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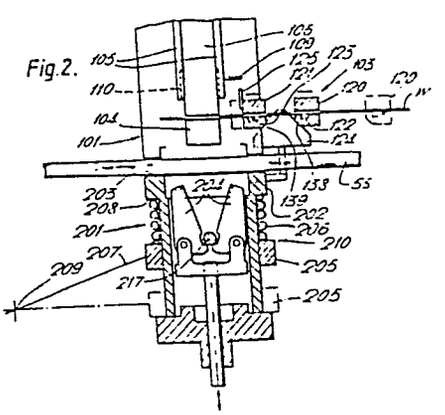
(54) Wire stitchers and methods of binding sets of sheets.

(57) A wire stitcher includes a cutter 125 for cutting a length of wire W from a supply thereof and a stitcher head 101, having a former 105 and driver 106, for forming and driving the length of cut wire for binding a set SS of sheets. The length of cut wire which is presented to the head 101 by wire advancing and cutting mechanism 103 is automatically determined in dependence upon the thickness of the set SS. The mechanism 103 includes a movable gripper block 120 which advances the wire and the cutter 125 is carried on a movable cutter block 121. Movement of the blocks 120 and 121 is limited such as by an inhibitor 124 which is positioned in dependence upon set thickness.

Fig.2.



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Wire stitchers and methods of binding sets of sheets

This invention relates to wire stitchers, particularly for binding sets or signatures of sheets or documents, and to methods of binding sets of sheets. Stichers take various well-known forms. There are those (called staplers) which use pre-formed staples, those using pre-cut lengths of wire which are formed in the machine and those in which the staples are formed from a continuous wire wound on a spool from which pieces are cut and formed in the machine. In each case the legs of the formed staple or stitch are driven through the set until the crown of the staple lies against one face of the set and the ends of the staple legs are bent over against the opposite face of the set to form clinches. The present invention is concerned with wire stitchers including a cutter for cutting a length of wire from a supply thereof and a stitcher head for forming and driving the length of cut wire for binding a set of sheets.

It will be understood that where the stitcher is capable of accommodating sets of varying thickness it is desirable to have some means of adjusting the length of wire used for forming the stitch and although it is possible to accommodate varying set thicknesses by permitting the clinches to vary according to the thickness of the set, even to the extent in some cases of angling the clinches so that they overlap for very thin sets, this imposes limits on the capacity of the machine and is also aesthetically undesirable. In order to avoid this, machines are available in which the length of wire cut to form the stitch may be varied, but in order to achieve such variation it has been necessary to stop the machine in order to perform an accurate and usually intricate manual adjustment requiring a skilled operator. Such a procedure is acceptable where long runs of identical

sets or signatures are being produced such as occurs in the printing industry (e.g. saddle stitching magazines) but does not provide a solution in the case where frequent and often substantial variations in set thickness occur such as in a finisher receiving sets from an office copier or duplicator.

The invention is characterised in that the length of the piece of wire is determined automatically in dependence on the thickness of said set of sheets.

In one embodiment, the cutter is movable and the length of cut wire presented to the stitching head is automatically determined by advancing the wire by a distance dependent upon the thickness of the set and positioning the cutter in dependence upon the thickness of the set.

Preferably, the wire is advanced past a normal or rest position of the cutter by a distance made up of a constant (crown length plus twice clinch length) plus the set thickness and the cutter is retracted from the rest position by a distance equal to the set thickness. However, given that there will be a minimum set thickness (two sheets) the constant may instead include twice the minimum set thickness in which case the cutter will be retracted, in all cases except for a minimum thickness set, by the set thickness minus the minimum set thickness. This latter arrangement avoids the need to move the cutter when binding minimum thickness sets. In each case a cut wire of the required length is obtained which is automatically centred on the head.

In a specific form, this is achieved by inhibitor means which is automatically adjusted in dependence upon set thickness and acts as a stop for the cutter and for a gripper device by which the wire is advanced. Thus the wire gripper and the cutter may each have angled faces which engage with correspondingly angled faces

respectively of an inhibitor member which is moved at right angles to the wire advancing direction. The gripper device and the cutter are advantageously biassed towards each other and driven by a common drive member, suitably in the form of a cam having opposite faces acting on the gripper and cutter respectively.

The wire is conventionally fed to a stitcher head via a dancer which maintains a controlled tension in the wire and it is therefore necessary to arrange for the wire to be continuously gripped at the head. This is most conveniently achieved in accordance with a preferred feature of the invention by means of wire diodes incorporated in the gripper device and a cutter member by each of which the wire is gripped only against relative movement in the direction opposite the wire advancing direction.

In another embodiment, there are provided first means for advancing the wire through a fixed distance past the cutter and second means for further advancing the wire and positioning the cutter in dependence upon the thickness of the set.

Preferably, the wire is advanced by the first means past a normal or rest position of the cutter by a fixed distance (crown length plus twice clinch length) and thereafter the wire is advanced by the second means by a distance equal to the set thickness and the cutter is retracted from the rest position by a distance equal to the set thickness. However, given that there will be a minimum set thickness (two sheets) the constant may instead include twice the minimum set thickness in which case, in all cases except for a minimum thickness set, the wire will be advanced by the second means by a distance equal to the set thickness minus the minimum set thickness and the cutter will be retracted by the set thickness minus the minimum set thickness. This

latter arrangement avoids the need to move the second means and the cutter at all when binding minimum thickness sets. In each case a cut wire of the required length is obtained which is automatically centred on the head.

In a preferred form of this embodiment, the stitcher includes a first wire gripper for advancing the wire past the cutter by said fixed distance and a second wire gripper for further advancing the wire by a distance dependent upon the thickness of the set, a third wire gripper being associated with the cutter for gripping the wire during retraction of the first and second wire grippers. Movement of the second wire gripper and the cutter is controlled by an actuator positioned in dependence upon set thickness. The second wire gripper and the cutter are interconnected for equal and opposite movements along the wire paths e.g. by being slideably mounted and respectively connected to different ones of a pair of racks arranged to be driven by a common pinion in opposite directions, the pinion being rotatable by the actuator proportionately to the set thickness.

In another form of this embodiment, the first means drives a wire gripper to advance the wire by said fixed distance and the second means drives the wire gripper by said further distance and retracts the cutter. Thus, a feed block is arranged to be driven through a fixed distance for advancing the wire by said fixed distance and the wire gripper is slideably mounted on the feed block for further advancing the wire in dependance upon set thickness.

A stitcher according to this invention may be incorporated in a sheet stitcher/compiler as part of a finisher for a photocopier and such a finisher may form part of the photocopier or take the form of a separate unit.

From a further aspect, the invention provides a method

of binding a set of sheets in which a piece of wire is cut from a supply of wire and formed and driven through a said set to bind the sheets together, characterized in that the length of said piece of wire is determined automatically in dependence upon the thickness of said set of sheets.

In order that the invention may be more readily understood, reference will now be made to the accompanying drawings, in which:-

Figure 1 is a schematic side elevation of an exemplary form of photocopier having a finisher incorporating a stitcher according to this invention;

Figure 2 is a schematic view illustrating the principles of one embodiment of stitcher of this invention suitable for use in the finisher of Figure 1;

Figure 3 is a scrap view of the stitcher shown in Figure 2 illustrating schematically the relationship of various of its major parts;

Figure 4 is a schematic perspective view of the clincher showing the drive therefore;

Figure 5 is a perspective view of the mechanism for feeding wire to the stitcher;

Figure 6 is a sectional view illustrating a preferred form of wire diode for use in the wire feeder of Figure 4;

Figure 7 is a side elevation of a second embodiment of stitcher suitable for use in the machine shown in Figure 1;

Figure 8 is a view from above looking in the direction

of arrow VIII of the wire advancing and cutting mechanism of the stitcher shown in Figure 7;

Figure 9 is a side elevation of the wire advancing and cutting mechanism of Figure 8;

Figure 10 is an end elevation of the wire advancing and cutting mechanism of Figure 8;

Figure 11 is a partial section through the wire advancing and cutting mechanism of Figure 8;

Figure 12 is a schematic view illustrating the principles of another embodiment of stitcher suitable for use in the finisher of Figure 1;

Figure 13 is a side elevation of the main or fixed distance feed mechanism of the stitcher shown in Figure 12;

Figure 14 is a perspective view of the stitcher head of the stitcher of Figure 12 showing one form of proportional or secondary wire feed mechanism;

Figures 15 and 16 illustrate schematically the operation of the secondary wire feed mechanism of the stitcher of Figure 12;

Figure 17 is a perspective view like that of Figure 14 showing an alternative form of secondary wire feed mechanism;

Figure 18 is a side elevation of a second embodiment of stitcher suitable for use in the machine shown in Figure 1; and

Figure 19 illustrates schematically another embodiment of wire advancing and cutting mechanism in accordance

with the invention.

Referring to Figure 1 there is shown an automatic xerographic reproducing machine 10 having a finisher 70 incorporating a stitcher 100 according to this invention. The copying machine 10 is capable of producing either simplex or duplex copies in sets from a wide variety of originals which may be advanced in recirculating fashion by recirculating document apparatus 12 described in U.S. Patent No. 3556512. Although the present invention is particularly well suited for use in automatic xerography, the apparatus generally designated 100 is equally well adapted for use with any number of devices in which cut sheets of material are delivered or compiled in a set or stack.

The processor 10 includes a photosensitive drum 15 which is rotated in the direction indicated so as to pass sequentially through a series of xerographic processing stations: a charging station A, an imaging station B, a developer station C, a transfer station D and a clearing station E.

A document to be reproduced is transported by document handling apparatus 12 from the bottom of a stack to a platen 18 and scanned by means of a moving optical scanning system to produce a flowing light image on the drum at B. Cut sheets of paper are moved into the transfer station D from sheet registering apparatus 34 in synchronous relation with the image on the drum surface. The copy sheet is stripped from the drum surface and directed to a fusing station F. Upon leaving the fuser, the fixed copy sheet is passed through a curvilinear sheet guide system, generally referred to as 49, incorporating advancing rolls 50 and 51. The advancing rolls forward the sheet through a linear sheet guide system 52 and to a second pair of advancing rollers

53 and 54. At this point, depending on whether simplex or duplex copies are desired, the simplex copy sheet is either forwarded directly to the finisher 70 via pinch rolls 61, 62 or into upper supply tray 55 by means of a movable sheet guide 56 before the finishing apparatus for the duplexed copy. Movable sheet guide 56, and associated advancing rolls are prepositioned by appropriate machine logic system to direct the individual sheets into the desired path.

The finisher 70 comprises a tray 71 having a base or support surface 72 inclined downwardly in the direction of sheet travel towards a registration corner defined by registration fences 74, 75 extending along the lower edge and one side of the tray. Above the upper end of the support surface is arranged a pair of coacting sheet feed rolls 64, 65 arranged to receive sheets fed along path 63 by pinch rolls 61, 62. From the feed rolls 64, 65, a sheet is directed by guide throat 78 towards the tray 71. A corner registration device 79 such as a paddle wheel like that described in U.S. Patent No. 3669447 is arranged over the surface 72 to urge the sheets S into the registration corner to position them for receiving a stitch from the apparatus 100. The registration fence 74 is rotatable about an axis 74a so that it may be retracted for ejection of bound sets SS into a collection tray 69. Any suitable ejection mechanism, such as drive rollers, may be employed.

Referring now to Figures 2 and 3 of the drawings, the stitcher 100 comprises a stitcher head 101, a reel 102 (Figure 1) from which wire W is supplied via a dancer (not shown) to the head 101 and an active clincher 201. The head 101 includes a wire advancing and cutting mechanism generally indicated at 103 for presenting lengths of cut wire to the stitcher head, an anvil 104 for supporting the wire, a former 105 including two elements at opposite sides respectively of the driver

for forming the wire into a generally U-shape about the anvil and a driver 106 for driving the formed staple through the set SS. The clincher 201 comprises a clincher housing 202 having a clamping surface 203 by which a set SS may be clamped against the underside of the stitcher head 101 and containing clinch ears 204 arranged to receive and act upon staple legs driven through the set and into the housing through a slot in the surface 203.

In Figure 2, the clincher 201 is shown in its operative position with a set SS positioned against the head 101 which is fixed in position above the compiler tray. It will be understood, however, that during compilation of the set, the clincher is lowered so that the clamping surface 203 is below the support surface 72 of tray 71. During a stitching operation the clincher 201 is raised to lift the set SS against the underside of the head 101 and clamp it in position. Variations in set thickness are accommodated by the drive mechanism 210 by which the clincher housing is raised to lift the set against the underside of the stitcher head and clamp it into position to receive a stitch. This mechanism comprises a force applying ring 205 which lifts the housing via a compression spring 206, being moved through a fixed distance by a lever 207 (see Figure 4). The spring 206 is positioned between the force applying ring 205 and a shoulder 208 and the lever 207 which is arranged to pivot about axis 209 is actuated by a cam (not shown) which acts on its free end 207a. As shown in Figure 4 the other end of the lever is bifurcated to form a yoke 207b which is pivotally connected to the force ring 205. The clincher housing 202 is supported and guided by a pair of arms 211 pivotally connected between the housing and the frame of the stitcher. The mechanism 210 in addition to accommodating varying set thicknesses, varies the clamping pressure applied to the set as a function of set thickness. Thus, the

thinner the set the less the compression of spring 206 and the less the clamping force applied. The clincher ears 204 are positioned in fixed relation to the housing 202 so that they are always presented to the set in the same relation regardless of the set thickness.

The wire advancing and cutting mechanism 103 comprises movable wire advancing and cutter blocks 120, 121 and an inhibitor member 124 positioned by the clincher 201 in dependence on the thickness of the set of sheets SS. The blocks 120, 121 include wire diodes 122, 123 which grip the wire only against movement relative to the respective block in the direction opposite the wire advancing direction. Thus, the diodes grip the wire when the blocks are moved to the left but allow each block to be moved to the right along the wire while the other block holds the wire. At the start of a wire feed cycle, the blocks 120 and 121 are positioned as shown in dotted lines in Figure 1. To feed the wire W, the advancing block 120 is moved to the left, its diode 122 gripping the wire, to advance the wire past the rest or start-of-cycle position of the cutter 125 by a distance made up of a constant (crown length plus twice clinch length) plus the set thickness and the cutter block is retracted from its rest position by a distance equal to the set thickness. These movements and thus the length of wire W presented to the stitcher head 101 for severing by the cutter 125 are determined by the inhibitor member 124 which limits the movement of the blocks 120, 121, according to the thickness of the set. The blocks 120, 121 are shown in full lines in their final positions at the end of a wire advancing movement. As the mechanism recycles to its start position (which takes place at the end of the complete stitching cycle) the cutter block 121 returns to its rest position pulling the wire with it - so that the wire end is always in the same position at the start of a feed cylce - and the advancing block 120 traverses back along the wire

to its rest position.

The wire advancing and cutting mechanism 103 is more fully illustrated in Figures 5 and 6 from which it will be seen that the advancing block 120 and the cutter block 121 are both mounted for horizontal sliding movement on a guide rail 126. In Figures 2, 5 and 6, the wire advancing direction is from right to left and the cutter 125 is pivotally mounted on the left-hand end 127 of the cutter block which forms a shear face. The cutter is actuated by a projection 109 on the former 105 as described below and is returned to its inactive position following an operating cycle by a tension spring 128. The blocks 120, 121 have bores 129 through which the wire W is threaded and which incorporate the wire diodes 122, 123. As best shown in Figure 6 the diodes comprise a cavity 130 along the bore 129 which contains a roller 131 lightly loaded by a spring 132. The face 133 of the cavity opposite the bore is inclined so that the cavity tapers in the wire advancing direction and the spring 132 urges the roller into engagement with the wire. The blocks 120, 121 are respectively driven by levers 134, 135 through override springs 136, 137. The levers are driven by cams (not shown) through a fixed travel and the springs 136, 137 accommodate the variations in the travel of the blocks 120, 121 imposed by the inhibitor member 124. The latter is mounted for vertical sliding movement with the clincher housing 202 as schematically illustrated in Figure 2. The inhibitor member 124 has two opposed 45° faces 141, 142 which are engaged by 45° faces 138, 139 respectively on the advancing block 120 and the cutter block 121. Using 45° faces, the relationship between the position of the clincher housing and the inhibitor 124 is linear and 1:1.

While the inhibitor member 124 may be directly connected to the clincher housing 202 as schematically represented

in Figure 2, other arrangements are possible. Thus, in a second embodiment as shown in Figure 7, the inhibitor member 124 is carried on an arm 143 pivoted to the stitcher head at 144 and is positioned by means of an actuator 145 mounted on one of the clincher housing guide arms 211. As shown the actuator is adjustable for correctly setting the mechanism and comprises a bolt 146 threaded through a bracket 147 and locked into position by a nut 148. While the clincher is retracted, the inhibitor is supported by a limit stop 149.

The embodiment of Figure 7 also includes a modified drive for the force ring 205 in which as a space-saving measure, the lever 207 carries a cam follower 270 intermediate the force ring 205 and pivot axis 209 which is controlled by a face cam 219 the centre-line of the guideway of which is shown by the dash-dot line 219a. The cam 270 is mounted on a cam shaft 218.

The length of wire presented to the stitcher head 101 by the mechanism 103 is cut, formed and driven in the following manner. While the anvil 104, which is pivotally mounted at 107 and biassed to its start-of-cycle position by a spring 108 as shown in Figure 2, is held against movement, the driver 106 is moved downwardly against the wire to clamp it in position on the anvil. The former elements 105 then start moving downwardly. Initial movement of the former operates the cutter 125 through actuator 109 to sever the required wire length and further movement thereof shapes the wire about the anvil 104 into a generally U-shape. In order to accommodate the wire during this operation, the formers have guide grooves 110 along their inner faces. At the end of the forming operation the former is in its lower limit position with the lower ends of the former elements 105 below the underside of the anvil 104 and adjacent the set. The driver 106 is now driven downwardly, pivoting the anvil about its axis 107, to drive the formed staple.

As seen in Figure 3, the anvil includes a sloping surface 104a. During the driving operation, the anvil surface 104a forms a support for the crown of the staple. Similarly the former elements serve to support the legs of the staple in the grooves 110 during the driving movement.

It will be realised from the foregoing that the anvil must be held against movement during the cutting and forming stage but be pushed out of the way during the driving stage. This may be achieved by using a spring 108 which is strong enough to hold the anvil stationary during cutting and forming. However, this requires that the force available to drive the driver must be sufficient also to overcome the resistance of the spring. It is preferred therefore that as described with reference to our copending U.K. Application No. 50326/78 filed on 29 December 1978, the anvil be held locked in position during the cutting and forming stage and released by the former 105 at the end of its travel whereby only a relatively light spring 108 is required which is sufficient to return the anvil to its start-of-cycle position and to ensure that the anvil supports the staple crown during the driving stage. One way of achieving this is shown in Figure 7 in which the anvil is geometrically locked in position during the cutting and forming steps by arranging the pivot axis 107 above the line of pressure engagement between driver and anvil, the lock being released by a projection 190 on the former engaging an actuator surface 170 on the anvil support area.

As described above, the stitcher has a two stage driver action in which following wire feed a first stage motion operates to grip the wire W against the anvil 104 during cutting and forming and a second stage motion acts following forming to effect driving of the formed staple. A mechanism suitable for this operation based on pivoted motions which first holds the wire against the anvil

and then provides the driving motion all from one continuous input lever travel is described in our copending U.K. Application No. 50324/78 filed on 29 December 1978. The ends of the staple legs are turned over and wiped flat against the underside of the set by the clincher ears 204. The clincher 201 is operated as described more fully in our copending U.K. Application No. 50327/78 filed on 29 December 1978 so that the staple legs having passed through the set move through air and meet no further resistance during driver travel. This is achieved by arranging the clincher ears out of the paths of the staple legs during driver travel so that leg wander is accommodated wholly within the clinch ears by profiling the ears with a groove wide enough to accommodate the maximum leg wander anticipated. The drive to the clincher ears may be by a spring which is loaded during return motion of the clincher housing at the completion of a stitching operation as more fully described in our copending U.K. Application No. 50323/78 filed on 29 December 1978, the clinch ears being held latched in the position shown in Figure 2 prior to the operation thereof, or by a cam drive 250 as illustrated in Figure 7 where the clincher rod 213 is driven by an edge or ramp cam 250 mounted on the same drive shaft 218 as, and alongside, the cam 219 which drives the force-ring lever 207. The drive to the clincher rod from the cam 250 is effected by a roller follower 251 mounted on one end of a crank arm 252 pivoted to a bracket 253 depending outwardly from the clincher housing 202. The other end of the crank arm carries a stop 254 which engages the bottom end of the clincher rod 213. As shown, the stop 254 is adjustable to permit setting of the clincher ear movement. The clincher ears 204 are biassed to their open, retracted position by a spring schematically represented at 255. The cam shaft 218 is driven in synchronism with the head 101 drive and the cam 250 is disposed so that the clincher rod is driven only after the formed staple has been completely

driven through the set. It will be noted that by using a drive arrangement as shown with the face cam 250, variations in set thickness are accommodated without affecting the timing (except to an insignificant degree caused by slight variations in the position of the cam follower 251 to cam 250) of the clincher ear movement relative to that of the driver.

An embodiment of wire advancing and cutting mechanism is shown in Figures 8 to 11 in which as noted above the inhibitor member 124 is pivoted to stitcher head at 144 and positioned by an actuator 145 seen in Figure 7. More specifically it will be seen that the inhibitor member is pivoted to a frame 150 of the stitcher which like the head 101 is fixed. The frame includes end plates 151, 152 (the latter being omitted in Figure 10 for clarity) and cross bars 153-156 of which bars 154, 155 act as rails for the wire advancing and cutter blocks 120, 121 and bar 156 carries the pivot 144 for inhibitor member 124.

The wire advancing and cutter blocks 120, 121 are permanently biassed together by spring mechanism 157 and driven apart by a double-face cam 158 during positioning of the inhibitor member 124. The spring mechanism 157 best comprises tensator springs 159 of which a pair are used. The springs 159, which are each of three layers of spring steel 0.15mm thick, are secured at one end between brackets 160 mounted on the cutter block 121 and at the other end wrap around posts 161 on the wire advancing block 120. The blocks 120, 121 carry cam followers 162, 163 which act respectively on the opposite faces 164, 165 of the cam 158. As will be seen, the cam 158 is asymmetric in view of the greater variation in movement required of the wire advancing block 120 compared with the cutter block 121.

In Figures 8 to 11 the wire advancing and cutter blocks

are shown in their closest position (corresponding to the longest length of wire which can be fed) in which the inhibitor member 124 touches the blocks 120, 121 but does not spread them beyond the minimum spacing effected by the narrowest portion of cam 158. In their start-of-cycle positions prior to the feeding of a wire length, the blocks 120, 121 are fully spread apart with the followers 162, 163 on the widest portion of the cam 158. As will be noted by reference to Figure 11 in which the wire is fed from left to right, as the blocks are separated, the cutter block (diode 123 locked) carries the wire to the right as the advancing block (diode 122 free) runs along the wire to the left. As the blocks return together, the advancing block (diode 122 locked) pushes the wire through the cutter block (diode 123 free) which - see cam profile in Figure 8 - initially remains stationary. During the final movement of cam 158 to the position shown in Figure 11, the cutter block is retracted (diode 123 still running free) back to the position shown while the advancing block (diode 122 still locked) finalises its return movement. For shorter lengths of wire these return movements of the blocks 120, 121 are limited by the inhibitor 124. The cam profile is chosen so that the portion 165a of cutter block actuating face 165 corresponds to the position of the cutter for the wire length required for a minimum thickness set. This not only ensures that for a minimum thickness set, the cutter block does not have to move but provides a ready means of accurately setting the inhibitor.

As shown in Figures 9 and 10 the limit stop 149 for the inhibitor 124 is carried by an arm 124a secured to the frame 150.

Referring to Figure 11, the advancing and cutter blocks 120, 121 are each constructed in two parts bolted together, as by bolt 166 and the cutter block 121 includes an adjustable shear member 167. The cutter 125 is carried

at the end of a pivotally mounted arm 180 and is driven by pivot plate 181 via a pin 182 on the arm 180 engaging in a slot 183 in plate 181. The plate 181 is itself driven by projection 190 (see Figure 7) on the former which engages in a recess 184 in the plate 181.

As described in the above embodiments, in order to accommodate the variations in stroke of the gripper device 120 and cutter 125, these are driven through a spring mechanism and for all except the thickest sets, potential energy stored in the spring is wasted, being dissipated without being used. In applications where most sets will commonly be thin rather than thick an alternative wire feed mechanism is proposed as shown schematically in Figure 12. Figure 12 shows a stitcher having a head 101 and clincher 102 like that of Figure 2, like references being used to designate like parts.

The wire advancing and cutting mechanism 303 comprises a primary or main feed mechanism consisting of movable wire advancing block 320 by which the wire is advanced by a fixed distance, a secondary or proportional feed mechanism consisting of movable wire advancing and cutter blocks 321, 322 and an actuator member 324 positioned by the clincher 201 in dependence on the thickness of the set of sheets SS. The blocks 320, 321, 322 include wire diodes 323 which grip the wire only against movement relative to the respective block in the direction opposite the wire advancing direction. Thus, the diodes grip the wire when the blocks are moved to the left in Figure 2 but allow each block to be moved to the right along the wire while the other block(s) hold(s) the wire. At the start of a wire feed cycle, the blocks are positioned as shown in dotted lines in Figure 2. To feed the wire W, the main advancing block 320 is moved to the left, its diode 323 gripping the wire, to advance the wire past the rest or start-of-cycle position of the cutter 125 by a fixed distance d made up of a constant (crown

length plus twice clinch length). Thereafter, the secondary wire feed mechanism comprising the blocks 321, 322 is actuated, the block 321 further advancing the wire by a distance equal to the set thickness and the cutter block being retracted from its rest position by a distance equal to the set thickness further to uncover the wire by that amount. The movements of the secondary wire feed blocks 321, 322 and thus the length of wire W presented to the stitcher head 101 for severing by the cutter 125 are determined by the actuator member 324 which determines the movement of the blocks 321, 322 according to the thickness of the set. The blocks 320, 321 and 322 are shown in full lines in Figure 2 in their final positions at the end of a wire advancing movement. As the mechanism recycles to its start position (which takes place at the end of the complete stitching cycle) the cutter block 321 returns to its rest position pulling the wire with it - so that the wire end is always in the same position at the start of a feed cycle - and the advancing blocks 320 and 321 traverse back along the wire to their rest positions.

In a preferred modification, block 320 advances the wire by a constant equal to crown length plus twice clinch length plus twice minimum set thickness and the blocks 321, 322 are each moved by a distance equal to the set thickness minus the minimum set thickness. With this arrangement the blocks 321, 322 are not moved at all during biding of a minimum thickness set.

The wire diodes 323 incorporated in the wire advancing and cutting blocks 320, 321, 322 are like the blocks illustrated in Figure 5.

As schematically illustrated in Figure 2 by the dotted lines, the actuator 324 is connected to the advancing and cutter blocks 321, 322 such that the vertical movement of the actuator is translated into equal and opposite

movements towards one another of the blocks along the wire. Suitable mechanisms for achieving this are described below with reference to Figures 14 to 16 and 17.

The length of wire presented to the stitcher head 101 by the mechanism 303 is cut, formed and driven in the manner described above with reference to the embodiment of Figure 2.

The wire advancing and cutting mechanism 303 is more fully illustrated in Figures 13 to 16. The main wire advancing mechanism 320 by which the wire is advanced a fixed distance is shown in Figure 13 and is arranged upstream of the secondary or proportional wire advancing and cutting mechanism 321, 322 which is mounted on the stitcher head as shown in Figure 14. The main wire feed block 320 is incorporated in a crank 351 pivoted at its lower end 352 to the frame 350 of the stitcher and having a slot 353 at its other end engaged by a pin 354 on a drive plate 355 rotation of which oscillates the crank 351 about pivot 352. The block 320 is aligned between a flexible wire guide tube 356 extending from the wire reel and a rigid wire guide tube 357 leading to the stitcher head. To advance the wire by fixed distance d, the drive plate 355 is driven through a single revolution by a drive motor mounted on the back of bracket 358, the motor being controlled by a microswitch 359. The wire is advanced during the first half revolution of the plate 355 and as the crank returns, the wire is gripped against return movement by the diodes in the blocks 321, 322.

The wire is further advanced and the cutter 125 positioned by the secondary or proportional wire feed mechanism shown in Figures 14 to 16. As explained above movement of the secondary blocks 321, 322 is effected in response

to movement of an actuator 324 which itself is proportional to set thickness. As shown in Figure 14 and also Figure 18, the actuator 324 includes a rod 360 fixed to the force ring 205 and slideably mounted in a guide in the clincher body 206. The vertical movement of the rod 360 is translated into horizontal sliding movement of the blocks 321, 322 along the wire by the following mechanism. The rod 360 raises and lowers a lever 361 pivoted to the clincher housing 202 and this in turn actuates a crank 362 which drives a rack 363 via a drive 362a. The rack 363 is fixed to the cutter block 322. The cutter block 322 and the proportional feed block 321 are slideably mounted on a guide rail 364 carried by a support 365 for movement towards and away from each other along the wire path. A second rack 366 fixed to the feed block 321 is connected to rack 363 via a pinion 367 rotatably mounted on support 365. As will be seen from Figure 14, lifting of the rod 360 causes the rack and pinion 363, 366, 367 to move the feed and cutter blocks 321, 322 towards each other by equal amounts, the movement of the blocks being proportional to the movement of the actuator rod 360.

For a minimum thickness set, as illustrated in Figure 15, the wire is advanced by the main feed block 320 but the actuator rod 360 moves insufficiently to operate the crank 362 and the feed blocks 321, 322 remain stationary so that the wire fed is solely that advanced by the main feed block. As shown, this wire is centred about the centre-line CL of the stitcher head. For a thicker set the actuator rod 360 operates crank 362 which in turn causes rack and pinion 363, 366, 367 to draw the blocks 321,322 together as shown in Figure 16 so that additional amounts of wire T1, T2 equal to the set thickness are uncovered beyond the cutter block 322 by the movements of the blocks 321, 322 respectively. Since the cutter block is retracted equally to the advance

of the feed block 321, the wire fed remains centred about the centre-line CL of the stitcher head.

In a modification as shown in Figure 17, the rack and pinion is replaced by an endless belt 368 entrained over rollers 368a, 368b, mounted on the support 365 and to opposite runs of which the blocks 321, 322 are respectively secured by clamps 369. The crank 362 drives roller 368a.

In a specific embodiment, the stitching wire (0.6 to 0.7 mm diameter) is supplied on a 300mm diameter moulded spool having a capacity of 2Kg of wire or approximately 40,000 stitches. The main wire feed supplies a 23.5mm length of wire and the proportional wire feed accommodates sets up to 7.5mm thick. The main feed is effected in 150ms outside the stitching cycle of 300ms. Proportional wire feed of course takes place during the main stitching cycle.

Figure 18 shows a stitcher like that of Figure 7, like references being used to designate like parts, but including a wire advancing mechanism including actuator rod 360 and lever 361 illustrated like that shown in Figure 14 or 17.

In another embodiment schematically illustrated in Figure 19, the secondary or proportional wire feed block 321 is slideably mounted on the main wire feed 320 and the two feed blocks share the same wire diode (gripper) 323. During the main or fixed distance feed, the main and secondary feed blocks 320, 321 move as a single unit and may be driven for example by a drive as shown in Figure 13 or by a cam. The required movement of the proportional wire feed and cutter blocks 321, 322 is effected by Bowden cables 380, 381 connected between

the respective feed blocks and the force ring 205 of the clincher. Springs 382, 383 serve to return the blocks 321, 322 to their rest positions at the end of a feed cycle. It will be noted that the two Bowden cables are connected to diametrically opposite points on the force ring to equalise the forces on the ring.

Whilst specific embodiments of the invention have been described above it will be understood that various modifications may be made to the specific details referred to herein without departing from the scope of the invention as defined in the appended claims. Thus, the principles of this invention although described in relation to a flat bed stitcher may equally be applied to a saddle stitcher.

Further, while in the apparatus described above the stitcher is fixed in position, it may be movable for varying the position of the stitch or for inserting more than one stitch in a set. Also, two or more stitchers according to the invention, which may themselves be movable, may be operated in tandem, in which case various of the drive elements may be common to avoid duplication.

It will also be understood that while in the embodiments described, the stitcher head is fixed, the clincher could be fixed and the clamping means be formed by the sheet receiving surface of the head itself.

It will further be understood that although the embodiments of stitcher described and illustrated show the stitcher head above the clincher, the stitcher may be arranged in any suitable orientation and specifically the clincher may be arranged over the stitcher head.

For clarity, it is to be noted that the term staple is used herein to mean either a wire-fastener which is pre-formed outside the stitching machine or one which is formed within the machine.

The ends of the staple or stitch legs may be turned over by an active clincher including ears which are wiped against the leg ends as described above or by a passive clincher having fixed guide surfaces. The advantage of an active clincher is that the legs are wiped flat against the set.

Although in the embodiments described herein, the constant by which the wire is advanced is either crown length plus twice clinch length or crown length plus twice clinch length plus a minimum set thickness, it will be understood that various other permutations are possible. For example, in the embodiments of Figures 1 to 11 the constant may equal crown length plus once clinch length in which case the cutter will include a clinch length. Furthermore, the cut wire length may be varied so as to produce a constant clinch size regardless of set thickness or the clinch size may be variable as a function of set thickness, being longer for thicker sets. Furthermore the cut wire length may be varied so as to produce a constant clinch size regardless of set thickness or the clinch size may be variable as a function of set thickness, being longer for thicker sets.

The embodiments described with reference to Figures 12 to 19 may, as appropriate or desired, include any or all of the features described in relation to the embodiments of Figures 1 to 11 and particularly those features described in our aforesaid co-pending applications.

Claims:

1. A wire stitcher (100) including a cutter (125) for cutting a length of wire from a supply thereof and a stitcher head (101) for forming and driving the length of cut wire for binding a set of sheets (SS) characterized in that the length of said piece of wire (W) is determined automatically in dependence upon the thickness of said set of sheets (SS).

2. A wire stitcher according to Claim 1, in which the cutter (125) is movable and the length of cut wire presented to the stitching head (101) is automatically determined by advancing the wire (W) by a distance dependent upon the thickness of the set (SS) and positioning the cutter (125) in dependence upon the thickness of the set (55).

3. A wire stitcher according to Claim 1, comprising first means (320) for advancing the wire through a fixed distance past the cutter (125) and second means (321, 322, 324) for further advancing the wire (W) and positioning the cutter (125) in dependence upon the thickness of the set (55).

4. A stitcher according to Claim 2 in which the cutter (125) has a rest position and the end of the wire supply (W) is advanced past the rest position of the cutter by a distance dependent upon the set thickness and the cutter (125) is retracted (optionally except in the case of a minimum thickness set) by a distance dependent upon the set thickness, or according to Claim 3 in which the cutter (125) has a rest position and the end of the wire supply (W) is advanced by the first means (320) past the rest position of the cutter by a fixed distance and (optionally except in the case of a minimum thickness set) additionally by a distance dependent upon the set

thickness (55) and the cutter (125) is retracted (optionally except in the case of a minimum thickness set) by a distance dependent upon the set thickness.

5. A stitcher according to Claim 2 or 3, in which the cutter (125) has a rest position and in the case of a stitcher according to Claim 2 the end of the wire supply (W) is advanced past the rest position of the cutter by a distance made up either of a first constant (equal to crown length plus twice clinch length plus a minimum set thickness) or a second constant (equal to crown length plus twice clinch length) plus the set thickness and the cutter (125) is retracted from its rest position by a distance equal in the case of the first constant to the set thickness minus the minimum set thickness and equal in the case of the second constant to the set thickness, and in the case of a stitcher according to Claim 3 the end of the wire supply (W) is advanced by the first means (320) past the rest position of the cutter (125) by a fixed distance equal to crown length plus twice clinch length plus twice a minimum set thickness in which case the wire is thereafter, except in the case of a minimum thickness set, advanced by the second means (321, 322, 324) by a distance equal to the set thickness minus the minimum set thickness and the cutter (125) is retracted from its rest position by a distance equal to the set thickness minus the minimum set thickness, or the wire end is advanced by a fixed distance equal to crown length plus twice clinch length in which case the wire is thereafter advanced by the second means (321, 322, 324) by a distance equal to the set thickness and the cutter (125) is retracted from its rest position by a distance equal to the set thickness.

6. A stitcher according to Claim 1 or 2 or Claim 4 or 5 as appendant to Claim 2, in which the wire (W)

is advanced by gripper means (120) and the gripper means (120) and the cutter (125) are biassed towards each other and are driven by a common drive member (158), preferably a cam having opposite faces (164, 165) acting on the gripper means (120) and the cutter (125) respectively.

7. A stitcher according to Claim 2 or Claim 4 or 5 as appendant to Claim 2, or Claim 6, in which the wire is advanced by movable gripper means (120) and movement of the gripper means (120) and the cutter (125) is limited by an inhibitor (124) positioned in dependence upon set thickness.

8. A stitcher according to Claim 7 in which the inhibitor (124) is positioned by movable clamping means (203) arranged opposite the stitcher head (101) for positioning a set of sheets (SS) against the stitcher head (101) or by movement of the stitcher head (101) relative to a fixed clamping means (203) by which a set (SS) is positioned against the head (101), in which the gripper means (120) and the cutter (125) have faces (138, 139) which engage with corresponding faces (141, 142) respectively of the inhibitor (124) which is moved in a plane at right angles to the plane of movement of the cutter (125) and gripper means (120), and in which wire diodes (122, 123) are associated respectively with the gripper means (120) and the cutter (125) which grip the wire (W) only against relative movement to the respective one of the gripper means (120) and the cutter (125) in the direction opposite the wire advancing direction.

9. A stitcher according to Claim 3 or Claim 4 or 5 as appendant to Claim 3, including a first wire gripper (320) for advancing the wire (W) past the cutter (125) by said fixed distance, a second wire gripper (321) for futher advancing the wire (W) by a distance dependent upon the thickness of set (SS) and a third wire gripper

(322) is associated with the cutter (125) for gripping the wire during retraction of the first and second wire grippers (320, 321), movement of the second wire gripper (321) and the cutter (125) being controlled by an actuator (324) positioned in dependence upon set thickness.

10. A stitcher according to Claim 9, in which the second wire gripper (321) and the cutter (125) are interconnected for equal and opposite movements along the wire path.

11. A stitcher according to Claim 3 or any preceding Claim appendant to Claim 3, in which the first means (320) drives a wire gripper (321) to advance the wire (W) by said fixed distance and the second means (205) drives the wire gripper (321) by said further distance and retracts the cutter (125).

12. A stitcher according to Claim 11, including one or more of the following features:

(a) a feed block (320) arranged to be driven through a fixed distance for advancing the wire (W) by said fixed distance, the wire gripper (321) being slideably mounted on the feed block (320) for further advancing the wire (W) in dependence upon set thickness;

(b) the cutter (125) is moved and the wire gripper (321) is further advanced by an actuator mechanism (205) in dependence upon set thickness;

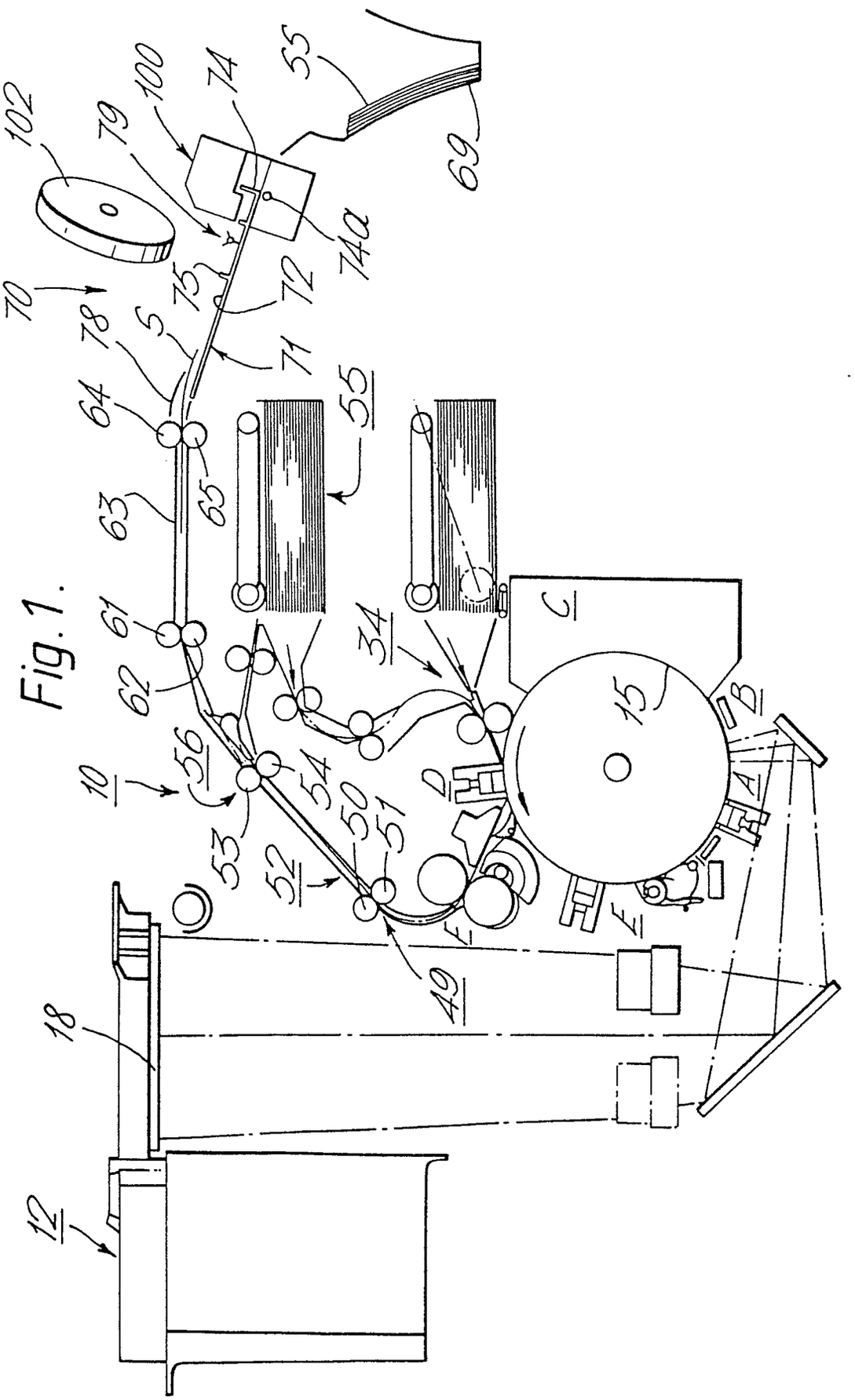
(c) the actuator mechanism (205) comprises Bowden cables (381, 380) connecting the cutter (125) and wire gripper (321) to a movable clamping means (205) for the set (SS);

(d) a wire gripper (322) is associated with the cutter (125) for gripping the wire (W) during retraction of the wire gripper (321) which advances the wire.

13. A method of binding a set of sheets in which a

piece of wire is cut from a supply of wire (W) and formed and driven through a said set (SS) to bind the sheets together characterised in that the length of said piece of wire is determined automatically in dependence upon the thickness of said set of sheets (SS), preferably by advancing the wire (W) by a distance dependent upon the thickness of the set (SS) and positioning a wire cutter (125) in dependence upon the thickness of the set.

14. A method of binding a set of sheets according to Claim 13, in which the length of said piece of wire is determined automatically in dependence upon the thickness of said set of sheets by first advancing the wire (W) by a fixed distance and then further advancing the wire (W) by a distance dependent upon the thickness of the set (SS) and positioning a wire cutter (125) in dependence upon the thickness of the set.


102
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100
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55
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74a
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75
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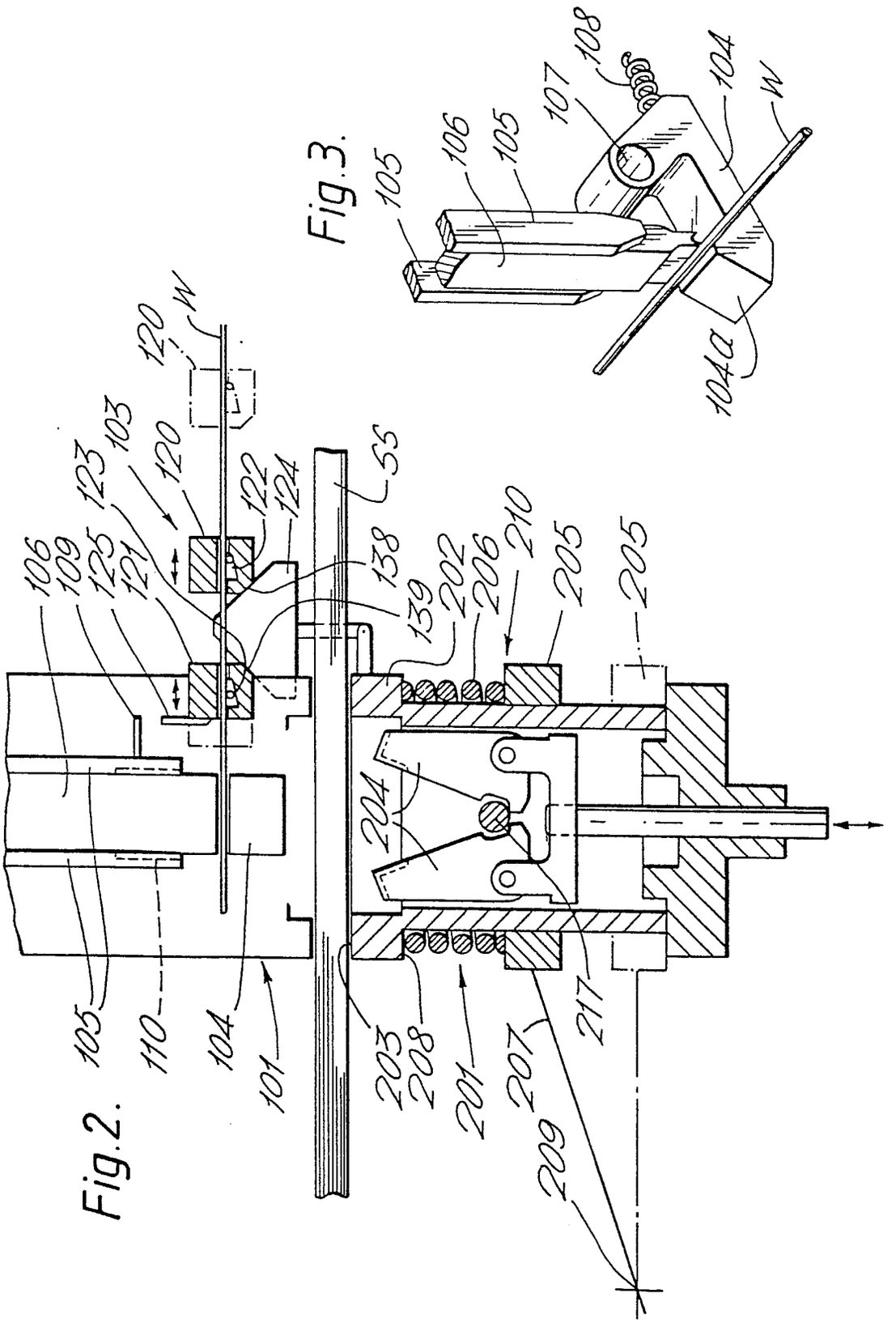
78
5
71
64
65
63
61
62
56
10
54
53
52
50
51
49
34
C
15
B
A
D
E
E
18
12

Fig. 1.


105
106
105
107
108
104
W
104a
120
W
103
123
120
122
124
55
106
109
125
121
138
139
202
206
210
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205
204
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203
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201
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217
209

Fig.3.

Fig.2.

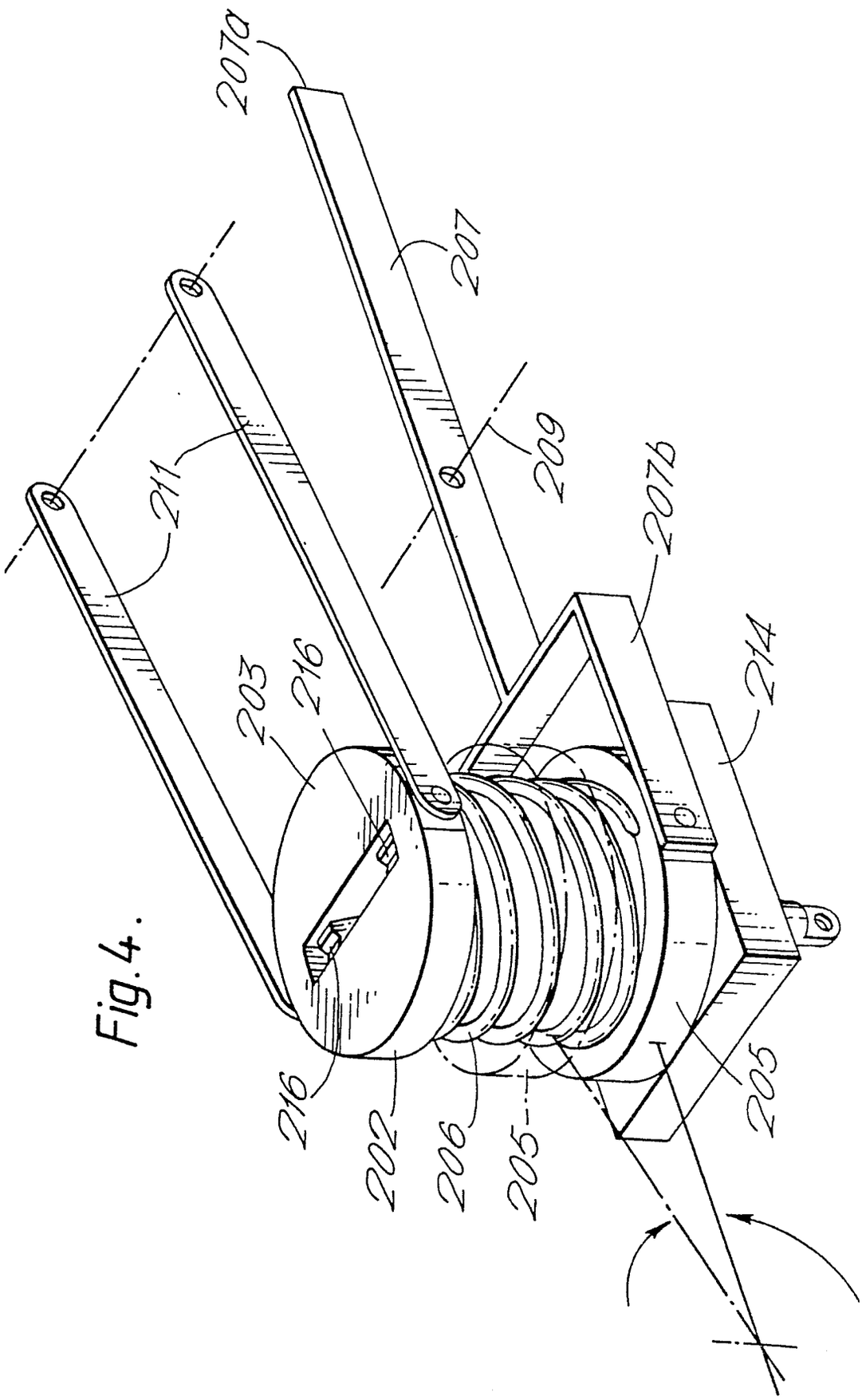


Fig. 4.

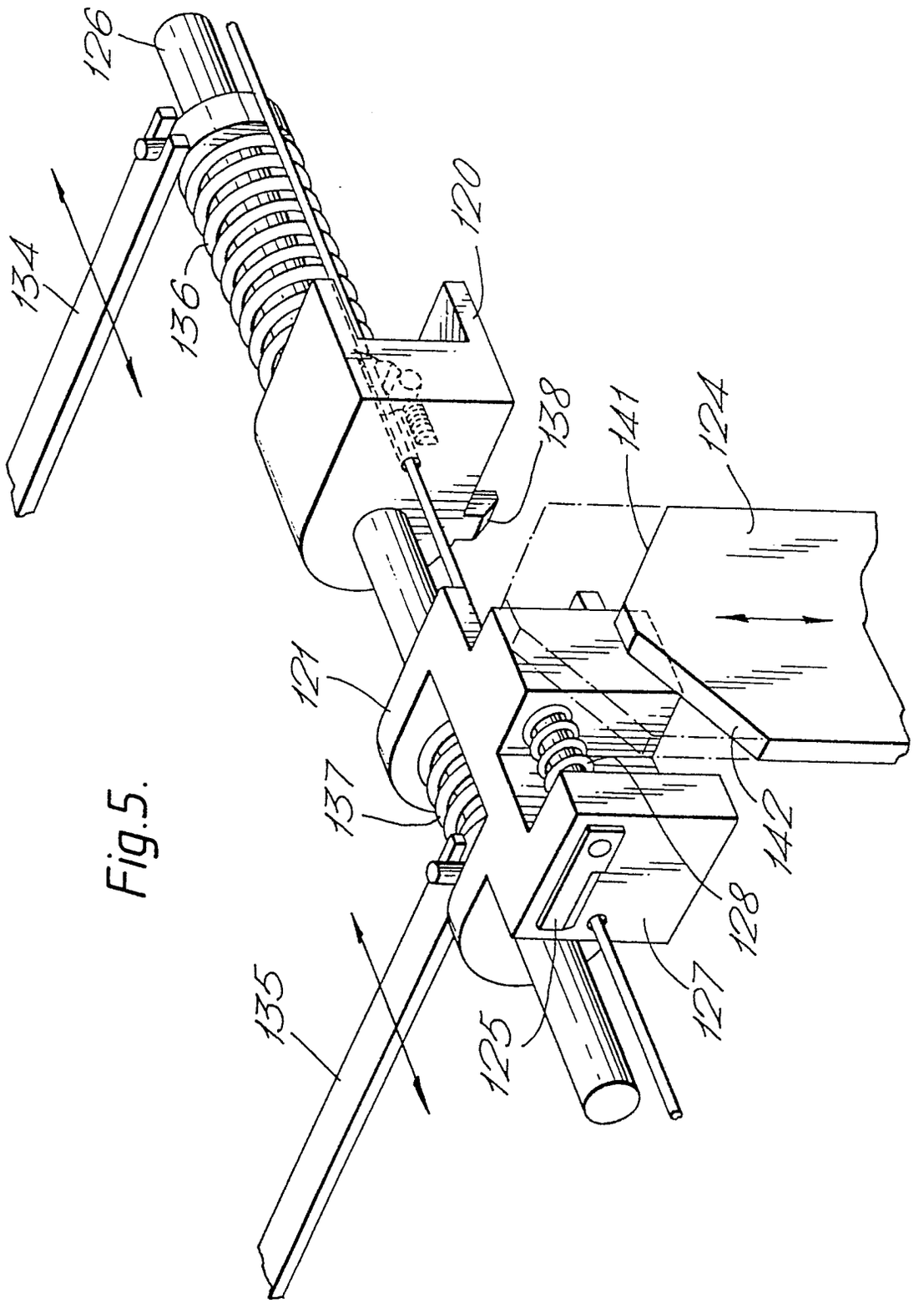
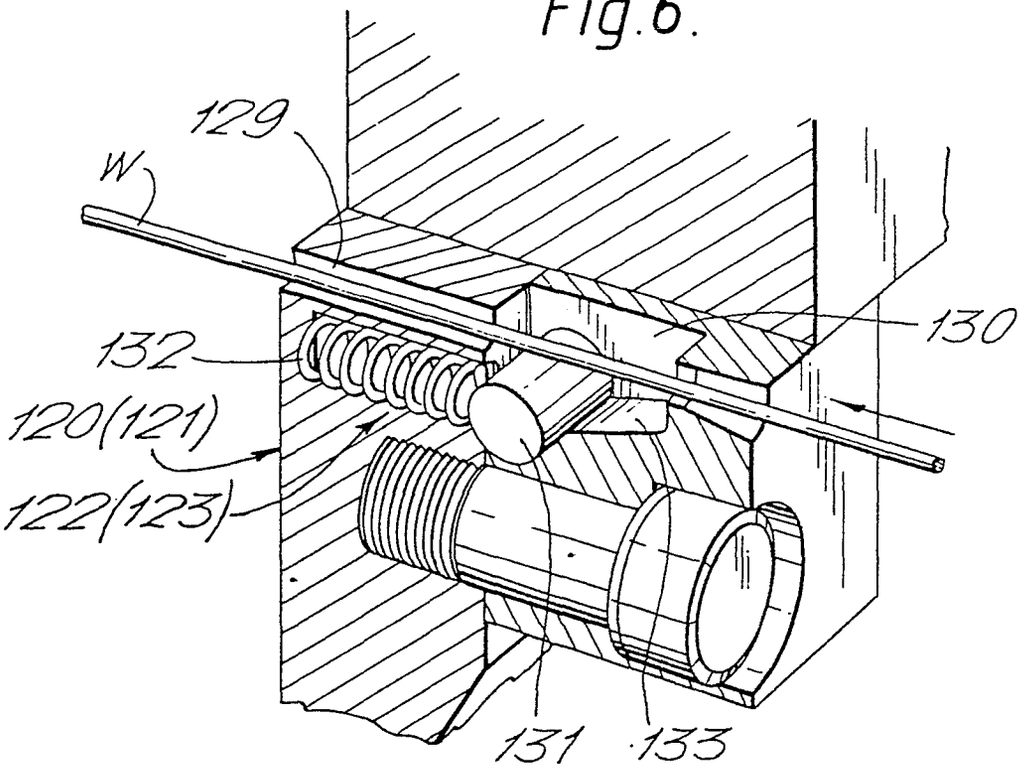


Fig.5.

Fig.6.


129
W
130
132
120(121)
122(123)
131
133

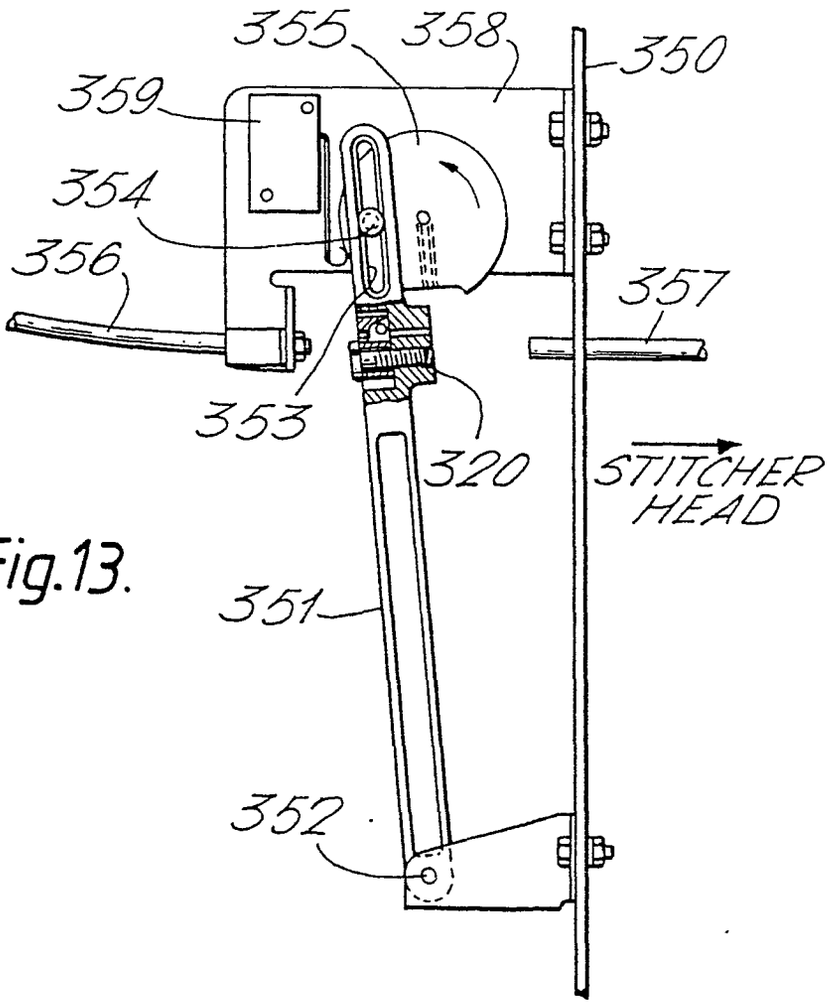
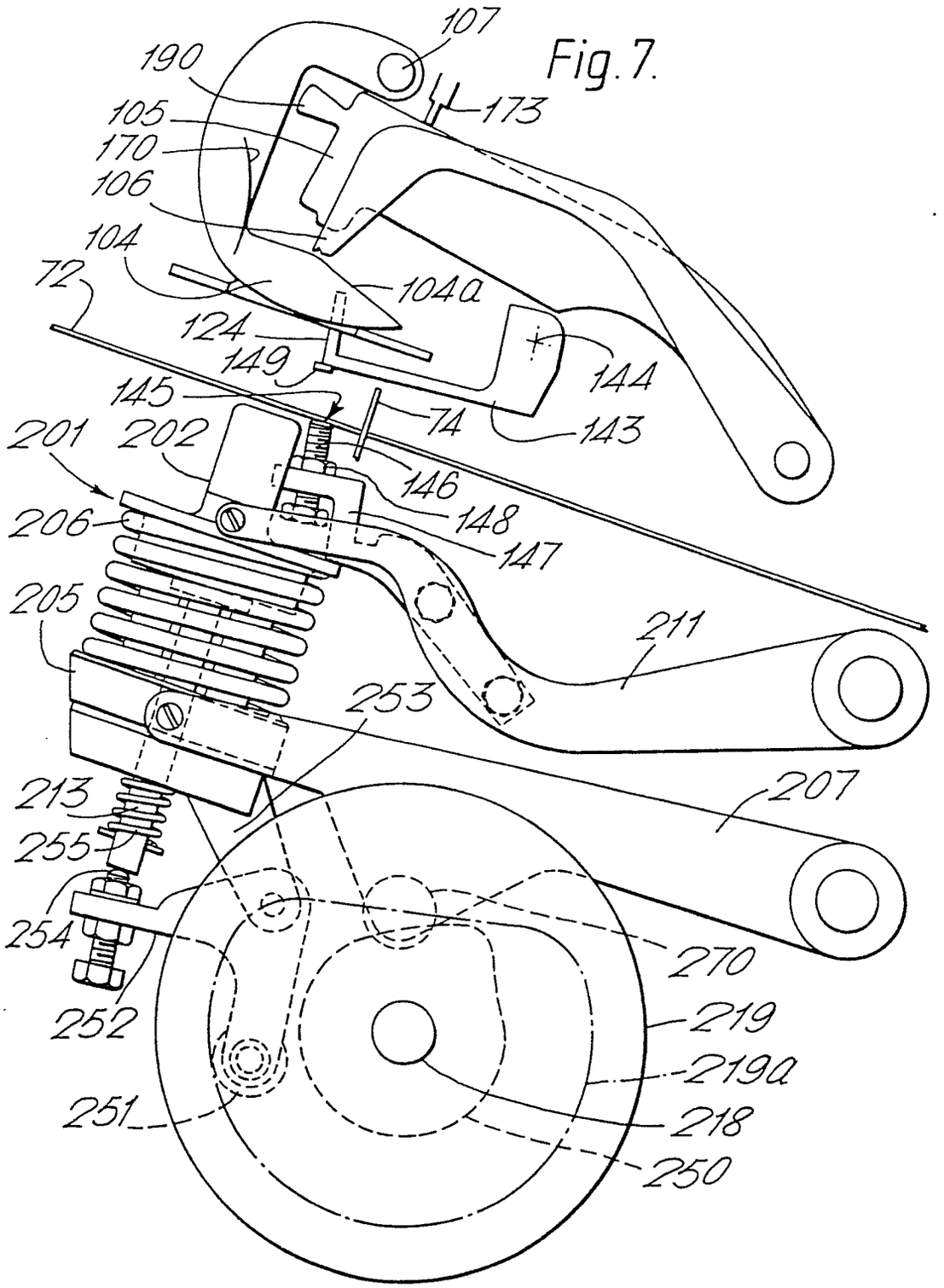

355
358
350
359
354
356
357
353
320
STITCHER HEAD
351
352

Fig.13.

Fig. 7.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190
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170
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104
104a
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124
149
144
145
74
143
201
202
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206
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147
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213
207
255
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219a
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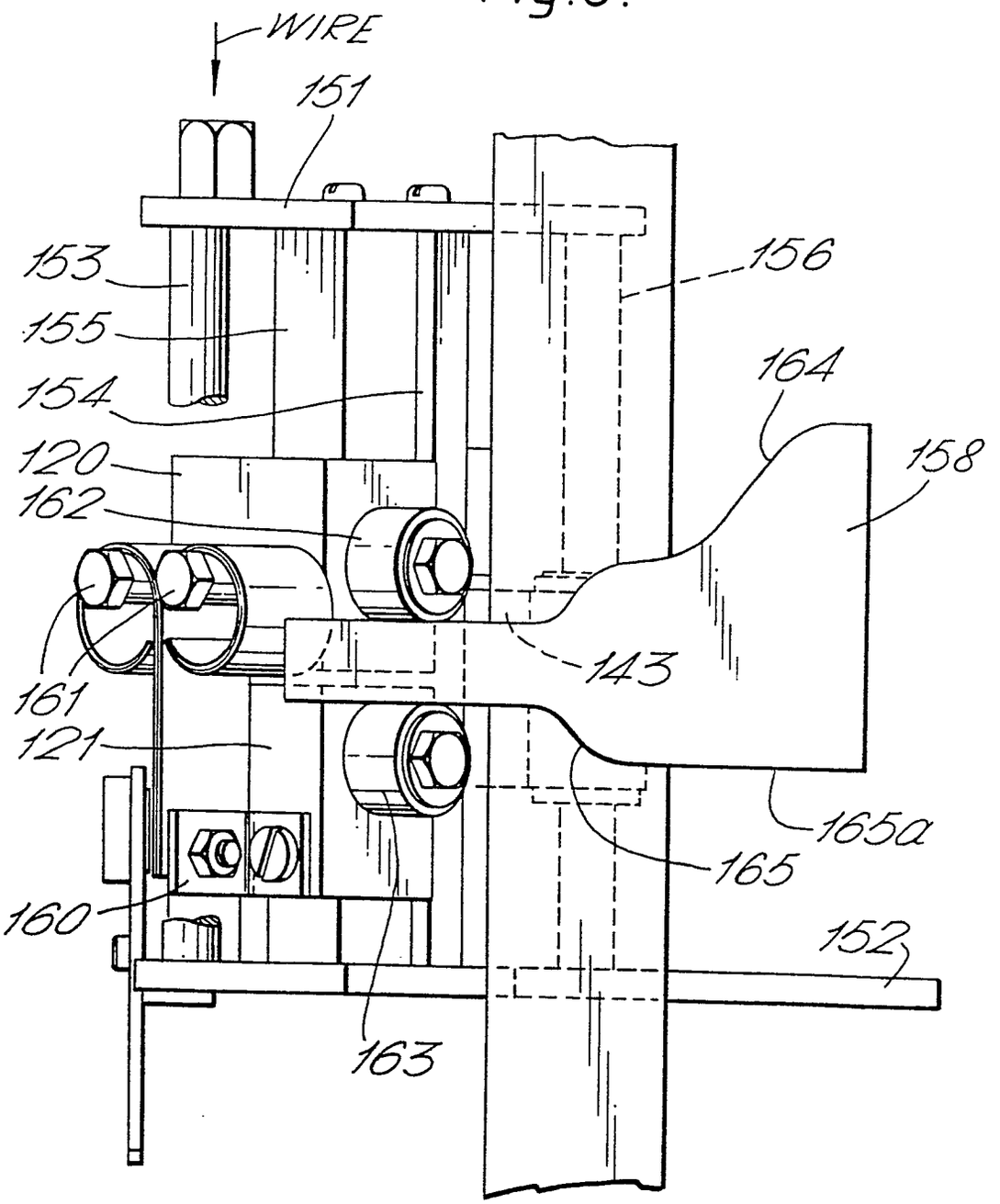
218
250

Fig.8.


WIRE
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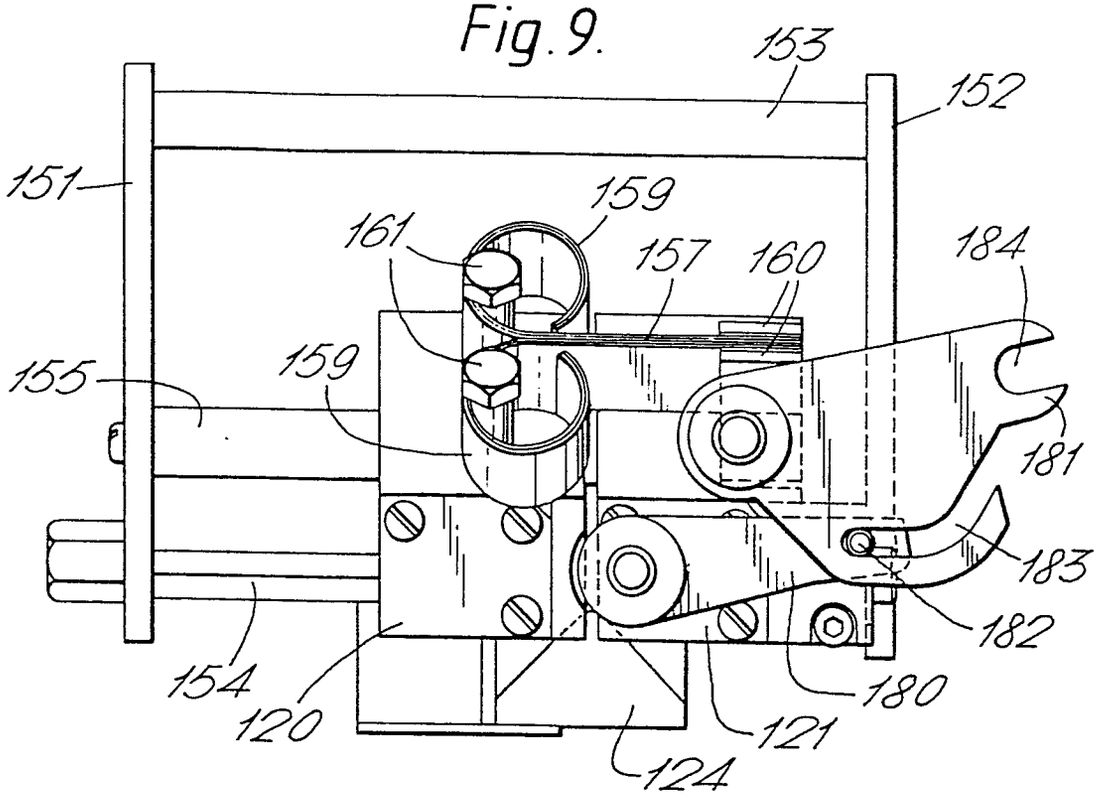
153
155
154
120
162
161
121
160
163
156
164
158
143
165a
165
152

Fig. 9.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152
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157
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184
155
159
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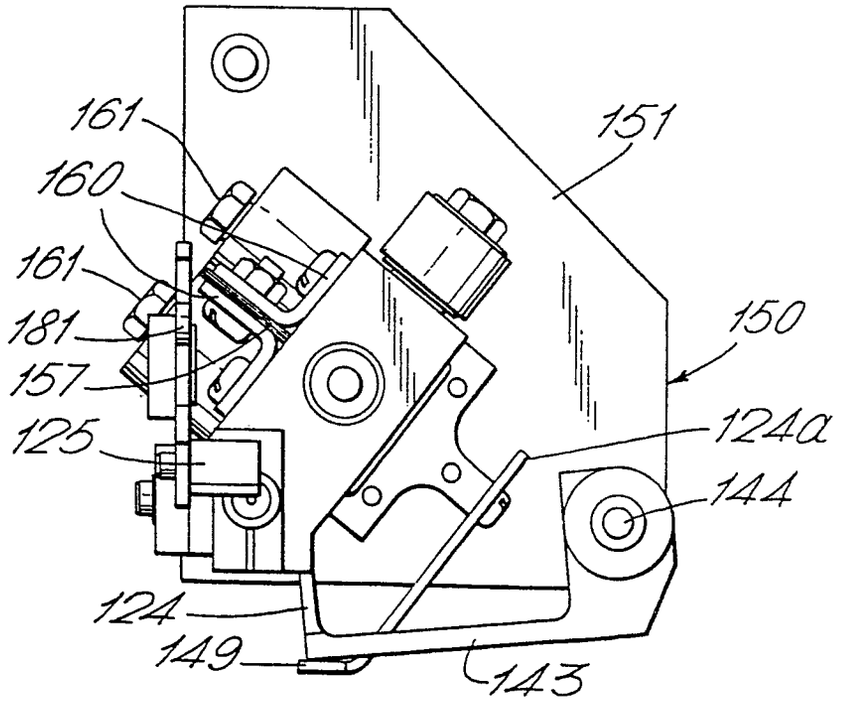
154
120
180
121
124

Fig. 10.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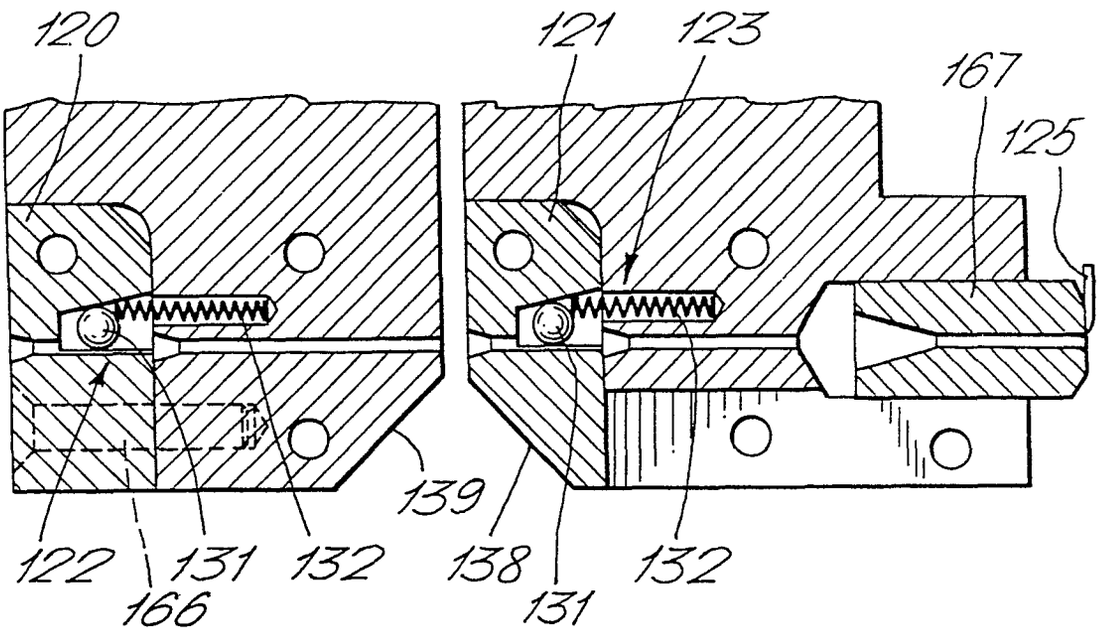
125
144
124
149
143

Fig. 11.



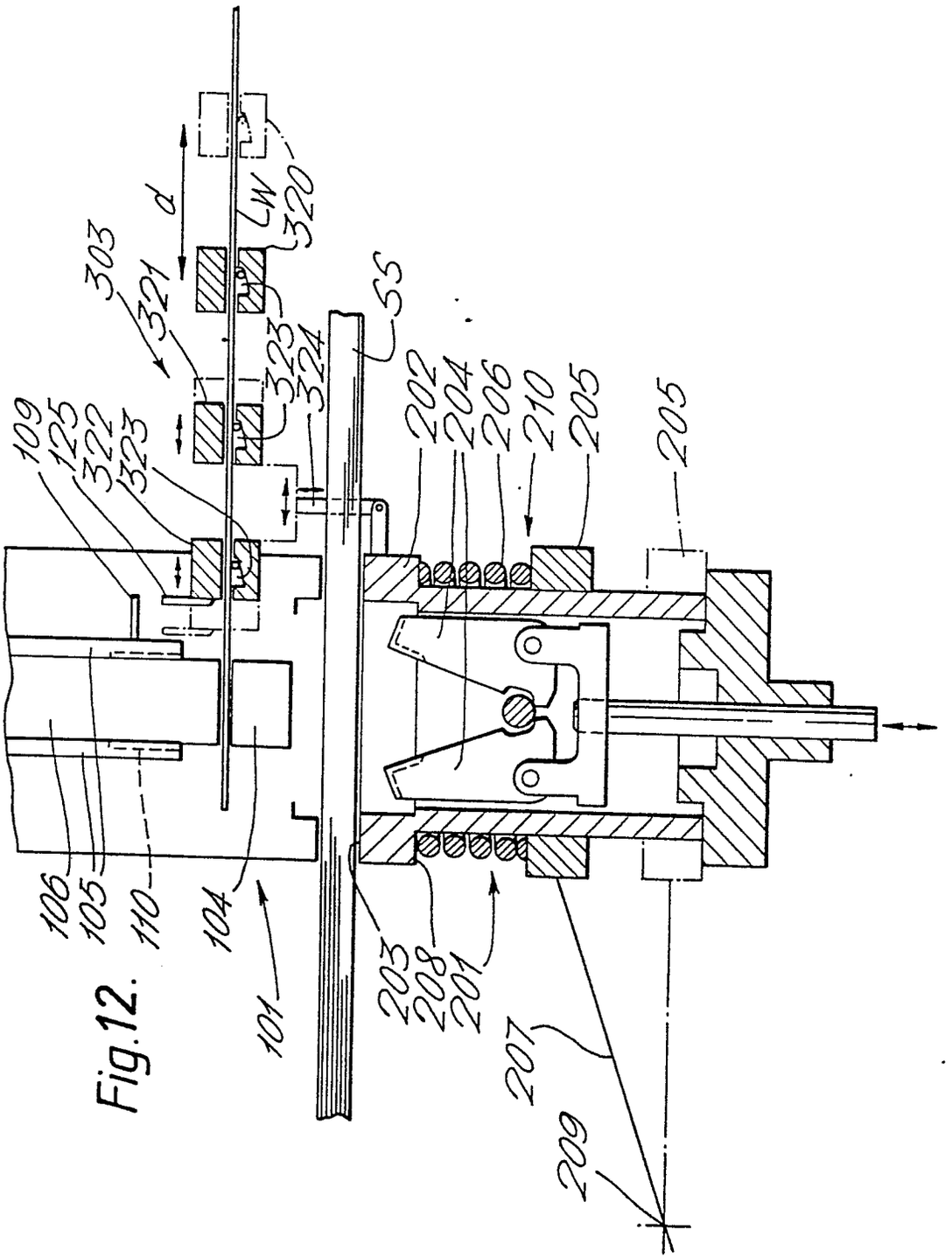

303
321
d
320
LW
55
323
324
109
125
322
323
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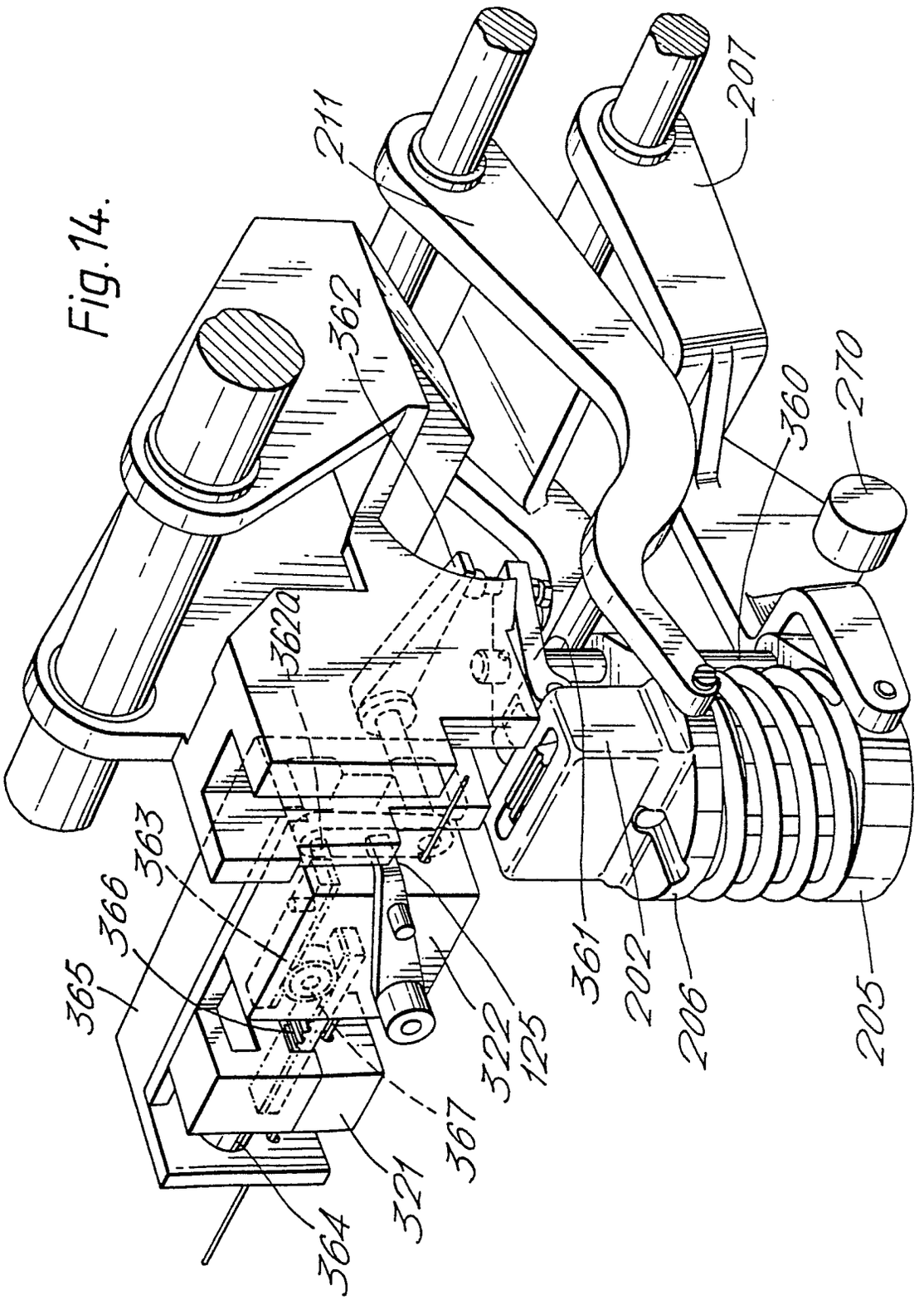
Fig.12.

Fig. 14.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125
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321
364

Fig. 15.

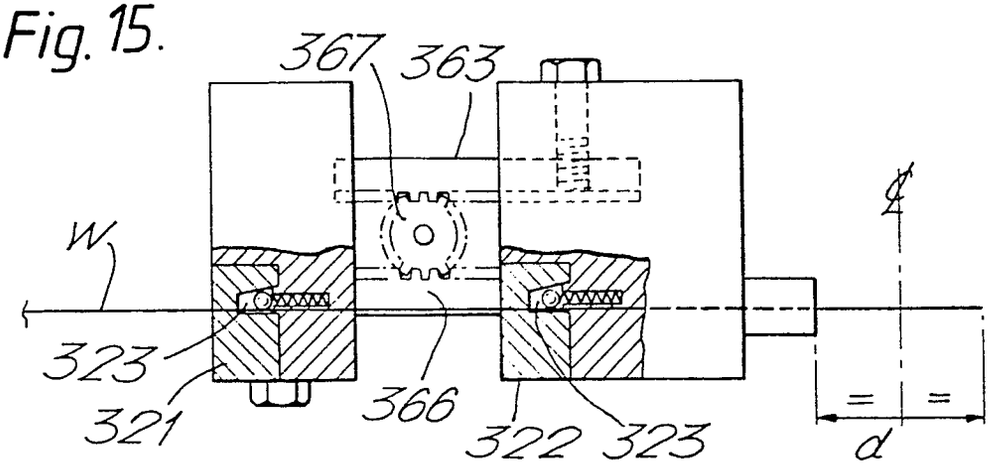


Fig. 16.

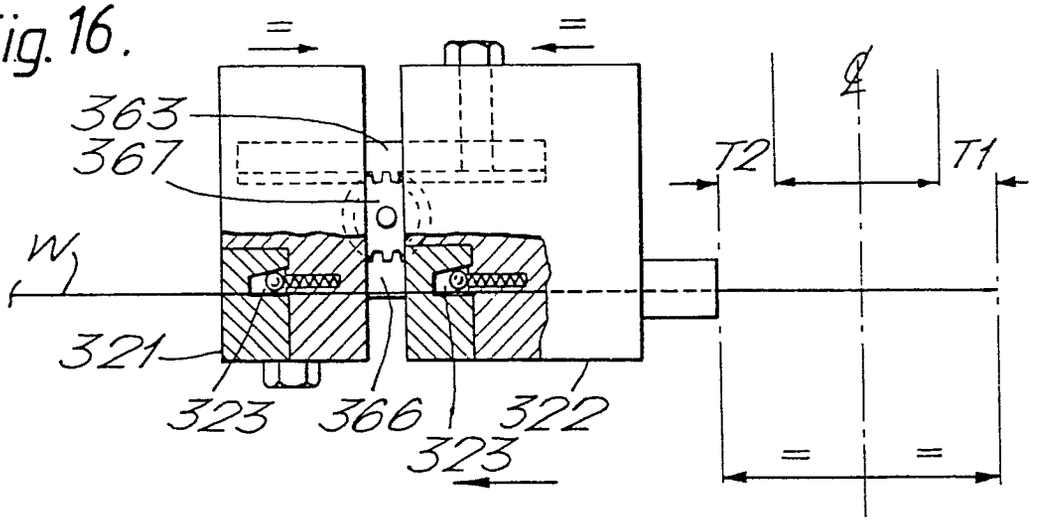


Fig. 19.

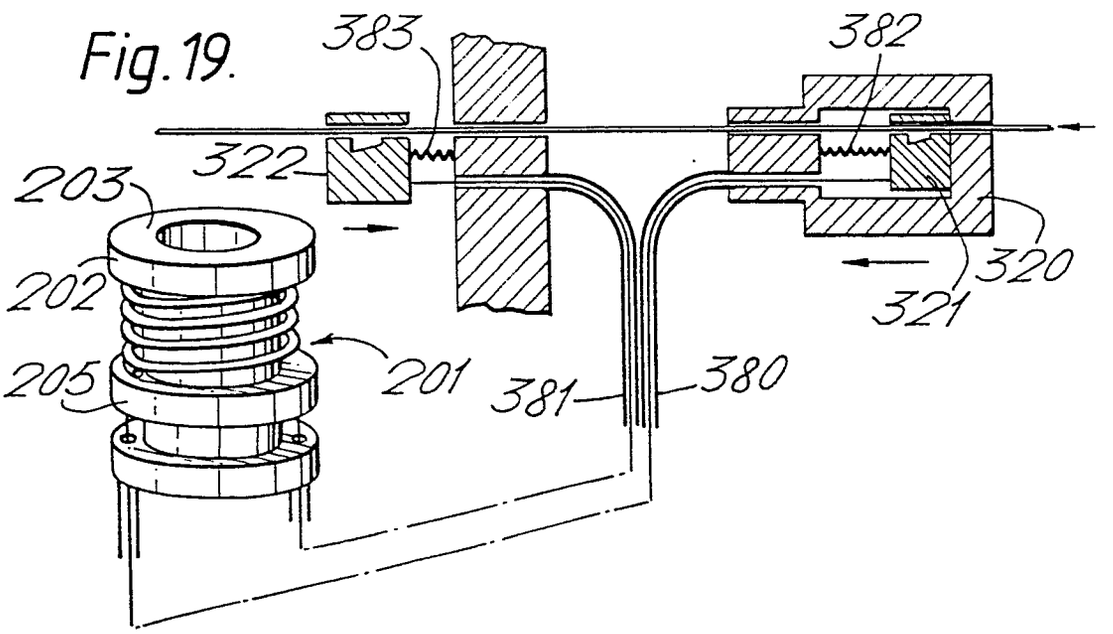
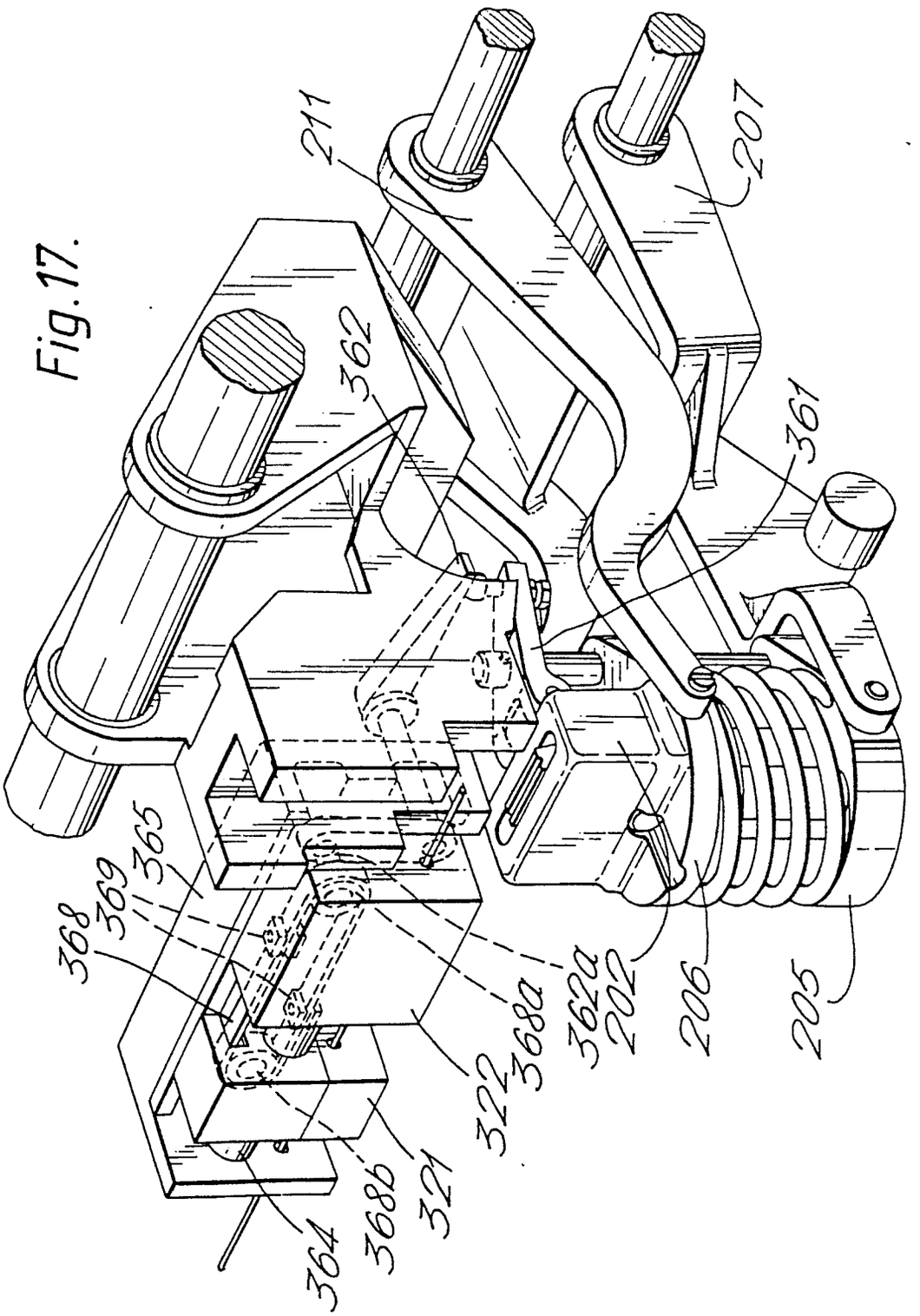


Fig. 17.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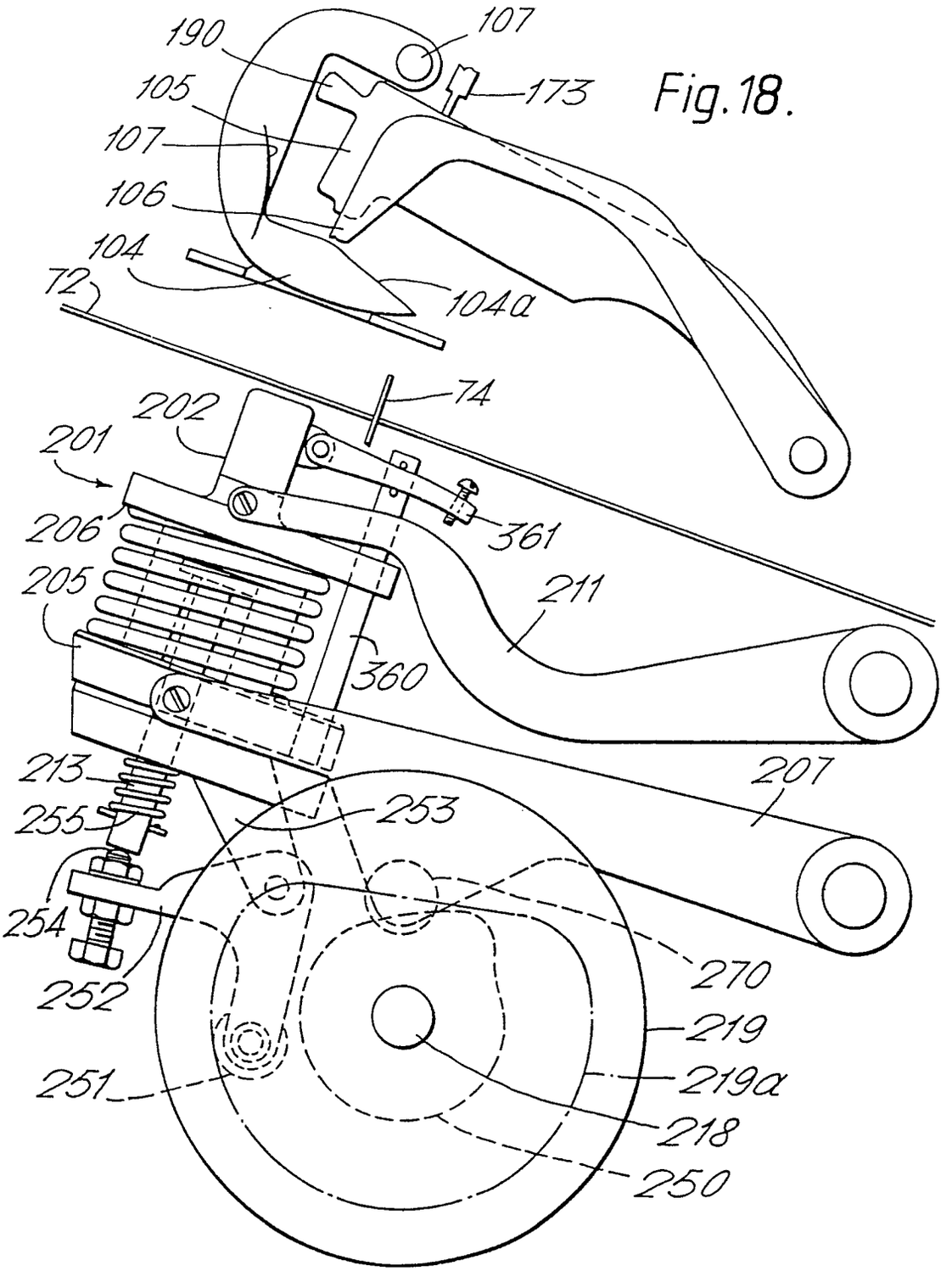
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270
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251
219a
218
250

Fig. 18.

European Patent Office

EUROPEAN SEARCH REPORT

Application number 001316
EP 79 30 3015

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim
X	FR - A - 651 636 (LEIB) * Complete description * --	1,13
A	GB - A - 692 106 (VICKERS) * Page 3, lines 49-90; figures * ----	1

CLASSIFICATION OF THE APPLICATION (Int Cl)

B 42 B 4/00
B 25 C 5/08

TECHNICAL FIELDS SEARCHED (Int Cl

B 42 B
B 25 C

CATEGORY OF CITED DOCUMENTS

X: particularly relevant
A: technological background
O: non-written disclosure
P: intermediate document
T: theory or principle underlying the invention
E: conflicting application
D. document cited in the application
L: citation for other reasons

&: member of the same patent family, corresponding document

X The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	10-03-1980	LONCKE

EPO Form 1503.1 06.78