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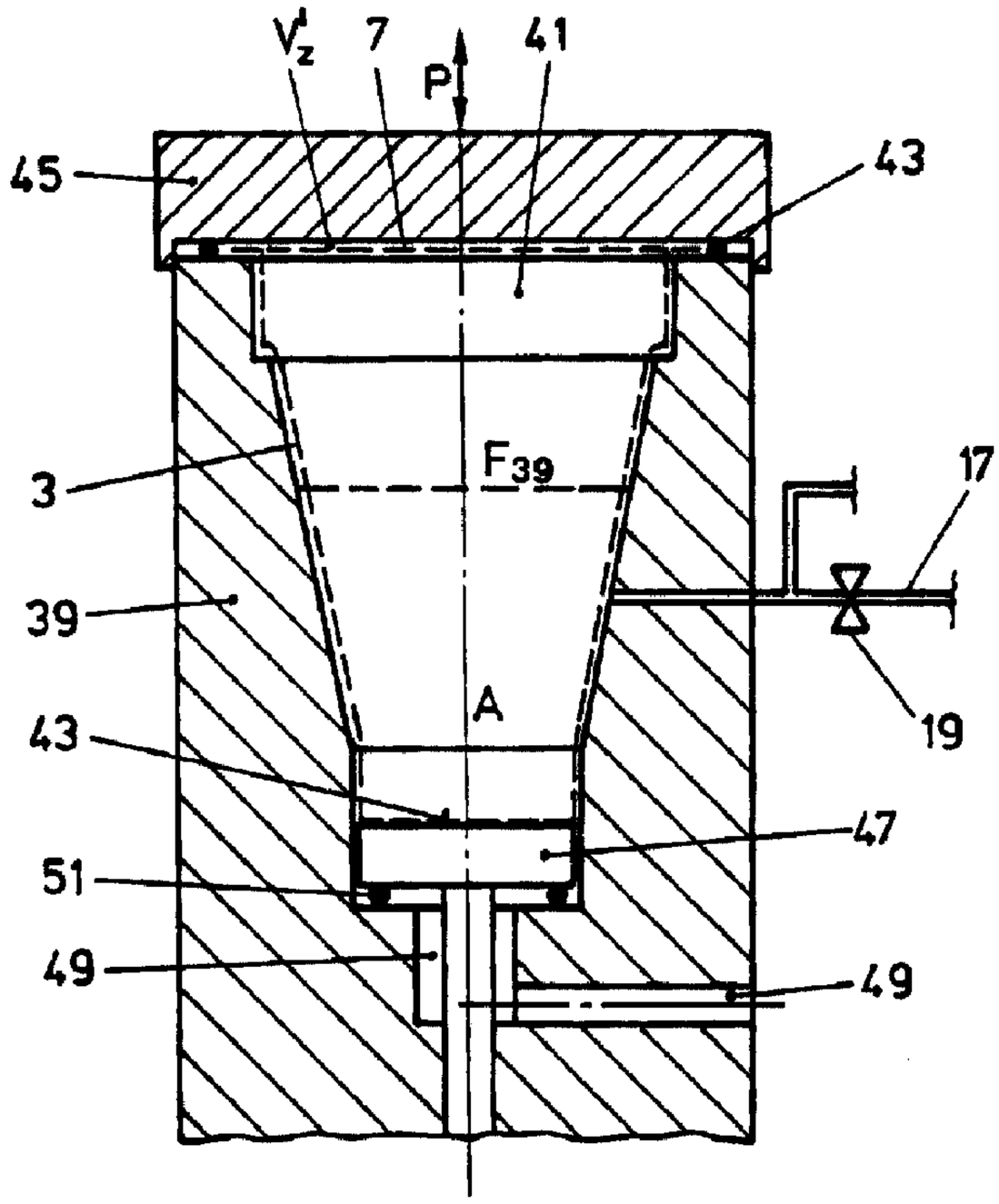
(54) Titre : METHODE VISANT A REDUIREE LE TEMPS DU CYCLE D'ESSAI ET A AMELIORER LA PRECISION DES MESURES DANS UN ESSAI D'ETANCHEITE

(54) Title: METHOD FOR REDUCING TEST CYCLE TIME AND FOR IMPROVING MEASURING ACCURACY AT A LEAK TESTING PROCESS



(57) Abrégé/Abstract:
The present invention relates to a method and apparatus for reducing the test cycle time and for improving the measuring accuracy of a leak testing process of a container. The process comprises the steps of providing a pressure difference as an initial predetermined pressure between the exterior of a closed container and the interior of the closed container without

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(57) Abrégé(suite)/Abstract(continued):
destroying the integrity of the container. The pressure exterior to the sealed container is measured for a certain time. This measurement determines the pressure integrity of the closed container. The method also includes the step of minimizing the volume of the exterior of the closed container wherein the size of that volume determines the test cycle time and the measuring accuracy. The invention further comprises a test chamber which is closable and contains a cavity for introducing the container under test. A means is provided for installing or introducing a pressure difference at an initial predetermined value between the exterior of the container under test and the interior of the cavity. A measuring unit is provided for measuring the pressure value which is dependent on the pressure difference and the leakage of the container. The shape of the cavity is at least substantially geometrically similar to the shape of the container so as to minimize the volume of the cavity outside the sealed container under test.

Abstract:

The present invention relates to a method and apparatus for reducing the test cycle time and for improving the measuring accuracy of a leak testing process of a container. The process comprises the steps of providing a pressure difference as an initial predetermined pressure between the exterior of a closed container and the interior of the closed container without destroying the integrity of the container. The pressure exterior to the sealed container is measured for a certain time. This measurement determines the pressure integrity of the closed container. The method also includes the step of minimizing the volume of the exterior of the closed container wherein the size of that volume determines the test cycle time and the measuring accuracy. The invention further comprises a test chamber which is closable and contains a cavity for introducing the container under test. A means is provided for installing or introducing a pressure difference at an initial predetermined value between the exterior of the container under test and the interior of the cavity. A measuring unit is provided for measuring the pressure value which is dependent on the pressure difference and the leakage of the container. The shape of the cavity is at least substantially geometrically similar to the shape of the container so as to minimize the volume of the cavity outside the sealed container under test.

METHOD FOR REDUCING TEST CYCLE TIME AND FOR IMPROVING MEASURING ACCURACY AT A LEAK TESTING PROCESS

This is a division of co-pending Canadian Patent Application 2,008,372 filed on January 23, 1990.

Field and background of the invention

The present invention relates in general to a method for leak testing of a container to a test chamber therefor and to a test machine for in-line testing of such containers. More particularly, the present invention is directed on a method for reducing test cycle time and for improving the measuring accuracy at a leak testing process as well as to a test chamber and to a test machine with reduced test cycle time and improved measuring accuracy.

Methods for leak testing of containers are known at which a pressure difference is applied between the interior and the exterior of a container to be tested as an initial value for latter measuring. Afterwards, the time course of a pressure value, which is dependent from the pressure difference installed as the initial value and from leakage conditions of the container to be tested, is measured, significant for leak conditions of the container under test.

Such a leak testing method is e.g. known from the German laid open print no. 24 47 578. This reference provides for a testing method to test the welding seam of such container with respect to leakage. Therefore such containers are pressure loaded inside and also outside, through an opening of the container to be tested. There is provided separately a test chan-

nel around the welding seam of the container and leakage is monitored by measuring the time course or timely development of pressure within said test channel. This measuring is indicative for the leakage of the welding seam of the open container.

From the German laid open print no. 21 15 563 it is further known to test the seam of containers which are closed by a foil lid. Thereby, the bottom of the container is perforated by means of a needle-like end part of a pressure line, by which the inside of the container is pressurized. By monitoring the time course of the inside pressure of the container, an indication is provided indicative of tightness of the container.

From the article "Lecksuche mittels Differenzdruckmessungen" from J.T. Furness, VFI 4/78, it is generally known to test a container on leakage by monitoring its internal or its external pressure. Thereby it is described that the smaller that a volume is selected wherein the time course of pressure is monitored, the more accurate such a measuring will become.

There exists a clear need for shortening the time span necessitated for a test cycle of a container on one hand and of improving the accuracy of such tests to be able to detect smallest leakages of such containers.

Summary of the invention

It is an object of the present invention to shorten the time span necessitated to leak test a container and to simultaneously improve the measuring accuracy for leak detection, thus leading to the possibility to detect significantly reduced leakages in shorter test time.

In accordance with one aspect of the present invention there is provided a method of leak testing a container with a substantially flexible wall portion, the method comprising the steps of: introducing the container into a test cavity so that said flexible wall portion of said container is spaced from an inner adjacent wall portion of said test cavity with a gap being defined between said inner adjacent wall portion of said test cavity and said flexible wall portion of said container; installing a pressure difference as an initial value between the interior of said container and at least said gap by applying a pressure at least to said gap which is smaller than a pressure inside said container; supporting said flexible wall portion from its exterior side and a further wall portion opposite to said flexible wall portion within said test cavity at distinct loci so as to prevent said flexible wall portion from bending outwardly into contact with said inner adjacent wall portion of the test cavity as a result of said pressure difference; and measuring the time course of a pressure prevailing within said gap as a leak indicative signal.

In accordance with another aspect of the present invention there is provided a test chamber for leak testing a container with a wall with at least a flexible wall portion, the test chamber comprising: a closable test cavity with an inner wall within which a container to be leak tested can be positioned with the flexible wall portion of the container spaced from an adjacent portion of said inner wall; means for controllably reducing pressure within said cavity; means for measuring pressure within said cavity; and supporting means with at least one supporting surface, said surface being spaced from said adjacent portion of the inner wall of the test cavity to prevent the flexible wall portion of the container from bending outwardly into contact with said adjacent portion of said inner wall due to a reduced pressure within said cavity with respect to pressure within said container.

In accordance with yet another aspect of the present invention there is provided a test machine for in-line leak testing of containers after their filling and their closing, the test machine comprising: a multitude of closable test cavities for introducing respective ones of said closed and filled containers; means for installing a pressure difference as an initial value between the inside of said containers and the remaining volume of respective ones of said test cavities once respective containers are introduced in said respective cavities; and means for measuring pressure within said test cavities and means for supporting portions of the walls of said container, which face each other respectively at distinct loci spaced from an inner wall of at least a part of said cavities.

In accordance with still yet another aspect of the present invention there is provided a method of using selected closed unleaky containers, the method comprising the steps of: producing a closed container with a substantially flexible wall portion; introducing the container into a test cavity so that said flexible wall portion of said container is spaced from an inner adjacent wall portion of said test cavity with a gap being defined between said inner adjacent wall portion of said test cavity and said flexible wall portion of said container; installing a pressure difference as an initial value between the interior of said container and at least said gap by applying a pressure at least to said gap which is smaller than a pressure inside said container; supporting said flexible wall portion from its exterior side and a further wall portion opposite to said flexible wall portion within said test cavity at distinct loci so as to prevent said flexible wall portion from bending outwardly into contact with said inner adjacent wall portion of the test cavity as a result of said pressure difference; measuring the time course of a pressure prevailing within said gap as a leak indicative signal; and using said container if said leak indicative signal does not indicate leakiness.

Description of the drawings

The above and other features of the present invention will be more readily understood when the following detailed description is considered in conjunction with the accompanying drawings, in which:

fig. 1 shows schematically a prior art test chamber and its use for leak testing of closed and filled containers which containers have a diminishing cross-sectional area seen in direction of a transverse container axis,

fig. 2 shows schematically and in analogue representation to fig. 1, an inventive test chamber realized according to the inventive method,

fig. 3 shows schematically in a cross-sectional representation a preferred embodiment of an inventive test chamber for leak testing of cup shaped containers as of yoghurt cups.

In fig. 1 there is schematically shown a test chamber 1 as it is known also for leak testing of closed containers 3, which, seen in direction of an axis A of the container, have a diminishing cross-sectional area F_3. The container 3 is filled with a filling material 5 and is e.g. closed by a covering foil-like lid 7. The foil-like lid 7 is fixed along its periphery to the container 3, e.g. by glueing or welding. Such a container may be a plastic material cup being closed by an aluminium foil 7.

For leak testing, such containers 3 are introduced into the test chamber 1 which then is hermetically closed by means of a cover 11 and a seal 13. Between the container 3 and the interior wall of the test chamber, which latter consists of the cover 11 and the chamber receptacle 15, there is defined a remaining volume V_z which is pressurized by the test pressure p_z which test pressure is different from the pressure inside the closed container 3.

This is realized, as may be seen schematically from fig. 1, by means of a pressurizing feed line 17 with a valve 19. After pressurizing the remaining volume

V_z the valve 19 is closed and the time development of the pressure p_z within the remaining volume V_z is monitored, e.g. with the help of a pressure sensor 21, which is preferably a difference pressure sensor. There is led to one of the pressure inputs of the difference pressure sensor a reference pressure p_R, to the other of its inputs the pressure p_z of the remaining volume V_z which is on one hand dependent from the pressure previously installed before the valve 19 was shut and from leakage of the container 3.

If, as a testing pressure, a pressure is applied to the remaining volume V_z which is lower than the pressure residing inside the container 3, then a leak of the container 3 will result, after shutting valve 19, in a rising pressure in the remaining volume V_z because of the gas exchange stream out of container 3 through the leak of the container 3, into the volume V_z.

Inversely, a reduction of pressure in the remaining volume V_z will be registered due to a leak of the container 3 if, as a test pressure, an initial pressure is applied to the remaining volume V_z which is higher than the pressure residing inside the container 3.

To initially apply the test pressure p to the remaining volume V_z as an initial value for testing, a gas volume must be fed to or removed from the said remaining volume V_z, the amount of which being the larger, the bigger than the said remaining volume V_z is chosen.

The amount of gas which has to be fed or removed so as to instal the test pressure p_z, as an initial value, directly influences the time span necessitated to reach the test pressure initial value, given a defined power of a pressurizing or evacuation source connected to the feeding line 17: The smaller that the remaining volume V_z is selected, the smaller the time span for reaching a predetermined test pressure p_z as said initial value will be.

Further, by a given leak and by a given initial test pressure p_z, and thus an initial, given pressure difference between pressure in the remaining volume V_z and pressure in the interior of the container 3, the amount of gas flowing out of such leak per time unit is defined. Thus, a change of pressure within the remaining volume V_z as a result of leakage will become the bigger, the smaller that the said remaining volume V_z is.

To optimally exploit these conditions as schematically shown in fig. 2, the test chamber is tailored that it defines together with an introduced container 3 to be tested, an optimally small remaining volume V_z.

The inventive test chamber 31, shown schematically in fig. 2, comprises a one side open receptacle 35 with an opening 34, whereby cross-sectional areas F_{35} of the receptacle 35, seen from the opening 34, continuously diminish. The diminution of the cross-sectional area F_{35} along the axis A_{35} preferably accords to the diminution of the cross-sectional area F_3 of a container 3 to be tested and to be therefore introduced

into the test chamber 31. Thus, the wall of the container 3 and the inside wall of the test chamber 31 will be substantially aequidistant, once such a container 3 is introduced into the test chamber 31. Thus, the remaining volume V_z is minimalized.

The inventive test chamber 31 comprises a cover 33 which closes with schematically shown seals 37 the test chamber 31 sealingly after a container 3 to be tested having been introduced therein. Application of the initial test pressure and monitoring the time course of pressure at the remaining volume V_z is realized the same way as was described for prior art test chambers and methods according to fig. 1.

In fig. 3 there is shown a preferred embodiment of an inventive test chamber again schematically. As an example it is constructed for testing closed containers 3 of substantial truncated cone form, as for testing yoghurt cups, with respect to leakage.

A container 3 to be tested and with a covering lid 7 is shown in dashed lines. The inventive test chamber comprises a receptacle 39 which is formed according to the outside form of the container 3. The cross-sectional area of the receptacle 39, F_{39} diminishes in direction of the central axis A substantially cone-like departing from a receptacle opening 41, towards the bottom 43 of the receptacle 39 and defines a cavity which is substantially similar in the sense of geometric similarity with the container 3, so that, when the container 3 to be tested is introduced, there is defined between its wall and the inside

wall of the receptacle 39 substantially constant distances.

Adjacent to the opening 41 of the receptacle 39 there is preferably provided a positioning groove for a collar which is usually provided at such containers to which collar the covering foil-like lid of the container is welded (not shown).

The test chamber comprises further a cover 45 which is movingly driven as shown by reference P and is moved towards or from the receptacle 39, so as to either sealingly close it with the help of the seals 43 or to open it.

At the bottom of the receptacle 39 there is provided an axially movable and controllably driven piston 47 which retracted, when a container 3 to be tested is introduced in the test chamber and during testing of the container, and which, after opening the cover 45, is driven into the test chamber, so as to eject the tested container 3.

The piston 47 comprises an enlarged piston head.

At the bottom of the receptacle 39, adjacent to the piston head, a drain sleeve 49 enters into the test chamber which is sealingly closed by means of the head of the piston 47 by means of seals 51, once the piston 47 is retracted. Thus, after testing a container 3 which was leaking, so that material contained in the container 3 could possibly penetrate into the test chamber, the test chamber may be rinsed after

the piston 47 has been driven into the test chamber 31 to eject the leaking container 3. Thus, the test chamber 31 is rinsed and the rinsing liquid will be drained out of the open drain sleeve 49. For further improving rinsing of the test chamber, there may be provided, as at the cover 45, a rinsing liquid feed line, possibly with a nozzle arrangement, to eject rinsing liquid into the test chamber (not shown).

Preferably, and especially for use with containers which are closed by means of a covering foil 7, as yoghurt cups etc., the test chamber is so arranged that its opening 41 points upwards. By this one prevents that filling material within container 3 drops on the covering lid which could lead to deteriorate leak testing and especially leak testing of the weld seam between covering lid 7 and the wall of the container, because the lid 7 would then be loaded by filling material to a condition not nominal.

The test chamber according to fig. 3 comprises, as again schematically shown, pressure feed and pressure monitoring means as were described in connection with fig. 1 and 2.

For leak testing of containers, as of yoghurt-, cream- etc. cups, continuously in line with filling and closing operations for such containers, by which leak testing e.g. every container of the production shall be tested, a multitude of inventive test chambers, one of which having been described with the help of fig. 3, are combined to form a test machine. In such a machine the multitude of test chambers according to

fig. 3 are preferably arranged on a turnably driven carousel table (not shown), so that, in line with filling and closing of the containers, all of them are pressure leak tested before these containers are stored ready for package.

Especially for testing of containers with a flexible wall by means of applying under-pressure, areas of the container walls may be pressed on the inner wall of the test chamber. To prevent this it may be advisable to provide a mesh inlay along and slightly distant from the wall of the test chamber, so e.g. in the form of a cone-shaped mesh inlay which is open at its bottom end and in which the container 3 to be tested is introduced. Such a mesh inlay mechanically stabilizes the wall of the container 3 with respect to outwards bending. Thus, with the help of such a mesh inlay it is prevented that the flexible container wall is bent so as to tightly reside on the inner wall of the test chamber when under-pressure is used as a test pressure in the remaining volume V_z. Possibly pressure equalizing connections are provided between the lower part of the receptacle 39 and the upper part adjacent to the cover 41 to ensure pressure equalization all around a container 3 to be tested, if a cover of the container tends to sealingly separate the lower part volume of the test chamber from the said upper part volume.

Such connections between lower and upper parts of the test chamber to provide for equalization of the pressure may be provided by appropriate grooves at the cover region of the test chamber, linking the lower

part of the remaining volume V_z with the upper part V'_z thereof.

Thus, providing a receptacle, the open cross-sectional area thereof diminishing in direction towards the bottom of the receptacle and comprising a cover for tightly closing, there is realized a most simple test chamber, from which a container 3, once tested, may be removed without any problems.

It must be pointed out that the above described provision of a grid or mesh structured inlay into the test chamber may also prevent a mechanically deformed wall of a container under test to sealingly shut either an evacuation line for installing the initial test pressure and abutting into the remaining volume V_z or a measuring line for afterwards monitoring the time development of the pressure within the remaining volume.

Additionally, such a mechanical deformation of the container wall could lead to leakage of containers which would not occur if such a deformation is prevented as by the said mesh inlay.

Claims:

1. A method of leak testing a container with a substantially flexible wall portion, the method comprising the steps of:

introducing the container into a test cavity so that said flexible wall portion of said container is spaced from an inner adjacent wall portion of said test cavity with a gap being defined between said inner adjacent wall portion of said test cavity and said flexible wall portion of said container;

installing a pressure difference as an initial value between the interior of said container and at least said gap by applying a pressure at least to said gap which is smaller than a pressure inside said container;

supporting said flexible wall portion from its exterior side and a further wall portion opposite to said flexible wall portion within said test cavity at distinct loci so as to prevent said flexible wall portion from bending outwardly into contact with said inner adjacent wall portion of the test cavity as a result of said pressure difference; and

measuring the time course of a pressure prevailing within said gap as a leak indicative signal.

2. The method according to claim 1, wherein a mesh inlay is used at least along parts of the test cavity for said supporting of the flexible wall portion.

3. The method according to claim 1, wherein said flexible wall portion is supported at a multitude of locations distributed along said wall portion.

4. The method according to claim 1, including minimizing the volume of said gap by minimizing the distance between said flexible wall portion of said container and said inner adjacent wall portion of the said test cavity to reduce a time amount for installing said pressure difference and for improving sensitivity of said measuring.

5. A test chamber for leak testing a container with a wall with at least a flexible wall portion, the test chamber comprising:

a closable test cavity with an inner wall within which a container to be leak tested can be positioned with the flexible wall portion of the container spaced from an adjacent portion of said inner wall;

means for controllably reducing pressure within said cavity;

means for measuring pressure within said cavity; and

supporting means with at least one supporting surface, said surface being spaced from said adjacent portion of the inner wall of the test cavity to prevent the flexible wall portion of the container from bending outwardly into contact with said adjacent portion of said inner wall due to a reduced pressure within said cavity with respect to pressure within said container.

6. The test chamber according to claim 5, wherein said supporting means comprises a mesh structure which is spaced from said adjacent portion.

7. The test chamber according to claim 5, wherein said supporting means comprises a mesh structure which has a form such that the container can be introduced into the mesh structure for mechanically stabilizing the container with respect to outward bending due to a reduced pressure within said cavity with respect to pressure within said container.

8. The test chamber according to claim 5, further comprising means for positioning the container within said cavity so that substantial wall portions of said container are spaced from adjacent portions of said test cavity inner wall.

9. The test chamber according to claim 8, wherein said supporting means comprises a multitude of distinct supporting surfaces.

10. The test chamber according to claim 5, wherein the space of said test cavity is substantially geometrically similar to the shape of the container to be tested.

11. A test machine for in-line leak testing of containers after their filling and their closing, the test machine comprising:

a multitude of closable test cavities for introducing respective ones of said closed and filled containers;

means for installing a pressure difference as an initial value between the inside of said containers

and the remaining volume of respective ones of said test cavities once respective containers are introduced in said respective cavities; and

means for measuring pressure within said test cavities and means for supporting portions of the walls of said container, which face each other respectively at distinct loci spaced from an inner wall of at least a part of said cavities.

12. The test machine according to claim 11, wherein said cavities have a substantially truncated form to receive containers.

13. A method of using selected closed unleaky containers, the method comprising the steps of:

producing a closed container with a substantially flexible wall portion;

introducing the container into a test cavity so that said flexible wall portion of said container is spaced from an inner adjacent wall portion of said test cavity with a gap being defined between said inner adjacent wall portion of said test cavity and said flexible wall portion of said container;

installing a pressure difference as an initial value between the interior of said container and at least said gap by applying a pressure at least to said gap which is smaller than a pressure inside said container;

supporting said flexible wall portion from its exterior side and a further wall portion opposite to said flexible wall portion within said test cavity at

distinct loci so as to prevent said flexible wall portion from bending outwardly into contact with said inner adjacent wall portion of the test cavity as a result of said pressure difference;

measuring the time course of a pressure prevailing within said gap as a leak indicative signal; and

using said container if said leak indicative signal does not indicate leakiness.

14. The method according to claim 13, wherein a mesh inlay is used at least along parts of the test cavity for said supporting of the flexible wall portion.

15. The method according to claim 13, wherein said flexible wall portion is supported at a multitude of locations distributed along said wall portion.

16. The method according to claim 13, including minimizing the volume of said gap by minimizing the distance between said flexible wall portion of said container and said inner adjacent wall portion of the said test cavity to reduce a time amount for installing said pressure difference and for improving sensitivity of said measuring.

FIG.1
PRIOR ART

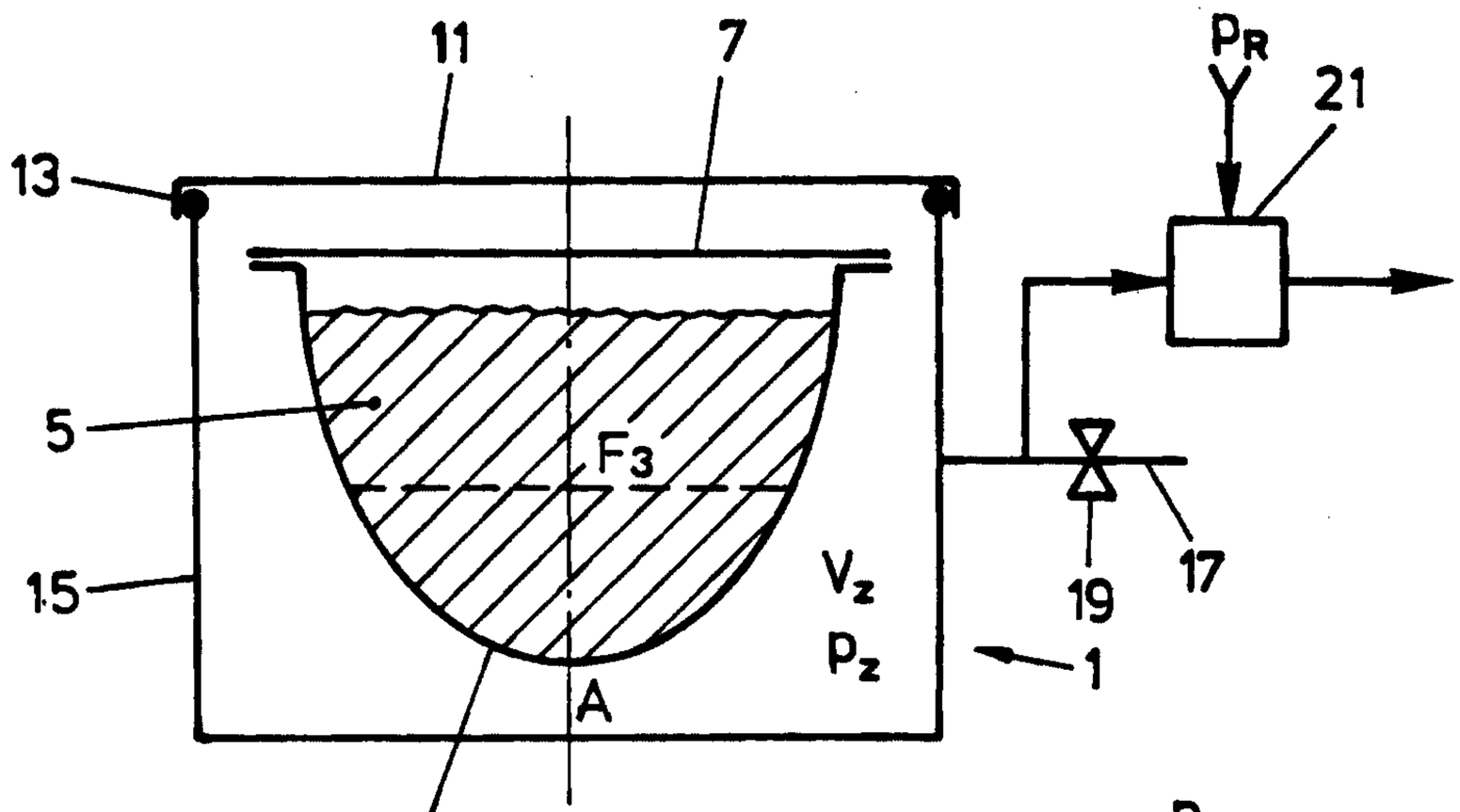


FIG. 2

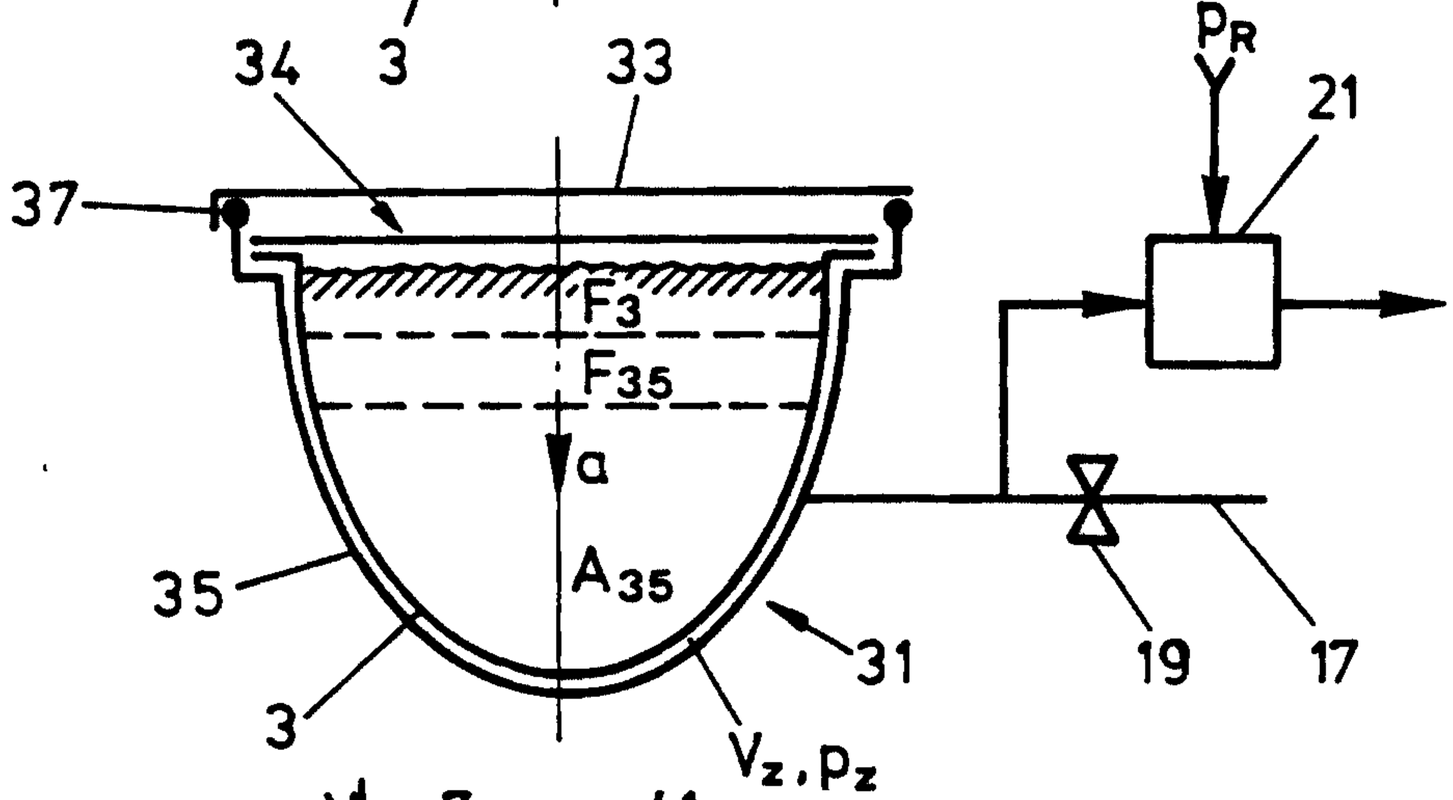
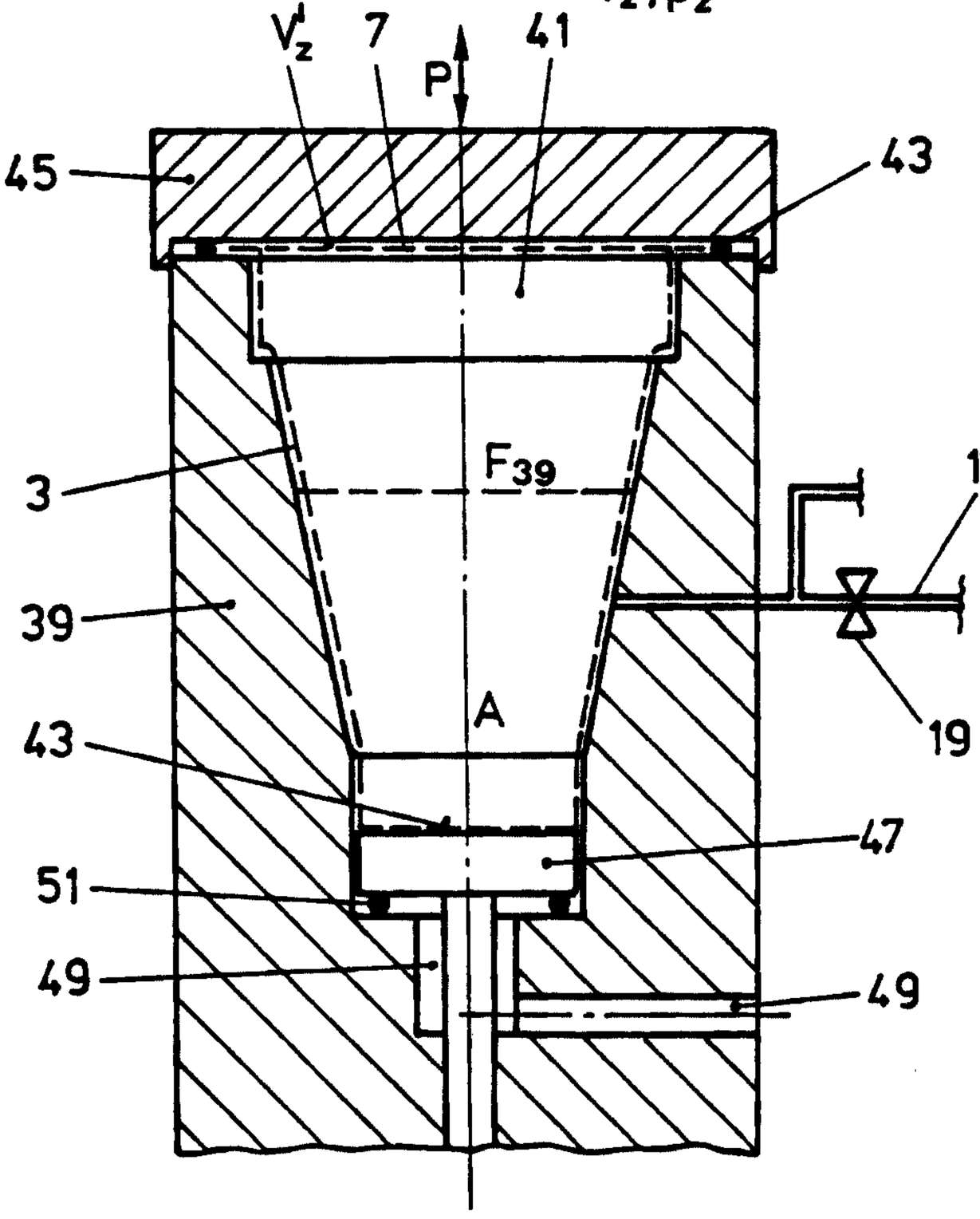
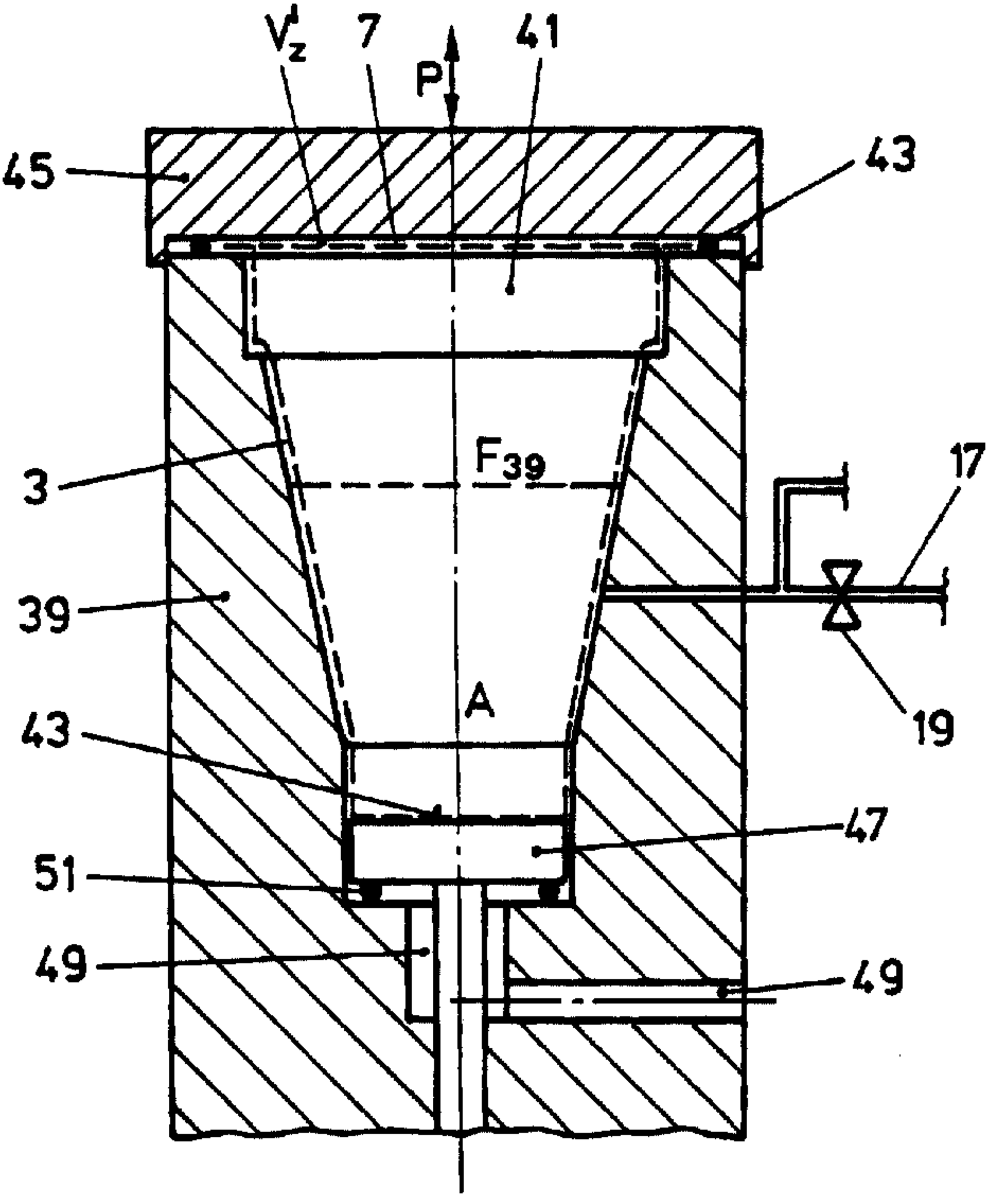


FIG.3




V_z
7
P
41
45
43
3
F_{39}
17
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A
19
43
47
51
49
49