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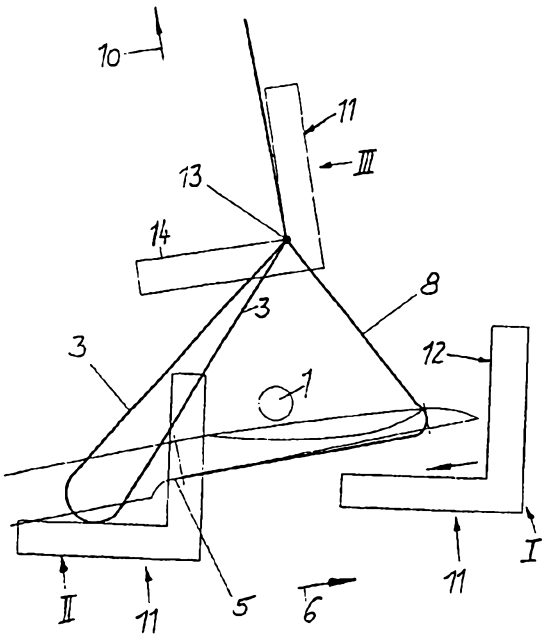
(54) Title: METHOD AND DEVICE FOR MECHANICALLY SEWING A DOUBLE CHAIN STITCH SEAM

(54) Bezeichnung: VERFAHREN UND VORRICHTUNG ZUM MASCHINELLEN NÄHEN EINER DOPPELKETTENSTICH-NAHT



(57) Abstract: The aim of the invention is to provide a method for mechanically locking a double chain stitch seam. The chain stitch is produced by means of an industrial sewing machine comprising a sewing needle and a sewing thread as well as by a main gripper comprising a gripper thread. The sewing direction is reversed for locking purposes. The aim of the invention is also to guarantee that the chain stitch seam is sewn in a simple and very precise manner by means of the inventive method and even when the sewing speed is high. According to the inventive method and after the sewing direction has been reversed, the thread loop which is formed by the sewing needle underneath the web of fabric is received by the main gripper in the stitching rhythm of the sewing needle. The thread loop is subsequently pushed on the main gripper against the working direction thereof by means of an auxiliary component that is driven in a synchronous manner by the sewing machine. The needle thread which forms the thread loop is then joined with the gripper head and held in this position underneath the sewing level at a distance from the needle and the main gripper in front of said needle and gripper and in the forward sewing direction by means of said auxiliary component. The joined thread area is moved in the forward sewing direction and a thread triangle formed by the needle thread rope that forms the loop is stretched in the gripper thread area that extends in parallel in relation to the main gripper and in the gripper thread area that leads to the joined area. The sewing needle stitches into said triangle. The thread triangle is subsequently held open by means of the auxiliary component until the next thread loop of the needle thread is formed. The joined thread area is released by the auxiliary component approximately at the same time.

(57) Zusammenfassung: Um ein Verfahren zum maschinellen Verriegeln einer Doppelkettenstichnaht, wobei der Kettenstich mittels einer industriellen Nähmaschine mit Nähnadel und Nähfaden sowie Hauptgreifer mit Greiferfaden gebildet wird und zum Verriegeln die Nährichtung umgekehrt

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— *vor Ablauf der für Änderungen der Ansprüche geltenden Frist; Veröffentlichung wird wiederholt, falls Änderungen eintreffen*

Zur Erklärung der Zweibuchstaben-Codes, und der anderen Abkürzungen wird auf die Erklärungen ("Guidance Notes on Codes and Abbreviations") am Anfang jeder regulären Ausgabe der PCT-Gazette verwiesen.

wird, zu schaffen, mit dem das Vernähen einer Kettenstichnaht in einfacher Weise und mit hoher Präzision auch bei hohen Nähgeschwindigkeiten sicherzustellen ist, wird vorgeschlagen, dass nach Nähtrichtungsumkehr im Stichrhythmus der Nähnadel die von der Nähnadel unterhalb der Stoffbahn gebildete Fadenschlinge vom Hauptgreifer aufgenommen wird, anschliessend die Fadenschlinge mittels eines synchron von der Nähmaschine angetriebenen Hilfsteiles auf den Hauptgreifer entgegen dessen Arbeitsrichtung aufgeschoben wird, nachfolgend mittels des Hilfsteiles der die Fadenschlinge bildende Nadelfaden unterhalb der Nähebene sant Greiferfaden mit Abstand von der Nadel und dem Hauptgreifer in Vorwärtsnährichtung vor diesen zusammengeführt und so gehalten wird so wie der zusammengeführte Fadenbereich in Vorwärtsnährichtung bewegt wird und ein Fadendreieck, gebildet aus dem die Schlinge bildenden Nadelfadenstrang, in dem parallel zum Hauptgreifer geführten Greiferfadenbereich und dem zum zusammengeführten Bereich führenden Greiferfadenbereich, aufgespannt wird, in welches die Nähnadel einsticht, nachfolgend mittels des Hilfsteiles das Fadendreieck bis zur Bildung der nächsten Fadenschlinge des Nadelfadens offen gehalten wird und etwa zeitgleich der zusammengeführte Fadenbereich vom Hilfsteil freigegeben wird.

METHOD AND DEVICE FOR MECHANICALLY SEWING A DOUBLE CHAIN STITCH SEAM

The invention concerns a method for mechanically sewing a double chain stitch seam, whereby the double chain stitch is produced by means of an industrial sewing machine with a sewing needle and needle thread as well as a main looper and looper thread, whereby the needle thread locks needle loops laid in a chain on the underside of the material being sewn, whereby during the stitch formation process the main looper which in particular moves at right angles to the direction of the seam, takes up the needle thread loop in the needle rise position of the sewing needle and carries the looper thread through the loop while the needle thread loop slides past the main looper, whereby the looper thread and the needle thread loop are formed into a thread triangle through which the needle passes at the next downstroke.

In industrial sewing of lengths of fabric or individual pieces of textile, particularly in sewing the seams, this same sewing process is used to produce a straight double chain stitch seam. The use of a double chain stitch is among other things advantageous, because it obviates the

need for a bottom spool and for spooling the looper thread. The thread guidance take place on the one hand by means of the sewing needle which carries the needle thread and passes through the sewing plane (the material being sewn) and forms a thread loop behind the sewing plane as the needle is withdrawn, whereby on the other hand a main looper is mounted below the sewing plane which carries the looper thread and threads it through the loop of the needle thread. When sewing in a straight seam direction the forming of the double chain stitch seam poses no problems. With conventional industrial sewing machines stitching speeds of more than 4,000, even more than 6,000 stitches per minute are achieved. This brings about that when sewing takes place in the direction of the seam, the transport alone of the material being sewn results in the formation of a thread triangle from the thread loop and the looper thread which the sewing needle perforates during the downstroke. This achieves the locking of the thread loops. Of course, if the thread triangle is not properly formed or not formed in the right position, faulty stitches occur which result in the seam coming undone. Such faulty stitches can e.g. occur when

the successive entry points of the needle are very close together, because then the area of the thread triangle is very small. If instead of a straight type of the double chain stitch seam, another type of seam, e.g. a zigzag seam, a cross seam or similar must be produced, it cannot be ensured with traditional devices that the thread triangle is formed in such a way that the needle at each subsequent downstroke perforates the area surrounded by the triangle. A particular problem is also the locking when a seam is being completed whereby sewing takes place against the direction of the seam. In such a case it is not possible to form a thread triangle through the transport of the material alone.

In the state of the art attempts have already been made to grab the threads underneath the sewing plane and to form a thread triangle with a looper finger to ensure locking. Such devices have not stood the test, because with automatic operation it was not possible to ensure proper sewing against the direction of the seam e.g. for completion of the seam. Also the mechanical stability of the relevant components was not adequate.

Furthermore there was considerable risk of thread breakage with such devices, particularly at high speeds. Additionally, there was a high incidence of faulty stitches with these devices so that they proved unsuitable.

From US-A-3 867 891 a multineedle double-chain stitching machine is known. With this known machine the object is to create a machine with which it is possible to stitch in a direction at a right angle to the direction movement of the loopers and specifically both to the right and the left. To achieve this a spreader with a spreader finger is provided there which engages the lower thread (looper thread) and, if the transport movement of the fabric or the like to be sown deviates from a rectilinear movement, deflects the looper thread to the side of the needle axis of the sewing needle away from the looper. With this machine the looper thread is therefore shifted sideways by means of the spreader to bring the looper thread behind the needle. This is disadvantageous, because only the looper thread is grabbed by the spreader so that there is a considerable risk of this thread breaking. A particular disadvantage of this design is that stitch formation can only happen in the transport direction and in directions at right angles to it in cases where the last formed stitch hole is not further forward than the next to be made.

This design does not make it possible to form stitches if e.g. for the purpose of finishing a seam, the sewing direction is reversed against the direction of the seam. Also in the case of stitches positioned closely together it is not possible to create a thread triangle of sufficient size for the needle to perforate and so avoid faulty stitches.

Against the background of these problems, the purpose of the invention is to create a method and a device of a similar type with which the locking of a double-chain stitch seam is ensured in a simple way and with great precision even at high sewing speeds, particularly if the seam does not run straight and if to finish the seam the sewing direction is reversed against the direction of the seam.

To meet this purpose the invention proposes that to avoid faulty stitches, a driven auxiliary component is used as a means to bring the needle thread loop and the looper thread together below the sewing plane in the area between the main looper and the sewing plane at a distance from the sewing needle and the main looper and that they are held and moved in such a

way that the thread triangle is formed which the sewing needle perforates at the downstroke.

The method proposed by the invention ensures that the thread triangle required for locking, which triangle the sewing needles perforates at the downstroke, is in every case formed and aligned so that the needle perforates the area enclosed within the thread triangle. With a normal straight seam the auxiliary component may not have a function or may even be turned off. If the stitches to be sewn are very close together, the thread triangle can be enlarged accordingly, because the forming of the triangle is not dependent on the amount of travel of the material, but depends solely on the movement of the auxiliary component. Proper locking is possible also for seams not running straight, e.g. a zigzag seam, a cross seam or the like, because here too the auxiliary component forms the thread triangle precisely in the area where the sewing needle enters at the downstroke.

Additionally it is preferably provided that for completion of the double chain stitch seam, the sewing direction is reversed, that after reversal of the sewing direction and synchronised with the up and down movement of the sewing needle, the thread loop formed by the sewing needle underneath the fabric is taken up by the main looper, then by means of the driven auxiliary component the needle thread forming the thread loop is brought together in the direction of the seam underneath the sewing plane with the looper thread at a distance from and in front of the needle and the main looper and is held there and the thread assembly is moved in the direction of the seam and a thread triangle, consisting of the needle thread forming the loop, the looper thread area parallel to the main looper and the looper thread area leading to the thread assembly area, is formed, which the sewing needle perforates and whereupon the thread assembly area is released by the auxiliary component.

This ensures that even when the sewing direction is reversed against the direction of the seam, e.g. for the completion of the seam, a thread triangle of suitable size is formed for the needle to perforate at the downstroke.

Preferably it is provided that the auxiliary component is driven synchronously with the sewing machine or with the stitching rhythm of the sewing needle.

In some cases it may also be provided that the auxiliary component is driven by the sewing machine.

The auxiliary component can e.g. be coupled to the drive of the sewing machine by means of a belt drive so that a common drive for both elements is sufficient.

However, it may preferably also be provided that the auxiliary component is driven by a separate drive.

There may thereby be provision for the auxiliary component to be driven by a servo drive.

Additionally it may hereby be provided that the separate drive is only activated when the auxiliary part must be in operation.

A separate drive makes it possible to use conventional sewing machines and operate them with the method as per invention without the need to rebuild or modify the sewing machine itself. Moreover the separate drive, particularly in the form of a servo drive, offers the

possibility of adapting the drive exactly to the particular seam production requirements or also of only activating the drive when operation of the auxiliary component is necessary.

Additionally it may preferably be provided that after take-up of the thread loop by the main looper, the auxiliary component then pushes the thread loop onto the main looper against the working direction of the looper.

This further improves the sewing certainty, because it prevents the thread loop from slipping off the main looper and moreover the pushing of the thread loop onto the main looper increases the area of the thread triangle.

Subject of the invention is further a device for the mechanical sewing of a double chain stitch seam, whereby the double chain stitch is formed with the aid of an industrial sewing machine with a sewing needle and needle thread and also a main looper and looper thread, whereby the needle thread locks needle loops laid in a chain on the underside of the material being sewn, whereby during the stitch formation process the main looper which in particular moves

at right angles to the direction of the seam, takes up the needle thread loop in the needle rise position of the sewing needle and carries the looper thread through the loop while the needle thread loop slides past the neck of the main looper, whereby the looper thread and the needle thread loop are formed into a thread triangle which the needle perforates at the next downstroke.

To meet the purpose mentioned above, it is proposed that to avoid faulty stitches, the thread needle loop and the looper thread are brought together underneath the sewing plane by a driven auxiliary component in the area between the main looper and the sewing plane at a distance from the sewing needle and the main looper and are held and moved in such a way that the thread triangle is formed which the needles perforates at the downstroke.

Preferred further developments thereof are set out in the sub-claims.

The design as per invention ensures that also for seams not running straight or in the case of a very short distance between the entry points of the sewing needle or also when sewing

against the direction of the seam, e.g. for completion of the seam, there is – even at high sewing speed - a simple and precise formation of the thread triangle which the sewing needle can perforate at the downstroke so that proper locking of the double chain stitch seam and also proper completion of the seam can be achieved.

In addition, the method and the design of the device as per invention result in gentle handling of the threads by the auxiliary component so that the risk of thread breakage is reduced to a minimum. If the auxiliary component is coupled to the drive of the sewing machine there is automatic synchronous movement of the elements so that a high seam precision is achieved. Particularly also when working on the seam against the actual direction of the seam, e.g. for its completion, early intervention in the sewing process guarantees suitable thread guidance.

In particular the method and device as per invention achieve that the intervention of the auxiliary part commences immediately at the take-up of the thread loop by the main looper and only ends at the release of the thread loop at a definite point in time when the locking of the double chain switch is complete. When considering a fully completed double chain stitch it is seen that the thread loop taken up spends more than 90% of the total time required to complete the stitch on the main looper. Within this period the thread loop assumes at certain times accurately predeterminable positions in order to correctly form the thread triangle and to guarantee correct locking without the production of faulty stitches which would lead to the seam coming undone. The fact that the auxiliary component has several functional surfaces and functional edges makes it possible, in concert with the kinetic sequence of the auxiliary part, to place the thread loop in defined time-related and spatial positions critical to the sewing process and to accurately position the thread triangle both in terms of size and location.

This ensures in particular that even under high-speed automatic operating conditions a double chain stitch seam, whether straight or otherwise, and also when the sewing direction is reversed, is produced.

The functional edge referred to in the claims can be of any design e.g. by angling a formed part. It may also be a smooth bar or the like with a groove or a similar element. What is only essential for its function is that the functional edge holds the needle thread and the looper thread together at one point so that through the motion of the auxiliary component the required thread triangle can be formed.

The invention is explained in more detail below with reference to the diagrams.

Illustrations:

Fig. 1 is a diagrammatic front view of the elements under discussion;

Figures 2 and 3 show a top view of the essential elements in different functional positions.

The illustrations only show the parts essential to the invention. The essential elements of the industrial sewing machine producing double chain stitches are the sewing needle 1 with a hole 2 at the needle tip to hold the needle thread 3 which is the top thread and a main looper 5 underneath the sewing plane 4 driven synchronously with the sewing needle 1 and whose working direction is indicated at 6. The sewing needle 1 carries out movements in the direction of arrow 7. The main looper 5 carries the looper thread 8 which exits at a hole 9 of the main looper. For the sake of simplicity the drawing does not show a needle plate or the like for supporting the length of fabric in the sewing plane 4, nor a possibly mounted presser which in the sewing plane 4 presses the fabric against the needle plate or against a possibly mounted fabric feed (also not shown).

While in Figure 1 the viewing direction of the illustration is oriented parallel to the transport direction of the material to be sewn in the sewing plane 4, the viewing direction in Figures 2 and 3 is orthogonal to the sewing plane 4 and, specifically, underneath the sewing plane 4.

The normal transport direction of the material to be sewn is indicated by an arrow at 10. This direction is the normal direction of the seam; whereas the opposite direction indicates a reversal of the direction of the seam. For the creation of a double chain stitch seam during sewing against the direction of the seam 10, an auxiliary component 11 becomes active (the method of operation will be explained below) which can be inactive during sewing in the direction of the seam 10, if the movement of the material to be sewn alone is sufficient to form the thread triangle which will be described later.

Figures 2 and 3 show the thread triangle formed by the looper thread 8 and the loop of the needle thread 3, which triangle is perforated by the needle 1 with the continuous needle thread 3.During sewing in the direction of the seam 10 this thread triangle is formed independently by the fabric transport alone so that the perforation of the descending needle 1 in the area surrounded by the thread triangle automatically takes place correctly.

In the case of deviations from the direction of the seam 10, especially also during sewing against the direction of the seam 10, the auxiliary component 11 ensures that the thread triangle is set up in such a way that the area enclosed by the triangle is hit by the needle 1 at the downstroke. The auxiliary component is shown in various positions, i.e. in the operating positions I to IV, whereby the auxiliary component 11 executes a movement deviating from the circular, curving, self-contained, beginning from Position I via Position II to Position III and then to Position IV and then back to Position I.

When sewing in a direction other than the direction of the seam 10, in particular also when sewing against the direction of the seam 10, the main looper 5 takes up the thread loop of the needle thread 3 formed by the sewing needle 1 as is shown particularly in Figure 1. Hereby the main looper 5 moves at right angles to the direction of the seam 10 in the direction of the arrow 6. In this position the auxiliary component 11 moves from Position I to Position II (as shown in Figures 1 and 2) so that with the first functional surface 12, e.g. an edge, the needle thread 3 forming the loop is taken up and pushed onto the main looper 5

against its working direction and is held to prevent the loop from slipping off the main looper 5 and to form a sufficiently large thread triangle. This happens by a relatively fast movement of the auxiliary component 11 against the working direction 6 of the main looper 5 from Position I to Position II.

To prepare the needle thread 3 and the looper thread 8 for the formation of the thread triangle, the auxiliary component 11 is then shifted from Position II to Position III until the needle thread 3 and the looper thread 8 reach the edge 13, e.g. a corner area, an angular area or rounded corner area of the auxiliary component 11 and are held there. In this way a thread triangle is formed between the area of the needle thread loop held on the main looper 5, the free looper thread 8 and the main looper 5, which triangle is perforated by the sewing needle 1 at the downstroke. The needle thread 3 and the looper thread 8 are carried on the corner area 13 until the sewing needle has securely perforated the thread triangle.

The second functional surface 14, e.g. an edge, takes the thread assembly area down from

the main looper 5, whereby the thread triangle as its area decreases remains open until the next loop formation by the needle thread 3 begins. By fast withdrawal of the functional surface 14 the locked stitch can slip off the looper 5 and the sewing process can start anew. This is clarified by the illustration in Fig. 3, Position IV, from which position the auxiliary component 11 resumes Position I.

The main looper 5 thereby moves back again to its initial position against the working direction 6. In the embodiment the auxiliary component 11 is represented by an L-shaped angle. The cross-section of the shanks is preferably round to exclude damage to the threads. The shape of the auxiliary component 11 is, however, not necessarily L-shaped, but any shape is possible as long as at least the corresponding functional surfaces and functional edges are retained. The actuation of the auxiliary component can be through a separate drive. However, actuation can also be by means of an eccentric drive, whereby through the eccentric design the retarded and accelerated movements of the auxiliary component 11 are easy to realise.

It is of course also possible to couple the auxiliary component to the drive of the sewing machine so that synchronization follows automatically.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. Method for mechanically sewing a double chain stitch seam, whereby the double chain stitch is produced by means of an industrial sewing machine with a sewing needle (1) and needle thread (3) as well as a main looper (5) and looper thread (8), whereby the needle thread (3) locks needle loops laid in a chain on the underside of the material being sewn, whereby during the stitch formation process the main looper (5) which in particular moves at right angles to the direction of the seam (10), takes up the needle thread loop in the needle rise position of the sewing needle (1) and carries the looper thread (8) through the loop while the needle thread loop slides past the neck of the main looper (5), whereby the looper thread (8) and the needle thread loop are formed into a thread triangle through which the needle (1) passes at the next downstroke, **characterised by the fact that** to prevent faulty stitches a driven auxiliary component (11) is used by which the needle thread loop and the looper thread(8) are brought together underneath the sewing plane (4) in the area between main looper (5) and sewing plane (4) at a distance from the sewing needle(1) and the main looper (5) and are held and moved there in such a way that the thread triangle is formed in the direction of the seam (10), which triangle is perforated by the sewing needle (1) at the downstroke.

2. Method as per claim 1, **characterised by the fact that** for finishing the double chain stitch seam the sewing direction is reversed against the direction of the seam (10), that after reversal of the sewing direction in the stitching rhythm of the up and down moving sewing needle (1), the thread loop formed by the sewing needle (1) underneath the fabric is taken up by the main looper (5), then by means of the driven auxiliary component (11) the needle thread (3) forming the thread loop is brought together in the direction of the seam (10) underneath the sewing plane (4) with the looper thread (8) at a distance from and in front of the needle (1) and the main looper (5) and is held there and the thread assembly area is moved in the direction of the seam (10) and a thread triangle consisting of the needle thread (3) forming the loop, the looper thread area parallel to the main looper (5) and the looper thread leading to the assembly area, is formed which the sewing needle (1) perforates and whereupon the thread assembly area is released by the auxiliary component (11).

3. Method as per claim 1 or 2, **characterised by the fact that** the auxiliary component (11) is driven synchronously with the sewing machine or with the stitching rhythm of the sewing needle (1).

4. Method as per one of the claims 1 to 3, **characterised by the fact that** the auxiliary component (11) is driven by the sewing machine.

5. Method as per one of the claims 1 to 3, **characterised by the fact that** the auxiliary component (11) is driven by a separate drive.

6. Method as per Claim 5, **characterised by the fact that** the auxiliary component (11) is driven by a servo drive.

7. Method as per one of the claims 5 or 6, **characterised by the fact that** the separate drive is only activated when the auxiliary component (11) must be in operation.

8. Method as per one of the claims 1 to 7, **characterised by the fact that** after take-up of the thread loop by the main looper (5), the auxiliary component (11) then pushes the thread loop onto the main looper (5) against the working direction of the looper.

9. Device for mechanically sewing a double chain stitch seam with an industrial sewing machine with a driving motor, with a sewing needle (1) which moves up and down and on which the needle thread (3) is carried, a main looper (5) underneath the sewing plane (4) and carrying the looper thread (8), whereby the double chain stitch is produced in such a way that the needle thread (3) locks thread loops laid in a chain on the underside of the material to be sewn, whereby in the course of the stitch formation process the main looper (5) takes up the needle thread loop in the needle rise position of the sewing needle (1) and carries the looper thread (8) through the loop, whereby by means of the looper thread (8) and the needle thread loop a thread triangle is formed which is the entry area for the sewing needle (1) at the downstroke, **characterised by the fact that** to prevent faulty stitches an auxiliary component (11) is provided which is arranged movable underneath the sewing plane (4) and has functional areas or edges by means of which, after the main looper (5) has taken up the thread loop formed underneath the sewing plane by the sewing needle (1), on one functional edge (13) the needle thread (3) and the looper thread (8) are held together at one point situated in the direction of the seam (10) before the next entry point of the sewing needle (1) so that between the loop of the needle thread (3) which is on the main looper (5) and the looper thread (8) as well as the point (at 13) a thread triangle is formed which the sewing needle (1) perforates.

10. Device as per claim 9, **characterised by the fact that** the auxiliary component (11) is rigidly mounted.

11. Device as per one of the claims 9 or 10, **characterised by the fact that** the auxiliary component (11) is driven synchronously with the sewing machine or the stitching rhythm of the sewing needle.

12. Device as per one of the claims 9 to 11, **characterised by the fact that** the auxiliary component (11) is movable parallel to the sewing plane (4) around an axis oriented vertically to the sewing plane (4).

13. Device as per one of the claims 9 to 12, **characterised by the fact that** the auxiliary component (11) is movable by means of an eccentric drive.

14. Device as per one of the claims 9 to 13, **characterised by the fact that** the auxiliary component (11) is coupled to the drive motor of the sewing machine and is driven by it.

15. Device as per one of the claims 9 to 13, **characterised by the fact that** the auxiliary component (11) is driven by a separate drive.

16. Device as per claim 15, **characterised by the fact that** the auxiliary component (11) is driven by a servo drive.

17. Device as per one of the claims 9 to 16, **characterised by the fact that** the auxiliary component (11) has a first functional surface (12) or a first functional ridge by means of which the needle thread (3) and the loop formed by the needle thread (3) positioned on the main looper (5) are held on the main looper (5) and cannot slip off.

18. Device as per one of the claims 9 to 17, **characterised by the fact that** the needle thread (3) and the looper thread (8) are held together at a point situated in the direction of the seam (10) in front of the axis of rotation of the sewing needle (1).

19. Device as per one of the claims 9 to 18, **characterised by the fact that** that a second functional surface (14) or a second functional ridge is provided on the auxiliary component (11) which adjoins the functional edge (13) on which the needle thread (3) and looper thread (8), previously brought together, are carried until the stitch is completed.

20. Device as per one of the claims 9 to 19, **characterised by the fact that** the second functional surface (14) releases the needle thread (3) and looper thread (8), previously brought together, once the stitch is completed.

21. Device as per one of the claims 9 to 20, **characterised by the fact that** the auxiliary component (11) basically has two shanks which lie in one plane and run parallel to the sewing plane (4) and form the first and second functional surfaces (12, 14) and enclose a corner area forming the functional edge (13).

Dated this 30th day of December 2003
SCHMALE-HOLDING GMH & CO
By their Patent Attorneys
COLLISON & CO

Fig. 1

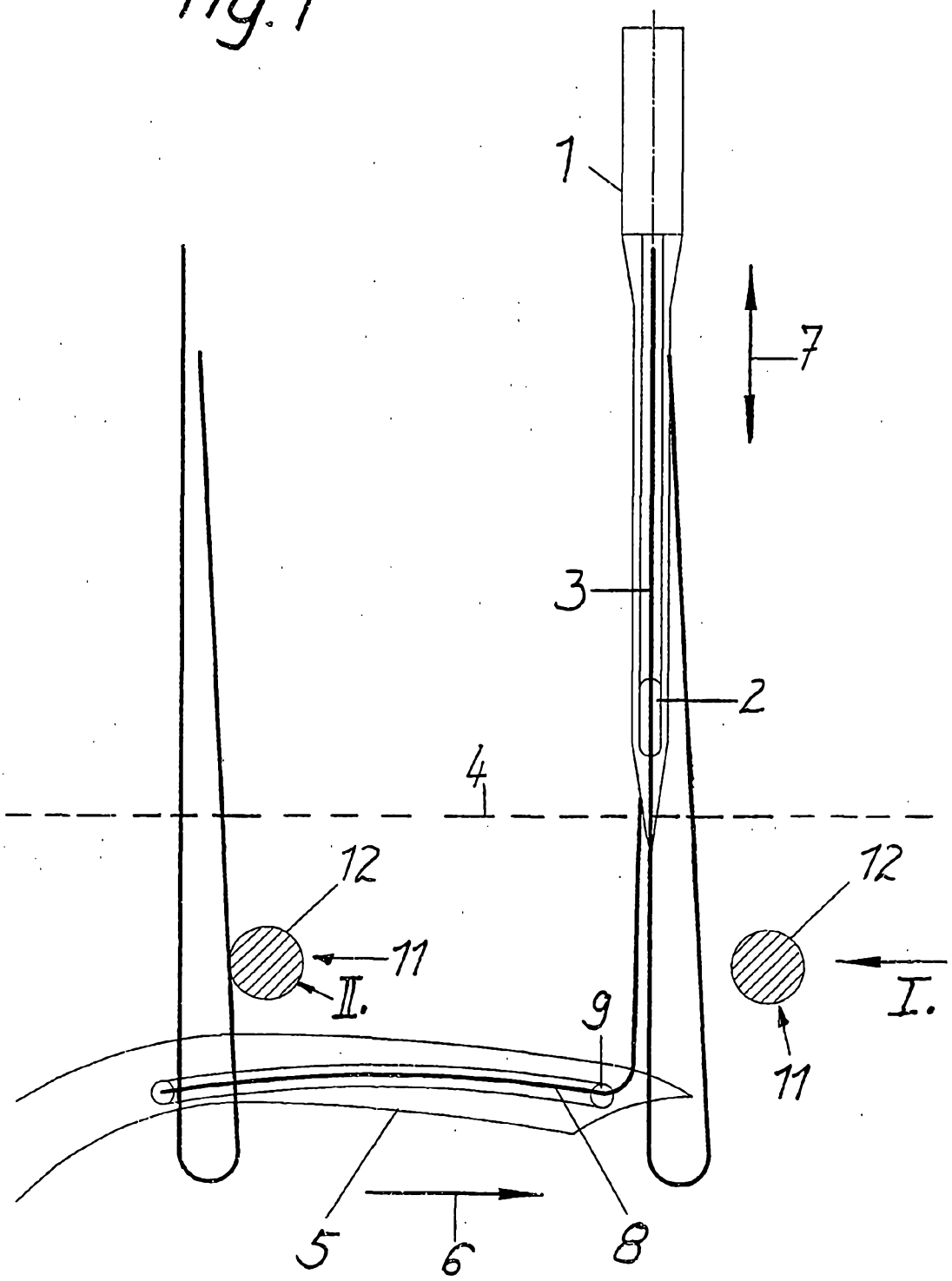

Fig. 2

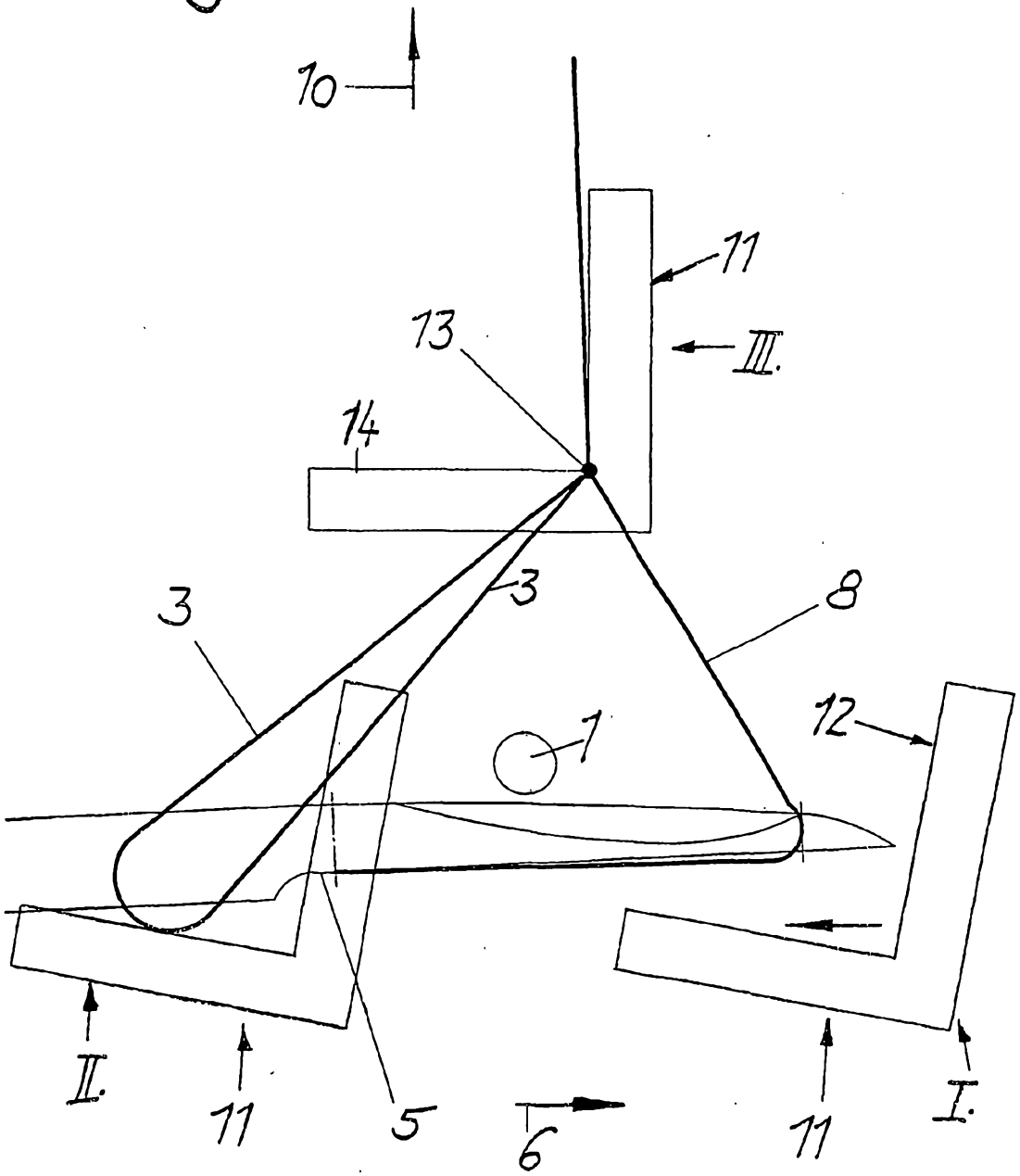

Fig. 3