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(54) BUTTONHOLE-SEWING MACHINE

(71) I, GÜNTER TÖLLE, a Citizen of the German Federal Republic, of Wendelinusstrasse 15, 7520 Bruchsal 4, German Federal Republic, do hereby declare the

invention for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:–

The invention relates to buttonhole-sewing machines.

Buttonhole-sewing machines are usually equipped with a thread-monitoring device which, in the event of the thread's breakage, not only brings the machine's main shaft to rest but also prevents cutting of the unfinished buttonhole by the buttonhole-cutting apparatus. If the thread breaks the unfinished buttonhole is subsequently completely resewn, care must be taken that the seam of the buttonhole overlaps the previous, unfinished seam of the buttonhole. In order here to be able to retain unaltered, even during the second sewing operation, the relative position of the work material to the work clamp, which position is determined by the first sewing operation, known devices are so designed that when the machine's main shaft is brought to rest by a thread breakage the work clamp is not opened. This is easily possible in sewing machines whose loop takers are arranged below the needle plate and whose needles are arranged above the needle plate, since the loop taker is always accessible irrespective of the position of the work clamp and the closure of the work clamp does not hinder the threading of the needle.

The situation is different in a sewing machine whose loop taker is disposed above the needle plate and whose needle is disposed below the needle plate. In such a machine the work clamp's lower part or jaw serves as a needle plate, and by remaining in its closed position, prevents free access to the needle's eye. It is possible to thread the needle, when the work clamp is closed, only by auxiliary implements, for example a pair of tweezers.

According to the invention, in a buttonhole-sewing machine which has a stationary base, an arm provided with a loop taker, which arm is pivotally mounted on the base and is movable from a lockable sewing position into a rest position remote from the stitch-formation point, said loop taker cooperating with a needle which is guided in the base and pierces the work material from below, a buttonhole-cutting apparatus, a thread-monitoring device and a shiftable work clamp which has a lower jaw, which has a resilient support in the base, and an upper jaw against which the arm is applied in the sewing position thereof, there is provided a detent which is engageable with said support and is releasable therefrom in response to the detection, by the said monitoring device, of the thread's breakage to allow the support to urge the jaws together if the clamp is raised after the said breakage.

In preferred embodiments of the invention the lower jaw remains in a horizontal position during the ordinary production of a buttonhole, the work clamp being opened when the loop-taker arm or clamp upper part moves upwards. If the buttonhole is not properly finished, i.e. the thread-monitoring device has been actuated, the detent limiting the vertical movement of the support is released. The lower jaw is moved upwards by the resilient support synchronously with the upper jaw when the loop-taker arm or upper jaw is moving upwards so that the eye of the lowered needle may be exposed but the grip of the clamp may be maintained.

Actuation of the detent need not require an additional control.

The detent may be released in response to movement of the clamp and may be returned into its operative position as a function of the movement of the buttonhole cutter. In this way the detent is in fact released during the sewing operation, but the loop-taker arm, when moved into the sewing position, prevents any upward movement of the clamp. If at the end of the sewing operation the operating movement of the cutter of the buttonhole-cutting device stops, the detent released by the

work clamp remains in its inoperative position and permits upward movement of the clamp.

The detent may be a slide bar which can move into an indentation in a stud forming the support, which slide bar has an extension projecting into the movement path of the work clamp and is connected with the drive of the buttonhole cutter *via* a drive connection operating with idle stroke.

Since the slide bar, both in its operative position and in its rest position, is not rigidly connected to its drive means which determines its particular position and it could move independently of its drive means after reaching the particular position, the slide bar can be locked both in its operating position and in its rest position.

One embodiment of the invention will now be described with reference to the accompanying drawings, in which:

Figure 1 shows a general view of the sewing machine with the work clamp raised in the closed position;

Figure 2 shows a diagrammatic illustration of the work clamp; and

Figure 3 shows a top view of a part of the work clamp.

The drawings illustrate a buttonhole-sewing machine which has a stationary base 1 and an arm 2 pivotally connected thereto. The arm is mounted on a pivot 3 secured in the base 1. For moving the arm 2 from its sewing position into its rest position remote from the stitch-formation point, the arm is joined, laterally of the pivot 3 to the armature of a bilaterally acting electromagnet 4 which can be locked in its two end positions, so that both the sewing position and rest position of the arm 2 are determined thereby. It would also be possible to lock the arm 2 in its two positions additionally by corresponding detents or latches.

In the base 1 of the sewing machine there is mounted a main shaft 5 which carries a pulley 6 driven by a stepping motor (not shown). At the free end of the main shaft 5 there is a crank 7 which drives *via* a link 8 and a connecting member 9 the needle bar 11 carrying a thread-carrying needle 10. The needle 10 thus pierces the work material from the bottom upwards and cooperates with a loop taker 12 which is mounted at the front end of the arm 2.

For driving the loop taker 12 there is fastened on the main shaft 5 a pulley 13 which drives, *via* a toothed belt 14 and counterpulley 15, a shaft 16 mounted in the arm 2. The shaft 16 in turn imparts rotary motion to a vertically disposed shaft 18 through a pair of bevel gears 17. The shaft 18 is in drive connection, through a further pair of bevel gears 19, with the shaft 20 of the loop taker 12, which is thus driven *via* the aforementioned transmission in the ratio 2:1 relative to the needle's motion.

For receiving the work material, the sewing machine has a work clamp 21 constituted by an upper jaw 22 and a lower jaw 23.

The upper jaw 22 is held by a bearing block 24 mounted on the lower jaw 23 and can pivot about a horizontal spindle 25 extending obliquely to the machine's main shaft 5. At the front end of the jaw 22 there is mounted a pressure foot 26 pressing the work material against the lower jaw 23. The foot 26 has an opening 27 for the passage of the needle 10 and of a buttonhole cutter which will be described in more detail later. The front end of the upper jaw 22 is also provided with a pressure track 28 extending parallel to the work-material's feed direction, a pressure wheel 29 rolling along said track. The pressure wheel 29 is mounted freely rotatably at the bifurcated lower end of a guide rod 30 which is slidably accommodated inside a sleeve 31 secured to the arm 2. At its lower end the guide rod 30 is provided with a dog 32 which engages under the pressure track 28. The guide rod 30 carries a pin 33 extending perpendicular to the rod's longitudinal axis. This pin slides in a slot 34 of the sleeve 31. The slot extends parallel to the longitudinal axis of the rod and limits the longitudinal movement thereof. A spring 35 disposed between the sleeve 31 and the lower end of the guide rod biasses the upper jaw 22 to the lower position thereof.

The lower jaw 23, as shown most clearly in Figure 2, is formed by a cover plate 38, a carrier plate 39, an intermediate plate 40 and a base plate 41. The base plate 41 is pivotably mounted on the base 1 by means of a pivot 42 and abuts, in the zone of the stitch-formation point, a support 43 shiftably arranged in the base 1. The support 43 is constituted by a stud 44 which is shiftably mounted inside a guide bush 45 secured to the base 1 and which is urged upwards by means of a spring 46. The rate of the spring 46 is in this example greater than that of the spring 35. In place of the spring 46, the guide bush 45 could be provided with a compressed-air connection so as to form a pneumatic cushion below the stud 44.

The stud 44 is provided with an indentation 47 in which one end of a slide bar 49 acting as a detent 48 engages, when the arm 2 is in the sewing position, said slide bar protruding through an opening 50 in the guide bush 45. The slide bar 49 is guided longitudinally inside a guide 51 and has two notches 52, 53 in which a spring-loaded ball 54 of the guide 51 engages and locks the slide bar in one or other of its two end positions.

When the arm 2 is in the sewing position, the vertical position of both the work clamp

21 and the stud 44 may vary according to the thickness of the work. The height of the indentation 47 in the stud 44 exceeds, by a specific amount, the thickness of the slide bar 49 to ensure that the slide bar 49 can engage the indentation 47 notwithstanding the particular thickness of the work material, when the arm 2 is in the sewing position.

At its other end the slide bar 49 is provided with a transverse channel 55 which accommodates, and is wider than an arm 56 of a bell crank 57 mounted in the base 1. A pin 60 engages an elongated slot 59 provided in the arm 58 of the crank 57, said pin being carried by an arm 61 which is connected at its upper end *via* a link 62 to the cutter bar 63 of a buttonhole-cutting device. The cutter bar 63, which is substantially U-shaped, is pivotably mounted in the base 1 and carries at its free end a buttonhole-cutter 64 of any suitable design. The bottom end of the arm 61 is connected *via* a clevis 65 to the traction rod of an electromagnet 66. At the conclusion of one stitch-formation cycle, a cam of a programme-control unit (not shown) completes the circuit of the electromagnet 66 at a first interruption point, so that said electromagnet imparts a cutting motion to the buttonhole-cutter 64 against the force of a spring 67 surrounding its traction rod. In the circuit of the electromagnet 66 there is provided another contact (likewise not shown) which interrupts the circuit of the electromagnet 66 at a second interruption point and is controlled by a thread-monitoring device 68 disposed in the vicinity of the needle 10. Here the design is such that the circuit of the electromagnet remains incompleted if the thread-monitoring device 68 detects a breakage. Thus, if a buttonhole's seam is not regularly finished, any movement of the buttonhole-cutter 64 and, accordingly, any further cutting of the buttonhole are prevented.

The slide bar 49 is provided with an extension 69 which protrudes into the path of movement of a bar 70 which is fastened to the work-carrier plate 39 of the lower jaw 23. The base plate 41 is provided with two guideways 71, 72 extending parallel to the machine's main shaft 5, a roller 73 and a slider 74 being shiftably arranged in said guideways. Both the slider 74 and the roller 73, which is rotatable about a vertical pivot 75, are firmly connected to the intermediate plate 40 of the lower jaw 23, which plate is thereby guided in the base plate 41. The intermediate plate 40 has a guideway 76 extending at an oblique angle to the guideways 71, 72. Through the guideway 76 penetrates a stud 77 on the carrier plate 39. The stud's lower end projects into a guideway 78 in the base plate 41. The guideway 78 likewise extends obliquely to said angled guideway 76 in the intermediate plate. By the arrangement of the two oblique guideways 76, 78 in the intermediate plate 40 and base plate 41 respectively, the stud 77 is shifted inside the guideway 78 of the base plate 41 in the course of a sliding movement of the intermediate plate 40 along the guideways 71 and 72 and the work-carrier plate 39 is moved parallel to the guideway 78 in the base plate 41. In order to avoid lifting of the work-carrier plate 39 or of the stud 77, this latter is provided at its lower end with a lateral flange which slides inside an undercut groove 79 in the guideway 78 of the base plate 41. For accurate parallel guidance of the work-carrier plate 39, in the vicinity of the front end of the base plate 41 a guide roller 80 is arranged on a pivot 81 mounted in the base plate 41. This roller projects into a guide slot 82 which extends, in the plate 39, parallel to the guideway 78 in the base plate 41.

The work-carrier plate 39 is firmly connected to the cover plate 38 so as to receive the work material. For the support thereof, two support rollers 84, each rotatable about a horizontal spindle 83, are provided in the vicinity of the front end of the base plate 41. The work-carrier plate 39 is supported directly on one of the support rollers and *via* the cover plate 38 on the other. As is also evident from Figure 2, the base plate 41 is provided in the region of its front end with an insert operating as a needle plate 85, which insert has an elongate slot 86 for the buttonhole-cutter 64 and a needle hole 87 for the passage of the needle 10, and projects into an opening 88 in the cover plate 38 covering the work-carrier plate 39.

The slider 74, secured to the intermediate plate 40 and having substantially U-shaped cross-section with outwardly bent arms engaging under the base plate 41, serves to accommodate a foot 89 which forms part of a coupling 91 disposed between a stepping drive mechanism 90 and the work clamp 21. The foot 89, which is pivotably mounted on a pin 92 held by the slider 74, is closely embraced by a shoe 94 which has a recess 93, complementary to the foot. The shoe 94 is firmly connected to a rod 95. The rod 95 is disposed parallel to the machine's main shaft 5 and is accommodated inside a hollow threaded spindle 96. At the free end of the rod is an adjustable nut 97. A spring 98 disposed between the nut 97 and the end of the threaded spindle 96, maintains the foot 89 in frictional engagement with the shoe 94. Accordingly, the slider 74 is applied frictionally against an angle bracket 99. The bracket is connected with the threaded spindle 96 which, in turn, is surrounded by a threaded nut 100 arranged rotatably in the base 1 but secured axially and is moved to and fro according to the direction of rota-

tion of the threaded nut 100. A pulley 101 is mounted on the threaded nut 100, which pulley cooperates with the stepping drive mechanism 90 *via* a toothed belt 103 guided by way of an idler pulley 102. The stepping drive mechanism 90 further comprises two cams 104, 105 mounted on the main shaft 5 and (in accordance with known practice) imparting to a jockey 106 oscillating feed motion and clamping motion respectively, whereby the motion derived from the feed cam 104 is transmitted *via* the toothed belt 103 as intermittent rotary motion to the threaded nut 100. Reference may be made to Specification No. 1 425 185 for further details, which form no part of the present invention.

The mode of operation of the sewing machine is as follows: Firstly it is assumed that the arm 2 is occupying its rest position remote from the stitch-formation point and the work material is positioned on the cover plate 38 of the lower jaw 23. During the insertion operation the lower jaw 23 occupies an almost horizontal position, in which case the base plate 41 rests on the support 43 formed by the stud 44 and the slide bar 49 projects into the indentation 47 of the stud 44. The dog 32 provided at the lower end of the guide rod 30 engages under the pressure track 28, in which case the pin 33 is applied against the lower end of the slot 34, when the spring 35 is relaxed. The upper jaw 22 is retained in its raised position, whereas the lower jaw 23 rests loosely on the stud 44 whose vertical mobility is limited by the slide bar 49 which, in turn, is held in its operative position by the ball 51 engaged in the notch 53.

The electromagnet 4 is energised in order to transfer the arm 2 from its rest position into the sewing position, so that the arm 2 carries out a pivotal movement about the pivot 3. The upper jaw 22 is moved downwards synchronously with the arm and in doing so pivots about the spindle 25. As soon as the presser foot 26 bears on the work material, because the spring 35 has a lesser rate than the spring 46, the arm 2 is displaced relative to the guide rod 30, in which case the pressure wheel 29 bears on the pressure track 28 and the spring 35 is compressed. The guide rod 30 is moved upwards in the sleeve 31 until the pin 33, which prevents it from rotating, reaches the upper limit of the slot 34. The arm 2 and upper jaw 22 now form a rigid unit, so that during the continuation of the descending movement of the arm 2 the spring 46 is compressed until the arm 2 has reached its sewing position set by the end position of the electromagnet 4, wherein there is ensured mutual coordination of the needle 10 or needle stroke and loop taker 12. Since the lower jaw 23 also carries the needle plate 85, this latter is pressed downwards to a greater or lesser extent according to the thickness of the work material. Accordingly, variation in the work material thickness is compensated by the vertical position of the needle plate or of the lower jaw 23 holding said plate, so that the distance from the upper side of the work material to the loop taker 12 or to the needle eye is kept constant for any particular needle setting. Accordingly, the length of the needle thread loop formed between the needle eye and the work material surface is kept constant irrespective of the thickness of the work material.

Because the height of the indentation 47 in the stud 44 exceeds the thickness of the slide bar 49, the stud 44 can execute such movement inside its guide bush 45 as may be necessary for compensating the work material's thickness, even when the slide bar 49 engages the indentation 47.

For the formation of the buttonhole seam, the loop taker 12 and needle 10, which pierces the work material from the bottom upwards, are driven *via* the illustrated drive means. The pressure wheel 29 rolls along the pressure track 28 so that the clamping pressure applied by the compressed spring 46 is exerted between the jaws 22 and 23. An intermittent rotational movement is transmitted from the two cams 104, 105 of the stepping drive mechanism *via* the jockey 106 and the toothed belt 103 to the pulley 101 firmly connected to the threaded nut 100. The threaded spindle 96, arranged so as to be incapable of independent rotation, is displaced in the direction corresponding to the direction of rotation of the threaded nut 100 and moves the carrier 99 connected thereto parallel to its axis. The carrier 99 is thus applied against the end face of the slider 74 and imparts thereto a longitudinal movement. The intermediate plate 40, which is guided in the guideways 71, 72 by means of the guide roller 73 and slider 74 respectively, thus carries out a longitudinal movement, whereupon the stud 77 is displaced inside the angled guideway 76 of the intermediate plate 40 and is thus moved simultaneously along the angled guideway 78 provided in the base plate 41. Because the work-carrier plate 39 is securely connected with the stud 77, said plate carries out a sliding movement predetermined by the position of this angled guideway 78 and is thus additionally guided by the guide roller 80 carried by the base plate 41 and projecting into its guide slot 82.

The bar 70 fastened to the work-carrier plate 39 of the lower jaw 23 participates in the movement of the work clamp 21 and, accordingly, moves along the work material feed line *a* in Figure 3. The extension 69 of the slide bar 49 projecting into its path of

movement is hereby moved along the line *b* extending parallel to the guide path of the slide bar 49, whereby the extension 69 of the slide bar 49 is forced out of the movement path of the bar 70 of the work clamp 21 and, accordingly, the end of the slide bar 49 is moved out of the indentation 47 in the stud 44, so that the detent 48 occupies its inoperative position which is maintained by the ball 54 engaging in the notch 52. Because the channel 55 in the slide bar 49 is wider than the arm 56 of the crank 57, the crank 57 remains in its starting position during the movement of the slide bar 49.

After the sewing of the first buttonhole stitching and of the corresponding overstitching, the motion to be transmitted from the jockey 106 to the toothed belt is reversed by suitable means, which are not shown in any detail, so that the threaded nut 100 is driven contrary to its original direction of rotation. Since the slider 74 is applied, *via* the shaped foot 89 pivotably mounted thereon and *via* the shoe 94 acted upon by the spring 98, frictionally against the carrier 99 securely connected to the threaded spindle 96, the reversal of the direction of movement of the work clamp 21 takes place entirely without lost motion.

At the end of the sewing operation the sewing machine is stopped with the needle 10 in the lowered position. If, during the formation of the buttonhole seam, the thread-monitoring device 68 is not actuated, the buttonhole seam is finished normally. The circuit of the electromagnet 66 is accordingly completed at the second interruption point interrupted by the thread-monitoring device 68. The cam of the programme-control unit completes the circuit of the magnet at its first interruption point, whereby the magnet 66 is energised and the arm 61 is moved downwards. The cutter bar 63 is actuated thereby and the button hole is cut out. As a result of the downward movement of the arm 61, the crank 57 is swung out and its arm moves the slide bar 49 to the left (in relation to Figure 1). The end of the slide bar 49 thereby engages in the indentation 47 of the stud 44. Subsequently, the electromagnet 4 is energised which transfers the arm 2 from the sewing position into the rest position. As the arm 2 moves upwards, the spring 46 applying the clamping pressure between the upper and lower jaws is firstly relaxed to some extent, whereby the work clamp 21 carries out a pivotal movement about the pivot 42 and the lower jaw 23 is transferred from its sewing position into the charging position located somewhat above the horizontal. As soon as the end of the slide bar 49 abuts the lower boundary edge of the indentation 47, the spring 35 relaxes during the continuation of the pivoting motion of the arm 2. This has the effect that the upper jaw 22 remains resting on the work material, as the arm 2 continues to move upwards, until such time as the pin 33 of the guide rod 30 is located in the region of the bottom end of the slot 34 provided in the appendage 31. Only at the termination of this relative movement between the arm 2 and the upper jaw 22 (which movement is brought about by the idle stroke of the drive connection between the arm 2 and work clamp 21) does the guide rod 30 situated in its lower position entrain the clamp top part 22 upwards by way of the dog 32 engaging under the pressure track 28, thereby opening the clamp. The arm 2 continues its pivotal motion about the pivot 3 until it reaches its rest position, whereupon the upper jaw 22 effects a pivotal movement about the spindle 25 and is held in the rest position of the arm 2 by the dog 32 engaging under the pressure track 28.

If the needle thread is broken during the formation of the buttonhole seam, the thread-monitoring device 68 is actuated and, accordingly, it interrupts the circuit of the electromagnet 66 at its second interruption point. Although at the conclusion of the sewing cycle the circuit of the electromagnet 66 is completed by the cam of the programme-control unit at the first interruption point, the magnet 66 remains de-energised, however, so that the buttonhole-cutter 64 is inoperative. Since the slide bar 49 is transferred from its locking position into an inoperative position by the work clamp 21 at the beginning of the sewing operation, said bar remains in the position shown in Figure 1 while the lever 61 is stationary. Upon subsequent energising of the electromagnet 4, the arm 2 is transferred from the sewing position into the rest position. During upward movement of the arm both the lower jaw 23 and the upper jaw 22 follow the arm movement. The stud 44 is moved upwards when the spring 46 relaxes and said stud follows the upward movement of the arm 2 as far as its rest position. In its end position, predetermined by the rest position of the arm 2, a residual stress is still present in the spring 46 ensuring the clamping position between the upper jaw 22 and lower jaw 23. The stud 44 and the work clamp 21 together with the base plate 41 occupy, at the termination of the upward movement of the arm 2, the position illustrated in Figure 1, in which the needle 10 in its lowered position is completely exposed, but the clamping position is still maintained between the jaws 22 and 23.

If the needle 10 has to be exposed for threading or replacement, with the arm 2 in the rest position, it is possible for the work clamp 21 to be pivoted about the pivot 42 independently of the arm 2. The slider 74

securely connected to the intermediate plate 40 thus takes part in the pivotal movement, whereas the shoe 94 connected to the rod 95 retains its position. During the relative movement between the slider 74 and shoe 94, the foot 89 pivots on the pin 92 and alters its position relative to the recess 93 in the shoe 94. Since, however, the shoe 94 is held by the spring 98 in frictional engagement with the foot 89, there is restored unaltered and without play the drive connection between the stepping drive mechanism 90 and the work clamp 21, once this latter has regained its starting position.

Because, when a buttonhole's seam is normally finished, the slide bar 49 forming the detent 48 engages the indentation 47 of the stud 44 and that the detent 48 is held in position by the ball 54 engaged in the notch 53, the stud 44 remains in the position predetermined by the detent if the work clamp 21 is raised by hand.

WHAT I CLAIM IS:–

1. Buttonhole-sewing machine having a stationary base, an arm provided with a loop taker, which arm is pivotally mounted on the base and is movable from a lockable sewing position into a rest position remote from the stitch-formation point, said loop taker cooperating with a needle guided in the base and piercing the work material from the bottom upwards, and also having a buttonhole-cutting apparatus, a thread-monitoring device and a shiftable work clamp which has a lower jaw, which has a resilient support in the base, and an upper jaw against which the arm is applied when this latter is in its sewing position, wherein there is provided a detent which is engageable with said support and is releasable therefrom in response to the detection, by the said monitoring device, of the thread's breakage to allow the support to urge the jaws together if the clamp is raised after the said breakage.

2. Buttonhole-sewing machine according to claim 1 in which the detent can be released as a function of the movement of the work clamp and can be returned into its operative position as a function of the movement of the buttonhole cutter.

3. Buttonhole-sewing machine according to claim 1 or claim 2 in which the detent is a slide bar which can move into an indentation in a stud forming the support, which slide bar has an extension projecting into the path of movement of the work clamp and is connected to the drive of the buttonhole-cutter via a lost motion drive connection.

4. Buttonhole-sewing machine according to claim 3 in which the slide bar can be locked in its operative position and in its rest position.

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1 SHEET This drawing is a reproduction of the Original on a reduced scale

Fig.1

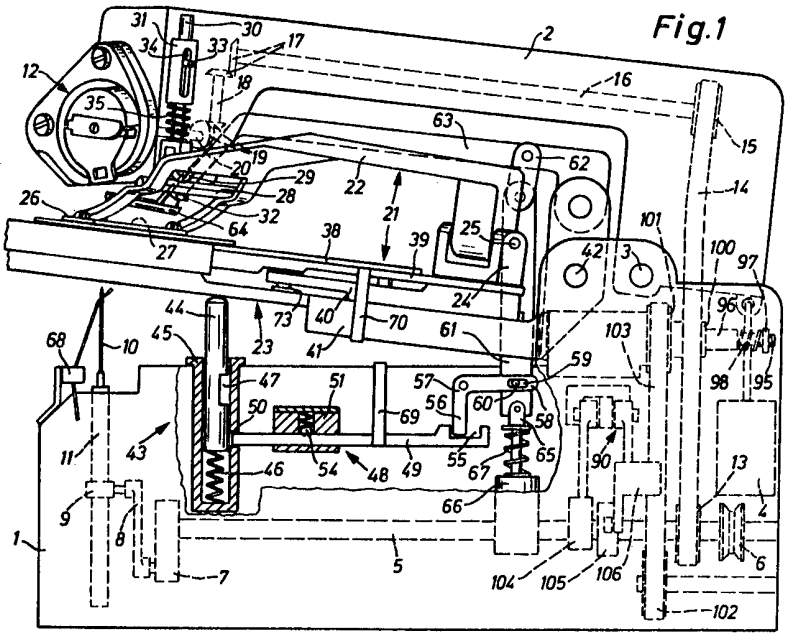

Fig.2

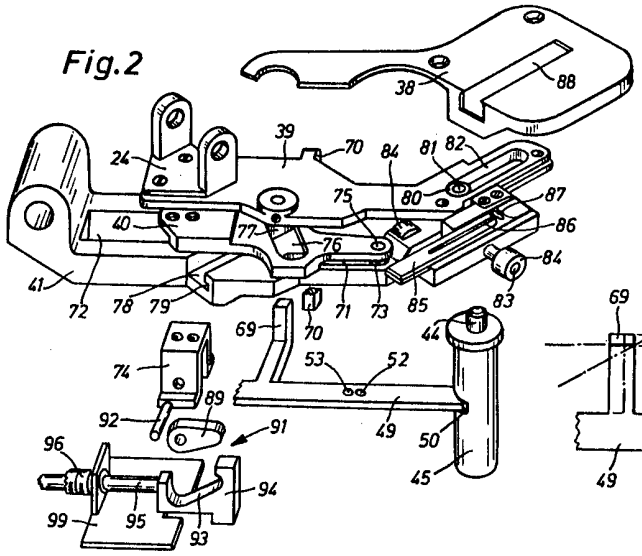

Fig.3