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54 **Method of knitting fabric and circular knitting machine for this use.**

57 The amount of vertical movement imparted to the needles (1a) during stitch loop formation is reduced by supporting special types of sinkers (8) for movement in a radial direction and along an inwardly and downwardly inclined path of travel (7a) relative to the needles (1a). As the needles (1a) are raised to the latch clearing level the sinkers (8) are moved inwardly and downwardly to lower the level of the stitch forming ledge (8a) thereof so that the amount of vertical upward movement of the needles (1a) is reduced. As the needles (1a) are then lowered to stitch drawing level, the sinkers (8) are simultaneously moved outwardly and upwardly to raise the stitch drawing ledge (8a) so that a portion of the length of the stitch being formed is determined by the amount of downward movement of the needle (1a) and the remaining portion of the length of the stitch being formed is determined by the amount of upward movement of the sinkers (8).

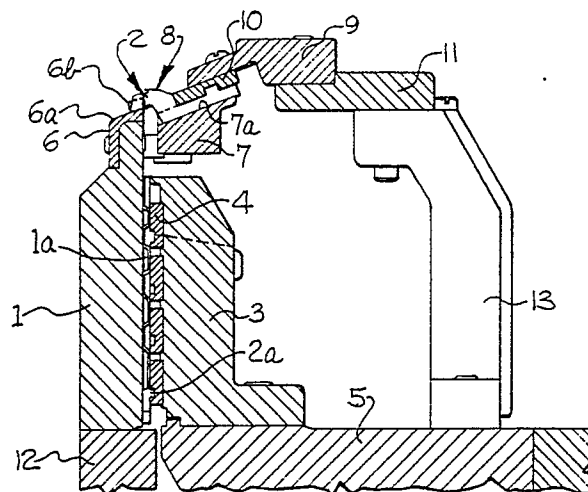


Fig. 1

EP 0 351 935 A2

METHOD OF KNITTING FABRIC AND CIRCULAR KNITTING MACHINE FOR THIS USE

This invention relates generally to a method of knitting fabric and to the circular knitting machine for carrying out this method wherein the vertical length of travel of the needles is reduced by lowering the stitch forming ledge of the sinkers as the needles are being raised to clearing level and raising the stitch forming ledge of the sinkers as the needles are being drawn downwardly to stitch looping level, and more particularly to such a method and machine wherein the sinkers are supported for inward and outward movement between the needles along a downwardly inclined path of travel and with the sinkers being moved outwardly and upwardly as the needles are drawn downwardly to raise the level of the stitch drawing ledge during stitch loop formation and with the sinkers being moved inwardly and downwardly as the needles are raised so that the shed stitch loops are moved inwardly by the nebs of the sinkers.

In conventional knitting machines the previously formed stitch loop in the hook of the knitting needle is moved downwardly along the needle shank and forces the latch of the knitting needle downwardly to the open position as the stitch loop is moved down the shank of the needle and while the needle is being raised to stitch loop clearing position in preparation for picking up a yarn in the hook thereof to form a new stitch loop. The sinkers are normally supported for inward and outward sliding movement between the needles at a right angle to the knitting needles so that the sinkers move radially along a horizontal path of travel and the stitch drawing ledges of the sinkers are maintained at the same level during both the inward and outward movements. In this conventional arrangement, the amount of vertical movement imparted to the needles by the knitting cams to form stitch loops is determined by the distance between the stitch drawing level of the needles and the clearing level to which the needles must be raised to clear the latches of the previously formed stitch loops as they are moved below the lower ends of the tips of the latches.

The amount of movement of the needles by the knitting cams can be determined by the addition of the distance between the stitch drawing ledges and the stitch drawing level to which the needles are drawn and the distance between the stitch drawing ledge and the level to which the needles must be raised to clear the previously formed stitch loops below the tips of the latches. For example, a 14 cut single jersey knitting machine generally requires a stitch forming movement of 2.5 mm, representing the distance from the stitch drawing ledge of the sinker to the stitch

forming level of the hook of the needle. The clearing height, which includes the distance from the stitch drawing ledge to the clearing level of the hook of the raised needle, varies according to the length of the latch of the knitting needle. When the latch length is 6 mm and the stitch drawing movement is 2.5 mm, the minimum required clearing height of the needle is 8.5 mm. In this case, the total vertical stroke imparted to the needle by the knitting cams must be 2.5 mm plus 8.5 mm, or a total of 11.0 mm. To provide this total distance of vertical movement of the needle by the knitting cams, the angle of inclination of the knitting cams must be very steep, on the order of 55° or 56° in a knitting machine having four feeds per diametric inch. Many knitting feeds are provided in modern high production knitting machines so that the inclined angle of a cam to raise a knitting needle to clearing level and the inclined angle of a stitch cam to lower a knitting needle must be very steep. The steep angle of inclination of the knitting cams imparts a very high speed of movement to the latch during opening and closing motions. To improve this problem, an effort has been made to make the weight of the latch lighter or to make the length of the latch shorter to decrease inertia of the opening and closing of the latch.

It is also known that the needle cam angle of inclination and the amount of vertical movement required to be imparted to the knitting needles can be reduced by raising the stitch drawing ledge of the sinkers while the needles are being drawn downwardly to stitch forming level. For example, Japanese Patent Publication SHO 62-8543 and U.S. Patent No. 4,532,781 disclose a sinker arrangement in which the sinkers are raised and lowered in cooperation with the vertical movement of the needles. In this arrangement, a portion of the length of the stitch loop is formed by raising the stitch drawing ledge of the sinker and the remaining length of the stitch loop is formed by the downward vertical movement of the needle so that the downward movement of the needle may be reduced by an amount which corresponds to the amount the stitch drawing ledge of the sinker is raised. However, this arrangement requires the addition of long vertical sinker operating shafts extending downwardly into slots in the needle cylinder and requires the addition of appropriate cams for raising and lowering the sinkers.

U.S. Patent Nos. 3,837,185 and 3,986,371 disclose supporting the sinkers for movement along an upwardly inclined path of travel between the needles. In this arrangement, inward and upward movement is imparted to the sinker so that the

horizontally disposed stitch drawing ledge of the sinker is raised as the needle is lowered to form stitch loops, thereby permitting a reduction in the vertical downward movement of the needle during the stitch forming process. After the new stitch loop has been formed, the sinker is further raised and moved inwardly as the needle is being raised to shed the previously formed stitch loop therefrom. This upward and inward movement of the fabric by the sinkers while the needles are being raised tends to cause the fabric to be dislodged from the throat of the sinker beneath the neb and can cause a jam-up of the knitting needles.

The raising of the stitch drawing ledge of the sinkers during the downward movement of the needles, as proposed in the above discussed prior art, does permit the angle of inclination of the knitting cams to be reduced. However, the rocking sinker system of the type disclosed in Japanese Patent Publication SHO 62-8543 and U.S. Patent No. 4,532,781 requires that the needle cylinder be modified to accommodate the vertical extensions of the sinkers so that the shape of the needle cylinder and the associated mechanism becomes complicated. Also, the placement or removal of the sinkers takes more than the usual time required in removing and replacing conventional sinkers. Further, special types of cams must be provided to operate the sinkers up and down and back and forth in synchronization with the vertical movement of the needles. Additionally, when knitting open end spun yarn, a great amount of lint is generated and this lint can cause excessive load concentration on the butt to operate the sinker up and down and back and forth so that the load applied to the rocking sinkers is several times higher than that applied to conventional types of radially movable sinkers.

When sinkers are supported for movement along an upwardly inclined path of travel, as disclosed in U.S. Patent Nos. 3,837,185 and 3,986,371, the raising of the stitch drawing ledge of the sinker as the needle is being drawn downwardly to stitch forming level, permits a reduction in the normal length of vertical travel of the needle. However, the shedding motion of the sinkers is carried out by further inward and upward movement of the neb of the sinker while the needle is being raised so that the most advantageous shedding operation of the sinker is not achieved, as has been pointed out above.

With the foregoing in mind, it is an object of the present invention to provide a method of knitting fabric on a circular knitting machine which reduces the stress imparted to the needles and the sinkers to permit high speed knitting and increased productivity in a highly efficient manner, and wherein the method can be practiced on a conven-

tional circular knitting machine while requiring only minor modifications thereof.

In accordance with the present invention, special types of sinkers are supported on a rotatable sinker bed located exteriorly of the needle cylinder for movement in a radial direction and along a downwardly inclined path of travel between the needles. As the needles approach the knitting station, they are raised to the clearing level while the sinkers are moved inwardly and downwardly so that the stitch drawing ledges are in a low position. This lowering of the sinkers permits the needles to be raised to a lower than normal height and reduces the overall vertical movement which must be imparted to the needles. Yarn is fed to the needles while in the raised clearing level and the needles are successively moved downwardly to draw the yarn downwardly therewith. The sinkers are simultaneously moved in an outwardly and upwardly direction along the downwardly inclined path of travel while the needles are being lowered to move the stitch drawing ledge of the sinker upwardly in a vertical direction so that the stitch drawing ledge engages the yarn and cooperates with the associated adjacent needles to form stitch loops. The length of the formed stitch loops is determined by the amount of upward vertical movement imparted to the stitch forming ledge of the sinker and the amount of vertical downward movement imparted to the needle. After forming the stitch loop, the needle is moved upwardly while the sinker is simultaneously moved in an inwardly and downwardly direction along the downwardly inclined path of travel so that the sinker neb engages the fabric and moves the same inwardly and downwardly to aid in shedding the previously formed stitch loop from the needle as it is raised with the newly formed stitch loop thereon.

Thus, as the needle is being drawn downwardly to stitch forming level, the stitch forming ledge of the sinker is being raised in a vertical direction by withdrawing the sinker outwardly and upwardly so that a portion of the length of the stitch loop is determined by the vertical upward movement of the stitch forming ledge and a portion of the length of the stitch loop is determined by the amount of vertical downward movement imparted to the needle. Also, after the formation of the stitch loop, the sinkers are successively moved downwardly and inwardly so that the stitch forming ledge and the associated neb engages and moves the fabric downwardly and inwardly to aid in shedding the stitch loops from the needles as they are raised after the formation of the stitch loop. The sinkers are supported for radial movement in a sinker bed fixed on and rotating with the needle cylinder while the needles are supported in the usual manner for vertical movement in slots in the needle cylinder

and are controlled by knitting cams surrounding the needle cylinder. Sinker cams are provided for engaging the operating butts of the sinkers to impart inward and outward movement thereto and along the downwardly inclined path of travel. The angle of the downwardly inclined path of travel of the sinkers may be in the range of from 5° to 60° , preferably within the range of 10° to 45° , and is disclosed in the present application as being inclined downwardly at an angle of 20° .

The special type of sinker provided for use in accordance with the present invention includes an elongate body portion having a lower planar sliding edge. An operating butt extends upwardly from an outer end portion of the elongate body portion and a planar stitch drawing ledge is provided on the inner end portion of the elongate body portion of the sinker. A neb extends over the outer portion of the stitch drawing ledge and defines a throat between the neb and the outer portion of the stitch drawing ledge. This special type of sinker is characterized by the stitch drawing ledge being slanted downwardly toward the operating butt on the outer portion of the elongate body portion. The stitch drawing ledge extends along a line defining an acute angle with the junction of a line extending along the lower planar sliding edge of the sinker. Further, the juncture of the line extending along the stitch drawing ledge and the line extending along the lower planar sliding edge is located adjacent the outer end portion of the elongate body portion of the sinker.

Other objects and advantages will appear as the description proceeds when taken in connection with the accompanying drawings, in which --

Figure 1 is a vertical sectional view through the needle cylinder of the knitting machine and illustrating the manner in which the sinkers are mounted for radial sliding movement along a downwardly inclined path of travel relative to the needles;

Figure 2 is a side elevational view of one of the special type of sinkers utilized in the present invention;

Figure 3 is a somewhat schematic developed elevational view showing the paths of travel of the needles and associated sinkers at one yarn feeding position and illustrating a side elevational view of a needle and the inner portion of an associated sinker; and

Figures 4-12 are side elevations of the upper portions of the needles and associated sinkers showing their relationship during the successive steps of forming a stitch loop and shedding a previously formed stitch loop from the needles, being taken along the respective section lines 4-4 through 12-12 of Figure 3.

As shown in Figure 1, a rotating needle cyl-

inder 1 is supported on a driven ring gear 12 and the outside surface of the needle cylinder 1 is provided with the usual needle slots 1a in which hooked latch needles, broadly indicated at 2, are supported for vertical movement parallel to the axis of rotation of the needle cylinder 1. Each knitting needle 2 is provided with an operating butt, as indicated at 2a (Figure 1), a hook 2b, and a pivoted latch 2c (Figure 3). Conventional knitting cams, including stitch cam means supported on cam plates 4, are provided for imparting vertical movement to the knitting needles 2. The cam plates 4 are supported on the inner surface of a cam holder ring 3 which is fixed on a cam ring plate 5.

A sinker nose support ring 6 is fixed on the upper inner surface of the needle cylinder 1 and is provided with a downwardly inclined surface 6a defined by the lower surfaces of sinker slots 6b provided in the upper end of the sinker nose support ring 6. A sinker support bed 7 is fixed to the exterior of the upper end of the needle cylinder 1 and is provided with a downwardly inclined sinker sliding surface 7a defined by the lower ends of sinker slots formed in the sinker bed 7 and at the same downwardly inclined angle as the sinker sliding surface 6a of the sinker nose ring 6.

Special types of sinkers, broadly indicated at 8, cooperate with the needles 2 to form stitch loops and are supported for movement in a radial direction and along a downwardly inclined path of travel between the needles 2. Inward and outward radial sliding movement of the sinkers 8, along the downwardly inclined path of travel, is controlled by sinker cams 10 supported in a fixed position on a sinker cap 9. Sinker cap 9 is in turn supported on a sinker cap ring 11 which is supported in spaced-apart locations on the upper ends of support standards 13 surrounding the needle cylinder 1. As will be noted, the sinker cams 10 are supported in a downwardly inclined position at the same downwardly inclined angle as the inclined sliding surfaces 6a and 7a on the respective nose ring 6 and sinker bed 7. The sinker sliding surfaces 6a and 7a are illustrated in Figure 1 as being downwardly inclined at an angle of 20° relative to a line perpendicular to the vertically disposed needles 2. While this 20° downwardly inclined angle is preferred, the present invention is not limited to this particular angular inclination but may be positioned at an angle of from 5° to 60° , and preferably within the range of 10° to 45° .

As best shown in Figure 2, the special sinker 8 includes an elongate body portion having a main lower planar sliding edge 8e adapted to rest upon and slide along the inclined surface 7a of the sinker bed 7, and an inner lower additional planar sliding edge 8b adapted to rest on and slide along the inclined sliding surface 6a of the sinker nose ring 6.

A stitch drawing ledge 8a is provided on the upper inner portion of the sinker and a neb 8d extends over the outer portion of the stitch drawing ledge 8a and defines a sinker throat 8c between the neb 8d and the outer portion of the stitch drawing ledge 8a. An upstanding operating butt 8f is provided on the outer end portion of the elongated body portion of the sinker 8. The butt 8f extends upwardly at a right angle from the body portion of the sinker 8 and is adapted to be engaged by the sinker cams 10 to impart the required inward and outward radial movement to the sinkers 8.

In conventional sinkers, the stitch drawing ledge extends along a line which is parallel with the lower planar sliding edge of the sinker. In contrast to this conventional construction, the present special type sinker is characterized by the stitch drawing ledge 8a being slanted downwardly toward the operating butt 8f on the outer end portion of the elongate body portion of sinker 8. As shown in Figure 2, the stitch drawing ledge 8a is slanted downwardly toward the operating butt 8f and along an angle represented by a dash-dot line 16 extending outwardly beyond the butt 8f and the outer end of the sinker 8. A dash-dot line 17 represents the angle of the lower planar sliding edge 8e and joins the dash-dot line 16 at a juncture beyond the outer end of the sinker 8. The juncture of the line 16 extending along the stitch drawing ledge 8a and the line 17 extending along the lower planar sliding edge 8e is located adjacent and beyond the outer end portion of the elongate body portion of the sinker 8. The angle, indicated at α in Figure 2, between the lines 16 and 17 defines an acute angle of 20° . Thus, the downwardly inclined or outwardly slanting stitch drawing ledge 8a of the sinker 8 of the present invention is different from the normal type of sinker in which the stitch drawing ledge extends parallel to the lower planar sliding edge of the sinker. The present sinker is also different from the special sinkers of the type disclosed in U.S. Patent Nos. 3,837,185 and 3,986,371 wherein the stitch drawing ledge slants downwardly or inwardly in the direction of the inner end of the sinker.

In Figure 3, the solid line 50 indicates the path of travel of the top of the hook of the knitting needle 2 during a knitting cycle while the dash-dot line 52 indicates the path of travel of the stitch drawing ledge 8a of the sinker 8 during a knitting cycle. The solid line 51 indicates the normal horizontal path of travel of conventional sinkers. A yarn feed finger 54, positioned at one knitting station, is shown in position to feed a yarn 53 to the needles 2 as they are lowered to stitch forming level.

As the needles 2 successively approach the knitting station they are successively raised to the clearing level along the solid line 50 in Figure 3 to a position where the previously formed loops sur-

rounding the shank of the needle are lowered below the tip of the latch, as shown in Figure 4. At the same time, the sinkers 8 are moved inwardly and downwardly along the downwardly inclined path of travel 52 between the needles so that the fabric is moved inwardly by the neb 8d to maintain the previously formed stitch loop below the tip of the latch and in tight engagement with the shank of the needle, as shown in Figure 4. The inward and downward movement of the sinker 8 lowers the position of the stitch drawing ledge 8a below the normal horizontal path of travel so that the needles 2 do not have to be raised as high to reach clear level as would be the case if the sinkers 8 were maintained at a higher level.

While the needles 2 are in the raised latch clearing position, the yarn 53 is fed to the needles and the needles are lowered while the sinkers 8 begin to move outwardly and upwardly along the downwardly inclined path of travel, as illustrated in Figure 5. With further downward vertical movement of the needles 2, as indicated in Figure 6, the previously formed stitch loop closes the latch and the sinker 8 continues to move outwardly and upwardly so that the yarn in the hook of the needle will be drawn downwardly over the stitch drawing ledge 8a while the stitch drawing ledge 8a remains in the highest level, as illustrated in Figures 7-9.

As the needle 2 begins to move upwardly from the lower stitch drawing level, as indicated in Figure 10, the sinker 8 begins to move inwardly and downwardly so that the previously formed stitch loop shed from the upper end of the hook of the needle 2 is engaged by the neb 8d and moved inwardly to aid in shedding the stitch loop from the needle. This inward and downward movement of the sinkers 8 insures that the raising needles 2 do not again pass upwardly through the shed stitch loop. The sinkers 8 continue to move the fabric inwardly and downwardly as the needle 2 continues to rise, as shown in Figure 12, so that the newly formed stitch loop is maintained in engagement with the outer surface of the needle shank and imparts a positive opening motion to the latches of the needles. With further vertical upward movement of the needles 2, the sinker 8 is maintained in the innermost and lowermost position while the formed stitch loop moves below the latch tip and is maintained on the outer surface of the needle shank by the sinker, as illustrated in Figure 4, to begin another knitting cycle. This knitting cycle is repeated at each of the subsequent knitting stations around the needle cylinder to form the knit fabric.

In accordance with the present invention, the sinkers are supported around the outside of the upper end of the needle cylinder and are supported for movement in a radial direction along a downwardly inclined path of travel between the

needles. When stitch loops are being formed, the stitch drawing ledge of the sinker moves outwardly and upwardly along the downwardly inclined path of travel of the sinkers and the needles are drawn downwardly while the stitch drawing ledge is maintained at its upper level so that the distance the needle must be lowered to stitch forming level is considerably reduced and the angle of inclination of the knitting cams can be reduced. When the needles are raised to the clearing level, the stitch drawing ledges of the sinkers are moved to their innermost downward level so that the knitting needles do not need to be raised as high as they would normally be if the sinkers were moved in a horizontal path of travel. Therefore, it is not necessary to raise the knitting needles as high as would normally be required by the knitting cams to obtain the latch clearing level.

In the conventional knitting method, yarns have a tendency to break when the angle of the stitch forming cams is steep and a relatively weak yarn is being knit. By reducing the steep angle of inclination of the stitch cams, in accordance with the present invention, and forming a portion of the length of stitch by raising the stitch drawing ledge of the sinker to reduce the length of vertical downward movement of the needle, the yarn is fed to a smaller number of needles as they are being drawn downwardly toward stitch forming level. Thus, the passage of the yarn from one needle to the next during the stitch forming cycle is easier and less yarn breakage occurs, even when knitting a relatively weak yarn.

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

Claims

1. A method of knitting fabric on a circular knitting machine including a plurality of needles (1a) supported in a rotating needle cylinder (1) for vertical movement parallel to the axis of rotation of the needle cylinder, knitting cam means (4) surrounding said needle cylinder (1) and being operable to successively raise said needles (1a) to a clearing level to pick up a yarn (53) and then lower said needles to a stitch loop forming level, sinkers (8) supported for inward and outward movement between said needles (1a), and a stitch drawing ledge (8a) and a neb (8d) on the inner end portion of each of said sinkers (8) and cooperating with adjacent needles (1a) in the formation of knit stitch

loops, said machine being characterized in that said sinkers (8) are supported on a rotatable ring (7) located exteriorly of said needle cylinder (1) for movement in a radial direction and along a downwardly inclined path of travel (7a) between said needles (1a), said method being characterized by the steps of feeding a yarn (53) to said needles (1a) while in the raised clearing level, successively moving said needles (1a) downwardly and drawing the yarn downwardly therewith, simultaneously moving said sinkers (8) in an outwardly and upwardly direction along the downwardly inclined path of travel (7a) while the needles (1a) are being lowered to move said stitch drawing ledge (8a) vertically upwardly so that said stitch drawing ledge (8a) engages the yarn (53) and cooperates with the associated adjacent needles to form stitch loops of a length determined by the amount of upward vertical movement imparted to said stitch forming ledge (8a) of said sinker (8) and the amount of vertical downward movement imparted to said needles (1a), successively moving said needles (1a) upwardly after forming the stitch loop therewith, and while simultaneously moving said sinkers (8) in an inwardly and downwardly direction along the downwardly inclined path of travel (7a) to engage said sinker nebs (8d) with the fabric and move the same inwardly and downwardly to aid in shedding the stitch loops from the needles (1a) as they are raised with the newly formed stitch loop thereon.

2. A method according to Claim 1 and being further characterized by the step of moving said sinkers (8) inwardly and downwardly to lower the level of said stitch drawing ledges (8a) while said needles (1a) are being raised to the clear level to reduce the amount of upward vertical movement which must be imparted to said needles (1a) to reach latch clearing level.

3. A circular knitting machine including a plurality of needles (1a) supported in a rotating needle cylinder (1) for vertical movement parallel to the axis of rotation of the needle cylinder (1), knitting cam means (4) surrounding said needle cylinder (1) and being operable to successively raise said needles (1a) to a clearing level to pick up a yarn (53) and then lower said needles to a stitch loop forming level, sinkers (8) supported for inward and outward movement between said needles (1a), and a stitch drawing ledge (8a) and a neb (8d) on the inner end portion of each of said sinkers (8) and cooperating with adjacent needles (1a) in the formation of knit stitch loops, characterized by means for supporting said sinkers for movement in a radial direction and along a downwardly inclined path of travel between said needles, said sinker support means comprising a rotatable ring (7) located exteriorly of said needle cylinder (1), radially extending slots formed in said ring (7) for slideably re-

ceiving and supporting said sinkers (8) therein, and wherein said slots are inclined downwardly and inwardly (7a) toward said needles (1a).

4. A circular knitting machine according to Claim 3 and being characterized in that said slots are inclined downwardly and inwardly toward said needles at an angle within the range of from 10° to 60° .

5. A circular knitting machine according to Claim 4 and being further characterized in that said slots are inclined downwardly and inwardly toward said needles at an angle of 20° .

6. A sinker for use in a circular knitting machine and comprising an elongate body portion including a lower planar sliding edge (8e), operating butt means (8f) extending upwardly from an outer end portion of said elongate body portion, a planar stitch drawing ledge (8a) on an inner end portion of said body portion, and a neb (8d) extending over the outer portion of said stitch drawing ledge (8a) and defining a throat (8e) between said neb (8d) and the outer portion of said stitch drawing ledge (8a), said sinker (8) being characterized by said stitch drawing ledge (8a) being slanted downwardly toward said operating butt means (8f) on the outer end portion of said elongate body portion, said stitch drawing ledge (8a) extending along a line (16) defining an acute angle (a) with the juncture of a line (17) extending along said lower planar sliding edge (8e), and wherein the juncture of the line (16) extending along said stitch drawing ledge (8a) and the line (17) extending along said lower planar sliding edge (8e) is located adjacent the outer end portion of said elongate body portion.

7. A sinker according to Claim 6 and being characterized in that said stitch drawing ledge (8a) is slanted downwardly toward said operating butt means (8f) at an angle between the range of 5° to 60° .

8. A sinker according to Claim 6 and being characterized in that said stitch drawing ledge (8a) is slanted downwardly toward said operating butt means (8f) at an angle between the range of 10° to 45° .

9. A sinker according to Claim 6 and being further characterized in that said stitch drawing ledge (8a) is slanted downwardly toward said operating butt means (8f) at an angle of 20° .

10. A sinker according to Claim 6 and being further characterized in that said operating butt means (8f) comprises a butt extending from said elongate body portion in a direction perpendicular to said lower planar sliding edge (8e).

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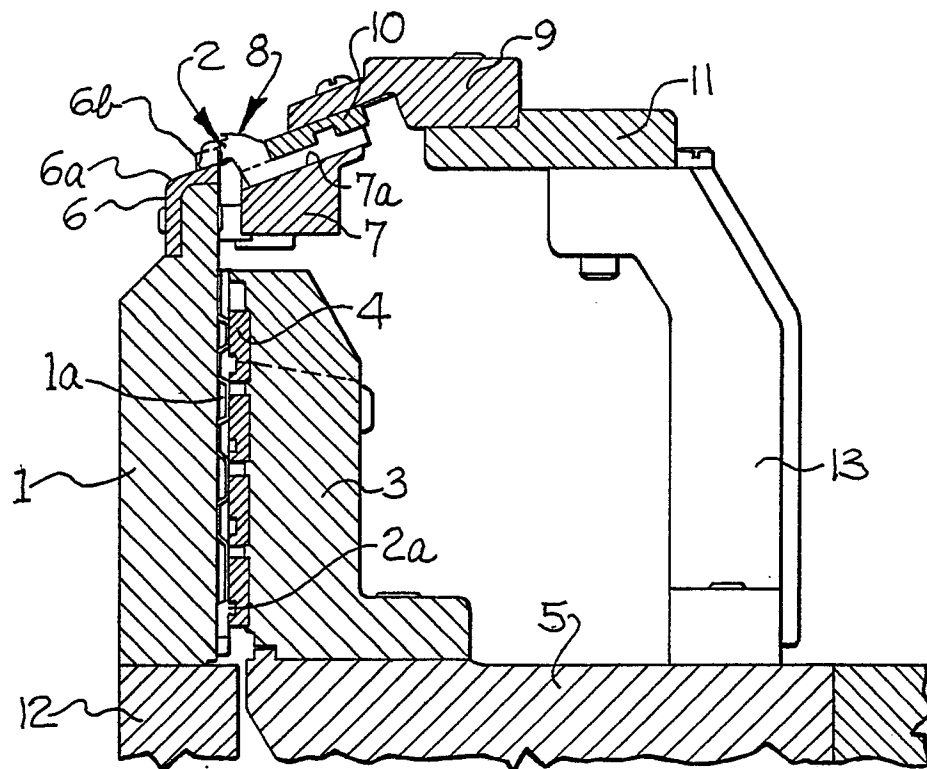


Fig-1

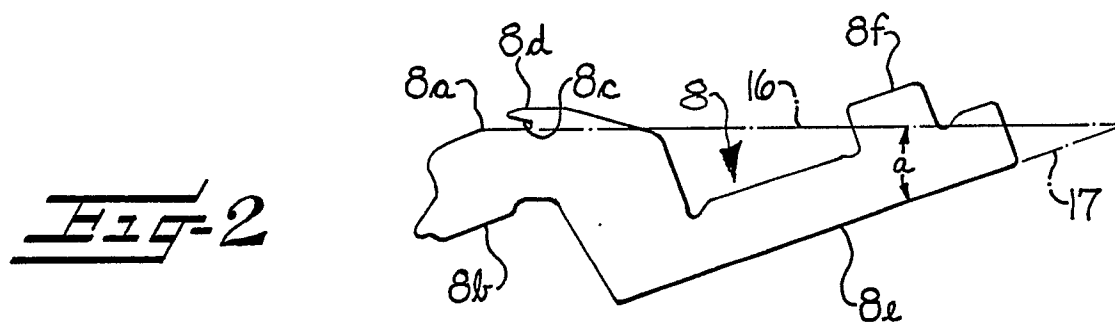


Fig-2

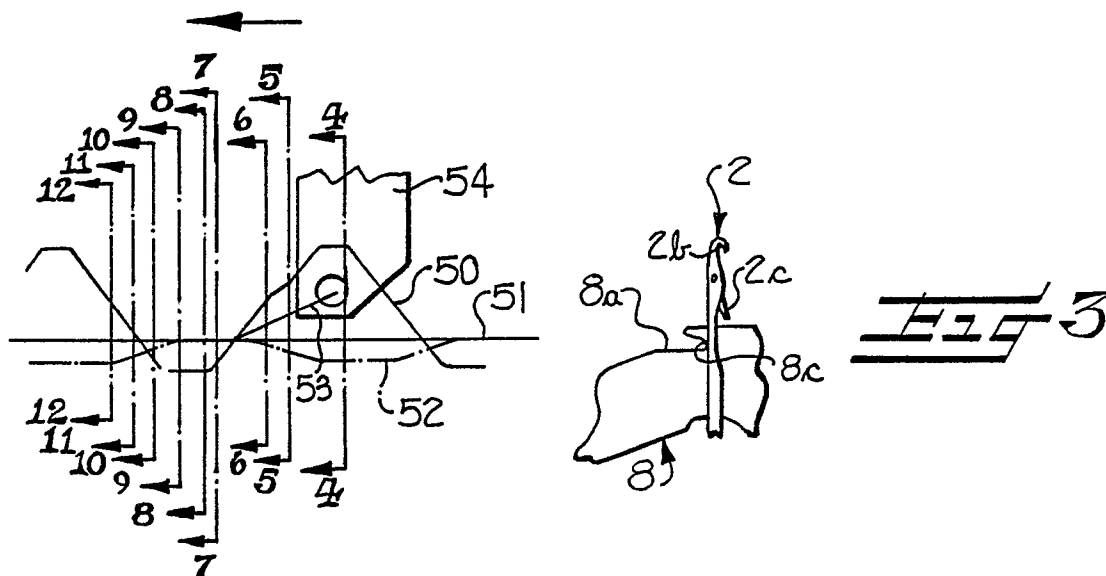
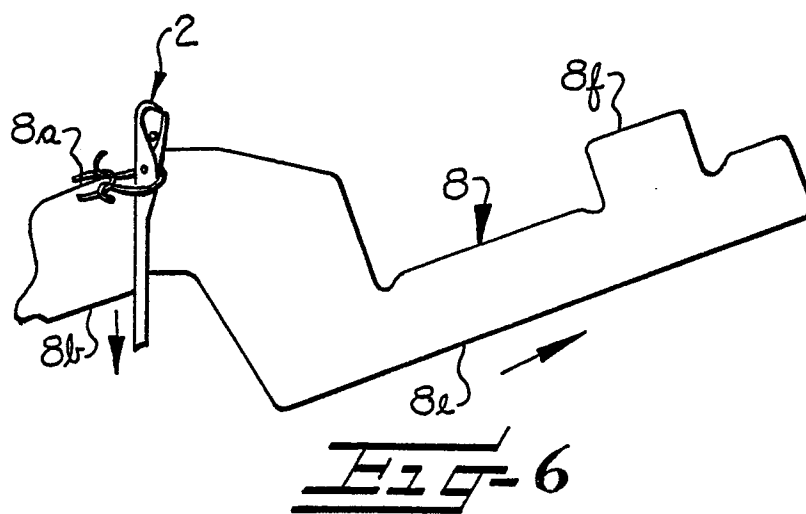
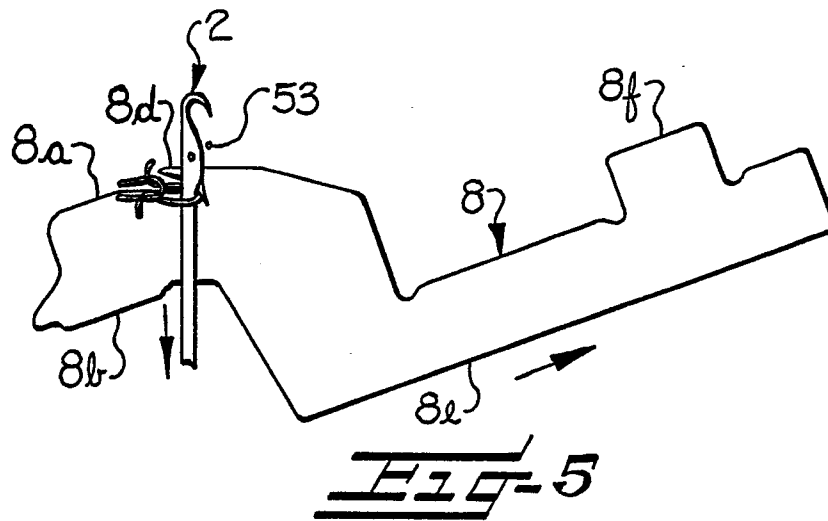
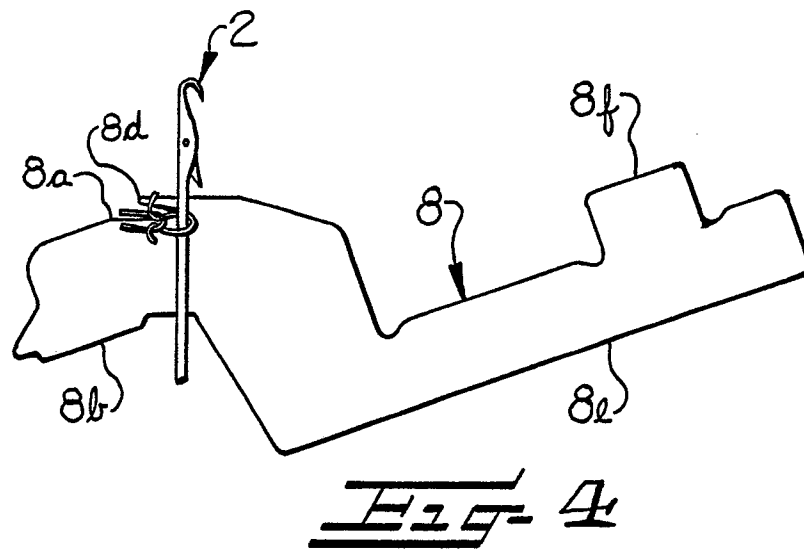


Fig-3



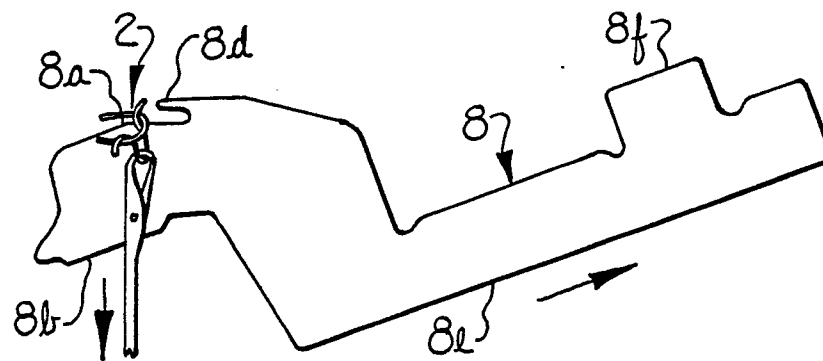


Fig-7

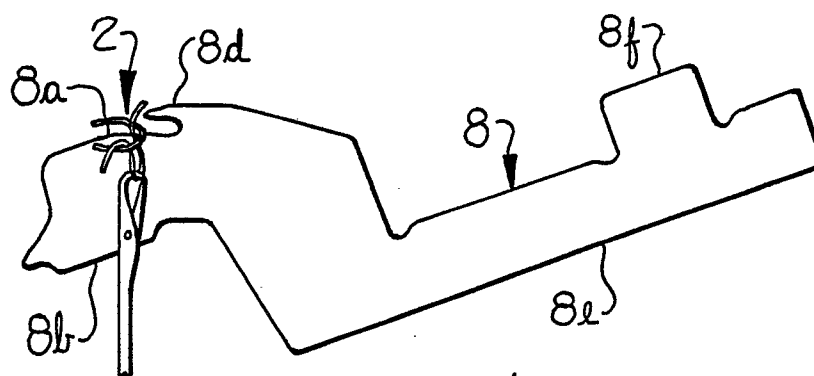


Fig-8

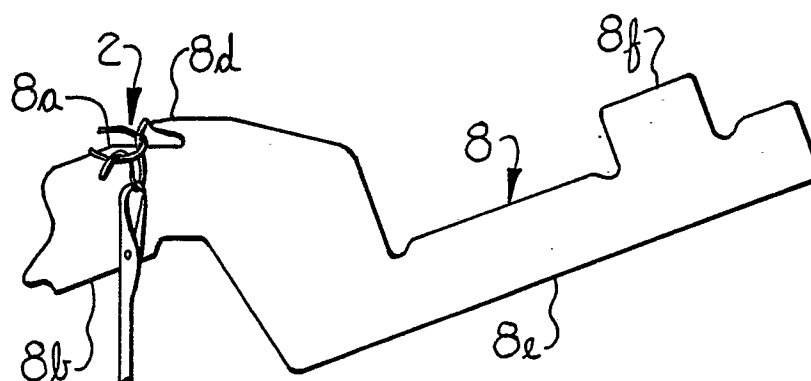


Fig-9

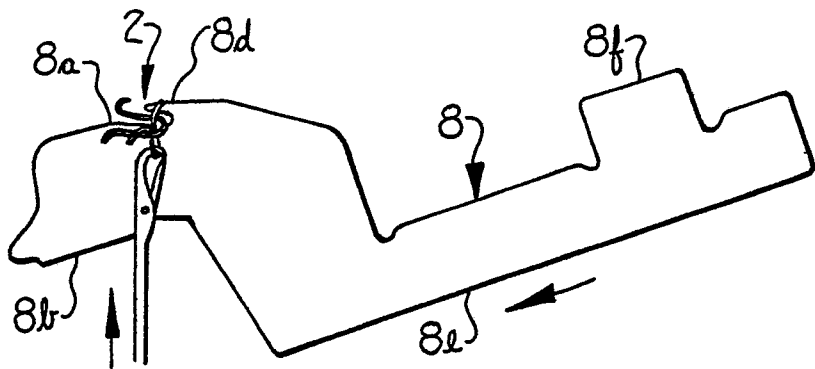


Fig-10

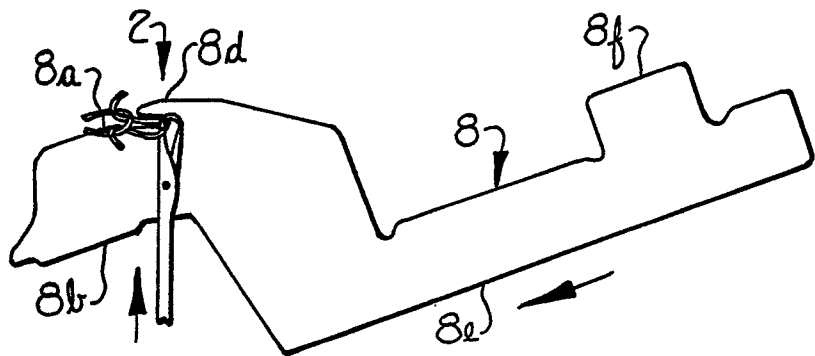


Fig-11

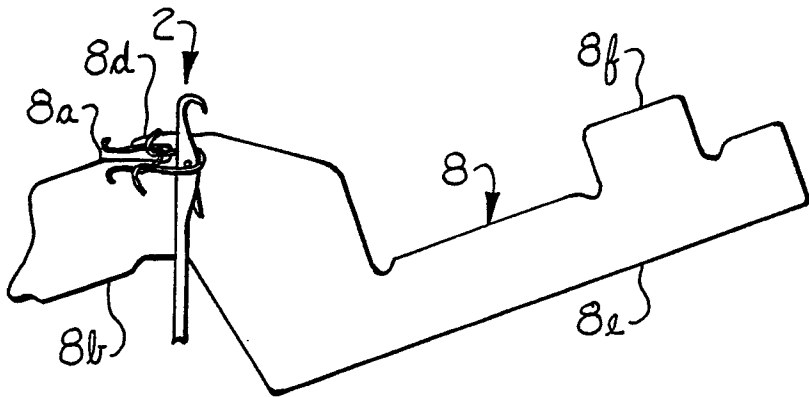


Fig-12