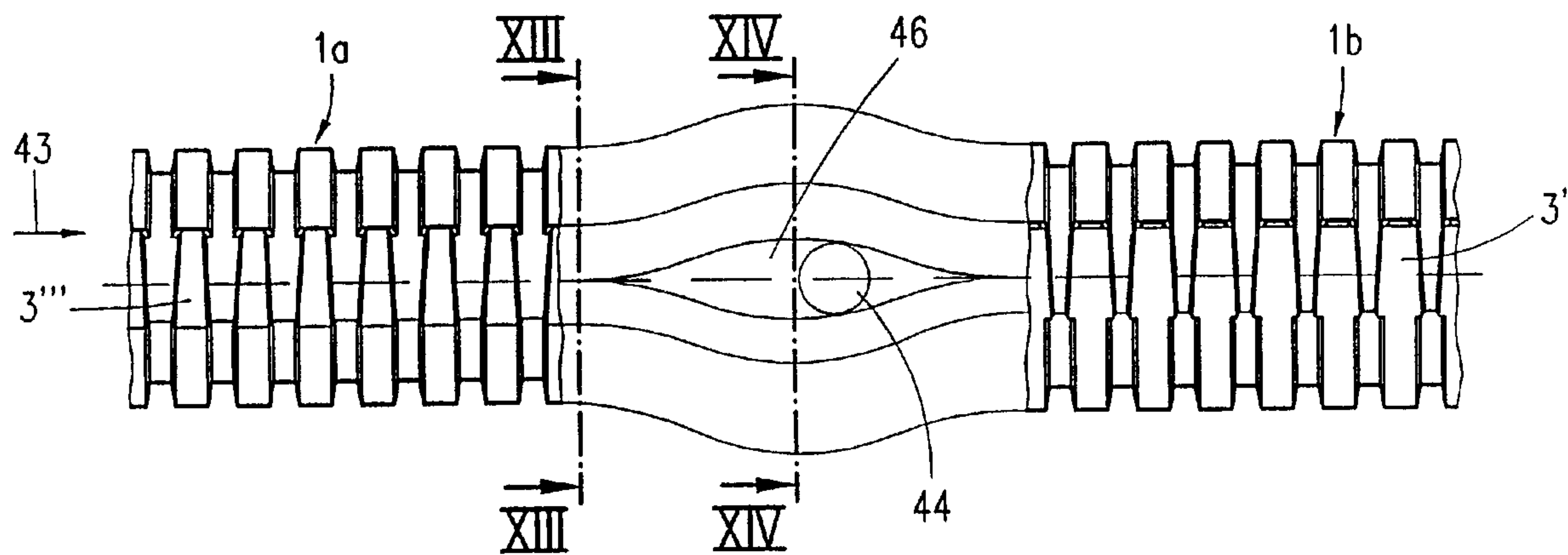




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(54) Titre : PROCÉDE POUR PRODUIRE UN TUBE DE GAINAGE ONDULE D'UNE SEULE PIÈCE
 (54) Title: METHOD FOR PRODUCING A ONE-PIECE CORRUGATED JACKET-TUBE



(57) Abrégé/Abstract:

For the manufacture of a single-piece corrugated jacket pipe of thermoplastic material, this pipe is formed to have corrugated sub-sections (3'', 3''') which are deformed for them to lie one upon the other radially of the axis of the corrugated pipe in the opposite direction as should be the case in the locked condition after insertion of electric lines.

Abstract

For the manufacture of a single-piece corrugated jacket pipe of thermoplastic material, this pipe is formed to have corrugated sub-sections (3", 3")
5 which are deformed for them to lie one upon the other radially of the axis of the corrugated pipe in the opposite direction as should be the case in the locked condition after insertion of electric lines.

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METHOD FOR PRODUCING A ONE-PIECE
CORRUGATED JACKET-TUBE

5 The invention relates to a method of producing a one-piece corrugated jacket pipe of thermoplastic comprising the steps of forming a thermoplastic tube; shaping the tube into a corrugated pipe, which is closed over its circumference and has an axis and a corrugated section formed by a first corrugated partial section and a second corrugated section, the partial sections being such that when radially overlapping each other, the first partial section lies radially outwards and engages with the radially inward second partial section; 10 cutting the corrugated pipe parallel to the axis in a cutting plane for the corrugated partial sections to form; thermally deforming the corrugated pipe such that the two corrugated partial sections lie one above the other radially and lap over each other in a peripheral direction. The invention further relates to a method of inserting at least one electric line into such a corrugated jacket pipe.

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A method of the generic type is known from WO98/32 202. In this case, the corrugated jacket pipe is thermally formed in such a way that the first corrugated partial section rests radially outwards on, and engages with, the second corrugated partial section directly after the forming. Practice has shown that the engagement of the first and the second 20 corrugated partial section does not take place with the required radial prestress. This may result in small gaps forming so that electric lines might get squeezed or damaged. Moreover, the corrugated jacket pipe may open when bent during installation for instance in a vehicle, and the electric lines disposed in it may come out. This too may lead to damages of the electric lines.

25

The above explanations also apply to the corrugated jacket pipe known from WO97/32379.

30 It is an object of the invention to further develop the method of the species such that after placement of the electric lines, the corrugated sub-sections are engaged by sufficient radial prestress.

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In one aspect, the invention provides a method of producing a one-piece corrugated jacket pipe of thermoplastic, the method comprising the following steps:

forming a thermoplastic tube;

5 shaping the tube into a corrugated pipe which is closed over its circumference and has an axis and a corrugated section;

cutting the corrugated pipe parallel to the axis in a cutting plane along said corrugated section to form a first and a second corrugated partial section;

10 thermally deforming the cut corrugated section such that the first and second corrugated partial sections radially and peripherally overlap each other with the first partial section

laying radially inward and second partial section laying radially outward; and

engaging the first partial section and second partial section by radial prestress, when the first partial section lies radially outwards and overlaps the second partial section radially and peripherally.

15 The measures according to the invention help ensure that, in the corrugated pipe that constitutes an intermediate product, the first corrugated sub-section, which is positioned radially outside after placement of at least one electric line and closure of the corrugated jacket pipe, lies radially inside prior to the placement of the electric line so that, after the radial position of the two sections relative to each other has been changed, they bear
20 against each other by important radial prestress in their position of mutual lap.

In another aspect, the invention provides a method of inserting at least one electric line into a one-piece corrugated jacket pipe of thermoplastic produced according to the following steps:

25 forming a thermoplastic tube;

shaping the tube into a corrugated pipe which is closed over its circumference and has an axis and a corrugated section;

cutting the corrugated pipe parallel to the axis in a cutting plane along said corrugated section to form a first and a second corrugated partial section;

30 thermally deforming the cut corrugated section such that the first and second corrugated partial sections radially and peripherally overlap each other with the first partial section laying radially inward and second partial section laying radially outward;

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forming in the vicinity of the cutting plane, an aperture by spreading the first and second corrugated partial sections elastically in the peripheral direction; and
inserting at least one electric line through the aperture into the corrugated pipe;
wherein the aperture is closed by moving the first corrugated partial section to overlap
5 radially outwards the second corrugated partial section in the peripheral direction by
elastic restoring forces of the corrugated pipe.

Further advantages of the invention will become apparent from the ensuing description of
an exemplary embodiment of the invention, taken in conjunction with the drawing, in
10 which

Fig. 1 is a lateral longitudinal view of a corrugated pipe constituting a first
intermediate product;

15 Fig. 2 is a cross-sectional view through the corrugated pipe in accordance with the
line II-II of Fig. 1;

Fig. 3 is a cross-sectional view through the corrugated pipe in accordance with the
line III-III of Fig. 2;

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Fig. 4 is a cross-sectional view through the corrugated pipe in accordance with the
line IV-IV of Fig. 2;

Fig. 5 is a lateral longitudinal view of the finally assembled corrugated pipe;

- Fig. 6 is a cross-sectional view through the corrugated pipe in accordance with the line VI-VI of Fig. 5;
- 5 Fig. 7 is a cross-sectional view through the corrugated pipe in accordance with the line VII-VII of Fig. 6;
- Fig. 8 is an illustration of a plant for the manufacture of a corrugated pipe according to Figs. 1 to 7;
- 10 Fig. 9 is a sectional view through a delivery arrangement in accordance with the line IX-IX of Fig. 8;
- Fig. 10 is a sectional view through a postforming device in accordance with the line X-X of Fig. 8;
- 15 Fig. 11 is a plan view of an assembly tool;
- Fig. 12 is a plan view of the corrugated pipe with the assembly tool in use;
- 20 Fig. 13 is a sectional view through the corrugated pipe in accordance with the line XIII-XIII of Fig. 12; and
- 25 Fig. 14 is a sectional view through the corrugated pipe in accordance with the line XIV-XIV of Fig. 12.

The corrugated pipe 1 seen in Figs. 1 to 4, which constitutes a first intermediate product, consists of a known thermoplastic material such as polyethylene, polypropylene, polyamide or the like. It has a central

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ethylene, polypropylene, polyamide or the like. It has a central longitudinal axis 2 concentrically of which the corrugated pipe 1 is provided with corrugated sections 3 which, as seen in Fig. 2, extend over approximately three quarters of the circumference. These corrugated sections 3 include
5 inner pipe sections 4, which are substantially circular cylindrical and are concentric to the axis 2; and outer pipe regions 5, which are substantially circular cylindrical and also concentric to the axis 2. An inner pipe section 4 is united with the adjoining outer pipe regions 5 in each case by means of flanks 6, 7. The flanks 6, 7, which are connected with the outer pipe region
10 5 slightly incline toward each other – as seen from the axis 2 radially outwards – so that, between an outer pipe region 5 and the adjoining flanks 6, 7, a cavity 8 is formed which stands back radially outwards from the inner pipe sections 4, approximately having the cross-sectional shape of a trapezoid that expands toward the pipe region 5 as seen in Fig. 3. This design of
15 a corrugated pipe illustrated at the top and bottom and on the left of Fig. 2 is general practice.

As seen in Figs. 1, 2 and 4, the corrugated pipe 1 has corrugated sections 3' approximately over part of its circumference, these sections 3' also includ-
20 ing pipe sections 4' which continue the inner pipe sections 4, closing them over the circumference; and outer pipe regions 5' which continue the outer pipe regions 5, closing them over the circumference; and flanks 6' and 7' which join the inner pipe sections 4' to the outer pipe regions 5'. The cross-sectional shape of the cavity 8' formed in the corrugated section 3' changes
25 along the circumferential extension of the corrugated section 3'.

The corrugated sections 3' have a start 9, which is illustrated on the right at the bottom of Fig. 2 and which corresponds to an end of the corrugated section 3. The corrugated section 3' further comprises an end 10, which is

illustrated at the top of Fig. 1 and on the right at the top of Fig. 2 and which corresponds to the other end of the corrugated section 3. As seen in Figs. 1 and 2, at the start 9, the outer pipe region 5 of a corrugated section 3 passes continuously into the outer pipe region 5' of the corrugated section 3'. By contrast, the inner pipe section 4' is misaligned outwards radially of the axis 2 as compared to the inner pipe section 4. The flanks 6' and 7' of the corrugated section 3' are misaligned in the axial direction as compared to the flanks 6, 7 of the adjoining corrugated section 3. The inner pipe section 4' passes into the inner pipe section 4 by way of a transition section 11; the flanks 6' and 7' pass into the flanks 6 and 7 by way of transition sections 12, 13 which extend from the flanks 6 and 7 outwards in the axial direction.

At the end 10 of the corrugated sections 3', the inner pipe section 4' thereof passes continuously into the adjoining inner pipe section 4 of the adjoining corrugated section 3 as seen in Fig. 2. By contrast, the outer pipe region 5' stands back radially inwards as compared to the adjoining pipe region 5. At the end 10, the outer pipe region 5' passes into the adjoining outer pipe region 5 by way of an outwardly extending transition section 14. Furthermore, the flanks 6' and 7' pass into the flanks 6, 7 by way of transition sections 15, 16, with the transition sections 15, 16 extending from the flanks 6, 7 inwards in the axial direction.

When the corrugated pipe 1 is cut unilaterally in the middle between the start 9 and the end 10 of the corrugated sections 3' in a cutting plane 17 that coincides with the line IV-IV of Fig. 2 and also passes through the axis 2, then two corrugated sub-sections 3'' and 3''' are formed from each corrugated section 3', the corrugated sub-section 3'' extending from the start 9 as far as to the cutting plane 17 and the corrugated sub-section 3''' extending

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from the cutting plane 17 as far as to the end 10. Correspondingly, the corrugated sub-section 3" comprises a partial inner pipe section 4", a partial outer pipe region 5" and partial flanks 6" and 7". The corrugated sub-section 3''' correspondingly comprises a partial inner pipe section 4''', a partial outer pipe region 5''' and partial flanks 6''' and 7'''. When – as seen in Figs. 5 to 7 – the corrugated pipe 1 that is cut in the cutting plane 17 is bent, then, owing to the described design of the corrugated sections 3', the corrugated outer sub-section 3" receives the corrugated inner sub-section 3''' in such a way that the partial inner pipe sections 4" and 4''', the partial outer pipe regions 5" and 5''' and the partial flanks 6" and 6''' and 7" and 7''' rest on each other as seen in Fig. 7. The partial inner pipe section 4''' extends such that, at the transition section 11, it passes into the adjoining inner pipe section 4 without any irregularity. Correspondingly, at the transition section 14, the partial outer pipe region 5" has no serious radial irregularity toward the pipe region 5. As seen in Figs. 5 and 7, the partial flanks 6" and 7" pass without irregularity into the flanks 6, 7 at the transition sections 15, 16. The same is true for the partial flanks 6''' and 7''' at the transition sections 12, 13. Further details of the corrugated pipe 1, in particular the dimensioning, become apparent from WO98/32202.

20

Manufacture of the corrugated pipe 1 takes place on a plant that is diagrammatically illustrated in Fig. 8. A plant of this type comprises an extruder 18, from the extrusion die 19 of which is extruded a tube 20 of thermoplastic material.

25

In a downstream molding machine 21, the tube 20 is deformed into the corrugated pipe 1 by so-called vacuum treatment or so-called blow molding or combined vacuum blow molding. Molding machines 21 of the generic type are generally known for instance from German patents 1 203 940 and

1 211 789 (corresponding to British patent 971021). Emerging from the molding machine 21 is a corrugated pipe 1 that is inherently stable.

5 This corrugated pipe 1 is further cooled in a downstream cooling bath 22 by means of a suitable coolant, which may be air or water. Cooling baths 22 of this type are general practice.

10 The cooling bath 22 is followed by a belt or Caterpillar delivery arrangement 23, by means of which the corrugated pipe 1 is conveyed in the direction of production 24. Belt or Caterpillar delivery arrangement 23 of this type are also general practice. In this delivery arrangement 23, provision is also made for a cutting device substantially including a knife 25 by means of which to slit the corrugated pipe 1 longitudinally in the cutting plane 17. Since, otherwise, the belt and Caterpillar delivery arrangement 23 is general practice, only the delivery belts 26 are roughly outlined diagrammatically.

15 In the direction of production, the delivery arrangement 23 is followed by a postmolding device 27 which comprises heaters 28, by means of which the corrugated pipe 1 is heated to a temperature suitable for thermal postforming. In the postforming device 27, forming rolls 29, 30 are disposed, which are allocated to each other in pairs, having axes 31, 32 that run crosswise of the central longitudinal axis 2 of the corrugated pipe 1. They further have concave surfaces 33, 34 which are arched inwardly toward the respective axis 31 and 32 and by means of which the corrugated pipe 1, which is slit in the cutting plane 17, is deformed from its original shape seen in Figs. 1, 20 2 and 9. The concave surface 33 of the forming roll 29 is configured such that it corresponds substantially to the semi-cylindrical outer circumference of the corrugated pipe 1. The convexity of the surface 34 of the forming roll 30 is such that the corrugated pipe 1, in the vicinity of the sub-sections 25

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3", is bent in the direction toward the axis 2 so that the corrugated sub-sections 3" slip under the corrugated sub-sections 3'" as seen in Fig. 10. Fig. 10 illustrates how to form the corrugated pipe 1 into a corrugated pipe 1a, which is a second intermediate product. In this case, the corrugated sub-sections 3" extend in the circumferential direction beyond the transition sections 14, 15, 16 at the end 10. The corrugated pipe 1a is then wound up on a commercial coiling device 35.

The finished corrugated pipe 1b seen in Figs. 5 and 6 serves as a corrugated jacket pipe for electric lines 36 or the like, some of which are illustrated in Fig. 6. The lines 36 that are to be inserted in the corrugated pipe 1a, inclusive of the plug-type connectors, are pre-positioned. In the vicinity of the corrugated sub-sections 3" and 3'", the respective corrugated pipe 1a is then opened approximately radially of the axis 2 by means of a corresponding assembly tool 37, and the strand of lines 36 is inserted.

An assembly tool of this type is illustrated in Figs. 11, 13, 14. It has an approximately U-shaped cross-section. Externally, the legs 38, 39 of the U are concave crosswise of the axis 2, as seen in Figs. 13, 14; they are also concave in the direction of the axis 2 as seen in Fig. 11. The legs are united by a web 40. The assembly tool 37 has an opening section 41 from where to slip the corrugated pipe 1a on to the assembly tool 37 for opening purposes. The opposite end forms a locking section 42, by means of which the opened corrugated pipe 1a is closed, the constituting the corrugated pipe 1b (see Figs. 5 and 6). The direction of assembly in which to push the corrugated pipe 1a on to the assembly tool 37 is marked by the arrow 43 in Figs. 11 and 12. A holder 44 is fixed approximately centrally on the web 40, keeping the assembly tool 37 stationary or displacing it counter to the direction of assembly 43 – in case the corrugated pipe 1a is kept stationary.

Subsequent to the holder 44, an insertion opening 45 for electric lines, which is open toward the end, is formed in the opening section 41.

As seen in Figs. 11 in combination with Figs. 13 and 14, the assembly tool 5 37 is arched so that the corrugated pipe 1a, when moving on to the assembly tool 37, is expanded in the opening section 41 thereof in such a way that the corrugated sub-sections 3" and 3'" are expanded outwards from their position seen in Fig. 10 as far as into their position seen in Fig. 14, in which the free ends of the corrugated sub-sections 3" and 3'" have a dis- 10 tance from each other in the circumferential direction that is given by the thickness of the holder 44; and in which the corrugated sub-section 3" lies radially further outwards than the corrugated sub-section 3'" which comes to lie inside in the final shape of the corrugated pipe 1b. Through the inser- 15 tion opening 45, the collected electric lines 36 are inserted in the corrugated pipe 1a while it is pushed continuously over the assembly tool 37; this takes place through the opening 46, seen in Fig. 12, formed by expansion of the corrugated pipe 1a between the sub-sections 3" and 3'''.

In the locking section 42, the design of the leg 38 that is allocated to the 20 corrugated sub-section 3'" is such that this corrugated sub-section 3'" can more rapidly relax radially and in the circumferential direction, taking its final inside position, than can the corrugated sub-section 3", as a result of which the corrugated sub-section 3" comes to lie upon the sub-section 3'" as seen in particular in Figs. 5 and 6. To this end, a recess 47 is formed be- 25 tween the web 40 and the leg 38, expanding in the direction of assembly 43; this recess 47 allows the sub-section 3'" to rapidly relax radially, while the sub-section 3" is still guided on a radially projecting shoulder 48 of the assembly tool 37.

- 10 -

Opening and then again closing the corrugated pipe helps obtain change-over thereof from a corrugated pipe 1a that constitutes an intermediate product into the corrugated pipe 1b of final configuration. The elasticity of the corrugated pipe causes the closure thereof after it has been opened and
5 the electric lines 36 have been inserted.

When the corrugated pipe 1b has its final shape, the two corrugated subsections 3" and 3'" are pressed against each other radially of the axis 2, owing to the prestress that has been conferred to them by the deformation into
10 the corrugated pipe 1a.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A method of producing a one-piece corrugated jacket pipe of thermoplastic, the method comprising the following steps:
 - forming a thermoplastic tube;
 - shaping the tube into a corrugated pipe which is closed over its circumference and has an axis and a corrugated section;
 - cutting the corrugated pipe parallel to the axis in a cutting plane along said corrugated section to form a first and a second corrugated partial section;
 - thermally deforming the cut corrugated section such that the first and second corrugated partial sections radially and peripherally overlap each other with the first partial section laying radially inward and second partial section laying radially outward; and
 - engaging the first partial section and second partial section by radial prestress, when the first partial section lies radially outwards and overlaps the second partial section radially and peripherally.

2. A method of inserting at least one electric line into a one-piece corrugated jacket pipe of thermoplastic produced according to the following steps:
 - forming a thermoplastic tube;
 - shaping the tube into a corrugated pipe which is closed over its circumference and has an axis and a corrugated section;
 - cutting the corrugated pipe parallel to the axis in a cutting plane along said corrugated section to form a first and a second corrugated partial section;
 - thermally deforming the cut corrugated section such that the first and second corrugated partial sections radially and peripherally overlap each other with the first partial section laying radially inward and second partial section laying radially outward;
 - forming in the vicinity of the cutting plane, an aperture by spreading the first and second corrugated partial sections elastically in the peripheral direction; and
 - inserting at least one electric line through the aperture into the corrugated pipe;
 - wherein the aperture is closed by moving the first corrugated partial section to overlap radially outwards the second corrugated partial section in the peripheral direction by elastic restoring forces of the corrugated pipe.

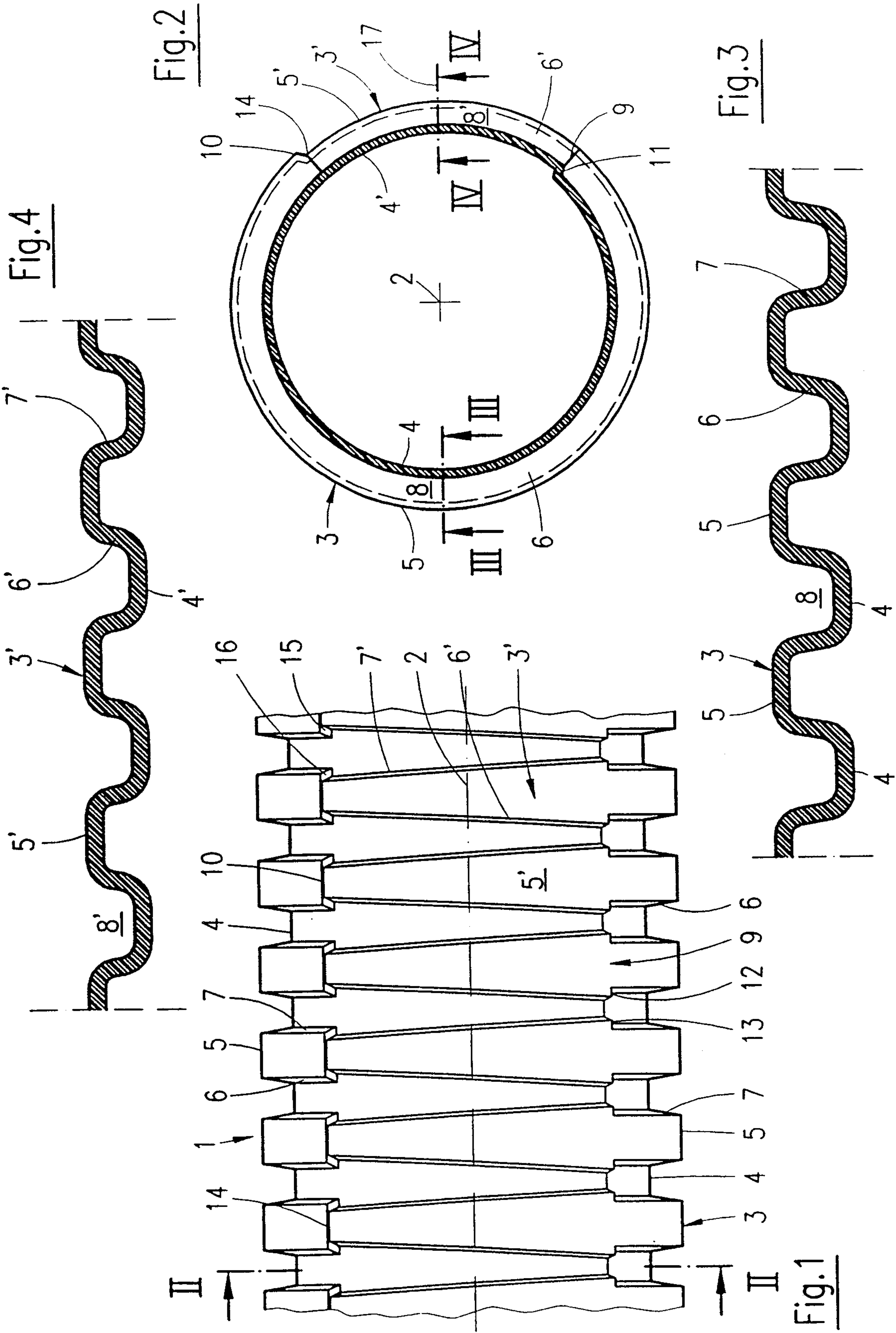


Fig.7

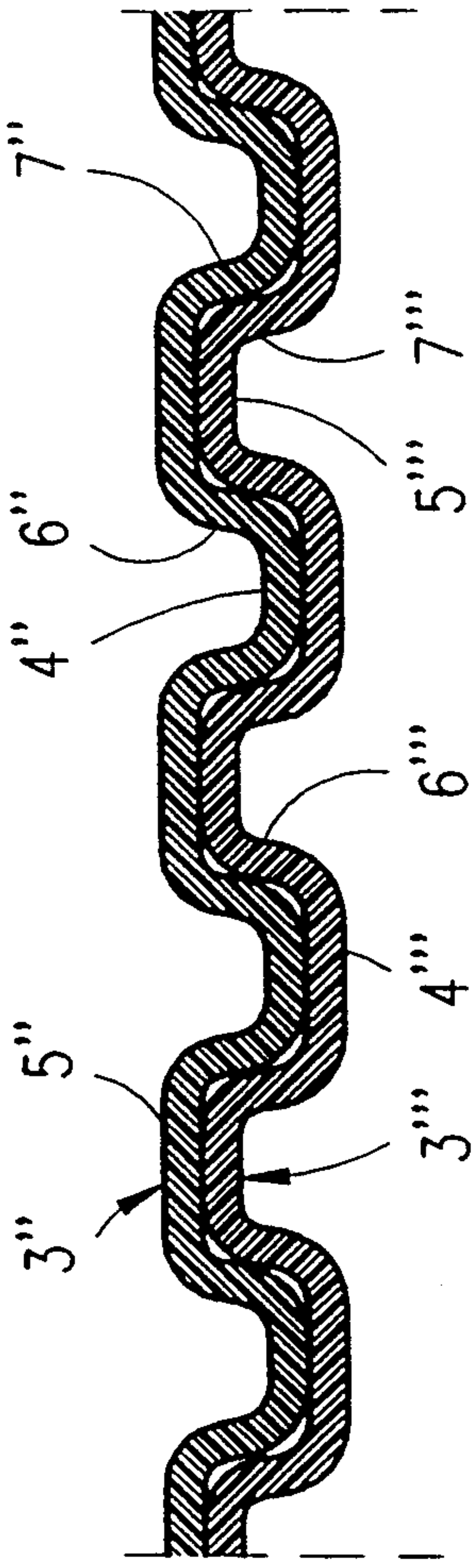


Fig.5

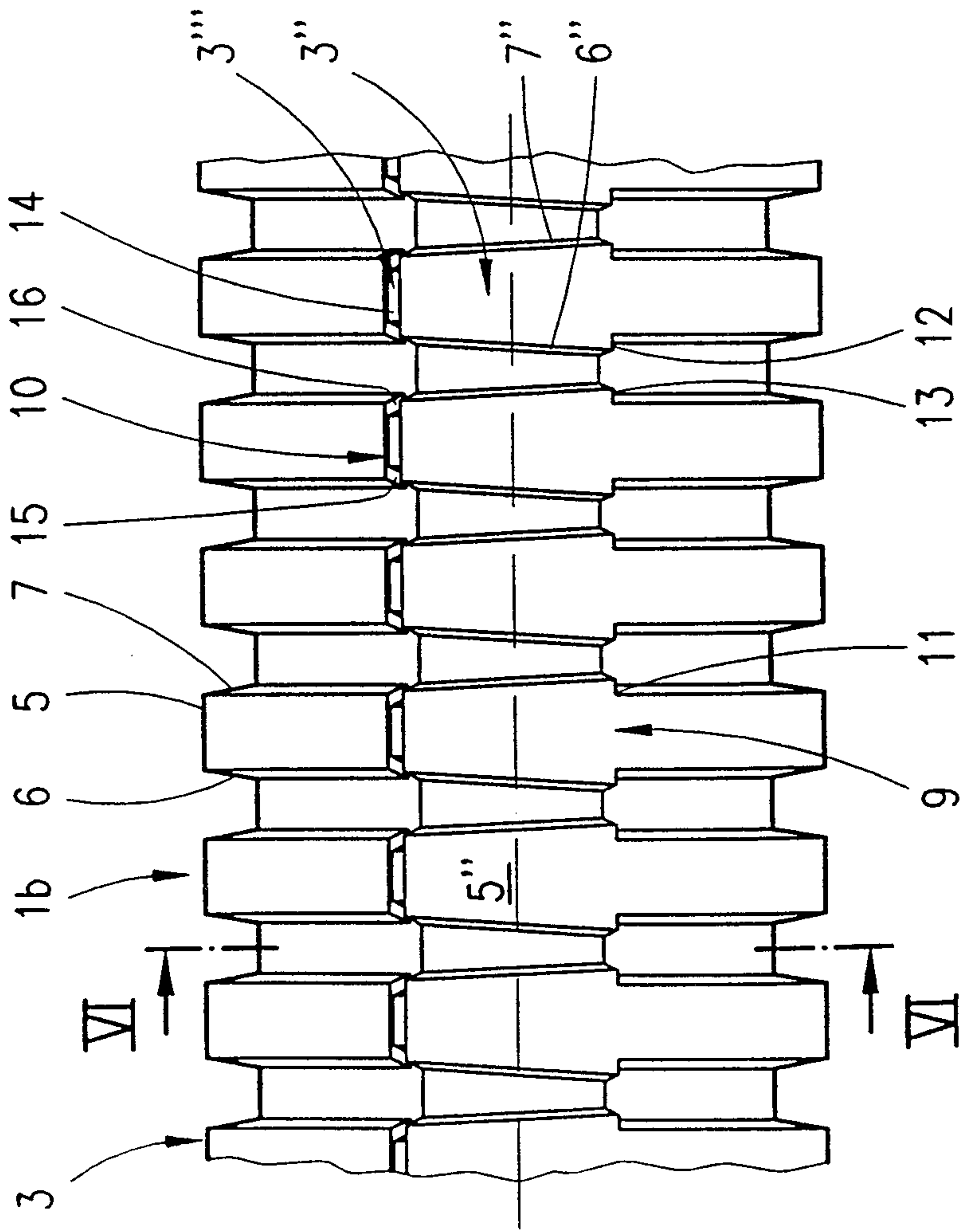


Fig.6

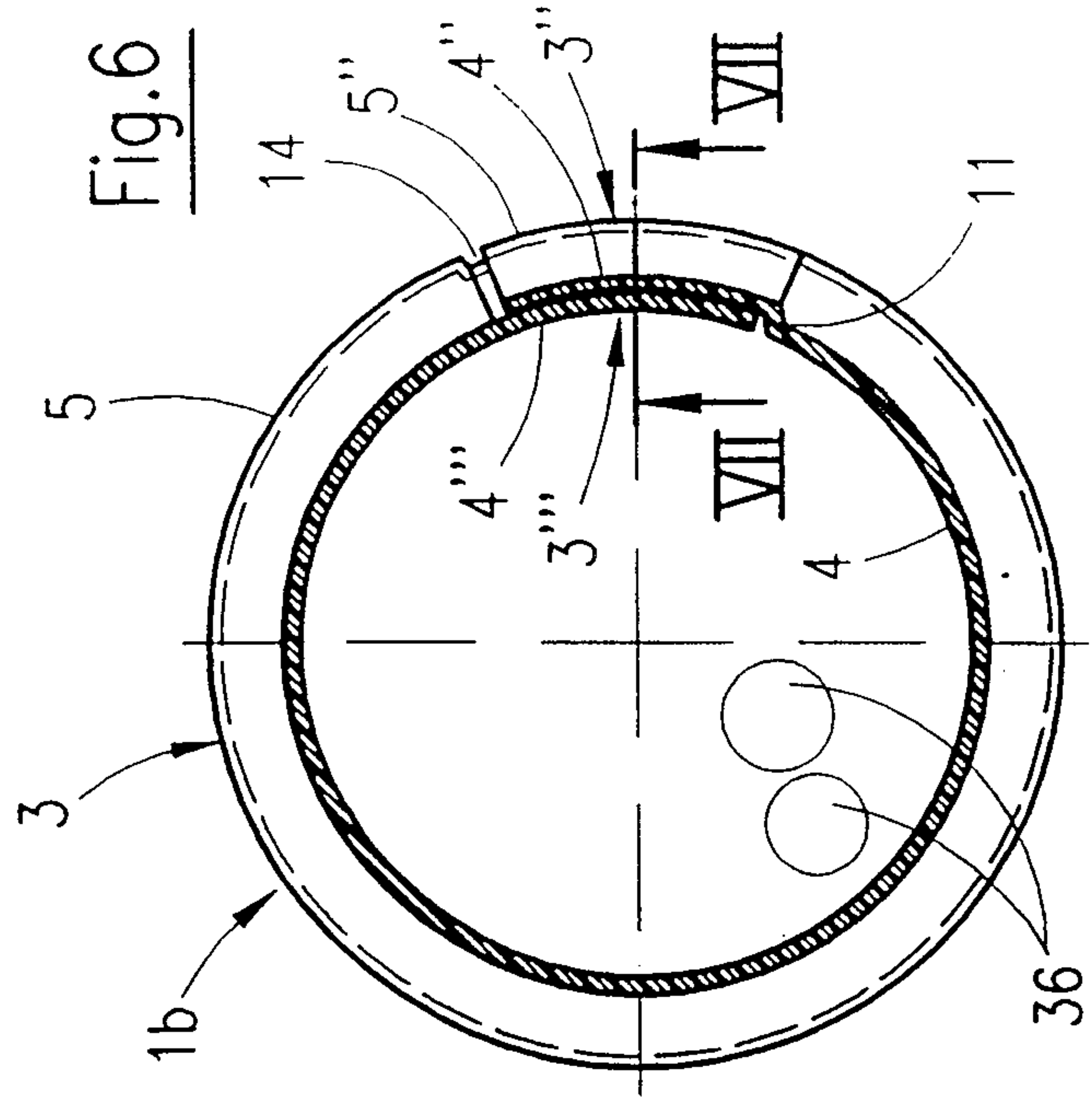


Fig.8

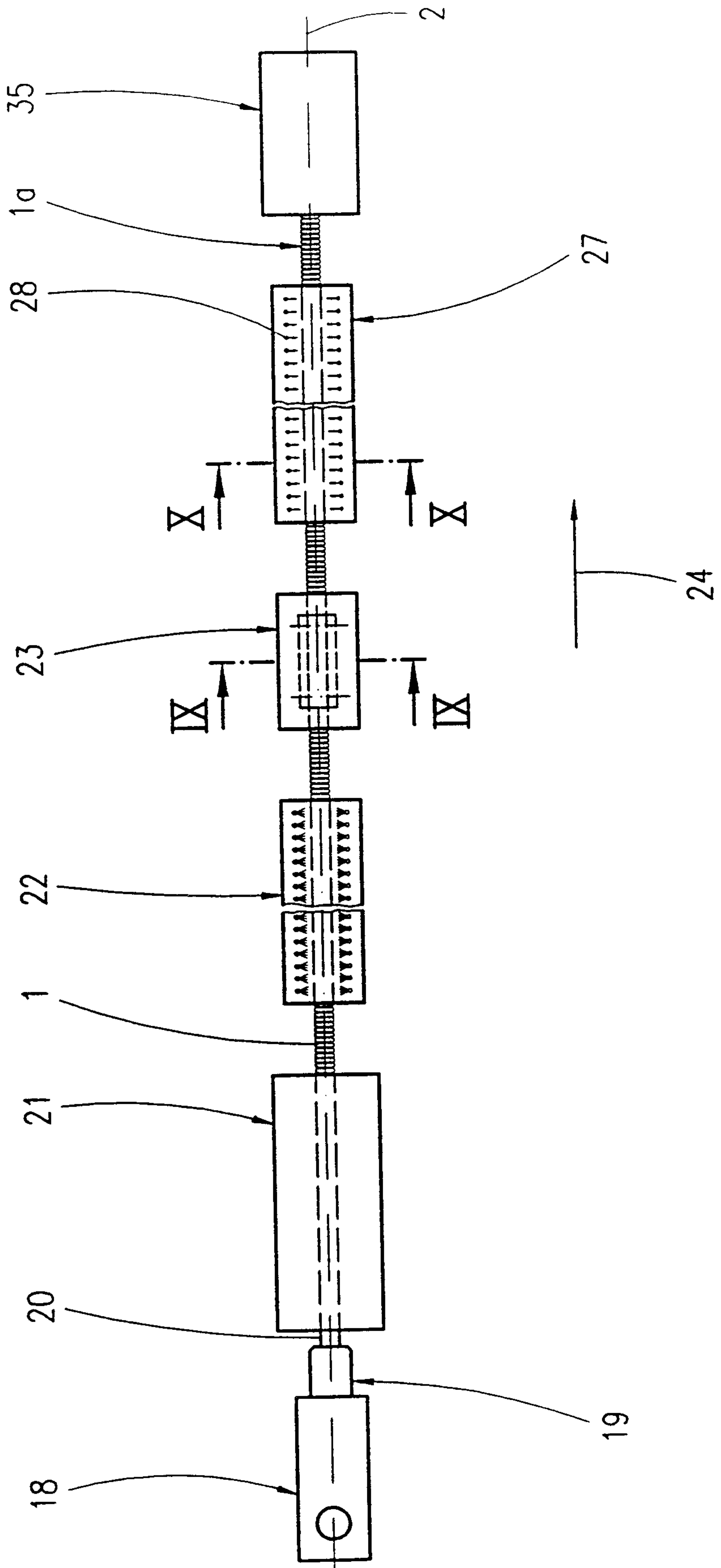


Fig.9

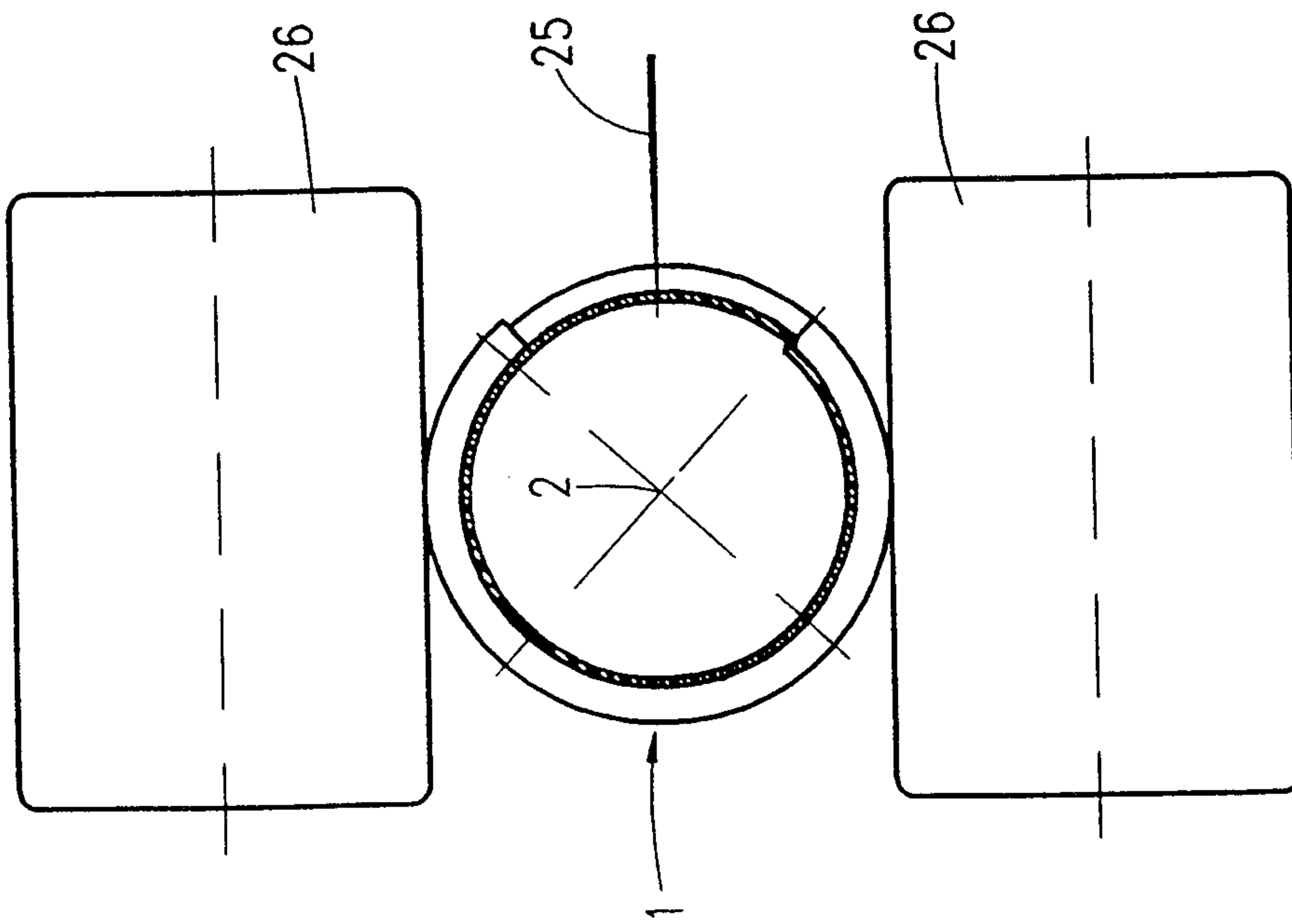


Fig.10

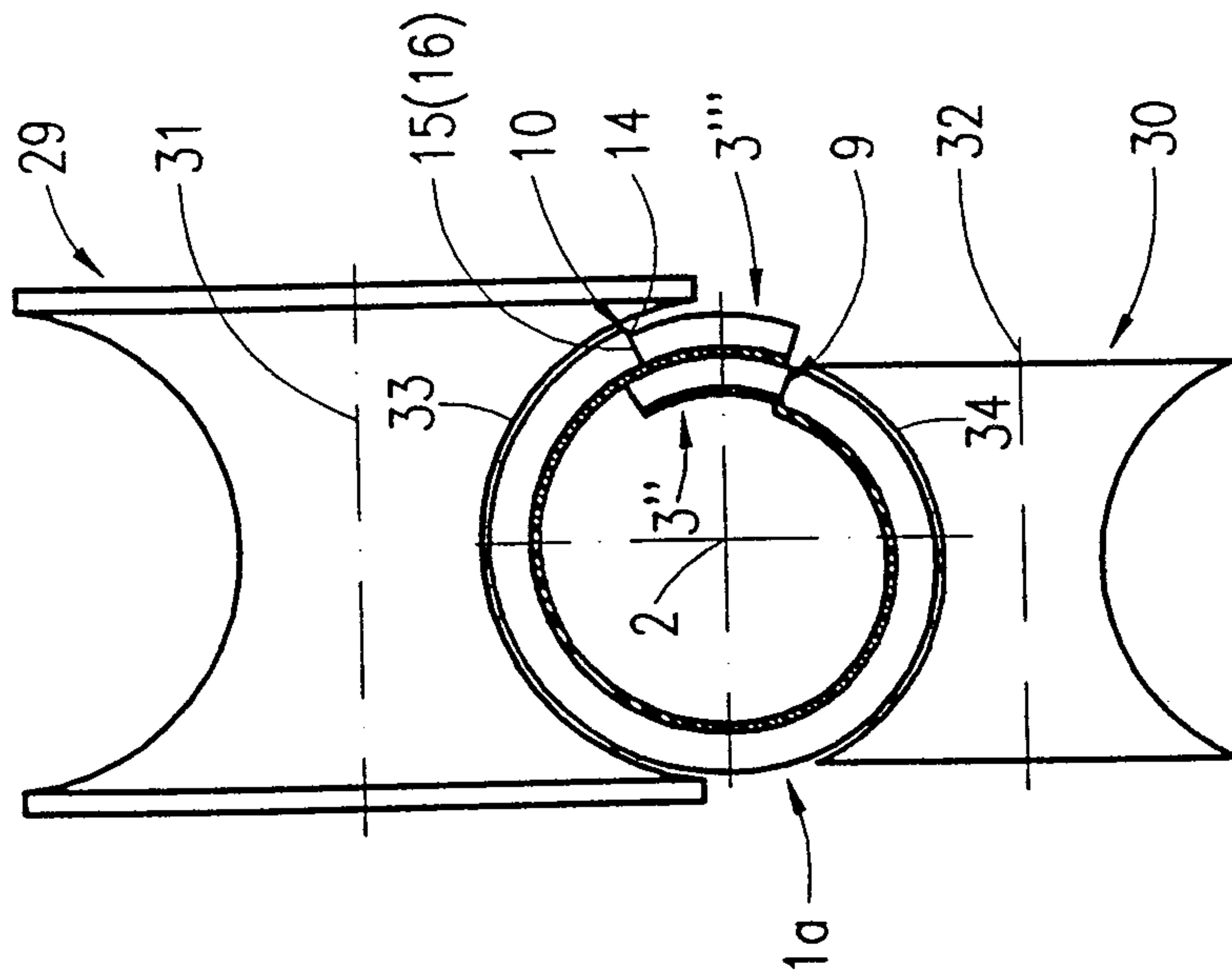


Fig.11

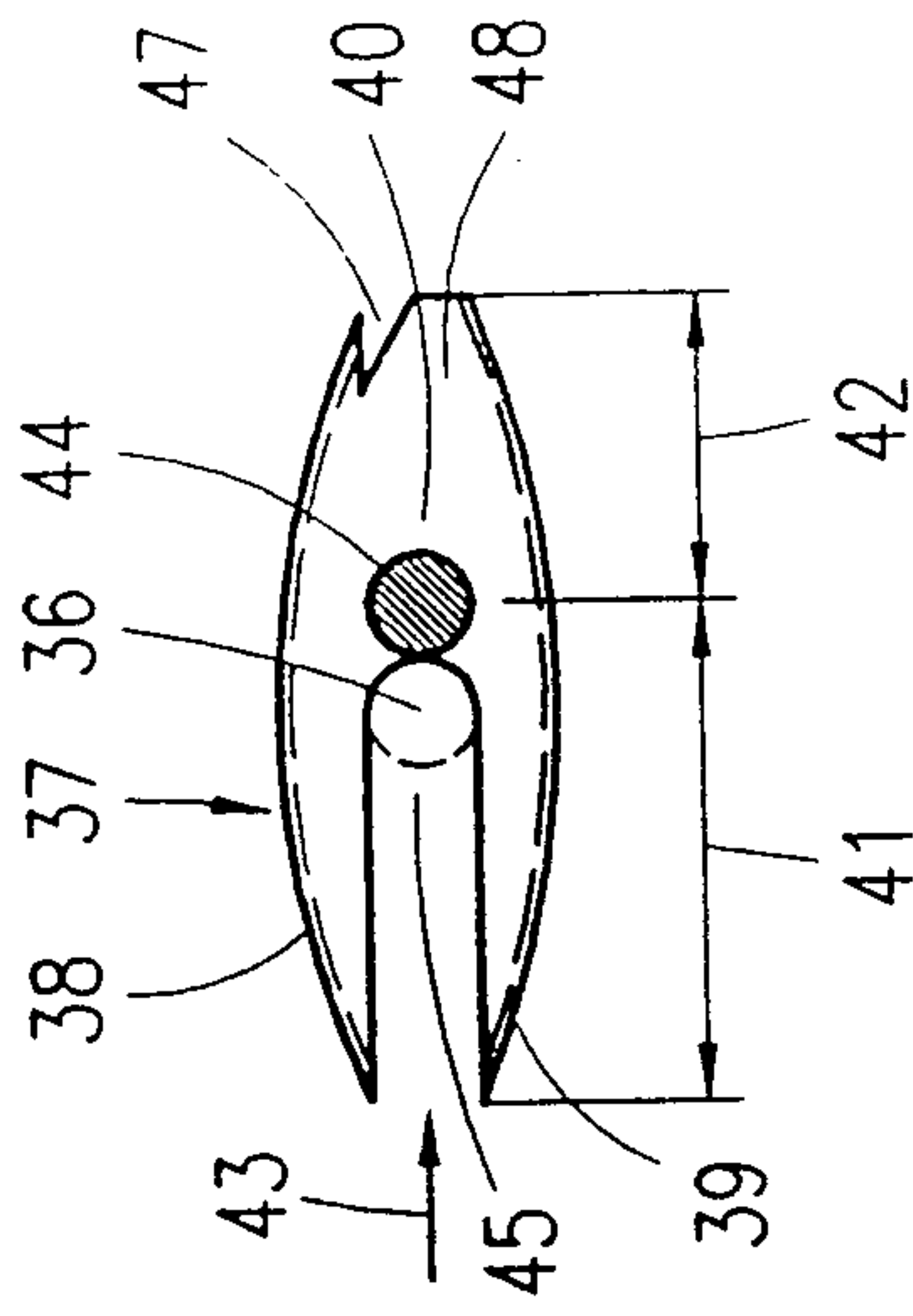


Fig.12

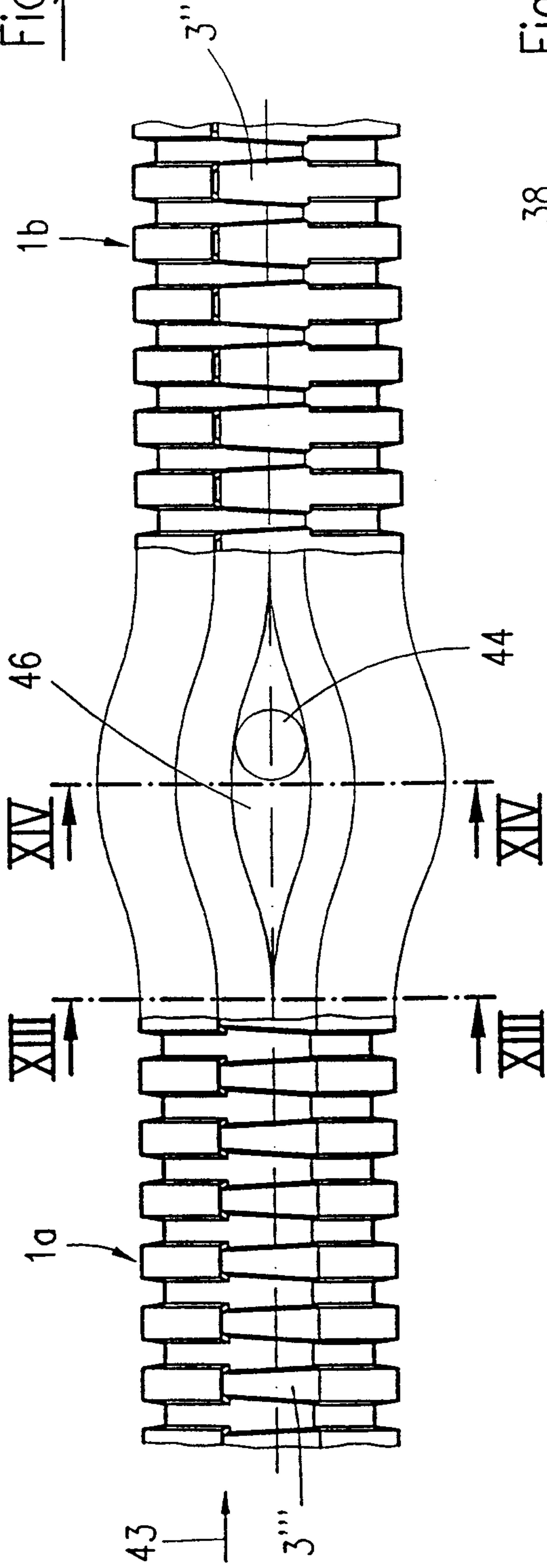


Fig.14

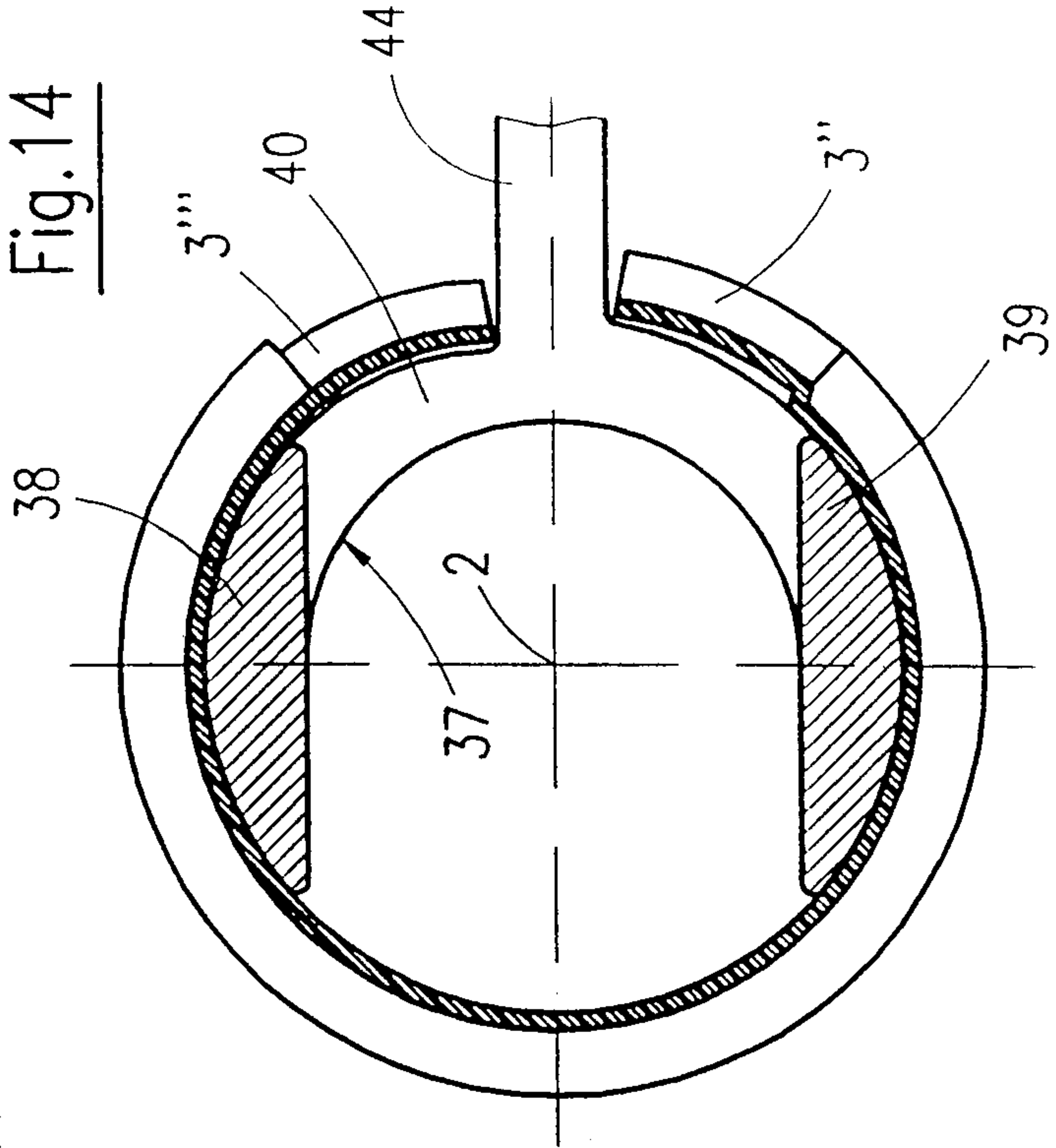


Fig.13

