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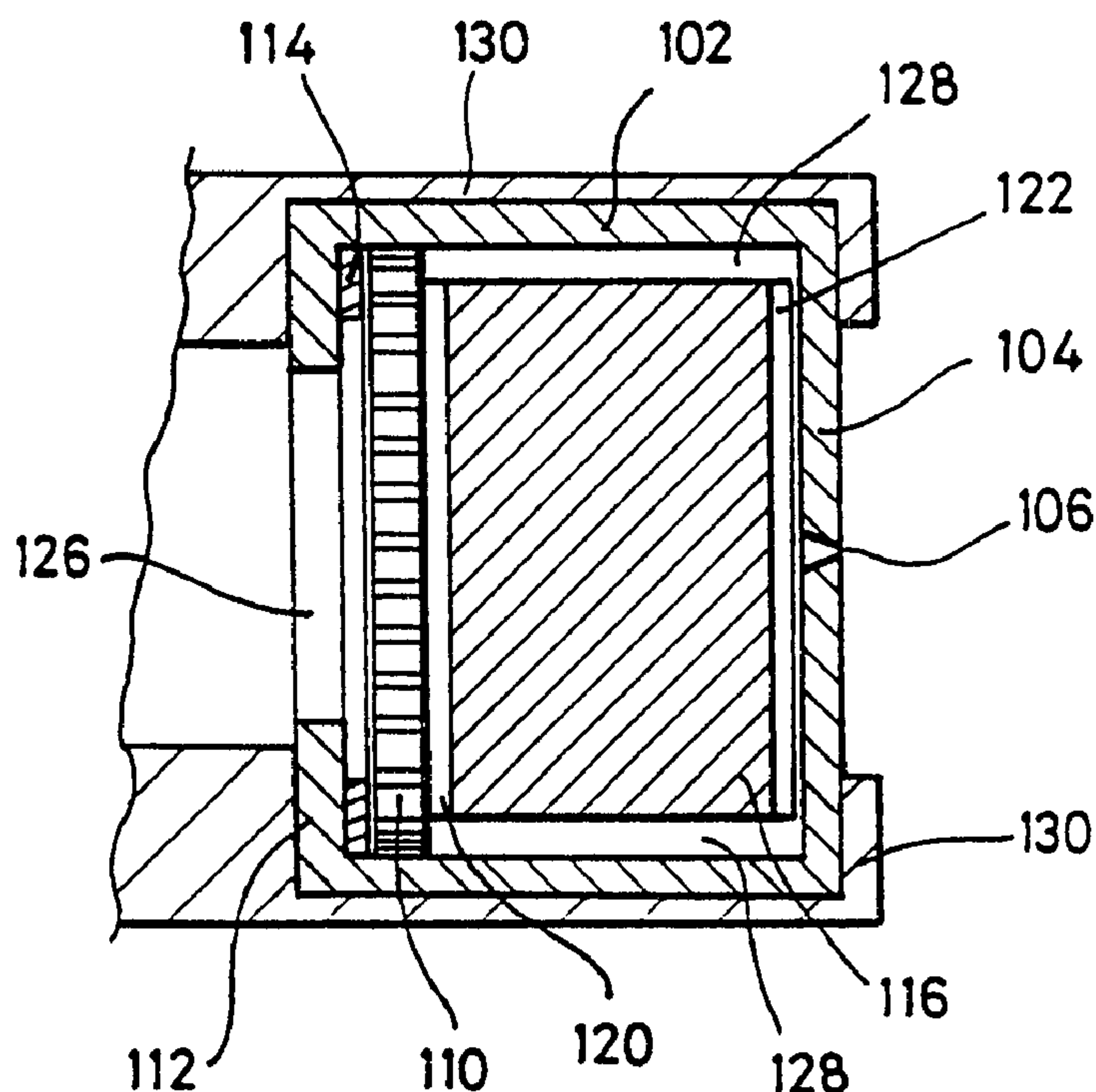
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(54) Title: NOZZLE ASSEMBLY FOR PREVENTING BACK-FLOW



(57) Abrégé/Abstract:

The present invention relates to a device for controlling flow which comprises: a) a housing member (102) having an internal chamber through which fluid is adapted to flow; and b) a static infill member (116) located within the chamber and forming a passageway (120, 122, 128) for the flow of fluid between the internal wall of the chamber and the external wall of the support chamber, which passageway is dimensioned so as to restrict the back flow of fluid therethrough at an ambient pressure differential. Preferably, the internal chamber and the infill member are circular in cross-section and the passageway is provided by the annular gap between the opposing axial walls of the chamber and the infill member. The invention also provides a nozzle assembly incorporating the flow control device and spray generating devices incorporating the nozzle assembly.



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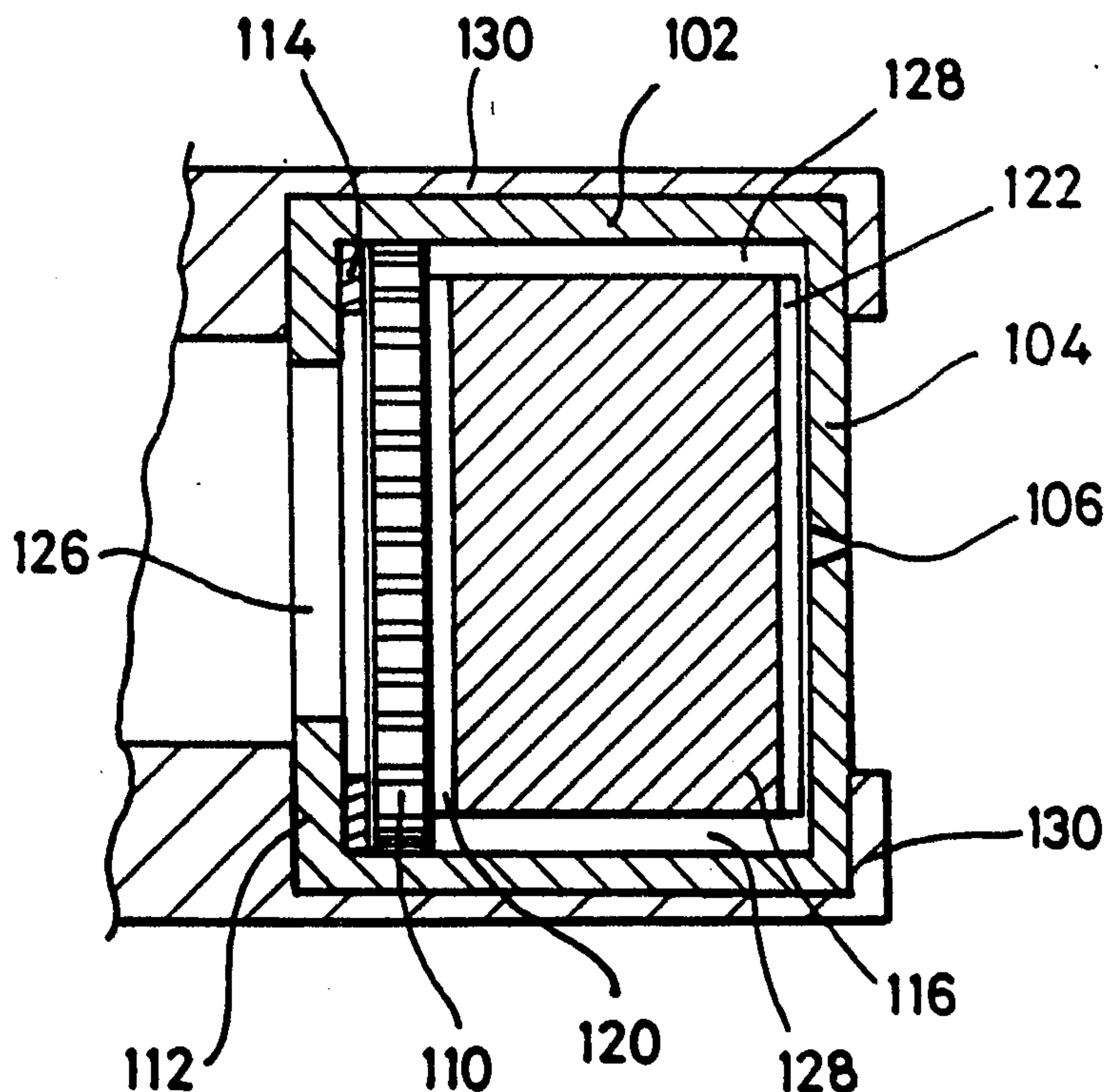
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(54) Title: NOZZLE ASSEMBLY FOR PREVENTING BACK-FLOW

(57) Abstract

The present invention relates to a device for controlling flow which comprises: a) a housing member (102) having an internal chamber through which fluid is adapted to flow; and b) a static infill member (116) located within the chamber and forming a passageway (120, 122, 128) for the flow of fluid between the internal wall of the chamber and the external wall of the support chamber, which passageway is dimensioned so as to restrict the back flow of fluid therethrough at an ambient pressure differential. Preferably, the internal chamber and the infill member are circular in cross-section and the passageway is provided by the



annular gap between the opposing axial walls of the chamber and the infill member. The invention also provides a nozzle assembly incorporating the flow control device and spray generating devices incorporating the nozzle assembly.

Nozzle assembly for preventing back-flow

This invention relates to a valve, notably to a non-return valve which can also act as a filter for use in devices for
5 forming sprays of droplets.

BACKGROUND TO THE INVENTION

Many forms of device have been proposed for dispensing
10 fluids, for example medicaments, as sprays of fine droplets or aerosols. In some forms of device, it has been proposed that the aqueous solution of the medicament or other active ingredient be discharged through a fine orifice nozzle to form the spray using mechanical pressuring means, for
15 example using a compressed spring to drive a piston in a cylinder containing the fluid; in others, a pressurised gas is used as the propellant. For convenience the term pressurising means will be used herein to denote all means by which the pressure required to dispense the fluid is
20 generated and includes mechanical and pressurised gas operated means.

Where very small nozzle apertures, for example those having a diameter of 10 micrometres or less, are used to form fine
25 droplets sizes, it is important to ensure that such small orifice apertures do not become blocked. It has therefore been proposed to provide a filter in the fluid discharge line upstream of the nozzle aperture. Small dimension filters are available, and these typically comprise a mesh
30 or gauze which has a mesh aperture size as low as 3 micrometres or less. However, such filters are flimsy and therefore require some support means to prevent rupturing under the large pressures generated by the pressuring means. Furthermore, such filters and their support means are
35 additional and often expensive components.

There is, therefore, a continuing requirement for an effective and reliable filter capable of filtering fluid stream down to very small particle sizes. In spray generating devices, there is usually also a requirement for a non-return valve positioned between the pressurising means and the atomising nozzle orifice so as to reduce the risk of residual fluid in the nozzle assembly draining back into the pressurisation chamber and contaminating fluid held in a reservoir in the device.

10 We have devised a form of nozzle assembly incorporating a non-return valve assembly which provides a simple and effective means for reducing the risk of drain back of fluid from the nozzle assembly and may also be used to provide the functions of a filter and/or a filter gauze support in the nozzle assembly.

SUMMARY OF THE INVENTION:

20 Accordingly, the present invention provides a spray generating device which comprises: a. pressurising means for applying a predetermined amount of energy by means of a spring loaded pump mechanism to a metered quantity of fluid in order to subject the fluid to a predetermined increase in pressure, said pump mechanism having retaining means for retaining the pump mechanism in a loaded state at which the fluid in the pump is held at ambient pressure, and means for releasing the retaining means, thereby to cause the said predetermined increase in pressure in the fluid; and b. means for atomising the pressurised fluid into droplets which incorporates a nozzle

assembly comprising a conduit in fluid flow communication with a nozzle aperture through which fluid is to be discharged as a spray of droplets, wherein the effective minimum cross-sectional area of the conduit transverse to the line of flow of fluid at the point of effective minimum area is selected so that flow of fluid through said conduit is restricted by the minimum effective cross-sectional area whereby back-flow of fluid from said nozzle aperture through said conduit at an ambient pressure differential is substantially prevented, the ambient pressure differential being the pressure across the nozzle assembly when the spray generating device is in its rest condition or the device is being recocked in preparation for a subsequent discharge stroke.

The term effective is used herein with respect to the cross-

sectional area of the conduit to denote that cross-section of the conduit which is not occupied by an infill or other member, and through which fluid may flow. Thus, the conduit may be a fine bore tube, in which case the effective cross-sectional area is the cross-section of the fine bore. However, the conduit may also be in the form of a wide bore chamber into which is fitted a solid or hollow plug which reduces the free cross-sectional area of the chamber through which fluid can flow.

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For convenience, the term upstream will be used herein to denote the direction opposed to a flow of fluid from the conduit to the nozzle aperture; the term discharge flow to denote a flow of fluid from the conduit to the nozzle aperture; and the term back flow to denote a flow of fluid from the nozzle aperture back to the conduit.

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The clearance or passageway(s) within or between components of the nozzle assembly forming the conduit through which the flow of fluid is restricted acts to minimise the back flow of fluid in the nozzle assemblies of the invention during the rest state of a spray generating device incorporating the nozzle assembly or when suction is applied to the nozzle assembly as the pump or other means for discharging the spray is re-cocked after use. During the rest state there will usually be no pressure differential across the nozzle assembly and it will be the surface tension effects at the nozzle aperture and the flow resistance caused by the walls of the passageway(s) which restrict back flow of fluid. However, when a pump or other discharge means is being re-cocked, some suction may be applied to the nozzle assembly, typically to give a pressure differential of about 0.2 to 0.5 bar across the nozzle assembly, although it is possible that a pressure differential across the nozzle assembly of up to 1 bar could be drawn during the suction stroke of the

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pump. The nozzle assemblies of the invention should therefore be dimensioned so that the surface tension and other flow restrictive effects prevent flow through the nozzle assembly when a minimum pressure differential of about 0.2 bar, preferably 1 bar, is applied across the assembly. In order to provide a measure of safety, for example if the spray generating device is dropped or otherwise subjected to sudden forces, it will usually be preferred that a pressure differential of up to 3 bar causes no significant flow of fluid through the nozzle assembly of the invention in the event that the device is dropped. The term ambient pressure differential is therefore used herein to denote the pressure differential across the nozzle assembly, ie. between the exterior of the nozzle aperture and the upstream inlet to the conduit, when the nozzle assembly or the spray generating device incorporating it is in its rest condition or the device is being re-cocked in preparation for a subsequent discharge stroke of the spray generating device of which the nozzle assembly forms part.

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Although the ambient pressure differential is not sufficient to cause back flow of fluid through the nozzle assembly, when the spray generating device is operated, the fluid is pressurised, often to up to 500 bars, to discharge the fluid as a spray of fine droplets from the nozzle aperture. The high pressure differential across the nozzle assembly overcomes the surface tension and other flow restriction effects of the nozzle assembly and forces the fluid through the nozzle assembly. Typically, significant flow of fluid through the nozzle assembly to form a spray occurs in excess of about 50 bars pressure differential across the nozzle assembly of the invention, although a slow flow of fluid may occur at pressure differentials below this, for example at above 10 to 25 bars.

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The conduit(s) serving to restrict the back flow of fluid can be provided by one or more fine bore tubes or conduits in the housing. Such fine bores can be formed as bores leading radially from an annular feed gallery to the axial bore to the nozzle orifice or can be axial bores within the housing, for example formed by laser drilling the bores in a plastic or similar nozzle block and securing a nozzle plate having the appropriate radial connecting grooves or bores to connect the fine bores to the nozzle aperture to the end face of the nozzle block. Alternatively, the flow restriction can be provided by constricting a wider bore tube feeding fluid to the nozzle aperture.

However, it is preferred to form the conduit as a comparatively wide bore chamber and to achieve the restriction of the back flow by locating an infill member within the chamber. The infill member can be a flat plate with holes therethrough of the desired aperture size and shape, or a ceramic or other fritted or bonded material with a suitable foraminous or porous structure so that the infill member occupies the full width of the chamber and the fluid flows through the pores or apertures in the infill member. However, it is preferred that the infill member be a solid or hollow plug which does not extend fully to the side or end walls of the chamber so that the clearance gap between the infill member and the side and/or end walls of the chamber form the required restricted flow passageways. These passageway(s) can be radial, as when the infill member does not extend fully to the end of the chamber, and/or can be axial as when the clearance is between the side walls of the infill member and the chamber. However, it is within the scope of the present invention for the infill member to carry one or more circumferential ribs or the like and for the clearance fit to be between the radially outward extremities of these and the opposing wall of the chamber to

provide the flow restriction(s) or vice versa where the chamber wall carries the circumferential ribs. Similarly the clearance between the transverse end wall of the chamber and the end face of the infill member can be provided by the axially extreme faces of one or more annular ridges carried by the chamber wall or the infill member. For convenience, the invention will be described hereinafter in terms of opposing walls of the chamber and infill member which do not carry such ribs. Preferably, the passageway(s) are axial and for convenience the invention will be described hereinafter in terms of an annular axial passageway formed by the clearance gap between the side walls of the chamber and the infill member. It will be appreciated that the passageway(s) can also be provided by axial grooves in the surface of the infill member. It is also preferred that the infill member be provided with one or more radial ducts, for example grooves or ribs, which allow fluid to flow across the end faces of the infill member to the annular passageway.

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In a particularly preferred form of the nozzle assembly of the invention, the conduit is provided as a blind ended axial chamber having the nozzle aperture located at or adjacent the blind end of the chamber, preferably in the transverse end wall of the chamber; and the infill member is substantially congruent with the internal transverse end wall and/or the axial side walls of at least the blind end of the chamber and is a clearance fit therein to form the passageway(s) between the opposed walls of the chamber and the infill member.

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It is particularly preferred that the chamber be cylindrical and that the infill member be a corresponding cylinder to form an annular passageway between the internal radial wall of the chamber and the external radial wall of the infill

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member, although other cross-sectional shapes, for example triangular or hexagonal, may be used if desired. For convenience, the invention will be described hereinafter in terms of a generally cylindrical housing having a circular cross-section chamber formed within it.

The optimum radial and axial dimensions for the flow restricting passageway(s) can readily be determined for any given case by simple calculations from the rheological properties of the fluid and by simple trial and error tests. Preferably, the minimum cross-sectional dimension of the passageway(s) in the nozzle assembly, for example the clearance between the relevant walls of the infill member and the chamber, is less than the maximum dimension, for example the diameter, of the nozzle aperture, whereby the passageway(s) serves both as a flow restrictor to reduce back flow of the fluid and as a filter for the fluid flowing through the nozzle assembly. Typically, the passageway(s) will have a flow-transverse dimension of from 1 to 50 micrometres, notably less than about 20 micrometres, for example from 2 to 10 micrometres. The required dimensions between the infill member and the walls of the chamber within which it is located can be achieved by making the infill member a tight clearance fit within the chamber so that the roughness of the opposed surfaces provides the necessary clearance fit.

We believe that flow restriction valves incorporating the chamber and infill member concept described above are novel. The invention therefore also provides a device for controlling the flow of a fluid, which device comprises:

- a. a housing member having an internal chamber through which fluid is adapted to flow; and
- b. a static infill member located within the chamber and forming a passageway for the flow of fluid between the

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internal wall of the chamber and the external wall of the infill member, which passageway is dimensioned so as to restrict the back flow of fluid therethrough at an ambient pressure differential.

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Preferably, the nozzle aperture is formed as an integral part of the housing member within which the chamber and conduit are formed, for example as an axial bore or conduit fed from the chamber within the housing body. The nozzle aperture can take a number of forms, but is preferably an aperture in a jewel or metal nozzle orifice member, for example the transverse end wall of the chamber, through which the fluid is fed under pressure from the chamber. Preferably, the nozzle orifice has an aperture diameter of less than 10 micrometres, for example from 2 to 6 micrometres. If desired, the nozzle orifice can be non-circular or the nozzle assembly can incorporate a swirl chamber and/or other means for enhancing the production of fine droplets, for example droplets with a mass median diameter of less than 10 micrometres. Such other means can be, for example, an impingement ball, plate, blade or other static or vibrating surface. Where a non-circular aperture is employed, it is preferred that the ratio of the maximum radial dimension of the aperture to its minimum radial dimension be at least 2:1, eg. from 3:1 to 10:1, and that any angles in the lip of the aperture be sharp.

As indicated above, the nozzle assembly of the invention may act to separate solid particles from the fluid passing through it where the passageway(s) in the assembly are smaller than the maximum nozzle aperture dimensions. However, it may be preferred to incorporate one or more separation means, for example a conventional fine aperture metal gauze filter mesh, notably one having a mesh aperture size in the range 1 to 10 micrometres, to separate solid

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particles from the fluid upstream of the passageway(s) in the nozzle assembly. Conveniently, such separation means are provided by a disc of suitable filter mesh which is located within the chamber of the nozzle assembly
5 immediately upstream of the infill member and is supported by the upstream end face of the infill member.

Thus, in a particularly preferred form of the nozzle assembly of the invention, the assembly is formed from
10 generally cylindrical housing having a blind ended cylindrical axial chamber substantially co-axially therein so that the nozzle assembly has radial symmetry; and the axial configuration is that the nozzle aperture is formed in the transverse end wall of the chamber, the infill member is
15 located within the chamber and immediately adjacent the transverse end wall of the chamber, the separation means is located transversely and adjacent the upstream face of the infill member and the open end of the housing is crimped over or provided with other means whereby the assembly is
20 retained as a unitary construction.

As indicated above, the nozzle assembly of the invention finds especial use with spray generating devices. The exact nature, form of construction and method of operation of the
25 spray generating device can be of any suitable type, for example a pressurised or liquefied gas propellant aerosol can type device. However, the invention is of especial use with mechanically actuated devices in which a measured dose of fluid is subjected to an increase in pressure to expel
30 the fluid through the nozzle assembly of the invention. Particularly preferred spray generating devices are those described in our International Application No GB/91/00433, notably one which comprises:

a. pressurising means for applying a pre-determined amount
35 of energy by means of a spring loaded pump mechanism to a

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metered quantity of fluid on order to subject the fluid to a pre-determined increase in pressure, said pump mechanism having retaining means for retaining the pump mechanism in a loaded state at which the fluid in the pump is held at ambient pressure, and means for releasing the retaining means, thereby to cause the said pre-determined increase in pressure in the fluid; and

b. means for atomising the pressurised fluid into droplets which incorporates a nozzle assembly of the present invention.

DESCRIPTION OF THE DRAWINGS:

To aid understanding thereof, the invention will now be described with respect to a preferred form thereof as shown in the accompanying drawings, in which Figure 1 is a diagrammatic axial cross-section through one form of the nozzle assembly of the invention; Figures 2, 3 and 4 are axial cross-sections through alternative forms of the nozzle assembly; and Figure 5 is an axial plan view of an alternative form of the infill device for use in the assembly of Figure 1.

DESCRIPTION OF THE PREFERRED EMBODIMENTS:

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The device of the invention, notably that shown in Figure 1, is of particular use in the atomization of aqueous solutions of medicaments, notably in measured dose inhalation devices (MDI's). For convenience the invention will be described in respect of a device for such use.

The device comprises a main hollow generally cylindrical housing body 102 having one end closed by a transverse end wall 104 to define a blind ended chamber located substantially co-axially within it. The closed end wall 104

is provided with a fine bore nozzle aperture 106 directed generally axially and located with its axis substantially co-incident with the longitudinal axis of the body 102. A transverse filter mesh 110 is located within the open end of
5 body 102 and is held within the body by folding over the exposed lip of the body 102 to form an annular retaining flange 112 as shown. This also forms the axial entry port 126 to the chamber within body 102. A plastic sealing ring or gasket 114 or the like is located between said flange 112
10 and the filter 110.

A cylindrical infill member 116 is located substantially co-axially within the chamber within the body between the filter 110 and the end wall 104. This cylinder is formed
15 with its radially outward face substantially congruent to the interior wall of the chamber. The upstream end face of the cylinder 116 acts to support the filter 110. One or more radial grooves or ribs 120 and 122 are formed in both end faces of the cylinder 116 to allow the passage of fluid
20 from the entry port 126 to the nozzle aperture 106. An annular passageway is formed between the radially outward wall of cylinder 116 and interior wall of the chamber in body 102 to allow fluid to flow past the cylinder 116. The flange 112 is folded into place after assembly of the
25 cylinder 116, filter 110 and gasket 114, to retain the nozzle assembly as a unitary whole in which the cylinder 116 is retained against axial movement within the chamber of body 102.

30 The body 102 is securely held in position on the MDI or other spray generating device by any suitable means, for example by means of a crimped over sleeve extension 130 to the body of the spray generating device. Alternatively, the body 102 can be screw threaded, bayonet fitted, welded or
35 otherwise secured to the body of the spray generating

device, for example to the valve outlet stem of a pressurised container.

The clearances between the end faces of the cylinder and the filter 110 and the transverse end wall 104 and/or the clearance between the radially outward wall of the cylinder and the inner wall of the chamber are selected so that the ambient pressure differential experienced between nozzle aperture and the inlet 126 will not be sufficient to cause a back flow of fluid from the nozzle aperture to the inlet 126. Typically, the clearance is also selected so that it will act to filter out particles which pass through filter mesh 110 so that the nozzle aperture 106 is not blocked by them. Thus, for a 5 micrometre nozzle aperture, it will usually be preferred that the radial passageways 120 and 122 have an axial dimension of from 1 to 4 micrometres, notably about 2.5 micrometres. Such dimensions for the radial passages also provide an adequate restriction on back flow under most conditions. Where the annular passageway 128 is to provide the back flow restriction, similar radial dimensions for the annular clearance have been found to give satisfactory results both as a filter and to restrict back flow. Such clearances can conveniently be achieved by a rough finish to the interior walls of the chamber within the body 102 and/or to the exterior of cylinder 116. Thus, if the cylinder is a push fit within the housing and can just be rotated manually therein, the clearance is typically as required by the present invention.

In operation of the spray generating device, a metered dose of the medicament or other fluid is applied under pressure to inlet 126, typically at from 100 to 400 bars. This overcomes the surface tension and drag effects in the nozzle assembly and forces fluid to flow via the radial grooves 120 into the annular axial passageway 128 and then via radial

grooves 122 to the nozzle aperture 106. When the spray has been discharged, there is no significant pressure differential between the chamber within the assembly and the ambient environment downstream of the nozzle aperture. If anything, there is a slight positive pressure within the chamber due to the restriction to free flow achieved by the nozzle assembly. Back flow of fluid to inlet 126 from the nozzle aperture 106 is substantially prevented due to the small dimensions of the grooves 120, 128 and the annular passageway 128.

When the spray generating device is re-loaded for a subsequent operation, a negative pressure of no more than approximately 1 bar max vacuum is generated at the entry 126 as the measured dose of fluid is drawn into the measuring chamber (not shown) by retraction of a piston in a cylinder or other means. However, the flow restriction imposed by the combined passageway formed by the grooves 120 and 122 and the annular passageway 128 prevents the pressure differential between the nozzle aperture and the inlet 126 from moving any fluid in said passageway remaining from the previous discharge operation of the spray generating device. However, the large positive pressure generated when dispensing the fluid is sufficient to overcome the surface tension forces and other flow restrictions to ensure that the fluid is dispensed as a spray from the nozzle aperture.

In the variation of the nozzle assembly 10, shown in Figure 2, the filter mesh is omitted and the annular passageway 13 between the cylinder 12 and the chamber wall 11 provides an effective filter for solid particles where the radial dimension of the passageway 13 is about half the diameter of the nozzle aperture 14 formed in the end face 16. Again the radial passage(s) 15 between the end wall 16 and the end face of the cylinder 12 may be fine to assist the operation

of the annular passageway or may be large enough to have little or no back flow restriction effect. The clearance between the cylinder 12 and the wall 13 works both as a filter and as a non-return valve.

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In the variations shown in Figures 3 and 4, the clearance is provided between as the radial clearance 21 between a radial projection, for example a circumferential rib 20, on the cylinder 12 and the axial wall 11 of the chamber (in Figure 10 3); or as the axial clearance 31 between an annular axially extending rib 30 carried by the end face of the cylinder 12 (in Figure 4). The ribs shown in Figures 3 and 4 could be carried by the chamber walls 11 and/or 16 and not upon the cylinder 12 as shown.

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In the form of nozzle assembly as shown in Figure 5, the cylinder 12 is formed as a composite structure from a series of annular sleeves 41, 42 mounted co-axially upon one another with the inner sleeve mounted upon a solid cylinder 20 48. Annular clearances 43 and 49 between each sleeve and the next provide a number of axial passageways in the overall cylinder construction which act in the same way as the annular passageways 13 or 21 in Figures 3 and 4.

25 With water based solutions, the fluid is applied to the inlet 126 of the nozzle assembly of Figure 1 at a pressure of between 100 and 400 bars. For a nozzle aperture of mean diameter of 5 micrometres, the nozzle assembly will filter out particles above about 2.5 micrometres size with an 30 annular gap 128 of about 2.5 micrometres. Where the annular gap 128 in the nozzle assembly is not to act as a filter, but the nozzle assembly relies upon the filter 110 to remove solid particles, the annular gap 128 can be larger, for example as much as 50 micrometres. With these pressures and 35 dimensions, we have found it sufficient to use rough

surfaces at the faces of the cylinder to act as the fluid grooves 120 and 122. Likewise the annular passageway 128 can be formed by the roughness of the surface finish of the body 102 and cylinder 116.

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

1. A spray generating device which comprises:

a. pressurising means for applying a predetermined amount of energy by means of a spring loaded pump mechanism to a metered quantity of fluid in order to subject the fluid to a predetermined increase in pressure, said pump mechanism having retaining means for retaining the pump mechanism in a loaded state at which the fluid in the pump is held at ambient pressure, and means for releasing the retaining means, thereby to cause the said predetermined increase in pressure in the fluid; and

b. means for atomising the pressurised fluid into droplets which incorporates a nozzle assembly comprising a conduit in fluid flow communication with a nozzle aperture through which fluid is to be discharged as a spray of droplets, wherein the effective minimum cross-sectional area of the conduit transverse to the line of flow of fluid at the point of effective minimum area is selected so that flow of fluid through said conduit is restricted by the minimum effective cross-sectional area whereby back-flow of fluid from said nozzle aperture through said conduit at an ambient pressure differential is substantially prevented, the ambient pressure differential being the pressure across the nozzle assembly when the spray generating device is in its rest condition or the device is being recocked in preparation for a subsequent discharge stroke.

2. A device as claimed in claim 1, wherein the conduit is a fine bore tube and the effective cross-sectional area is the transverse cross-section of the fine bore.
3. A device as claimed in claim 1, wherein the conduit is a chamber of greater cross-sectional area than the nozzle aperture, and wherein a static infill member is located within said conduit so as to occupy at least part of the cross-section of said chamber.
4. A device as claimed in claim 3, wherein one or more passageway(s) are provided through the infill member and/or between the opposing end walls and/or side wall(s) of the conduit and said infill member.
5. A device as claimed in claim 4, wherein the conduit is provided as a blind ended axial chamber having the nozzle aperture located at or adjacent the blind end of the chamber, and the infill member is substantially congruent with the internal transverse end wall and/or the axial side walls of at least the blind end of the chamber and is a clearance fit therein to form the passageway(s) between the radially and/or axially opposed walls of the chamber and the infill member.
6. A device as claimed in any one of claims 3 to 5, wherein the maximum cross-sectional dimension of the passageway(s) is less than the minimum dimension of the nozzle aperture, whereby the passageway(s) serves both as a flow restrictor to reduce back-flow of fluid and as a filter for the fluid flowing through the nozzle assembly.

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7. A device as claimed in any one of claims 1 to 5, wherein the nozzle assembly also comprises a filter element.

8. A device as claimed in any one of claims 1 to 7, wherein an ambient pressure differential of 0.2 bar applied
5 across the assembly is insufficient to produce significant flow of fluid through the nozzle assembly.

9. A device as claimed in claim 1, wherein the conduit comprises:

a. a housing member having an internal chamber
10 through which fluid is to flow; and

b. a static infill member located within the chamber and forming a passageway for the flow of fluid between the internal wall of the chamber and the external wall of the infill member.

15 10. Use of a device as claimed in any one of claims 1 to 9, for discharging a fluid as a spray of droplets, in which device an ambient pressure differential of 0.2 bar applied across the assembly is insufficient to produce significant flow of fluid through the nozzle assembly.

20 11. Use of a device as claimed in any one of claims 1 to 9, for dispensing a metered quantity of a fluid medicament.

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PATENT AGENTS

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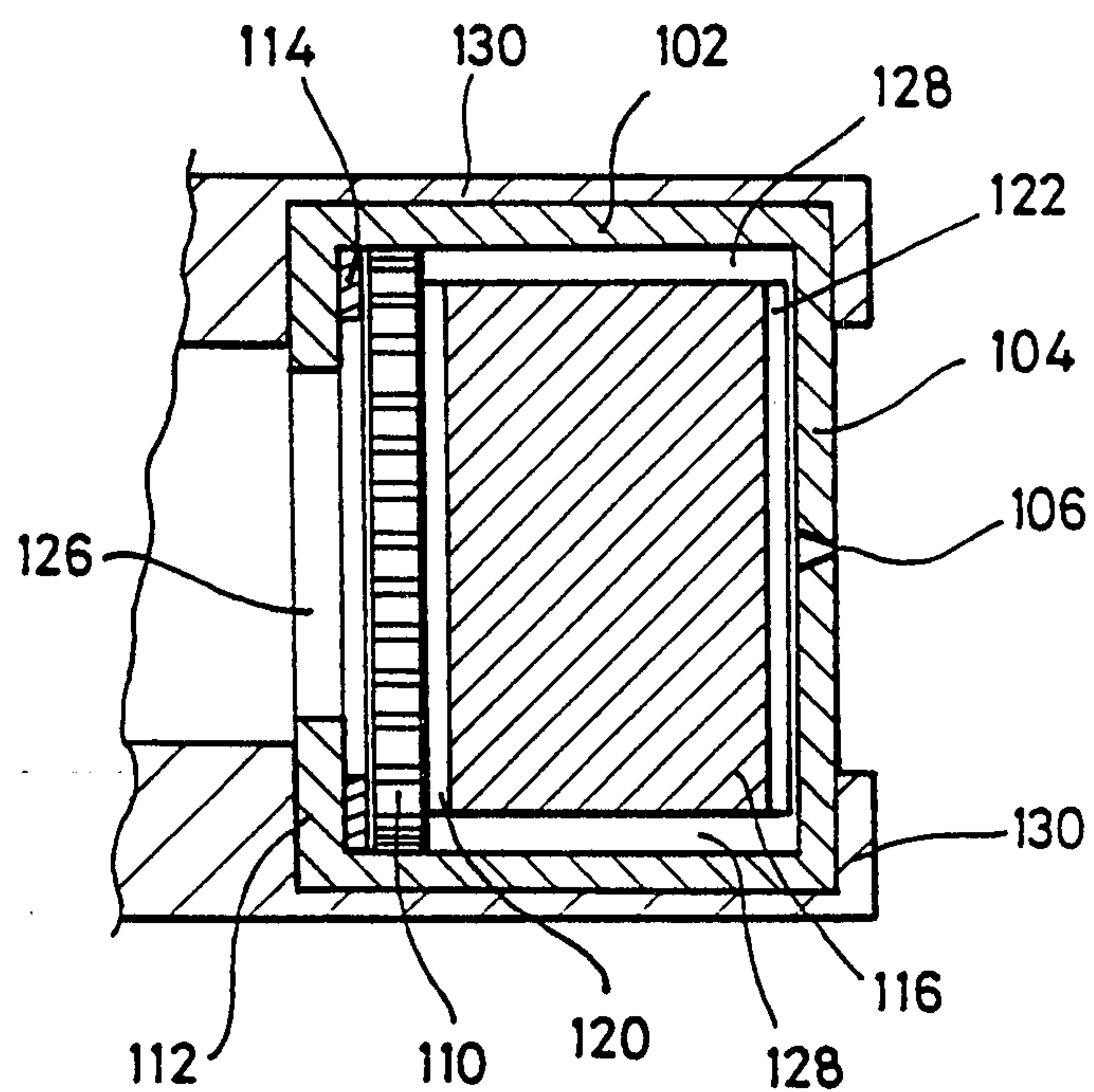


Fig. 1

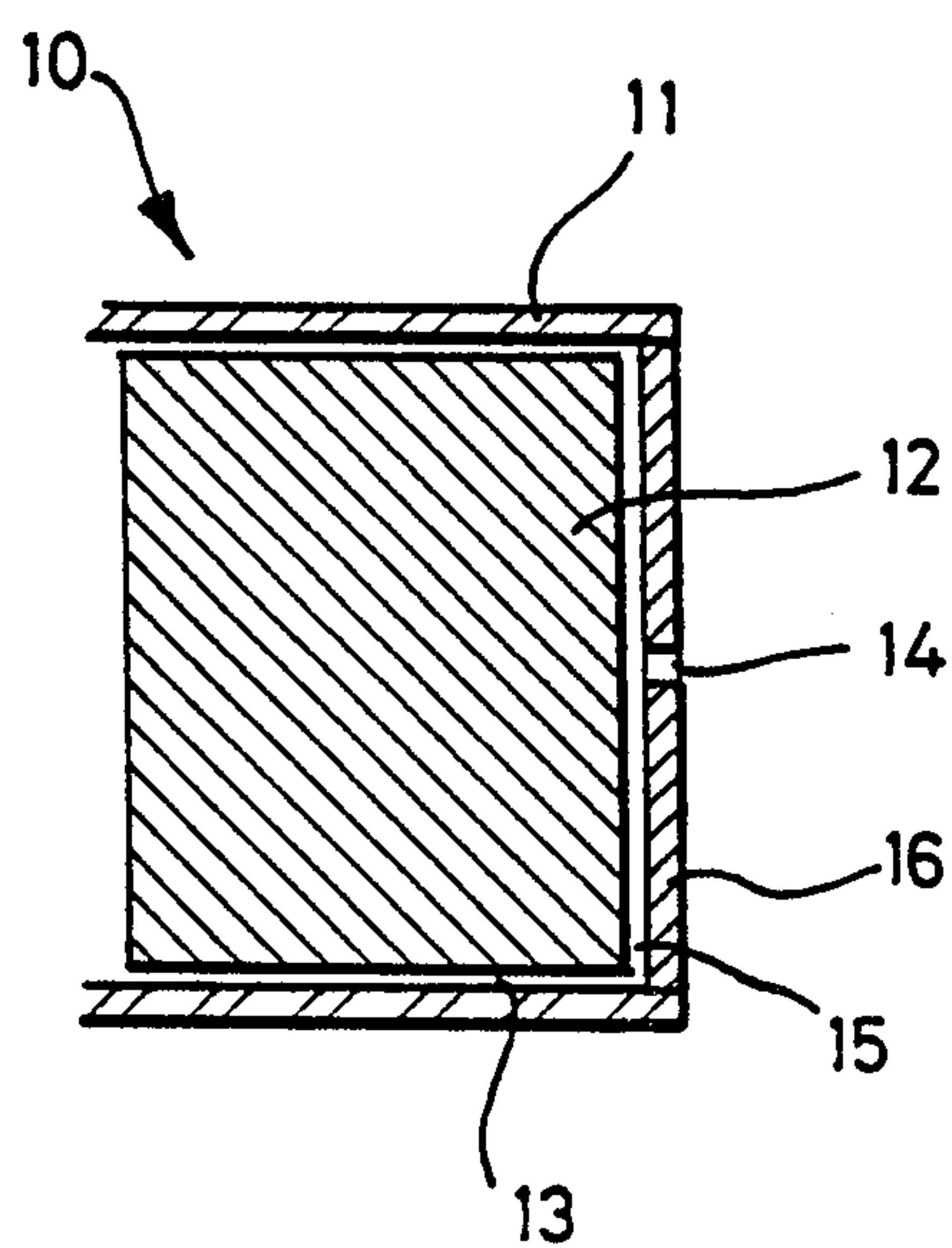


Fig. 2

SUBSTITUTE SHEET

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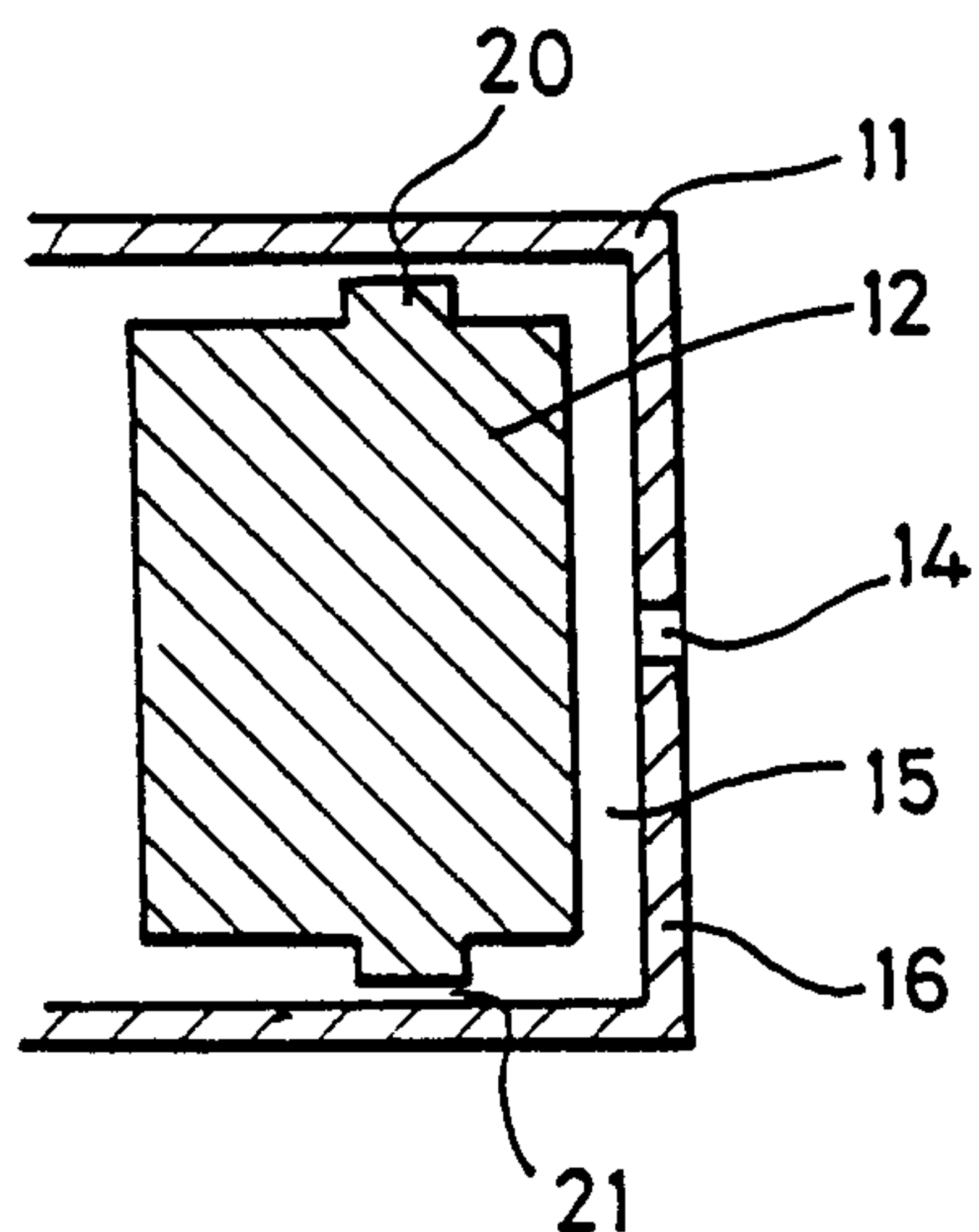


Fig. 3

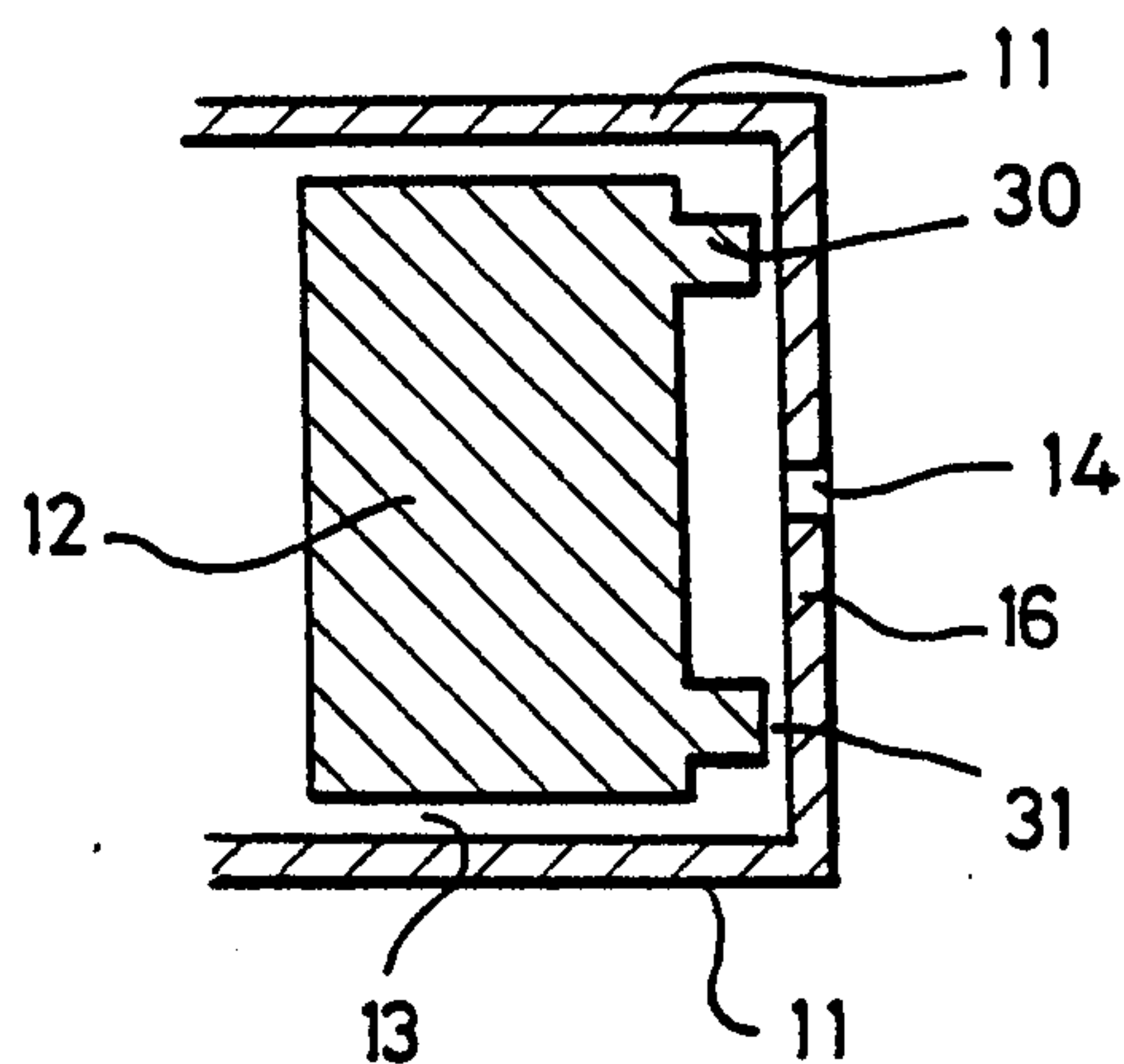


Fig. 4

SUBSTITUTE SHEET

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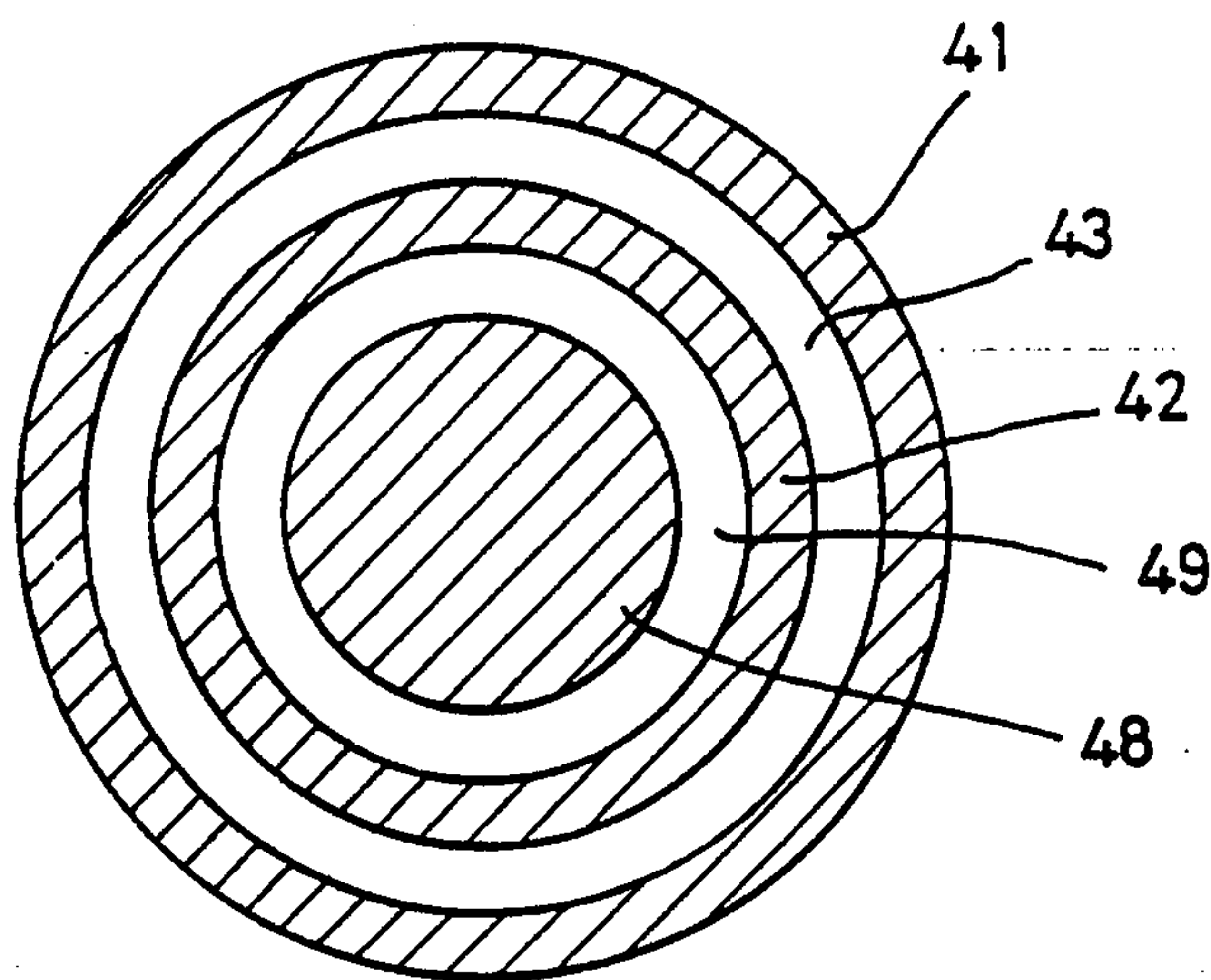


Fig. 5

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