(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 036 195**
A2

(12) EUROPEAN PATENT APPLICATION

(21) Application number: **81101872.0**

(22) Date of filing: **13.03.81**

(51) Int. Cl.³: **D 04 B 9/06**

(30) Priority: **19.03.80 IT 2077080**

(43) Date of publication of application:
23.09.81 Bulletin 81/38

(84) Designated Contracting States:
DE FR GB

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(54) Single-cylinder circular knitting machine having two needle beds for knitting plain and purl stitches.

(57) In a single-cylinder circular knitting machine having two needle beds or needle-carrying structures (1,2), the lower structure (2) comprises a needle cylinder and the upper structure (1) penetrates for its major portion into the cylinder and has needle tricks (15) therein of arcuate shape with their center of curvature located on the same side as the cylinder, for accommodating arcuately bent latch needles (16). The needles (16) have their hooks and latches arranged on the convex side of the arcuate shape. They may have butts intended for controlling their movements, or be controlled by means of jacks. The upper needle-carrying structure (1) may advantageously be open at the center to allow the knitted fabric (25) to be pulled and/or discharged to the top. A machine of this type may have the same number of needles in both needle-carrying structures (1,2), even where the latter have small diameters, and a smaller height dimension than traditional needle cylinder and dial machines of equal diameter.

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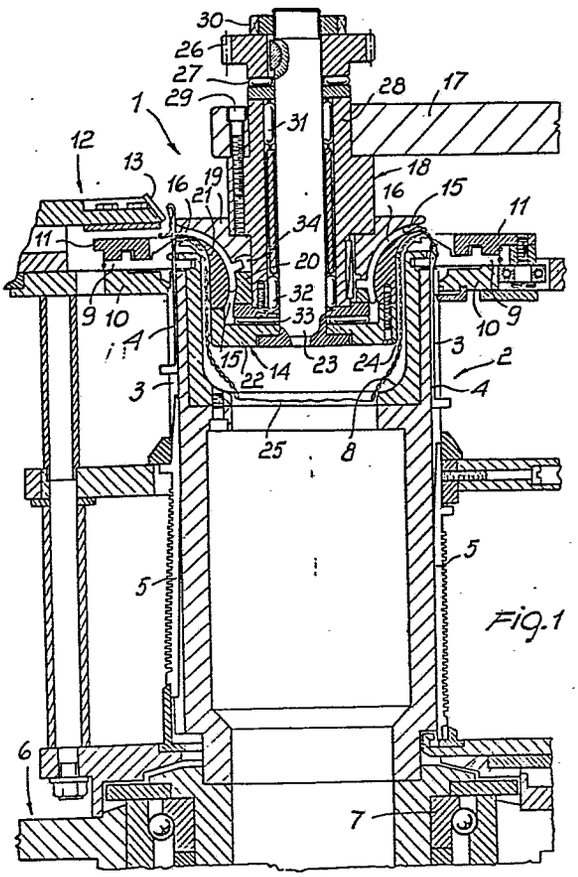
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Fig.1

This invention relates to a single-cylinder circular knitting machine having two needle beds or needle-carrying structures, for knitting plain and purl stitches.

In conventional machines of the above general type, those needles which are knitting plain stitches are movable vertically in the needle cylinder, and those needles which are knitting purl stitches are movable radially in the needle dial overlying the cylinder. With small diameter machines as primarily employed in knitting stockings, however, the reduced size of the dial imposes a limitation on the number of the needles that can be provided in the dial, for otherwise, the needles would end by interfering with one another at the nearest area to the dial center.

To obviate the above limitation, which materially affects the machine versatility, it has been suggested of arranging the needle tricks, or grooved needle seats, in the dial -- and accordingly the needles themselves -- rather than radially as usual, at an angle with respect to the radial direction, that is to say tangent to a circle concentrical to the dial. However, even this approach failed to provide satisfactory results.

It has been further proposed (refer to German Patent No. 667,499) of providing the dial with arcuate needle tricks in a pattern that from an essentially radial direction at the outermost edge

of the dial is progressivelly deflected upwardly until it follows a substantially parallel direction to the machine axis. In the needle tricks, there are movably arranged respective needle of arcuate configuration which extend over an arc of about 90° and have their hooks and latches located on the concave side. On that same side, the needles are further provided with butts for engagement with tilting jacks, in turn controlled through horizontal sliders being driven by overlying cams. Thus, the needle movements at the outer edge of the dial occur approximately radially to the dial.

The arcuate configuration of the needle tricks enables the provision of a higher number of tricks in the dial, for a given diameter, than with a conventional dial, since the needle tricks are kept at a substantial distance away from the machine central area. This affords the possibility of knitting high fineness fabrics even with small diameters.

However, the arcuate lay of the needle tricks increases the height dimension of the machine with respect to a similar machine equipped with a conventional dial, while the arcuate needle control mechanism is a complex and bulky one, in that it requires several members for each needle and takes up much room even in the horizontal direction, beyond the dial maximum diameter.

Attempts have been made at attenuating the complexity of the arcuate needle control mechanism by increasing the needle extension to cover an arc up

to about 180°, and by controlling the needles directly through cams arranged to act on needle butts located at the opposite ends thereof to the work ends, as disclosed in German Patent No. 675,210. However, this approach involves an additional increase of the dial height dimension, through the requisite that said height be at least equal to twice the needle radii of curvature.

German Patent No. 687,914 discloses a knitting machine including a needle-carrying structure which also has an arcuate shape near the needle cylinder. This structure is an upper cylinder with a smaller diameter than the lower one and outwardly bent at its bottom region to define needle tricks of arcuate configuration. Movable in said tricks are needles which are provided with an elastic shank portion adapted to conform itself to the arcuate shape of the respective trick. The remaining portion of the needles is straight and movable in a vertically extending trick of the upper cylinder, it being provided with a butt subjected to the action of cams which surround the cylinder. However, it will be appreciated that the latter machine, besides its complicated construction and the critical operation of its flexible shank needles, also exhibits a high vertical dimension of the needle-carrying structure positioned above the lower cylinder.

This invention sets out to provide a single-cylinder circular knitting machine having two needle

beds or needle-carrying structures, wherein both needle beds can accommodate an equal number of needles even in the case of small diameter dimensions, without bringing about any increase of the machine overall height dimension beyond that of a conventional cylinder and dial machine having the same diameter, and even affording a reduction of that dimension.

Within the above general aim, it is possible to arrange that the dual needle bed single-cylinder knitting machine of this invention can also effectively discharge the knitted fabric from above, i.e. in a reversed condition.

According to one aspect of the present invention, there is provided a single-cylinder circular knitting machine having two needle beds or needle-carrying structures arranged one above the other and being each formed with needle tricks, wherein respective needles are slidably accommodated, the lower structure comprising a needle cylinder and the upper structure comprising a needle dial, the needles in both said structures being controlled through control means at least in part movable relative to said structures, the machine being characterized in that said needle dial extends into said needle cylinder and has needle tricks therein of arcuate configuration with the center of curvature being located on the same side as the needle cylinder, in said arcuate needle tricks there being slidably arranged arcuate needles having hooks and latches located on the convex side of the arcuate shape.

In a machine thus configured, wherein the needle tricks in the dial and related needles extend from an approximately radial direction of lay at the top end of the respective tricks progressively downwards, while remaining substantially away from the machine central area, it becomes possible to not only arrange in the upper needle-carrying structure the same number of tricks which can be formed in the lower needle-carrying structure, even in the case of small diameters, but also to reduce the machine overall height for a given set of characteristics, because the control cams for the needles in the upper needle-carrying structure are also accommodated substantially within the lower needle-carrying structure, and therefore, do not occupy the space volume above it.

Since the needles are held substantially away from the center of the machine, the cams controlling such needles are also located sufficiently away from the machine central area, and therefore, pose no problems regarding their configuration and dimensions. The upper needle-carrying structure, moreover, may advantageously be of hollow construction, that is open at the central area over its entire height to enable -- for the first time in a single-cylinder machine -- the product to be pulled and discharged from the top , with all those attendant advantages which are well known to the experts in the art.

Further features and advantages of the invention will be more readily apparent from the following detailed description of some preferred embodiments thereof, given herein by way of example and not of limitation, and being illustrated in the accompanying drawings, where:

Figure 1 is an axial section through a single-cylinder circular knitting machine according to this invention, illustrating a first embodiment thereof;

Figure 2 shows an axial section of the knitting machine of Figure 1 on an enlarged scale with respect to that of Figure 1;

Figure 3 shows, on an enlarged scale, a needle from the upper needle-carrying structure of the knitting machine of the preceding figures;

Figure 4 is a detail plan view of the machine of Figures 1 and 2;

Figure 5 is a fragmentary axial sectional view of a knitting machine according to the invention, illustrating another embodiment thereof;

Figure 6 is an axial sectional view of a knitting machine according to the invention, illustrating a further embodiment thereof; and

Figure 7 is a detail view of a needle from the upper needle-carrying structure of the embodiment shown in Figure 6.

With initial reference to Figures 1 and 2, a single-cylinder circular knitting machine according

to the invention comprises two needle beds or needle-carrying structures 1 and 2, which are arranged to extend coaxially above each other, the lower structure 2 comprising a conventional needle cylinder, and the upper structure 1 comprising a novel needle dial which will be described hereinafter.

In the cylinder 2, there are formed in a manner known per se needle tricks 3, wherein the needles 4 knitting plain stitches are movable, such needles being of conventional design and controlled through jacks 5 being selected by conventional selection devices, not shown. The cylinder 2 is carried rotatably on a stationary or fixed portion 6 of the machine main frame through bearings 7, and is rotatively driven in a manner known per se. Inside its top or upper portion, the cylinder 2 is advantageously provided with a cup-like element 8 which is open at the bottom and is adapted to function as a fabric guiding element, as will be explained hereinafter. Said element 8, however, may be omitted and the cylinder 2 have a smooth configuration throughout its inner portion, similarly to conventional machines.

The reference numeral 9 designates sinkers of conventional design, which are slidably received in a rotating support ring 10 and controlled through a fixed ring 11, the whole assembly being in accordance with well known practices. The numeral 12 designates a yarn feed unit comprising yarn feeding fingers 13, of a known type. The machine further comprises means

for controlling the needles 4 and jacks 5, which means comprise traditional cams controlling the movements of the needles 4 and jacks 5, such cams being not shown in any detail herein because known per se.

In accordance with this invention, the upper needle-carrying structure or dial 1 extends into the cylinder 2 and has, formed on a supporting body 14, needle tricks 15 of arcuate shape, their center of curvature being located on the same side as the cylinder 2. Advantageously, the topmost portion of the tricks 15 is substantially tangent to a horizontal plane. In the tricks 15, there are slidable respective needles 16, also of arcuate shape, the radius of curvature of the needles being equal to the radius of the tricks 15. The supporting body 14 is carried rotatably in a fixed portion 17 of the machine main frame and has a fixed structure 18 overlying it which carries control means for the needles 16, said means comprising control cams 19,20.

More specifically, in the embodiment shown in Figures 1 and 2, the supporting body 14 comprises a portion 21, which is configured substantially like the top portion of a wineglass and has internal tricks 15, a substantially cup-like portion 22, made rigid with the wineglass portion 21 and supporting the latter, and a shaft 23, made rigid with the portion 22 and extending out of the cylinder 2 in an upward direction. The portions 21 and 22 have outside diameters such that they define, relatively to the cylinder 2, an interspace 24 for the passage

of the knitted fabric 25 therethrough.

The shaft 23 is made rigid with a gear wheel 26, which is journalled, through bearings 27, in a sleeve element 28, which is a part of the fixed structure 18 and coaxial with the shaft 23. The sleeve element 28 is fastened, as by means of screws 29, to the fixed portion 17, the top end of the shaft 23 being threaded to receive a nut 30 or the like in threaded engagement thereon, thereby the element 28 practically supports the whole supporting body 14 and keeps it correctly positioned with respect to the fixed structure 18 with the intermediary of the bearings 31,32 and 33. The gear wheel 26 is rotated by the machine motive means at the same rpm as the cylinder 2, as is usually the case with the dial.

The cams 19,20 are attached to the sleeve element 28 and define a passageway 34 therebetween for respective control butts 16a of the needles 16. The cams 19,20 have a circumferential extension pattern which is essentially similar to that of the cams controlling the dial needles in a conventional machine, and may be constructed in the same way as the cams which control the sinkers in a double cylinder knitting machine, with the exception of the geometry of the passageway 34.

Advantageously, the tricks 15 will extend substantially over a slightly larger arc of a circle than 90 degrees, the needles 16 extending over an arc of a circle substantially equal to 90 degrees.

The needles 16 are of the latch type and have, as shown more clearly in Figure 3, a hook 16b and latch 16c, which are arranged on the convex side of the arcuate needle, that is upwardly when the needles are installed in the machine. It will be apparent how, under the influence of the cams 19,20 whose profiles are set in accordance with the machine knitting program, the needles 16 are caused to move along an arc of a circle between a position whereat their hooks 16b and latches 16c move out of the supporting body 14 (and specifically out of the wineglass portion 21), as illustrated for the left needle 16 in Figures 1 and 2, and a position whereat the hooks and latches are internal to the periphery of the supporting body 14 (and specifically of the wineglass portion 21), as illustrated for the right needle 16 in Figures 1 and 2. It will be also appreciated that the useful movement of the hooks and latches of the needles 16 between said two limit positions does not substantially differ from conventional practice, it occurring in a substantially horizontal and radial direction at the stitch formation area. Thus, the stitches are also formed in a conventional manner, and will require no further explanation. The knitted fabric 25 is collected gradually inside the cylinder 2, like in a cylinder and dial machine, after passing through the interspace 24, to then continue towards the bottom portion of the cylinder 2. Advantageously, there may be provided a suction means to favor the downward movement of the fabric 25, at least along the inter-

space 24, it being possible for such means to be of a known type.

As may be seen more clearly in Figure 4, which shows a plan view of the wineglass portion 21 and part of the cylinder 2, the tricks 15 extend radially over a short distance only at their top portion, to then become gradually parallel to the rotation axis of the machine and extend at a distance from said axis which is appreciably greater than in a conventional dial of equal diameter. The short radial extension of the tricks 15 makes it readily possible to arrange the same number of tricks 15 therein as are the tricks 3 of the cylinder, as shown again in Figure 4, even where the machine has a small diameter. This enables the machine knitting fineness to be improved considerably, as can the fineness of the resulting knitwork, for a given diameter of the cylinder.

Advantageously, the supporting body 14 may be made internally hollow and open at the top, such as to allow the knitted product 25 to be discharged upwardly, that is in a reversed condition, which is known to favor the carrying out of the final or finishing operations on the knitwork, especially where the latter is a hose or stockings article. To this aim, the shaft 23 may be of hollow construction. However, since with small diameter machines the hollow in said shaft could be insufficient, the embodiment of Figure 5 is provided wherein similar elements to those appearing in the preceding figures carry the same

reference numerals, and equivalent elements are identified with the same reference numerals but with a prime ('). In this embodiment, the shaft 23 is replaced with a bottom flanged sleeve 35, which is made rigid with the centrally open gear wheel 26' and provided with a top thread for the nut 30'. The fixed structure 18', being carried on the fixed portion 17', supports the gear wheel 26' through bearings 27' and holds in position the sleeve 35 through bearings 31',32',33'. The cams 19' and 20' are rigidly held between the bottom flange of the sleeve 35 and the fixed structure 18'. The wineglass portion 21 is attached to the sleeve 35 by means of an annular element 22' which is secured to the sleeve 35. Advantageously, under the flange of the sleeve 35, there is arranged a rounded body 36 adapted for facilitating the guiding and advancing of the fabric 25 in an upward direction.

This embodiment comprises a means for favoring the downward movement of the fabric 25 through the interspace 24, e.g. a suction means acting from below through the cylinder 2 with the sleeve 35 closed, and a means for conveying and pulling the fabric toward the top upon reaching a given length, said last-mentioned means comprising optionally a suction means operative through the sleeve 35, or tensioning means, e.g. of the same type as used in upward take-up double cylinder knitting machines.

In the embodiment of Figure 6, wherein similar elements to those shown in Figures 1 and 2 are

designated with the same reference numerals and the equivalent elements are identified with double primed (") numerals, the latch needles 16" (refer also to Figure 7) have no butts and are each provided with a hooked bottom end 16"a, which is hingedly associated with a hooked top end 37a of a respective linear jack 37. The engagement and configuration of the hooked ends 16"a and 37a are such as to enable the needles 16" to be pushed and pulled by the respective jacks 37.

The jacks 37 are each provided with at least one butt 37b, adapted to follow control cams 19", 20", attached to an annular body 38 made rigid with the fixed structure 18. The jacks 37 move linearly in respective axial inner grooves or tricks 39 of an annular guiding element 40 clamped between the wineglass portion 21" of the supporting body 14 and the bottom 22" thereof. The wineglass portion 21" is so configured as to leave a sufficient clearance for the rectilinear movement of the selectors 37 between two limit positions, shown again in Figure 6, whereto there correspond, respectively, the limit positions of the needles 16" discussed with reference to Figures 1 and 2. The annular blocks 41,42, defining the control cams for the needles 16 in the preceding embodiments, are now in mutual engagement and define a continuous guiding surface for guiding the needles 16".

It will be appreciated from the foregoing that a single-cylinder machine according to the invention

has, in any of the embodiments described hereinabove, the peculiar capability of combining the typical advantages afforded by single-cylinder knitting machines with the advantages typifying the double cylinder machines.

The invention as described is susceptible to many modifications and variations, without departing from the purview of the instant inventive concept. Thus, as an example, the machine could be implemented with the cylinder 2 and upper needle-carrying structure 1 stationary and rotating cams. Instead of the hooked connection between the needles 16" and jacks 37 a clevis pin system could be provided, e.g. as utilized between the shank and latch of the needles. To avoid a rubbing contact and excessive stresses in the needles 16", under the pushing force applied by the jacks 37, against the fixed blocks 41 and 42, the latter may be arranged to be rotary. Of course, the upper needle-carrying structure of Figure 5 may be implemented with jacks 37 in accordance with the embodiment shown in Figure 6, that is to arrange for upward discharge even in the embodiment providing jacks. It is to be understood that the machine described hereinabove and illustrated in the accompanying drawings may not be set up for hose or stockings article knitting, and may have larger diameters, there being no limitations in this respect. Similarly, it is not strictly required that the machine has an equal number of tricks on both its needle-carrying structures, and the upper needle-

carrying structure may have, for example, one half the number of needles provided on the cylinder.

C L A I M S

1. A single-cylinder circular knitting machine having two needle beds or needle-carrying structures (1,2) arranged one above the other and being each formed with needle tricks (3,15), wherein respective needles (4,16) are slidably accommodated, the lower structure (2) comprising a needle cylinder and the upper structure (1) comprising a needle dial, the needles (4,16) in both said structures (1,2) being controlled through control means (5;19,20;19',20';19", 20";37) at least in part movable relative to said structures (1,2), characterized in that said needle dial (1) extends into said needle cylinder (2) and has needle tricks (15) therein of arcuate configuration with the center of curvature being located on the same side as the needle cylinder (2), in said arcuate needle tricks (15) there being slidably arranged arcuate needles (16,16") having hooks (16b) and latches (16c) located on the convex side of the arcuate shape.

2. A knitting machine according to Claim 1, characterized in that said needle tricks (15) in said upper needle-carrying structure (1) have their top-most portions substantially tangent to a horizontal plane.

3. A knitting machine according to either Claim 1 or 2, characterized in that said needles (16) of said upper needle-carrying structure (1) are each provided with a control butt (16a) located on the convex side for engagement with said control means (19,20;19',20').

4. A knitting machine according to one or more

of Claims 1 to 3, characterized in that said needles (16") of said upper needle-carrying structure (1) are hingedly associated with respective jacks (37), said jacks (37) being movable each along a respective axial trick (39) in an annular guiding element (40) of said upper needle-carrying structure (1), said jacks (37) being each provided with at least one control butt (37b) for engagement with said control means (19",20").

5. A knitting machine according to Claim 4, characterized in that said needles (16") have each a hooked bottom end (16"a) in removable engagement with a hooked top end (37a) of a respective one of said jacks (37), said hooked ends (16"a, 37a) being configured for engagement both in pull and push relationship of said jacks (37) with said needles (16"a).

6. A knitting machine according to one or more of Claims 1 to 3, or one or more of Claims 1,2 and 4,5, characterized in that said upper needle-carrying structure (1) comprises a hollow supporting body (14) for discharging the knitted product (25) in an upward direction.

7. A knitting machine according to Claim 6, characterized in that said supporting body (14) is made rigid with a gear wheel (26') arranged above said supporting body (14) and being open at the center for allowing said knitted product (25) to be discharged upwardly.

8. A knitting machine according to Claim 1, characterized in that said upper needle-carrying structure (1) comprises a supporting body (14) arranged

coaxially with said lower needle-carrying structure (2), said supporting body (14) comprising a substantially wineglass-like portion (21) formed with said tricks (15) of arcuate shape, a substantially cup-like portion (22) made rigid with said substantially wineglass-like portion (21) and supporting the latter, and a shaft (23) made rigid with said substantially cup-like portion (22) and extending out of said needle cylinder (2) coaxially therewith, said shaft (23) being journalled in the machine stationary frame (17), said substantially wineglass-like portion (21) and said substantially cup-like portion (22) having outside diameters selected to define, in cooperation with said needle cylinder (2), an interspace for passing the knitted product (25) therethrough.

9. A latch needle of arcuate shape for a circular knitting machine having two needle beds or needle-carrying structures for knitting plain and purl stitches, characterized in that it is provided with a hook (16b) and latch (16c) arranged on the convex side of said arcuate shape.

10. A needle according to Claim 9, characterized in that it is provided with a hooked end (16"a) for removably engaging a hooked end (37a) of a control jack (37).

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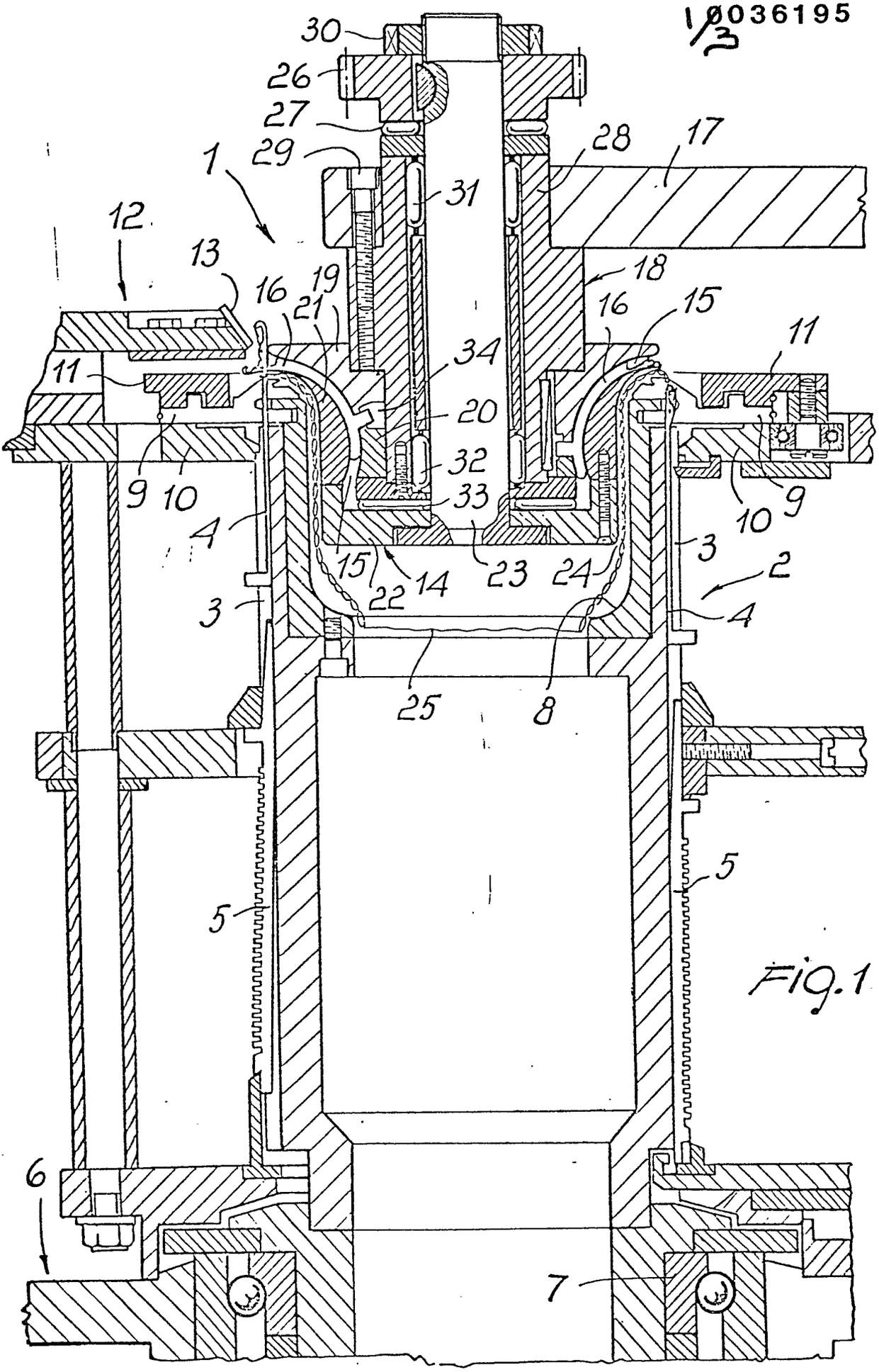

Fig. 1

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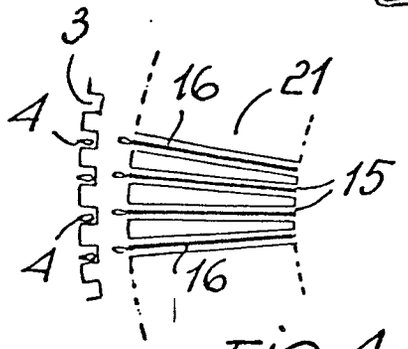


FIG.4

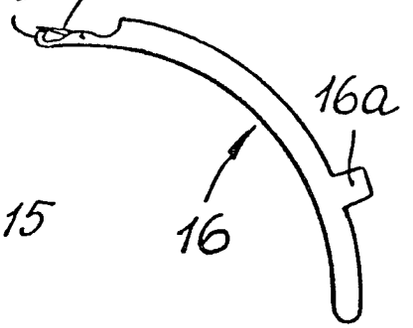
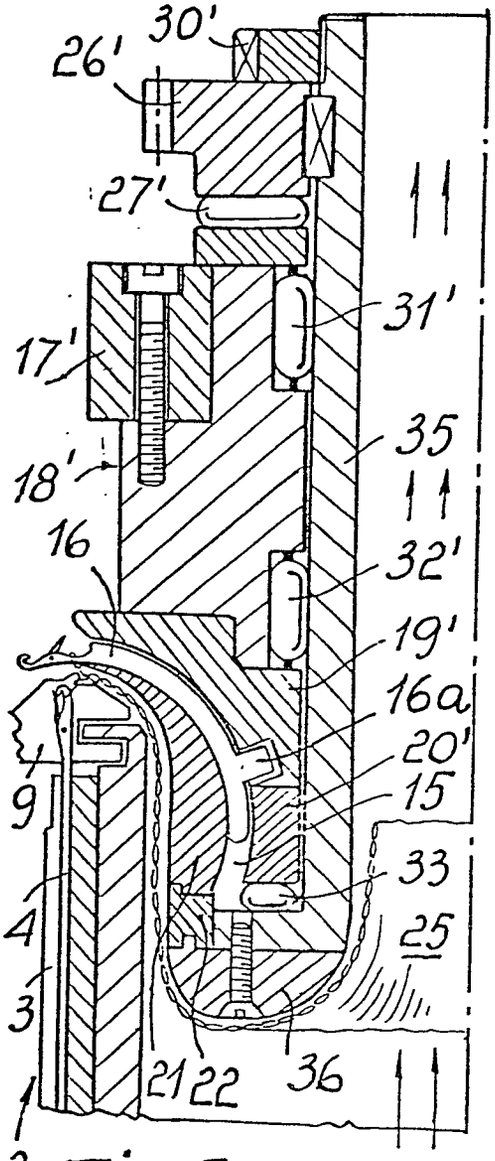


FIG.3



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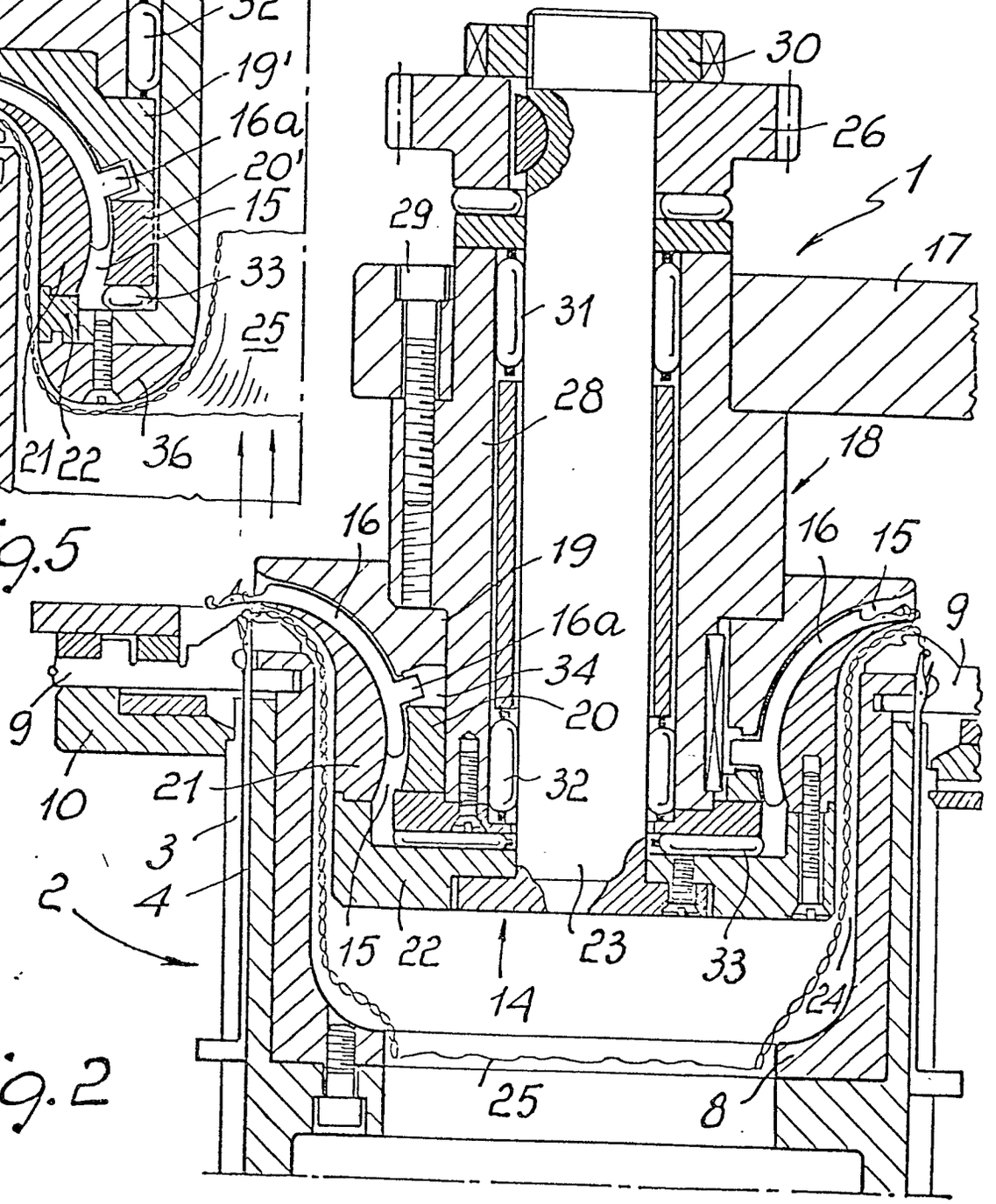


FIG.2

Fig.7

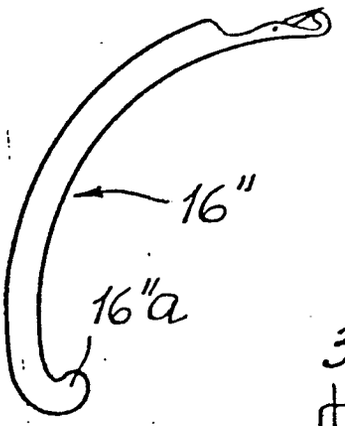
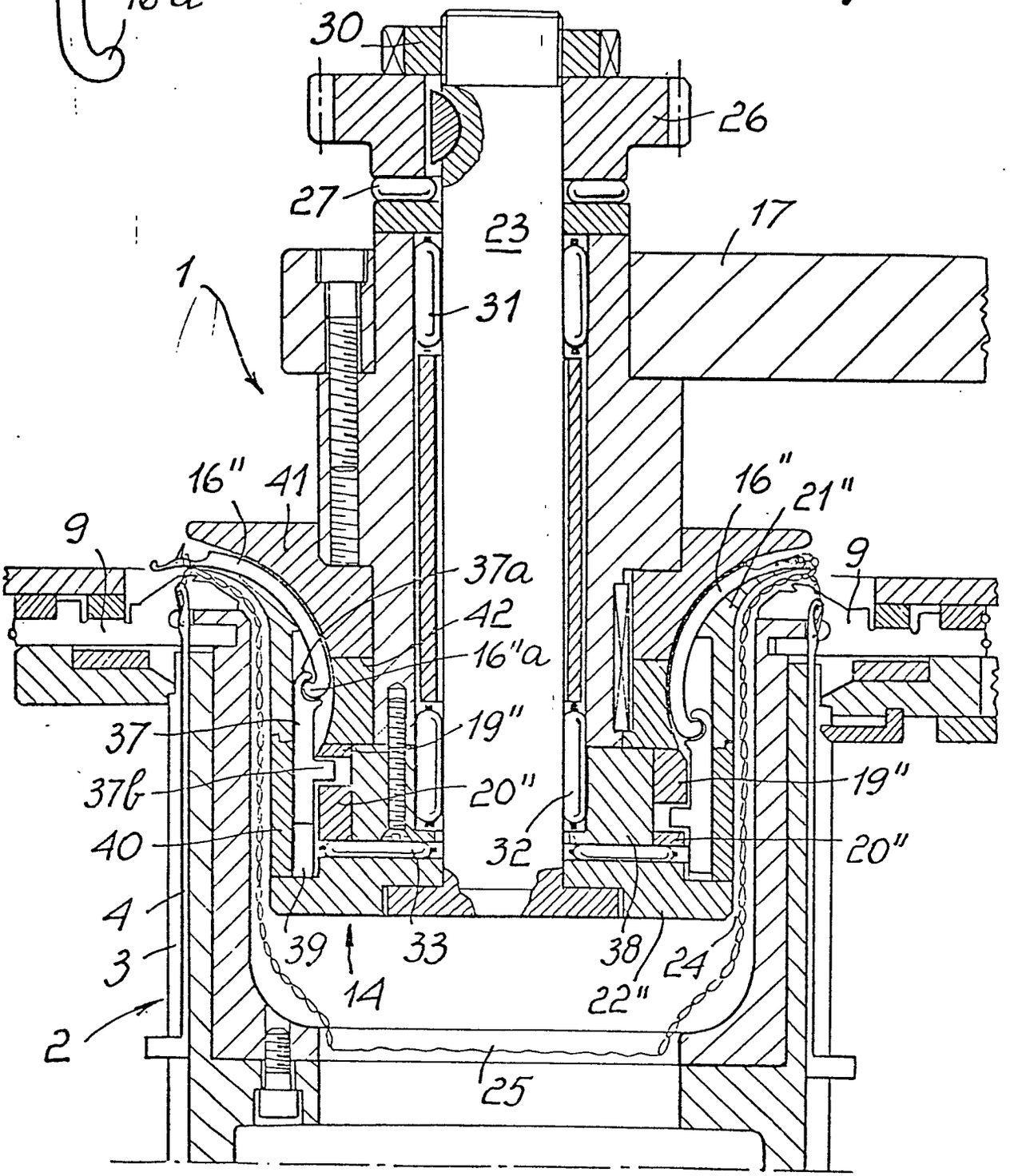

16"
16"a

Fig.6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