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(54) Novel sewing machines and processes.

(57) A novel sewing machine comprises means for bonding a thread into fixed positioned relationship with the fabric stock to be sewn.

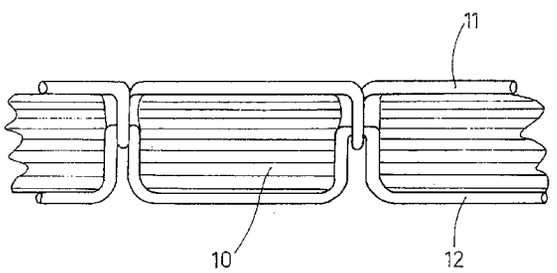

Fig. 1

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Field of the Invention

This invention relates to sewing machines and processes, and more specifically to novel sewing machines which do not include a mechanical lower thread carrier, such as a bobbin or equivalent element as is included in conventional lock-stitch sewing machines, and yet are capable of performing essentially the same work as said conventional lockstitch machines; and to sewing processes that do not require passing a mechanical element, specifically a lower thread carrier, through thread loops and therefore eliminate the prior art limitations as to the amount of lower thread located in the lower bobbin that can be fed without interruption to the sewing operation.

Background of the Invention

Conventional lock-stitch type sewing machines which have been known in the art for a very long time, use two continuous threads to create a stitch. The upper thread is fed from an upper bobbin, is engaged by the needle of the machine, is carried through the fabric stock, comprised of one or more layers, which is to be stitched or decorated or stitched together, a loop is thus generated, the thread is engaged by a hook or equivalent mechanical element on the underside of the fabric stock and retained by it as the needle withdraws upwards, and finally is abandoned by the hook and is drawn tight by the movement of the needle. The lower thread, which is usually carried by a lower bobbin or by an equivalent mechanical element, is carried by said bobbin or equivalent element through the aforesaid loop, and when the loop is tightened an interlocking engagement is created between the two continuous threads. The resulting structure is schematically illustrated in cross-section in Fig. 1, where for simplicity of illustration the fabric stock to be sewn is shown as consisting of a single layer and being interrupted to leave open spaces where the two threads interlock. The fabric stock is indicated by numeral 10, the upper thread by numeral 11 and the lower thread by the numeral 12.

This technique has several disadvantages, the main one of which is that the bobbin or other lower thread carrier must necessarily be of small size, in order to pass through the upper thread loops, and therefore can store only a small amount of thread and must be refilled at short intervals, causing interruption of the sewing operation.

It is a purpose of this invention to eliminate that drawback and to provide sewing machines and processes which do essentially the same work as a conventional lock-stitch type sewing machine and processes, but do not require the use of a mechanical lower thread carrier.

It is another purpose of the invention to provide such sewing machines and processes which do not involve the use of lower thread supply carriers of limited size.

It is a further purpose of this invention to provide such sewing machines and processes which do not involve frequent interruption of the work to renew the lower thread supply.

It is a still further purpose of the invention to provide such sewing machines and processes which will produce a sewn fabric stock which will be equivalent to and almost impossible to differentiate from a sewn stock produced by conventional lock-stitch machines and processes.

Other purposes and advantages of the invention will appear as the description proceeds.

Summary of the Invention

The novel sewing machine according to the invention is characterized in that it comprises means for bonding a thread into fixed positioned relationship with the fabric stock to be sewn.

Said bonding is preferably carried out by microinjection, e.g,. by the bubble-jet or like technique, of a thermoplastic or thermosetting synthetic bonding material to the points at which the bonding is to be effected.

In a preferred form of the invention, sewing machine comprises, in combination with a first, essentially continuous thread (hereinafter "upper thread") supply, such as an upper bobbin, and means for forming a loop of said thread on the side of the fabric stock to be sewn that is opposite to said upper thread supply (hereinafter called "the underside") - e.g. as in conventional lock-stitch sewing machines -

means for bringing a second thread (hereinafter "lower thread") into engagement with said upper thread loops, and

means for bonding said lower thread in fixed positioned relationship to said fabric stock by

a) bonding it or segments thereof to the underside of the fabric stock; or

b) bonding it or segments thereof to the upper thread; or

c) bonding segments of said lower thread each to the end of the previous segment and thus reconstructing said lower thread.

In a preferred form of the invention, the lower thread is cut into thread segments after it has been bonded to the fabric stock or to another thread or to a previous thread segment.

The engagement of the lower thread with the upper thread loops may involve or not involve inserting said lower thread through said loops prior to bonding.

In any case, the bonding of the lower thread or thread segments determines a fixed, permanent positioned relationship between the lower thread and the fabric stock.

In a variant of the invention, a single thread chain

stitch is created by drawing a thread by means of the needle through the fabric stock, alternatively from the top to the bottom side and from the bottom to the top side thereof, and connecting it to the underside of the fabric stock by the micro-injection of a bonding substance.

The means for bringing the lower thread into engagement with said upper thread loops, may comprise, in a preferred form of the invention, means for feeding said lower thread and inserting it in the form of a continuous thread into each upper thread loop, bonding it and then cutting it to detach from it a segment which will become engaged with the loop when the upper thread is tightened.

In a preferred form of the invention, the aforesaid means a) and/or b) comprise means for bringing the lower thread to the vicinity of the upper thread loops and preferably pneumatic means for urging said lower thread into and through said loops.

The means for bonding said lower thread segments in fixed positioned relationship to said fabric stock or to one another may comprise, in preferred forms of the invention:

I) means for connecting lower thread segments, thermoplastic or of a different kind, to said stock or to the upper thread or to one another by micro-injection;

II) means for bonding lower thread segments to said stock or to the upper thread or to one another by means of an adhesive; or

III) means for applying additional, preferably synthetic bonding material to said lower thread segments and to said stock, or to said lower thread segments and to the upper thread, or to adjacent lower thread segments, to connect them together.

The aforesaid means III), which is the most preferred one, preferable comprises means for producing, by a bubble jet device, drops of liquid bonding material, for applying said drops to the lower thread and fabric stock and for causing or allowing the drops to solidify to bind together thread and fabric stock or different threads or segments of the same thread.

The synthetic bonding material should be such as to solidify in the time in which a stitch is intended to be made. The number of stitches, and therefore of bonding material injection shots, may vary according to the work to be done and may be as high as some thousands per minute. The solidification may occur by the cooling of a molten thermoplastic material or by the polymerization of a monomeric or oligomeric, polymerizable material. The polymerization, in the latter case, may be carried out by photochemical initiation. Thermoplastic materials that can be melted and then re-solidified are well known and commonly used in the injection art and need not be exemplified. Materials that will polymerize by photochemical initiation include, e.g., those presently used in fast photochemical label printing, e.g. acrylate-capped oligomers (generally having molecular weight of about 2000-5000). Examples of these are acrylate-capped polyurethanes, which, when solidified, provide cross-linked (thermosetting) non-fusible polymers, which are unaffected by solvents; or acrylate-capped epoxies, which provide similar polymers, having a higher modulus and smaller elongation-at-break. The choice between said materials depends on the particular bond that is to effected in each case and can easily be made by persons skilled in the art.

The novel sewing process according to the invention is characterized in that it comprises the step of bonding a thread into fixed positioned relationship with the fabric stock to be sewn. Said step preferably comprises micro-injecting a thermoplastic or thermosetting synthetic bonding material to the points at which the bonding is to be effected.

In a variant of the invention, said process comprises, feeding an upper thread, forming loops of said upper thread on the underside of the fabric stock, bringing a lower thread into engagement with said upper thread loops, and bonding said lower thread in fixed positioned relationship to said fabric stock. In various embodiments of the invention, said lower thread is bonded in fixed positioned relationship to said fabric stock by bonding it or segments thereof to the underside of the fabric stock, or by bonding it or segments thereof to the upper thread, or by bonding segments of said lower thread each to the end of the previous segment and thus reconstructing said lower thread.

In an embodiment of the invention, the bonding materials are polymerizable oligomeric materials, preferably chosen from materials that will polymerize by photochemical initiation, in particular those presently used in fast photochemical label printing, e.g. acrylate-capped polyurethanes or acrylate-capped epoxies.

Description of the Drawings

In the drawings:

Fig. 1 is a schematic cross-section of a conventionally sewn fabric stock;

Fig. 2 is a schematic illustration of a sewing machine according to an embodiment of the invention;

Fig. 3 is a schematic illustration of the phases of a sewing process according to an embodiment of the invention;

Fig. 4 is a schematic illustration of the phases of a micro-injection operation according to an embodiment of the invention;

Fig. 5 (a) to (c) is a schematic illustration of kinds of thread bonding according to three embodiments of the invention;

Fig. 6 (a) and (b) shows schematic cross-sections

of fabric stock sewn according to two embodiments of the invention;

Fig. 7 is a schematic cross-section of fabric stock sewn according to another embodiment of the invention;

Fig. 8 schematically illustrates a possible geometric relationship between upper and lower thread according to an embodiment of the invention;

Fig. 9 is a schematic illustration, similar to Fig. 3, of the phases of another sewing process according to an embodiment of the invention; and

Figs. 10 and 11 illustrate further embodiments of the invention.

Detailed Description of Preferred Embodiments

With reference now to the drawings, Fig. 2 schematically illustrates the structure and operation of a machine according to an embodiment of the invention.

The body 20 of the machine with its upper thread bobbin 21 and the assembly generally indicated at 22 of its needle and parts cooperating therewith, may be identical to that of a conventional lock-stitch sewing machine and need therefore not be described in detail. Additionally, in this embodiment of the invention, the machine is provided with a continuous lower thread supply of any convenient type, illustrated as in the form of bobbin 24. The lower thread 25 fed from said bobbin 24 passes through a guide tube 26 which leads it to the underside of the fabric stock to be sewed, only a portion of which is shown at 27. This is only schematically indicated in the drawings, and it should be understood that many different means may be employed by skilled persons to guide the thread to the desired positions. Tube 26 leads thread 25 to the vicinity of the loops 28 which are formed in the upper thread by the action of a hook or similar mechanical element, not shown, as in conventional sewing machines. From that point, the thread is thrust through said loops 28, preferably by pneumatic or other suitable feed means which are schematically indicated at 29. The means for permanently bonding the lower thread to the fabric stock, which are micro-injection devices, are symbolically indicated at 23 and will be described later on. It is clear, however, that different means may be used to lead the lower thread 25 to the vicinity of the loops, and for urging it through the loops. These may be, e.g., mechanical and not pneumatic means. The length of the segments to be inserted into the upper thread loops will be determined by suitable mechanical means and will correspond to the length of the desired stitches.

In the embodiment illustrated in Fig. 2, the lower thread 25 is continuous and must be cut at each stitch by a suitable mechanism. For example, a rotating disk which has a cutting edge may be positioned beyond the means 23 for bonding the lower thread to the fabric. Alternatively, the cutting of the thread may be achieved by thermal means, such as by a small laser source which emanates a beam which is strong enough to burn off the lower thread and thereby cut it at the desired point. In any case, the cutting must occur after the lower thread has been inserted into the loop of the upper thread and bonded either to the fabric stock, or, as in other embodiments to be described, to the free end of the upper thread.

Fig. 3, (a) to (d), further schematically illustrates the process according to the invention. Though thermal cutting means may be employed, as hereinbefore stated, the figure schematically shows mechanical cutting means, viz. a knife. The same numerals as in Fig. 2 are used to designate the same parts.

In Fig. 3(a) the beginning of the formation of the stitch is shown. The needle 22 has engaged the upper thread 30, and is beginning to form a loop. The needle has already penetrated into the fabric 27, which is shown as interrupted at the point of needle penetration to make the drawing clear, but obviously is not so interrupted.

In Fig. 3(b) a loop 28 has been formed through the intervention of the hook 35.

In Fig. 3(c), the lower thread 25, originating from any source of continuous thread 34, which might be the bobbin 24 shown in Fig. 2 or any other convenient source, is passed through the loop 28, e.g. by the means shown in Fig. 2.

In Fig. 3(d), the stage of the process is shown wherein the lower thread 25 is about to be engaged by the upper thread 30, which has been drawn upwards by the needle 22, and is permanently bonded to the underside of the fabric stock 27 on both sides of the stitch by means of the two micro-injection elements 31-31', which may be of any convenient type, e.g. bubble-jet nozzles or other permanently-bonding means known or easily devised by persons skilled in the art. After the said bonding has been effected, and only then, is the lower thread cut by a cutter schematically indicated at 36 (Fig. 3 (c)).

Fig. 4, (a) to (e), schematically illustrates the way in which the material for creating the bonding between the lower thread and the fabric stock, in some embodiments of the invention, is injected onto the lower thread and the fabric, or the material which creates the bonding between upper and lower thread is injected on the threads. The technique used is well known in the art, and is a so-called "bubble-jet" technique.

In Fig. 4(a), a nozzle 40 is schematically illustrated which contains a thermoplastic, preferably synthetic material 41. 42 indicates a heating element, e.g. an electric resistance. A bubble 44 is firstly formed within the thermoplastic material. Then, as shown in Fig. 4(b), the bubble expands because of the heating, and forces thermoplastic material, in

fused condition, out of the nozzle, creating a drop, indicated at 45. 46 schematically designates the substrate, such as a thread and a fabric, or two threads, onto which the bonding bubble of molten material is to be applied. Fig. 4(c) illustrates a more advanced stage of the operation. The bubble 45 of molten material has been completely formed, and is about to be applied on the substrate 46. Meanwhile, the heating has been discontinued and a cooling has begun to take place, which cooling is very rapid because of the small amount of micro-injected bonding material, and, if desired, of a cooling by means of an air stream or other convenient means. The bubble 44 has began to contract and in so doing attracts fresh, synthetic material from any convenient supply, such as a thread or yarn, within the nozzle. Finally, in the last stage shown in Fig. 4(d), the bubble 45 has become detached from the body of molten material to form a bonding element 47, applied to substrate 46, the bubble has completely contracted and has disappeared, and the device is ready to start the cycle once again. Fig. 4(e) illustrates a case in which a fabric 48 is bonded to a thread 49 by means of the bonding material 47.

Fig. 5, (a) to (c), generally illustrates various ways in which two thread or two thread segments or a thread and a thread segment - regardless of whether they belong to the upper or lower thread or to a single thread - can be connected to one another. The word "thread" as used in describing this figure includes therefore any and any thread segment that may be involved in the sewing.

In Fig. 5(a), two threads 50 and 51, which are assumed to be thermoplastic, are bonded by applying heat to them so as to fuse them partially and create a fused welding 52.

In Fig. 5(b), two threads 53 and 54 are bonded by the interposition of an adhesive, 55.

In Fig. 5(c), two threads 56 and 57 are bonded by additional synthetic material 58, which is injected by means of a device 59 of any suitable kind, e.g. such as that illustrated in Fig. 4. The results obtained by this last method are substantially better than those obtainable by the two previous ones, both as to the strength of the resulting bond between threads and as to the "feel" of the sewing, and therefore said last method is preferred in carrying out the invention.

Fig. 6, (a) and (b), shows in schematic cross-section two types of bonding that may be obtained in this way, particularly as in Fig. 5(c). In Fig. 6(a) the adjacent ends of two successive lower thread segments 60 are superimposed and bonded at 61. The fabric stock 62 and the upper thread 63 do not participate in the bonding. In Fig. 6(b) the successive lower thread segments 64 are bonded end to end at 65.

Fig.7 shows in schematic cross-section the structure of the sewn fabric stock resulting from an embodiment of the invention in which the lower thread segments are bonded to the fabric stock. Once again, said stock is shown, for simplicity of illustration, as consisting of a single layer and as being interrupted where the sewing threads pass through it. Numeral 70 designates the fabric stock, numeral 71 designates the upper thread and numeral 72 designates the lower thread, which is constituted by separate segments that are bonded at both ends, as at 73 and 74, to the underside of the fabric stock, by any one of the means indicated hereinbefore, and in this particular case, by the application of an additional synthetic material that is injected at 73 and 74.

Fig. 8 schematically illustrates a possible geometric relationship between upper and lower threads. It shows an arrangement in which the lower thread segments 80 are not parallel to the upper thread 81 - as they might be - but are set at an angle and bonded thereto at points 82.

Fig. 9 illustrates the phases of a sewing process similar to that illustrated in Fig. 3, the only difference being that a single micro-injection device is used - device 31' is missing. The numerals used are the same as in Fig. 3. This figure exemplifies the way in which a lower thread is reconstructed.

Fig. 10 schematically illustrates another embodiment of the invention, wherein the lower thread 90 is not passed through the loops of the upper thread 92, but is bonded to said upper thread at its lowermost points on the underside of the fabric stock 91 by micro-injection, as indicated at 93. The bond obtained by the micro-injection retains the upper thread at points 93 on the underside of the fabric stock.

Fig. 11 schematically illustrates another embodiment of the invention, which consists of a single thread chain stitch. A thread 85 is drawn by the needle through the fabric stock 86. a loop is formed and is seized by the hook and drawn sideways at a short distance from the point of penetration of the needle, viz. to points 87. There it is bonded preferably by micro-injection to the underside of the fabric stock. Thus the thread is connected to said stock in fixed positioned relationship, though no lower thread is present.

Furthermore, as has been noted, instead of bonding the fabric and the thread together as illustrated by the bubble-jet technique illustrated in Fig. 4, other bonding means, such as fusion by heat-generating sources, e.g. laser jet beams or by means of adhesive, or welding, could be used.

If the bubble jet technique or some equivalent technique is used, practically any kind of thread can be associated with practically any kind of fabric. If, on the contrary, fusion techniques or the like are used, then the chemical nature of the thread must be compatible with that of the fabric or the chemical nature of the lower and upper threads must be compatible with one another in ways that will be obvious to a person skilled in the art, in order that the bonding by fus-

ing may be possible.

Furthermore, it is to be noted that the lower thread may be bonded to the fabric stock alone, or both to the upper thread and to the fabric stock, or may be reconstructed from its segments by bonding each segment to the successive one.

Examples of materials that can be used for threads are cotton, polyester, nylon, etc. By means of such yarns, most fabrics can be sewn, and that includes woollen fabrics, woollen and polyester fabrics, and so forth.

Once the sewing has been carried out, it is practically indistinguishable from the user's point of view from the conventional one, carried out by the lockstitch sewing machines.

From the upper side, viz. the side to which the upper yarn only is applied, there is obviously no difference between the conventional sewing and the sewing according to the invention. Even when seen from the underside, the materials sewn according to the invention are not substantially different from the conventional ones, even when the invention is carried out by reconstructing the lower thread through the bonding of successive segments to one another.

For the purpose of carrying out the bonding described, e.g. with reference to Fig. 4, any convenient thermoplastic material can be used. Synthetic thermoplastic material, such as nylon or polyester, are quite suitable, and in general, it will be desirable to use a material that is similar to that of the lower yarn and compatible therewith.

In all the embodiments of the invention hereinbefore described or any other embodiments the lower thread can be produced in situ by extrusion of a thread forming extrudable matter, e.g. of a thermoplastic synthetic polymer, from an extruder. The spinneret of the extruder will be inserted within the upper thread loop, will extrude a thread starting from such a position that the formed thread will become bonded to the end of the previously formed segment of the same thread, and while extruding will move backwards out of the upper thread loop. The extruder itself is easily provided by persons skilled in the art. The remaining operations will be carried out as described hereinbefore with reference to the examples.

While some embodiments of the invention have been described by way of illustration, it will be apparent that the invention may be carried into practice by persons skilled in the art with many variations, adaptations and modifications, without departing from its spirit or exceeding the scope of the claims.

Claims

1 - Sewing machine, characterized in that it comprises means for bonding a thread into fixed positioned relationship with the fabric stock to be sewn.

2 - Sewing machine according to claim 1, wherein the bonding means comprise micro-injection means for injecting a thermoplastic or thermosetting synthetic bonding material to the points at which the bonding is to be effected.

3 - Sewing machine according to claim 1, which comprises, in combination with an upper thread supply, means for forming a loop of said upper thread on the underside of the fabric stock, means for bringing a lower thread into engagement with said upper thread loops, and means for bonding said lower thread in fixed positioned relationship to said fabric stock.

4 - Sewing machine according to claim 3, wherein the means for bonding said lower thread in fixed positioned relationship to said fabric stock comprise means for bonding it or segments thereof to the underside of the fabric stock.

5 - Sewing machine according to claim 3, wherein the means for bonding said lower thread in fixed positioned relationship to said fabric stock comprise means for bonding it or segments thereof to the upper thread.

6 - Sewing machine according to claim 3, wherein the means for bonding said lower thread in fixed positioned relationship to said fabric stock comprise means for bonding segments of said lower thread each to the end of the previous segment and thus to reconstruct said lower thread.

7 - Sewing machine according to claim 3, comprising means for cutting the lower thread into thread segments after it has been bonded to the fabric stock or to another thread or thread segment.

8 - Sewing machine according to claim 3, comprising means for inserting the lower thread through the upper thread loops prior to bonding.

9 - Sewing machine according to claim 1, comprising means for drawing a thread by means of the needle through the fabric stock, alternatively from the top to the bottom side and from the bottom to the top side thereof, and connecting it to the underside of the fabric stock by the micro-injection of a bonding substance.

10 - Sewing machine according to claim 3, wherein the means for bringing the lower thread into engagement with the upper thread loops comprise means for feeding said lower thread and inserting it in the form of a continuous thread into each upper thread loop and then cutting it to detach from it a segment which will become engaged with the loop when the upper thread is tightened.

11 - Sewing machine according to claim 3, wherein the means for bringing the lower thread into engagement with the upper thread loops means for bringing the lower thread to the vicinity of the upper thread loops and means for urging said lower thread into and through said loops.

12 - Sewing machine according to claim 3, where-

in the means for bonding the lower thread in fixed positioned relationship to the fabric stock comprise means for applying additional, synthetic bonding material to lower thread segments and to said stock, or to lower thread segments and to the upper thread, or to adjacent lower thread segments, to connect them together.

13 - Sewing machine according to claim 12, wherein the means for applying additional, synthetic bonding material comprise means for producing, by a bubble jet device, drops of liquid material, for applying said drops to the lower thread and fabric stock and for causing or allowing the drops to solidify to bind together thread and fabric stock or different threads or segments of the same thread.

14 - Sewing machine according to claim 13, wherein the means for causing or allowing the drops to solidify comprise means for causing or allowing the cooling of a molten thermoplastic material.

15 - Sewing machine according to claim 13, wherein the means for causing or allowing the drops to solidify comprise means for causing or allowing the polymerization of a monomeric or oligomeric, polymerizable material.

16 - Sewing machine according to claim 13, wherein the means for causing or allowing the polymerization comprise photochemical initiation means.

17 - Sewing process according to claim 3 , comprising means for feeding the lower thread and inserting it in the form of a continuous thread into each upper thread loop and then cutting it to detach from it a segment which will become engaged with the loop when the upper thread is tightened.

18 - Sewing machine according to claim 1, wherein the bonding means comprise means for applying an adhesive to the points at which the bonding is to be effected.

19 - Sewing machine according to claim 1, wherein the bonding means are welding means.

20 - Sewing process, characterized in that it comprises the step of bonding a thread into fixed positioned relationship with the fabric stock to be sewn.

21 - Sewing process according to claim 20, comprising micro-injecting a thermoplastic or thermosetting synthetic bonding material to the points at which the bonding is to be effected.

22 - Sewing process according to claim 20, comprising effecting the bonding by welding or by the application of an adhesive.

23 - Sewing process according to claim 20, comprising feeding an upper thread, forming loops of said upper thread on the underside of the fabric stock, bringing a lower thread into engagement with said upper thread loops, and bonding said lower thread in fixed positioned relationship to said fabric stock.

24 - Sewing process according to claim 20, comprising bonding the lower thread it or segments thereof to the underside of the fabric stock.

25 - Sewing process according to claim 20, comprising bonding the lower thread or segments thereof to the upper thread.

26 - Sewing process according to claim 20, comprising bonding segments of said lower thread each to the end of the previous segment and thus reconstructing said lower thread.

27 - Sewing process according to claim 21, wherein the bonding materials are polymerizable oligomeric materials, chosen from materials that will polymerize by photochemical initiation.

28 - Sewing process according to claim 21, wherein the bonding materials are polymerizable oligomeric materials, chosen from acrylate-capped polyurethanes or acrylate-capped epoxies.

29 - Sewing machine according to any one of claims 1 to 16, comprising extruding means for forming the lower thread in situ.

30 - Sewing process according to any one of claims 17 to 28, wherein the lower thread is formed by extrusion in situ.

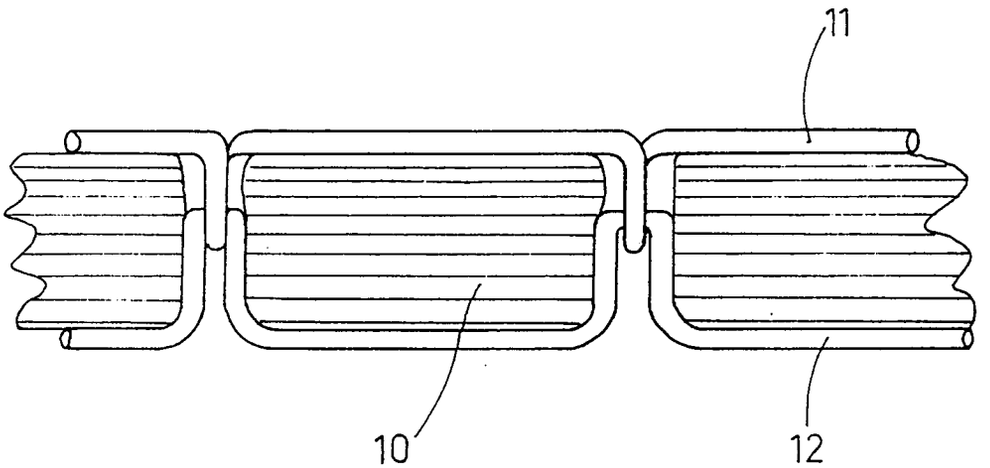

Fig. 1

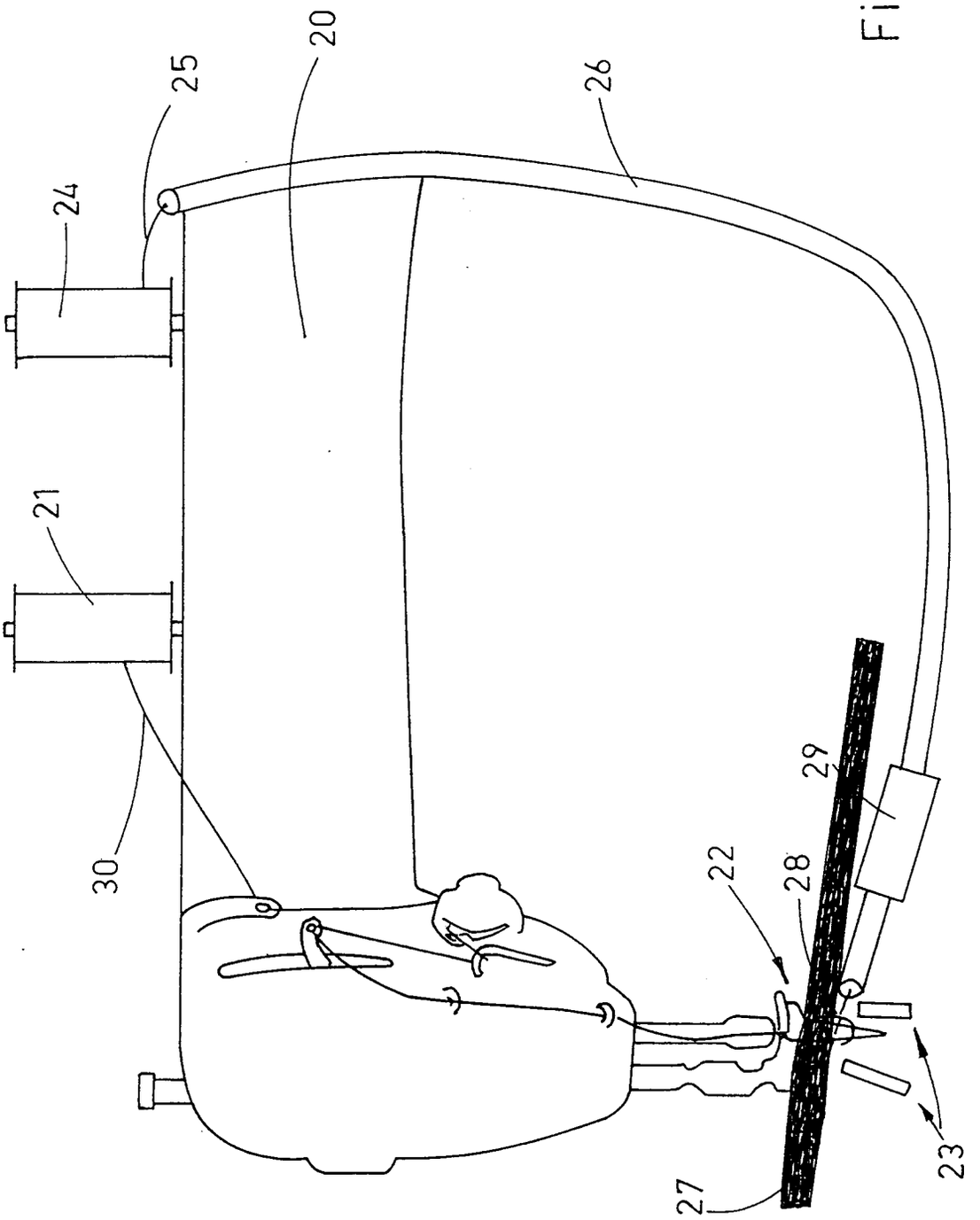

Fig. 2

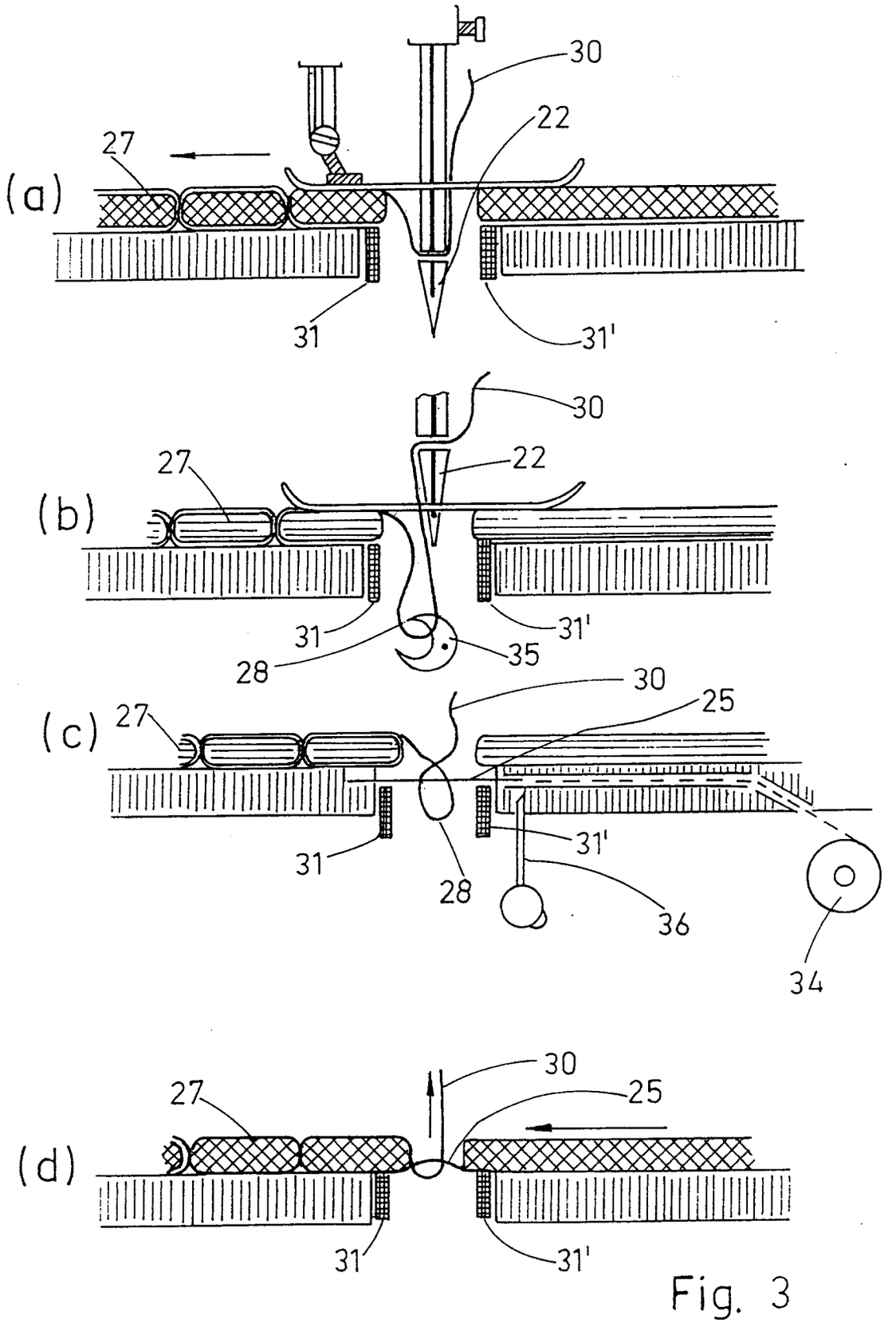
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Fig. 3

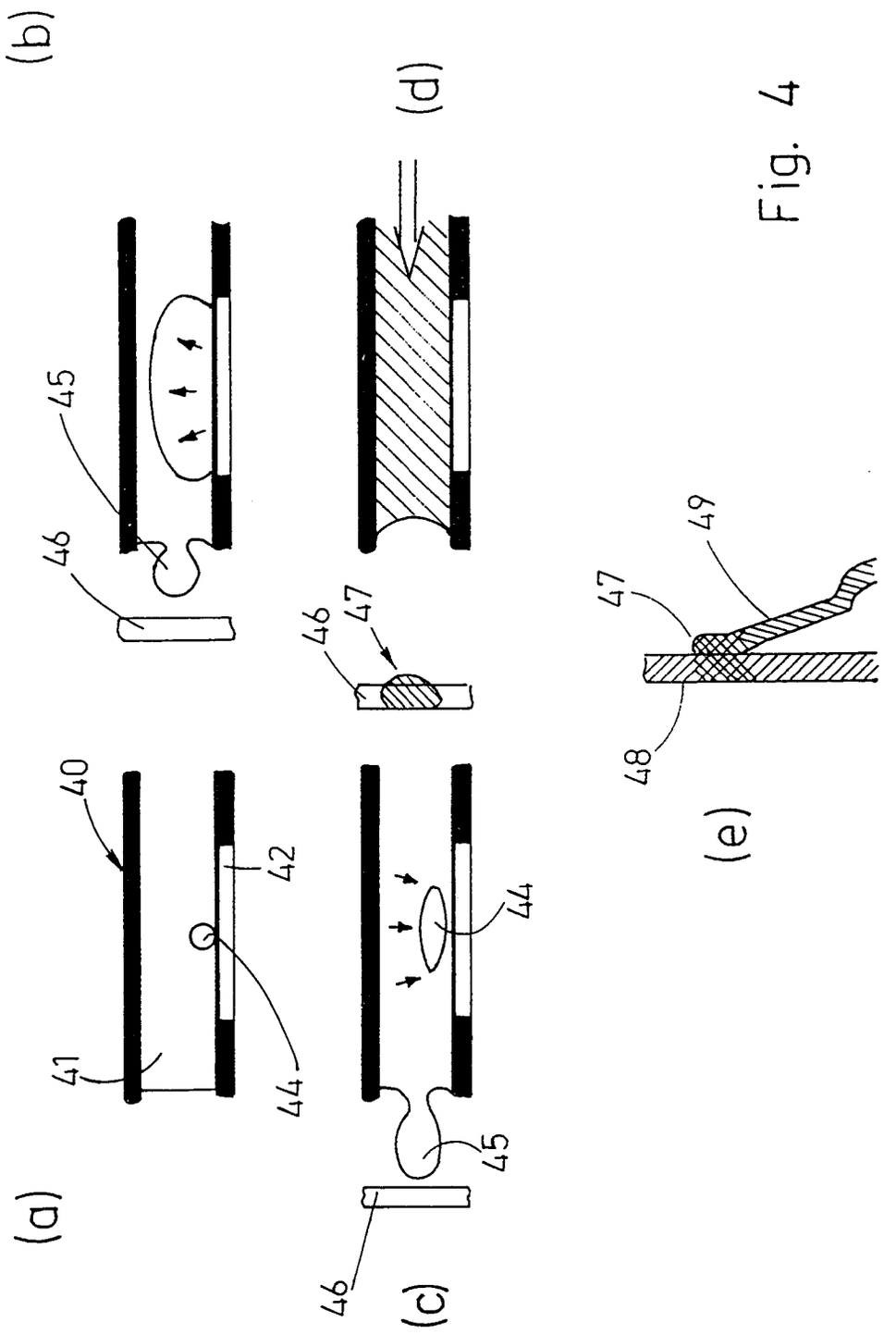


Fig. 4

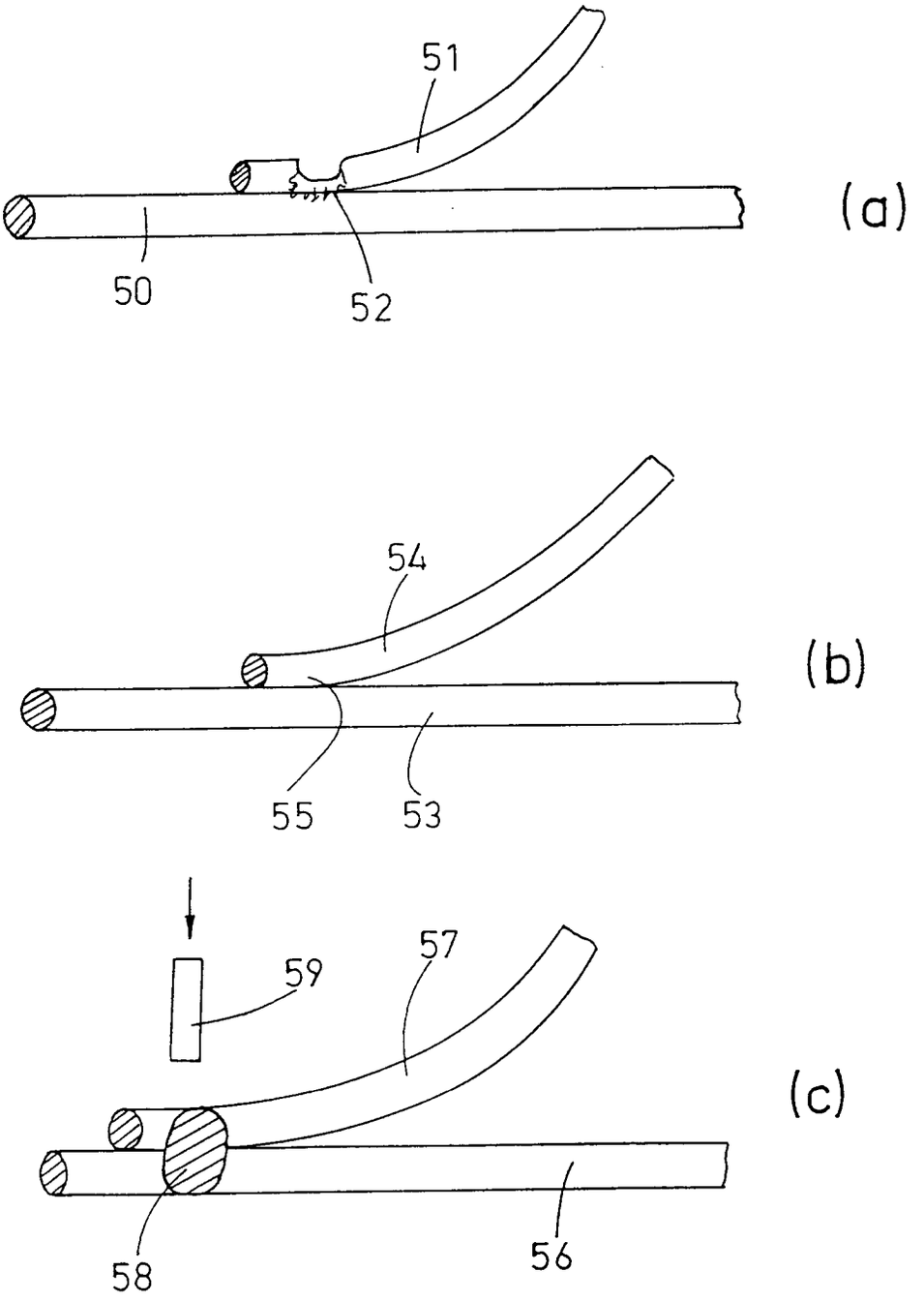
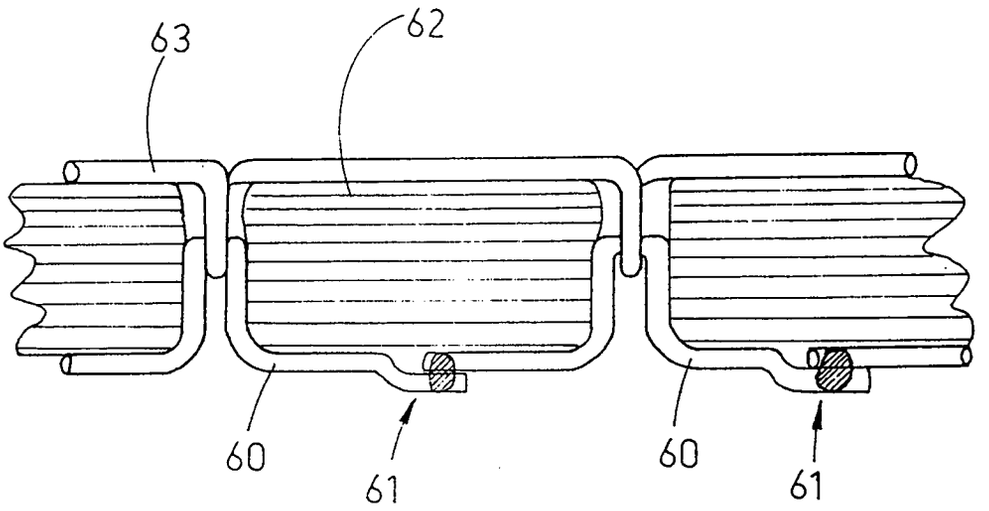


Fig. 5



(a)

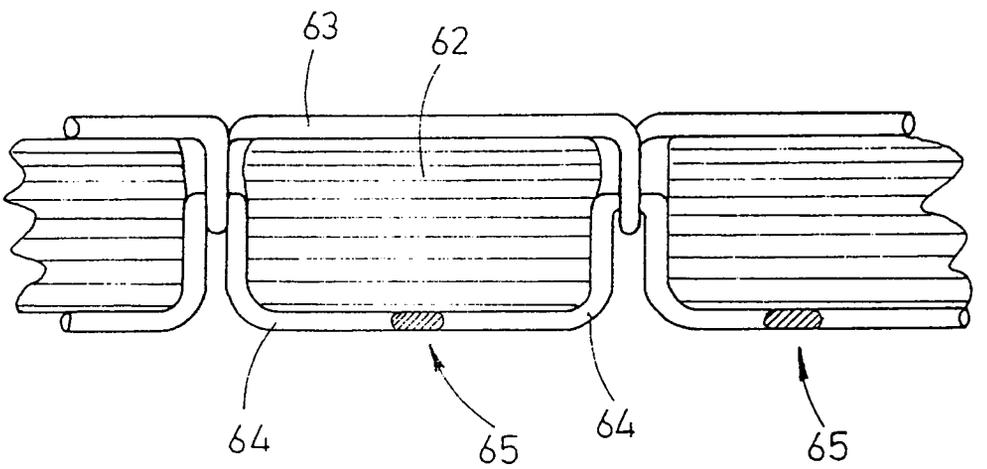


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Fig. 6

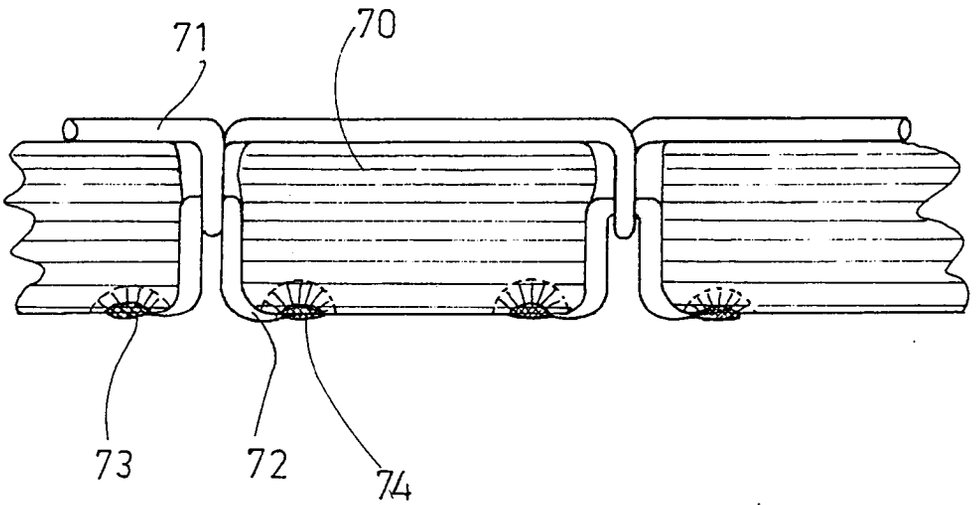

Fig. 7

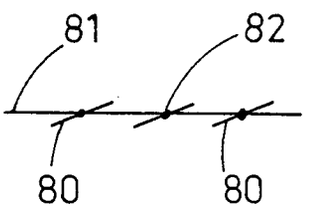

Fig. 8

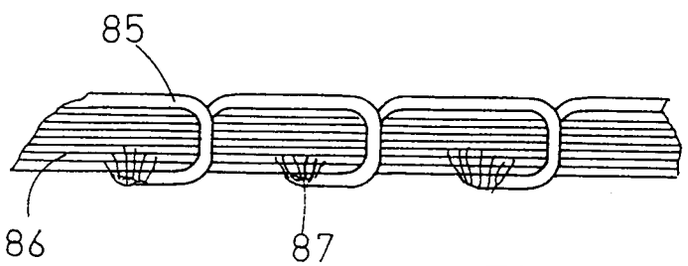

Fig. 11

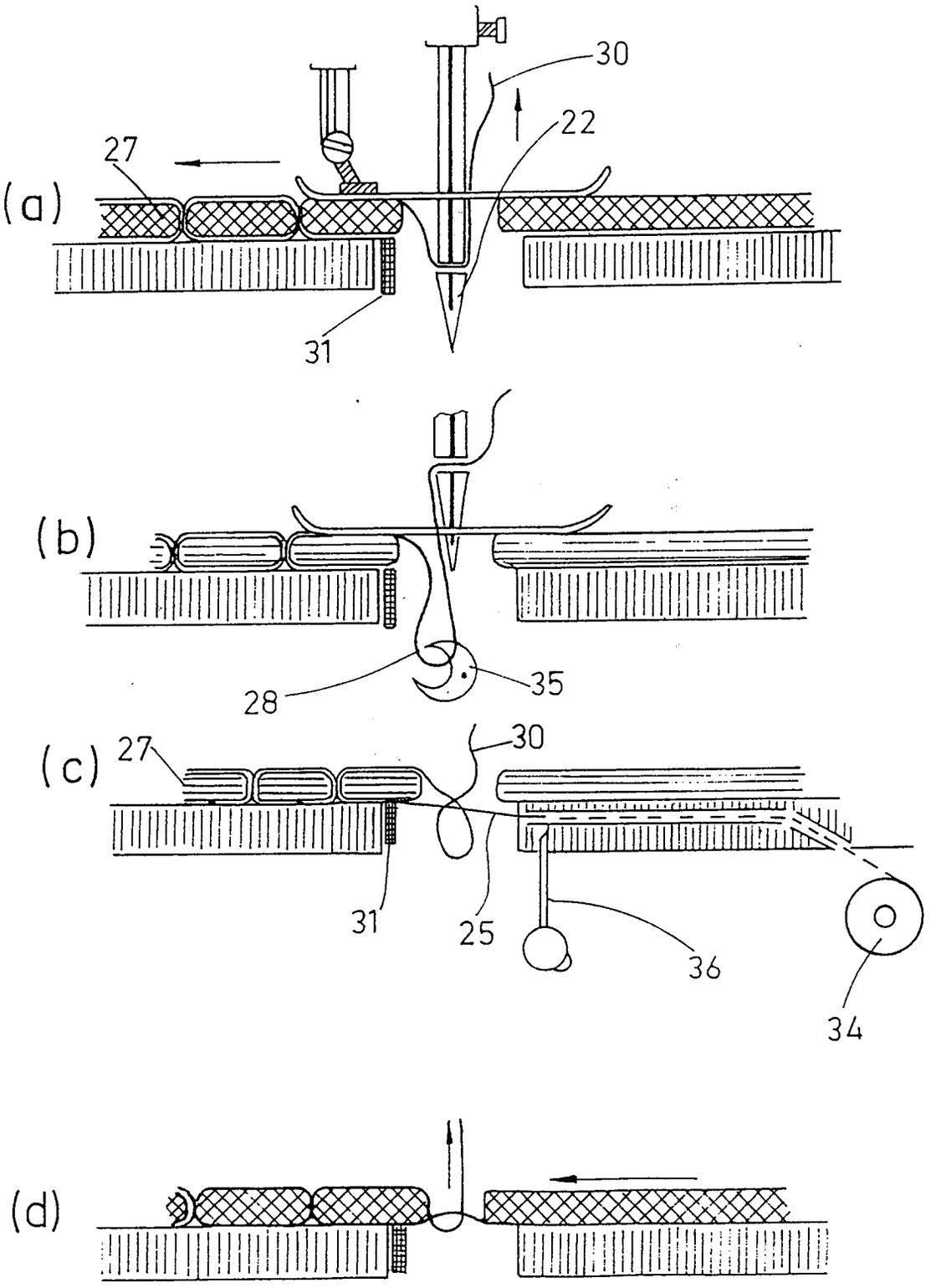

Fig. 9

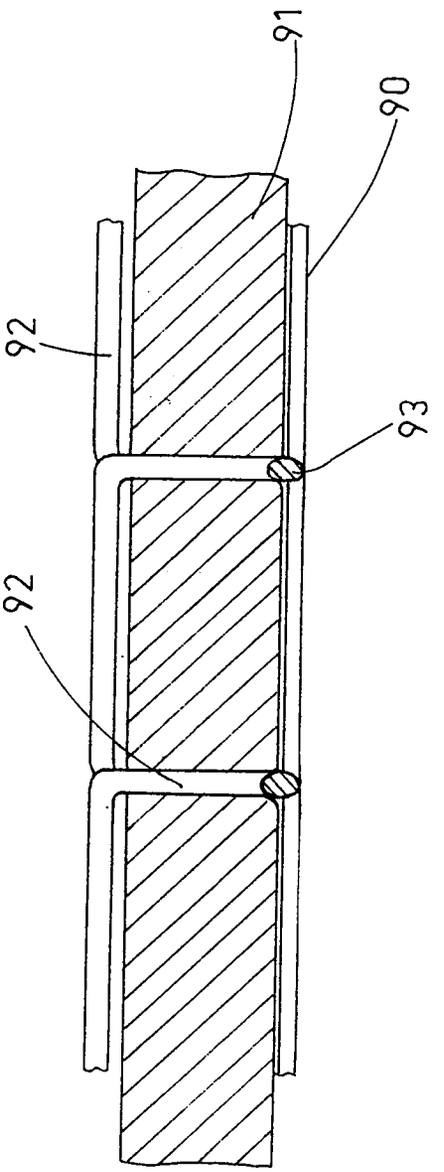

Fig. 10