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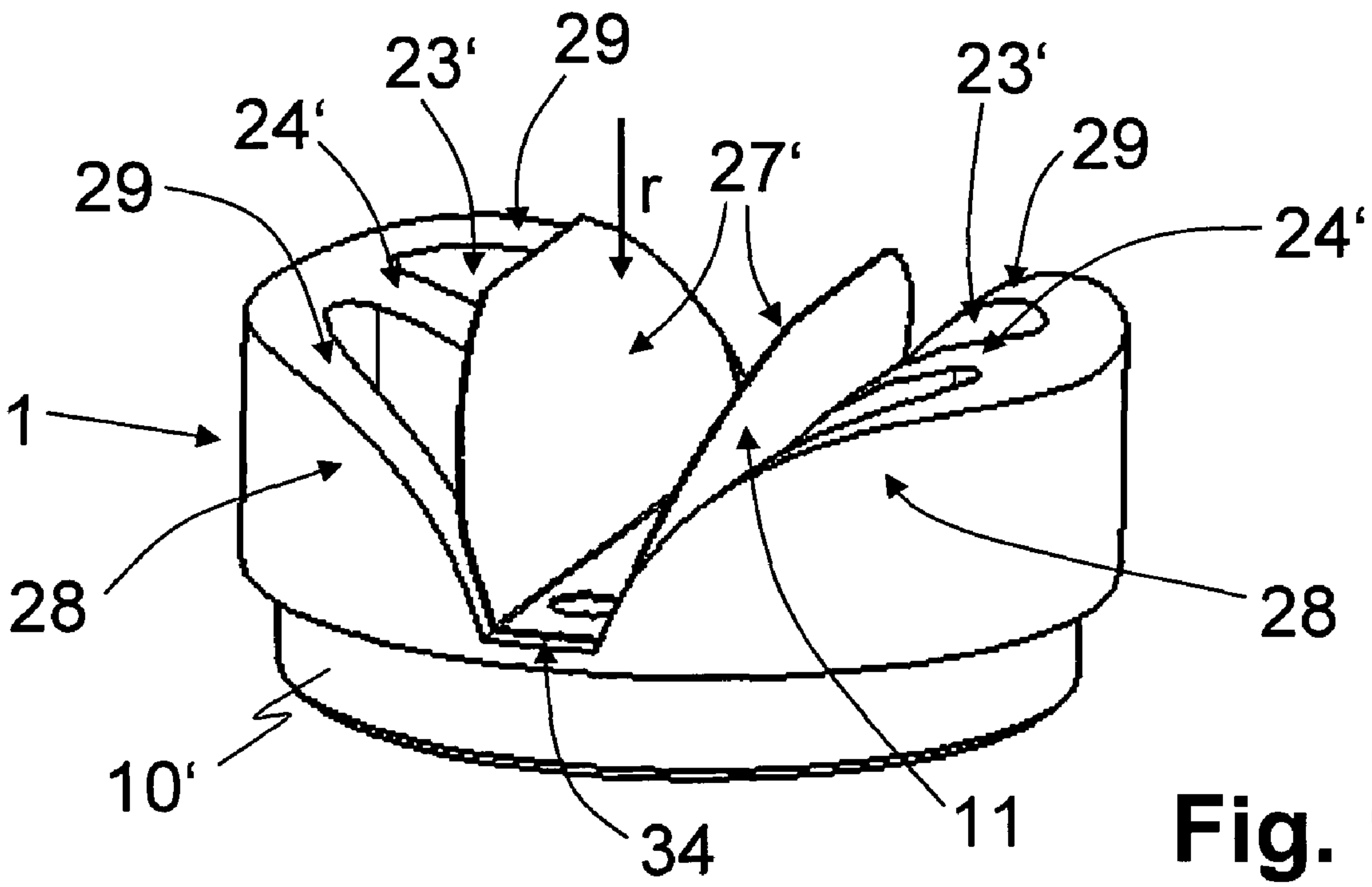

Fig. 13c

(57) Abrégé/Abstract:
The invention relates to a flow limiter (1) for limiting a volumetric flow through a liquid line, comprising a carrier (101) having a passage and a flat spring (11) attached to the carrier (10'). The flat spring (11) comprises at least one spring tongue (27') and the passage comprises at least one opening (23'), wherein the spring tongue (27') is designed and arranged above the opening (23') in such a way that the spring tongue increasingly lies against the carrier (10') as the differential pressure rises and in the process reduces the opening (23') and continuously reduces the passage within a defined pressure range. A body is arranged upstream of the spring tongue in such a way or the spring tongue (27') is oriented in the flow direction (r) in such a way that the spring tongue (27') offers a direct contact surface to a substantially reduced flow cross-section. Thus the spring tongue (27') is deflected, or rather rested against the carrier (10'), to a lesser extent at low differential pressure values so that at a low differential pressure, a constant volumetric flow rate is achieved and thus an expanded operating range having a constant volumetric flow rate is achieved.

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(54) Title: FLOW LIMITER

(54) Bezeichnung : DURCHFLUSSBEGRENZER

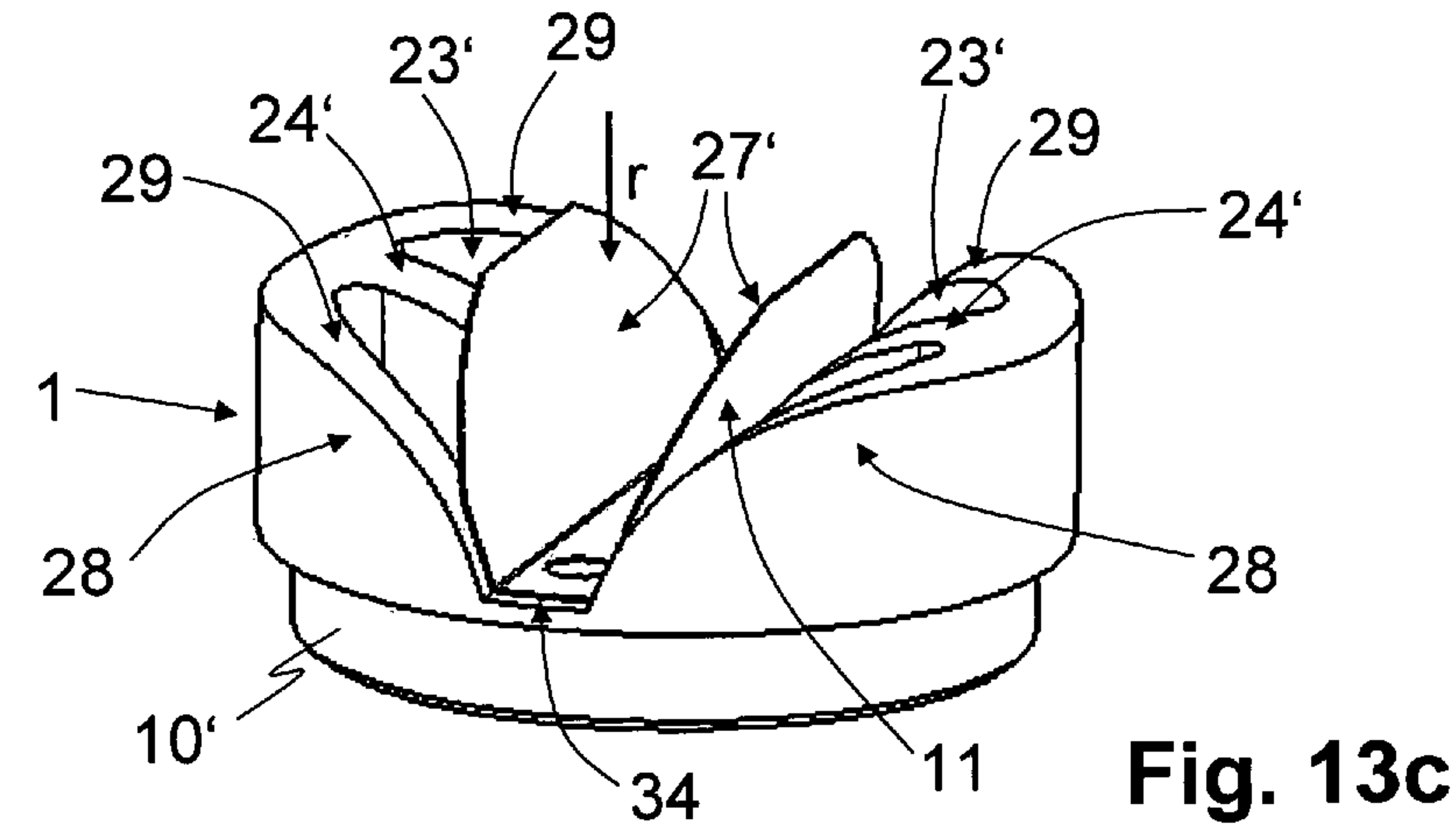

Fig. 13c

(57) Abstract: The invention relates to a flow limiter (1) for limiting a volumetric flow through a liquid line, comprising a carrier (101) having a passage and a flat spring (11) attached to the carrier (10'). The flat spring (11) comprises at least one spring tongue (27') and the passage comprises at least one opening (23'), wherein the spring tongue (27') is designed and arranged above the opening (23') in such a way that the spring tongue increasingly lies against the carrier (10') as the differential pressure rises and in the process reduces the opening (23') and continuously reduces the passage within a defined pressure range. A body is arranged upstream of the spring tongue in such a way or the spring tongue (27') is oriented in the flow direction (r) in such a way that the spring tongue (27') offers a direct contact surface to a substantially reduced flow cross-section. Thus the spring tongue (27') is deflected, or rather rested against the carrier (10'), to a lesser extent at low differential pressure values so that at a low differential pressure, a constant volumetric flow rate is achieved and thus an expanded operating range having a constant volumetric flow rate is achieved.

(57) Zusammenfassung:

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— *vor Ablauf der für Änderungen der Ansprüche geltenden Frist; Veröffentlichung wird wiederholt, falls Änderungen eingehen (Regel 48 Absatz 2 Buchstabe h)*

Ein Durchflussbegrenzer (1) zum Begrenzen eines Volumenstroms durch eine Flüssigkeitsleitung umfasst einen Träger (101) mit Durchlass und eine am Träger (10') angebrachte Flachformfeder (11). Die Flachformfeder (11) umfasst mindestens eine Federzunge (27') und der Durchlass mindestens eine Öffnung (23'), wobei die Federzunge (27') so ausgestaltet und über der Öffnung (23') angeordnet ist, dass sie sich mit steigendem Differenzdruck zunehmend an den Träger (10') anlegt und dabei die Öffnung (23') verkleinert und den Durchlass innerhalb eines definierten Druckbereichs kontinuierlich reduziert. Der Federzunge ist ein Körper so vorgelagert oder die Federzunge (27') ist in Strömungsrichtung (r) so ausgerichtet, dass die Federzunge (27') einem wesentlich reduzierten Strömungsquerschnitt direkte Angriffsfläche bietet. Dadurch wird die Federzunge (27') bei niedrigen Differenzdruckwerten weniger stark ausgelenkt respektive an den Träger (10') angelegt, so dass bei kleinerem Differenzdruck ein konstanter Volumenstromwert erreicht und damit ein erweiterter Arbeitsbereich mit konstantem Volumenstromwert erzielt wird.

FLOW LIMITER

Technical field

The present invention relates to a flow limiter for limiting a volumetric flow through a liquid line. The present invention relates particularly to a flow limiter which has a carrier with a passage and a flatform spring attached to the carrier, the flatform spring being set up to come to bear increasingly against the carrier with a rising differential pressure and at the same time to reduce the size of the orifice.

Prior art

Flow limiters or flow rate controllers limit the volumetric flow through a liquid line, for example a pipeline, within a defined working range of the differential pressure and thus make it possible to have a constant volumetric flow through the line independently of pressure changes in the line.

The patent specification GB **783,323** describes a flow limiter which comprises a round flatform spring fastened, centered, to a carrier of round configuration. The carrier has a multiplicity of small round orifices which are arranged on two concentric rings symmetrically about the center of the carrier and which determine the maximum passage. With an increase in liquid pressure in the pipeline, the flatform spring is flattened, so that the open region between pipeline and flatform spring is reduced. According to GB **783,323**, the flattening of the spring is not linear with respect to the increasing pressure, because the flattening commences at the center and progresses outward, and because the round configuration of the spring has the effect that the non-flattened region decreases rapidly toward the marginal region with increasing flattening. In the flow limiter according to GB **783,323**, the overall passage orifice is limited by the annularly arranged perforations which, moreover, have an increased risk of soiling and clogging due to their small size. Furthermore, there is an increased tendency to oscillation when, with an increasing flattening of the flatform spring, the individual holes are closed individually and the overall passage is thereby reduced in steps.

US-A **4,884,750** discloses a flow limiter for limiting a volumetric flow through a liquid line, which has a carrier with a passage and a bent spring which is attached to the carrier and is set up to be flattened increasingly with a rising differential pressure (Δp). The various forms of the springs either have the disadvantage of an insufficient volumetric flow or start to oscillate when the passage is increasingly closed.

WO **2009/062997** describes a flow limiter for limiting a volumetric flow through a liquid line, which comprises a carrier with a passage and a flatform spring attached to the carrier. The flatform spring has at least one spring tongue and the passage has at least one orifice. The spring tongue is configured and arranged above the orifice such that the spring tongue comes to bear increasingly against the carrier with a rising differential pressure and at the same time reduces the orifice and reduces the passage within a defined pressure range.

GB **2 231 940** describes a flow controller for washing machines, which comprises a fixed carrier element with orifices which can be partially covered by plastic elements. The plastic elements are designed as round disks which are arranged so as to be lifted off from the carrier element at their center. With an increasing pressure, the plastic elements bend in the direction of the carrier element with their outer marginal regions facing away from the center, so that they form a curved screen over the orifices. According to GB **2 231 940**, two such plastic elements are arranged concentrically and at a defined distance one above the other, the lower plastic element having a larger diameter than the upper plastic element. Moreover, the lower plastic element is provided with orifices which, when the upper plastic element is being bent in the direction of the carrier element, are covered in an screen-like manner.

Presentation of the invention

An object of the present invention is to propose a flow limiter for limiting a volumetric flow through a liquid line, which does not have at least some of the disadvantages of the prior art. In particular, an object of the present invention is to propose a flow limiter which, as compared with the prior art, has a lower risk of soiling and a lower tendency to oscillation. In particular, a further object of the present invention is to propose a flow limiter which generates a constant volumetric flow within an extended pressure range.

According to the present invention, these aims are achieved, in particular, by means of the elements of the independent claims. Further advantageous embodiments may also be gathered from the dependent claims and the description.

The flow limiter for limiting a volumetric flow through a liquid line comprises a carrier with a passage (passage orifice) and a flatform spring attached to the carrier. The flatform spring comprises at least one spring tongue and the passage comprises at least one orifice. In this case, the spring tongue is configured and arranged above the orifice such that, with a rising differential pressure, the spring tongue comes to bear increasingly against the carrier and at the same time reduces the size of the orifice and reduces the passage within a defined pressure range.

The abovementioned aims are achieved by the present invention, in particular, in that the spring tongue is preceded by a body or the spring tongue is oriented in the direction of flow such that the spring tongue offers a direct attack surface to a flow cross section which is reduced by at least **25**%. In other words, the spring tongue is preceded by a body or the spring tongue is oriented in the direction of flow such that the spring tongue is exposed directly to a reduced cross-sectional part of the flow which amounts to less than **75**% of the surface of the spring tongue. The flow cross section to which the spring tongue offers a direct attack surface increases in size with the rising differential pressure when the spring tongue comes to bear increasingly against the carrier. Since the spring tongue is exposed to the direct flow to a lesser extent at low differential pressure values, that is to say, in particular, in the essentially deflection-free initial position, this affords the advantage that the spring tongue is deflected or brought to bear against the carrier to a lesser extent at low differential pressure values, and consequently the passage is reduced less (quickly) at low differential pressure values, so that a nominal throughflow, that is to say a constant volumetric flow value, is obtained even in the case of a lower differential pressure and therefore an extended working range with a constant volumetric flow value is achieved.

Preferably, the spring tongue and the corresponding orifice have in each case an essentially identical extent along a longitudinal direction. Since the orifice is dimensioned correspondingly to the size of the spring tongue, an overall larger passage and a reduced risk of soiling, as compared with the prior art, can be achieved for the comparable size of the flow limiter. In other words, with the same overall passage, the flow limiter can be designed to be more compact and less susceptible to dirt. Moreover, since the spring tongue is brought to bear against the carrier increasingly with a rising differential pressure, a nonlinear increase in the spring resistance in the case of a rising pressure is achieved, but at the same time a tendency to oscillation which is reduced, as compared with the prior art, is achieved due to the resulting continuous reduction in size of the passage.

In one design variant, at a low differential pressure of the defined pressure range, the spring tongue is oriented in the direction of flow such that the majority of the spring tongue runs in the direction of flow and the spring tongue offers a direct attack surface to a reduced flow cross-sectional part which amounts to less than **75**% of the surface of the spring tongue, preferably a flow cross-sectional part of between **8**% and **25**% of the spring tongue surface. If the spring tongue is straight in the flow-free initial position, the spring tongue has correspondingly an angle of less than **45**°, preferably an angle in the range of approximately **5**° to approximately **15**°, with respect to the longitudinal axis of the liquid line.

In one design variant, the carrier has a ramp rising opposite to the direction of flow and the spring tongue is configured such that, with a rising differential pressure, it is bent increasingly and comes to bear against the ramp, and at the same time continuously reduces the size of the orifice and continuously reduces the passage within the defined pressure range.

In one design variant, the body preceding the spring tongue is set up and arranged such that, at a low differential pressure of the defined pressure range, it generates a flow shadow (projection shadow) for at least a surface part of **25**% of the spring tongue, preferably for a surface part in the range of **90**% to

100% of the spring tongue. In this case, the carrier is in essentially planar configuration and the spring tongue is configured such that, with a rising differential pressure, it is increasingly flattened and comes to bear against the carrier and at the same time continuously reduces the size of the orifice and continuously reduces the passage within the defined pressure range.

In one design variant, the passage comprises at least two orifices lying next to one another and the carrier comprises a web which separates the orifices lying next to one another from one another. In this case, the spring tongue is arranged such that, with a rising differential pressure, it lies increasingly on the web and continuously reduces the orifices, the orifices remaining open in defined remaining ranges.

In a further design variant, the passage comprises a plurality of orifices arranged in a rotationally symmetrical manner and the flatform spring comprises a plurality of spring tongues which are arranged in a rotationally symmetrical manner and are in each case arranged such that, with a rising differential pressure, they lie increasingly on the carrier and continuously reduce, that is to say increasingly cover, the orifices.

In a preferred design variant, the flatform spring has at least two spring tongues oriented in directions opposite to one another along a common longitudinal axis.

In various design variants, the spring tongues are fastened to an outer marginal region of the carrier, in the center of the carrier or to a fastening web running through the center.

In one design variant, the carrier is configured as a round disk which comprises at the outer marginal region a set-up collar for insertion into a pipeline, for example into a connection piece between two pipelines or into a valve, for example a ball valve or a lifting valve.

In addition to the flow limiter, the present invention also relates to a method for limiting a volumetric flow through a liquid line.

Brief description of the drawings

An embodiment of the present invention is described below by means of an example. The exemplary embodiment is illustrated by the following accompanying figures:

figure **1** a shows a view of a flow limiter with a flatform spring which is configured as a spring tongue and which is attached via two orifices separated from one another by a web.

Figure **1** b shows a cross section of the flow limiter of figure **1** a installed in a liquid line.

Figure **1** c shows a top view of the flow limiter of figure **1** a installed in a liquid line.

Figure **2**a shows a view of a flow limiter with a flatform spring which has a plurality of spring tongues which are arranged in a rotationally symmetrical manner and are fastened, centered, and which are attached over a plurality of orifices in each case separated from one another by a web.

Figure **2**b shows a cross section of the flow limiter of figure **2**a installed in a liquid line.

Figure **2**c shows a top view of the flow limiter of figure **2**a installed in a liquid line.

Figure **3**a shows a view of a flow limiter with a flatform spring which has a plurality of spring tongues which are arranged in a rotationally symmetrical manner and are fastened to the outer marginal region of the flow limiter and which are attached over a plurality of orifices in each case separated from one another by a web.

Figure **3**b shows a cross section of the flow limiter of figure **3**a installed in a liquid line.

Figure **3**c shows a top view of the flow limiter of figure **3**a installed in a liquid line.

Figure **4** shows a cross section of the flow limiter with a low differential pressure and a correspondingly slightly deflected spring tongue, and a curve which illustrates the nonlinear dependence of deflection and spring force.

Figure **5** shows a cross section of the flow limiter with a high differential pressure and a correspondingly highly deflected spring tongue, and a curve which illustrates the nonlinear dependence of deflection and spring force.

Figure **6** illustrates diagrammatically the rate profile of the volumetric flow rate through the flow limiter.

Figure **7** shows a cross section through a lifting valve with an installed flow limiter in the liquid supply line.

Figure **8** shows a cross section through a ball valve with an installed flow limiter in the liquid supply line.

Figure **9**a shows a view of a flow limiter with a flatform spring which has two spring tongues which are fastened to the fastening web running transversely over the flow limiter between the outer marginal regions and which are attached in each case above two orifices separated from one another by a web.

Figure **9**b shows another view of the flow limiter of figure **9**a.

Figure **9**c shows a cross section of the flow limiter of figure **9**a installed in a liquid line.

Figure **9**d shows a top view of the flow limiter of figure **9**a installed in a liquid line.

Figure **10** shows a top view of a flow limiter with a flatform spring which has four spring tongues which are arranged in a rotationally symmetrical manner and are fastened at the center of the flow limiter and which are attached in each case via an assigned web which separates two orifices from one another, in each case assigned to a spring tongue.

Figure **11** shows a top view of a further flow limiter with a flatform spring according to fig. **9**, the two spring tongues of which are attached in each case via two assigned webs which flatform spring separates the passage into three orifices in each case assigned to a spring tongue.

Figure **12**a shows a cross section of a flow limiter with a body which precedes the flatform spring and which shields the flatform spring from the direct impingement of the flow in the case of a low differential pressure.

Figure **12**b shows a top view of the flow limiter of figure **12**a.

Figure **12**c shows a **3**D view of the flow limiter of figure **12**a.

Figure **13**a shows a cross section of a flow limiter with a flatform spring, the spring tongues of which are oriented in the direction of flow, in order to offer a reduced attack surface in the case of a low differential pressure of the flow.

Figure **13**b shows a top view of the flow limiter of figure **13**a.

Figure **13**c shows a **3**D view of the flow limiter of figure **13**a.

Ways of implementing the invention

In figures **1**a, **2**a, **3**a, **4**, **5**, **7**, **8**, **9**a, **9**b, **10**, **11**, **12**a, **12**b, **12**c, **13**a, **13**b and **13**c, reference symbol **1** denotes a flow limiter which is also designated as a flow rate controller and limits the volumetric flow through a liquid line **2** within a defined working range (Δp_{min}, Δp_{max}) of the differential pressure Δp. A pressure-independent volumetric flow $\dot{V}$ is achieved in that the passage of the flow limiter **1**, that is to say the throughflow cross section or the throughflow area, is reduced in dependence on the force generated from the differential pressure Δp. For this purpose, the flow limiter **1** comprises a flatform spring **11** which has a defined radius (of the order of magnitude of the liquid line **2**, for example of the order of magnitude of the pipe diameter) and which is fastened to a carrier **10** of the flow limiter **1** and is arranged above the passage orifices **13, 18, 23, 23'** of the flow limiter **1** such that with an increasing pressure Δp it increasingly covers and closes the variable orifice area, in other words the passage of the flow limiter **1**. In this case, the flatform spring **11** comes to bear increasingly against the carrier **10**, for example on a web **14, 24** and/or on side margins **29** of the orifices **18**, with the result that the flatform spring **11** becomes increasingly hard. The flatform spring **11** becomes harder because its effective length is reduced due to the fact that it lies increasingly against the carrier **10**. Thus, the passage and therefore the throughflow are regulated in a directed manner even at a higher differential pressure Δp and are kept substantially constant within a specific working range [Δp_{min}, Δp_{max}]. The passage orifices are in each case formed as perforations in the carrier **10**.

As is clear in figures **1**a, **1**b, **1**c, **2**a, **2**b, **2**c, **3**a, **3**b, **3**c, **9**a, **9**b, **9**d, **10**, **11**, **12**b and **12**c, the carrier **10** preferably has a round configuration to fit the cross section of the liquid line **2** and has a projecting collar **15**. The collar **15** is attached to the outer marginal region of the disk-shaped carrier **10** and is produced, for example, by compressive strain, in one piece with the carrier **10**. In one variant, the collar **15** has a plurality of portions **15'** which are spread slightly and engage into corresponding receptacles **21**, for example a groove, in the wall of the liquid line **2** and fix the flow limiter **1** axially in the liquid line **2**.

In one design variant (not illustrated), part of the collar **15** is bent back onto the carrier **10** and firmly clamps the flatform spring **11** to the carrier **10**.

However, the flatform spring **11** may also be fastened to the carrier **10** by means of a rivet **16** or by adhesive bonding.

In the design variant according to figures **1**a, **1**b and **1**c, the flatform spring **11** comprises a spring tongue **12** and the carrier **10** has a passage with two orifices **13** lying next to one another. As is clear from figure **1**c, the two orifices **13** and the spring tongue **12** have an essentially identical extent (length) in the longitudinal direction L. The carrier **10** has a web **14** which separates the two orifices **13** from one another. The flatform spring **11** is attached to the outer marginal region of the round carrier **10**. The two orifices **13** are rectangular or trapezoidal and extend from the outer marginal region, where the flatform spring **11** is fastened, as far as the opposite outer marginal region of the carrier **10**. The flatform spring **11** or the spring tongue **12** is oriented along (parallel to) the orifices **13** along the longitudinal axis of the web **14** and is arranged above the orifices **13** such that, when it comes to bear increasingly on the web **14** of the carrier **10** with a rising differential pressure Δp, it increasingly and continuously covers and closes the orifices **13** within the defined working range [Δp_{min}, Δp_{max}] until, when the spring tongue **12** comes to bear to the maximum, a minimum passage remains. The minimum passage is formed by remaining regions which remain open in marginal regions, facing away from the web **14**, of the orifices **13** and which are not covered by the spring tongue **12**.

In the design variant according to figures **2**a, **2**b, **2**c, **3**a, **3**b and **3**c, the carrier **10** has a passage with four orifices **18** which are arranged in a rotationally symmetrical manner and are in each case separated from one another by a web **14**. As is clear in figures **2**c and **3**c, the webs **14** may be considered as spokes of a wheel which is formed from the round carrier **10** by the orifices **18**. The orifices **18** are in each case designed as approximately triangular circle sectors of the round carrier **10** which do not extend completely as far as the center of the carrier **10**. The flatform spring **11** comprises a plurality of spring tongues **17**, **19** which are arranged in a rotationally symmetrical manner and are in each case arranged such that, with a rising differential pressure, they lie increasingly on the carrier **10** and continuously reduce the orifices **18**.

In the design variant according to figures **2**a, **2**b and **2**c, the flatform spring **11** is attached in the center Z of the carrier **10** and the spring tongues **17** are in each case assigned to an orifice **18**. As is clear from figure **2**c, the orifices **18** and the spring tongues **17** have an essentially identical extent (length) along the longitudinal direction L, L'. The spring tongues **17** are in each case arranged above an assigned orifice **18** such that, with a rising differential pressure Δp, they in each case lie increasingly on the two webs **14** which delimit the respective orifice **18**. Thus, the orifices **18** are increasingly and continuously covered and closed within the defined working range [Δp_{min}, Δp_{max}], until, when the spring tongue **17** comes to bear to the maximum, a minimum passage remains. As regards the orifices **18**, the minimum passage is formed in each case by a remaining region, remaining open, in marginal regions of the orifices **18**, which marginal regions face away from the center Z and are not covered by the spring tongues **17**.

In the design variant according to figures **3**a, **3**b and **3**c, the flatform spring **11** has an outer hoop region **110** which is attached to the carrier **10**. In contrast to the design variant according to figures **2**a, **2**b and **2**c, the spring tongues **19** are therefore fastened to the outer marginal region of the carrier **10**.

As is clear from figure **3**c, the orifices **18** and spring tongues **19** have an essentially identical extent (length) from the hoop region **110** to the center Z along their longitudinal direction, that is to say along their respective axis of symmetry. The spring tongues **19** are in each case arranged above an assigned web **14** such that, with a rising differential pressure Δp, in each case they lie increasingly on the respective web **14** and increasingly cover the two orifices **18** adjacent to the web **14**. Thus, the orifices **18** are increasingly and continuously covered and closed within the defined working range $[\Delta p_{min}, \Delta p_{max}]$, until, when the spring tongue **19** comes to bear to the maximum, a minimum passage remains. As regards the orifices **18**, the minimum passage is formed in each case by a region which remains open between two adjacent spring tongues **19** along the axis of symmetry of the respective orifice and which is not covered by the spring tongues **19**.

A person skilled in the art will understand that even three or more than four orifices **18** and corresponding spring tongues **17, 19** may be provided.

Figure **7** shows a cross section through a lifting valve **7** with a removably or fixedly installed flow limiter **1** (according to one of the design variants described) in the liquid supply line **2**.

Figure **8** shows a cross section through a ball valve **8** having a removably or fixedly installed flow limiter **1** (according to one of the design variants described) in the liquid supply line **2**.

Figures **9**a, **9**b, **9**c and **9**d show views, a cross section and top views of a flow limiter **1** with a flatform spring **11** which has two spring tongues **27** fastened to a fastening web **34** which runs transversely over the flow limiter **1** between the outer marginal regions. In this case, the fastening of the spring **11** on the web **34** may be adhesively bonded, riveted or configured according to the other fastening methods mentioned above. Each part region of the spring **11**, that is to say each spring tongue **27**, is in each case attached above two orifices **23** separated from one another by a web **24**. The orifices therefore take up in each case approximately, minus the webs **24** and **34**, a quadrant of the circular passage for the flow limiter **1**.

It is clear in the cross section of figure **9**c in the initial position, that is to say without a fluid flow, that the spring tongues **27** have a tangential angle between **10** and **30** degrees with respect to the longitudinal axis a of the liquid line **2**. With the rising fluid flow, this curvature diminishes and, in particular, the middle part **32** of the spring tongue **27** is deposited onto the web **24**, while the lateral parts **33** of the spring tongues **27** are deposited on the marginal regions **44** of the carrier.

Between the middle part **32** and lateral parts **33** of the spring tongues **27** there are recesses **43** which may be implemented, in particular, as punched-out portions. These correspond, in the top view, to half an ellipse or to an ovally rounded slot. However, the recesses **43** are introduced into the marginal region of the spring tongues **27** preferably with smoother transitions than illustrated. If the angle **0** degrees is assigned in the radial direction to the mid-axis of a spring tongue **27** which is arranged above the web **24**, these two recesses **43** of a spring tongue **27** are arranged at an angle between **20** and **45** degrees, in particular at approximately **30** degrees.

The flatform spring **11**, when flattened, and not in the pre-bent form illustrated in figure **9**c, is not a complete circular disk, but instead is cut off, in particular, in the region of the middle part **32**. The cut-off edge corresponds to a chord **47** of the circle. This chord **47** may merge into the circular margin of the spring **11** in a rounded manner in the lateral parts **33**. Thus, when the spring **11** lies completely on the webs **24** and **34**, a remaining double passage is obtained. This, on the one hand, is the region of the recesses **43** and, on the other hand, the space for the two orifices **23** which remains on the far side of the chord **47**. It is clear that, in an exemplary embodiment not illustrated in the drawings, on one hand, only the recesses **43** may be present and, on the other hand, only the remaining space for the two orifices **23** which is predetermined by the chords may be present.

Here, too, the collar **15** has a plurality of portions **15'** which are spread slightly and can fix the flow limiter **1** axially in the liquid line **2**.

Figure **10** shows a top view of a flow limiter **1** with a flatform spring **11** which has four spring tongues **37** arranged in a rotationally symmetrical manner and fastened at the center Z of the flow limiter **1**. These spring tongues **37** are rotated through **45** degrees with respect to the exemplary embodiment of figure **2**, so that they are attached in each case above an assigned web **24** which separates from one another two orifices **23** assigned in each case to a spring tongue **37**. Conversely, here, each orifice **23** is in each case assigned two spring tongues **37**. The passage regions remaining free arise here from the cloverleaf-like intermediate orifices between the spring tongues **37**. In another exemplary embodiment, not illustrated in the drawings, the corners **48** of the spring tongues may be cut off in order to form more extensive recesses, or there may be recesses corresponding to the oval punched-out portions according to the exemplary embodiment of figure **9**.

Figure **11** shows a top view of a further flow limiter **1** with a flatform spring **11** which is modified in relation to fig. **9**, and the two spring tongues **27** of which are attached in each case above two assigned webs **24**. The webs **24** intersect at the center at a **90** degree angle to one another and at a **45** degree angle to the fastening web **24**. Here, therefore, the passage is divided into three orifices **23** assigned in each case to a spring tongue **27**. Recesses **43** and the chord portion **47** correspond to those of fig. **9**, so that, in particular, the remaining passage region remains open in the middle portion **32**, while the lateral spring tongue regions are deposited on the marginal region **44** of the carrier **10**. It is also possible, however, that the recesses **43** are also or only or additionally provided in the lateral regions **33**.

The flatform spring **11** is preferably made from a spring steel which, depending on the variant, has a straight or pre-bent configuration, particularly in the range of between approximately **30** degrees, as in the exemplary embodiments of figures **1**, **2** and **3**, or up to **80** degrees, as in the exemplary embodiments of figures **9** and **11**. The width of the webs **14** and **24** is configured so as to form a reliable mechanical bearing surface. For this purpose, a width of **5** to **10**%, at most **20**%, of the diameter of the flow limiter **1** or of the width, projecting on both sides of the flatform spring **11** is sufficient.

The nonlinear relation between spring force F and deflection s is illustrated in figures **4** and **5**. Figure **4** shows a relatively slight deflection s of the flatform spring **11** or of a spring tongue **12**, **17**, **19**, **27** of the flatform spring **11** in a range with a low pressure difference Δp and with a correspondingly low spring force F. Figure **5** shows the comparatively high deflection s of the flatform spring **11** or of the spring tongue **12**, **17**, **19**, **27** in a range with a relatively high pressure difference Δp and with correspondingly high spring force F increasing to a greater extent.

In figure **6**, D_{max} denotes the (rate) profile of the volumetric flow $\dot{V}$ through the flow limiter **1** in dependence on the differential pressure Δp in the case of a maximum uncontrolled passage (completely open passage orifice). Reference symbol D_{min} designates the (rate) profile of the volumetric flow $\dot{V}$ through the flow limiter **1** in dependence on the differential pressure Δp in the case of a minimum passage which remains open (open remaining region with the passage orifice closed to the maximum) when the flatform spring **11** or spring tongue **12, 17, 19, 27** comes to bear completely. As is clear from figure **6** the controlled (rate) profile of the volumetric flow $\dot{V}_{ctrl}$ follows the bold unbroken line which assumes an essentially constant volumetric flow value $\dot{V}_{const}$ in the working range, between the minimum differential pressure Δp_{min2} and the maximum differential pressure Δp_{max}, below the minimum differential pressure Δp_{min2} follows essentially the profile D_{max} of the volumetric flow $\dot{V}$ in the case of an uncontrolled maximum passage, and, above the maximum differential pressure Δp_{max}, follows the profile D_{min} of the volumetric flow $\dot{V}$ in the case of a minimum (that is to say, maximum covered) passage. In this case, the part, designated by $\dot{V}_{ctrl2}$, of the controlled (rate) profile of the volumetric flow $\dot{V}_{ctrl}$ constitutes, up to the differential pressure Δp_{min1}, an improvement in relation to the (rate) profile, designated by $\dot{V}_{ctrl1}$ and indicated by dashes, of the volumetric flow $\dot{V}_{ctrl}$. As compared with the profile $\dot{V}_{ctrl1}$ indicated by dashes, the improved profile $\dot{V}_{ctrl2}$ has a working range [Δp_{min2}, Δp_{max}] extended in the lower pressure range [Δp_{min2}, Δp_{min1}] and having a constant volumetric flow value $\dot{V}_{const}$. In the profile indicated by dashes, a constant volumetric flow value $\dot{V}_{const}$ is present only in the smaller range [Δp_{min1}, Δp_{max}]. This marked improvement for low values of the differential pressure Δp below the differential pressure Δp_{min1} is achieved in that, in the case of low differential pressure values Δp (that is to say, in particular, in the essentially deflection-free initial position), the flatform spring **11** or the spring tongue **12, 17, 19, 27, 27′** is exposed to the direct flow to a lesser extent. As a result, in the case of low differential pressure values Δp, the flatform spring **11** or spring tongue **12, 17, 19, 27, 27′** is deflected or brought to bear against the carrier **10, 10′** to a lesser extent, and consequently the passage is reduced less (quickly) at low differential pressure values Δp, so that the nominal throughflow, that is to say the constant volumetric flow value $\dot{V}_{const}$, is obtained even at a lower differential pressure Δp_{min2} and therefore an extended working range [Δp_{min2}, Δp_{max}] with a constant volumetric flow value $\dot{V}_{const}$ is achieved.

Depending on the design variant, the reduced flow exposure of the flatform spring **11** or the spring tongue **12, 17, 19, 27, 27′** is achieved in that the spring tongue **12, 17, 19, 27,** is preceded by a body in order to shield the spring tongue **12, 17, 19, 27** from the direct impingement of the flow, or in that the majority of the orientation of the spring tongue **12, 17, 19, 27′** is in the direction of flow r in order to offer a reduced attack surface to the flow.

Figures **12**a, **12**b and **12**c illustrate a design variant of the flow limiter **1** with a flatform spring **11** and with a body **50** which precedes the latter in the direction of flow r and which is attached to the carrier **10.** The body **50** generates a flow shadow for at least a part region of the flatform spring **11** or of the spring tongues **27,** and in this case the flow shadow (as in a light source) is to be understood as an (idealized) projection shadow and any vortex effects are not taken into account. The body **50** preferably shades the flatform spring **11** or spring tongues **27** completely from the direct impingement of the flow and generates **100**% flow shadow, that is to say a projection shadow, as is clear in the top view of figure **12**b where the flatform spring **11** is covered completely by the body **50** in the axial direction (of flow) of the liquid line **2**. Bodies **50** which generate a proportionally smaller flow shadow are also possible, especially when only the more rigid part of the spring tongue **27** in the fastening region of the flatform spring **11** is not shaded. The body **50** is preferably made from plastic and has a screening surface **51** which faces the flow and faces away from the flat spring **11** and which runs perpendicularly with respect to the axial direction of the liquid line **2** and generates the flow shadow. The screening surface **51** preferably has a basic form which corresponds to the inner cross section of the liquid line **2** and which has one or more recesses serving as supply regions **52**. Figures **12**a, **12**b and **12**c show the preceding body **50** in combination with a flow limiter **1** according to figures **9**a, **9**b, **9**c and **9**d. However, a person skilled in the art would understand that a body **50** formed according to the respective variant may also precede the flatform spring **11** or the spring tongues **12**, **17**, **19**, **27** in other designs of the flow limiter **1** according to figures **1**a, **1**b, **1**c, **2**a, **2**b, **2**c, **3**a, **3**b, **3**c, **10** and/or **11**. The screening surface **51** has, for example, a circular basic form which, in the embodiments of the flow limiter **1** according to figures **1**a, **1**b, **1**c, **2**a, **2**b, **2**c, **9**a, **9**b, **9**c, **9**d, **10** and **11**, is reduced by circle segments arranged in the supply regions **52** and, in the embodiments of the flow limiter **1** according to figures **3**a, **3**b and **3**c, has a, for example, circular recess to a central supply duct through the body **50** to the spring tongues **19**. The body **50** has, for example, bent supply walls **53** which face the flatform spring **11** and extend essentially in the supply regions **52**, from the screening surface **51** of the body **50** to the fastening side, facing away from the screening surface **51**, of the body **50**. With an increasing differential pressure Δp, fluid streams are conducted through the supply region **52** along the supply walls **53** into supply gaps **54** which are formed essentially in a wedge-shaped manner between the supply walls **53** and the spring tongue **12, 17, 19, 27** and which are enlarged with an increasing differential pressure Δp and consequently an increasing deflection of the spring tongue **12, 17, 19, 27**. In the embodiments of the flow limiter **1** according to figures **1**a, **1**b, **1**c, **2**a, **2**b, **2**c, **9**a, **9**b, **9**c, **9**d, **10** and **11**, the supply walls **53** taper the body **50** essentially from the outer marginal region of the screening surface **51** of the body **50** to the fastening side of the body **50**, for example, in arcuate form, and in the variants according to figures **2**a, **2**b, **2**c, **9**a, **9**b, **9**c, **9**d, **10** and **11**, increasingly toward the center Z of the carrier **10**. In the embodiments of the flow limiter **1** according to figures **3**a, **3**b and **3**c, the supply walls **53** prolong the supply duct through the body **50** essentially from the screening surface **51** of the body **50** to the fastening side of the body **50** increasingly toward the outer marginal region of the carrier **10**, for example in arcuate form. The body **50** is fastened, for example, together with the flatform spring **11**, to the carrier **10** by means of a rivet, for example by rivet holes **50**, or by adhesive bonding.

In the design variant of the flow limiter **1** according to figures **12**a, **12**b, **12**c, which, like the variants according to figures **9**a, **9**b, **9**c, and **9**d, has a double-tongued flatform spring **11**, the body **50** is based, for example, on a cylindrical basic form, the lateral area of which is formed by the bent supply walls **53** and the screening surface **51** and the base and top area **56, 57** of which have a configuration essentially in the form of a circle segment, the screening surface **51** running through the circle chords and the supply walls **53** running through the circle arc of the base and top area **56, 57**. In the case of a (circularly) round configuration of the carrier **10**, the base and top areas **56, 57** are of correspondingly round form, that is to say the body **50** has rounded base and top areas **56, 57** which are arranged in each case perpendicularly to the screening surface **51** and which make it possible for the body **50** to be inserted into the ring formed by the collar **15**. The body **50** is, for example, of hollow configuration and is provided with orifices on the base and top areas **56**, **57**. As is clear in figure **12**a, the body **50** and the flatform spring **11** are attached to a fastening web **34**.

Figures **13**a, **13**b and **13**c illustrate a design variant of the flow limiter **1** in which the (double-tongued) flatform spring **11** or the spring tongues **27'** in the initial position, that is to say without a fluid flow and with low differential pressure values Δp, are in each case of non-bent form, that is to say of a form stretched out flat, and are oriented in the majority in the direction of flow r. That is to say, the spring tongues **27'** run in each case straight and for the most part in the direction of flow r and have in each case an angle β of less than **45**°, preferably an angle β of between **5**° and **15**°, with respect to the longitudinal axis a of the liquid line **2**, as is clear in the cross section of figure **13**a. As a result, the spring tongues **27'** offer a reduced attack surface to the flow at low differential pressure values Δp. Even smaller angles β between the spring tongues **27'** and the longitudinal axis a of the liquid line **2** are possible but, depending on the rigidity of the spring tongues **27'**, there is the risk that, if the angle β is too small, undesirable oscillation and/or bending round of the spring tongue **27'** into the wrong direction (not the desired direction) will occur. Figures **13**a, **13**b, and **13**c show the flow limiter **1** in a design variant which corresponds in the top view essentially to the embodiment according to figures **9**a, **9**b, **9**c and **9**d, although the set-out spring tongues **27'** form essentially a V-shaped cross section. However, a person skilled in the art will understand that, even on the basis of other designs of the flow limiter **1** according to figures **1**a, **1**b, **1**c, **2**a, **2**b, **2**c, **3**a, **3**b, **3**c, **10** and/or **11**, the flatform spring **11** or the spring tongues **12**, **17**, **19**, **27** and the carrier **10** can be adapted according to the embodiment described below with reference to figures **13**a, **13**b and **13**c. In particular, the spring tongues **12**, **17**, **19**, **27** can also be set up and formed such that, in the initial position, they are stretched out straight and have an angle β of less than **45**°, preferably an angle β of between **15**° and **25**°, with respect to the longitudinal axis a of the liquid line **2**. Moreover, the carrier **10**, having an essentially identical top view, that is to say with in horizontal projection essentially the same configuration of the webs and orifices, in the axial direction of the liquid line **2** (direction of flow r), can be adapted according to the carrier **10′** illustrated in figures **13**a, **13**b and **13**c. As illustrated in figures **13**a, **13**b and **13**c, that region of the carrier **11′** which lies beneath the spring tongue **27′** is in each case configured as a ramp **28** rising opposite to the direction of flow, for example with an arcuate cross section. It is clear in figure **13**c, that the ramp **28** is formed by the web **24′** and the side regions **29** of the orifices **23′**. The ramp **28** thus formed rises from the fastening region of the flatform spring **11** on the carrier **10′**, in particular from the fastening web **34**, opposite to the direction of flow, before it descends again slightly in the arcuate variant. In the embodiments of the flow limiter **1** according to figures **1**a, **1**b, **1**c, **2**a, **2**b, **2**c, **9**a, **9**b, **9**c, **9**d, **10**, **11**, **12**a, **12**b, **12**c, **13**a, **13**b and **13**c, the ramp **28** in each case rises toward the outer marginal region of the carrier **10**, **10′**; in the embodiments of the flow limiter **1** according to figures **3**a, **3**b and **3**c, the ramp **28** rises in each case toward the center Z of the carrier **10**. The spring tongue **27′** and the ramp **28** are designed such that, with an increasing differential pressure Δp, the spring tongue **27** is bent in the direction of the ramp **28**, at the same time comes to bear increasingly against the ramp **28** and consequently increasingly reduces the passage. In this case, the angle β of the spring tongue **27′** with respect to the longitudinal axis a of the liquid line **2** is enlarged, and the flow-exposed attack surface of the spring tongue **27′** increases.

Finally, it should be noted that, by the flatform spring **11** or the spring tongues, **12, 17, 19, 27, 27′, 37** coming to bear increasingly against the carrier **10, 10′**, the opening angle between the flatform spring **11** or the spring tongue or spring tongues **12, 17, 19, 27, 27′, 37** and the carrier **10, 10′** is reduced from a maximum value in the initial position in the deflection-free state, bent away from the carrier **10, 10′**, of the flatform spring **11** or of the spring tongue or spring tongues **12, 17, 19, 27, 27′, 37** to a minimum value (typically zero) in the flattened state, lying on the carrier **10, 10′**, of the flatform spring **11** or of the spring tongue or spring tongues **12, 17, 19, 27, 27′, 37.** In this case, the flow cross section to which the flatform spring **11** or the spring tongue or spring tongues **12, 17, 19, 27, 27′, 37** offer a direct attack surface is increased in size with a rising differential pressure when the flatform spring **11** or the spring tongue or spring tongues **12, 17, 19, 27, 27′, 37** come to bear increasingly against the carrier **10, 10′**.

THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. A flow limiter (**1**) for limiting a volumetric flow through a liquid line (**2**), comprising a carrier (**10, 10'**) with a passage and a flatform spring (**11**) attached to the carrier (**10, 10'**), the flatform spring (**11**) having at least one spring tongue (**12, 17, 19, 27, 27', 37**) and the passage having at least one orifice (**13, 18, 23, 23'**) and the spring tongue (**12, 17, 19, 27, 27', 37**) being configured and arranged above the orifice (**13, 18, 23, 23'**) such that, with a rising differential pressure (Δp), the spring tongue (**12, 17, 19, 27, 27', 37**) comes to bear increasingly against the carrier (**10, 10'**) and at the same time reduces the size of the orifice (**13, 18, 23, 23'**) and reduces the passage within a defined pressure range, characterized in that
the spring tongue (**27**) is preceded by a body (**50**) or the spring tongue (**27'**) is oriented in the direction of flow (r) such that the spring tongue (**27, 27'**) offers a direct attack surface to a flow cross section which is reduced by at least **25**% and which increases in size with a rising differential pressure (Δp) when the spring tongue (**12, 17, 19, 27, 27', 37**) increasingly comes to bear against the carrier (**10, 10'**).

2. The flow limiter (**1**) as claimed in claim **1**, characterized in that the spring tongue (**27**) is preceded by a body (**50**) or the spring tongue (**27'**) is oriented in the direction of flow (r) such that the spring tongue (**27, 27'**) is exposed directly to a reduced flow cross-sectional part which amounts to less than a surface part of **75**% of the spring tongue (**27, 27'**).

3. The flow limiter (**1**) as claimed in either one of claims **1** and **2**, characterized in that, at a low differential pressure (Δp_{min2}) of the defined pressure range, the spring tongue (**27'**) is oriented in the direction of flow (r) such that the majority of the spring tongue (**27'**) runs in the direction of flow (r) and the spring tongue (**27'**) offers a direct attack surface to a reduced flow cross-sectional part which amounts to less than a surface part of **75**% of the spring tongue (**27'**), in particular a surface part of between **8**% and **25**% of the spring tongue (**27'**).

4. The flow limiter (**1**) as claimed in one of claims **1** to **3**, characterized in that, in a flow-free initial position, the spring tongue (**27'**) is of straight form and has an angle (β) of less than **45**°, in particular an angle (β) in the range of **5**° to **15**°, with respect to a longitudinal axis (a) of the liquid line (**2**).

5. The flow limiter (**1**) as claimed in one of claims **1** to **4**, characterized in that the carrier (**11'**) has a ramp (**28**) rising opposite to the direction of flow, and in that the spring tongue (**27'**) is configured such that, with a rising differential pressure (Δp), it is bent increasingly and comes to bear against the ramp (**28**), and at the same time continuously reduces the size of the orifice (**23'**) and continuously reduces the passage within the defined pressure range.

6. The flow limiter (**1**) as claimed in either one of claims **1** and **2**, characterized in that the body (**50**) preceding the spring tongue (**27**) is set up and arranged such that, at a low differential pressure (Δp_{min2}) of the defined pressure range, it generates a flow shadow for at least a surface part of **25**% of the spring tongue (**27**), in particular for a surface part in the range of **90**% to **100**% of the spring tongue (**27**).

7. The flow limiter (**1**) as claimed in claim **6**, characterized in that the carrier (**10**) is in essentially planar configuration, and in that the spring tongue (**27**) is configured such that, with a rising differential pressure (Δp), it is increasingly flattened and comes to bear against the carrier (**10**) and at the same time continuously reduces the size of the orifice (**23**) and continuously reduces the passage within the defined pressure range.

8. The flow limiter (**1**) as claimed in one of claims **1** to **7**, characterized in that the passage comprises at least two orifices (**13, 18, 23, 23'**) lying next to one another, in that the carrier (**10,10'**) comprises a web (**14, 24, 24'**) which separates the orifices (**13, 18, 23, 23'**) lying next to one another from one another, and in that the spring tongue (**12, 17, 19, 27, 27', 37**) is arranged such that, with a rising differential pressure (Δp), it lies increasingly on the web (**14, 24, 24'**) and continuously reduces the orifices (**13, 18, 23, 23'**), the orifices (**13, 18, 23, 23'**) remaining open in defined remaining regions.

9. The flow limiter (**1**) as claimed in one of claims **1** to **8**, characterized in that the passage comprises a plurality of orifices (**18**) arranged in a rotationally symmetrical manner, and in that the flatform spring (**11**) comprises a plurality of spring tongues (**17, 19**) which are arranged in a rotationally symmetrical manner and are in each case arranged such that, with a rising differential pressure (Δp), they lie increasingly on the assigned webs (**14**) and continuously reduce the size of the orifices (**18**).

10. The flow limiter (**1**) as claimed in one of claims **1** to **9**, characterized in that the flatform spring (**11**) has at least two spring tongues (**17, 19, 27, 27'**) oriented in directions opposite to one another along a common longitudinal axis.

11. The flow limiter (**1**) as claimed in one of claims **1** to **10**, characterized in that the spring tongues (**12, 19**) are fastened to an outer marginal region of the carrier (**10**).

12. The flow limiter (**1**) as claimed in one of claims **1** to **10**, characterized in that the spring tongues (**17, 27, 27', 37**) are fastened in the center (Z) of the carrier (**10**) or to a fastening web (**34**) running through the center (Z).

13. The flow limiter (**1**) as claimed in one of claims **1** to **12**, characterized in that the spring tongues (**12, 17, 19, 27, 27', 37**) and the orifice (**13, 18, 23, 23'**) have in each case an essentially identical extent along a longitudinal direction.

14. A method for limiting a volumetric flow through a liquid line (**2**), comprising: attaching a flatform spring (**11**) to a carrier (**10, 10'**) with a passage, providing the flatform spring (**11**) with at least one spring tongue (**12, 17, 19, 27, 27', 37**) and providing the passage with at least one orifice (**13, 18, 23, 23'**), and configuring and arranging the spring tongue (**12, 17, 19, 27, 27', 37**) above the orifice (**13, 18, 23, 23'**) such that, with a rising differential pressure (Δp), the spring tongue (**12, 17, 19, 27, 27', 37**) comes to bear increasingly against the carrier (**10, 10'**) and at the same time reduces the size of the orifice (**13, 18, 23, 23'**) and reduces the passage within a defined pressure range, characterized by preceding the spring tongue (**27**) by a body (**50**) or arranging the spring tongue (**27'**) in the direction of flow (r) such that the spring tongue (**27, 27'**) offers a direct attack surface to a flow cross section which is reduced by at least **25**% and which increases in size with a rising differential pressure (Δp) when the spring tongue (**12, 17, 19, 27, 27', 37**) increasingly comes to bear against the carrier (**10, 10'**).

15. The method as claimed in claim **14,** characterized in that the spring tongue (**27**) is preceded by a body (**50**) or the spring tongue (**27'**) is oriented in the direction of flow (r) such that the spring tongue (**27, 27'**) is directly exposed to a reduced flow cross sectional part which amounts to less than a surface part of **75**% of the spring tongue (**27, 27'**).

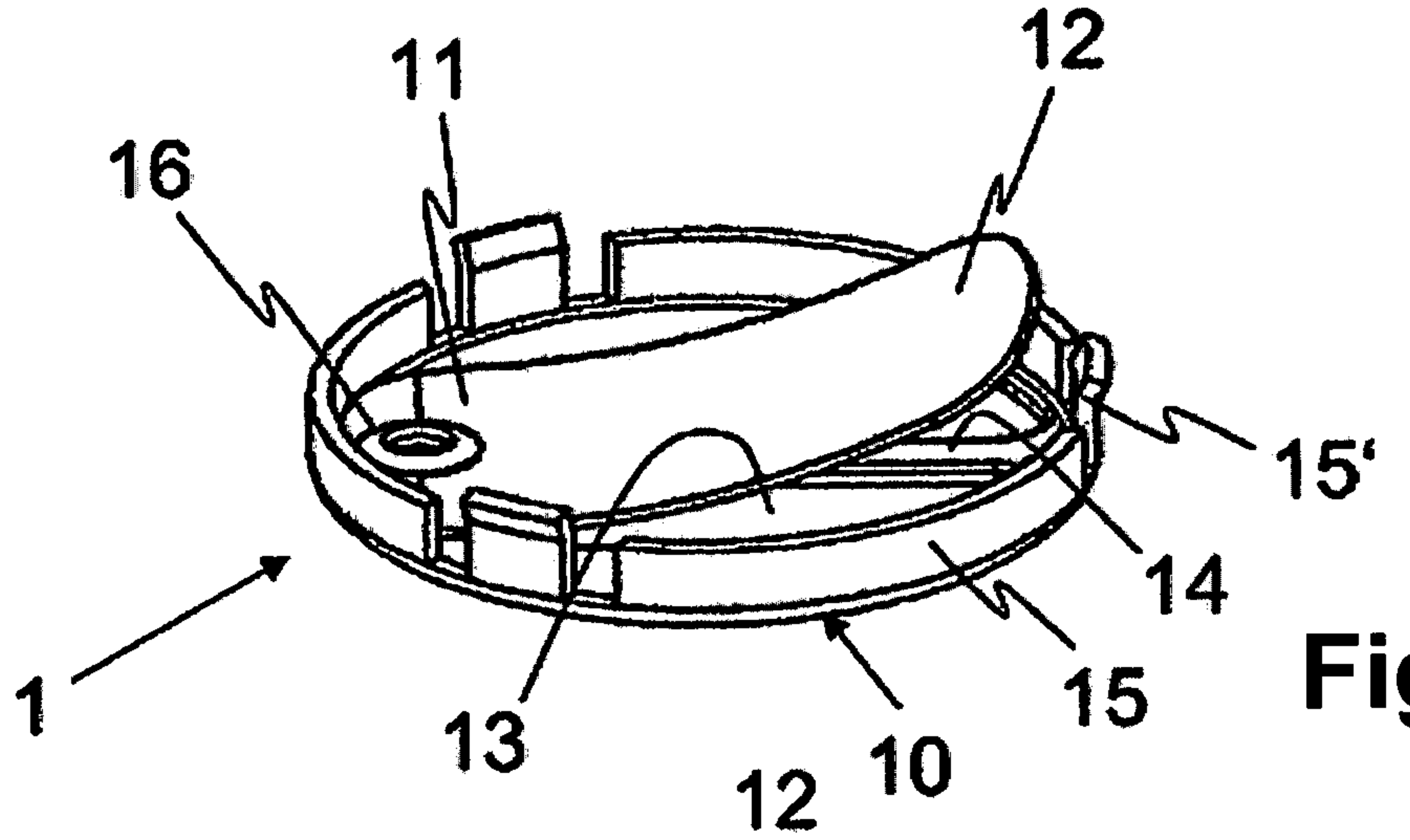

Fig. 1a

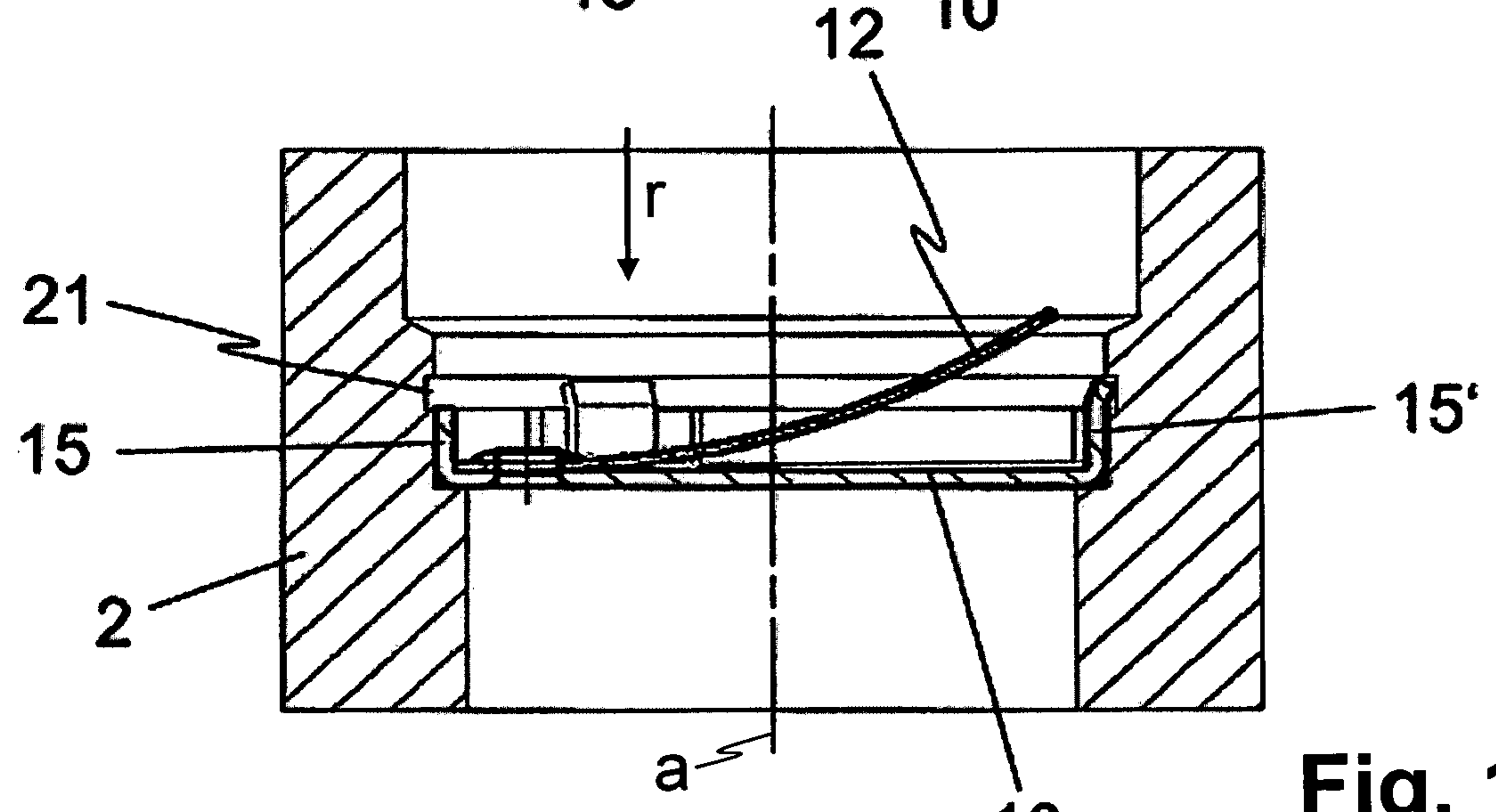

Fig. 1b

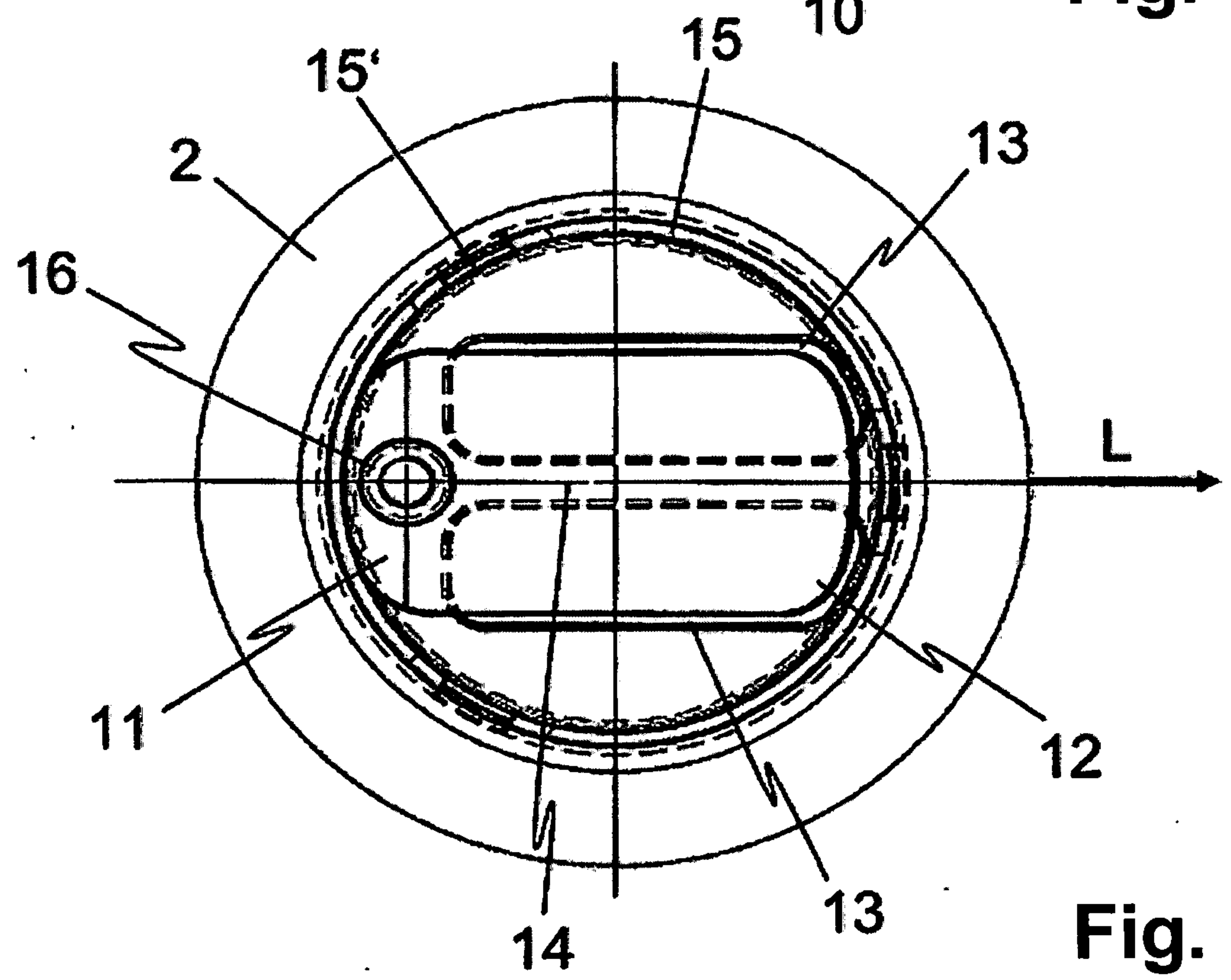

Fig. 1c

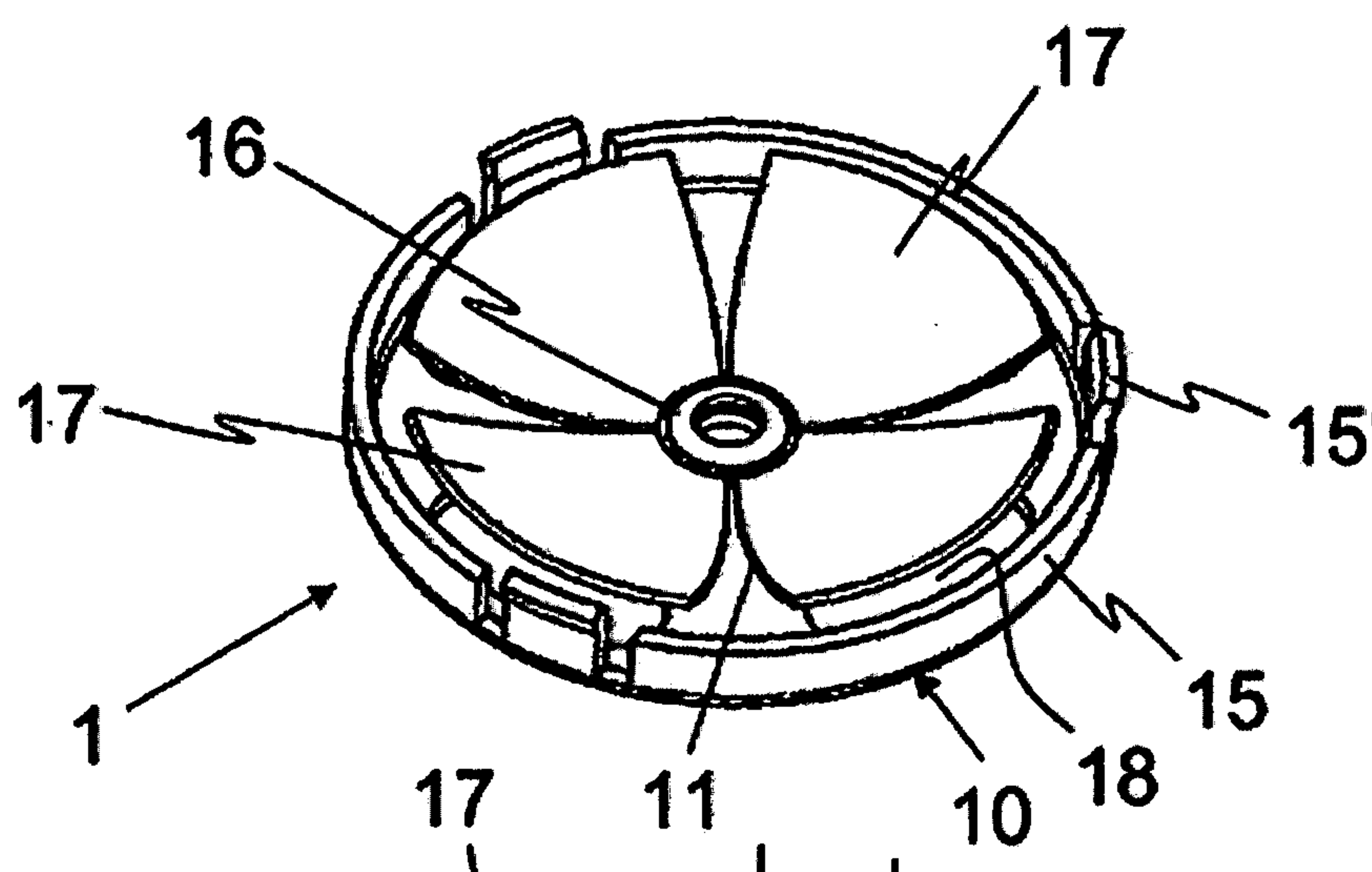

Fig. 2a

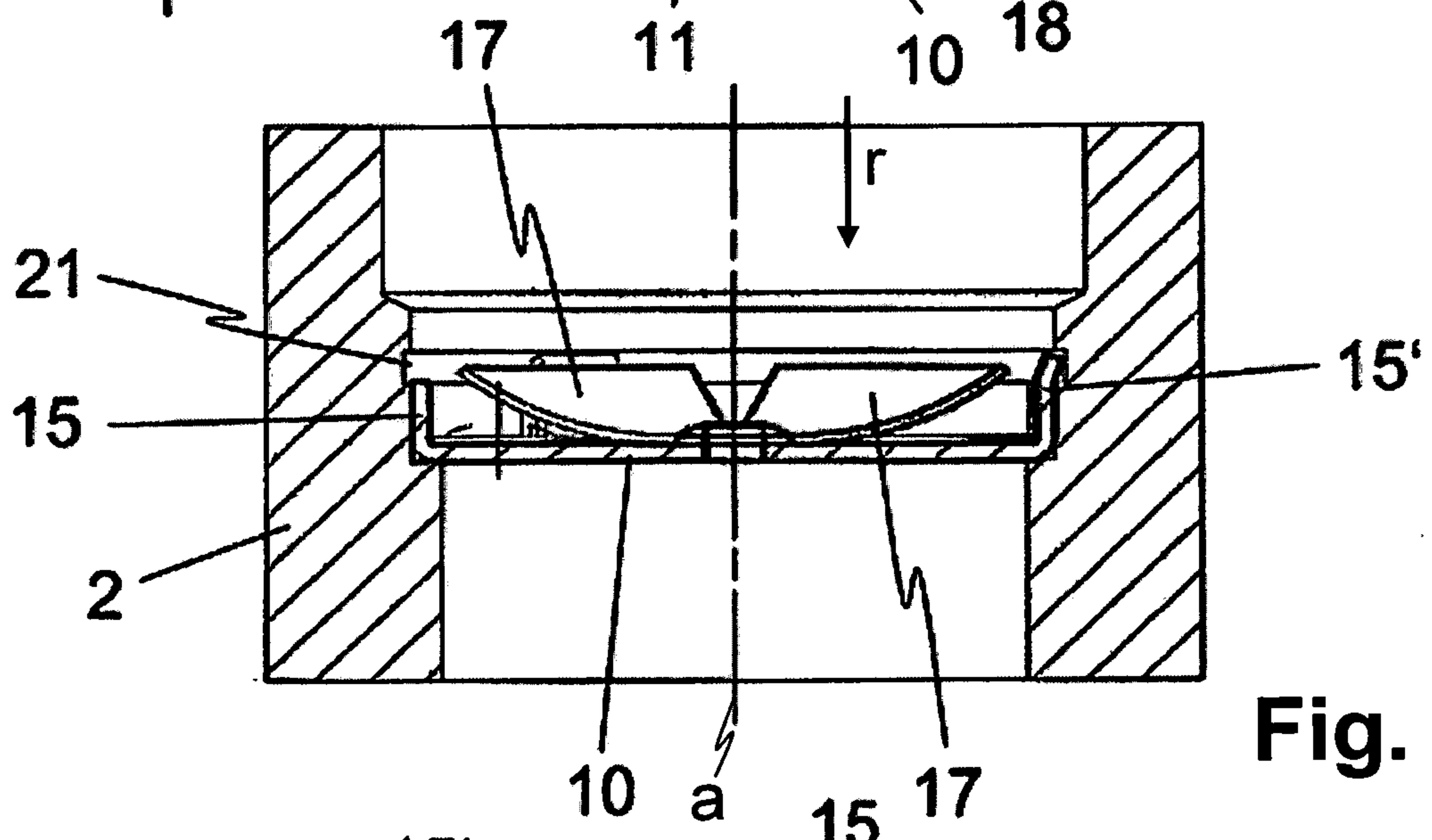

Fig. 2b

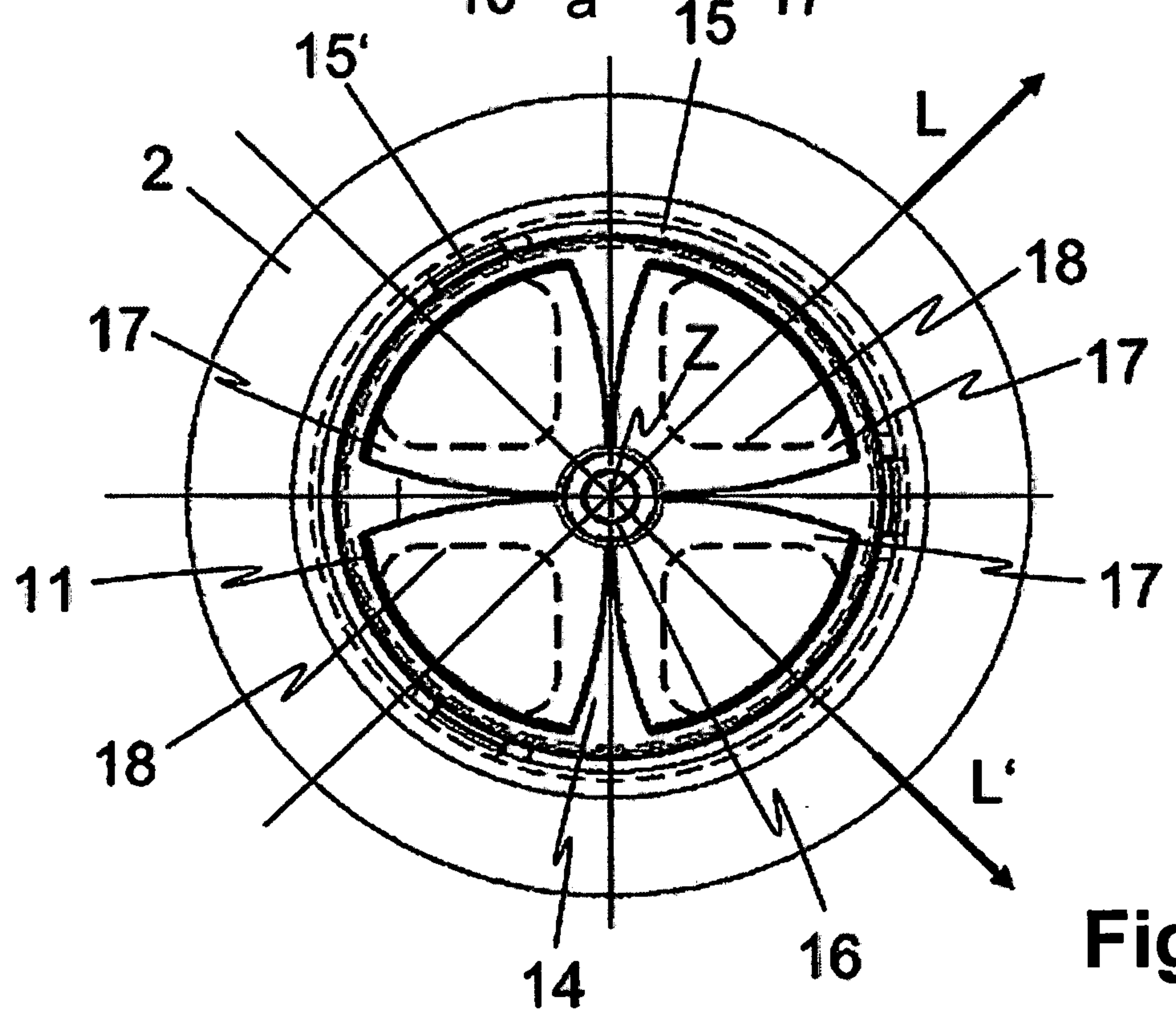

Fig. 2c

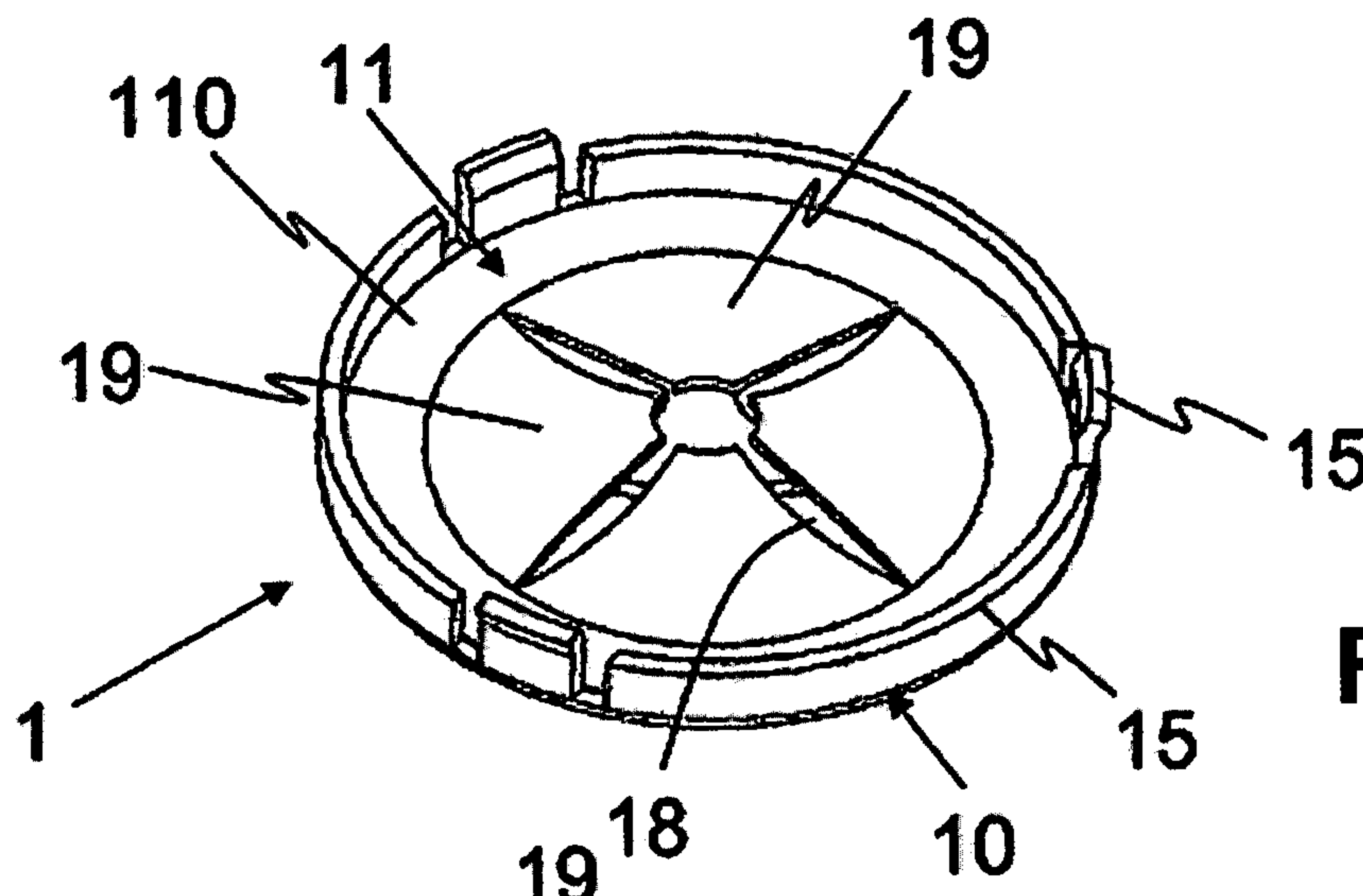

Fig. 3a

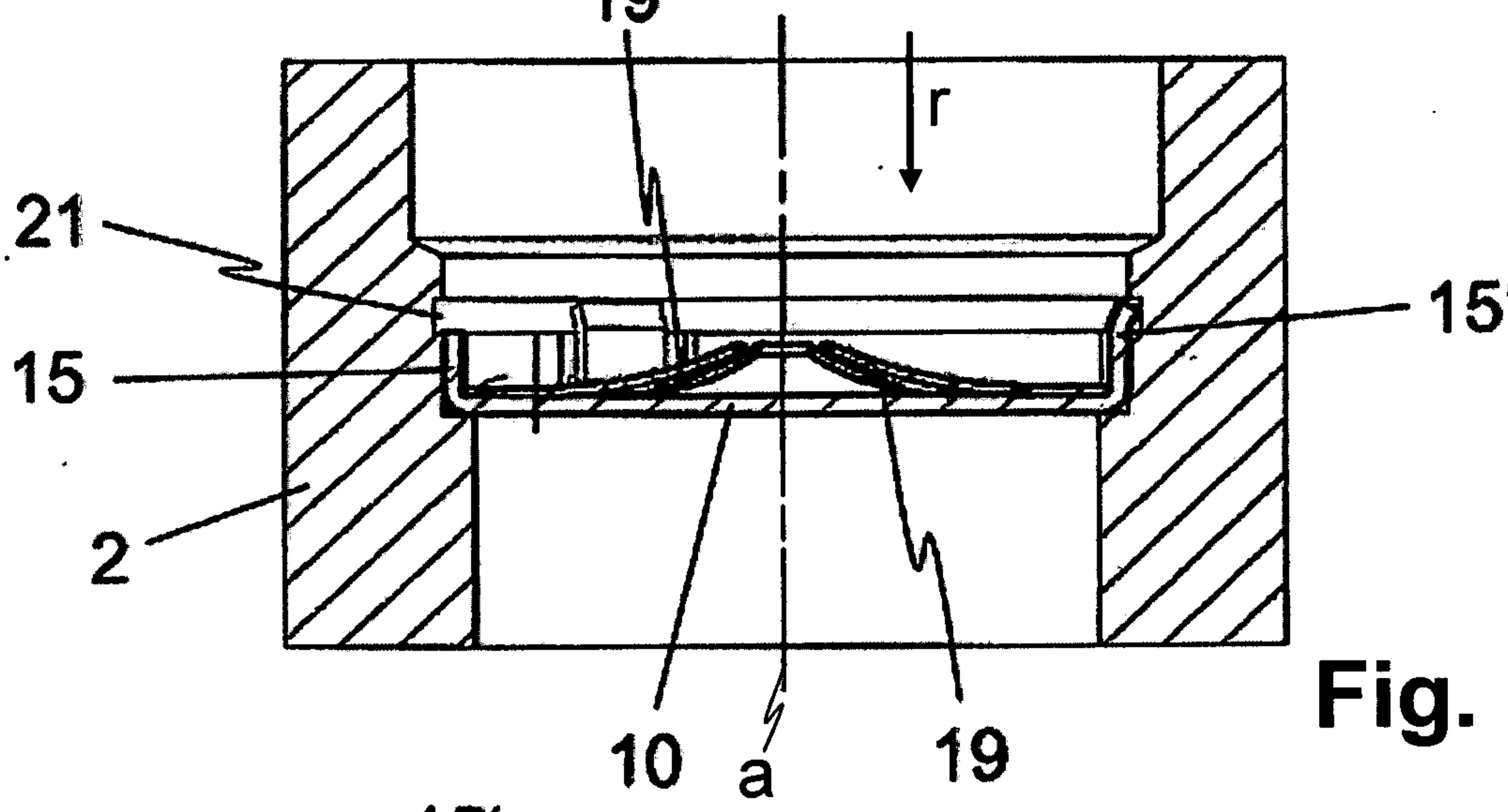

Fig. 3b

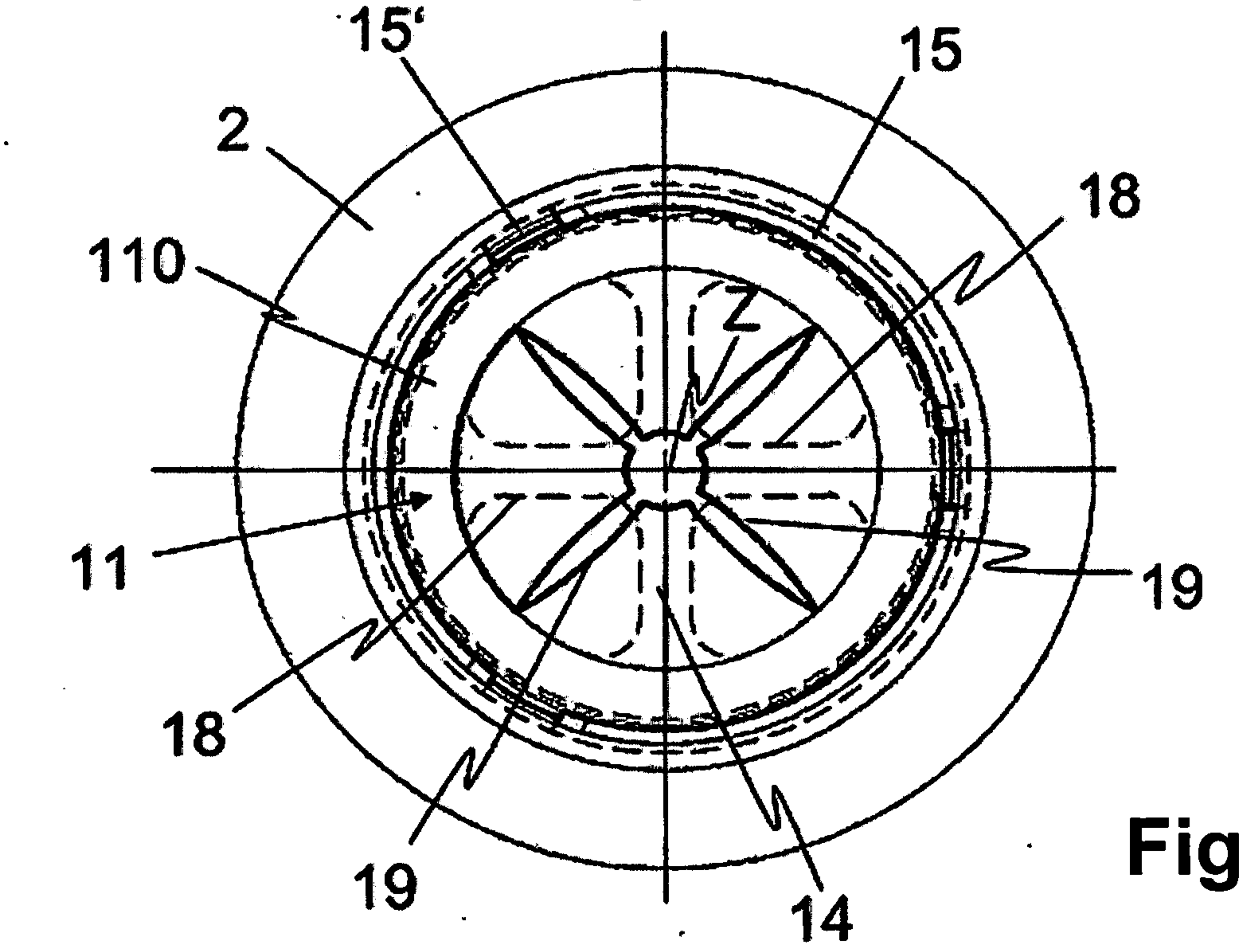

Fig. 3c

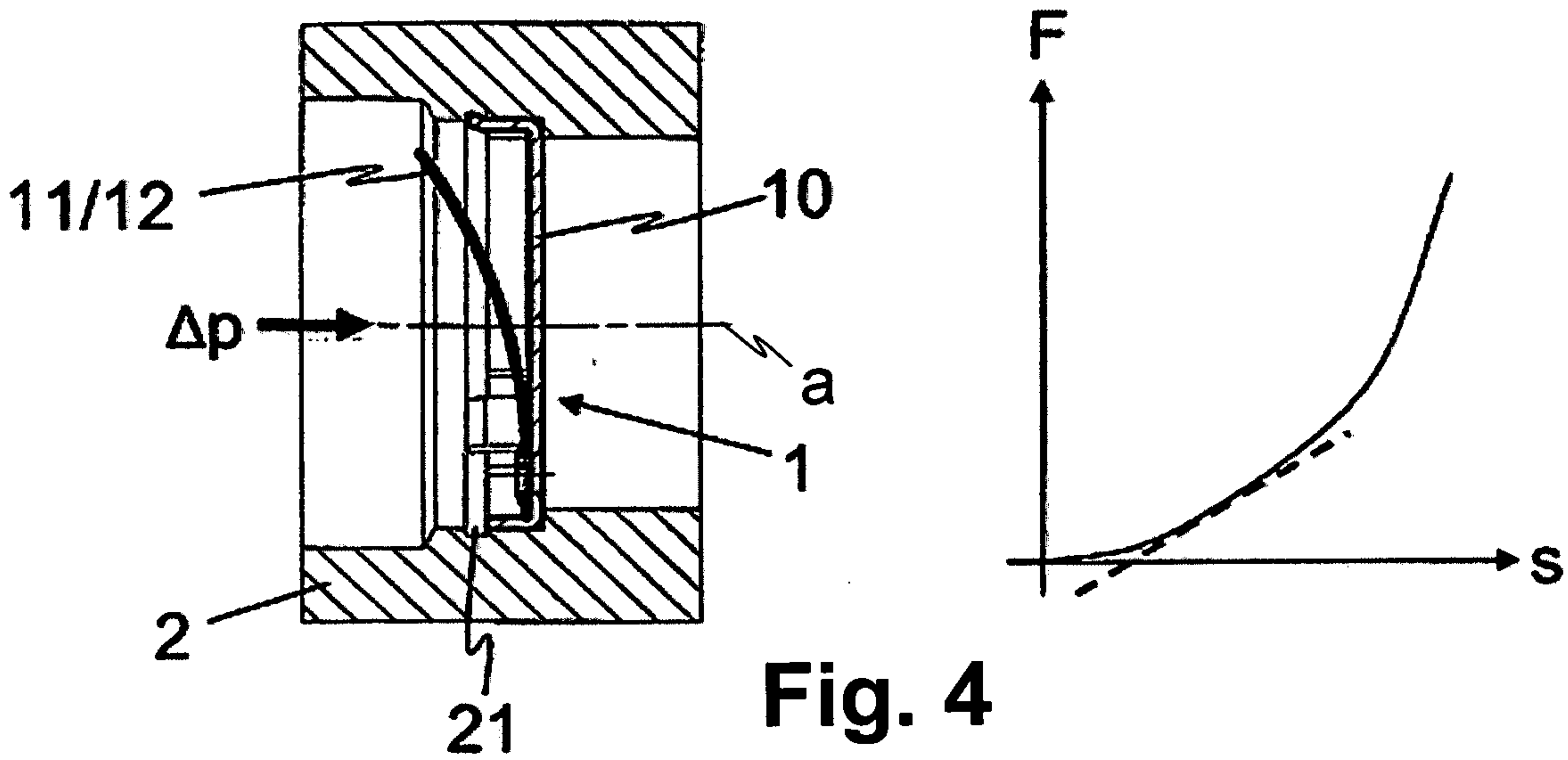

Fig. 4

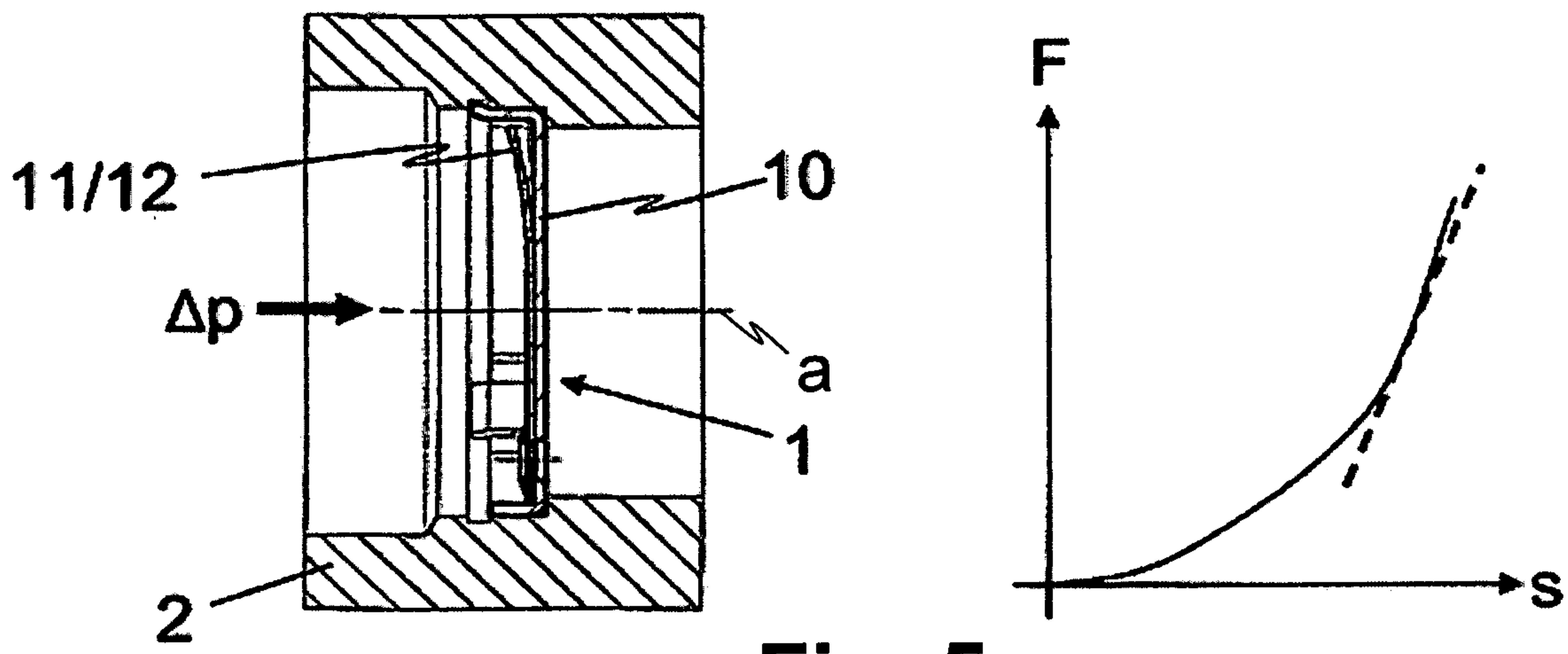

Fig. 5

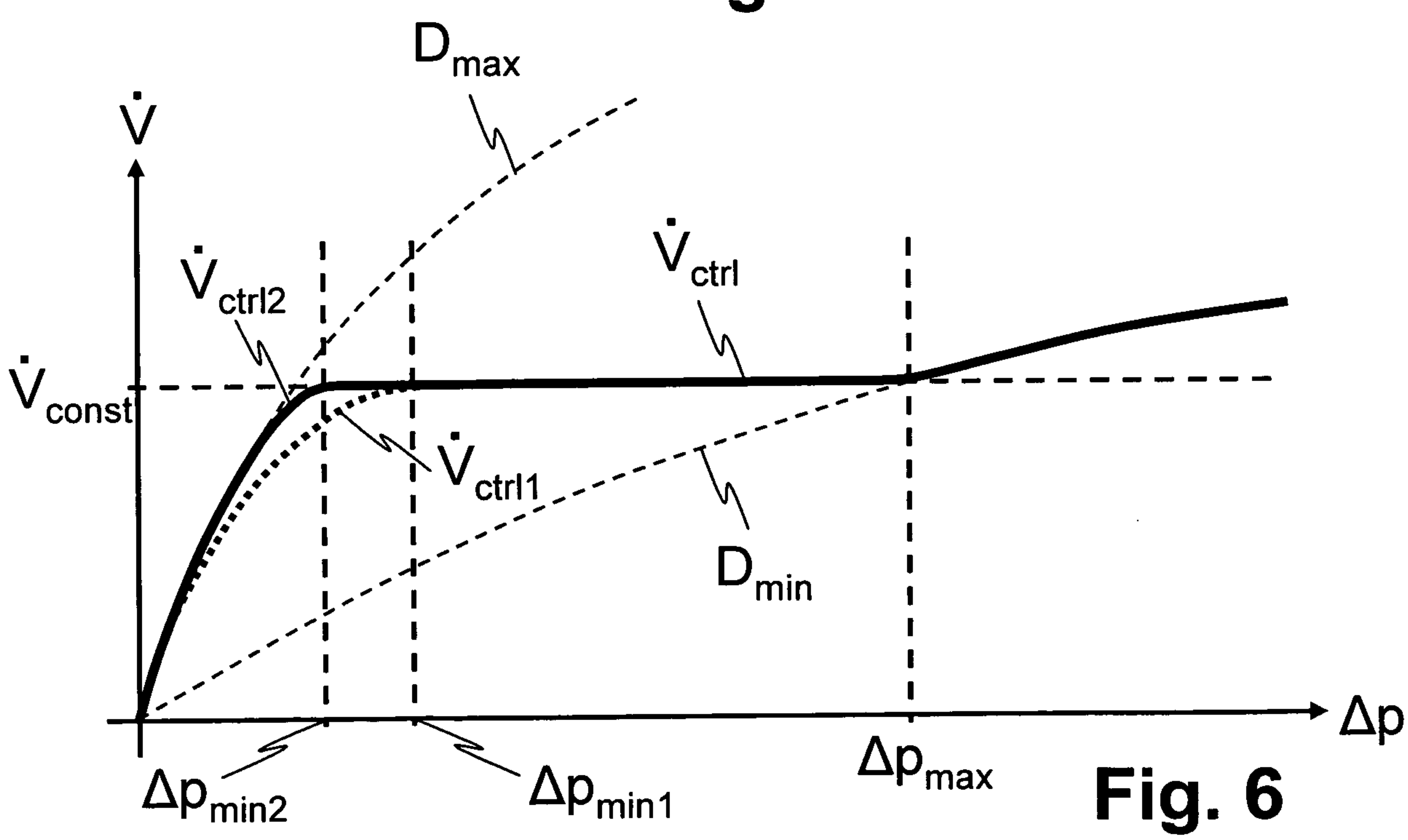

Fig. 6

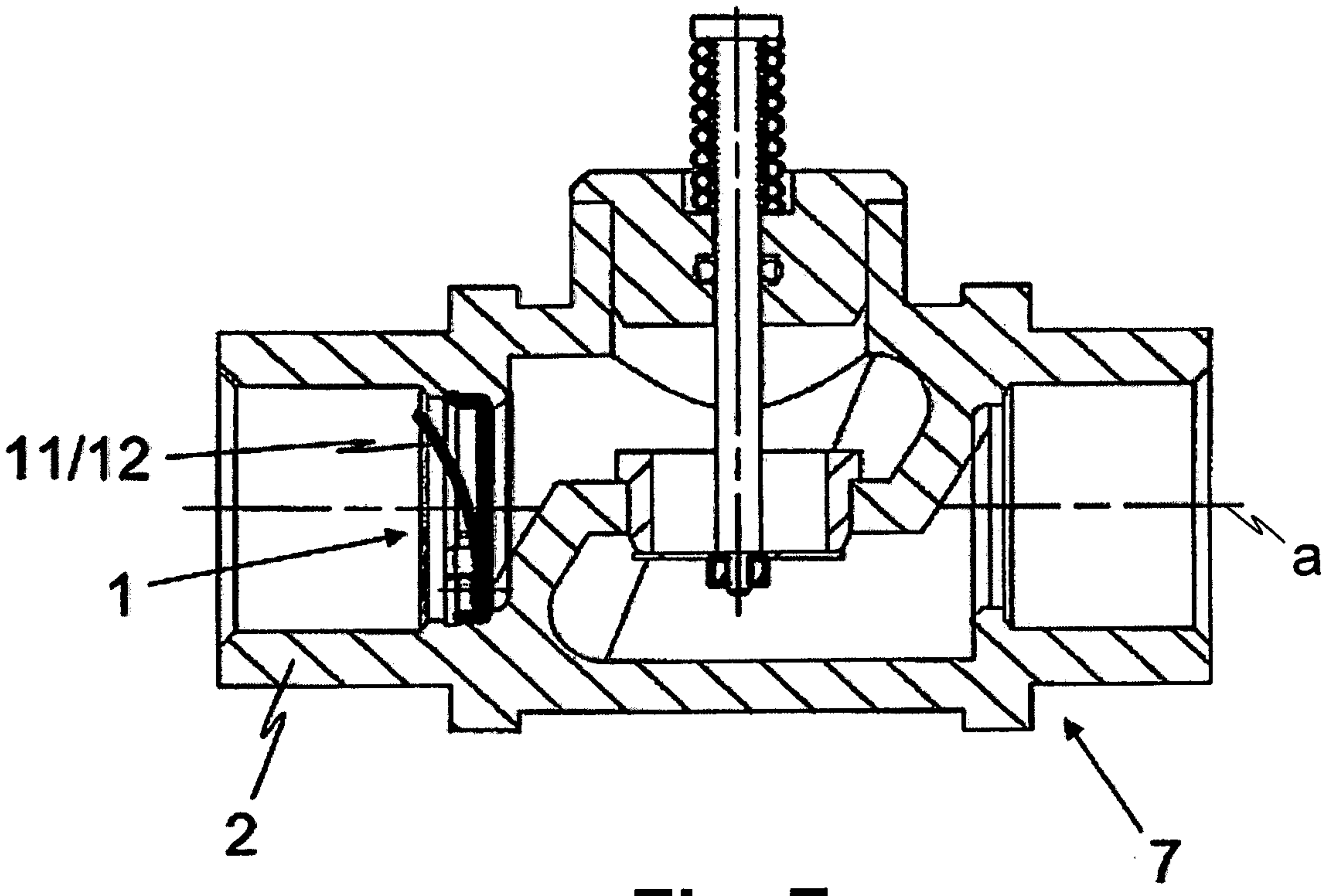

Fig. 7

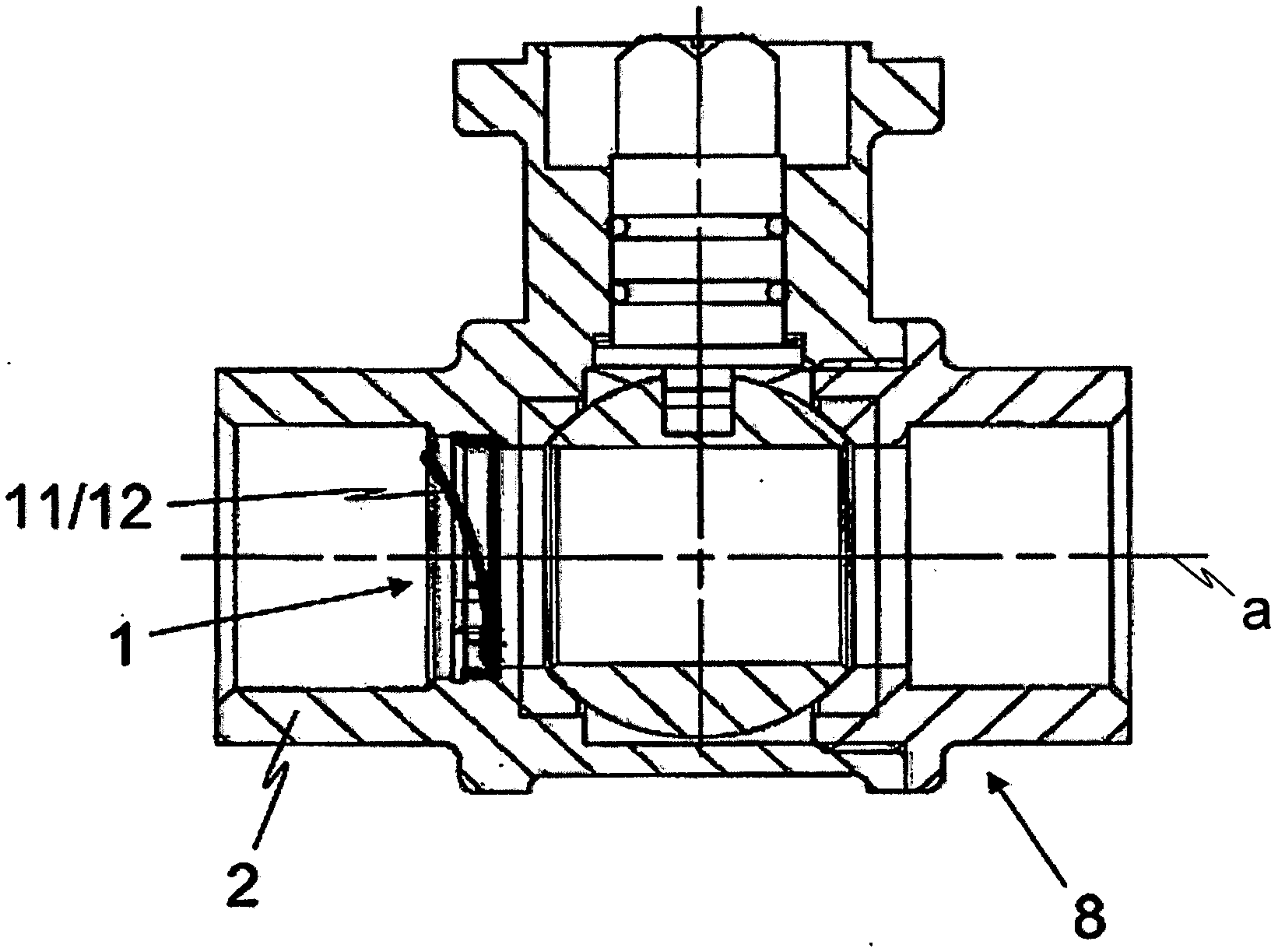

Fig. 8

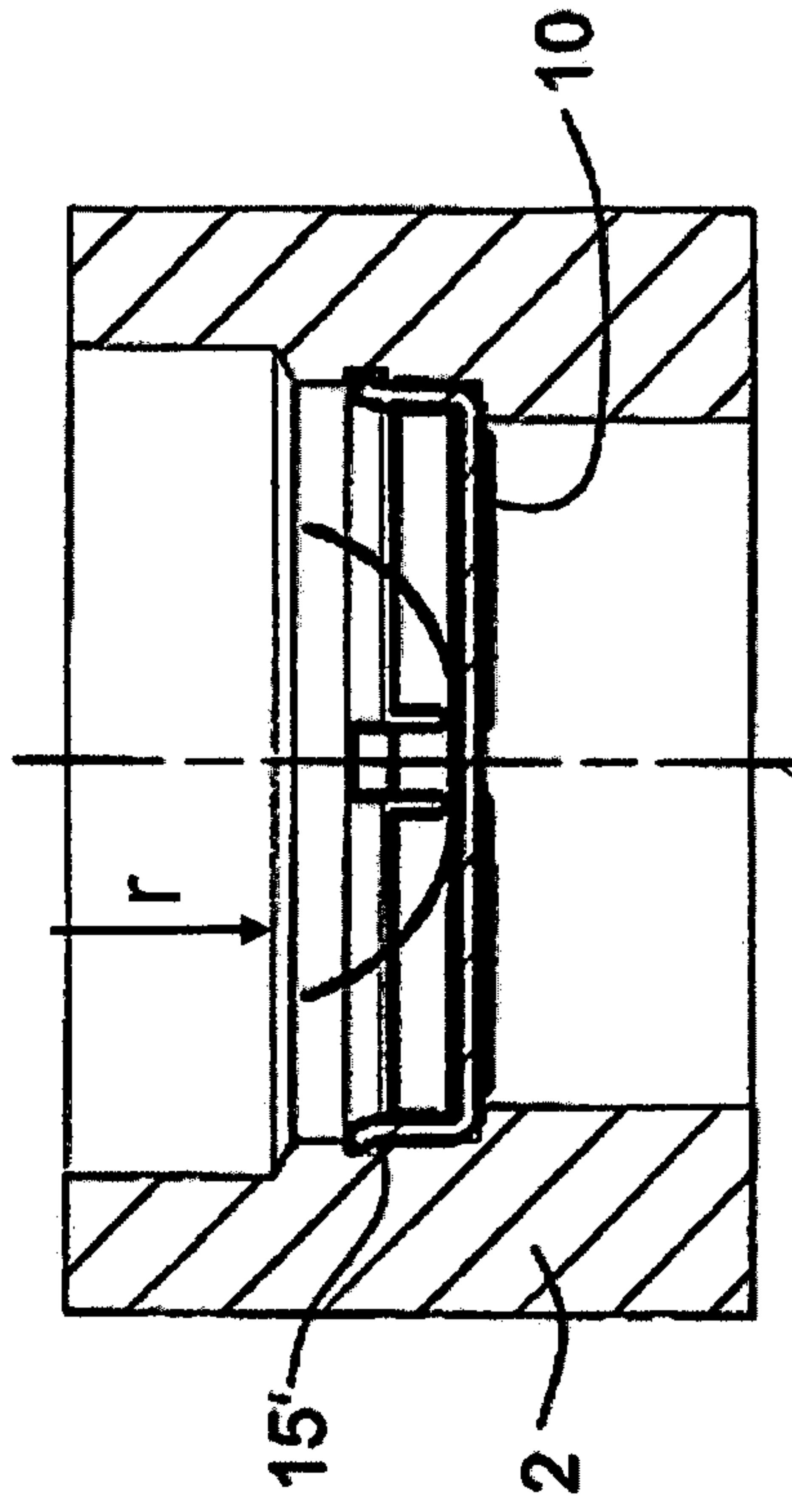

Fig. 9c

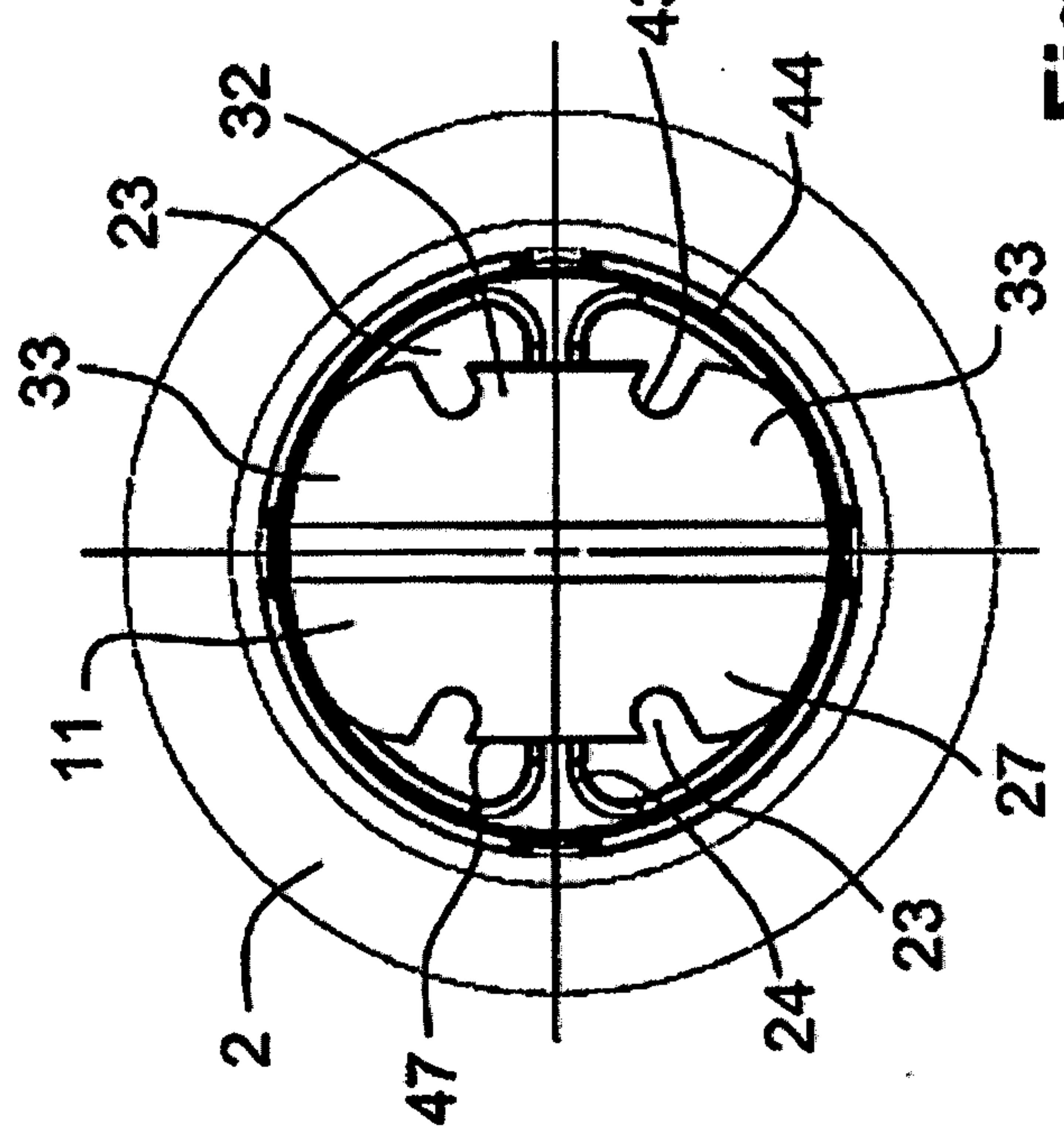

Fig. 9d

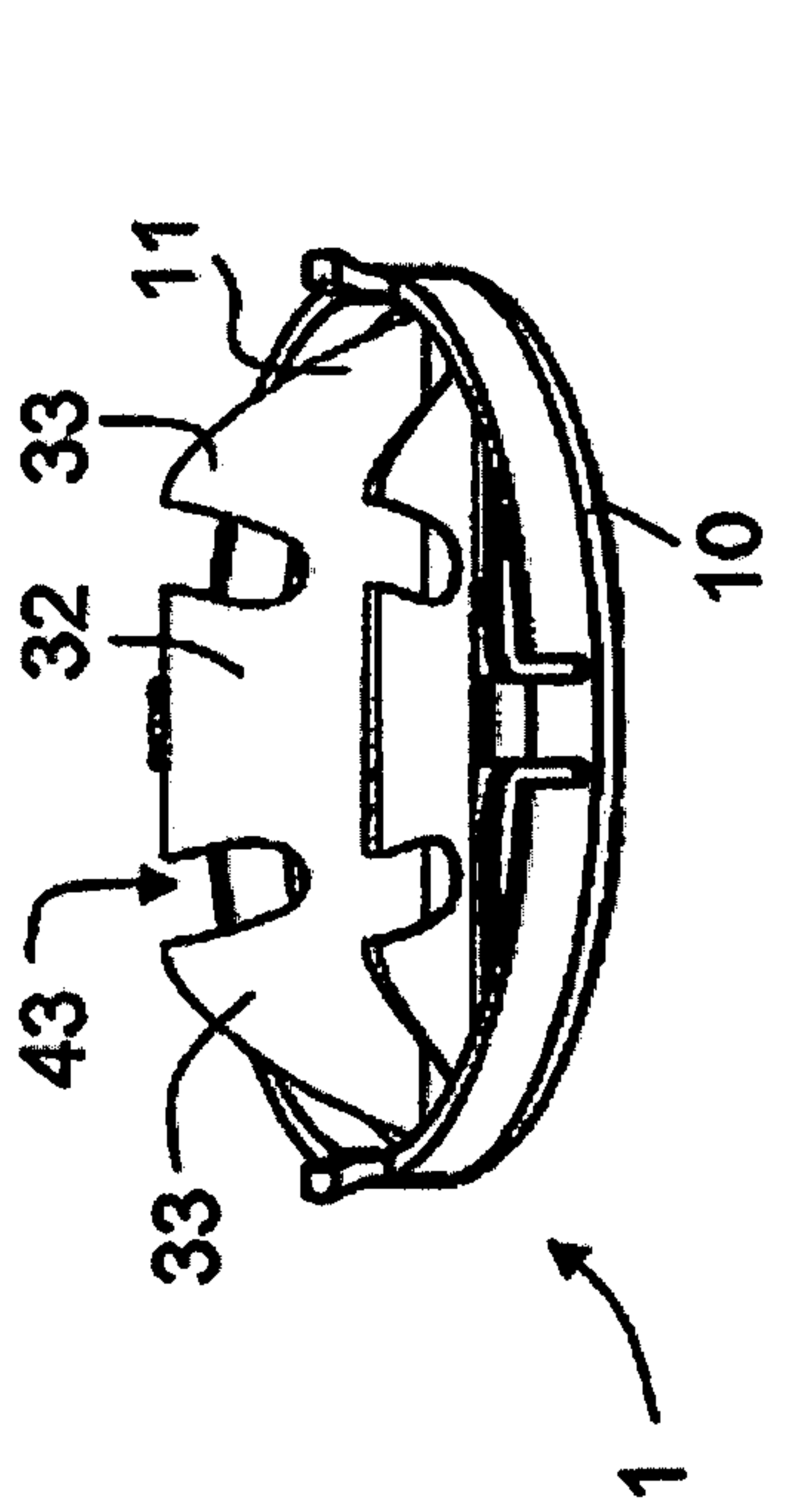

Fig. 9a

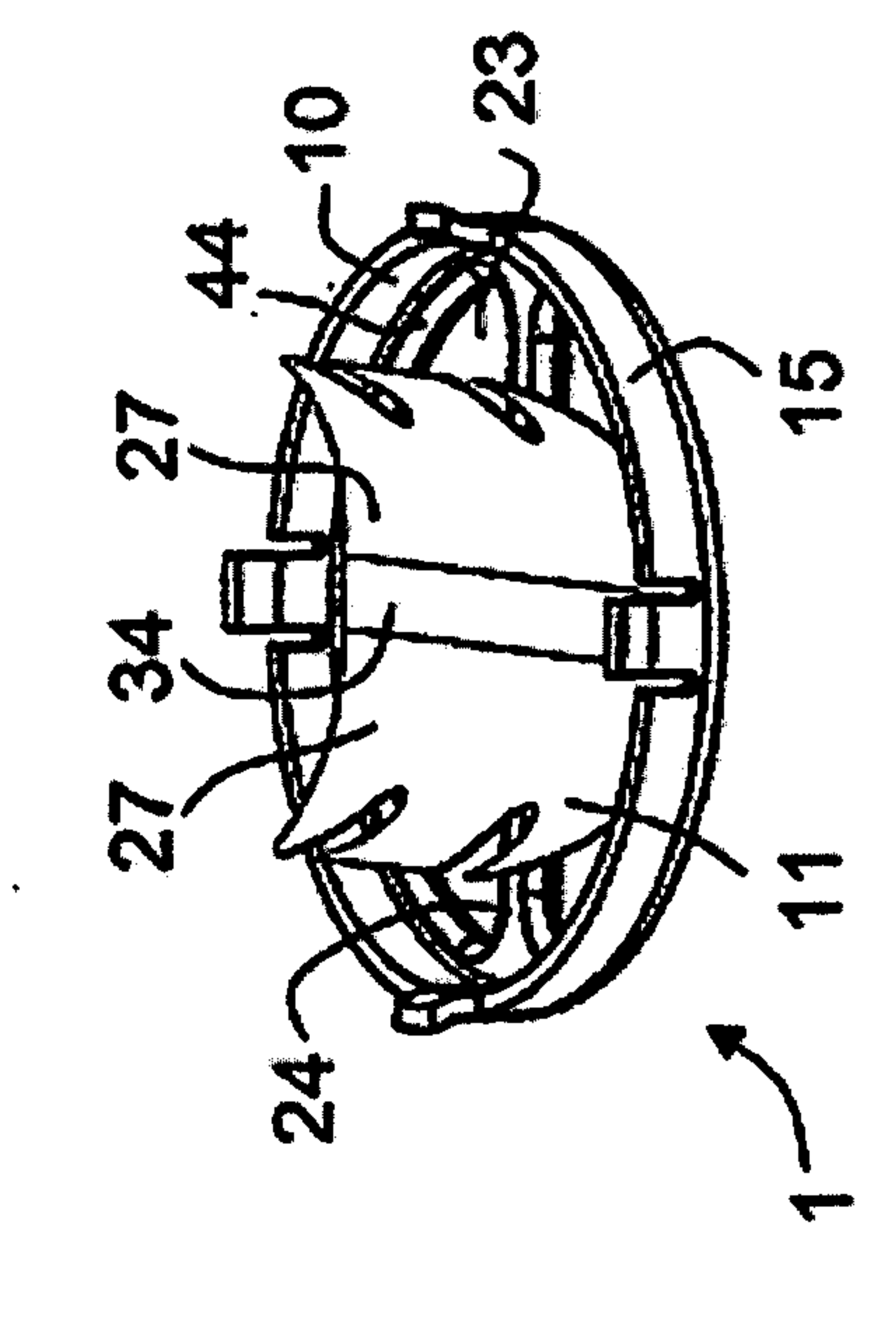

Fig. 9b

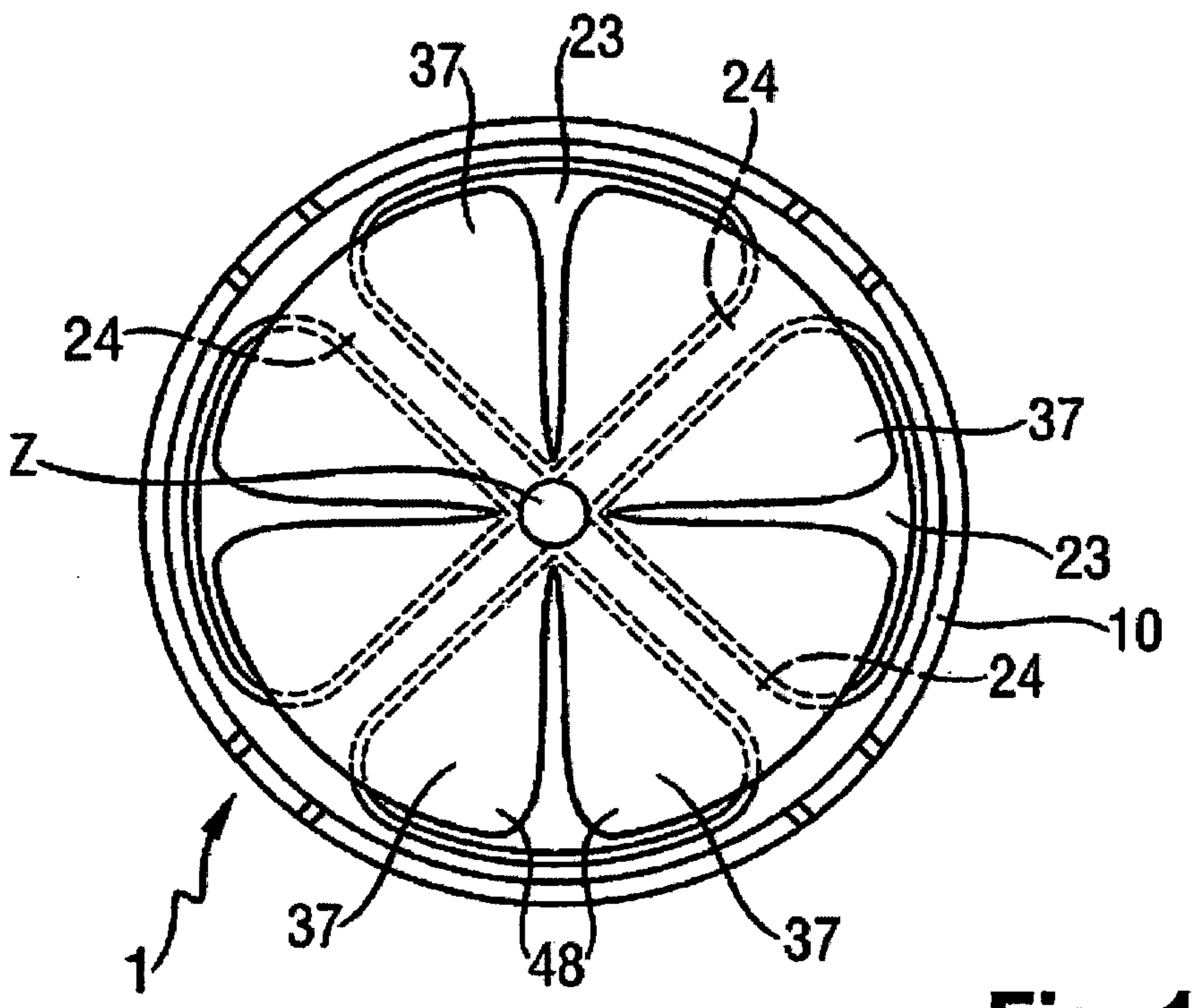

Fig. 10

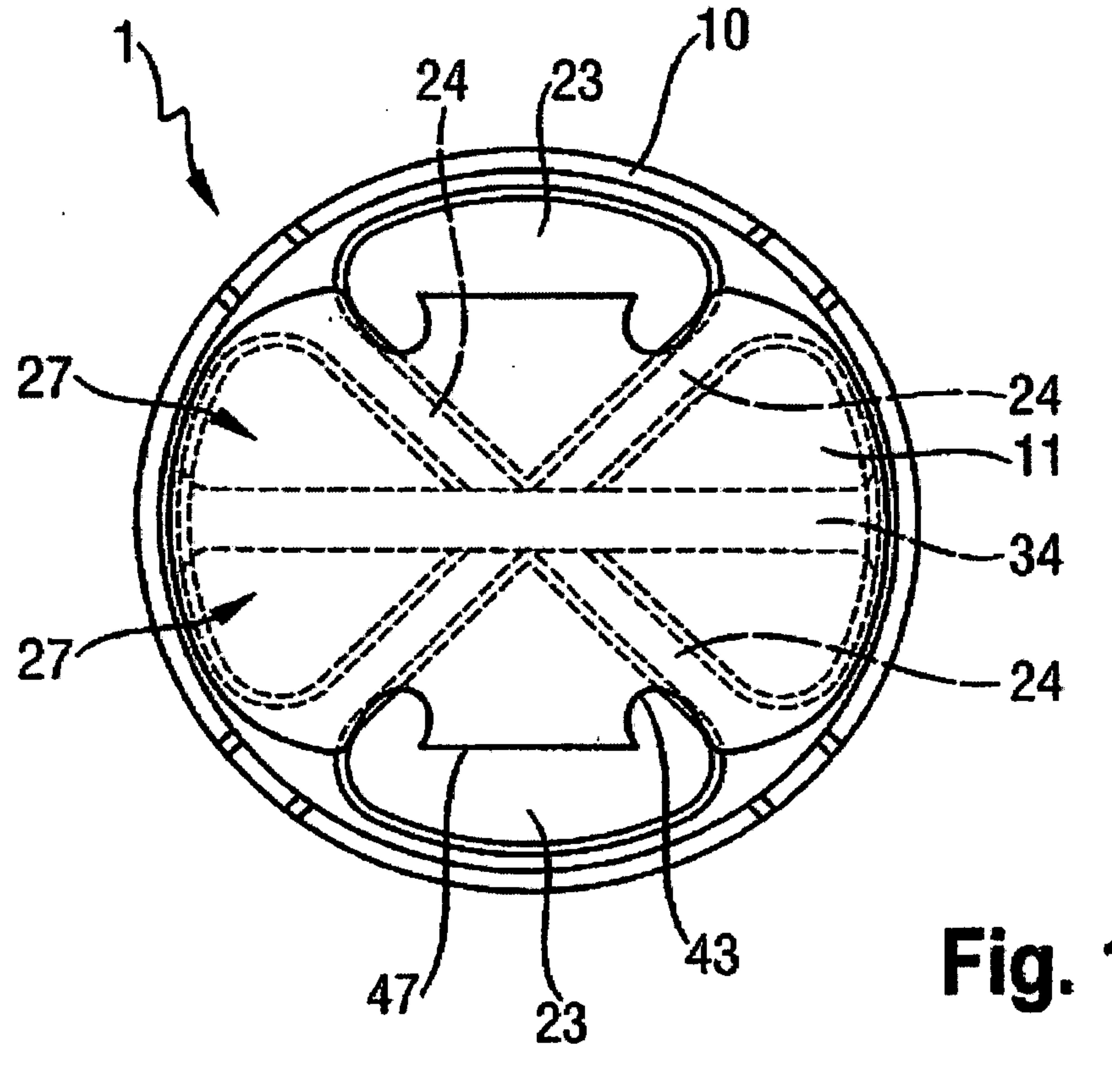

Fig. 11

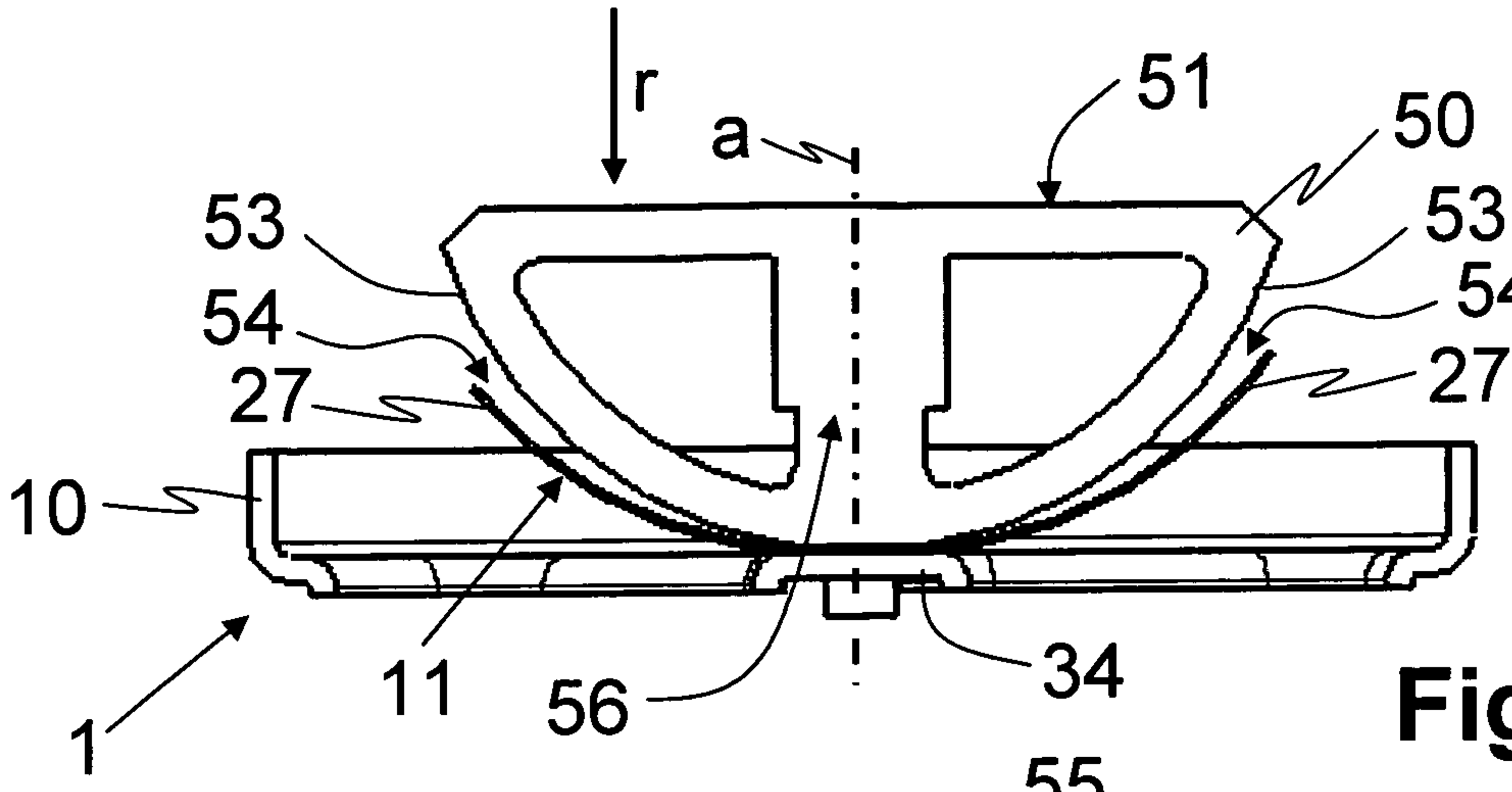

Fig. 12a

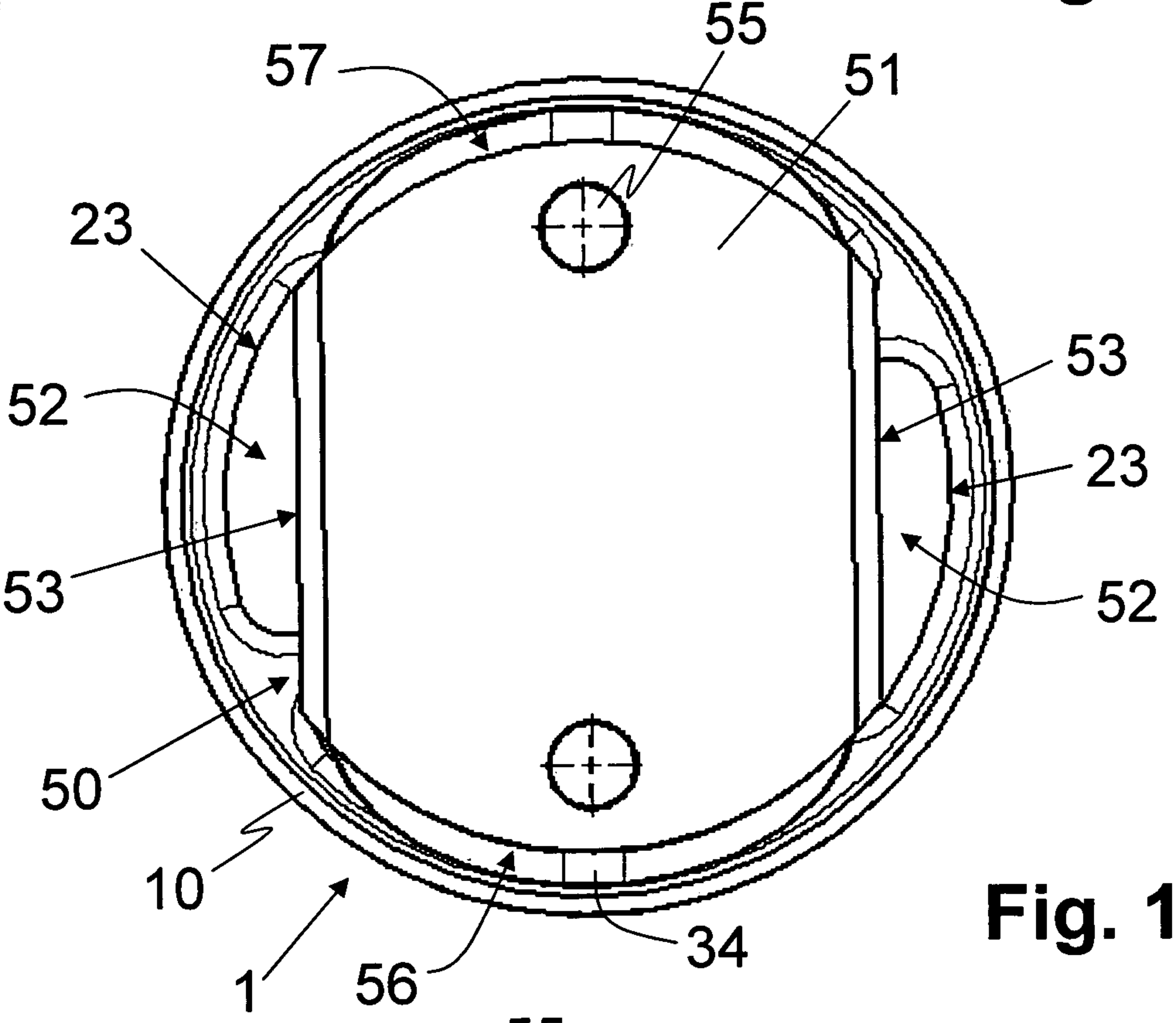

Fig. 12b

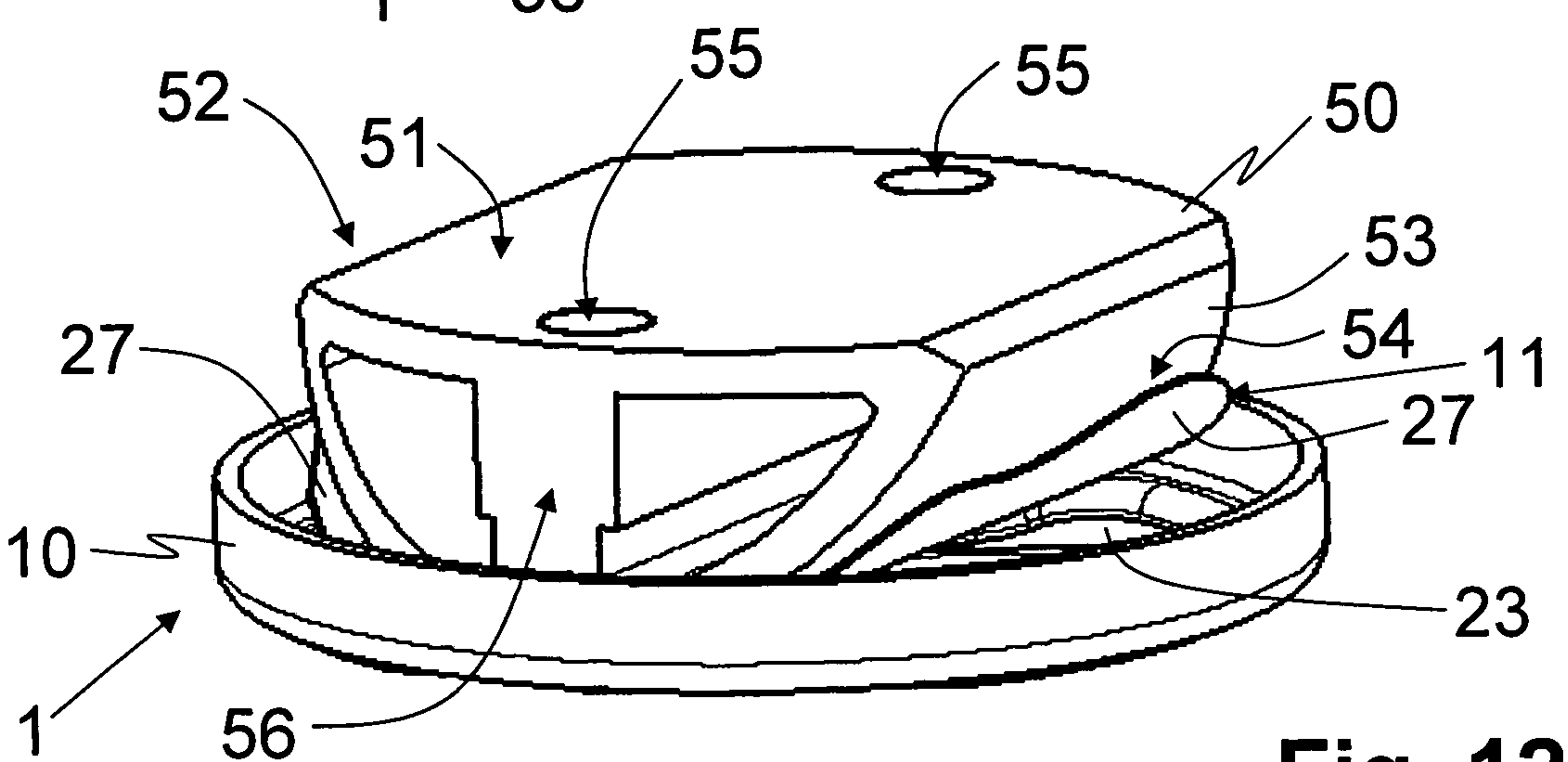

Fig. 12c

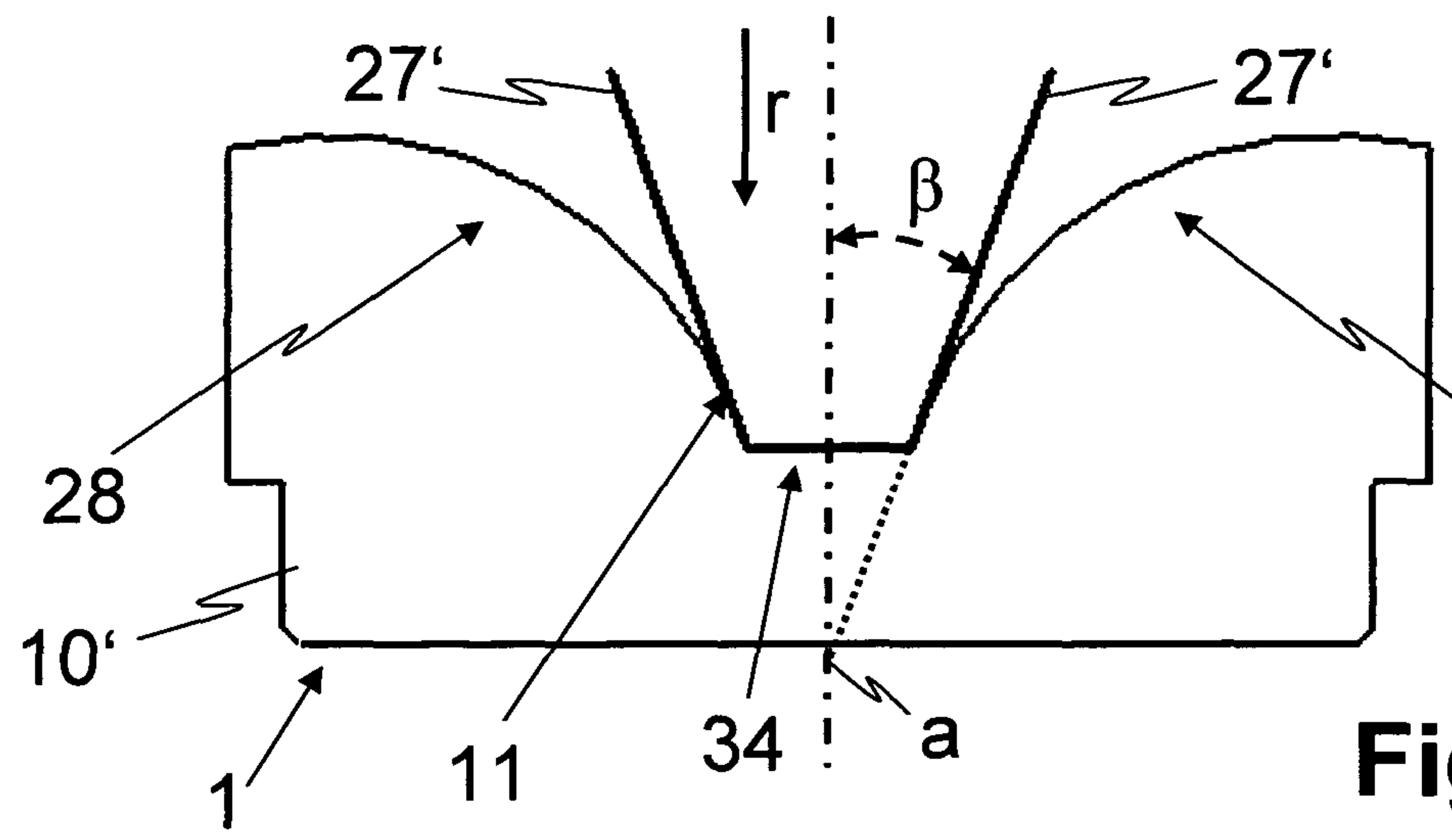

Fig. 13a

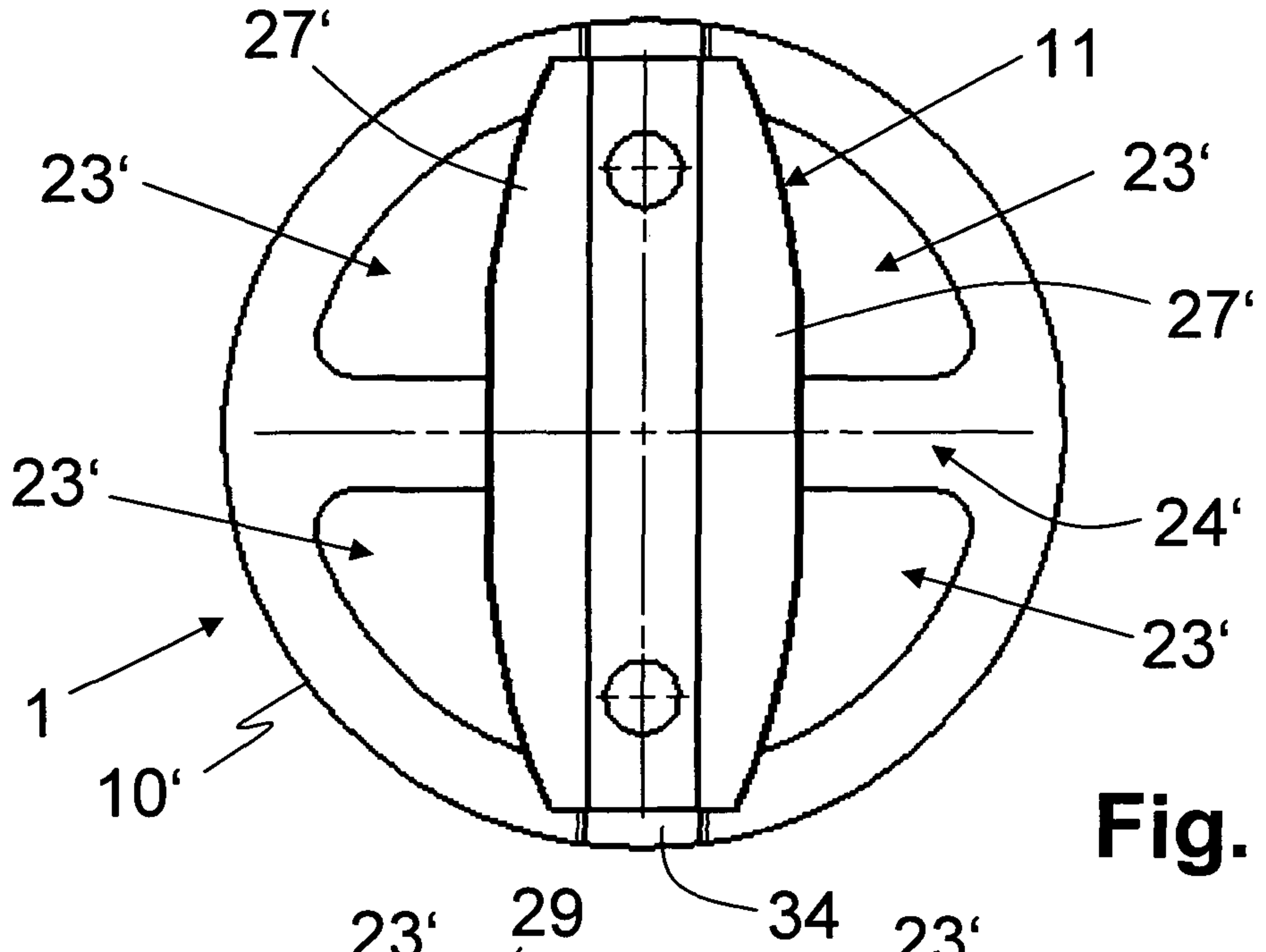

Fig. 13b

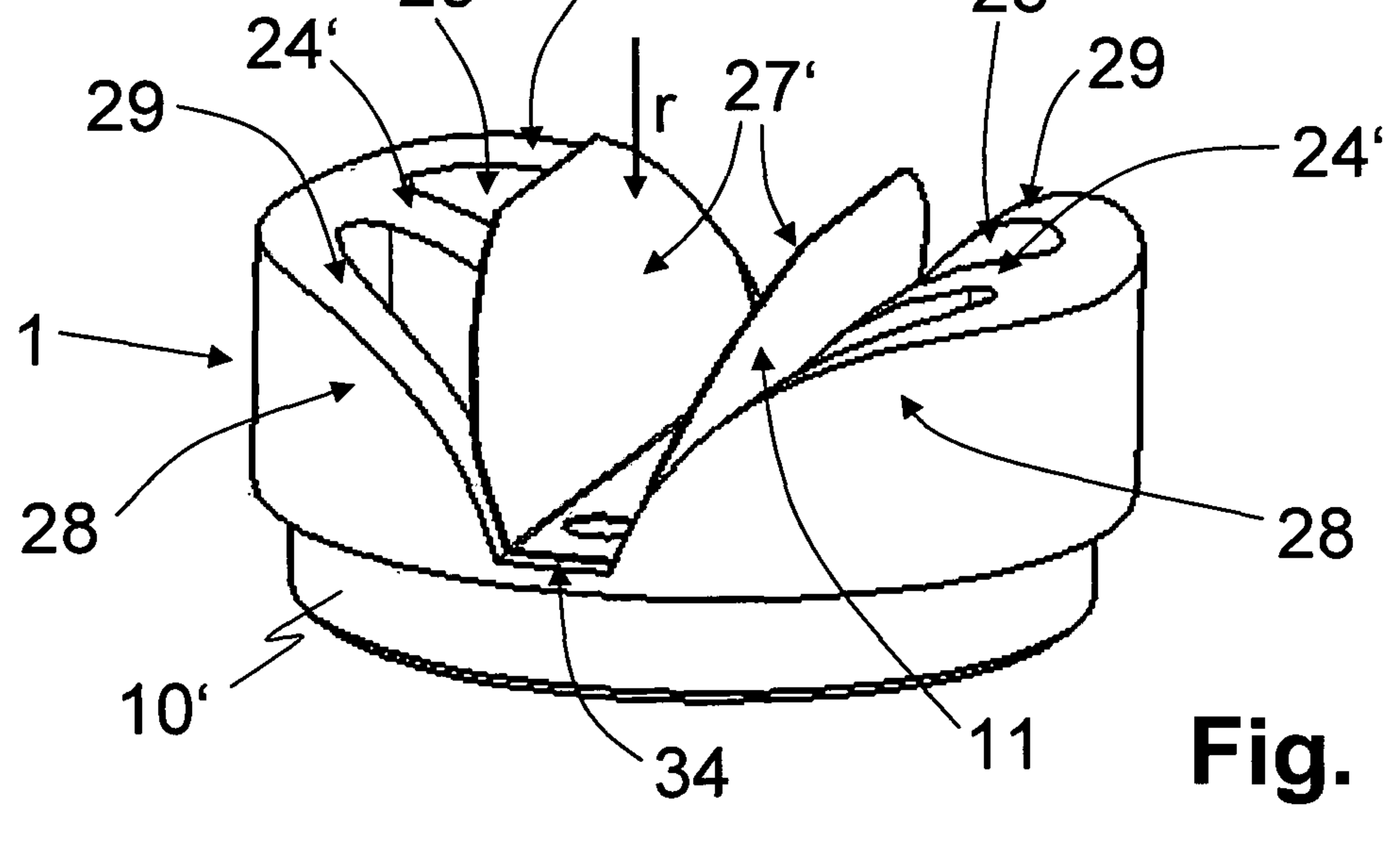

Fig. 13c

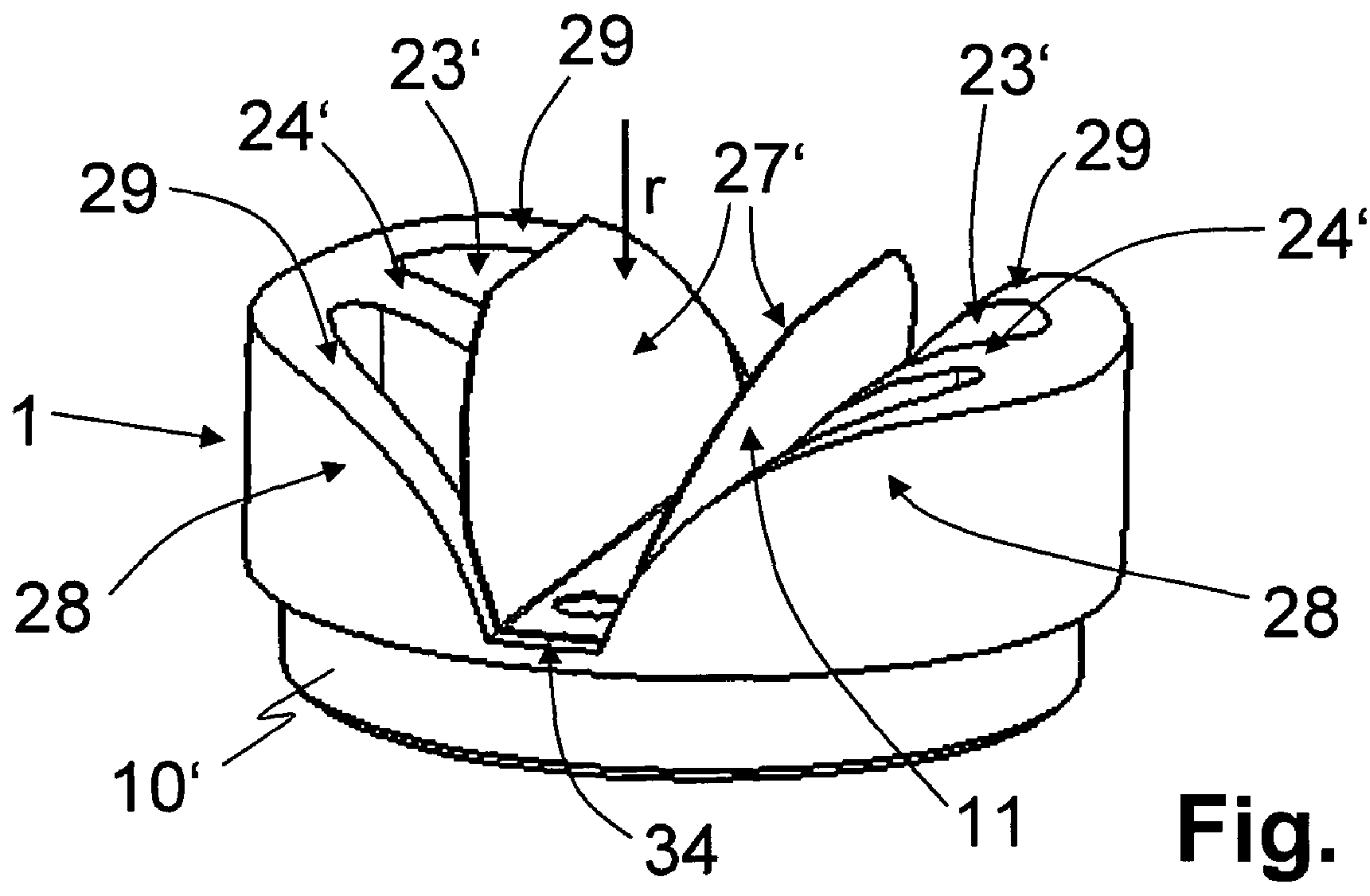

Fig. 13c