Jan. 30, 1962 H. SCHURICH 3,018,644

FLAT HAND KNITTING MACHINE WITH A DETACHABLE AUXILIARY NEEDLE BED

Filed April 29, 1959 5 Sheets-Sheet 1

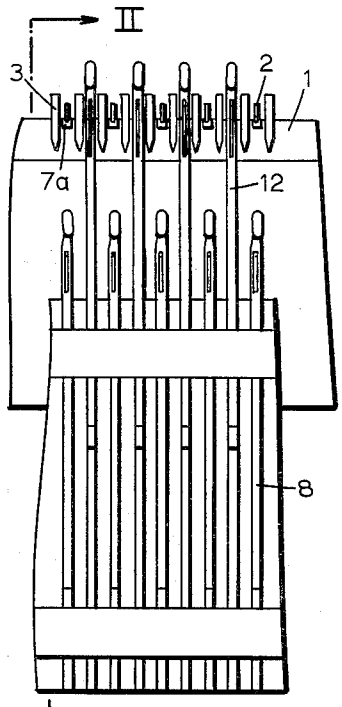


FIG. 1

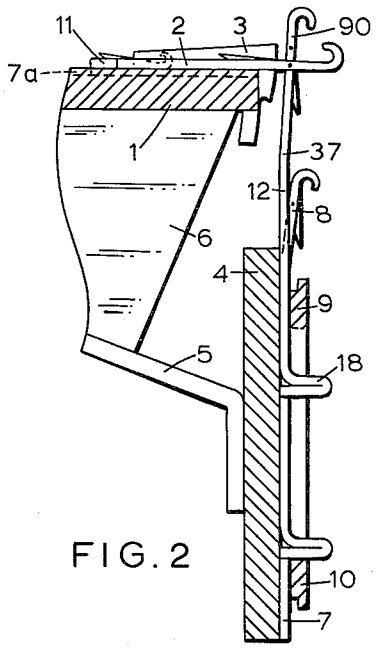


FIG. 2

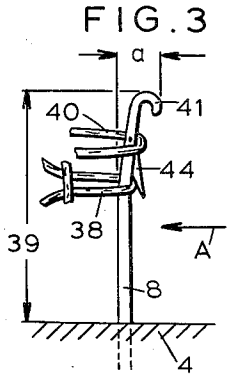


FIG. 3

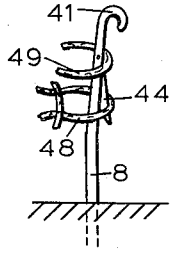


FIG. 9

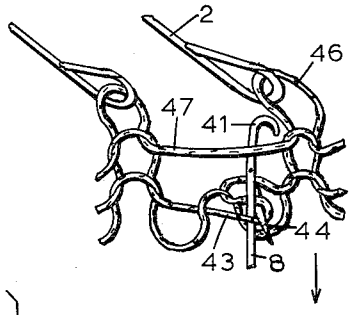


FIG. 8

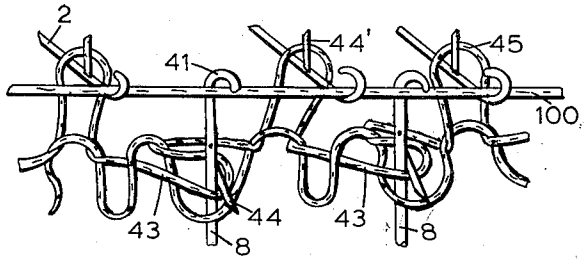


FIG. 7

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FLAT HAND KNITTING MACHINE WITH A DETACHABLE AUXILIARY NEEDLE BED

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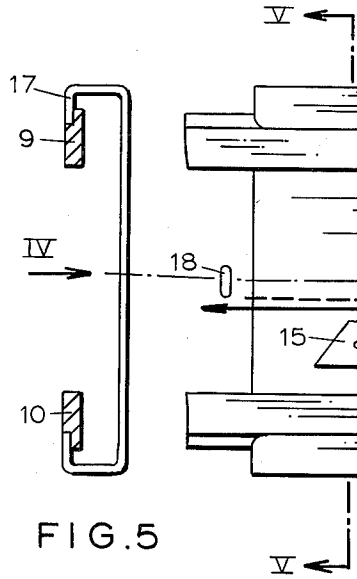


FIG. 5

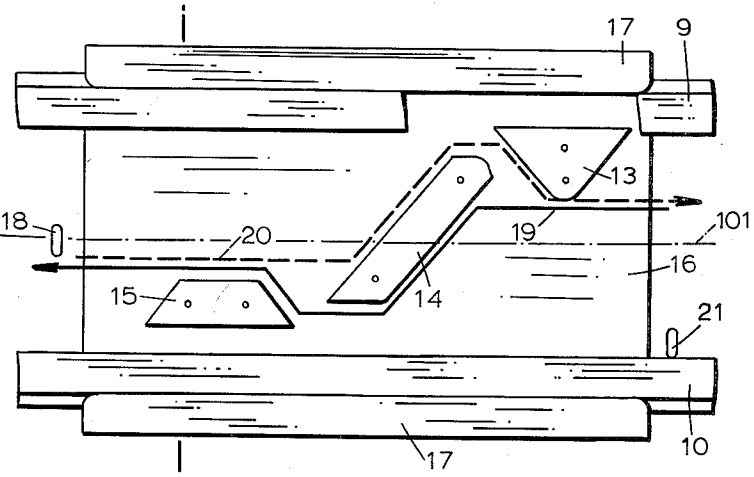


FIG. 4

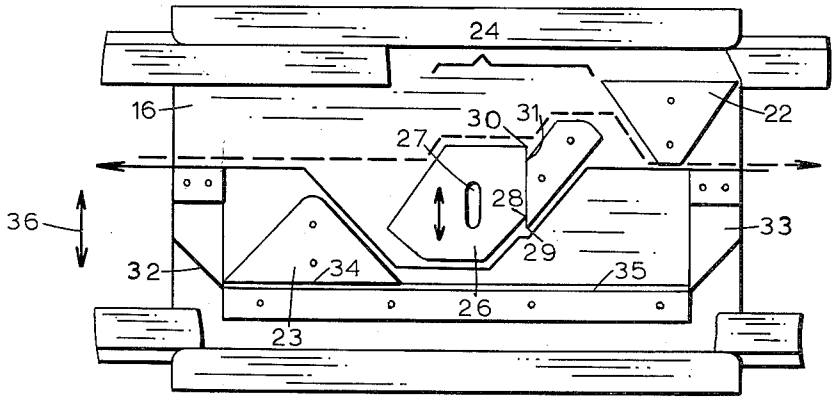


FIG. 6

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FLAT HAND KNITTING MACHINE WITH A DETACHABLE AUXILIARY NEEDLE BED

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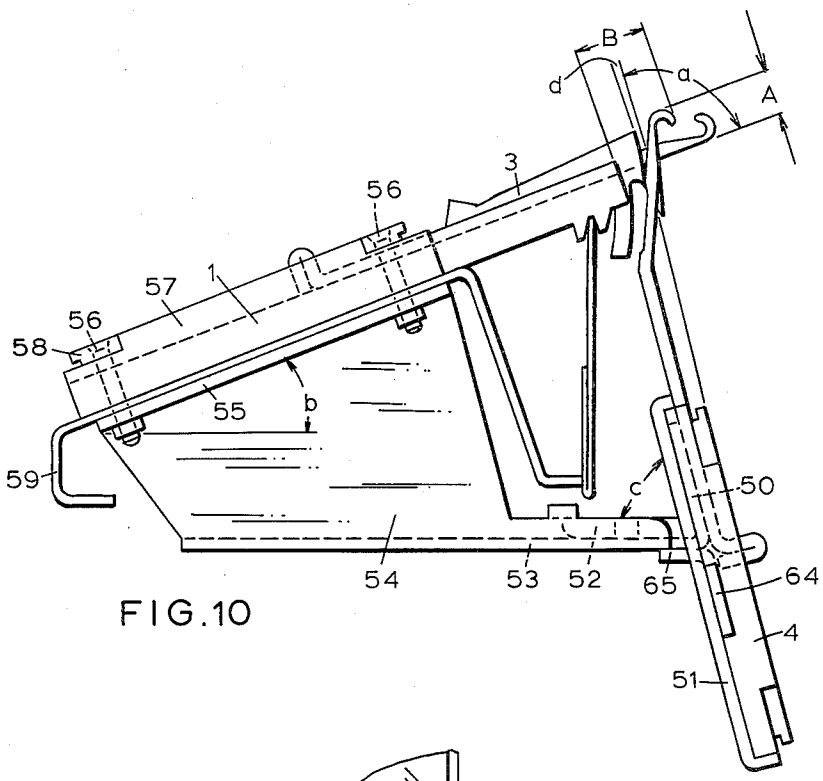


FIG.10

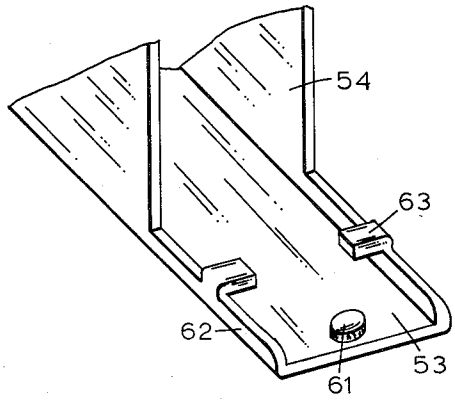


FIG.11

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FLAT HAND KNITTING MACHINE WITH A DETACHABLE AUXILIARY NEEDLE BED

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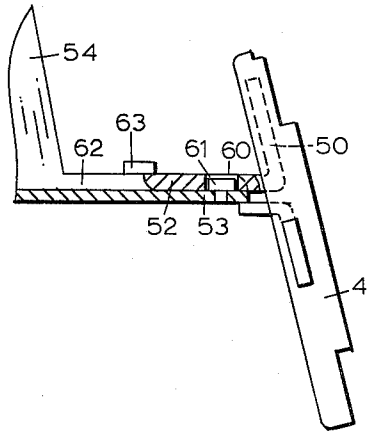


FIG. 12

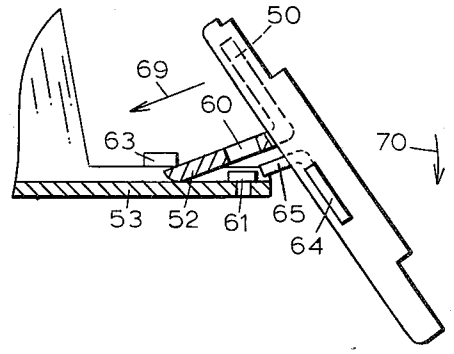


FIG. 13

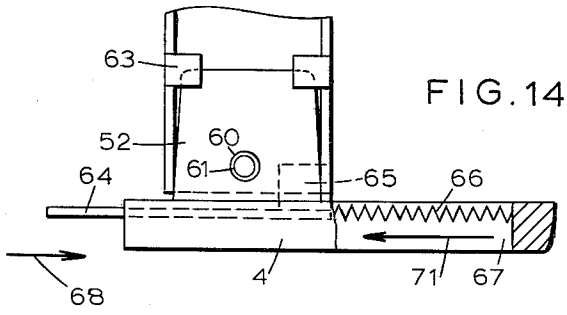


FIG. 14

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FLAT HAND KNITTING MACHINE WITH A DETACHABLE AUXILIARY NEEDLE BED

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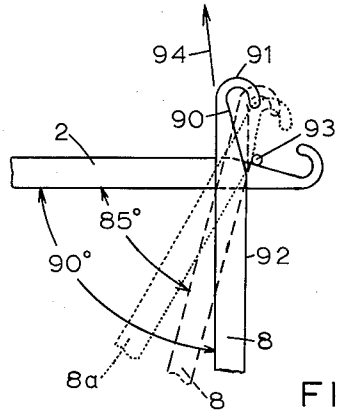


FIG.15

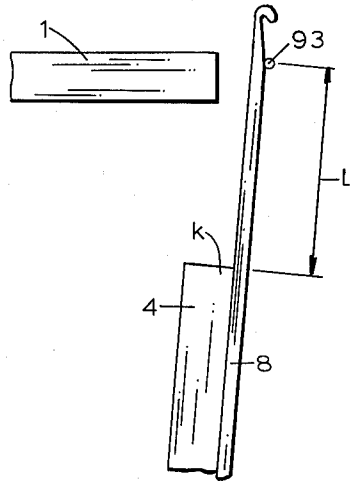


FIG.16

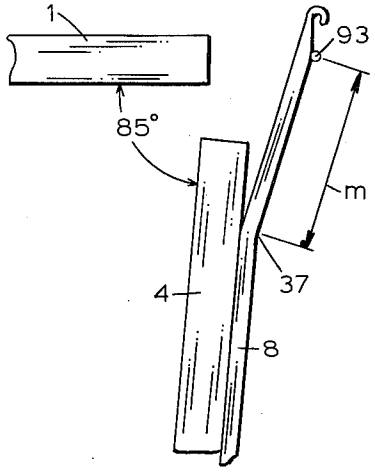


FIG.17

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BY Mestern, Ross & Mestern

United States Patent Office 3,018,644 Patented Jan. 30, 1962

3,018,644

FLAT HAND KNITTING MACHINE WITH A DETACHABLE AUXILIARY NEEDLE BED

Herbert Schurich, 1 Mudrackzeile, Berlin-Reinickendorf, Germany

Filed Apr. 29, 1959, Ser. No. 809,728
11 Claims. (Cl. 66—64)

This invention relates to an apparatus for the production of knitted work, in particular stocking-stitch (i.e. knit one, purl one) knitting on hand knitting machines. The present application is a continuation in part of my prior application, Serial No. 499,115, filed April 4, 1955, for Method for the Production of Knitted Work by Means of Hand Knitting Machines and a New Knitting Machine for This Method, which is now abandoned.

Flat knitting machines of conventional construction are provided with a special needle bar which is arranged in front of the main needle bed so that certain patterns such as offset, openwork, color or fancy work patterns can be made, the needle bar being provided with a number of parallel adjacent latch needles pointing in a direction perpendicular to the direction of the main needles.

The needle bar is located so that the needles project several millimeters in front of the front edge of the main needle bed, in the gaps between the main needles of the knitting machine. In order to produce the desired pattern, the needles are pivoted on pins at their lower ends so that they can be swung down, and those needles which are not required for the forming of the pattern are swung down into their lower position.

With this needle bar the pattern is formed by means of a framework knitting process carried out by the needle of the needle bar at the same time as the knitting process by means of the main needles, where this needle bar is reciprocated in the vertical direction so that all needles of this bar in the knitting position are reciprocated at the same time. The disadvantage of this well known method of producing a pattern, noticed in particular when the method is employed in connection with a hand knitting machine, is that a considerable effort is required to operate the machine, which is particularly undesirable in the case of hand knitting machines which are mostly operated by women and where easy operation is an important feature. The comparatively great effort is due to the fact that all needles of the needle bar taking part in the formation of the pattern are pulled through the stitches at the same time, so that the force required to pull the loop through the stitch by means of the needle of the needle bar is multiplied by the number of needles operated at the same time.

According to this invention these disadvantages are avoided by producing the pattern, in particular stocking-stitch knitting, by means of an entirely different apparatus. The main needles are so employed that the stitches are formed by them successively and are cast off consecutively.

An improvement and a further development of the present invention consists in the auxiliary needle bed being designed so that it is fixed to the frame of the main needle bed, but can always be detached easily. This has been found to be convenient because frequently for fairly long periods the auxiliary needle bed is not in use and it is more convenient for the knitter to remove the auxiliary bed from the instrument during this period. For the satisfactory functioning of the device and in particular for the formation of stitches it is important that the two needle beds are located in a definite relation to each other.

The present invention includes special mounting plates, which are placed immediately between the main needle bed and the auxiliary needle bed, and the mounting plates

are manufactured with a sufficient degree of accuracy, so that no tolerances greater than the maximum permissible tolerances are found in the relative positions of the two needle beds.

The use of special mounting plates also has the further advantage that devices can be conveniently provided for detaching the auxiliary needle bed quickly and safely by means of a few manual operations.

It is another object of the present invention to provide means implementing the production of knit-knit patterns, i.e. plain or Jersey stitches, on hand knitting machines.

A further object of the invention is to provide means affording efficacious and economical construction of a two-part rather than an integral apparatus, so that a consumer can first obtain a basic or main knitting apparatus which can be utilized primarily to provide plain knitting and which, by the addition of an attachment coupled with the main apparatus, can produce various and different patterns, particularly knit-knit patterns. This provides a highly important commercial advantage since it is possible to first purchase the basic or main knitting apparatus which is completely adequate for the production of knit fabric but which does not provide for the production of more complicated patterns. If the owner of the basic apparatus wishes to change to such complicated patterns, he only has to buy the attachment which can be simply affixed to the main apparatus to form a complete and highly improved machine.

The combined form of apparatus has certain similarities to a conventional "Lamb-type" double-bed machine. However, the latter cannot be changed readily to and never was constructed or intended to fulfil the requirements of a hand knitting apparatus. The latter, moreover, has the serious disadvantage that it requires a delivery reed with weights in order to keep the knitting down. This is very inconvenient in a hand knitting machine since there is no room in the latter for weights unless the machine is so secured on a table by clamps that it projects forwardly to a considerable extent therefrom. In such an arrangement, the reed with the weights can move down freely in front of the table edge during the knitting process. However, since a substantial advantage of the hand knitting machine resides in the ability of the apparatus at any time to be attached freely on a table or the like, the previously described fastening with clamps would destroy the foregoing advantage.

The problem arises therefore in the development of a hand knitting machine with attachment to do without the reed and weights. This is only possible, however, if other devices are provided to keep the knitting down.

To this end, pivoted sinkers are arranged according to the present invention in the main needle bed, in addition to the needles, which serve to press the sinker loops down. In the attachment, which has a second needle bed, these sinkers for depressing the loops are not provided, mainly because they would make the attachment more complicated. Instead of the sinkers for depressing the loops, the latch needles of the attachment are made resilient, so that the needles of the attachment are bent during the formation of the loops by the tension of the yarn. When these loops are cast off, the tension stops and the needles can rebound so that when the needles rise again there is no danger that the needle heads will engage loops that already have been formed, thus disturbing the formation of the loops. The resiliency of the needles has thus, in the attachment, the same function as the depression of the loops already formed by the sinkers in the main apparatus.

In order that the invention may be clearly understood and readily carried into effect, the same will now be described more fully with reference to the accompanying drawing in which:

FIG. 1 is a front view of a hand knitting machine with an auxiliary needle bed mounted on it;

FIG. 2 is a partial side view of the hand knitting machine in section along the line II—II of FIG. 1;

FIG. 3 is a diagrammatical presentation of an auxiliary needle with one stitch and one loop lying on this needle;

FIG. 4 is a view from below (looking in the direction of the arrow IV of FIG. 5) of a cam slide or lock for controlling the auxiliary needles;

FIG. 5 is a cross-section through the auxiliary needle lock, along the line V—V of FIG. 4;

FIG. 6 is a view from below of another form of auxiliary needle lock;

FIG. 7 is a view of some stitches with all needles in the operating position;

FIG. 8 is a view of some stitches with the main needles in the inoperative position and the auxiliary needles in the operative position;

FIG. 9 is a diagrammatical representation of an auxiliary needle with a loop and a stitch lying one above the other, in order to produce a polka rib pattern;

FIG. 10 is a cross-section through the main and auxiliary needle beds;

FIG. 11 is a part of a mounting plate shown in oblique parallel projection;

FIG. 12 is a partial cross-section through the auxiliary needle bed and the mounting plate at the location of the locking pin in the inoperative position of the needle bed;

FIG. 13 is a cross-section similar to that of FIG. 12, but in this case the auxiliary needle bed is shown while being placed in the operative position;

FIG. 14 is a partial front view of the auxiliary needle bed with the mounting plate in the locked position; and

FIGS. 15, 16 and 17 are fragmentary detail views, similar to FIG. 2, drawn to an enlarged scale.

In the machine shown in FIGS. 1 and 2 the main needles **2** are located in grooves **7***a* in a conventional main needle bed **1** provided with the usual reciprocable cam slide or needle lock (not shown). Sinkers **3** are pivoted in grooves between the main needles (see also FIG. 10). Below and in front of the front edge of the main needle bed **1** the auxiliary needle bed **4** is arranged in a perpendicular position with respect to the main needle bed **1** and fixed to the frame **6** of the machine by means of angle cleats **5**. Auxiliary needles **8** are arranged so that they can slide in grooves **7** of the auxiliary needle bed **4**. These auxiliary needles **8** are prevented from dropping out of their grooves by means of the two lock-guide rails **9**, **10** of the auxiliary needle bed. These rails serve at the same time to limit the stroke of the auxiliary needles.

As shown in FIG. 1, the spacing of the auxiliary needles is the same as that of the main needles. Also, the auxiliary needle bed is fixed to the machine frame in such a way that the auxiliary needles are placed in alignment with and accurately opposite the main needles, and not in the gaps between them, as in conventional machines. Assuming that in FIGS. 1 and 2 a stocking-stitch pattern is to be knitted, alternate main needles are always positioned in the rest or inoperative position, as shown in both illustrations; these are the needles denoted by the number **11**.

In alignment with these needles, auxiliary needles denoted by the number **12** are placed in a working or operative position while the adjacent auxiliary needles **8** are in the lower rest or inoperative position.

While the main lock or cam slide is of conventional construction with two outer needle extenders, auxiliary needle retractors and latches and a central main needle retractor, whereby the operative needles **2** are necessarily retracted from an extended position and returned to the latter position in a single traverse of the main lock, the auxiliary needle lock shown in FIGS. 4 and 5 is much simpler. This lock is provided on its back on the right-hand side (as seen in the rear view of FIG. 4) with an auxiliary needle sinker **13**, in the center with a needle-transfer cam **14** acting as a combined raising and lowering means, and on the left-hand side with an auxiliary needle raiser **15**. These three parts are fixed to the auxiliary lock plate **16**, which by means of lock guides **17** slides in the lock-guide rails **9**, **10**. The relatively inverted auxiliary cams **13**, **15** terminate short of the median line **101** of the main cam **14**.

If the auxiliary lock is moved over the auxiliary needle bed from the left to the right as viewed in FIG. 4, the auxiliary needle butts **18** move, one after the other, along the path **19** shown as a full line, the butts **18** being forced downwardly upon striking the right-hand flank of cam **14**. The purpose of the auxiliary needle raiser lifter **15** is to lift the auxiliary needles at the first stroke so much that their butts **18** meet the left-hand flank cam **14** on the return stroke of the auxiliary lock. It will be seen that these flanks are substantially parallel while being inclined relatively to the direction of reciprocation of the lock.

It can be seen clearly from FIG. 4 that if the auxiliary needle raiser **15** were not provided, the needle butts would remain below the lower edge of the transfer cam **14**, so that the desired motion of the needles could not be accomplished.

On the return motion of the auxiliary lock, during the motion from the right to the left as viewed in FIG. 4, the needle butts **18** pass along the path **20** shown as a dotted line. In this case the auxiliary needle sinker **13** has, in contradistinction to the auxiliary needle raiser **15**, the function of pushing the auxiliary needles again downward, after they have been pushed far upward by the transfer cam **14**, so that the stitches are placed below the depending needle latch **44** (as particularly shown for a loop **38** in FIG. 3) between this latch and the auxiliary needle shaft, and are overlain by the latch. The auxiliary needle sinker **13** functions to lower the needle butts **18** so far during the first stroke, when moving from the left to the right, that, the needle butts meet the transfer cam **14** and do not remain above it, in which case they could not be moved by the said needle cam. In the retracted position (position **21** if FIG. 4) of the needles, the needles must be in a position low enough to avoid their hitting the lower part of the transfer cam **14** or the auxiliary needle raiser **15** when the lock is moved.

This determines the width of the auxiliary lock. In order to manufacture the lock economically, it should be made just wide enough to meet the aforesaid conditions with a sufficient degree of reliability.

The auxiliary needle sinker **22** and the auxiliary needle raiser **23** are shaped in principle similar to those shown in FIGS. 4 and 5. However, the needle cam **24** is made of two parts. It consists of a stationary part **25** corresponding approximately to the upper half of the needle cam **14** according to FIGS. 4 and 5. To this fixed part **25** a movable part **26**, which can be slid in a direction perpendicular to the direction of motion of the lock, is connected. This adjustability offers the possibility of setting accurately the vertical height of the rest position of the needles. The height adjustment of this transfer cam part **26** is limited by an elongated hole or slot **27** into which a projection, such as a key or pin (not shown), provided on the lock plate extends. The shape of this moving part, which corresponds as far as function is concerned to the lower portion of the transfer cam **14** of FIG. 4, has been widened, to take its adjustability into account, so that in the lowest position of the needle cam the corner **28** is not lower than the point **29** of the stationary part **25**.

Accordingly, in the lowest position of the transfer cam

part 26, the upper corner 30 must be above the corner 31 of the stationary transfer cam part 25. Only when these conditions are satisfied, is it ensured that the needle butts are not blocked by the stationary transfer part 25 when the needle cam part 26 is adjusted.

Guide plates 32, 33 are provided for the auxiliary lock as well as for the main lock, in order to prevent the needle butts from hitting parts of the auxiliary lock in an unfavorable position and blocking the said lock. Since the needle butts as a rule are pushed downward when they are taken out of operation, and since on the other hand, owing to the vertical arrangement of the auxiliary needle bed, gravity tends to move the needle downward, it is sufficient to provide plates only on both sides of the auxiliary needle raiser 23. On the left-hand side, the guide plate 32 can be arranged immediately next to the lower point of the auxiliary needle raiser, while this is not possible on the other side of the auxiliary needle sinker, since here the transfer cam 25, 26 interferes with this arrangement.

For this reason the lower edge 34 of the auxiliary needle raiser 23 is extended towards the right by means of a guide rail 35 and the other guide plate 33 is then seamed to this extension of the right-hand edge of the auxiliary needle sinker as shown in FIG. 6. For reasons of symmetry this second guide plate 33 is connected to the lock plate 16 just like the first guide plate 32, so that its outer edge is flush with the edges of the lock plate.

Since the auxiliary lock according to FIG. 6 is also intended to be used for making polka rib work patterns, the whole of the auxiliary needle raiser 23 must be determined according to a definite rule. The height 36 of this auxiliary needle raiser 23 is determined so that, after motion of the auxiliary lock from the left to the right, the needles are lifted so high, when they are required again, that the stitch is placed in the neighborhood of the lower end of the opened latch 44 so as to be above the tip of the latch, as illustrated in FIG. 9 for a loop 48. The stitch must assume this position so that the polka rib patterns can be made, as will be described below.

A further feature of this invention consists in the auxiliary needle being bent so as to make an obtuse angle below the point where the latches are fixed, that is at the point indicated by the number 37 in FIG 2. By this means the stitch 38 (FIG. 3) above the needle shank would be stretched forward by a distance *a*, if the auxiliary needles were moved down. But since the auxiliary needle 8 projects beyond the auxiliary needle bed 4 by a comparatively large distance 39, this part of the auxiliary needle bends resiliently in the direction of the arrow A towards the main needle bed. An important advantage results therefrom, as will be apparent from the following. The loop 38 of FIG. 3, whose position in the fabric is similar to that of loop 43 in FIG. 7, is held against displacement in a forward direction (i.e. to the right in FIG. 3) by the retaining action of the hooks of needles 2 upon adjacent loops of the fabric 42. Hence, as the needle 8 is lowered, loop 38 tends to straighten its forwardly bent upper part which is thus deflected toward the rear of its normal position (i.e. to the left in FIG. 3.) As the loop 40 formed during the knitting process is pulled through the stitch 38 by the downward motion of the auxiliary needle 8, the stitch 38 is guided by the latch 44 to slide over the needle hook 41. This will liberate the needle from the stitch 38, so that the auxiliary needle 8 can rebound to its original position, that is to say in a direction opposite that of the arrow A, so that after the auxiliary needle 8 has risen, the back of the hook 41 and thus also the side of the needle shaft opposite the side facing the hook and the latch 44 (i.e. the left-hand side as viewed in FIG. 3) slide along the outside of the stitch. This avoids with certainty the danger of the hook 41 of the auxiliary needle moving again into the old stitch when the needle rises.

The formation of the loop will now be explained in more detail with the aid of FIGS. 7 and 8. After the work has been cast on the main needle bed in the usual manner and the first two rows of stitches of fabric 42 have been formed, a fresh length of yarn 100 is placed on the extended main needles 2 so as to lie forwardly of the hooks 41 of the raised auxiliary needles 8 which rise in the planes of the retracted main needles (not shown in FIGS. 7 and 8). As shown in FIG. 7, every second stitch 43 of the second row previously cast on is traversed by a respective auxiliary needle 8; these loops 43 have come to rest below the latch 44 of the auxiliary needle 8. Just as the stitches 43 are under the opened latches 44 on the auxiliary needles, the stitches 45 are also situated under the open latches 44' on the main needles 2.

A row of stitches is knitted by means of the main lock (see FIG. 8) with the auxiliary lock out of action. In this case the main needles 2 pull the yarn 100 through the loops 45 to form normal stitches 46, but in the places where the auxiliary needles 8 are situated, the yarn is placed in the form of widened loops 47 around the auxiliary needles, in such a way that it rests against the needle shank at some point between the needle hook 41 and the needle latch 44. If the auxiliary lock is now moved once over the needle bed, the loops 47 formed above are now pulled by means of the hooks 41 of the auxiliary needles 8 through the stitches 43 on the auxiliary needle shank, so that the new stitches are formed.

Then the auxiliary lock is returned, so that the auxiliary needles are again pushed up, while the latches 44 of the auxiliary needles are moved upwardly through the stitches. After the auxiliary needles have again been pulled back a certain distance, the stitches 47 remain bracketed by the needle shank and the open latch 44. This position is shown in FIG. 7 for the stitches 43.

If the auxiliary lock of FIG. 6 is employed, polka rib patterns can be knitted. A polka rib pattern is obtained by moving the auxiliary needles upwards by a definite distance during the initial motion of the auxiliary lock, but limiting this motion so that the formed stitch 48 remains on the opened latch 44 so that it does not slip off the latch and onto the auxiliary-needle shank, as shown in FIG. 9. If now the main lock is again moved over the main needle bed, the yarn is pulled in loops 49 over the auxiliary needle 8, so that the loops 49 are in contact with the shank of the auxiliary needle 8 at one place between the hook 41 and the needle latch 44. If now the auxiliary lock is moved from the right to the left, both the loops 49 and the stitches 48 are pushed behind the open latches as the auxiliary needles move into their uppermost positions and subsequently are moved back again by a definite distance to their initial position.

The auxiliary needle bed 4 is provided according to the structure shown in FIGS. 10 to 14 at both ends with mounting cleats 50, which are fixed at the back of the auxiliary needle bed by means of fixing plates 51 and rest with their lug 52, projecting towards the back, on the frame body 53 with the mounting plates 54. The mounting plates 54 are made of heavy sheet metal, bent several times, and are fixed with their upper fixing flanges 55 at the back of the main needle bed 1 by means of screws 56, which are employed at the same time to fix the separate needle-guide plates 57 by means of the lock-guide rails 58 to the needle bed 1. The cover plate 59 is also fixed between the main needle bed 1 and the said fixing flanges 55.

In order to design the main needle bed so that it can be easily interchanged at any time, while it can be fixed accurately in its correct position, holes 60 are provided in lug 52 of the mounting cleat 50 for engaging pins 61, which are fixed to the frame body 53, when the auxiliary needle bed is placed in position. For lateral location of

the lugs 52, the side edges of the brackets for the lugs 52 are turned up as shown at 62.

In order to protect the lugs 52 against tilting over, the lugs 63 on the upturned edges 62 are also bent over, forming a right angle, so that the flat sides of these lugs are parallel to the main surface of the frame body 53. The lugs 63 are arranged as far back as possible, as far as allowed by the length of the lugs 52. This will ensure that the lever-arm distance is as long as possible so as to prevent the lugs 52 from tilting over.

In order to protect the auxiliary needle bed, after it has been placed over its hooks in position, against tilting, locking bolts 64 are provided one at each of the two ends of the auxiliary needle bed 4, which engage in a simple but suitable manner the fixing plate 51 for the mounting cleat 50, so that these locking bolts are located in grooves of the auxiliary needle bed 4 which are so deep that the upper surface of the locking bolt is flush with the upper surface of the auxiliary needle bed. A retaining lug 65 is provided on the locking bolt 64, projecting toward the back from the auxiliary needle bed, The locking bolt 64 is held in the locking position by means of a helical compression spring 66. This helical spring is located in a corresponding recess 67 of the needle bed 4 and is covered on the outside.

The process of placing the auxiliary needle bed in position by hooking it onto its support is carried out as follows: One grips the auxiliary needle bed with both hands and presses the two locking bolts 64 inward in the direction of the arrow 68, then pulls the auxiliary needle bed in an inclined position upward as shown in FIG. 13, so that the tips of the lugs 52 are placed on the frame body 53 between the lugs 63 and the pin 61. Now the auxiliary needle bed is moved backward in the direction of the arrow 69, but care must be taken that the lugs 52 are placed below the lugs 63 of the frame body 53, while at the same time the auxiliary needle bed is swiveled in the direction of the arrow 70, that is in the clockwise direction, until the holes 60 of the lugs 52 coincide with the heads of the pins 61. There is nothing to prevent this motion of the needle bed, because the retaining lugs 65 of the locking bolts 64 are now in a position outside the range of the two parts of the frame body 53, since the said retaining lugs have been moved inwards. If now the two locking bolts are released, they are pushed by the springs 66 outwards in the direction of the arrow 71, so that the retaining lugs 65 are pushed underneath the front edge of the frame body and thus hold the auxiliary needle bed against any unintentional release or tilting.

The selected method of fastening the auxiliary needle bed to the main needle bed has also important advantages from the point of view of manufacture. For reasons due to the technique of knitting it is necessary for the main needle bed to be disposed at an angle of 85° relative to the auxiliary needle bed. Referring to FIG. 15, it will be noted that with exactly vertical arrangement of the auxiliary needles (solid lines) the beveled transition edge 90 extends substantially obliquely to the rear between the thin hook part 91 and the substantially thicker shank 92, so that the loop 93 formed on this oblique edge would have the tendency to slide upward on the edge 90 in the direction of the arrow 94. This results in the danger that the loop will not arrive in the hook of the needle 2, during the return of the main needle 2, but will skip this hook so that there will be a defect in the knitting. That is the reason why the upper extremities of auxiliary needles 8 are not arranged vertically, that is, at an angle of 90° relative to the main needles, but extend slightly obliquely to the rear, that is, at a somewhat smaller angle relative to the main needles, as shown in dashed lines.

Therefore, it is necessary for technical reasons that the direction of the main needle bed to the auxiliary needle bed form an angle of 85°. If the auxiliary needles have such an oblique position, the oblique edge

90 will extend vertically so that the loop 92 will no longer have the tendency to slide upward into the hook 91.

Further development has shown that defects in the knitting due to non-engagement by the hook of the main needle 2, if care is taken that the edge 90 extends not just vertically, that is, perpendicular to the direction of the needles 2, but with a forward inclination, such as is indicated by the point-dotted line 8A in FIG. 15. It will be noted that the angle between needle 2 and the point-dotted line 8A ranges from more than 45° to about 85°, being preferably 70°. As a result, a downwardly directed pressure component is exerted on the loop 93, which ensures that this loop arrives in the hook of the main needle 2 when this needle returns.

But since the auxiliary needles with their auxiliary needle bed are intended as an attachment to the already existing main knitting apparatus, strictly constructional difficulties appeared in attempts to secure the auxiliary needle bed to the main apparatus in such an inclined position as indicated in FIG. 15, by the point-dotted line.

A solution was found in an arrangement wherein only the upper part of each of the needles was designed with a relatively large forward inclination, and the needles were bent forwardly, approximately at the point 37, at an obtuse angle, so that only the lower, relatively long part of each of the needles extends at an angle of 85° to the main needle bed. As a result, the beveled edge 90 of each needle 8 is substantially parallel to the plane of reciprocation of these needles as long as the outwardly bent upper extremity of the needle (above point 37) occupies its normal, undeflected position, as clearly illustrated in FIG. 2.

This bent construction of the needles has two advantages. First, it is thus possible to secure the attachment easily on the already available main apparatus because the needle bed of the attachment need not have the large inclination of the upper part of the needles but extends only at an angle of 85° to the main needle bed so that there is sufficient room between the main apparatus and the attachment for the downward motion of the knitting. The second advantage of this bent construction of the auxiliary needles is that one is to a great extent independent of the level of the needle bed of the attachment without impairing the resiliency of the auxiliary needles. This is due to the fact that the good resiliency of the auxiliary needles no longer depends on the distance l between the point of contact with the auxiliary needle and the upper edge k of the auxiliary needle bed, as shown in FIG. 16, but on the distance m between the point of contact of the loop with the auxiliary needles and the bend 37 of the auxiliary needles according to FIG. 17. A comparison of FIGS. 16 and 17 shows that one is to a great extent independent of the vertical positioning of the auxiliary needle bed by the bent construction of the needles. It will be noted from FIG. 17 that the upper bent part of needle 8, above bend 37, forms an acute angle with the main needle bed, and with the needles 2 thereon, in a range from more than 45° to about 85°, preferably 70°.

The lower positioning of the upper edge of the auxiliary needle bed compared to the main needle bed also has the advantage that it permits a good observation of the workpiece during the knitting through the gap between the main and auxiliary needle beds, so that it is possible to watch constantly not only the pattern but any defects that might appear.

It would have been obvious to choose in the design of the mounting plate 54 the same angle of 85°. But according to the present invention, as seen in FIG. 10, not the angle d of 5°, complementary to the angle α of 85° between the fixing flanges 55 and the main surface of the frame body 53, but a much larger angle b of about 20° was chosen. Correspondingly the lugs 52 include with the plane of the auxiliary needle bed 4

the angle *c* of 75° complementary to the difference of angles *b* and *d*.

Various changes and modifications may be made without departing from the spirit and scope of the present invention and it is intended that such obvious changes and modifications be embraced by the annexed claims.

Having thus described the invention, I claim:

1. In a flat knitting machine, in combination, a first needle bed provided with a set of hooked main needles reciprocally guided in a first plane, and a second needle bed provided with a set of hooked auxiliary needles reciprocally guided in a second plane generally perpendicular to said first plane, the needles of each set being reciprocable beyond the plane of the other set, said auxiliary needles being each provided with a flexible hook-bearing extremity resiliently bent out of said second plane in a direction away from said first needle bed for deflection toward said first needle bed by its engagement with a loop in a fabric held on said main needles upon retraction of each auxiliary needle through said loop, said auxiliary needles being each provided with a pivoted latch adapted to overlie its hook upon withdrawal through said loop whereby said extremity is liberated from said loop and resiliently moves away from said first needle bed for clearing said loop upon its next reciprocation.

2. The combination according to claim 1 wherein said extremity is provided between its hook and the pivot of its latch with a beveled edge facing away from said first needle bed, said edge extending substantially parallel to said second plane in the undeflected position of said extremity.

3. The combination according to claim 1 wherein said planes include with each other an angle of substantially 85°.

4. The combination according to claim 1 wherein said extremity in its undeflected position includes with said second plane an angle of substantially 70°.

5. In a flat knitting machine, in combination, a first needle bed provided with a set of hooked main needles reciprocally guided in a substantially horizontal first plane, and a second needle bed provided with a set of hooked auxiliary needles reciprocally guided in a substantially vertical second plane, the needles of each set being reciprocable beyond the plane of the other set, said auxiliary needles being each provided with a flexible hook-bearing extremity resiliently bent out of said second plane in a direction away from said first needle bed for deflection toward said first needle bed by its engagement with a loop in a fabric held on said main needles upon retraction of each auxiliary needle through said loop, said auxiliary needles being each provided with a pivoted latch adapted to overlie its hook upon withdrawal through said loop whereby said extremity is liberated from said loop and resiliently moves away from said first needle bed for clearing said loop upon its next reciprocation.

6. In a flat knitting machine, in combination, a first needle bed provided with a set of hooked main latch needles reciprocally guided in a first plane, a second needle bed provided with a set of hooked auxiliary needles reciprocally guided in a second plane generally perpendicular to said first plane, the needles of each set being reciprocable beyond the plane of the other set, said auxiliary needles being each provided with a flexible hook-bearing extremity resiliently bent out of said second plane in a direction away from said first needle bed for deflection toward said first needle bed by its engagement with a loop in a fabric held on said main needles upon retraction of each auxiliary needle through said loop, and sinker means between said main needles for depressing said fabric, said auxiliary needles being each provided with a pivoted latch adapted to overlie its hook upon withdrawal through said loop whereby said extremity is liberated from said loop and resiliently moves away from said first needle bed for clearing said loop upon its next reciprocation.

7. In a flat knitting machine, in combination, a first needle bed provided with a set of hooked main latch needles reciprocally guided in a substantially horizontal first plane, a second needle bed provided with a set of hooked auxiliary needles reciprocally guided in a substantially vertical second plane, the needles of each set being reciprocable beyond the plane of the other set, said auxiliary needles being each provided with a flexible hook-bearing extremity resiliently bent out of said second plane in a direction away from said first needle bed for deflection toward said first needle bed by its engagement with a loop in a fabric held on said main needles upon retraction of each auxiliary needle through said loop, and sinker means between said main needles for depressing said fabric, said auxiliary needles being each provided with a pivoted latch adapted to overlie its hook upon withdrawal through said loop whereby said extremity is liberated from said loop and resiliently moves away from said first needle bed for clearing said loop upon its next reciprocation.

8. In a flat knitting machine, in combination, a first needle bed provided with a set of hooked main needles reciprocally guided in a first plane, a second needle bed provided with a set of hooked auxiliary needles reciprocally guided in a second plane generally perpendicular to said first plane, the needles of each set being reciprocable beyond the plane of the other set, and a reciprocable camming slide on said second needle bed for successively displacing said auxiliary needles; said slide including a support, a main transfer cam fixedly held on said support and provided on opposite sides with flanks inclined at generally the same camming angle relatively to the direction of reciprocation of said slide, and a pair of relatively inverted auxiliary cams fixedly held on opposite sides of said main transfer cam, said auxiliary cams having inversely inclined flanks each terminating short of a median line of said main transfer cam, each of said auxiliary needles being provided with an extension engageable by said slide for maximum displacement in a respective sense and subsequent return movement by a lesser distance via a respective one of said auxiliary cams upon unidirectional advance of said slide.

9. The combination according to claim 8 wherein said main transfer cam includes a pair of relatively adjustable portions for varying the extent of said maximum displacement.

10. In a flat knitting machine, in combination, a first needle bed provided with a set of hooked main needles reciprocally guided in a first plane, a second needle bed provided with a set of hooked auxiliary needles reciprocally guided in a second plane generally perpendicular to said first plane, the needles of each set being reciprocable beyond the plane of the other set, said auxiliary needles being each provided with a flexible hook-bearing extremity resiliently bent out of said second plane in a direction away from said first needle bed for deflection toward said first needle bed by its engagement with a loop in a fabric held on said main needles upon retraction of each auxiliary needle through said loop, said auxiliary needles being each provided with a pivoted latch adapted to overlie its hook upon withdrawal through said loop whereby said extremity is liberated from said loop and resiliently moves away from said first needle bed for clearing said loop upon its next reciprocation, and a reciprocable camming slide on said second needle bed for successively displacing said auxiliary needles; said slide including a support, a main transfer cam fixedly held on said support and provided on opposite sides with flanks inclined at generally the same camming angle relatively to the direction of reciprocation of said slide, and a pair of relatively inverted auxiliary cams fixedly held on opposite sides of said main transfer cam, said auxiliary cams having inversely inclined flanks each terminating short of a median line of said main transfer cam, each of said auxiliary needles being provided with an extension engageable by said slide

for maximum displacement in a respective sense and subsequent return movement by a lesser distance via a respective one of said auxiliary cams upon unidirectional advance of said slide.

11. In a flat knitting machine, in combination, a first needle bed provided with a set of hooked main latch needles reciprocally guided in a first plane, a second needle bed provided with a set of hooked auxiliary needles reciprocally guided in a second plane generally perpendicular to said first plane, the needles of each set being reciprocable beyond the plane of the other set, said auxiliary needles being each provided with a flexible hook-bearing extremity resiliently bent out of said second plane in a direction away from said first needle bed for deflection toward said first needle bed by its engagement with a loop in a fabric held on said main needles upon retraction of each auxiliary needle through said loop, and sinker means between said main needles for depressing said fabric, said auxiliary needles being each provided with a pivoted latch adapted to overlie its hook upon withdrawal through said loop whereby said extremity is liberated from said loop and resiliently moves away from said first needle bed for clearing said loop upon its next reciprocation, and a reciprocable camming slide on said second needle bed for successively displacing said auxiliary needles; said slide including a support, a main transfer cam fixedly held on said support and provided on opposite sides with flanks inclined at generally the same camming angle relatively to the direction of reciprocation of said slide, and a pair of relatively inverted auxiliary cams fixedly held on opposite sides of said main transfer cam, said auxiliary cams having inversely inclined flanks each terminating short of a median line of said main transfer cam, each of said auxiliary needles being provided with an extension engageable by said slide for maximum displacement in a respective sense and subsequent return movement by a lesser distance via a respective one of said auxiliary cams upon unidirectional advance of said slide.

References Cited in the file of this patent

UNITED STATES PATENTS

755,135	Houseman	Mar. 22, 1904
2,893,225	Kuntz	July 7, 1959