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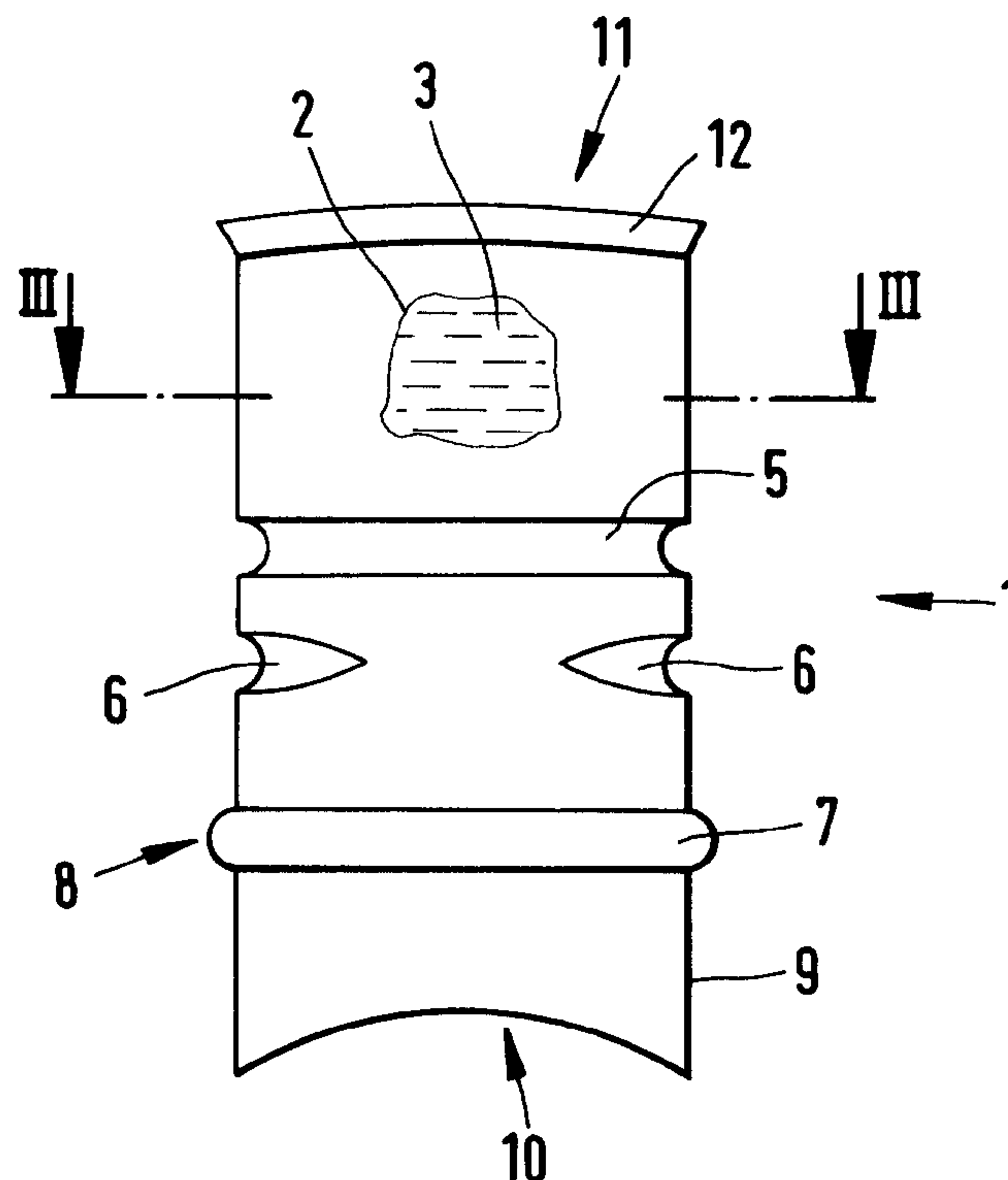
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(54) Titre : RECIPIENT D'UNE INSTALLATION DE SECHAGE PAR UN AGENT D'ADSORPTION

(54) Title: CONTAINER OF A DRYING SYSTEM CONTAINING ADSORPTION MEDIUM



(57) Abrégé/Abstract:

The present invention relates to a drying unit container, which has the advantage of comprising at least one replaceable cartridge (1) containing the adsorbent (3) needed for drying gas. The pressure prevailing between the adsorbent (3) and the cartridge (1) is such that the adsorbent (3) remains static inside the cartridge (1), including when the operating conditions and/or the ambient conditions change. Using a cartridge enables safe and quick replacement of same. Furthermore the invention guarantees a high quality drying of gas, with no additional risk of particulate emissions. Various cartridges, especially cartridges containing many kinds of adsorbents, can be used in a whole range of drying units.

(57) Abstract

The present invention relates to a drying unit container, which has the advantage of comprising at least one replaceable cartridge (1) containing the adsorbent (3) needed for drying gas. The pressure prevailing between the adsorbent (3) and the cartridge (1) is such that the adsorbent (3) remains static inside the cartridge (1), including when the operating conditions and/or the ambient conditions change. Using a cartridge enables safe and quick replacement of same. Furthermore, the invention guarantees a high quality drying of gas, with no additional risk of particulate emissions. Various cartridges, especially cartridges containing many kinds of adsorbents, can be used in a whole range of drying units.

Container of a drying system containing adsorption medium

The present invention relates to a container for a drying system, in which an adsorption medium is provided for a gas to be dried.

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In producing gas pressure, the moisture content of the gas often assumes an important role for downstream gas consumers. Amongst other things, the quality of the gas therefore depends on being able to produce a desired residual moisture content reliably. In order to do this, a known approach in drying systems is to use an adsorption medium, which adsorbs the
10 moisture contained in the gas. The dry proportions of gas pass through the adsorption medium, which might be provided in the form of a granulate, for example. This being the case, suitable adsorption media might be silica gel or silica gels, aluminium oxide, molecular screens, active carbons or others. the drying medium becomes saturated and is then re-generated during a regeneration cycle. After a certain number of adsorption and regeneration
15 cycles, the drying medium becomes so degraded that it has to be changed. A drying system of this type is described along with other driers in a brochure published by "Ultrafilter GmbH", Büssingstraße 1, D-42781 Haan, entitled "Trockene Druckluft. Mit Sicherheit ein reiner Gewinn", brochure reference T997.004.03D 10.95.

20 In order to ensure that the gas contains a defined residual moisture, in particular a maximum residual moisture, one particularly important factor apart from restoring the adsorption capacity of the spent adsorption medium is the manipulation of this adsorption medium in the container of the drying system when a plant is being operated on a continuous basis. The operating personnel of the drying system must be in a position to be able to completely
25 remove adsorption medium which has degraded too far from the container without having to subject the drying plant to prolonged down times.

An objective of this invention is to provide a system which makes it simple but safer to operate and manipulate the adsorption medium used in a container of a drying system, in
30 particular so that the quality of the gas to be dried is guaranteed to be constant for

78899-2

2

downstream consumers.

According to a broad aspect of the present invention, there is provided a container of a drying plant, in which an adsorption medium for a gas to be dried is arranged, having a first and a second cartridge, the adsorption medium for the gas to be dried being disposed in at least one cartridge arranged in the container so that it can be replaced, whereby a pressure prevailing between the adsorption medium and the cartridge is such that the adsorption medium is stationary in the cartridge, and is so specifically even under changing operating and/or environmental conditions, wherein a second cartridge can be stacked on top of a first cartridge in this container, so that there is a guaranteed guided flow from the first to the second cartridge and the connection of the two cartridges to one another and the container is substantially gas-tight, wherein at least a part of the cartridge can be reused after the adsorption medium has been replaced and the first and the second cartridge are at least partially of the same structure, wherein the cartridge has a top rim and/or a bottom rim, which is designed as a seal so that the gas to be dried is applied to the entire cross-section of the adsorption medium of the cartridges without being diverted between the first cartridge and the second cartridge.

According to another broad aspect of the present invention, there is provided a container of a drying plant, in which an adsorption medium for a gas to be dried is arranged, having a first and a second cartridge, the adsorption medium for the gas to be dried being disposed in at least one cartridge arranged in the container so that it can be replaced, whereby a pressure prevailing between the adsorption medium and the cartridge is such that the

78899-2

2a

adsorption medium is stationary in the cartridge, and is so specifically even under changing operating and/or environmental conditions, wherein a second cartridge can be stacked on top of a first cartridge in this container, so
5 that there is a guaranteed guided flow from the first to the second cartridge and the connection of the two cartridges to one another and the container is substantially gas-tight, wherein at least a part of the cartridge can be reused after the adsorption medium has been replaced and the first and
10 the second cartridge are at least partially of the same structure, wherein the cartridge has a top rim and/or a bottom rim, which is designed as a seal so that the gas to be dried is applied to the entire cross-section of the adsorption medium of the cartridges without being diverted
15 between the first cartridge and the second cartridge, the latter having a male-female system for connection at both ends.

According to still another broad aspect of the present invention, there is provided a first cartridge for a
20 container having a second cartridge at least partially of the same construction so that it can be stacked, at least a part of the cartridge being re-usable after an adsorption medium has been replaced, for a container as aforesaid, whereby the cartridge which, can be removably arranged in
25 the container, contains the adsorption medium for the gas to be dried, whereby a pressure prevailing between the adsorption medium and the cartridge is such that the adsorption medium is stationary in the cartridge and is so specifically even under changing operating and/or
30 environmental conditions, wherein the cartridge has a top rim and/or a bottom rim, which is designed as a seal so that a gas to be dried is applied to the entire cross-section of the adsorption medium of the cartridges without being

78899-2

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diverted between the first cartridge and the second cartridge.

According to yet another broad aspect of the present invention, there is provided a method of filling a
5 cartridge as aforesaid with an adsorption medium, wherein an aggregate is used as the adsorption medium, which is subjected to vibrations as it is poured into the cartridge.

According to a further broad aspect of the present invention, there is provided a method of filling a cartridge
10 as aforesaid with an adsorption medium, wherein a pre-tension is applied to the cartridge wall during filling, which will tend to cause a reduction in volume when released.

A container for a drying plant in which an
15 adsorption medium is provided for a gas to be dried has at least one cartridge, which can be removed from the container, the adsorption medium for the gas to be dried being disposed in the cartridge. The pressure prevailing between the adsorption medium and the cartridge is such that
20 the adsorption medium is stationary inside the cartridge. This is particularly the case under varying operating and/or environmental conditions. To this end, the adsorption medium is preferably inserted in the cartridge and fixed therein in such a way that it will remain stationary even
25 under the effect of higher gas flow rates.

If the container is filled directly with the adsorption medium, because it is placed in a rigid arrangement in the drying plant, it can be very awkward to remove the adsorption medium from the container and re-fill
30 it in such a way that all particles of drying medium are laid stationary and do not move against one another causing

78899-2

2c

wear as the gas or air flows through. Filling a cartridge and then fitting the cartridge in the container, means that the adsorption medium can be completely changed with very little manual contact on the one hand and, on the other, because it involves nothing more than a changeover of a single component, the cartridge, very little time will be required. Furthermore, using a cartridge with the adsorption medium placed in it obviates the need for lengthy checks to ascertain whether the adsorption medium has been completely removed from the container - this being difficult in corners, orifices and around seals or similar - which means that the cartridge can also be replaced by inexperienced personnel.

Another advantage of using adsorption medium in the cartridge is the fact that pressure is activated between the two so that the adsorption medium is unable to move in the cartridge.

Due to the fact that the moist gas to be dried flows through the adsorption medium, there can be no friction between particles of the adsorption medium which would otherwise occur, for example with an aggregate. Such friction causes surface wear, causing a fine particulate dust to be formed on the adsorption medium. These very fine particles can get into the gas circuit
5 downstream of the drying system, which is undesirable. Here, the particles are then in a position to cause damage not only to the gas lines but also in the gas consumers. In instances where the adsorption medium has a service life of one or two years in the drying plant, sometimes even longer, for example in heat or cold generating plants, the friction leads to increasing surface wear and hence to a progressively creeping surface loosening of the
10 adsorption medium itself. This is particularly exacerbated due to the fact that flows are fed through the adsorption medium alternately in opposite directions.

Even if the container is filled with adsorption medium in such a way that it is completely full, changing operating and or environmental conditions such as pressure, temperature, gas
15 elements, through-flow direction or similar, lead to a gradual loosening of elements in the adsorption medium. By applying a pressure between the adsorption medium and the cartridge, however, movement and abrasive wear is reduced, even if the cartridge is placed in the container of the drying system over a long service life. Another advantage of fixing the adsorption medium in the cartridge resides in the fact that the through-flow rate of the
20 gas to be dried can be enhanced by the cartridge without causing the adsorption medium to become virtually fluid.

One embodiment of the invention is such that the cartridge is made predominantly from a plastics material. The plastics material is capable of expanding, whether it be in an axial or
25 a radial direction. Similarly to a plastics material, a thin-walled metal material or similar would be suitable. A certain degree of flexing capacity in the cartridge when traction or pressure is exerted thereon enables a pressure state between the adsorption medium and the cartridge to be inherently applied to the unit comprising the two, so to speak. The cartridge can be manufactured in one integral piece, having an opening for filling purposes for
30 example, which will subsequently be closed off. All force-fit and form-fit connection

techniques are suitable for closing the cartridge, for example plastics, bonding, welding, fusion.

One particularly advantageous manner of ensuring sufficient pressure between the adsorption
5 medium and the cartridge is produced as a result of the fact that the cartridge wall can be pre-
tensioned. By capable of being pre-tensioned within the meaning of the invention is meant
that the wall possesses a certain elasticity, which can be used by means of pressure or
traction in such a way that when the tension or pressure causing external forces is released,
a pressure remains permanently between adsorption medium and cartridge. This pre-
10 tensioning is preferably produced using an appropriate design for the cartridge wall. For
example, it will have a bead at least around part of the circumference. If the cartridge wall
is built in sections having varying elasticity coefficients and/or heat expansion coefficients,
the adsorption medium contained therein can also be guaranteed to remain stationary. This
is particularly important when the cartridge is being transported since jolts, vibrations and
15 temperature changes in the range of 10°C and more could easily induce length variations
within the tenth of a millimetre range. The cartridge is pre-tensioned relative to the
adsorption medium in another embodiment of the invention due to the way the cartridge is
arranged in the container in the drying system, for example by securing the cartridge to a
cover belonging to the container, through which the gas to be dried is fed into the cartridge
20 or by attaching it to another component belonging to the container.

In another embodiment of the invention, the pressure between the cartridge wall and the
adsorption medium is produced by means of a pressure-exerting means arranged in the
immediate vicinity of the adsorption medium. The elastic properties of this means, which
25 might be a spring or an elastic material for example, will be such that it is capable of
maintaining a certain minimum pressure, even over a longer period. When inserting the
cartridge or mounting the cartridge in the container, it is of particular advantage if the
pressure-exerting means can be pre-tensed. This will ensure that if the pre-tension is
adequate, there will always be a sufficiently adequate range to the minimum tension needed
30 to fix the adsorption medium in the cartridge as required. The spring or elastic material may

be arranged in the cartridge or in the container. In one very practical embodiment, the interior wall of the cartridge has at least a partial cladding made from an elastic material. When the adsorption medium is inserted in the cartridge, the pressure will then build up automatically. The cladding itself may be a foam or a gas chamber covered with a film, for
5 example.

One particularly advantageous embodiment has an elastic hose in the interior of the cartridge, for example a fitted rubber hose. This can be inserted loosely and then so expanded as it is filled with adsorption medium that a permanent tension builds up in the
10 hose. This makes it possible to work with hoses of very small thicknesses. The hose or other elastic material may also be attached to the wall, by bonding for example.

In order to make more practical use of the interior of the container in the drying system, it is advantageous to mount not just one but several cartridges therein. In this manner, it will
15 be possible to make optimum use of cartridges of differing lengths and/or diameters for the different gases to be cleaned in different drying plants. In order to set up a path for the through-flowing gas, the cartridges can be stacked one on top of the other, for example. This is done in such a way that the flow will be guided from a first cartridge into a second cartridge placed thereon. The structural design will be such that the through-flowing gas is
20 guided in the interior of the cartridge onto the adsorption medium across the entire surface thereof. In order to standardise cartridges for manufacturing purposes as well as for users, it is of advantage if the stacking cartridges are at least partially of the same structure. This will simplify the connection of the first cartridge to the second for flow purposes. Using a male-female system to connect the first and second cartridges will also ensure that the first
25 and second cartridges can not be incorrectly assembled with one another even by inexperienced users or when fitting in designs which can not be overseen or are not visible. Undesired bypass flows of not yet fully dried gas will therefore not be able to occur at the connection point between the first and second cartridges. The solid design of the cartridge cover as a cambered base is a preferred embodiment for a cartridge, where one base is
30 inwardly cambered and the other base is outwardly cambered.

If cartridges are stacked in the container one above the other, this arrangement means that cartridges can be used to contain different fillings. They might contain a different adsorption material or filters. If a water-resistant or moisture-resistant adsorption medium is used in the first cartridge of the cartridges stacked one above the other in the direction in which the gas to be dried is flowing, it will be possible by using an appropriate layout of the drying system to use a medium in the subsequent cartridge on which, for example, water has an unfavourable effect but which nevertheless means that the residual moisture left behind can no longer cause any damage. Consequently, it is also possible to use media which will apply an adsorption or filtering effect to specific elements of the gas.

In another embodiment of the invention, the container is constructed in such a way that it has an opening for letting the gas out of the container which seals off an inserted cartridge under gas pressure by means of one section, in particular an elastic section. This enhances the operating safety of the drying plant. Pressure is prevented from building up in the container, although no adsorption medium is contained therein. If an attempt is made to operate the drying plant with a cartridge inserted but without the cartridge containing any adsorption medium, another embodiment removes the sealing effect between the cartridge and the container provided the adsorption medium has been removed from the cartridge.

Generally speaking, the adsorption medium is switched from adsorption to regeneration operation and vice versa at fixed time intervals, regardless of the actual charge of moisture. An operating mode of the plant adapted to current operating conditions is provided by means for transmitting and/or indicating the status of the adsorption medium, contained in the cartridge and/or the container. Advantageously, the status of the adsorption medium is ascertained by means of a capacitive measurement. Other measuring options, for example a measurement of the level of moisture, chemical action or similar, may also be used in conjunction with the cartridge or the container. The data picked up in this manner can then be transmitted to an appropriate control unit.

One option of transmitting signals relating to the status of the adsorption medium from the cartridge across the container to an appropriate control point of the drying plant consists in connecting the cartridge in an appropriate manner to the container. Furthermore, in order to ensure that the gas is fed into the cartridge correctly, it is of advantage if the cartridge is
5 connected to a cover of the container. This connection can be easily set up and sealed. In addition, this allows one or more cartridges connected to one another to be arranged in the container suspended from the cover. A flow path will be pre-determined from the cover through the cartridges so that, because of the suspended arrangement in the container, at least partially open towards the bottom, the pressure of the gas will also exert a certain effect there
10 too.

In order to connect the cartridge to a part of the container and/or another cartridge, particularly at high pressures, it has a thread or bayonet fitting. When fitted correctly, this closure ensures that correct sealing is provided between the connected parts. In order to
15 prevent bypass flows, which are not desirable inside the container, the cartridge in another embodiment is provided with a top and/or bottom rim, designed as a seal. This may be an elastomer collar which will adapt to different geometries on which the cartridge might be placed or mounted, but may also be a sealing lip or similar sealing means known from the prior art.

20

Other advantages, features and properties of the invention will now be described in more detail with reference to preferred embodiments illustrated in the appended drawings. Additional advantageous embodiments can also be provided by means of practical combinations of features outlined in the illustrations of embodiments of the invention. Of
25 these:

Figure 1 is a cartridge as proposed by the invention,

Figure 2 is a plan view of the cartridge illustrated in Figure 1,

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Figure 3 is a section along the section plane III-III of Figure 1,

Figure 4 is a sketch showing the design principle of a cartridge in a container of a drying plant,

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Figure 5, 6, 7 illustrate respective embodiments of the cartridge of the invention,.

Figure 8 shows on option for a connection between two cartridges,

10 Figure 9 shows several cartridges stacked in a container,

Figure 10 is a sketch showing the principle of how flow is guided inside the cartridges illustrated in Figure 9,

15 Figure 11 shows an orifice provided as a safety vent in a container, closed by means of a cartridge as used for the purposes of the invention,

Figure 12, 13, 14, show various seal designs for a cartridge,

20 Figure 15 shows a cartridge which can be at least partially re-used, having an adsorption medium display for the adsorption medium disposed inside the cartridge,

Figure 16 is another embodiment of the invention for transmitting information pertaining to the status of the adsorption medium,

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Figure 17 is an arrangement of cartridges suspended from a cover of a container of the drying plant, and

Figure 18, 19 are respective sketches of the principle whereby a cartridge is filled with aggregate as an adsorption medium.

30

Figure 1 illustrates an embodiment of a cartridge 1 as proposed by the invention. The internally hollow cartridge contains the adsorption medium 3 illustrated in the cut-out section 2. The cartridge wall 4 has a circumferential groove 5, reinforcing creases 6 around
5 part of the circumference and a circumferential collar 7. These ensure individually and, particularly as illustrated here in conjunction with one another, that the adsorption medium 3 is compressed by appropriate pre-tensioning of the cartridge 1 so that it can not move inside the cartridge 1. For example, in order to apply pressure, the collar 7 may be made from a different material or may be given a different elasticity coefficient as part of the
10 manufacturing process of the cartridge. This will make it possible to determine one or more wall sections 8 of the cartridge 1 which will have a specific capacity for deformation. Collars 7 or similar may lie towards the interior or towards the exterior, depending on what compensating motion is required.

15 The cartridge 1 in the design illustrated in Figure 1 has several other advantages. The cartridge 1 is of a longitudinal cylindrical basic shape 9 with a first 10 and a second 11 end face. Both end faces 10, 11 are cambered, the respective camber being in one direction in this embodiment. This being the case, the cartridge 1 has a male-female system so that cartridges 1 of the same construction can be correctly stacked. This rules out any confusion
20 as to the flow direction through the cartridge 1. In addition, because of the cambered design, the end faces 10, 11 are advantageously able to transmit the pressure acting on them to the cylindrically shaped base body 9. The cartridge 1 is therefore capable of allowing even high pressures between the adsorption medium 3 and the cartridge 1. In order to avoid gas losses if cartridges 1 are stacked one on top of the other, the second end face 11 has a seal 12. This
25 is so designed that a second cartridge 1 can be placed on the first cartridge 1 as illustrated by means of a virtual clip-on action between the oppositely lying end faces 10, 11, sealing off the gas flow between two cartridges 1.

Figure 2 illustrates the cartridge 1 of Figure 1 in a plan view. In addition to the seal 12 and
30 the collar 7, a plurality of orifices 13 is visible. These are so arranged on the second end face

11 that the flow will be applied to the surface of the entire cross-section of the adsorption
medium inside the now clearly cylindrically shaped base body 9. The dimensions of the
orifices 13 are such that the pressure loss on flowing through is only slight on the one hand
and on the other if an aggregate is used as the adsorption medium 3 it can not fall out
5 through the orifices 13. The interior of the cartridge 1 advantageously requires no retaining
filter when completely filled with adsorption medium 3, which means that pressure is
exerted from all interior walls of the cartridge 1.

Figure 3 illustrates a section through the cartridge 1 illustrated in Figure 1. The adsorption
10 medium 3 is so densely packed in the cartridge 1 that it will not be able to move from its
fixed position even when subjected to varying external influences such as pressure surges,
temperature changes or vibrations. In one advantageous embodiment of the cartridge 1, the
material of the cartridge wall 4 is the same as the material of the adsorption medium 3 or is
made from ceramic, preferably ceraminc. Subjected to a change in temperature, the
15 adsorption medium 3 and the cartridge 1 will then exhibit approximately the same expansion
behaviour.

In another embodiment, not illustrated here, the adsorption medium 3 is an inter-bonded or
grouted granulate. This ensures that it will lie absolutely fixed in cartridge 1.
20

Figure 4 illustrates another cartridge 1 as proposed by the invention, which is arranged in a
container 14, only partially illustrated. The cartridge 1 has a first end face 10, which is
arranged in the cylindrically shaped base body 9 so that it can move. When this cartridge 1
is inserted in the container 14, a spring acting as a pressure-exerting means 15 is biased.
25 This causes the end face 10 to apply permanent pressure to the adsorption medium 3. The
spring 15 is preferably designed and mounted on the container 14 so that a basic attachment,
not illustrated in more detail, is formed by the cartridge 1 on the container with a relatively
small amount of force, the ultimate attachment on the container 14 in effect enabling the
spring 15 to exert a pressure that will prevent the adsorption material 3 from becoming fluid
30 even at high flow rates of gas through the cartridge 1. To ensure that adsorption medium 3

can not escape from the cartridge 1 during transport, the cartridge 1 has a projection 16, restricting the path of the end face 10.

Figure 5 also illustrates an embodiment of the cartridge 1 proposed by the invention. This
5 has an external thread 17, a first internal thread 18 and a second internal thread 19. A
cartridge 1 of approximately the same construction is screwed onto the external thread 17
by means of the first internal thread 18 provided here. This provides a particularly robust
connection between two cartridges and the sealing effect of the screw-fit can be reinforced
by appropriate seals under certain circumstances. A first end plate 20 is screwed onto the
10 second internal thread 19, which acts as a thrust bearing for a pressure-exerting means 15,
illustrated here as a spring. A second end plate 21 in turn applies pressure to the adsorption
medium 3. In doing so, it slides at the rim on slide faces 22 which on the one hand keep the
friction resistance low and on the other produce an adequate sealing effect in conjunction
with the second end plate 21.

15

The system comprising first end plate 20, pressure-exerting means 15, second end plate 21
and oppositely lying third end plate 23 allows the pressure acting on the adsorption medium
3 to be varied by adjusting the first end plate 20. In particular, this allows a cartridge 1 to be
used for various adsorption media 3. The first intermediate wall 20 can be adjusted
20 depending on the pressure required between the adsorption medium 3 and the cartridge wall
4. The principle illustrated here as well as the idea of adjusting the pressure forces of the
pressure-exerting means 15 can also be applied with other embodiments proposed by the
invention. The cartridge 1 illustrated also has a conical shape, which means that a cartridge
1 of this type can also be used as the end cartridge in a stack. This facilitates connection to
25 the container, not illustrated in more detail, due to the conical guiding action.

Figure 6 illustrates another embodiment of a cartridge 1 in cross-section. The adsorption
medium 3 is disposed in the interior of the cartridge 1 under pressure. This pressure is caused
by an elastic material 24, cladding at least a part of the interior of the cartridge 1. When this
30 cartridge 1 is filled, the elastic material 24, which may be rubber for example, is compressed,

the adsorption medium inserted and the cartridge 1 sealed under pressure so that when the cartridge is then taken out of the pressurised environment a ratio of forces needed as a means of fixing the adsorption medium 3 remains. In one advantageous embodiment, the elastic material 24 has filling compartments which are filled with gas. When high pressure is applied, these cavities are squashed together making a larger interior available for filling in the cartridge 1. Another variant of this type of embodiment has an elastic film, which forms a sealed gas bubble in the interior of the cartridge 1.

Figure 7 illustrates another optional design for a pressure-exerting means 15 in a cartridge 1. In this case, a foam structure 15 is provided, which, because of its elasticity, is capable of applying the requisite pressure to the adsorption medium 3, even over a longer service life. In order to ensure the flow of gas through the cartridge 1, the foam structure 15 has continuous flow passages at the first end face 10 and the second end face 11 which are so fine, depending on the manufacturing method and material used for this foam 15, that an aggregate used as an adsorption medium 3 will not be able to fall through them or clog them.

Figure 8 illustrates a solution which ensures that cartridges 1 stacked one on top of the other have a flow-tight connection to one another. A second cartridge 26 is placed on a first cartridge 25. The positioning of the two is made easier by an inclined guide 27 on the first cartridge 25. A bayonet fitting 28 is closed by turning whilst simultaneously applying pressure. This offers an advantage in that the first 25 and the second 26 cartridge can be connected to one another by exerting mutual pressure. Extra support can be provided by inserting an appropriate seal, not illustrated in more detail, between two cartridges 25, 26 or even by crimping the latter. In addition to the bayonet fitting 28, other similar solutions may be used as a means of connecting several cartridges, whereby a turning of the first cartridge 25 relative to the second cartridge 26 will produce a pressure-fit.

Figure 9 depicts a stack of three cartridges 1, each of which has a seal 12. This stack 29 is inserted in the direction of the arrow indicated in the section of the container 14 illustrated. The free first end face 10 and second end face 11 each form the respective gas inlet and gas

outlet, depending on the flow direction of the gas. No gas can flow out between the cartridges 1. With the design of stack 29 in the container 14 illustrated here, the second end face 11 is placed on a coupling 30 with a matching form-fit arrangement. The coupling 30 has gas orifices, not illustrated in more detail, through which the gas can get into the stack 29 above. A gas-tight seal between this coupling 30 and the second end face 11 is provided by a circumferential seal 31 mounted on the container 14. The sealing effect is assisted by force of gravity due to the fact that the stack 29 is supported on the base of the container 14 if no bearing structure is provided for the first end face 10 on the container 14, to which the stack 29 is also connected. It is particularly practical if the stack is at least partially open towards the top so that the pressure of the gas is in the container 14 and only the container wall will be required to have a design suitable as a pressure container.

Figure 10 illustrates the main flow guide between a first cartridge 25 and a second cartridge 26. The gas, indicated by the arrows, is fed as far as possible without any diversions between the two cartridges 25, 26 but is uniformly applied to each cross-section of adsorption medium contained in the cartridges 25, 26. In order to promote as favourable a flow as possible in a cartridge, the cartridge has, depending on how it is constructed, an appropriate gas distributor device 32, as indicated by broken lines inside the cartridge 25. The gas distributor device 32 may consist of a cavity 34 and an internally mounted plate 33 with orifices 13 arranged in a shower-head pattern. A gas distributor device 32 of this construction ensures that the gas to be dried flows not only at the centre but also at the periphery of the cartridge 25.

Figure 11 depicts a safety vent 35 in the container 14, the cartridge 1 arranged in the container 14 having an elastic circumferential collar 7. When pressure is applied to the cartridge 1 by the gas to be dried, as indicated by the arrows, the collar 7 is pushed to the exterior of the cartridge 1. This closes off the safety vent 35. The purpose of this is to prevent operation of the drying plant if a cartridge 1 is not inserted, since the gas would otherwise flow out from the container 14. The collar 7 advantageously runs around the circumference so that on the one hand there is no need for accurate positioning of the

cartridge 1 at a particular section of the container 14. If the collar 7 is arranged at the centre of the cartridge 1 exactly matching the positioning of the safety vent 35 in the container 14, it will also be possible to rotate the cartridge 1 by 180° without use of this safety device being lost. Naturally, another section of the cartridge 1 may also be used for sealing
5 purposes. In another embodiment, the cartridge 1 is screwed onto the container 14 so that one or more matching safety vents can be sealed off by the screw fitting. In another embodiment, the cartridge 1 has at least one bellows-type section, which preferably has a different elastic capacity from the sections of the cartridge 1 which are not of a bellows design. At least one of these bellows can be used to produce the same effect as that obtained
10 by the circumferential collar 7.

Figure 12, Figure 13 and figure 14 illustrate embodiments of seals 12 located on the top and/or bottom rim of a cartridge 1. In Figure 12, the bottom rim 36 illustrated has an elastomer seal 37, which, because of its bead-type design is compressed when the cartridge
15 1 is placed on another cartridge or on a base, thereby producing a gas-sealing action. The seals 12 illustrated on the bottom rim of each cartridge 1 in Figure 13 and Figure 14 are an integral part of the cartridge 1 and made from the same material. Depending on the manufacturing method used, these seals 12, in spite of being made from the same material as the rest of the walls of the cartridge 1, may be given different elastic properties. In the
20 case of plastics, this could be controlled by applying appropriate temperatures or using additives, for example. Whilst the seal depicted in Figure 13 is particularly preferred for seating cartridges 1, the seal illustrated in Figure 14 in the form of a sealing lip is specifically used for connecting cartridges, illustrated by a broken line.

25 Figure 15 illustrates a cartridge 1 that is at least partially recyclable, having a display 38 for the status of the adsorption medium. The display 38 can be arranged in the container 14 by inserting the cartridge 1 in such a way that the display 38 can be observed through a circumferential viewing window 39 from the exterior of the container 14. The operator of the drying plant will therefore be able to see the status of the adsorption medium in the
30 cartridge 1 without the need for any complex means. In one advantageous embodiment in

which cartridges are stacked one on top of the other, a display of this type will be needed for one cartridge 1 only. From the status of this cartridge 1, it will be possible to ascertain the overall status of the stack. In this manner, it will be possible to decide when a stack of cartridges 1, not illustrated here, needs to be regenerated. The display option is provided by
5 a change in colour on the display 38 caused by a chemical reaction due to the moisture adsorption. The illustrated cartridge 1 is constructed in such a way that it has a predetermined seam 40. The seam 40 is a predetermined fracture at which the cartridge 1 can be opened, i.e. partially broken. Consequently, the part of the cartridge 1 with the display 38 can be re-used whilst the other part can be replaced under certain circumstances. As a result,
10 the adsorption medium in the cartridge 1 can be replaced if it can no longer be regenerated. It is of particular advantage if the adsorption medium can not be removed from the cartridge 1 unless the latter is broken. This will ensure that there can be no mishandling of already spent or no longer full cartridges 1. In a variant of the recycling principle, the cartridge 1 has a removable part, which can be replaced without the cartridge 1 having to be broken. This
15 can be done by means of a screw thread, for example.

Figure 16 depicts a cartridge 1 in a container 14 fitted with a first 41 and a second 42 electric conductor. These are used to take a capacitive measurement of the status of the adsorption medium. The respective status of the adsorption medium 3 in the cartridge 1 can then be
20 ascertained by comparing the relative curves. This is preferably done automatically, the electric conductors 41, 42 being connected via a first 43 and a second 44 contact on the interior wall of the container to a control unit, not illustrated in more detail. Another possibility for measuring the status of the adsorption medium consists in checking the actual flow of gas for moisture content. An appropriate means can be arranged in the container 14
25 for this purpose, for example a flow passage.

Figure 17 illustrates a stack 29 which is connected to the cover 46 of the container 14 by means of a thread 45. A gas line 47 is arranged in the cover 46, fitted with an inlet and outlet for the gas from the container 14. The stack 29 is suspended in the interior of the container
30 14. This means that the stack 29 can be removed from the container 14 simultaneously with

the cover 46. This means that no problems can occur due to seals becoming too tight under certain circumstances, which necessarily arise with a fixture to the base of the container 14. The container 14 and the stack 29 are sealed in such a way that the gas can only flow into and out of the container 14 through the gas line 47 and the base line 48. Bypass flows from the stack 29 are prevented by means of seals 12 between the cartridges 1. In another embodiment, not illustrated in more detail, the cover 46, provided with a matching guide and seal, is placed on top of the stack 29. The seal is positioned in such a manner that it provides a seal as it is compressed by means of the guide and the stack 29. The forces occurring as a result can be so high that a structure of this type is able to retain the stack 29 still freely depending from the cover 46. Otherwise, the stack 29 can be seated on a matching projection on the container base in such a way that pressure will be transmitted from the gas into the container 14. A preferred embodiment of a cartridge also provides a good attachment to a cover 46 of the container 14. A cartridge of this type has a seal on the external rim at the top and/or bottom and a thread and a threaded pin at the centre of the end face, for example. Accordingly, two cartridges can also be connected to one another by turning them relative to one another.

Figure 18 illustrates a method of filling a cartridge 1, whereby the cartridge is braced on a device 49. The device 49 has a cylinder system 50, by means of which it can be vibrated on a clamping table 51 attached thereto, indicated by the arrow. The adsorption medium 3 is then poured into the cartridge 1 and is distributed extremely evenly inside the cartridge 1 due to the vibratory action. As the cartridge wall 4 is simultaneously pre-tensioned, for example by tensioning means not illustrated, once the cartridge 1 is closed, a permanent pressure is produced between the adsorption medium 3 contained in the cartridge 1 and the cartridge wall 4.

Figure 19 illustrates a second method of filling a cartridge 1. The adsorption medium 3 is poured in under the action of a pressure p_2 prevailing in the interior of the cartridge 1 whilst a pressure p_1 prevails at the external wall of the cartridge 1. Since the pressure p_2 is greater than the pressure p_1 , the cartridge wall 4 widens. Consequently, it is possible to pour in more

adsorption medium 3 than would be the case if a pressure p_1 were acting in the interior of the cartridge 1. Once completely filled, the cartridge 1 is closed so that a permanent tension prevails in the cartridge walls 4. This ensures that the adsorption medium 3 is not able to work loose or to move. This filling method illustrates one possible way in which the
5 cartridge wall 4 can be pre-tensed, tending to cause a reduction in volume in the cartridge 1 when released.

The present invention provides an advantageous arrangement of the adsorption medium in the container of a drying plant. Using a cartridge enables the adsorption medium to be
10 changed rapidly and safely on site. In addition, the invention ensures a high quality of gas drying, in particular without the added risk of the particles coming loose. Different cartridges can also be used for different adsorption media and can therefore be optimised to suit the most varied of drying plants.

List of reference numerals

	1	Cartridge
	2	Cut-out portion
5	3	Adsorption medium
	4	Cartridge wall
	5	Circumferential groove
	6	Partial circumferential reinforcing crease
	7	Circumferential collar
10	8	Wall section
	9	Cylindrically shaped base body
	10	First end face
	11	Second end face
	12	Seal
15	13	Orifice
	14	Container
	15	Pressure-exerting means, spring, elastic material
	16	Projection
	17	External thread
20	18	First internal thread
	19	Second internal thread
	20	First end plate
	21	Second end plate
	22	Slide face
25	23	Third end plate
	24	Elastic material
	25	First cartridge
	26	Second cartridge
	27	Inclined guide
30	28	Bayonet closure

	29	Stack
	30	Coupling
	31	Circumferential seal on the container
	32	Gas distributor device
5	33	Internal plate
	34	Cavity
	35	Safety vent
	36	Bottom rim
	37	Elastomer seal
10	38	Display of the adsorption medium status
	39	Circumferential viewing window
	40	Seam
	41	First electric conductor
	42	Second electric conductor
15	43	First contact
	44	Second contact
	45	Thread
	46	Cover
	47	Gas line
20	48	Base line
	49	Device
	50	Cylinder system
	51	Clamping table

78899-2

20

CLAIMS:

1. A container of a drying plant, in which an adsorption medium for a gas to be dried is arranged, having a first and a second cartridge, the adsorption medium for the gas to be dried being disposed in at least one cartridge arranged in the container so that it can be replaced, whereby a pressure prevailing between the adsorption medium and the cartridge is such that the adsorption medium is stationary in the cartridge, and is so specifically even under changing operating and/or environmental conditions, wherein a second cartridge can be stacked on top of a first cartridge in this container, so that there is a guaranteed guided flow from the first to the second cartridge and the connection of the two cartridges to one another and the container is substantially gas-tight, wherein at least a part of the cartridge can be reused after the adsorption medium has been replaced and the first and the second cartridge are at least partially of the same structure, wherein the cartridge has a top rim and/or a bottom rim, which is designed as a seal so that the gas to be dried is applied to the entire cross-section of the adsorption medium of the cartridges without being diverted between the first cartridge and the second cartridge.

2. A container of a drying plant, in which an adsorption medium for a gas to be dried is arranged, having a first and a second cartridge, the adsorption medium for the gas to be dried being disposed in at least one cartridge arranged in the container so that it can be replaced, whereby a pressure prevailing between the adsorption medium and the cartridge is such that the adsorption medium is stationary in the cartridge, and is so specifically even under changing operating and/or environmental conditions,

78899-2

21

wherein a second cartridge can be stacked on top of a first cartridge in this container, so that there is a guaranteed guided flow from the first to the second cartridge and the connection of the two cartridges to one another and the container is substantially gas-tight, wherein at least a part of the cartridge can be reused after the adsorption medium has been replaced and the first and the second cartridge are at least partially of the same structure, wherein the cartridge has a top rim and/or a bottom rim, which is designed as a seal so that the gas to be dried is applied to the entire cross-section of the adsorption medium of the cartridges without being diverted between the first cartridge and the second cartridge, the latter having a male-female system for connection at both ends.

3. The container as claimed in claim 1 or 2, wherein the cartridge is predominantly made of a plastics material.

4. The container as claimed in claim 1 or 2, wherein the cartridge is at least partially made from the same material as the adsorption medium.

5. The container as claimed in claim 1 or 2 wherein the cartridge is at least partially made from ceramic and the adsorption medium made from ceramic.

6. The container as claimed in any one of claims 1 to 5, wherein the cartridge wall can be pre-tensioned, the cartridge wall having at least a partially circumferential crease and/or different wall sections having different coefficients of elasticity and/or heat expansion coefficients.

7. The container as claimed in any one of claims 1 to 5 wherein the cartridge wall can be pre-tensioned.

78899-2

22

8. The container as claimed in any one of claims 1 to 7, wherein a pressure-exerting means, which in particular can be pre-tensed, is arranged in the immediate vicinity of the adsorption medium.

5 9. The container as claimed in any one of claims 1 to 7 wherein a pressure-exerting means, which in particular can be pre-tensed, is arranged in the immediate vicinity of the adsorption medium, and is comprised of a spring or an elastic material.

10 10. The container as claimed in claim 8 or 9, wherein the interior of the cartridge is at least partially clad with an elastic material.

11. The container as claimed in claim 8 or 9, wherein the interior of the cartridge is at least partially fitted
15 with an elastic hose.

12. The container as claimed in any one of claims 1 to 11, wherein the container has a vent for letting the gas out from the container, which seals off the inserted cartridge with one section, in particular an elastic
20 section.

13. The container as claimed in any one of claims 1 to 12, wherein the cartridge and/or the container has means for transmitting and/or displaying the status of the adsorption medium.

25 14. The container as claimed in claim 13, wherein the cartridge and/or the container has means for taking a capacitive measurement of the adsorption medium status.

15. The container as claimed in any one of claims 1 to 14, having several cartridges stacked one above the

78899-2

23

other, wherein the adsorption medium of at least two cartridges differs.

16. The container as claimed in claim 15, wherein in the direction in which the gas to be dried flows through the
5 cartridges, the first cartridge contains a water-resistant adsorption medium.

17. The container as claimed in any one of claims 1 to 16, wherein it has a cover, which can be connected to a cartridge in such a way that a gas delivery into the
10 cartridge is ensured and the cartridge is suspended in the container.

18. The container as claimed in any one of claims 1 to 17, wherein at least two cartridges together are sealed from the container on one line only.

15 19. The container as claimed in claim 18, wherein the seal is in the vicinity of the opening of the gas line and/or base line.

20. A first cartridge for a container having a second cartridge at least partially of the same construction so
20 that it can be stacked, at least a part of the cartridge being re-usable after an adsorption medium has been replaced, for a container as claimed in any one of claims 1 to 19, whereby the cartridge, which can be removably arranged in the container, contains the adsorption medium
25 for the gas to be dried, whereby a pressure prevailing between the adsorption medium and the cartridge is such that the adsorption medium is stationary in the cartridge and is so specifically even under changing operating and/or environmental conditions, wherein the cartridge has a top
30 rim and/or a bottom rim, which is designed as a seal so that

78899-2

24

a gas to be dried is applied to the entire cross-section of the adsorption medium of the cartridges without being diverted between the first cartridge and the second cartridge.

5 21. The cartridge as claimed in claim 20 wherein the cartridge has a thread or bayonet closure to provide a connection with a part of the container and/or another cartridge.

22. The cartridge as claimed in claim 20 or 21 wherein
10 the first and the second cartridge have a male-female system for connection at both ends.

23. The cartridge as claimed in any one of claims 20 to 22 wherein the cartridge can only be opened by partly breaking it, a specific point being provided for this
15 purpose.

24. The cartridge as claimed in any one of claims 20 to 23 which can be filled with an adsorption medium.

25. A method of filling a cartridge as claimed in any one of claims 20 to 24 with an adsorption medium, wherein an
20 aggregate is used as the adsorption medium, which is subjected to vibrations as it is poured into the cartridge.

26. A method of filling a cartridge as claimed in any one of claims 20 to 24 with an adsorption medium, wherein a pre-tension is applied to the cartridge wall during filling,
25 which will tend to cause a reduction in volume when released.

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PATENT AGENTS

1/8

FIG. 1

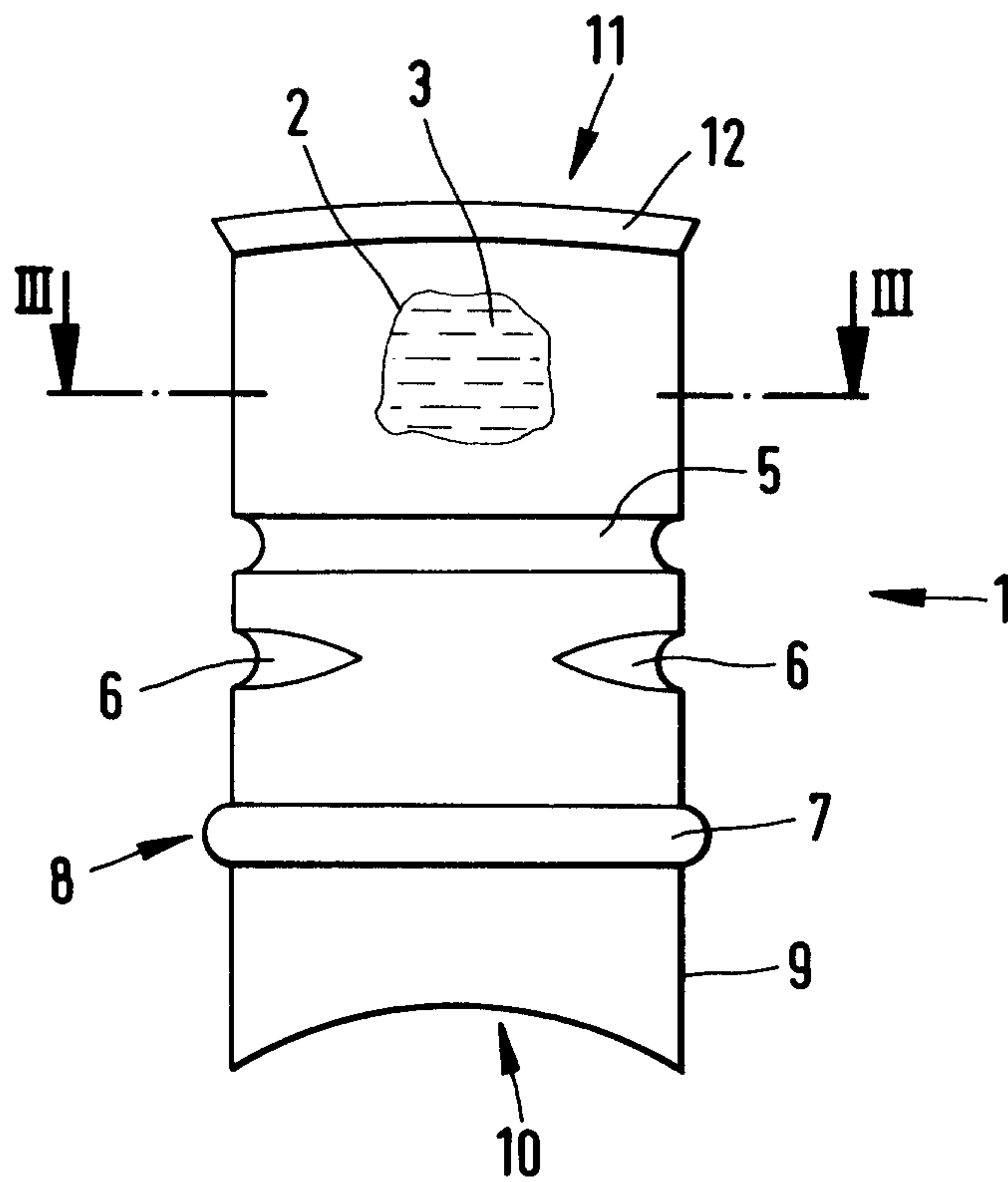


FIG. 2

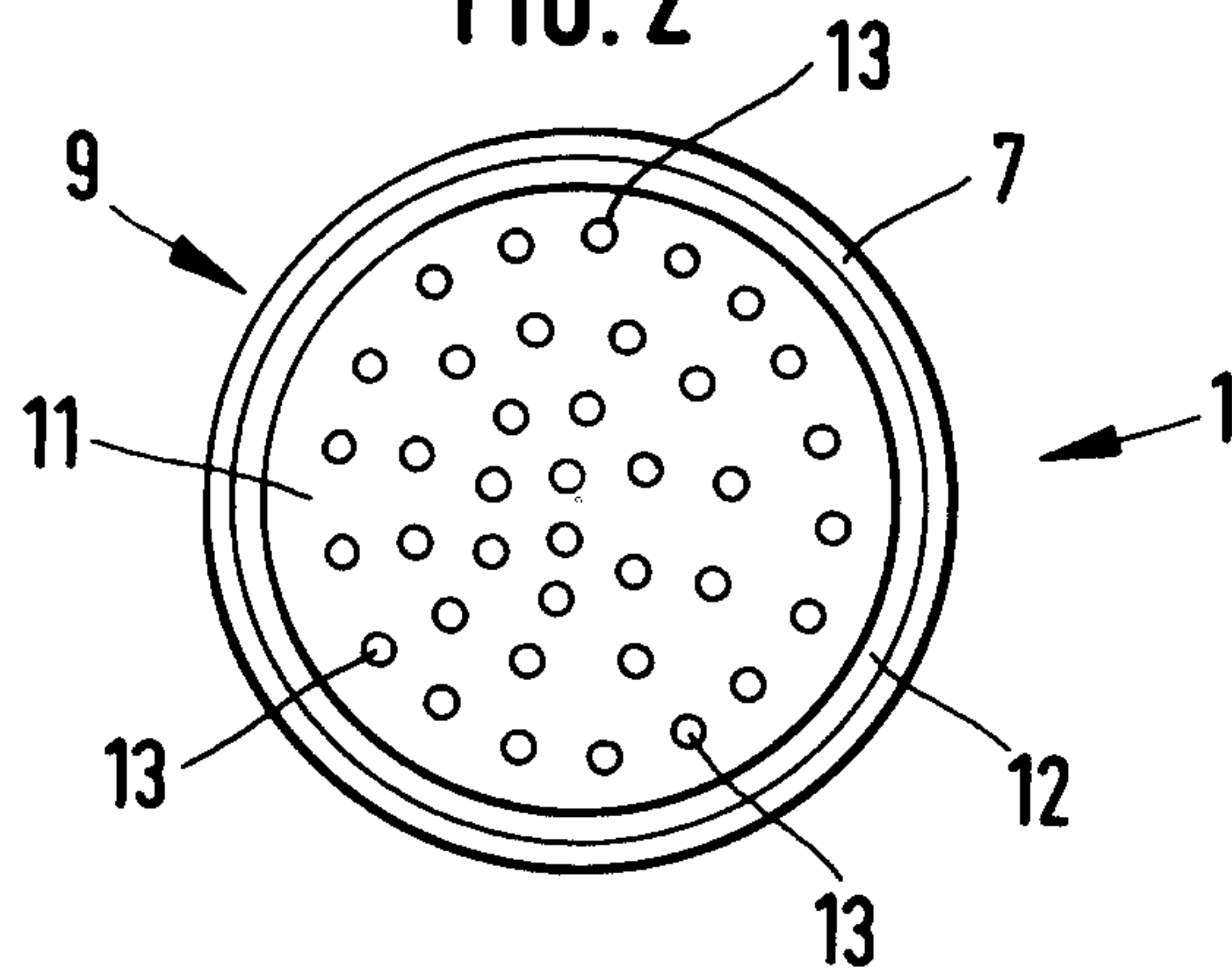
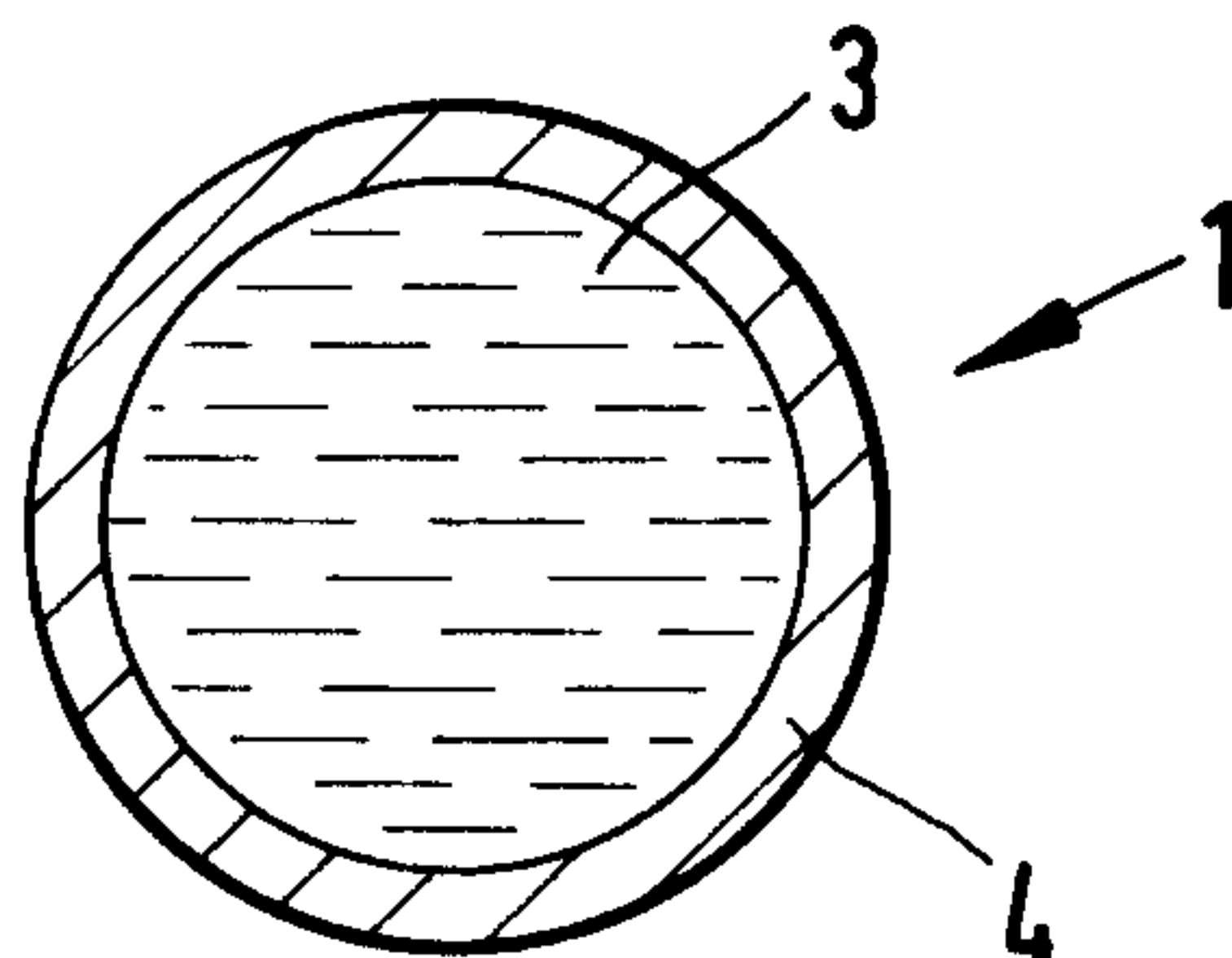


FIG. 3



2/8

FIG. 4

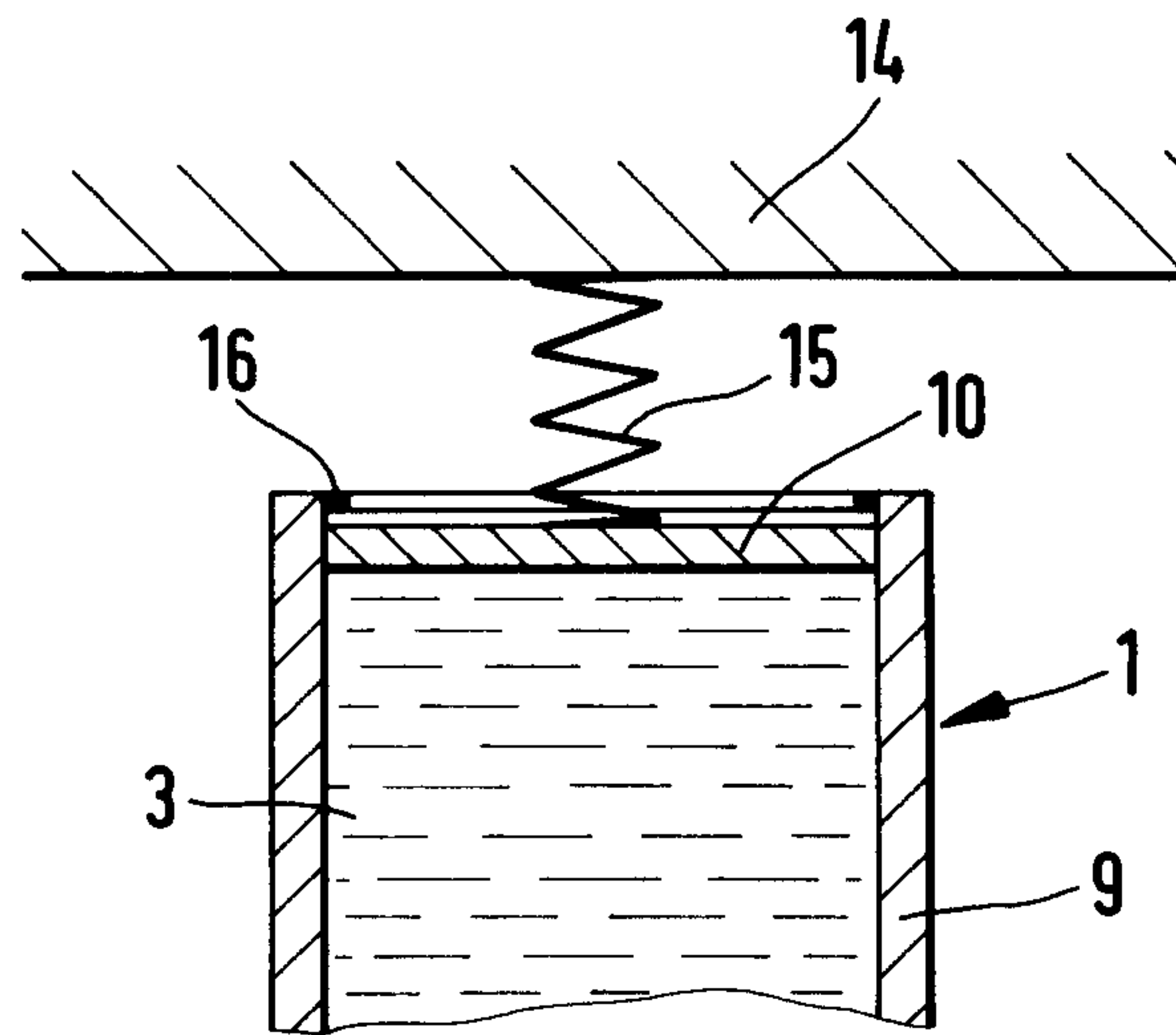
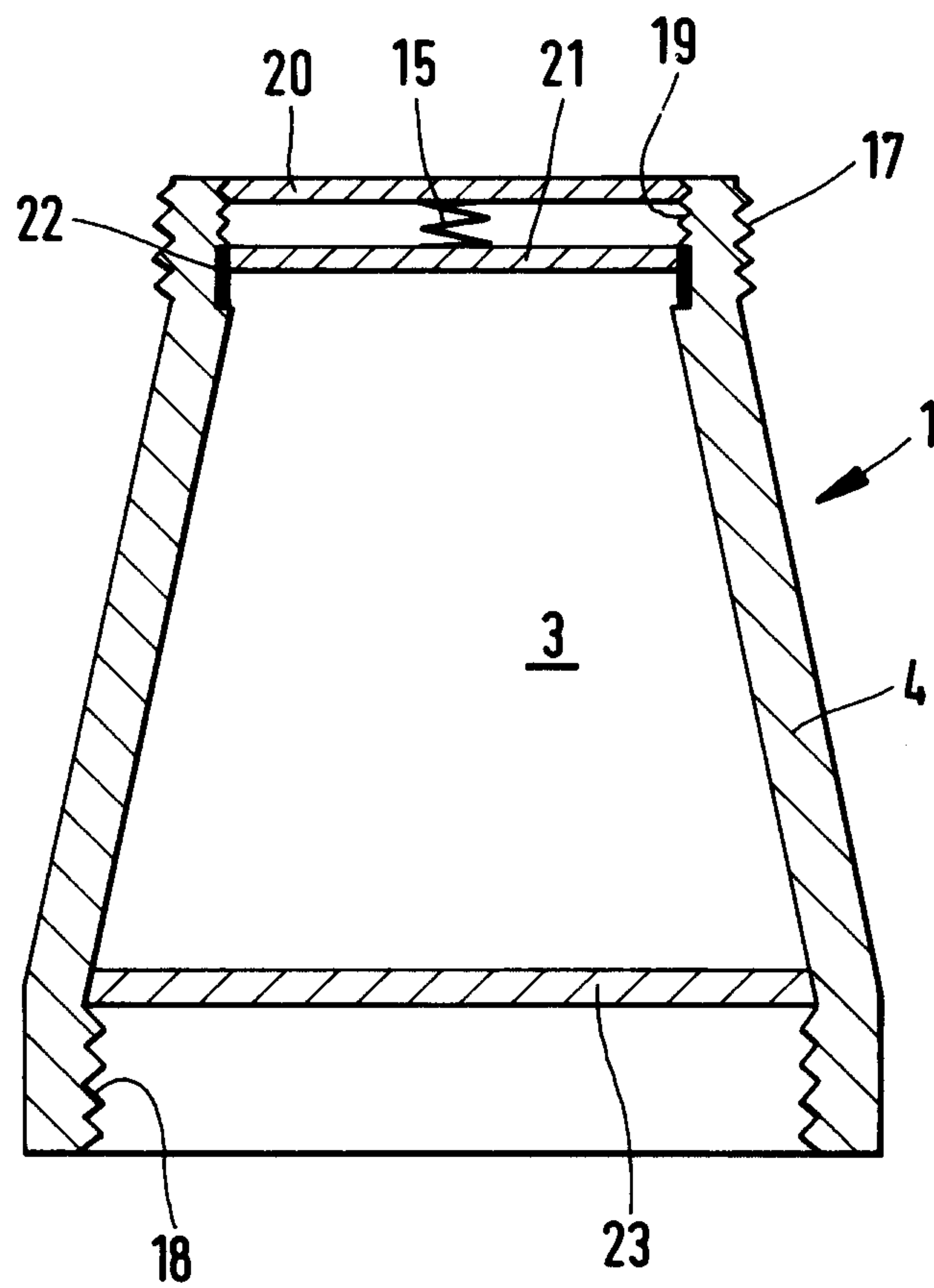


FIG. 5



3/8

FIG. 6

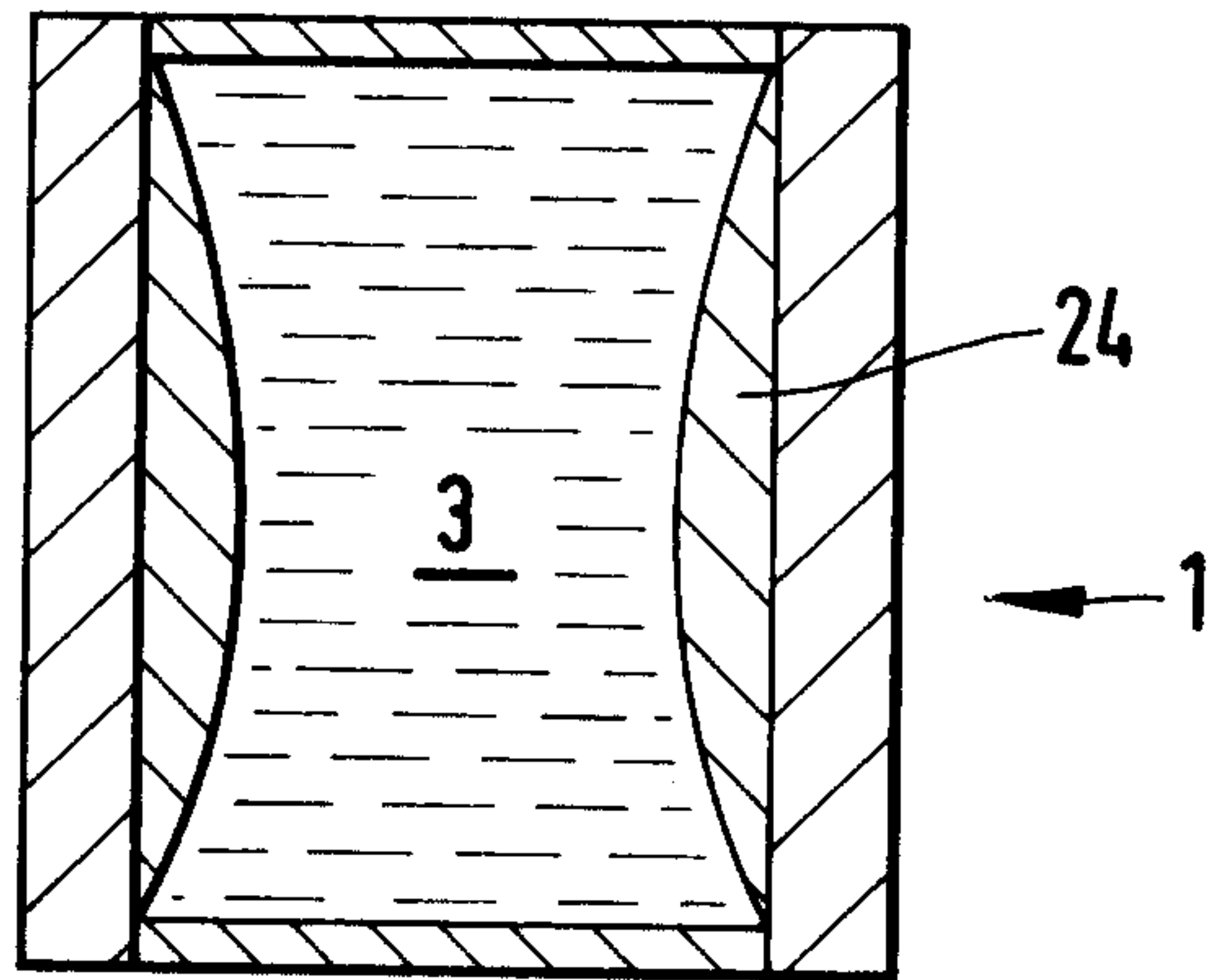


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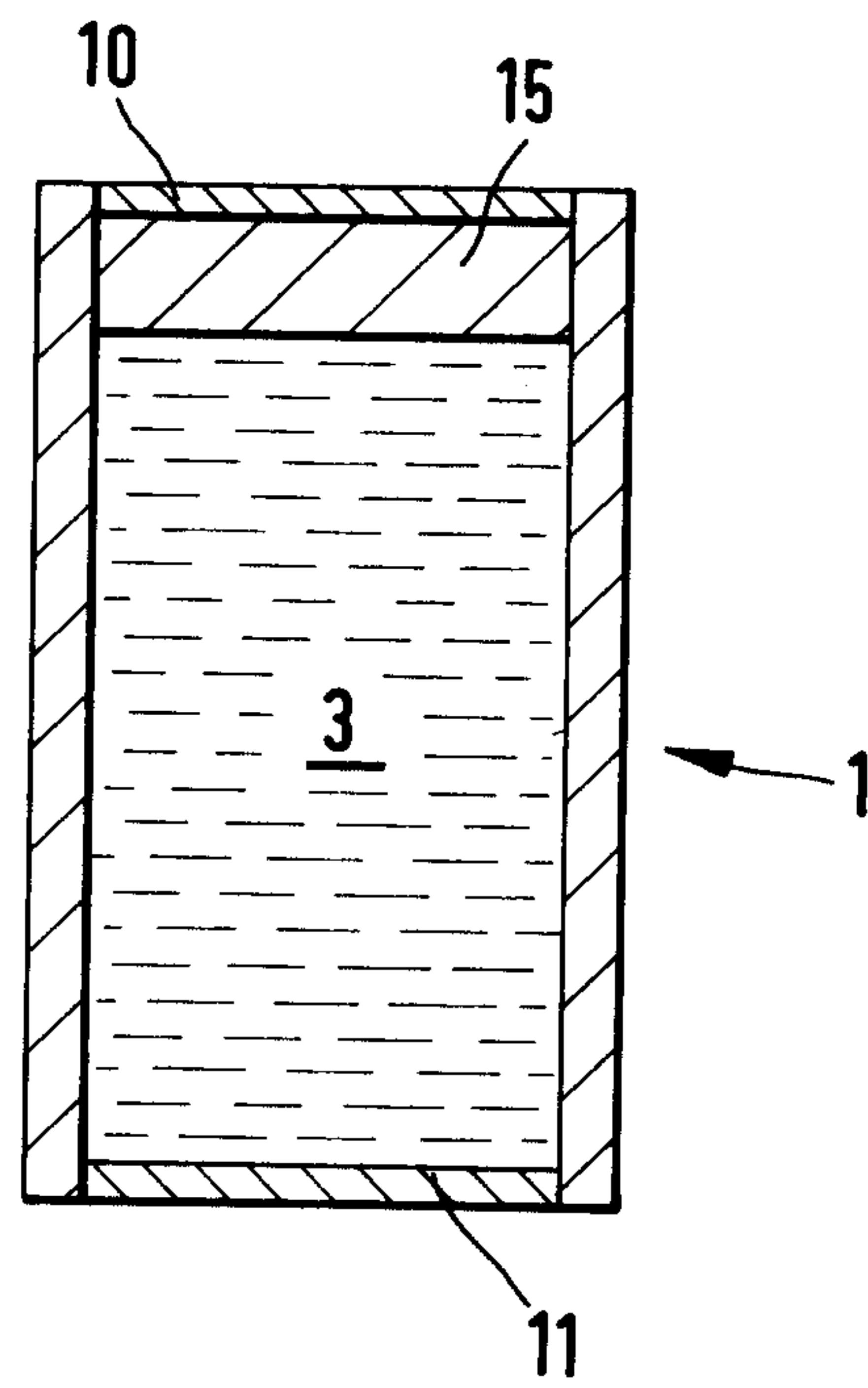
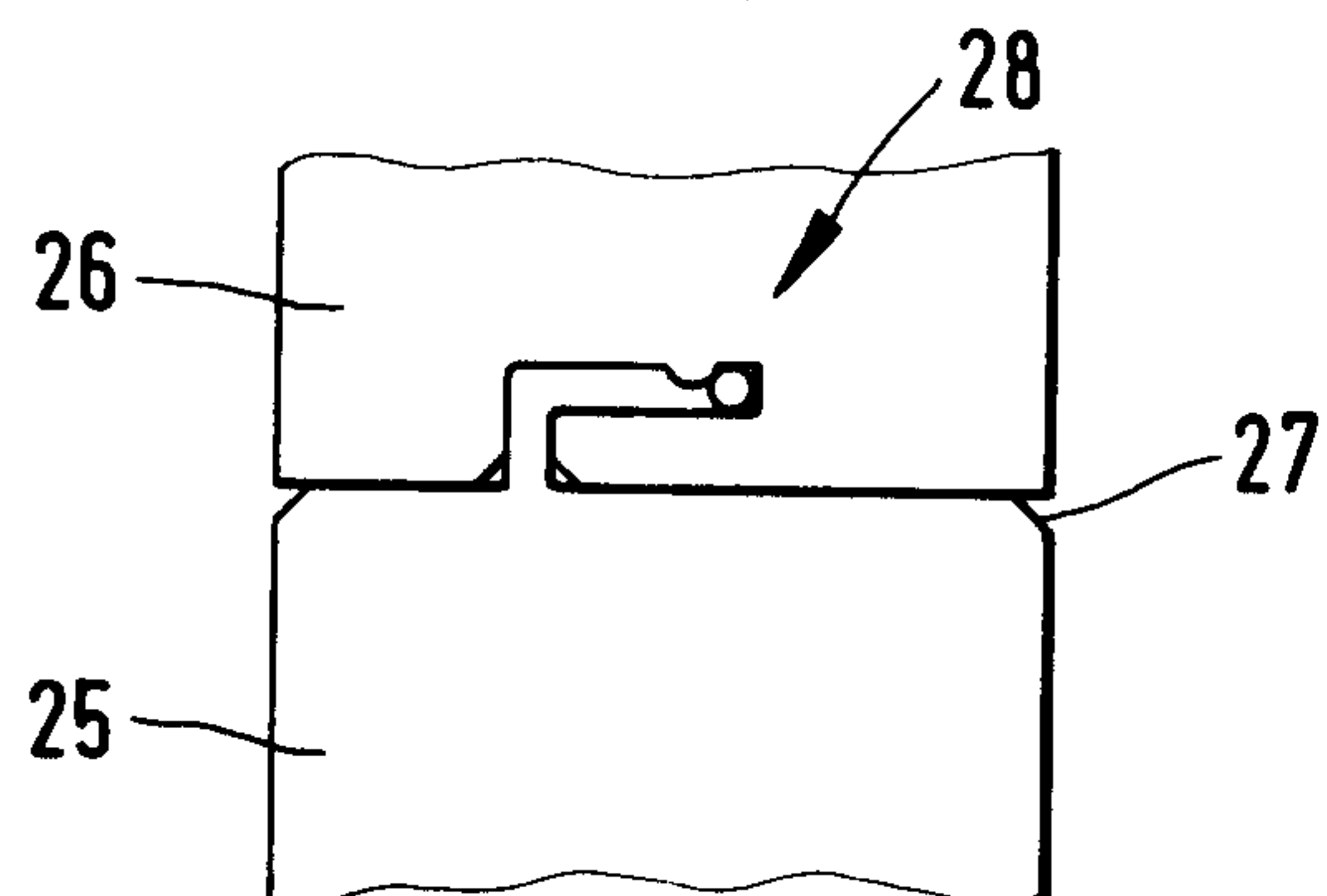


FIG. 8



4/8

FIG. 9

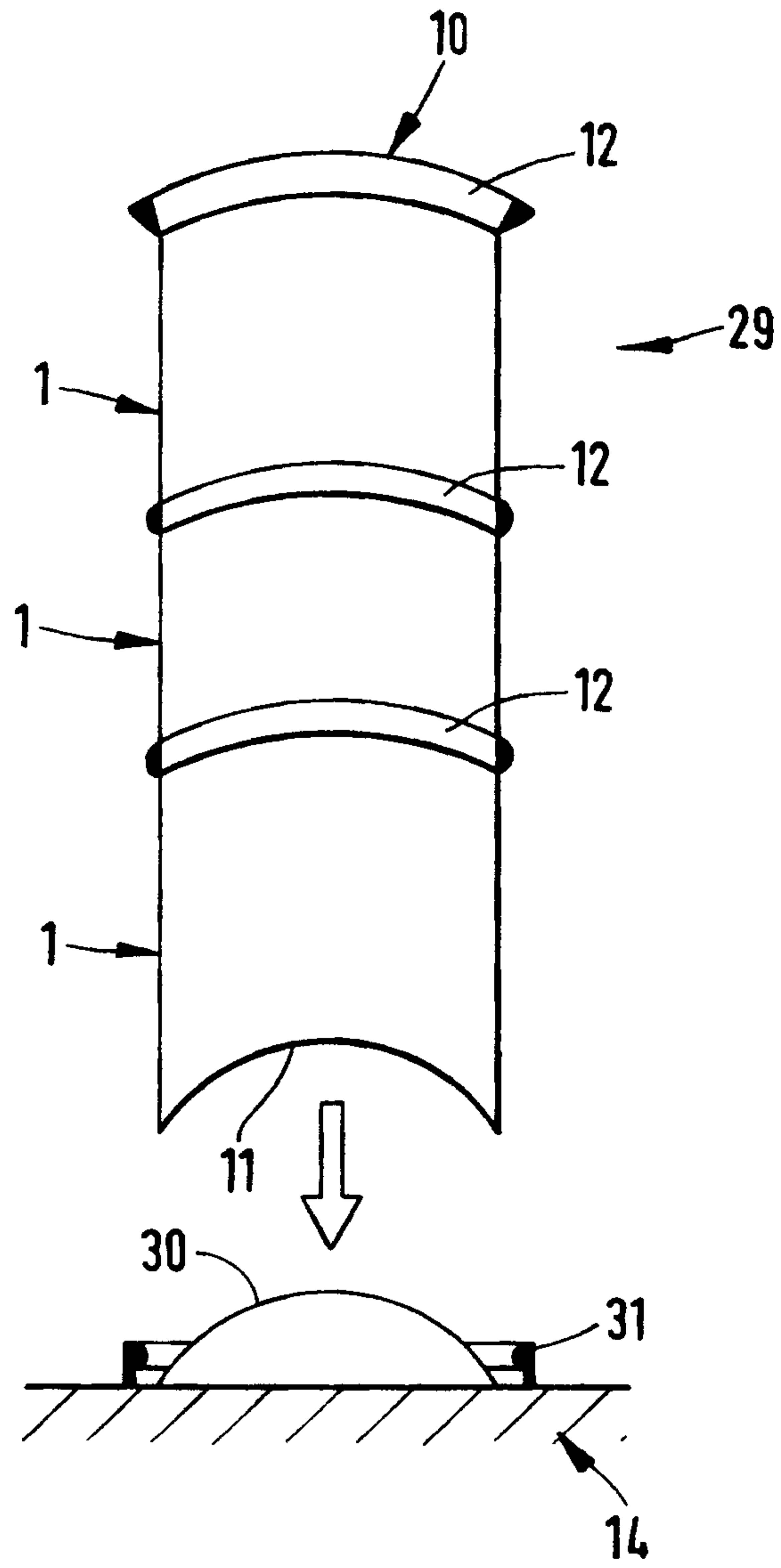
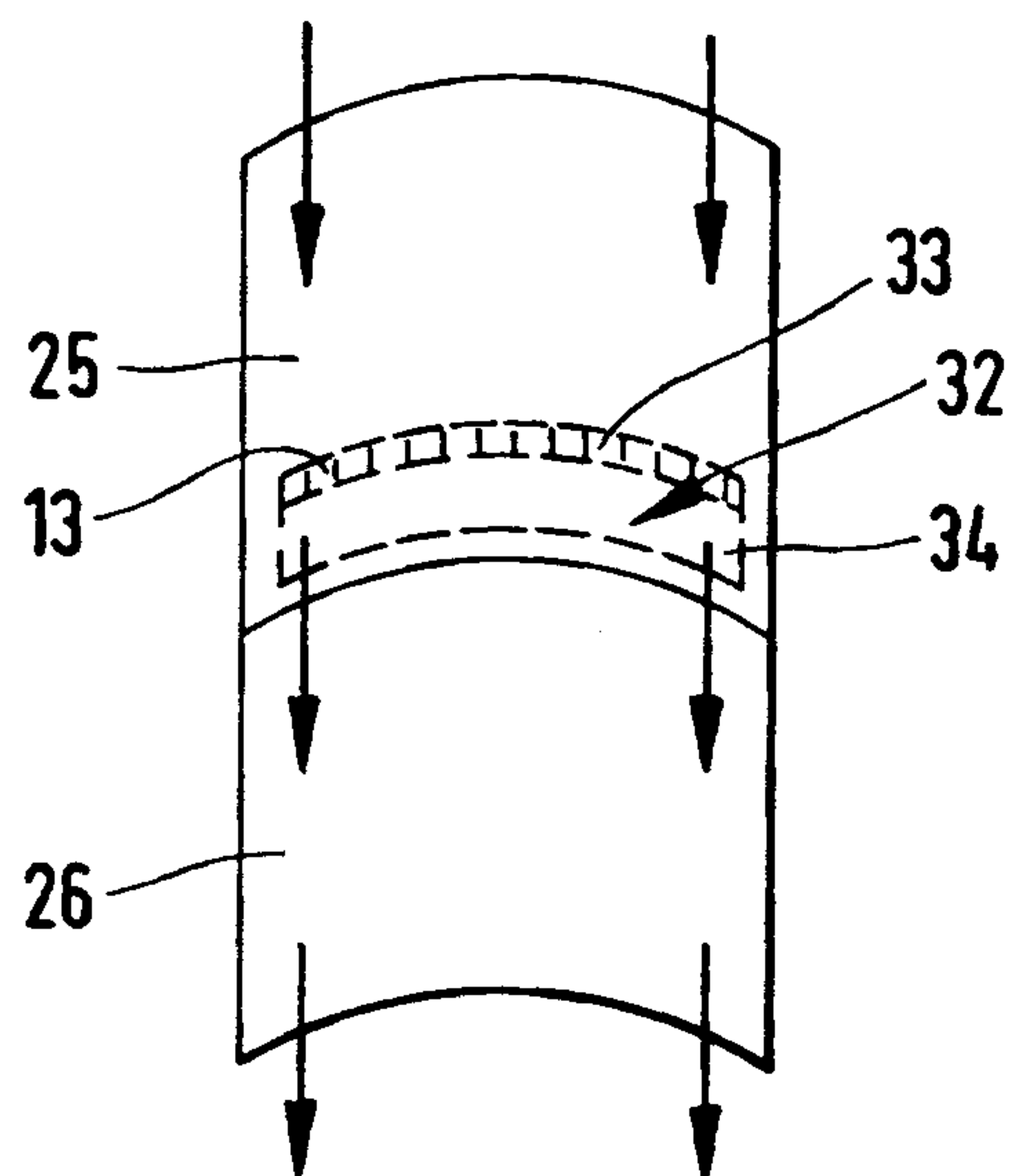
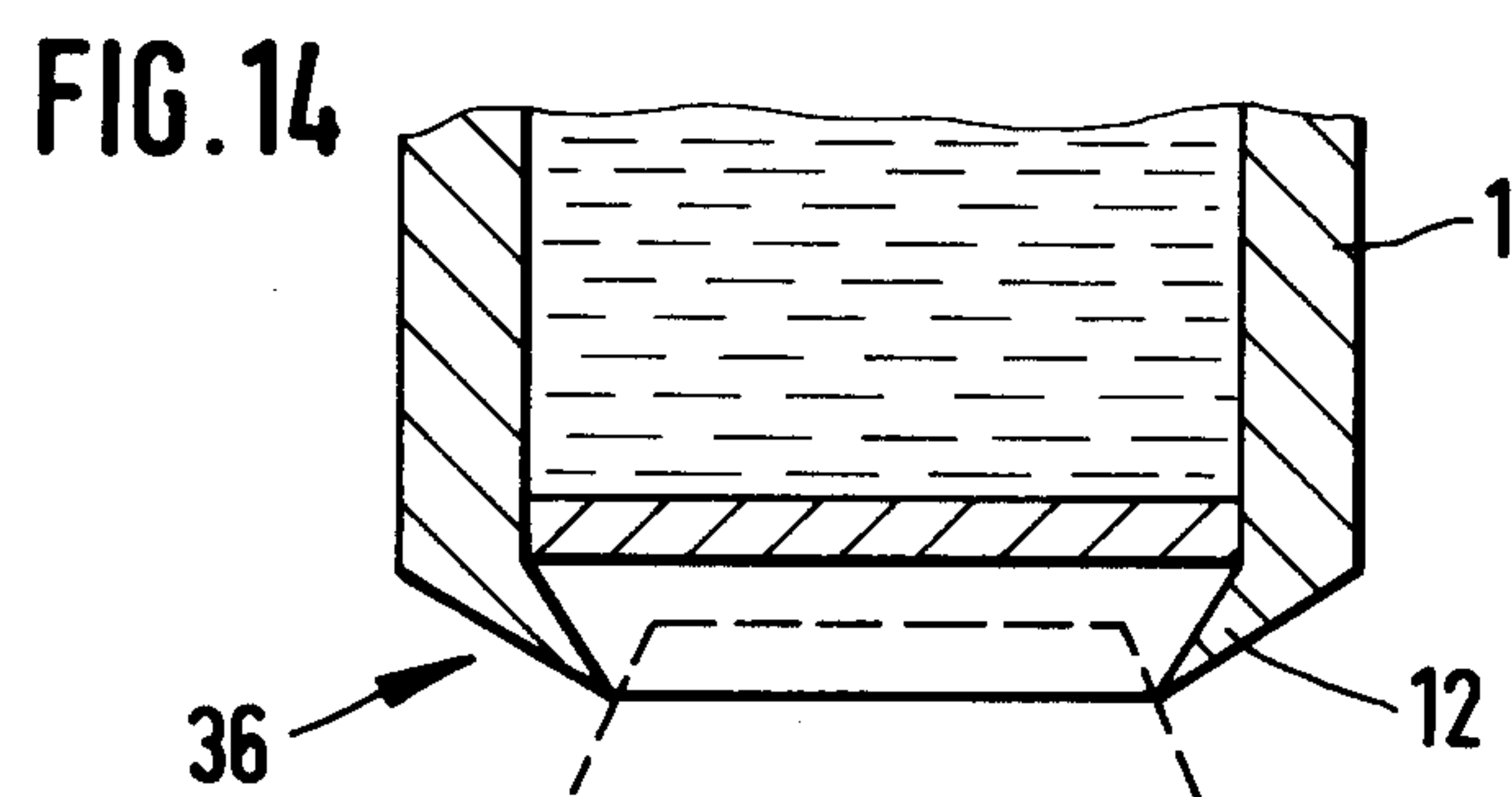
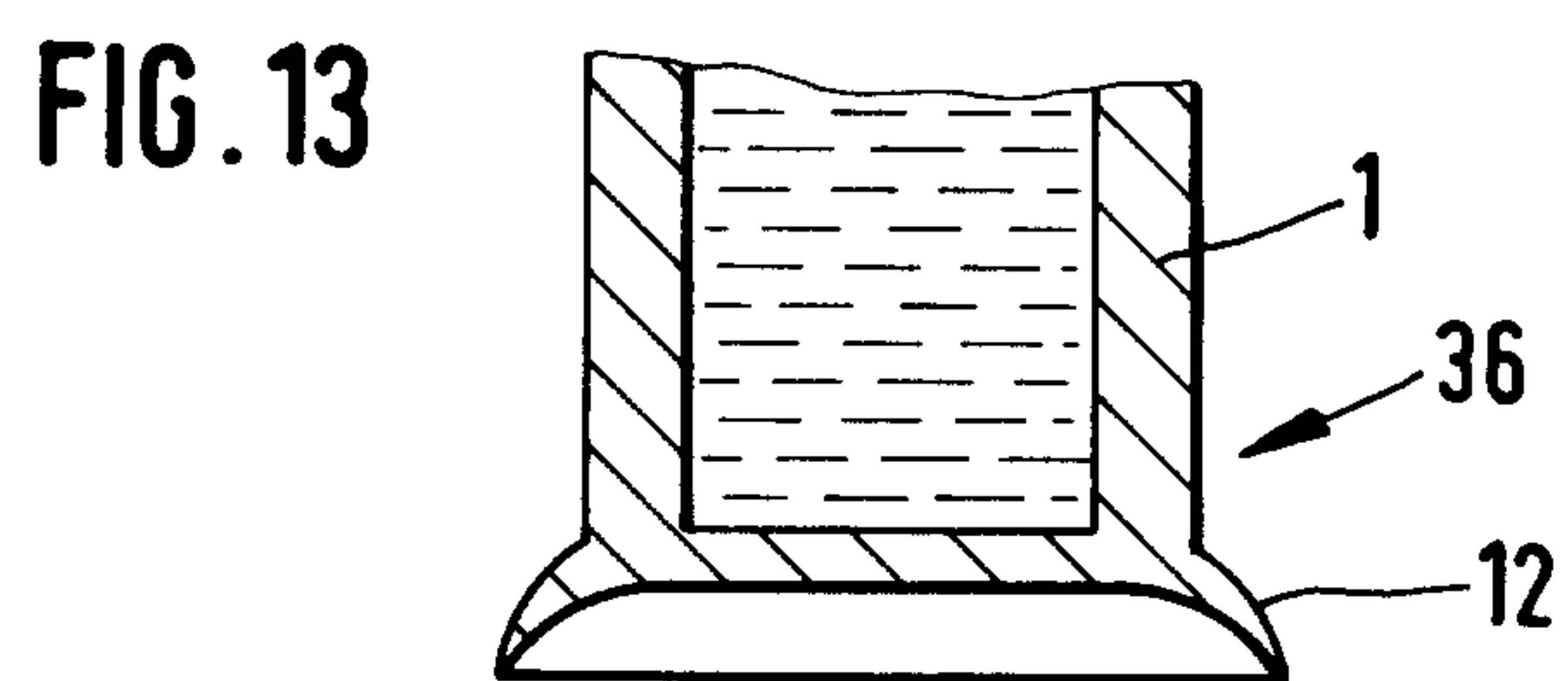
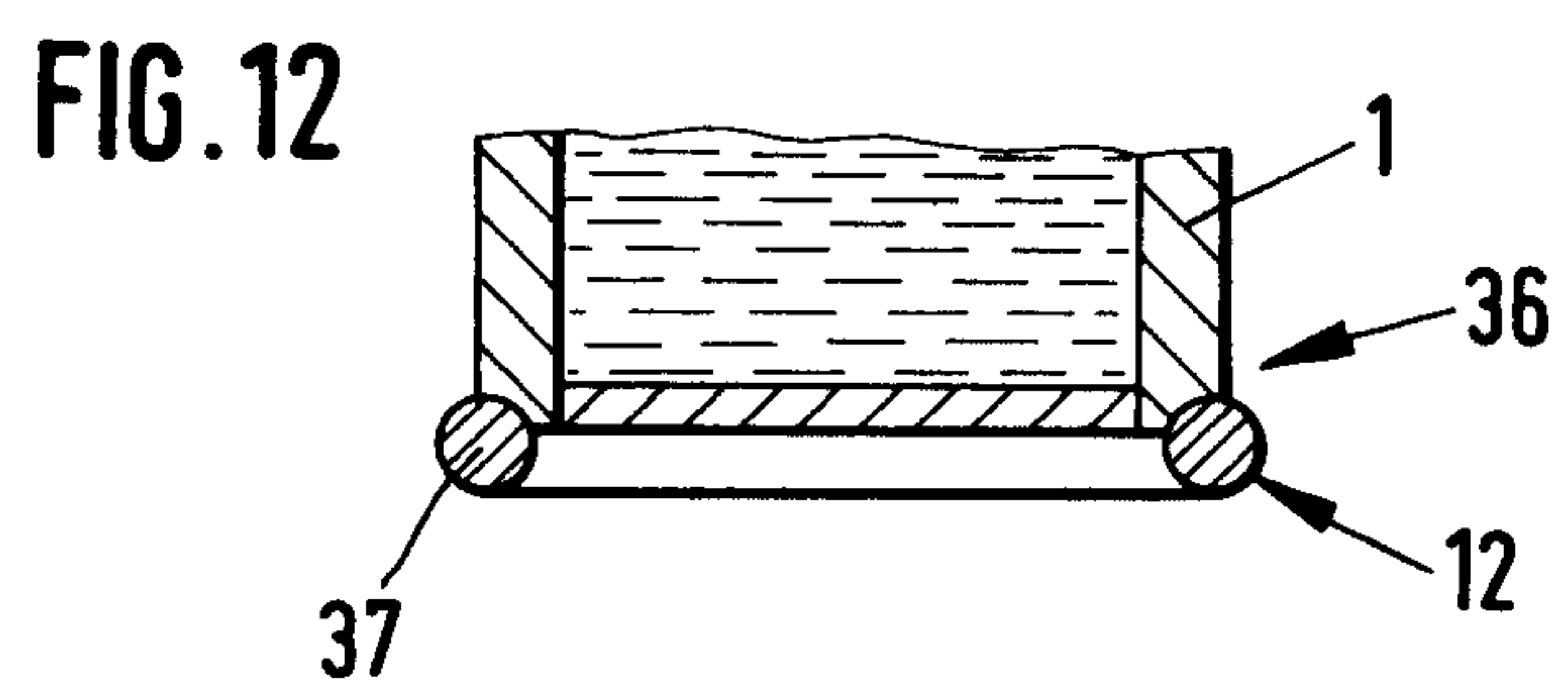
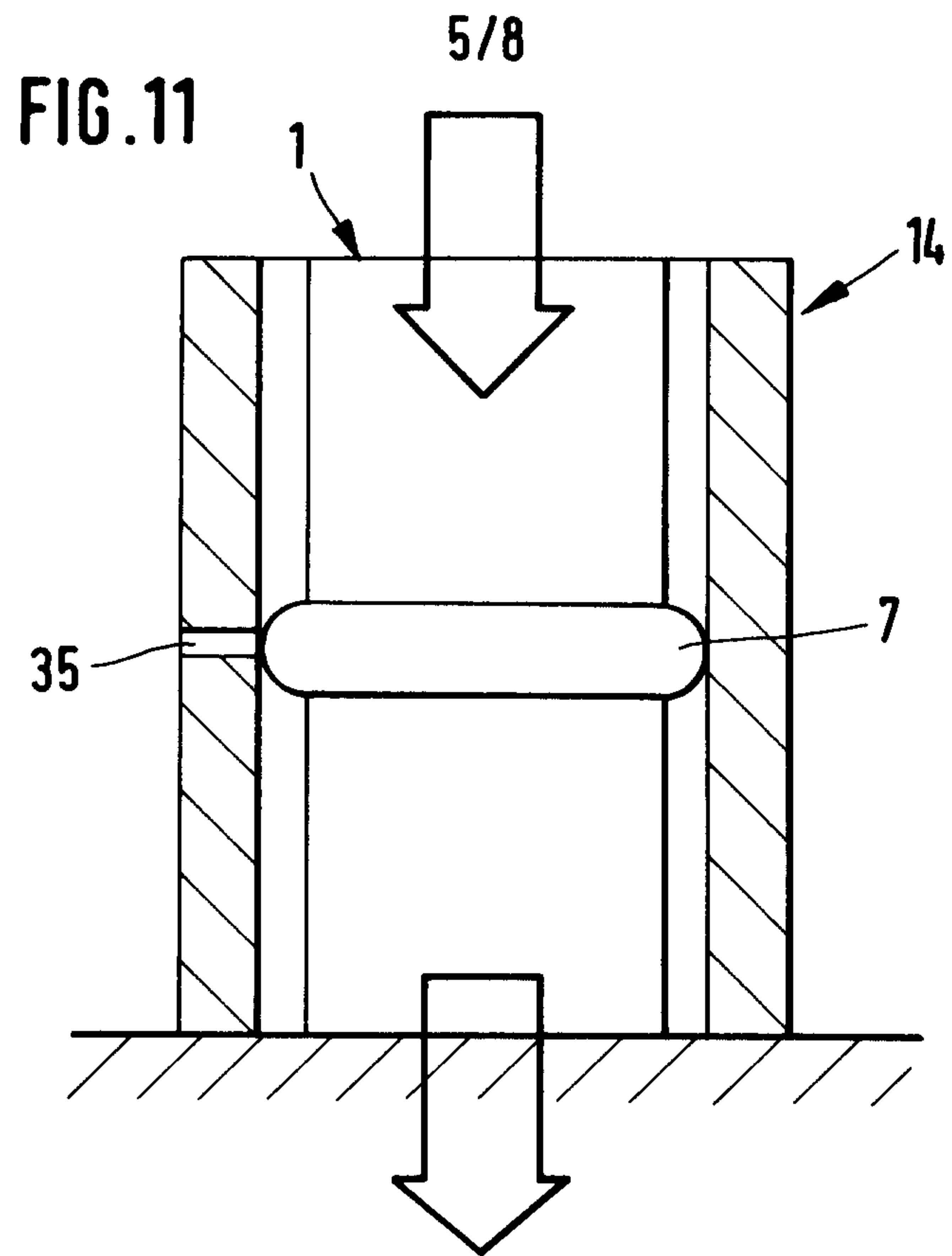


FIG. 10





6/8

FIG. 15

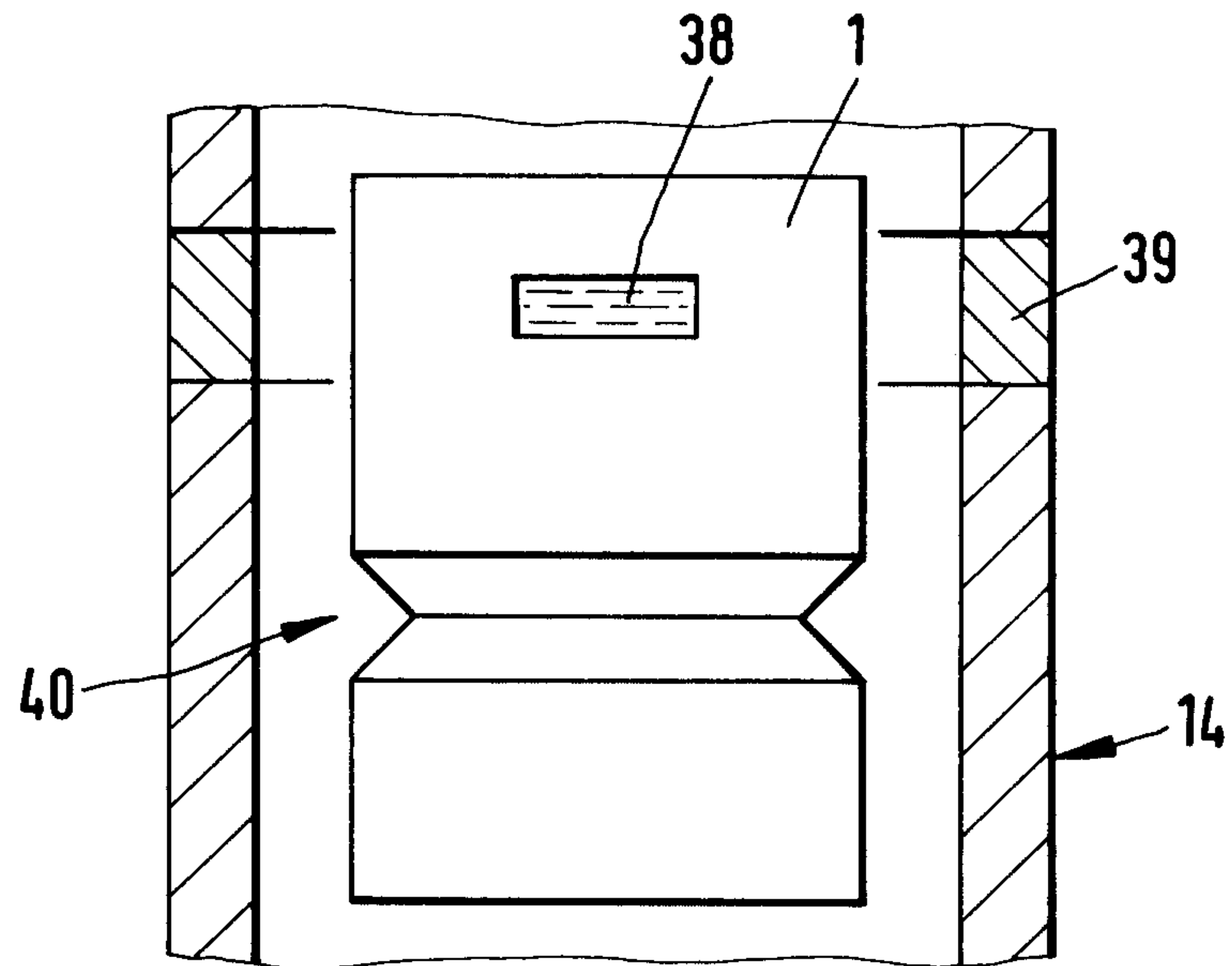
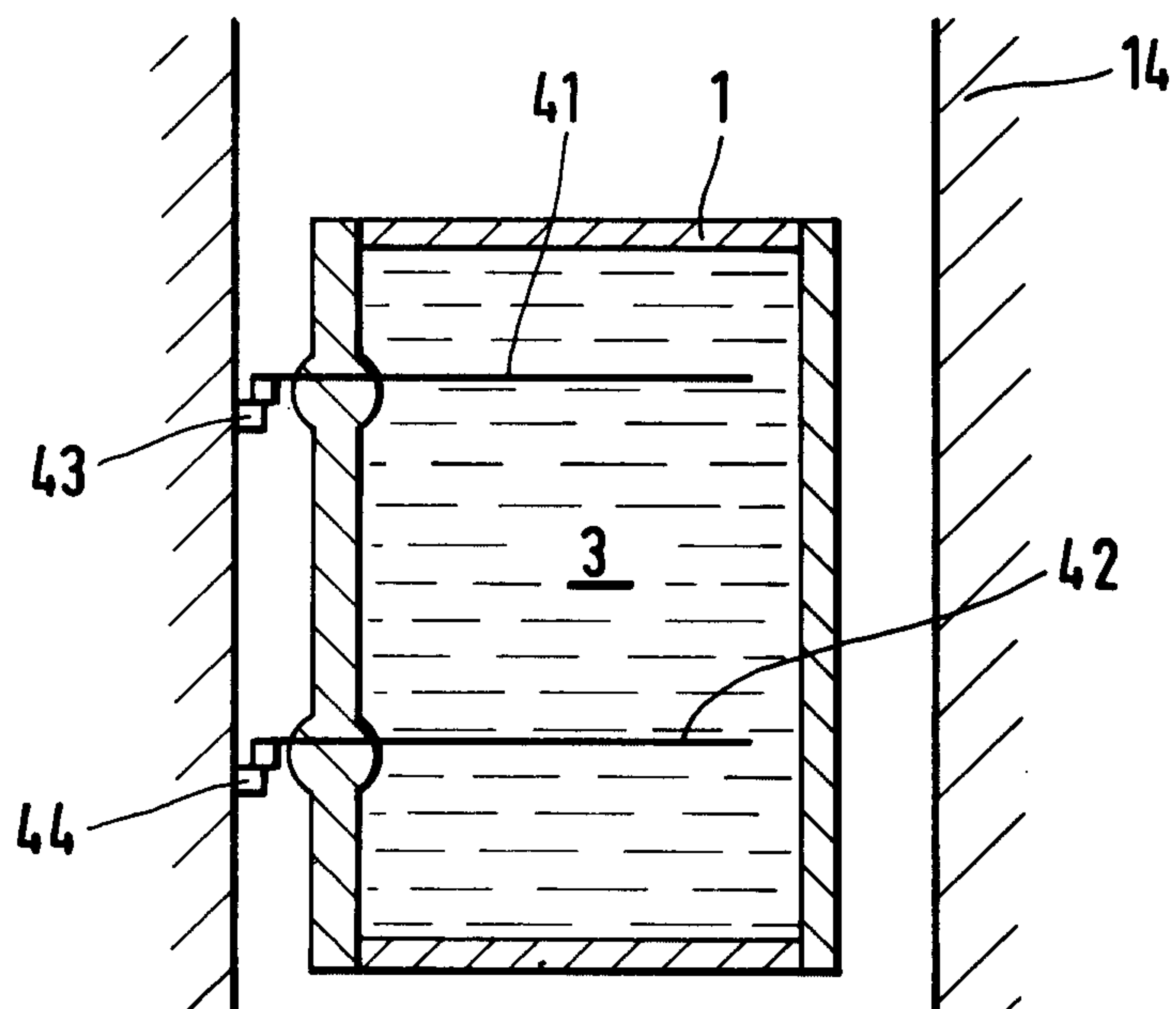
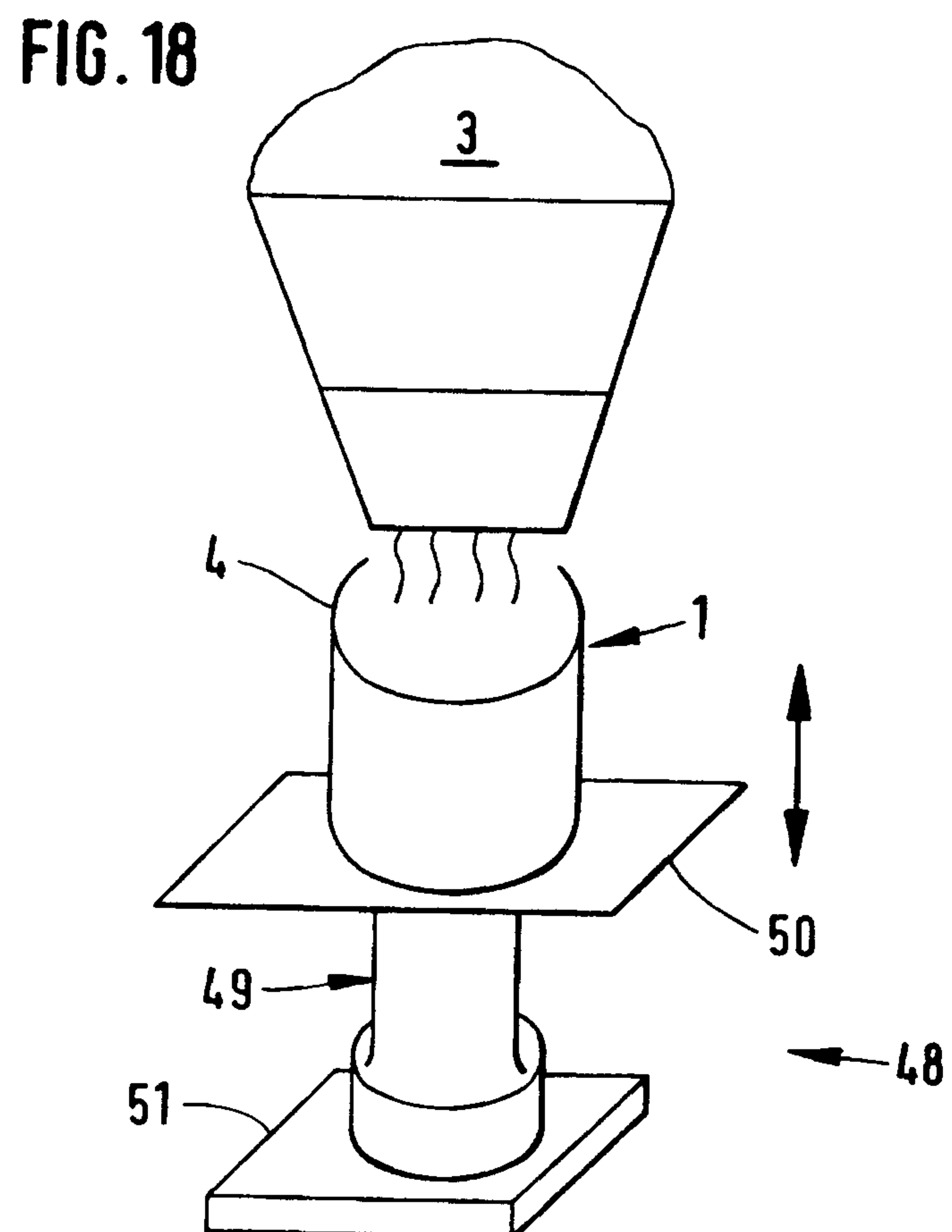
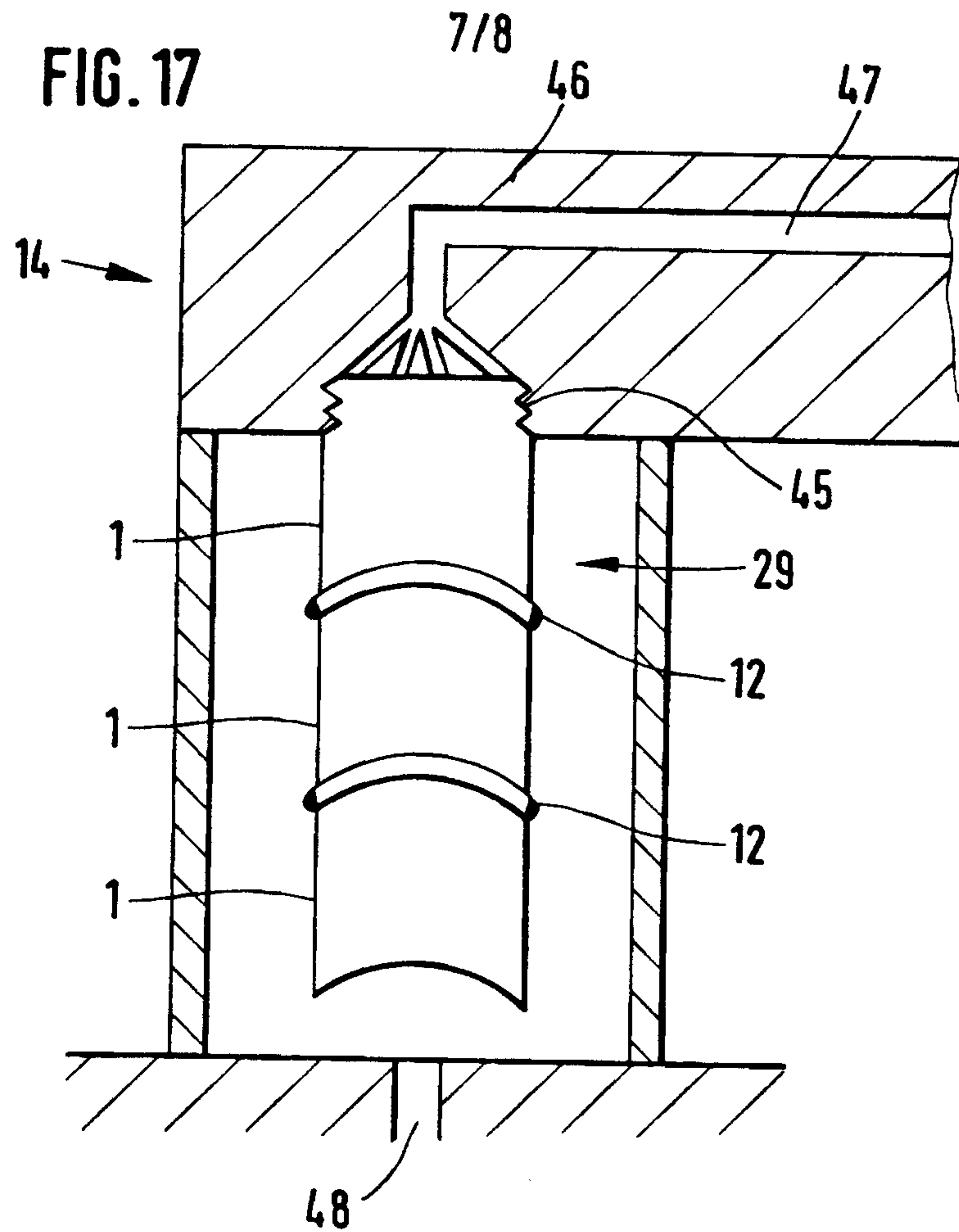


FIG. 16





8/8

FIG. 19

