the direction of travel of the actuator 405 as compared with the cam faces 426*a*. In dependence upon the difference between their inclinations, the needle N1 is forced to bend as the actuator 405 travels on the needle bed 2, in proportion to the difference. Such bending of the needle is shown in FIG. 19A in heavy line while the needle shown in dot and dash line implies a position as would otherwise be occupied by the needle N1. Under the condition shown in FIG. 19A, the needle N2 is projected so as to pass through the loop L as the same manner as that described in the discussion of the other embodiments. The guide member 482 has cam faces 483 and 484 to guide needles N1 and N2 respectively. The cam face 484 serves to raise the extremity of the needle N2 up to the level of the back guide plate 447 while the cam face 483 raises the extremity of the needle N1 up to the level of the guide plate 481 fastened to the abutting plate 480. The guide plate 450 prevents the latch 9 of the needle N1 from falling down and accordingly the loop is prevented from getting behind the latch until the hook of the needle N2 completely projects through the loop. The same result is obtained by this embodiment.

What is claimed is:

1. A hand knitting machine having

a needle bed;

a plurality of sinkers forwardly protruding from the extremity of the needle bed and arranged in parallel and at regular intervals in a plane;

a corresponding number of latch needles alternated with the sinkers and having a free sliding fit on the needle bed so as to project beyond and to retract from the neighboring sinkers;

a stitch forming actuator movably supported on the needle bed so as to reciprocate along the longitudinal direction of the needle bed and engage with said needles to have the needles project beyond and to retract behind the sinkers to form the stitches; and

a loop transferring actuator movably supported on the needle bed so as to reciprocate along the longitudinal direction of the needle bed;

said loop transferring actuator comprising first cam means for causing the needles to protrude from and retract into the needle bed, and laterally shifting means adjacent to extremities of selected ones of the needles in abutably relation therewith in the protruding movement of the selected needles to thereby shift laterally horizontally said extremities substantially close to non-selected neighboring ones of the needles past but not over free ends of the neighboring sinkers, whereby the neighboring needle co-projects through the yarn loop on the selected needle and transferring of the yarn loop is performed from the selected needle to said neighboring needles by having the loop gotten behind the latch of the selected needle and then ridden over the closed latch thereof.

2. A machine as recited in claim 1, wherein the laterally shifting means includes a pair of rotatable wheels disposed at the forward extremity of the needle bed and spaced from the first cam means with a relation therewith such that the first cam means forces the selected needles to abut the periphery of the wheels and further excessively push the selected needles against the periphery until the needles are flexed due to a lift of the cam means which is higher disproportionally to the curvature of the periphery.

3. A machine as recited in claim 2 in which latch holding magnetic means is further provided at a position closely adjacent to the path of the extremity of the selected needles when the selected needles follow the cam track of the first cam means so that the latch of the selected needles is in its raised up position to thereby secure the loop yarn in front of the latch.

4. A machine as recited in claim 3, in which flux guiding means is further provided with its edge portion positioned at a position closely adjacent to the path of the extremity of the selected needle so that a concentrated flux is directed to the latch of the selected needle to insure holding the loop yarn in front of the latch.

5. A machine as recited in claim 1 in which is additionally provided a cam face the lift of which is in a direction perpendicular to the plane in which lies the needle bed to thereby press the top end of the butt of the non-selected needle whereby the extremity of the non-selected needle is accordingly raised up to prevent the loop from being drawn off out of the hooked portion of the non-selected needle when the non-selected needle is retracted.

6. A machine as recited in claim 1, wherein said second cam means is provided with a steeper cam face as compared with neighboring cam faces for engagement with the selected needle, the pressure angle of the cam face being so calculated that a side thrust developed against the selected needle is sufficient to flex thereof through a predetermined angle immediately before the extremity of the selected needle abuts the periphery of the wheel whereby the extremity of the selected needle engages the periphery of the wheel out of the bottom dead point on the periphery for insuring the predetermined rotational direction of the wheel.

7. A machine of claim 1, wherein said laterally shifting means is a stationary plate fastened to the extremity of the needle bed and inclined relative to the direction of travel of the actuator, the inclination of laterally shifting means being so calculated that the corresponding cam face of the first cam means provides a higher cam lift than that provided by the laterally shifting means whereby projection of the selected needle develops a side thrust of the laterally shifting means to flex the selected needle with its extremity positioned at a position closely adjacent to the neighboring needle.

8. A machine as recited in claim 1, wherein said loop transferring actuator further comprises second cam means to raise the extremities of the selected needles and their neighboring non-selected needles without raising the extremities beyond the neighboring sinkers for ensuring safety transferring of the loop.

9. A machine as recited in claim 8 wherein said second cam means is formed with a substantially steep

cam face to laterally horizontally shift extremities of the non-selected needles toward the selected needles for assistance of the safety transferring of the loop.

10. A hand knitting machine having

a needle bed;

a plurality of sinkers forwardly protruding from the extremity of the needle bed and arranged in parallel and at regular intervals in a plane;

a corresponding number of latch needles alternated with the sinkers and having a free sliding fit on the needle bed so as to project beyond and to retract from the neighboring sinkers;

a stitch forming actuator movably supported on the needle bed so as to reciprocate along the longitudinal direction of the needle bed and engage with said needles to have the needles project beyond and to retract behind the sinkers to form the stitches; and

a loop transferring actuator movably supported on the needle bed so as to reciprocate along the longitudinal direction of the needle bed;

said loop transferring actuator comprising first cam means to axially move the needles on the needle bed, second cam means to move the extremities of the selected needles and their neighboring needles in corresponding planes both perpendicular to a plane in which lies said series of needles, and laterally shifting means for forcing the selected needles to flex with their extremities shifted closely toward the neighboring needle past the forward extremity of the neighboring sinker whereby the neighboring needle co-projects through the yarn loop on the selected needle and transferring of the yarn loop is perfomed from the selected needle to said neighboring needle by having the loop gotten behind the latch of the selected needle and then ridden over the closed latch thereof;

said laterally shifting means including a pair of rotatable wheels disposed at the forward extremity of the needle bed and spaced from the first cam means with a relation therewith such that the first cam means forces the selected needles to abut the periphery of the wheels and further excessively push the selected needles against the periphery until the needles are flexed due to a lift of the cam means which is higher disproportionally to the curvature of the periphery.

* * * * *