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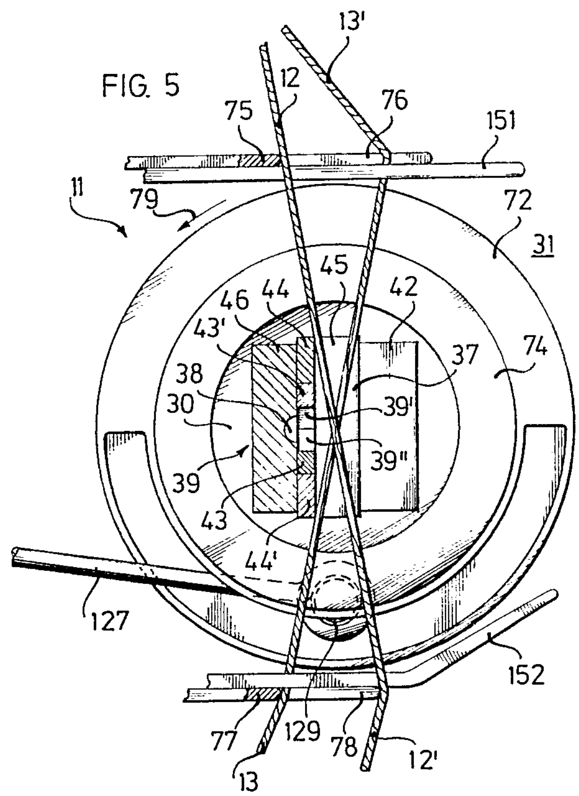
(54) **Apparatus for connecting textile threads by splicing by means of compressed air**

(57) Pneumatic splicing apparatus for connecting textile threads comprising a splicing chamber (30) and thread-holding elements for holding the textile threads supplied from two sides and inserted into the splicing chamber, characterised in that the threads (12, 13) are freed from their thread twist before splicing in the intended region of the spliced connection by means of a controllable thread twist varying element (31).

FIG. 5



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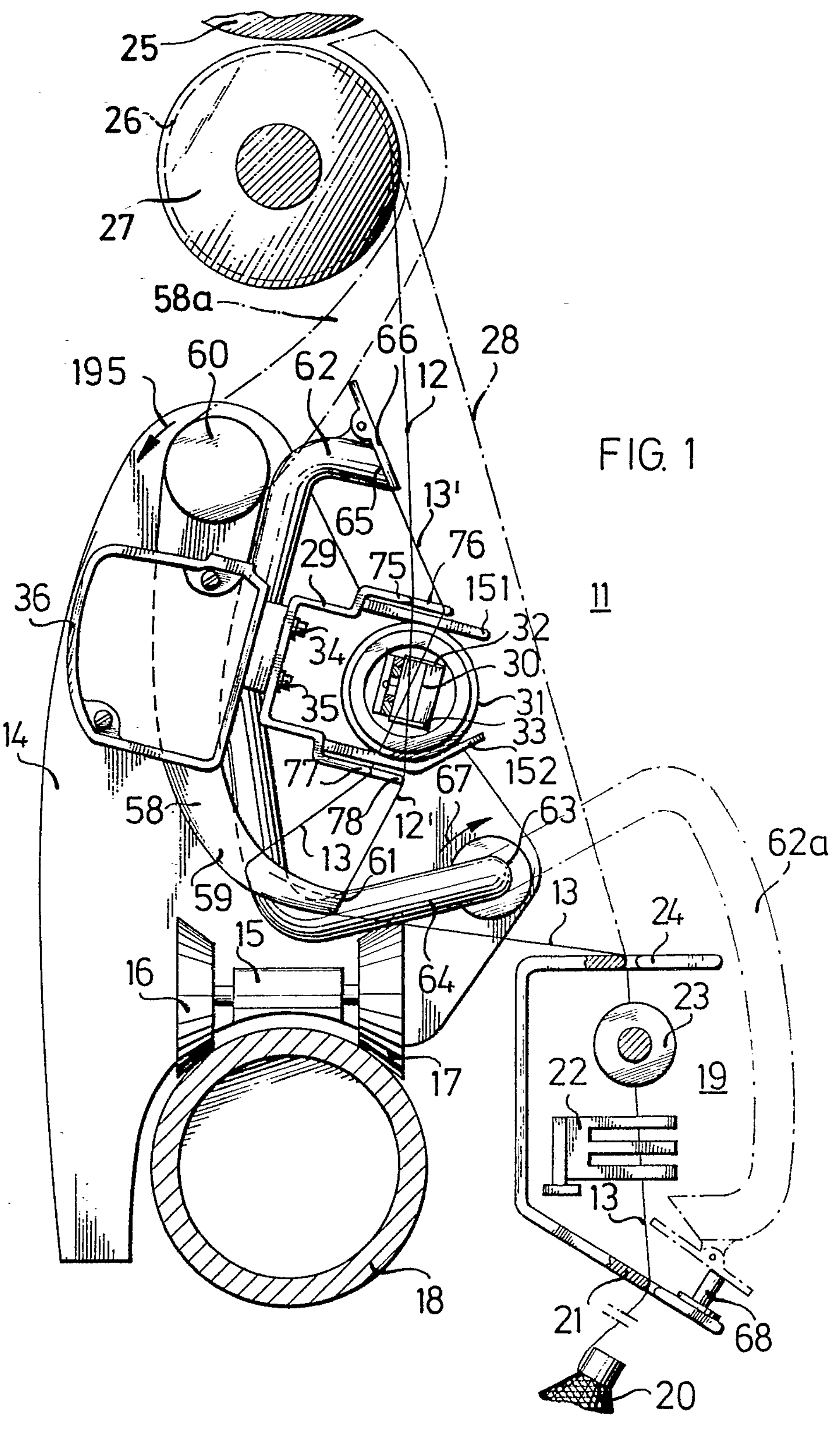
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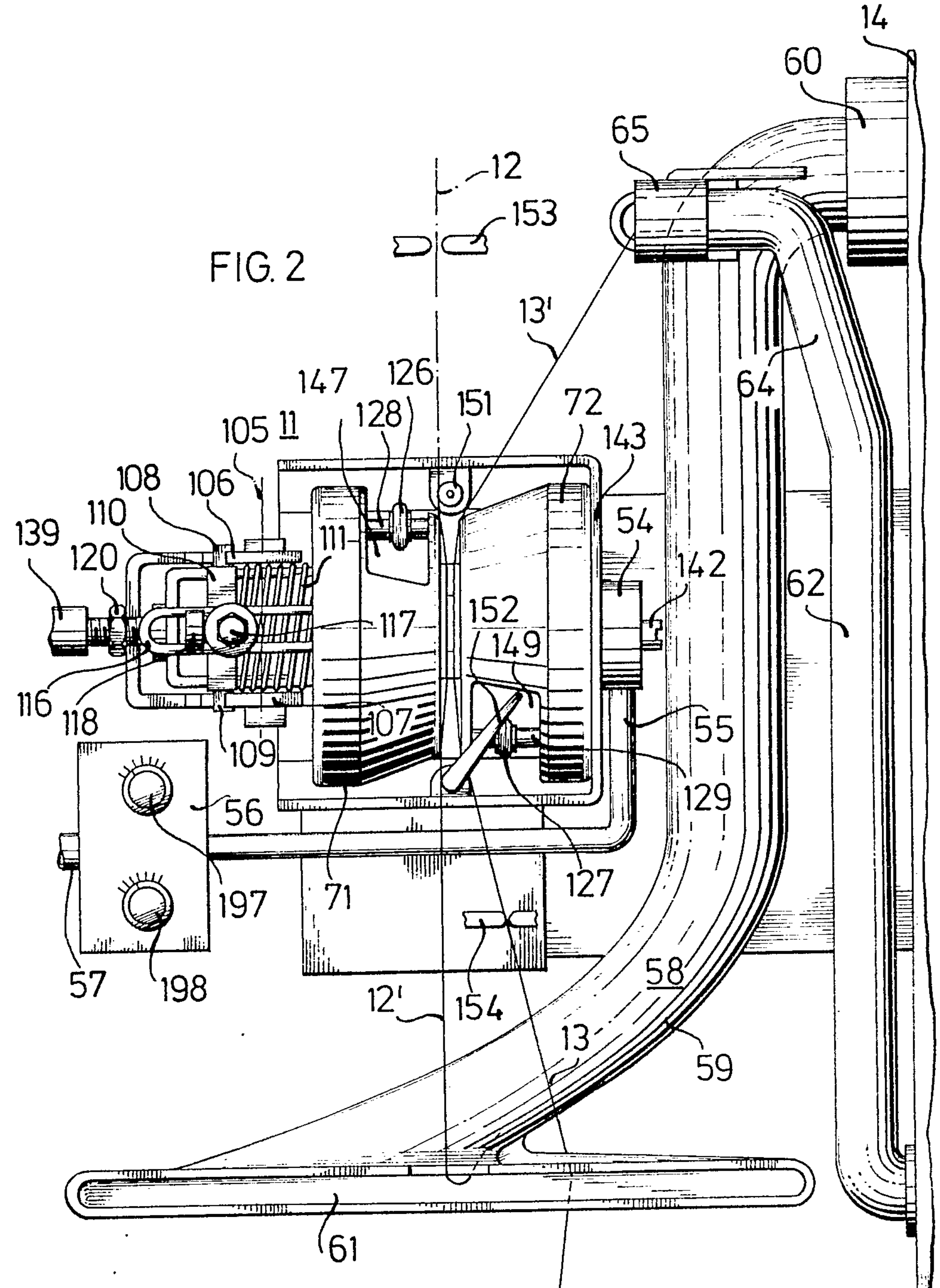
FIG. 1

FIG. 2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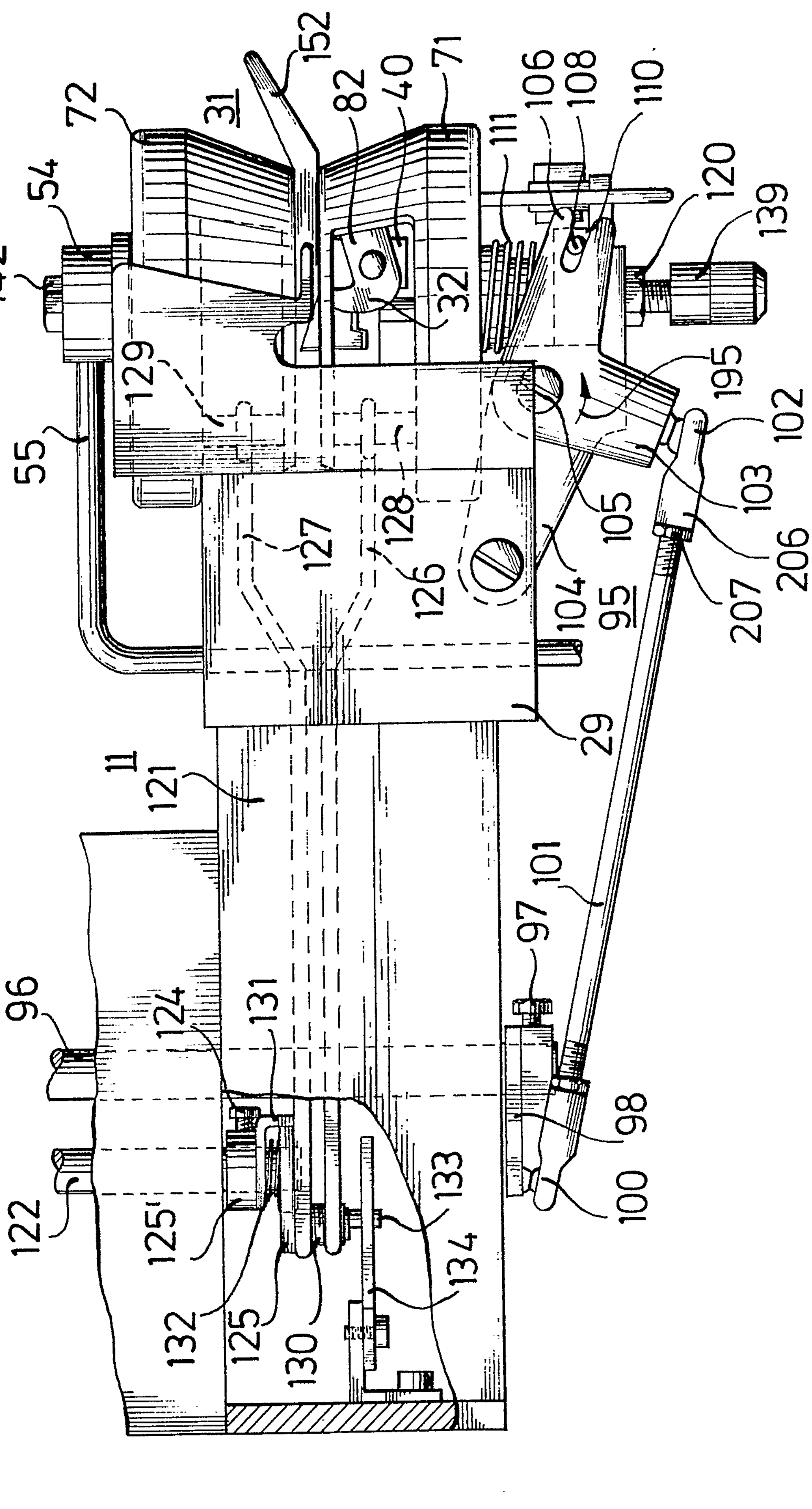
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FIG. 3

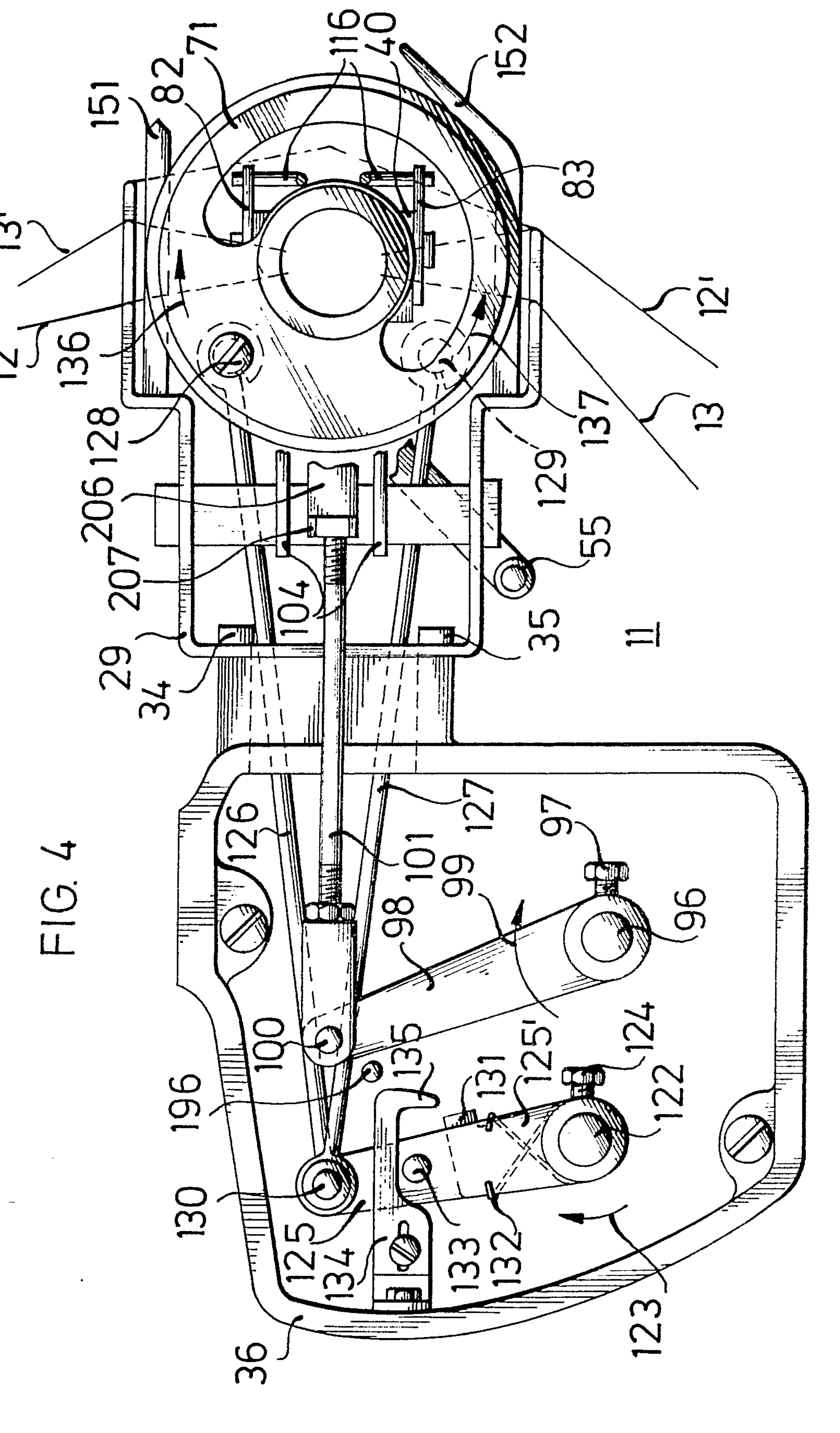
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FIG. 4

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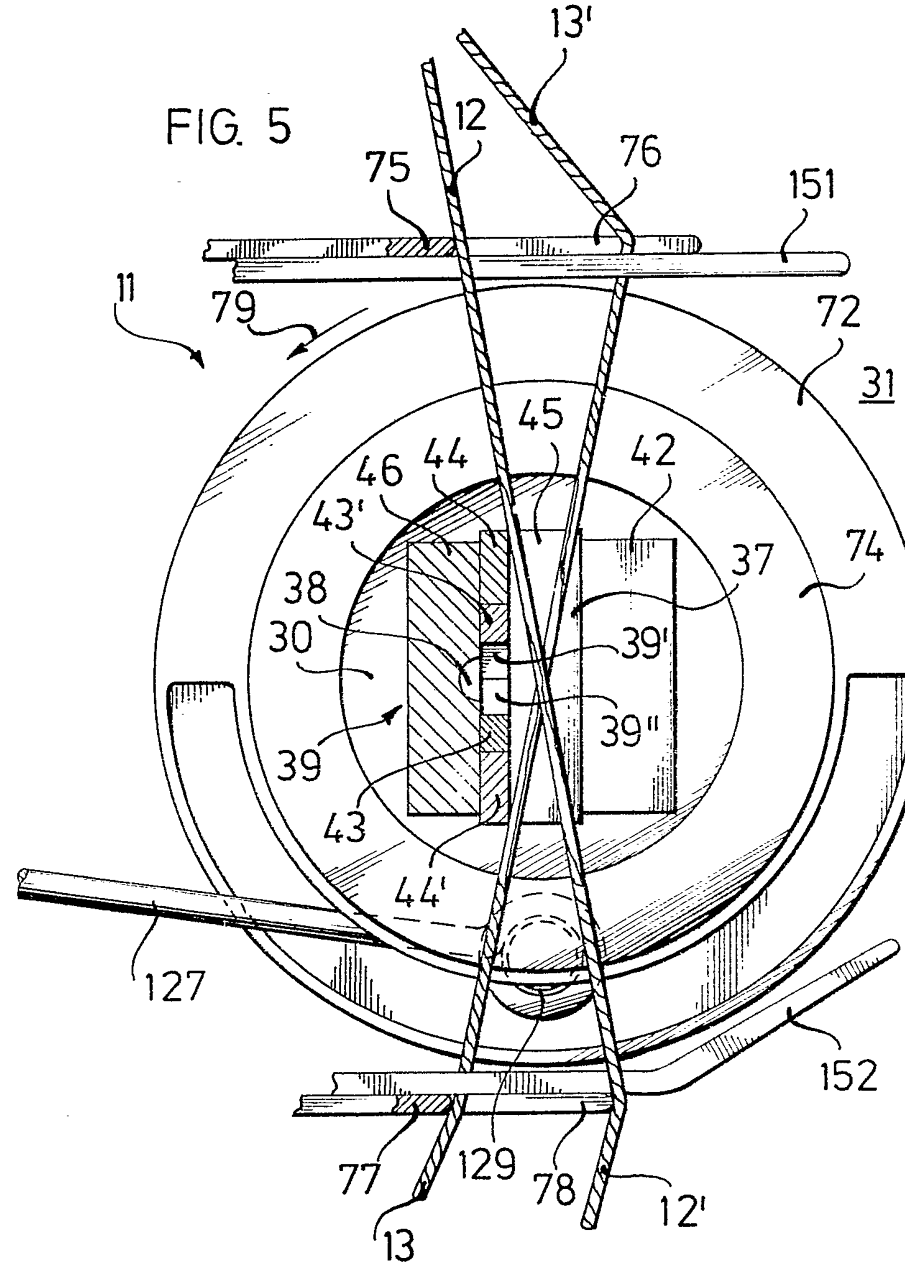
FIG. 5



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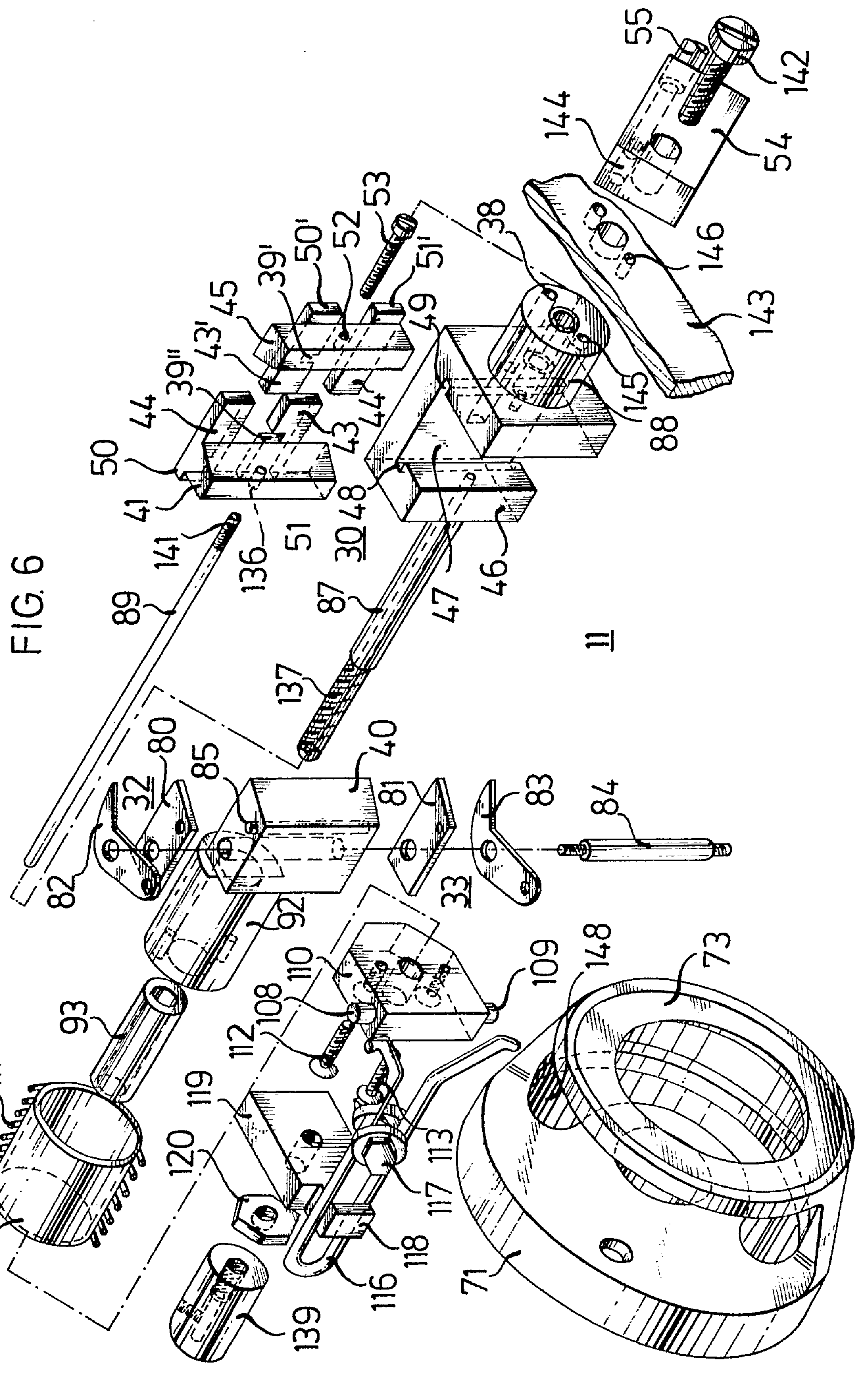
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FIG. 6

FIG. 7

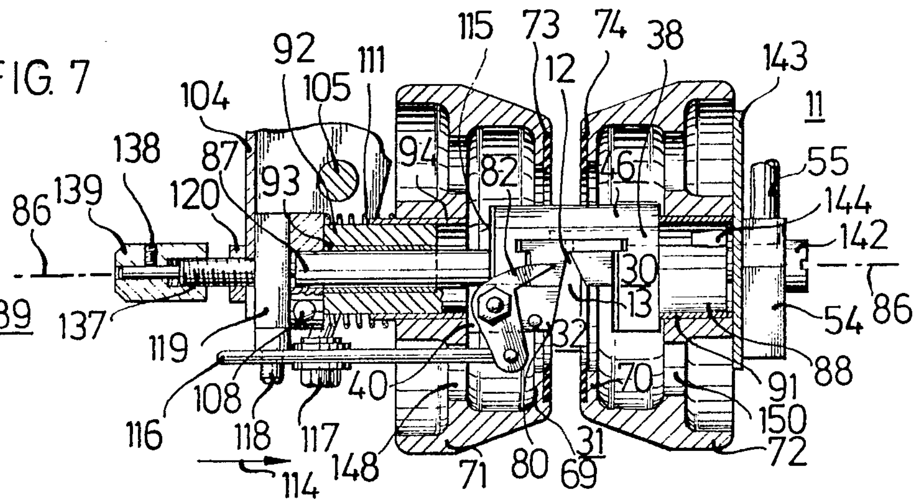

FIG. 8

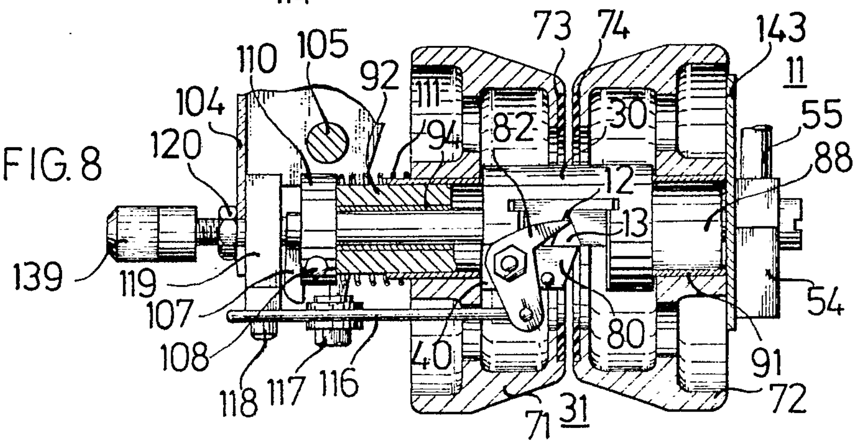

FIG. 9

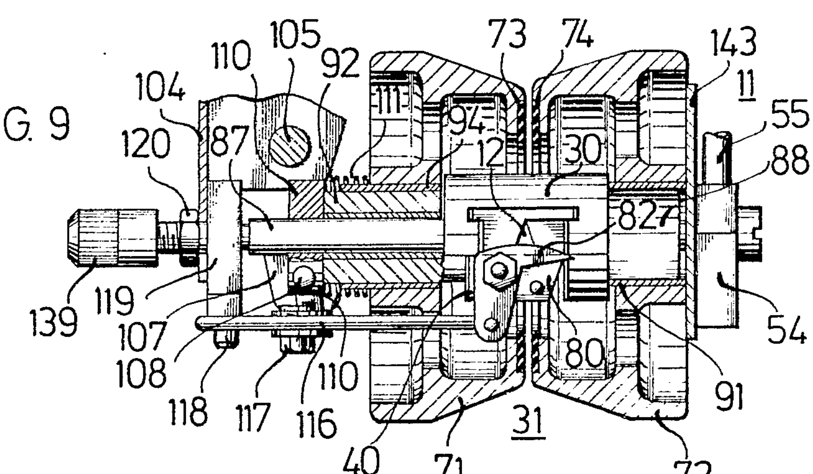

FIG. 10

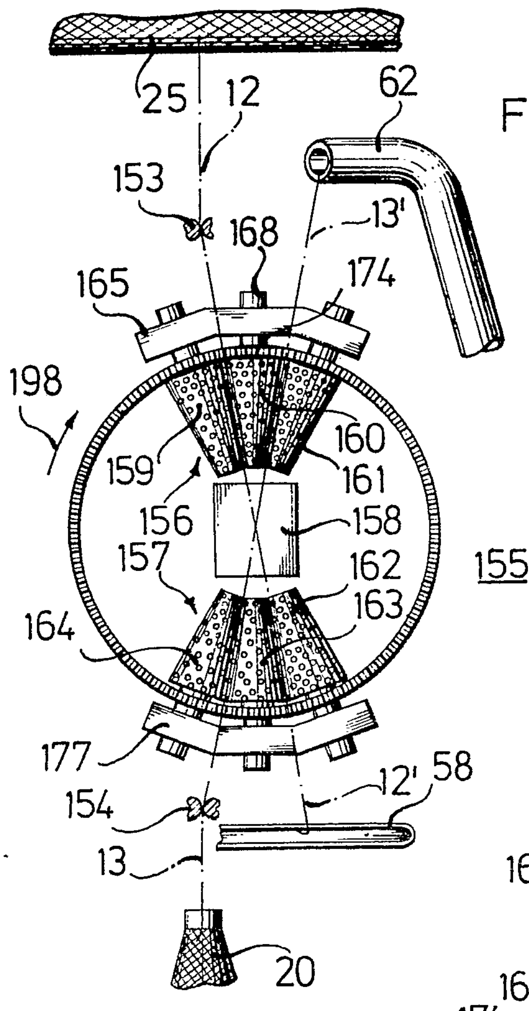
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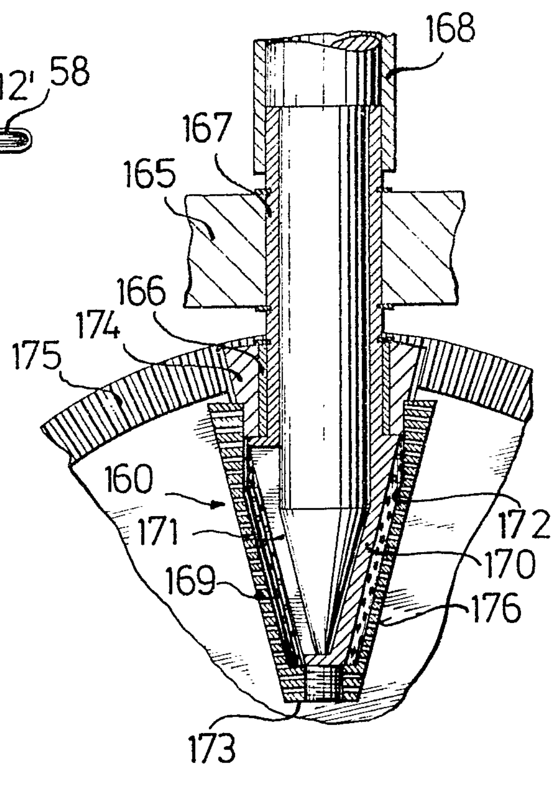
FIG. 11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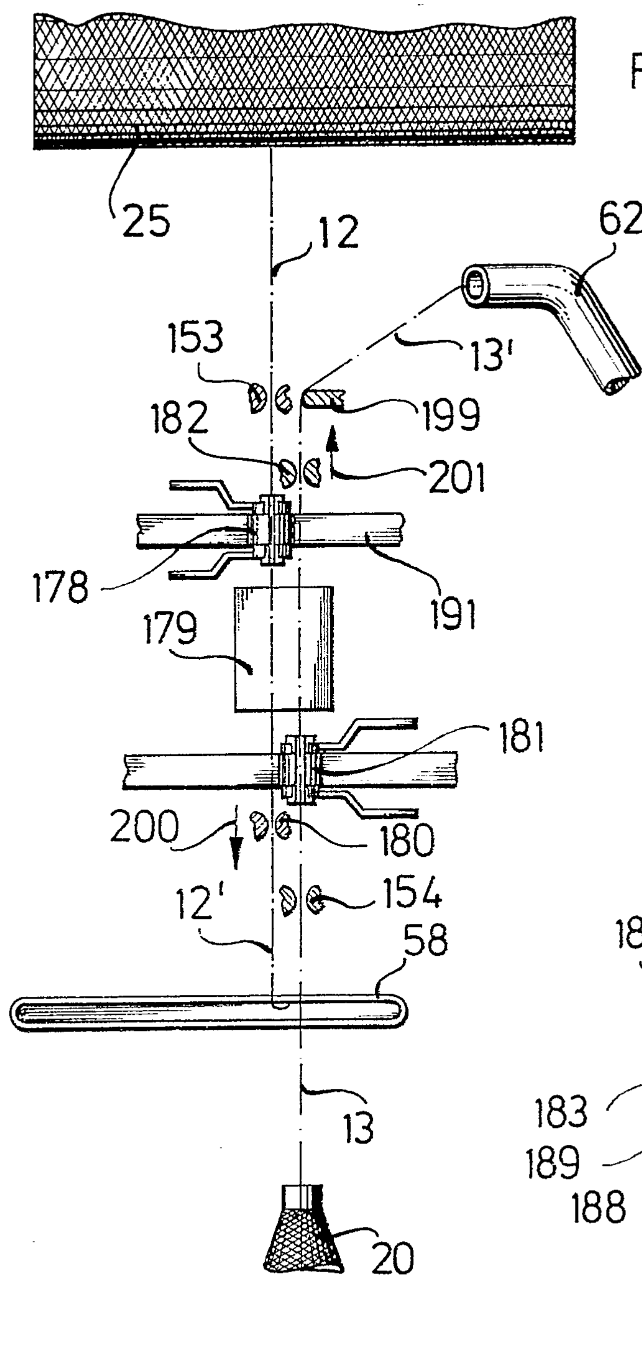
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FIG. 12

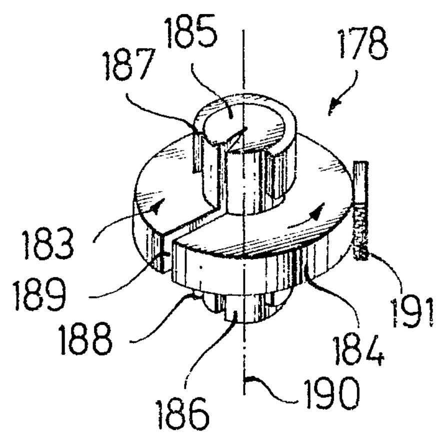
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FIG. 13

FIG. 14

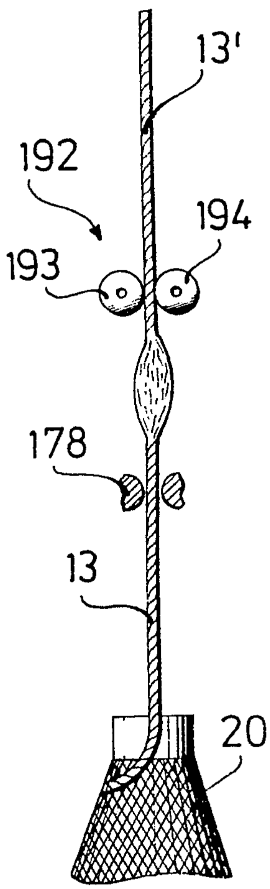

FIG. 15

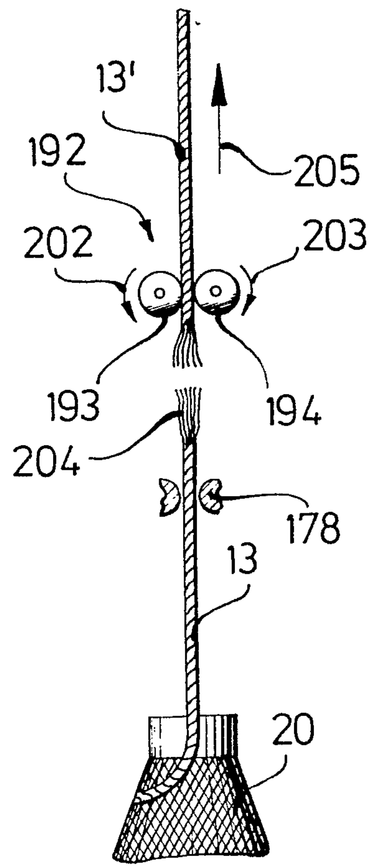

FIG. 16

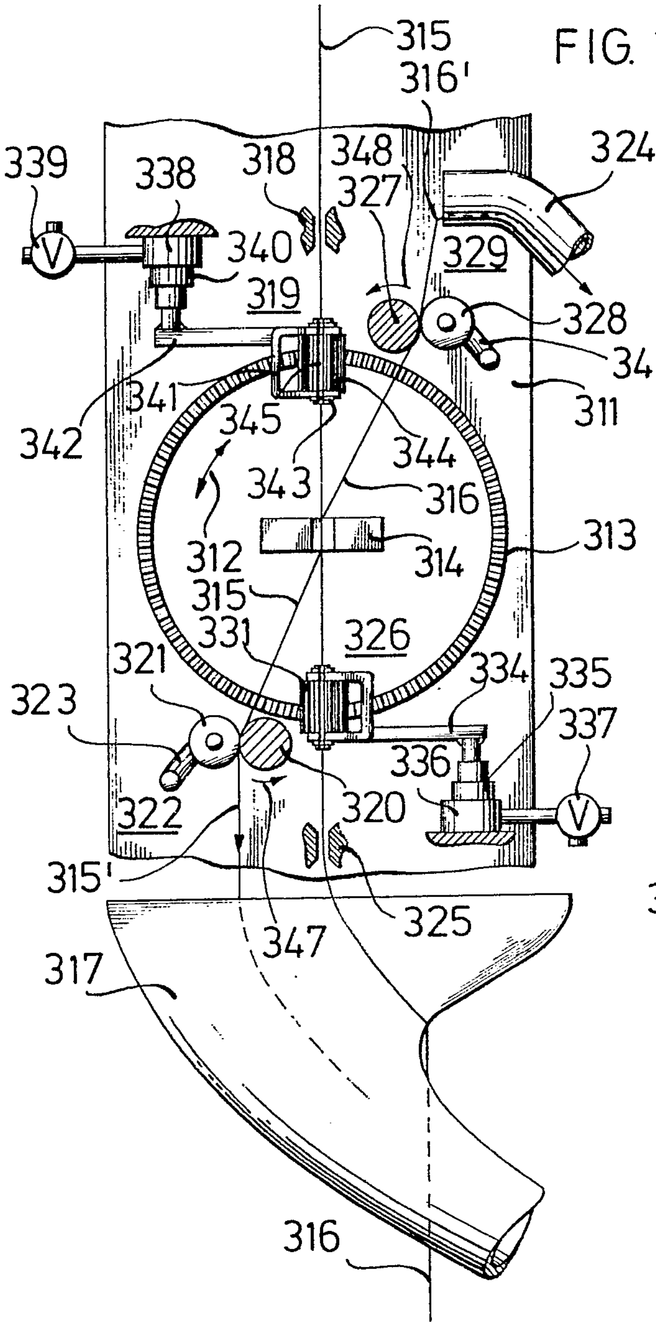
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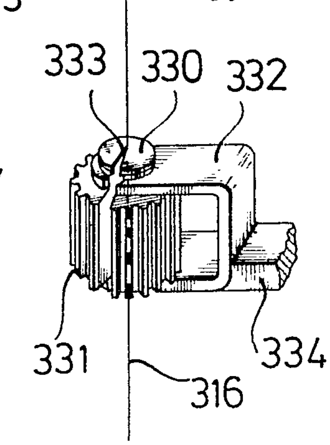
FIG. 17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SPECIFICATION

Method and apparatus for connecting textile threads by splicing means of compressed air

The invention relates to a method according to the opening statement of Claim 1 and a pneumatic splicing apparatus for carrying out the method according to the opening statement of Claim 4.

From Ger.Pub.Sp. 28 10 741 a method and a pneumatic splicing apparatus have become known in the use of which all quality-reducing influences and influences dependent upon manual skill in the production of a spliced connection are to be excluded.

However it has appeared that not all threads are equally suitable for splicing. With the methods and apparatuses known hitherto it is difficult or utterly impossible to splice heavily twisted threads especially.

The invention is based upon the problem of indicating a method and an apparatus with which even in the case of heavily twisted threads a good spliced connection can be produced.

As regards the method, this problem is solved by the invention as described in Claim 1. The new apparatus suitable for carrying out the method is described in Claim 4. Advantageous developments of the invention are described in the other Sub-Claims.

Before examples of embodiment of the invention are explained in greater detail, firstly reference should be made to the advantages of the invention.

When before splicing the threads are freed from their thread twist in the intended region of the spliced connection, the fibres of the two threads can mix well in pneumatic splicing. In this case it is not necessary to stretch the fibres as well, although this can do no harm and sometimes can have advantages. It is sufficient merely to free the threads from their thread twist. Therefore the individual fibres do not need to be stretched or made parallel. If the threads are free if only partially from their thread twist, in specific cases successful spliced connections are already possible. The lest thread twist is present at the splicing position, the better in general does the spliced connection become.

The freeing of the threads from their thread twist can already take place before they come into the splicing chamber. Thus prepared thread ends can be inserted into the splicing chamber. This has the advantage that the appearance of the prepared thread ends can be observed at any time. On the other hand other advantages arise if the threads are freed from their thread twist only when they are already situated in the splicing chamber. Then in fact they can be held fast by thread clamps placed outside the splicing chamber in such a way that the thread ends also remain clamped. The thread ends themselves in this case are not freed from their thread twist, but the threads are freed from their thread twist exactly only in the intended region of the spliced connection, which does not need to be the thread end.

Splicing with compressed air takes place, as is known, by entwining of the individual fibres. Even without a thread twist subsequently applied to the splice, in general here a durable spliced connection results.

If however the threads have very short fibres, it is better to provide the splice with a thread twist after splicing. It is an advantageous measure in this direction to shift the thread twist out of the intended region of the spliced connection into the thread regions extending from the splicing chamber to the thread clamps, and to release it towards the splice after splicing. This measure is the more effective if then firstly the respective thread ends are also held fast, accordingly the threads are freed from their thread twist only when they are already situated in the splicing chamber.

After splicing the excess thread ends are ordinarily cut away. A better spliced connection entirely without troublesome thread ends is obtained if the excess thread ends are removed by plucking out. This can be effected before splicing and/or during splicing and/or after splicing. The nature of the threads determines which moment is the most favourable in this case. Sometimes it can be better to carry out the plucking as slowly as possible and in other cases again as quickly as possible. The plucking out takes place for example by slowly increased traction on the thread ends, so that the excess fibres detach themselves slowly from the splice. In the case of short fibres on the contrary it can be more favourable for this purpose to tear out the excess thread ends from the splice, preferably after the completion of the spliced connection, by a brief jerk.

The mentioned advantages are obtained by the use of the thread twist varying element according to the invention, which is arranged in the thread region extending from the splicing chamber to the thread holding element. The thread twist varying element is controllable, not only as regards the working duration and the moment of working, but also as regards the amount of thread twist variation. It is not here necessary to eliminate the thread twist completely. In general only a displacement of the initially uniform thread twist occurs to the effect that in the intended region of the spliced connection the threads are freed from their thread twist, while the neighbouring regions receive an increased thread twist. It is self-evident that the thread twist varying element according to the invention takes account of the direction of the thread twist, with a Z-twist or S-twist. Otherwise the idea of the invention would not be realisable. It is also to be ensured that threads of like twist, that is either threads with Z-twist or threads with S-twist, are connected with one another.

Whether a thread twist varying element is used for each thread or whether a thread twist varying element common to both threads is used is greatly dependent upon the construction style of the thread twist varying element. The construction style of the thread twist varying element is again determined according to the nature of the threads. It is an advantage here that the invention proposes different styles of construction of thread twist varying elements.

In the case of a simple form of embodiment the thread twist varying element acts only upon the threads running to the splicing chamber but not on the thread ends protruding from the splicing chamber. The thread ends in any case are removed. Admittedly, as already mentioned, the better splicing result is obtained if the thread twist varying element is capable of acting both upon the threads leading to the splicing chamber and upon the thread ends protruding from the splicing chamber. In the case of such a construction of the thread twist varying element the threads in the region of the spliced connection are always reproducibly constantly prepared for splicing.

The thread twist varying element advantageously comprises a rotatable thread-holding element. In the simplest case this can be a twist clip which receives the thread and is then rotated about the longitudinal axis of the thread.

The rotatable thread-holding element advantageously possesses a displacing device for displacement along the thread axis.

The advantage here consists in that the pneumatic splicing apparatus is suitable for universal use. In the case of thin threads with short fibres for example the thread-holding elements are brought closer to the splicing chamber than in the case of thicker threads with longer fibres. A toothed ring driving the thread-holding elements can be driven for the purpose of splicing preparation, according to the thread twist, whether a Z-twist or S-twist, in the clockwise direction or in the counter-clockwise direction until the thread twist is eliminated at the splicing position. Since a build-up of twist occurs every time here behind the thread-holding elements, after the splicing the thread twist is passed to the splice, eliminating the build-up of twist, by reversing rotation of the toothed ring.

Good splicing results were achieved with a thread twist varying element which comprises at least one friction face bringable into contact with the thread and movable transversely of the longitudinal direction of the thread. It is still better if the thread twist varying element comprises at least two friction faces which are bringable from opposite sides into contact with the thread and movable in opposite directions. This applies preferably for a movement directed forward and subsequently back again after splicing, so that the thread twist is applied to the finished spliced connection not solely by release of the threads but additionally by positiv twisting.

The friction faces can lie on the surface of a body of strip, cylinder, cone, annular or disc form. The mutually opposite friction faces thus lie against the thread. If the two friction faces are moved at equal speed transversely of the thread longitudinal direction, the thread rotates about its own axis but remains in its direction and is also still clamped. It is advantageous here to produce the friction face by the use of a material having a high friction value, especially using a rubber-elastic material or thermoplastic synthetic plastics material. Admittedly here this must not be a rough surface on which fibres can be seized fast.

A simple and especially effective apparatus results if the thread twist varying element comprises two oppositely rotatingly drivable halves which grasp in cage or pot manner around the splicing chamber and are provided with annular-type edges, which edges carry the friction faces bringable into contact with the thread. These two halves of the thread twist varying element thus enclose the splicing chamber. When the halves are opened the threads can be inserted, preferably crossed, into the splicing chamber. Crossing of the threads on insertion has various advantages. One advantage results when the splicing chamber is arranged exactly centrally and the threads are conducted exactly radially, but with spacing from one another, through the thread twist varying element. If now the two halves of the thread twist varying element rotate oppositely, the threads rotate exactly about their longitudinal axis which remains stationary in three dimensions. The amount of the adjustable angle of rotation by which the two halves of the thread twist varying element are rotated in relation to one another with the threads inserted, and also the direction of rotation, are dependent upon the thread dimensions and the thread twist.

In place of the last-mentioned form of embodiment of the thread twist varying element another can also be selected in which the threads are rotated about their longitudinal axes by pairs or groups of rolls rotatable in the same direction and placed in close proximity to one another than the thread diameter. The roll pairs or groups can be formed for example as tapered rolls of which the tapered end points towards the splicing chamber. The longitudinal axes of the individual rolls in this case point radially towards the splicing chamber. The threads to be spliced are here again guided radially through the splicing chamber. In this guidance they are in contact with the rolls on a peripheral line preferably having a straight course. If such a thread twist varying element possesses two opposite rolls groups each of three tapered rolls, then each of the two threads can be guided and held both on the tapering section and at the thread end in each case between two rolls. The drive of such tapered rolls is of quite simple design if the rolls comprise toothed wheels which mesh with a toothed ring arranged in common for all rolls. In the case of this embodiment of the thread twist varying element the surfaces of the rolls are formed as friction faces. They should have firm contact with the thread, without damaging it. Such rolls can be formed for example as hollow cylinders, having a perforation and connected to an air suction device. The air suction then holds the thread fast, and in fact the suction effect is strongest at that straight generatrix of the roll which lies at the shortest distance opposite to the neighbouring roll. The effect of the air suction upon the thread prevents undesired slipping of the thread out of the line of contact between thread and roll.

The last-mentioned for of embodiment of the thread twist varying element has a quite simple assembly. The tapered rolls can also be produced at favourable price as mass-produced articles. This form of embodiment is advisable where an air suction installation is in any case already present.

It is helpful to the purpose of the invention if the splicing chamber itself is of optimum formation and adapted to the presence of a thread twist varying element. Therefore it is also advantageous if the splicing chamber comprises a controllable sliding lid in place of a hinged lid. A sliding lid does not need so much free space as a hinged lid and is simpler to control, especially if the splicing chamber itself is variably adjustable. This is advisable likewise for adaptation to the universally usable thread twist varying element.

The thread twist varying element can be optimally exploited only if the splicing chamber is not only variably adjustable but if also the size of the blow-out opening of the splicing chamber is variable adjustable. Here especially an increase or decrease of size of the blow-out opening in the same direction with the increase or decrease of volume of the splicing chamber is advisable. In the case of thin threads the splicing chamber has a smaller volume, in the case of thicker threads a larger volume, stated quite roughly. Exceptions are possible here too, namely with regard to the nature and magnitude of the thread twist and to the nature of the thread in other respects, especially also with regard to the nature and length of the fibres.

Advantageously at least one side wall of the splicing chamber is displaceable. The displaceability then is advantageously parallel with the direction of displaceability of the sliding lid. Thus for example the displaceable side wall of the splicing chamber can be formed as a slider which slides along on the bottom and on a bottom opening, serving for compressed air supply, of the splicing chamber. The side wall can here advantageously form one construction unit with a part of the bottom of the splicing chamber. Advantages in manufacture due to standardisation are then obtained if the non-displaceable side wall has the same form as the displaceable side wall, while the bottom parts of the two side walls interengage in comb manner and in doing so form a blow-out opening for example by mutually opposite apertures. The compressed air supply here takes place advantageously through a compressed air supply passage which is arranged in a housing in which all the parts of the splicing chamber are also mounted.

Since the adjustment of the splicing chamber and also the adjustment of the thread twist varying element are to take place according to the thread twist, the staple length or the fibre length, the thread thickness, the fibre material and the fibre thickness, a fine adjustment device for the adjustable side wall is advisable. Such a fine adjustment device should advantageously be very compact. This requirement is fulfilled if the fine adjustment device consists of the following parts:—

a) A threaded spindle engaging in a female threading situated in the adjustable side wall,

b) A fixed guide tube provided with a threading, preferably external threading, for the threaded spindle,

c) An adjusting knob connected with the threaded spindle and having a threading, preferably a female threading, which engages with the threading of the guide tube.

If here the pitch of the spindle threading corresponds to that of the guide tube threading, the displaceable side wall cannot shift on rotation of the adjusting knob. Only the spindle moves. If however the two threadings have a slight difference of pitch, a very finely sensitive displacement of the side wall takes place on rotation of the adjusting knob.

Since the thread twist varying element and the splicing chamber are adjustable finely to the threads to be spliced, increased attention must be devoted to the removal of the thread ends, with the object of a good splicing result. Firstly the thread ends should be as short as possible, next they should also remain as inconspicuous as possible. Not every thread end can be plucked out or broken away. Unfavourable fibre length and fibre thickness may under some circumstances require cutting.

In this case the invention renders it possible for the thread severing devices which remove the thread ends to be formed as cutter elements arranged directly on the sliding lid of the splicing chamber, each cutter element comprising two shears blades, namely a shears blade locked with the sliding lid and a controllable shears blade. Thus the thread severing element is brought as close as ever possible to the splicing chamber.

Naturally the thread severing device must not hinder the insertion of the threads into the splicing chamber. Therefore when the sliding lid is opened the shears blades advantageously lie beside the longitudinal groove of the splicing chamber and are conducted before the splicing chamber only on closing of the sliding lid, namely advantageously so that in each case one shears blade, preferably the controllable shears blade, slides itself between the inserted upper thread and the inserted lower thread. The back of the shears blade here points towards the arriving thread which is to be cut, and the cutting edge points towards the thread end of the other thread which is to be severed. There is no harm if in splicing the thread end to be severed is already partly cut by the still opened shears blade. Such an incipient cut already lies at the subsequent cutting point and may even facilitate cutting.

It is also advantageous if the threads are laid into the splicing chamber so that on the side from which they come they rest against the bottom of the splicing chamber and on the opposite side they emerge from the splicing chamber in the vicinity of the sliding lid, and if the mentioned shears blade slides in between the upper thread and lower thread in such a way that in splicing only little air can escape out of the splicing chamber along on the arriving upper thread or the arriving lower thread. The air is then in fact guided in the direction towards the thread ends to be severed, which facilitates the severing operation because the short fibres deriving from the severance point can be blown out immediately with increased air velocity. The arriving threads on the other hand are not grasped by the air current and therefore cannot be puffed out or split apart into fibres by the splicing air.

Since the thread twist varying element, the sliding lid and the thread severing elements have to carry out movements in approximately the same direction, a common actuating device is advisable for these parts.

Increased attention must also be applied to the holding of the splicing chamber, with regard to the function of the parts already mentioned. Here a holding device extending transversely of the direction of thread running is advisable. The holding device advantageously possesses two cylindrical hollow bodies of which the one serves as guide tube for the already mentioned threaded spindle of the fine adjustment device and the other serves as compressed air supply conduit. The two cylindrical hollow bodies have a common longitudinal axis. One hollow body is situated on the left and the other on the right on the splicing chamber or on the splicing chamber housing. Thus the splicing chamber mounting has in each case a double function. At the same time the splicing chamber mounting can however also serve to mount the thread twist varying element, for example due to the fact that the one half of the thread twist varying element is arranged rotatably over the one hollow body and the other half rotatably and at the same time displaceably over the other hollow body. So that now the sliding lid may also be actuated independently of the thread twist varying element, between the guide tube and the half of the thread twist varying element situated on the guide tube there is advantageously arranged a sliding sleeve which carries the sliding lid. This sliding sleeve can at the same time be a part of the common actuating device for the thread twist varying element, the sliding lid and the thread severing devices. When the sliding sleeve is displaced on the hollow body, at the same time the sliding lid, the thread severing device secured on the sliding lid and the half of the thread twist varying element mounted on the sliding sleeve are displaced. Since however the parts have different courses of movement, differently set retaining devices are advantageously present which are set to these different courses of movement. Resilient couplings, stops, a resiliently yieldable mounting or the like can constitute such retaining devices.

If the nature of the thread permits, the thread severing devices are advantageously formed as thread plucking devices. An inconspicuous fibre whisker appears at the splice if after splicing the excess thread ends are plucked out or broken away. At the break-away point the thread has in any case previously lost its thread twist, so that plucking out is facilitated. Such a thread plucking device can comprise for example a travelling clamp, that is a clamp which initially holds the thread fast but for the purpose of thread severance departs from the splice position and in doing so takes the clamped thread end with it. It is also possible to hold the thread end fast by a pair of rolls which is set in motion, that is comes into rotation, for the purpose of thread plucking. The speed of thread plucking can be very finely sensitively regulated with a pair of rolls.

If the splicing chamber, the thread twist varying element and the thread severing devices possess one common housing which also carries a part of the actuating device, if the remaining part of the actuating device possesses a second housing and if both the two housings and the elements of the actuating device allocated to the housings are made for coupling to one another, then the pneumatic splicing device can advantageously be easily replaced. Replacement can become necessary firstly in the case of replacement of worn parts and also when very thin and very thick threads are to be spliced in alternation, which cannot be spliced, or cannot be spliced equally well, with one and the same splicing device.

The housings can be connected with one another for example by two screws. The number of elements of the actuating device to be coupled with one another should be kept as small as possible. The condition is advantageously fulfilled if the mentioned second housing comprises two levers actuatable by cam discs, namely a first lever for the common actuation of the two halves of the thread twist varying element, as regards their rotation, and a second lever for the actuation of the sliding lid, the thread severing elements and the thread twist varying element as regards the bringing of its two parts closer to or further from one another. In this case only three dismantleable rods are present as coupling elements, namely one rod for connecting the second lever with those parts of the actuating device which actuate the sliding lid, the thread severing elements and the advance of one half of the thread twist varying element, and two further rods which each connect the first lever articulatedly with one half of the thread twist varying element for the purpose of rotation in opposite directions. For this purpose each half advantageously comprises a crank pin on which the removable rod is hooked.

The coupling of the actuating elements as describedadvantageously permits a rapid change of the direction of rotation of the thread twist varying element. The manner in which this takes place will be explained further below in the description of the example of embodiment.

Examples of embodiment of the invention are illustrated in the drawings. The invention is to be described and explained in greater detail in the following text passages by reference to these examples of embodiment.

A first example of embodiment of the invention is illustrated in Figures 1 to 9 of the drawings.

FIGURE 1 shows a diagrammatic lateral elevation,

FIGURE 2 shows a partial front elevation,

FIGURE3 shows a view from above,

FIGURE 4 shows a lateral elevation in partially dismantled condition,

FIGURE 5 shows a partial elevation on an enlarged scale with a view of the cut-away splicing chamber,

FIGURE 6 shows an exploded illustration and

FIGURES 7 to 9 show cross-sections in three different phases of production of a spliced connection of this first example of embodiment.

FIGURES 10 and 11 of the drawings show a second example of embodiment of the invention.

Here Figure 10 diagrammatically represents a partial front elevation and

Figure 11 represents a section through some elements of this second example of embodiment.

FIGURE 12 of the drawing diagrammatically shows a further variant while FIGURE 13 as partial elevation represents a twist clamp of this further example of embodiment.

FIGURES 14 and 15 of the drawing show diagrammatically the partial detail of a fourth example of embodiment of the invention in different phases of the plucking out of a thread end.

FIGURE 16 diagrammatically shows a fifth example of embodiment, of which FIGURE 17 represents a detail.

In Figures 1 to 9 of the drawings, there is seen an apparatus designated as a whole by 11 for connecting an upper thread 12 with a lower thread 13. The apparatus 11 has a machine frame 14 which according to Figure 1 is carried by a wheel frame 15. The wheel frame 15 possesses wheels 16 and 17 with the aid of which the apparatus 11 is mobile on a carrier tube 18.

The carrier tube 18 is conducted along a winding machine of which, according to Figure 1 of the drawing, only one winding station designated as a whole by 19 is visible. The apparatus 11 is operating specifically at this winding station 19. At the winding station 19 the lower thread 13 comes from a supply spool 20 by way of a thread guide 21, a rake feeler 22, a thread brake 23 and a further thread guide 24 at the apparatus 11. The upper thread 12 comes from a take-up spool 25 by way of a rotating thread guide drum 27, provided with reversing threading grooves 26, likewise at the apparatus 11.

In the narrower sense, the device supplying the lower thread 13 consists of the thread guide 21 and the device taking up the upper thread consists of the take-up spool 25. The line of the shortest possible, uninfluenced and undisturbed thread course is designated by 28.

The fact that the line 28 is in dot-and-dash form is intended to signify that the thread course is already disturbed and the thread itself is separated into an upper thread and a lower thread.

In a half-open housing 29 the apparatus 11 possesses a slicing chamber 30, a thread twist varying element 31 and thread severing devices 32, 33. The housing 29 is coupled by means of screws 34, 35 to a further housing 36.

As shown especially by Figures 5 and 7 of the drawings, the splicing chamber 30 has a coverable longitudinal groove 37 with a V-shaped cross-section. The longitudinal groove serves for the insertion and connection of the thread by means of compressed air. A compressed air supply passage 38, terminating at a blow-out opening 39, opens into the interior of the splicing chamber, that is to say into the longitudinal groove 37. The splicing chamber 30 has a controllable sliding lid 40. The volume of the splicing chamber 30 is variably adjustable. The size of the blow-out opening 39 of the splicing chamber 30 is also variably adjustable, and in fact the size of the blow-out opening 39 is increased or reduced in the same direction with the increase or reduction of the volume of the splicing chamber 30. For the purpose of volume variation one side wall 41 is displaceable, and in fact this side wall is formed as a slider which slides along on the bottom 42 and on the bottom opening 39 serving for compressed air supply.

As may be seen especially from the exploded drawing in Figure 6 of the displacement side wall 41 of the splicing chamber 30 forms one construction unit with parts 43, 44 of the bottom of the splicing chamber. The non-displaceable side wall 45 has the same form as the displaceable side wall 41. The parts 43, 43′ of the bottom which interengage in comb manner form a compressed air passage, here in the form of bottom openings 39′, 39″. All parts of the splicing chamber 30 are mounted in a housing 46. The housing 46 has the already mentioned compressed air supply passage 38.

The housing 46 of the splicing chamber 11 has a bottom surface 47 adjoined by lateral grooves 48, 49. The side walls 41 and 45 carry rearward extensions 50, 51 and 50′, 51′ respectively which fit into the mentioned grooves. The non-displaceable side wall 45 has a threaded bore 52 serving for securing in the housing 46 by means of a screw 53. The function of the splicing chamber 30 will be discussed in greater detail later. The compressed air connection 54 continues in a pipe 55 which leads according to Figure 2 to a compressed air regulating valve 56. The compressed air regulating valve 56 is connected on the entry side by a flexible pipe 57 with a compressed air supply conduit (not illustrated further).

As shown especially by Figure 1, a thread bringer and holding element 58 is provided with means for seeking and holding fast the thread end 12′ of the upper thread 12 on the take-up spool 25. These means consist of an inwardly hollow arm 59 which is connected through a pivot joint 60 to a suction source (not represented further), and of a suction slot nozzle 61. Figure 1 of the drawing shows the thread bringer and holding element 58 in the thread delivery position. Its thread reception position, represented in dot-and-dash lines, is designated by 58*a*.

A further pivotable thread bringer and holder element 62 is provided with means for seeking and holding fast the thread end 13′ of the lower thread 13. These means consist of a curved pipe 64, rotatable at the pivot joint 63, with a suction nozzle 65 which is closed by a spring-loaded clamping lid 66 and holds the thread end clamped in. In Figure 1 of the drawing the thread bringer and holding element 62 is also shown in the thread delivery position. Its thread reception position, illustrated in dot-and-dash lines, is designated by 62*a*. To receive the lower thread 13 the pipe 64 is pivoted downwards in the direction of the arrow 67, and the clamping lid 66 opens by abutment against a stop 68. Now the lower thread 13, which may be broken above the thread brake 23, can be sucked in through the suction nozzle 65 and, on pivoting back of the thread bringer and holding element 62 into the thread delivery position, clamped in, held fast and entrained between the clamping lid 66 and the edge of the suction nozzle 65. The movement of the two thread bringer and holding elements 58, 62 is effected by cam discs situated in the machine frame 14.

Figure 1 of the drawing shows that the controllable thread twist varying element 31 is arranged in the thread region extending from the splicing chamber 30 to the thread holding elements 58, 61; 62, 65. It is present in common for both threads 12, 13 and capable of acting both upon the threads 12, 13 leading to the splicing chamber 30 and upon the thread ends 12', 13' protruding from the splicing chamber and held by the thread bringer and holding elements 58, 62. The thread twist varying element 31 is correspondingly formed. It possesses two oppositely rotatingly drivable halves 71, 72 enclosing the splicing chamber 30 in cage or pot manner and provided with annular-type edges 69 and 70 respectively, which edges carry the friction faces 73, 74 bringable into contact with the threads. The friction faces 73, 74 are formed as annular inserts using a rubber-elastic material with high friction value. From Figure 7 of the drawing it is seen that the edges 69, 70 of the pot-like structures are drawn inwards to a smaller diameter in order to bring the friction faces 73, 74 to a suitable distance from the splicing chamber 30. The distance of the friction faces from the splicing chamber is determined primarily according to the length of the fibres and according to the staple length of the threads to be spliced.

Figures 1 and 5 of the drawings show that outside the thread twist varying element 31, thread guide means 75, 76, 77, 78 are arranged in connection with the housing 29. These thread guide means constitute steps of the edge of the housing 29. The thread guide means are so arranged that the threads to be spliced are insertable, when the halves 71, 72 of the thread twist varying element 31 are shifted apart, in crossed manner both into the splicing chamber 30 and into the thread twist varying element 31 itself, as shown especially by Figure 5. According to Figure 5 the threads 12 and 13 are guided exactly radially through the thread twist varying element 31. If now the friction face 73 of the half 71 (not shown in Figure 5) of the thread twist varying element 31 places itself with slight pressure against the threads, the threads are also applied to the friction face 74 of the half 72, that is to say held in their position with defined spring force between the friction faces 73 and 74. If now the half 72 is rotated in the direction of the arrow 79 and the half 71 contrarily of the direction of the arrow 79, with uniform rotation, the threads remain in their position in relation to one another, but the thread twist varies as shown in Figure 5 by the example of S-twisted threads. Outside the friction faces the thread twist is reinforced, but it is eliminated in the free part placed towards the splicing chamber. The elimination of the thread twist in the region of the splicing chamber is here the desirable effect which has the aim of a good spliced connection. At the same time however the threads are also held fast by the friction faces 73, 74 during splicing. After splicing the threads are not immediately liberated, but by rotation of the two halves 71, 72 contrarily of the direction of rotation as stated further above the thread twist is varied afresh, namely now so that the thread twist reinforced and built up outside the friction faces is cancelled again and conducted into the splice. According to choice the splice can here also receive an increased thread twist in that the turning back of the two halves of the thread twist varying element proceeds over a larger angle of rotation than in the rotating movement effected before the splicing. In this case the spliced connection is initially twisted somewhat more firmly than the thread, so that it cannot be pulled apart by the recommencing thread tension. Due to the subsequent further running of the thread over different deflection points then an equalisation of the thread twist occurs so that finally a splice produced in accordance with the invention is purely externally hardly distinguishable from an undisturbed thread.

As shown especially by Figures 6 and 7 of the drawings, the splicing chamber 30 has a controllable sliding lid 40. The thread severing devices 32, 33 are formed as cutting elements and arranged directly on the sliding lid 40. Each cutter element has two shears blades. Thus the cutter element 32 has for example a shears blade 80 locked with the sliding lid 40 and a controllable shears blade 82. The thread severing device 33 has a shears blade 81 locked with the sliding lid 40 and a controllable shears blade 83. The shears blades are connected with the sliding lid 40 by a bolt 84. A set pin 85 arrests the two shears blades 80 and 81. The controllable shears blades 82 and 83 are controlled in common. The details of the control system will be discussed later. Controlling takes place in such a way that the shears blades 80 to 83, when the sliding lid 40 is opened as shown especially by Figure 7 of the drawing, lie beside the longitudinal groove 37 of the splicing chamber 30 and that on closing of the sliding lid 40 the two controllable shears blades 82, 83 push themselves between the inserted threads 12 and 13.

Especially from Figure 5 of the drawing it can be seen that the threads are inserted into the splicing chamber 30 so that on the side from which they come they rest on the bottom of the splicing chamber and on the opposite side they emerge from the splicing chamber in the vicinity of the sliding lid. As shown especially by Figure 4, the shears blade 82 or 83 pushes itself between upper thread and lower thread in such a way that in splicing only little air can escape along on the arriving upper thread 12 and on the arriving lower thread 13 out of the splicing chamber 30. Thus in no case can the spliced thread be cut instead of the thread end by unfortunate chance.

Figures 3, 5 and 7 of the drawings show that the splicing chamber 30 and its housing 46 have a holding device which extends transversely of the thread running direction. According to Figure 7 this holding device consists of two cylindrical hollow bodies 87, 88 having a common longitudinal axis 86. The hollow body 87 serves at the same time as guide tube for a threaded spindle 89 of a fine adjusting device 90, which will be discussed in greater detail later. The other hollow body 88 serves at the same time as compressed air supply for the splicing chamber 30.

The one half 72 of the thread twist varying element 31 is arranged rotatably above the hollow body 88 firmly connected with the housing 46. For this purpose the half 72 is provided with a bearing bush 91. The other half 71 of the thread twist varying element 31 is arranged rotatably and at the same time displaceably over the other hollow body 87.

Between the hollow body 87, serving at the same time as guide tube, and the half 71 of the thread twist varying element 31 a sliding sleeve 92 is arranged which carries the sliding lid 40. In order to guarantee the capacity of the said parts for slipping, the sliding sleeve 92 carries a bearing bush 93 and the half 71 carries a bearing bush 94.

Especially Figure 3 of the drawing shows that the thread twist varying element 31, for the axial displacement of its halves, the sliding lid 40 and the thread severing elements 32 and 33 possesses a common actuating device which is designated as a whole by 95. The actuating device 95 consists of the following parts:–

A pivotable shaft 96 can be rotated by a cam disc (not shown further) or by a control gearing so that a lever 98 secured on the shaft 96 by means of a screw 97 can be pivoted in the direction of the arrow 99 (Figure 4) and back. A ball joint 100 connects the lever 98 with a rod 101. On the end of the rod 101 there is seated a threaded sleeve 206 with the aid of which the rod length is adjustable. The selected set length is fixed by a lock nut 207. A further ball joint 102 connects the threaded sleeve 206 with an angle lever bridge 103 which is mounted for pivoting about the axis 105 on an overhang arm 104 of the housing 29. Especially from Figures 2 and 3 of the drawings it can be seen that the fork ends 106, 107 of the angle lever bridge 103 grasp round two engaging pins 108, 109 of a slide block 110. The slide block 110, which is also visible in Figure 7, is screwed to the sliding sleeve 92. A helical spring 111 bears on the one side against the slide block 110 and on the other side against the half 71 of the thread twist varying element 31. While the sliding block 110 is connected by two screws 112, 113 with the sliding sleeve 92, there is a non-releasable connection between the sliding lid 40 and the sliding sleeve 92, as shown especially by Figure 6 of the drawing.

The parts actuated in common by the actuating device 95 are set by retaining devices to different courses of movement. On pivoting of the lever 98 firstly the sliding sleeve 92 and with it the sliding lid 40 are moved in the direction of the longitudinal axis 86 directly by means of the rod 101 of adjustable length. Since however as shown in Figure 7 the half 71 on the one hand rests against the sliding lid 40 and on the other hand is loaded by the helical spring 111, on a movement of the sliding sleeve 92 parallel with the direction of the arrow 114 the half 71 is also entrained until it comes to abut with its friction face 73 either on the inserted threads and thus on the adjacent friction face 74 or, when no threads are inserted, directly on the edge 115 of the housing 46. If now the sliding sleeve 92 is pushed further forward a further compression of the helical spring 111 occurs, while the half 71 does not further change its position. Thus here both the edge 115 and the helical spring 111 serve as retaining devices for the half 71.

The retaining device for the controllable shears blades 82, 83 of the thread severing devices 32, 33 consists of a wire loop 116, an adjustable clamping screw 117 and the hammer head 118 of a link piece 119. The link piece 119 is secured in common with the guide tube 87 by means of a nut 120 on the overhang arm 104 of the housing 29. The wire loop 116 is hooked in behind the hammer head 118. Its angled-off ends are articulatedly connected with the two controllable shears blades 82 and 83, as also indicated by Figure 6. In the initial position the thread severing devices 32 and 33 are opened, as shown by Figure 7 of the drawing. The amount of shears opening of the thread severing devices 32 and 33 is determined by the position of the adjustable clamp screw 117. If now the sliding sleeve 92 is displaced parallel with the direction of the arrow 114, then firstly the wire loop 116 travels therewith in the same direction and nothing changes in the position of the shears. In the position according to Figure 8 the end of the wire loop 116 has reached the hammer head 118 so that on further displacement of the sliding sleeve 92 the wire loop 116 is held back, which results in closure of the shears-type thread severing devices, as shown by Figure 9.

The statements hitherto disclose that the splicing chamber 30, the thread twist varying element 31 and the thread severing devices 32, 33 possess a common housing 29 which also carries a part of the actuating device 95 and of the actuating device 121 to be explained later, and that the remaining part of the actuating devices 95 and 121 possesses a special housing 36 secured to the machine frame 14. Both the two houses 29 and 36 and the elements of the actuating devices allocated to the housings are formed for coupling to one another. Dismantlability of the housing 29 was already mentioned. The rod 101 of the actuating device 95 is uncouplable in that the two ball joints 100 and 102 are formed as push-on ball joints.

The second actuating device 121, which is responsible for the contrary rotation of the two halves 71, 72 of the thread twist varying element 31, consists of the following parts:–

As may be seen especially from Figures 3 and 4 of the drawings, a shaft 122 is pivotable in and contrarily of the direction of the arrow 123 by a cam disc (not shown further) or by a control gearing. A lever 125 is pivotable with the shaft 122. Two rods 126, 127 are articulatedly attached to the end of the lever 125. The rod 126 is connected with a crank pin 128 which is secured on the half 71. The lever 127 is connected with a further crank pin 129 which is secured to the other half 72 of the thread twist varying element 31. Dismantlability of the rods 126 and 127 is obtained by the fact that the point of suspension on the lever 125 is effected by a screw connection 130.

The angle of rotation of the two halves 71, 72 of the thread twist varying element 31 is adjustable in the following manner:–

A short lever 125' is connected by a screw 124 with the shaft 122 and comprises a stop link piece 131 for a longer lever 125 which is likewise fitted on to the shaft 122 but is not connected with the shaft 122. The lever 125 is held in abutment on the stop link piece 131 by a coiled flexure spring 132. The lever 125 has a stop pin 133. An adjustable link piece 134 having a stop nose 135 is secured to the housing 36. The movement of the lever 125 in the direction of the arrow 123 is limited to that angle of rotation which results when the stop pin 133 comes to abut on the stop nose 135.

The direction of rotation of the two halves 71 and 72 of the thread twist varying element 31 is adjustable in the following manner:–

According to Figure 4 the crank pin 128 moves in the direction of the arrow 136 and the crank pin 129 moves in the direction of the arrow 137 when the lever 125 pivots in the direction of the arrow 123. This fixes the direction of rotation of the two halves 71, 72 of the thread twist varying element 31. If it is intended to change this direction of rotation, firstly the screw connection 130 is released. Now the two halves 71, 72 can be rotated so far that the crank pin 129 lies upwards and the crank pin 128 downwards, that is to say exactly opposite to the illustration in Figure 4. Then the two rods 126 and 127 are again secured to the lever 125. If now the lever 125 pivots in the direction of the arrow 123, the crank pin 129 now moves in the direction of the arrow 136 and the crank pin 128 in the direction of the arrow 137 that is to say in the opposite direction to previously. Thus however the two halves 1, 72 also move oppositely. Thus the changeover from S-twisted threads to Z-twisted threads can be brought about with a few operations.

Figure 7 of the drawing shows in combination with Figure 6 of the drawing that the displaceable side wall 41 of the splicing chamber 30 has a fine adjustment device which is designated as a whole by 90 in Figure 7. The fine adjustment device 90 consists according to Figures 6 and 7 of the following parts:–

a) The threaded spindle 89 which engages in a female threading 136 which is situated in the displaceable side wall 41,

b) A non-displaceable guide tube 87 provided with external threading 137 for the threaded spindle 89,

c) A setting knob 139 connected with the threaded spindle 89 by means of a set screw 138, having a female threading 140 which engages with the external threading 137 of the guide tube 87.

The pitch of the spindle threading 141 differs from the pitch of the guide tube threading 137. In the present example of embodiment the pitch of the spindle threading 141 is smaller than the pitch of the guide tube threading. Both are right-hand threadings. If the adjusting knob 139 is rotated in the clockwise direction the side wall 41 is displaced.

Figures 6 and 7 of the drawings also disclose the following details of the apparatus according to the invention:–

The compressed air feed passage 38 of the housing 46 opens into a compressed air connection 54 which is secured by a screw 142 on the hollow body 88 so that the two parts are connected at the same time with a side wall 143 of the housing 29. The compressed air connection 54 possesses a push-in tube 144 which fits into the compressed air feed passage 38. The push-in tube 144 at the same time secures the compressed air connection 54 against rotation. The hollow body 88 possesses a special protection against rotation in the form of a set pin 145 which fits into a bore 146 of the side wall 143. Figures 2, 6 and 7 of the drawings further show that the halves 71, 72 of the thread twist varying element 31, formed in cage or pot manner, have apertures on the side and at the bottom for the necessary actuating means. Thus for example in the half 71 in Figure 2 there is seen the aperture 147 for the crank pin 128 and the rod 126 and in Figure 7 the aperture 148 for the wire loop 116. For the other half 72 in Figure 2 there is seen the aperture 149 for the crank pin 129 and the rod 127 and in Figure 7 the semi-circular surrounding aperture 150.

In Figures 1 and 2 of the drawings there may also be seen thread-in aids 151, 152 in the form of pins on the housing 29. Figure 2 also shows an alternative controllable thread clamp device 153 and 154 respectively for the upper thread 12 and the lower thread 13 respectively.

In the second example of embodiment of the invention in Figures 10 and 11 of the drawings there is seen a thread twist varying element designated as a whole by 155. This thread twist varying element comprises rolls rotatable in the same direction and brought into closer proximity to one another than the thread diameter, which are united into roll groups 156, 157. The two roll groups are arranged lying opposite to one another at a short distance from a splicing chamber 158. The roll group 156 consists of the tapered rolls 159, 160, 161, the roll group 157 of the tapered rolls 162, 163, 164.

All the tapered rolls are of similar formation, as shown by the example of the tapered roll 160 in Figure 11. In Figure 11 there is seen a frame 165 with a pipe connector 167 carrying a bearing 166 for the tapered roll 160. On the rear end of the pipe connector 167 there is a hose connector 168 leading to an air suction apparatus (not shown). The tapered roll 160 is formed like the other tapered rolls as a hollow body. The wall 169 is perforated. The tapered inner wall 170 at its tip supports the tapered roll 160 and has a slot 171. Between outer wall and inner wall an annular passage 172 is formed as air collection passage. The narrowed end 173 of the tapered roll 160 points towards the splicing chamber 158. The other end carries a toothed wheel 174 formed as bevel wheel. The similar toothed wheels of all rolls engage in a toothed ring 175 arranged in common for all rolls. The surface 176 of the roll 160 is formed as a friction face.

Figure 10 of the drawing shows yet a further frame 177 for the roll group 157. Moreover in Figure 10 further details may be seen which are identical with those of the first example of embodiment, namely a supply spool 20, thread bringer and holding elements 58 and 62, a take-up spool 25 and controllable thread clamps 153, 154. In Figure 10 of the drawing it is seen that the upper thread 12 is conducted rectilinearly through the thread twist varying element 155, likewise the lower thread 13.

A further example of embodiment of the invention is represented diagrammatically in Figure 12 of the drawing. Figure 13 shows a detail of this. Of the known elements, in this example of embodiment the supply spool 20, the take-up spool 25, the thread bringer and holding elements 58 and 62 and the controllable thread clamps 153 and 154 are visible. The upper thread 12 lies in the controllable thread clamp 153, in a thread twist varying element 178, in a splicing chamber 179 and in a controllable travelling clamp 180, while the thread end 12' extends into the thread bringing and holding element 58. The lower thread 13 lies in the controllable thread clamp device 154, in a thread twist varying element 181, in the splicing chamber 179 and in a further travelling clamp 182, while its thread end 13' extends into the thread bringer and holding element 62. In this example of embodiment for each thread 12, 13 there is a thread twist varying element 178 and 181 respectively. The two thread twist varying elements are of similar formation and reproduced by the example of the thread twist varying element 178 in Figure 13.

In Figure 13 it is seen that the thread twist varying element 178 comprises a rotatable thread holding element 183. The thread holding element is formed as a rotating body having a middle part 184 and two end parts 185, 186 which are rotatably mounted in bearing shells 187 and 188 respectively. Furthermore in Figure 13 there is seen a thread clamp slot 189 which reaches as far as the central axis 190. The rotating drive is effected by a tangential belt 191.

In a last example of embodiment of the invention it is to be indicated by reference to Figures 14 and 15 of the drawings in what manner the threads can be freed from their excess thread ends, either before or after splicing, by plucking. In the drawings there are seen the supply spool 20, the thread twist varying element 178, illustrated in greater detail in Figure 13, and a thread plucking device 192 which consists of the roll pair 193, 194. Figure 14 shows the lower thread 13 which the thread end 13' not yet plucked out, in Figure 15 the thread end 13' of the lower thread 13 is already plucked out.

Since the various examples of embodiment of the invention have been described, the function of each individual device is to be explained.

In the first example of embodiment of the invention, according to Figures 1 to 9 of the drawings, let it first be assumed that at the winding station 19 the thread previously guided along the line 28 has broken. Here an upper thread 12 and a lower thread 13 have been produced. The upper thread 12 was taken up by the take-up spool 25, the lower thread 13 has been held fast by the thread brake 23 in combination with the rake feeler 22.

The thread breakage has been ascertained and communicated to the apparatus 11 in known manner, by means which are not illustrated. According to Figure 1 the apparatus 11 is driven on the carrier tube 18 to before the winding station 19. The thread bringer and holding elements 58 and 62 are in the rest position, which is identical with the thread delivery position as illustrated in Figure 1, if only one thinks of the already entered threads as absent.

Now the apparatus 11 becomes operative in the following manner:–

In the machine frame 14 there is a control gearing (not illustrated further) which upon a signal instigated automatically by the winding station 19 starts up and rotates the pivot joint 60 of the thread bringer and holding element 58 in the direction of the arrow 195 until the thread bringer and holding element 58 has reached the thread take-up position 58*a*. In this position the suction slot nozzle 61 is situated close before the surface of the take-up spool 25. The suction slot nozzle 61 reaches over the whole width of the take-up spool 25. The thread end 12' of the upper thread 12 is sought out, sucked in and held fast by the suction acting at the suction slot nozzle 61, with the take-up spool 25 rotating slowly.

At the same time the control gearing rotates the pivot joint 63 of the thread bringer and holding element 62 in the direction of the arrow 67, until the thread bringer and holding element 62 has reached the thread take-up position 62*a*. Here the clamping lid 66 runs against the stop 68 and in doing so opens. Now the suction nozzle 65 can suck in and hold fast the thread end 13' of the lower thread 13.

After a fixed short time of action the control gearing rotates the two pivot joints 60 and 63 back into the initial position. The two thread bringer and holding elements 58 and 62 then pivot simultaneously into the thread delivery positions represented in Figure 1. During the pivoting back of the thread bringer and holding element 62 the clamp lid 66 closes again and in doing so holds the thread end 13' clamped.

Meanwhile the splicing chamber 30 is opened, likewise the thread twist varying element 31. The thread position as illustrated in Figures 1, 2 and 5 of the drawings results. The upper thread 12 coming from the take-up spool 25 lies against the thread guide means 75, is guided along on the left side of the threading aid 151, goes through the longitudinal groove 37 of the splicing chamber 30 and lies radially between the friction faces 73 and 74 of the two halves 71 and 72 of the thread twist varying element 31, is guided along on the left side of the threading aid 152, lies against the thread guide means 78 and extends with its thread end 12' into the suction slot nozzle 61 of the thread bringer and holding element 58. The lower thread 13, coming by way of the thread guide 21 from the supply spool 20, is inserted into the rake feeler 22, the thread brake 23 and the thread guide 24, guided over the back of the suction slot nozzle of the thread bringer and holding element 58, lies against the thread guide means 77, is guided along on the right side of the threading aid 152, goes radially past the two friction faces 73 and 74 of the two halves 71 and 72 of the thread twist varying element 31, is inserted into the longitudinal groove 37 of the splicing chamber 30, where it crosses the upper thread 12, is guided along on the right side of the threading aid 151, lies on the thread guide means 76 and is clamped in with its thread end 13' between the edge of the suction nozzle 65 and the clamping lid 66 of the thread bringer and holding element 62.

If for any reason the mentioned thread holding means should not suffice to impart the requisite tension to the threads, then the controllable thread clamping devices 153 and 154 represented in Figure 2 can be arranged alternatively. Then these thread clamping devices would be still opened until this moment.

Figure 7 of the drawing shows the position of the sliding lid 40 and of the thread severing device 32 after the insertion of the threads 12 and 13 into the splicing chamber 30. The preparation, execution and termination of the actual splicing operation are now to be explained with special reference to Figures 3, 4, 7, 8 and 9 of the drawings.

The control gearing, which has already been mentioned but is not separately illustrated in the drawings, sets the two shafts 96 and 122 in motion in succession through cam discs in the direction of the arrows 99 and 123 respectively. Firstly the shaft 96 is rotated. The lever 98 then moves the rod 101 forward, whereby the angle lever bridge 103 is pivoted in the direction of the arrow 195. Its fork ends 106, 107 then take the engaging pins 108, 109 with them, so that the slide block 110 is compelled to travel further parallel to the direction of the arrow 114 (Figure 7) on the guide tube 87, namely at first into the position as illustrated in Figure 8. Since the slide block 110 is connected with the sliding sleeve 92, the sliding lid 40 connected with the sliding sleeve 92 is also displaced parallel to the direction of the arrow 114 until it has reached the position as illustrated in Figure 8. The friction faces 73 and 74 of the halves 71 and 72 now lie on the threads 12 and 13. The splicing chamber 30 is closed. The rear end of the wire loop 116 has reached the hammer head 118. The controllable shears blade 82 of the thread severing device 32 and also the controllable shears blade 83 of the thread severing device 33 have pushed themselves with their points between the threads 12 and 13.

Now in accordance with the control programme the shaft 122 is set in motion. The shaft 122 rotates in the direction of the arrow 123, and with it the lever 125′ and also the lever 125 resiliently connected with the lever 125′. The two rods 126 and 127 (Figure 4) are pushed forward in this action so that the crank pin 128 and thus the half 71 are rotated in the direction of the arrow 136 and the crank pin 129 and thus the half 72 are rotated in the direction of the arrow 137.

If now Figure 5 of the drawing is considered, the friction face 74 of the half 72 of the thread twist varying element 31 is seen. The direction of rotation is here indicated by the arrow 79. The friction face 73 which is not represented rotates oppositely to the illustrated friction face 74. The threads 12 and 13 clamped in between the friction faces are then rotated about their longitudinal axes so that in the desired manner, as shown by Figure 5 of the drawing, an elimination of the thread twist results in the region placed in the splicing chamber. The build-up of twist likewise illustrated in Figure 5 results outside the friction faces.

At the end of the pivoting movement of the shaft 122 the lever 125 comes before a proximity switch 196 which switches on the compressed air regulating valve 56 illustrated in Figure 2. The blowing pressure has previously been set on a setting knob 197 and the blowing time on a setting knob 198. After the switching on of the compressed air regulating valve 56 the compressed air glows through the conduit 55, the compressed air connection 54, the push-in tube 144, the compressed air feed passage 38 and the bottom opening 39 into the longitudinal groove 37 of the splicing chamber 30. Under the action of the compressed air the threads are spliced with one another. The length of this splice is precisely defined and predetermined, which amounts to a significant advantage of the invention. The length of the splice is equal to the length of the longitudinal groove 37. Since the two controllable shears blades 82 and 83 have pushed themselves with their points between the threads, the splice cannot go beyond the length of the longitudinal groove 37. Since the splicing air must escape to both sides from the splicing chamber, the arrangement according to the invention has also ensured that the air escapes substantially along the thread ends to be severed later, where it can no longer be detrimental to the threads to be spliced.

The time of action of the compressed air is normally only very short. After the elapse of this time of action the mentioned control gearing ensures that the lever 98 is rotated a little further in the direction of the arrow 99. The slide block 110 then comes into the position as illustrated in Figure 9. Both the sliding sleeve 92 and the sliding lid 40 accompany this movement, likewise the shears blades 80 and 81 arrested on the sliding lid 40. On the other hand the half 71 cannot accompany the movement, because it already bears under the pressure of the spring 111 on the threads 12 and 13 and thus indirectly also on the half 72. Thus the half 71 and also the half 72 remain in their position, the spring 111 being further compressed. The wire loop 116 is held back by the hammer head 118. This has the consequence that the thread severing devices 32 and 33 close, as shown by Figure 9 of the drawing for the example of the thread severing device 32. By this action the thread ends 12′ and 13′ are severed and held fast and sucked away by the thread bringer and holding elements 58 and 62.

Now the mentioned control gearing causes the rotation of the levers 98 and 125 or 125′ back into their initial positions as illustrated in Figure 4. This takes place in a manner in which the lever 125 has reached its initial position at the moment when the slide block 110 stands in the position according to Figure 8. Thus it is guaranteed that the splice receives a thread twist while the build-up of twist lying further outwards breaks up again. When the mentioned levers have reached their initial position the splicing chamber 30 is opened. On recommencement of winding tension the spliced thread springs out of the splicing chamber, slips laterally off from the rounded back of the suction slot nozzle 61 and then assumes the thread course designated by 28 in Figure 1. The activity of the apparatus 11 is now ended and it can drive on to another operating site. The winding station 19 can resume its normal operation.

The basic concept of the first example of embodiment does not need to be altered when a thread twist varying element 155 in the embodiment according to Figures 10 and 11 of the drawing is to be used. In this second example of embodiment of the invention again it is the two thread bringer and holding elements 58 and 62 which insert the threads 12 and 13 into the splicing chamber 158. The upper thread 12, coming from the take-up spool 25, is laid into the initially still opened thread clamping device 153, guided in between the tapered rolls 159 and 160 of the roll group 156, inserted into the splicing chamber 158, guided in between the tapered rolls 162 and 163 of the roll group 157 and held with its thread end 12′ by the thread bringer and holding element 58. The lower thread, 13, coming from the supply spool 20, is laid into the initially still opened controllable thread clamping device 154, guided in between the tapered rolls 163 and 164 of the roll group 157, laid into the splicing chamber 158, guided in between the tapered rolls 160 and 161 of the roll group 156 and finally is held with its thread end 13' by the thread bringer and holding element 62.

After the closing of the splicing chamber 158 and of the thread clamping devices 153 and 154, now in the case of S-twist threads the toothed ring 175 is rotated in the direction of the arrow 198 until the desired degree of elimination of the thread twist is reached. Here again a build-up of twist on the threads occurs outside the thread twist varying element 155. Then the splicing takes place in the manner as stated in the first example of embodiment, whereupon the toothed ring 175 is rotated back again by a specific amount. The reverse rotation distance can be somewhat greater, with the aim of imparting an increased thread twist to the finished splice. After the splicing, possibly before the reverse rotation of the toothed ring 175, the thread ends 12' and 13' are broken away by increased traction of the thread bringer and holding elements 58 and 62. After the opening of the thread clamping devices 153 and 154 and after the opening of the splicing chamber 158 the activity of the thread twist varying element 155 and also of the entire splicing apparatus is terminated. During the described operations air suction acts through the hose connections 168 upon the individual tapered rolls so that the threads remain in their predetermined position between the tapered rolls during the activity of the thread twist varying element 155.

In the third example of embodiment of the invention as shown in Figures 12 and 13 of the drawings again the take-up spool 25, the supply spool 20, the thread clamping devices 153 and 154 and the thread bringer and holding elements 58 and 62 are seen.

The upper thread 12 comes from the take-up spool 25, is guided through the opened thread clamping device 153 and through a thread twist varying element 178, lies in the splicing chamber 179 and in an opened travelling clamp 180. Its thread end 12' is held by the thread bringer and holding element 58. The lower thread 13 coming from the supply spool 20 lies in the opened thread clamping device 154, is inserted into a thread twist varying element 181 and into the splicing chamber 179, also lies in a travelling clamp 182, is deflected at a thread deflection point 199 out of its direction and is held with its thread end 13' by the thread bringer and holding element 62.

Before the insertion of the thread with the aid of the thread bringer and holding elements 58, 62 the thread clamp slots 189 of the two thread twist varying elements 178 and 181 stand forward, so that the threads can be inserted without constraint. Then the thread clamping devices 153 and 154 and the travelling clamps 180 and 182 are closed and the two thread twist varying elements 178, 181 are set in rotation by tangential belts 191, 191'. The direction of rotation is here again determined according to the nature of the thread twist. Finally the upper thread 12 is freed from its twist in the region between the thread twist varying element 178 and the travelling clamp 180 and the lower thread 13 is freed from its twist in the region between the thread twist varying element 181 and the travelling clamp 182.

In departure from the preceding examples of embodiment, the thread ends 12' and 13' are removed by plucking out even before the splicing. This is effected in that the travelling clamp 180 is moved parallel to the direction of the arrow 200 and the travelling clamp 182 is moved parallel to the direction of the arrow 201. After the plucking out of the thread ends the splicing takes place, whereupon the two thread twist varying elements 178 and 181 are turned back again into their initial position. If finally the thread clamping slots 189 lie forward with the thread twist varying elements stationary, the spliced thread, after opening of the splicing chamber 179, can spring forward out of the splicing device when the winding traction recommences.

The fourth example of embodiment of the invention according to Figures 14 and 15 of the drawings is limited to an alternative possibility of plucking out of the thread ends. In this example of embodiment again the supply spool 20 is seen from which the lower thread 13 derives. The lower thread 13 is inserted into the thread twist varying element 178, which is formed in accordance with Figure 13. Above it there is the thread plucking device 192, consisting of the roll pair 193, 194. The two rolls lie with light clamping pressure on the thread 13. The thread end 13' leads to a thread bringer and holding element (not illustrated further).

In this example of embodiment of the thread 13 is already freed from its thread twist in the region between the thread twist varying element 178 and the thread plucking device 192.

The activity of plucking out the thread end 13' is illustrated in Figure 15. The roll pair 193, 194 has here been set in rotation in the direction of the arrows 202 and 203 respectively. This has the consequence of plucking out of the thread end 13' in the region between the thread twist varying element 178, which *inter alia* also clamps the thread 13, and the thread plucking device 192. The lower thread 13 remains behind with a fibre whisker 204, the thread end 13' is sucked away parallel to the direction of the arrow 205.

As already mentioned, a fifth example of embodiment of the invention is illustrated diagrammatically in Figures 16 and 17 of the drawings.

A base plate 311 carries a toothed ring 313 which is rotatable in the direction of the double arrow 312 and in the central axis of which a splicing chamber 314 is situated. An upper thread 315 coming from above is to be connected in the splicing chamber 314 with a lower thread 316 coming from beneath. For this purpose the upper thread 315 has already been inserted by an automatic thread inserter 317 into a thread clamp 318, a thread twist varying element 319, into the splicing chamber 314 and in between the rolls 320, 321 of a thread plucking device 322. The roll 320 is drivable and is mounted on the base plate 311. The roll 321 is held by a pivot arm 323 and can be applied to or lifted away from the roll 320.

In the same way the lower thread 316 has been inserted by a thread inserter 324 into the thread clamp 325, a thread twist varying element 326, the splicing chamber 314 and in between the rolls 327, 328 of a thread plucking device 329.

The roll 327 is drivable and mounted on the base plate 311. The roll 328 is held by a pivot arm 346 and can be applied to or lifted away from the roll 327.

The thread twist varying element 326 is illustrated in perspective view in Figure 17. It possesses a thread holding element 330 which is provided with a toothed wheel 331. The toothed wheel 331 has an elongated form and engages with the toothed ring 313. The thread holding element 330 is held by a mounting yoke 332. The lower thread 316 is held in the thread holding element 330 due to the fact that it jams itself in the bottom of a V-shaped slot 333. The slot 333 also goes through a tooth gap of the toothed wheel 331 and through the yoke 332. If the toothed wheel 331 is placed as shown by Figure 16, then the insertion or withdrawal into or from the thread twist varying element 326 causes no difficulty.

The yoke 332 is connected by a link 334 with the end of a telescopic tube 335 which pertains to a shifting device 336. The shifting device 336 possesses a control valve 337. If the control valve 337 is set to compressed air, the thread twist varying element 326 moves in the direction towards the splicing chamber, if the control valve 337 is set to air suction, the thread twist varying element 326 departs from the splicing chamber 314.

In the same way the thread twist varying element 319 also has a shift device 338 with a control valve 339. The end of the telescopic tube 340 of the shifting device 338 is connected with a link 342 carrying the yoke 341. The yoke 341 again carries a thread holding element 343 which is provided with a toothed wheel 344. The V-shaped slot 345 has the same formation as the slot 333 of the thread holding element 330.

For preparation for splicing the threads are firstly inserted as shown by Figure 16. The thread end 316' of the lower thread 316 is situated behind the thread plucking device 329 and the thread end 315' of the upper thread 315 is situated behind the thread plucking device 322.

Before the actual splicing firstly the thread twist varying elements 319 and 326 are rotated by means of the toothed ring 313. The direction of rotation is here determined according to the thread twist. The thread clamps 318 and 325 must be closed, unless they are in any case formed as resilient thread clamps. The thread twist varying elements 319 and 326 receive so many revolutions that virtually no more thread twist is present between the thread plucking devices and the thread twist varying elements. On the other hand between the thread clamp 318 and the thread twist varying element 319 and between the thread clamp 325 and the thread twist varying element 326 a build-up of twist should occur in the thread which is again eliminated later after the splicing and introduced into the finished splice by turning back of the thread twist varying elements.

After these preparations the actual splicing can be effected, which occurs, according to the nature of the splicing chamber, by compressed air surges, electrostatic voltage surges or the like. Then firstly the thread plucking devices 322 and 329 come into action. For this purpose the roll 320 is driven in the direction of the arrow 347 and the roll 327 is driven in the direction of the arrow 348. Now the thread ends are plucked out in the vicinity of the splice. When this has taken place the toothed ring 313 is turned back again into its initial position. The completely spliced thread can now be drawn off forward and the pneumatic splicing apparatus is again ready for a renewed splicing operation.

In splicing it is also possible to adopt a procedure in which the thread plucking devices become operative before the spliced connection is produced. Then the already plucked-out thread ends are spliced with one another. This can be advantageous especially in the case of somewhat thicker threads.

The thread twist varying elements could for example also be of different design. Instead of shifting the entire toothed wheel, in the case of somewhat different configuration it would also be possible to provide a sliding sleeve as thread holding element in the interior of the toothed wheel, and to displace only this sleeve.

The invention is not intended to be limited to the examples of embodiment as illustrated and described. As already indicated, not only the complete but also the partial replacement of the one device by the other is possible and practicable. Especially the articulated assembly, divisible into construction groups, of the apparatus of the first example of embodiment permits integration of the variants as illustrated and described.

The terms "lower thread" and "upper thread" are not tied to the terms "upper" and "lower". Rather a thread coming from a thread delivery position, for example a supply spool, or from a thread producer, is called "lower thread". The upper thread is the thread leading to a thread take-up point, for example a take-up spool or a winding beam. The thread running direction can here lead from below upwards, as is the case in the examples of embodiment. However the thread run can also be directed oppositely or have any desired course in three dimensions, for example horizontal.

Although especially the first example of embodiment relates to an apparatus capable of travelling for pneumatic splicing, an apparatus according to the invention can of course equally be arranged at each individual working station. Likewise it is possible to arrange the splicing apparatus stationarily and to conduct the working stations to be serviced past the splicing apparatus in succession.

The apparatuses according to the invention are also usable with spinning machines, creels and the like textile machines, as well as with winding machines.

CLAIMS

1. Method for connecting textile threads by splicing by means of compressed air with the aid of an apparatus comprising a splicing chamber into which a compressed air passage opens, and further comprising thread-holding elements for holding the textile threads supplied from two sides and inserted into the splicing chamber, characterised in that the

threads (12, 13) are freed from their thread twist in the intended region of the spliced connection before splicing.

2. Method according to Claim 1, characterised in that the thread twist of the threads (12, 13) is shifted out of the intended region of the spliced connection into the thread regions extending from the splicing chamber (30, 148, 179) to the thread-holding elements (58, 62), and is liberated towards the splice after splicing.

3. Method according to Claim 1 or 2, characterised in that the excess thread ends (12', 13') are removed by plucking.

4. Pneumatic splicing apparatus for textile threads having a splicing chamber into which a compressed air passage opens and having thread-holding elements for holding the textile threads supplied from two sides and inserted into the splicing chamber, for carrying out the method according to one of Claims 1 to 3, characterised in that a controllable thread twist varying element (31, 155, 178, 181) is arranged in the thread region extending from the splicing chamber (30, 158, 179) to the thread-holding element (58, 62).

5. Apparatus according to Claim 4, characterised in that the thread twist varying element (178, 181) comprises a rotatable thread-holding element (183).

6. Apparatus according to Claim 4 or 5, characterised in that the rotatable thread-holding element (330, 343) possesses a shifting device (336, 338) for shifting along the thread axis.

7. Apparatus according to Claim 6, characterised in that the thread-holding element (330, 343) is provided with a toothed wheel (331, 344) the teeth of which engage in a tooth ring (313) arranged in common for both thread-holding elements (330, 343).

8. Apparatus according to one of Claims 4 to 7, characterised in that the thread twist varying element (31, 155) comprises at least one friction face (73, 74; 176) bringable into contact with the thread (12, 13) and movable transversely of the thread longitudinal direction.

9. Apparatus according to Claim 8, characterised in that the thread twist varying element (31, 155) comprises at least two friction faces (73, 74; 176) which are bringable into contact with the thread (12, 13) from opposite sides and are movable forward and back again in opposite directions.

10. Apparatus according to one of Claims 4 to 9, characterised in that the thread twist varying element (31) comprises two oppositely rotatingly drivable halves (71, 72) surrounding the splicing chamber (30) in cage or pot manner and provided with annular-type edges (69, 70), which edges carry the friction faces (73, 74) bringable into contact with the thread (12, 13).

11. Apparatus according to one of Claims 4 to 9, characterised in that the thread twist varying element (155) comprises roll pairs or roll groups (156, 157) rotatable in the same direction and brought into closer proximity to one another than the thread diameter.

12. Apparatus according to Claim 11, characterised in that the rolls (159 to 164) of the roll pairs or roll groups (156, 157) are formed as tapered rollers of which the tapered end (173) points towards the splicing chamber (158).

13. Apparatus according to Claim 11 or 12, characterised in that the rolls (159 to 164) comprise toothed wheels (174) which engage with a toothed ring (175) arranged in common for all rolls (159 to 164).

14. Apparatus according to Claim 13, characterised in that the rolls (159 to 164) are formed as hollow bodies having a perforation and are connected to an air suction supply device.

15. Apparatus according to one of Claims 11 to 14, characterised in that the volume of the splicing chamber (30) is variably adjustable.

16. Apparatus according to Claim 15, characterised in that the size of the blow-out opening (39) of the splicing chamber (30) is variably adjustable.

17. Apparatus according to Claim 15 or 16, characterised in that the size of the blow-out opening (39) is increased or decreased in the same direction with the increase or decrease of the volume of the splicing chamber (30).

18. Apparatus according to one of Claims 15 to 17, characterised in that at least one side wall (41) of the splicing chamber (30) is displaceable in such manner that the displaceable side wall (41) of the splicing chamber (30) is formed as a slider which slides along on the bottom (42) and on the blow-out opening (39) of the splicing chamber (30).

19. Apparatus according to Claim 18, characterised in that the displaceable side wall (41) comprises a fine adjustment device (90).

20. Apparatus according to one of Claims 4 to 19, characterised in that the thread twist varying element (31), the sliding lid (40) and the thread severing elements (32, 33) possess a common actuating device (95).

21. Apparatus according to one of Claims 4 to 20, characterised in that the thread severing devices which remove the thread ends (12', 13') are formed as thread plucking devices at (180, 182; 192).

22. Apparatus according to Claim 21, characterised in that the thread plucking device comprises a travelling clamp (180, 182).

23. Apparatus according to Claim 21, characterised in that the thread plucking device (192) comprises a pair of rolls (193, 194) acting upon the thread (12, 13).

24. Apparatus according to one of Claims 10 to 23, characterised in that the splicing chamber (30) the thread twist varying element (31) and the thread severing devices (32, 33) possess one common housing (29) which also carries a part of the actuating device (95), in that the remaining part of the actuating device (95) is arranged in a second housing (36) and in that both the two housings (29, 36) and the elements of the actuating device (95) allocated to the housings (29, 36) are formed for coupling to one another.

25. Apparatus according to Claim 24, characterised in that the second housing (36) comprises two levers (98, 125) operable by cam discs, namely a first lever (125) for the common actuation of the two halves (71, 72) of the thread twist varying element (31) as regards their rotation and a second lever (98)

for the actuation of the sliding lid (40), the thread severing devices (32, 33) and the thread twist varying element (31) as regards the approach of its two halves (71, 72) to one another and their removal from one another.

26. Method for connecting textile threads by splicing by means of compressed air substantially as described herein.

27. Pneumatic splicing apparatus for textile threads substantially as described herein with reference to the accompanying drawings.

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