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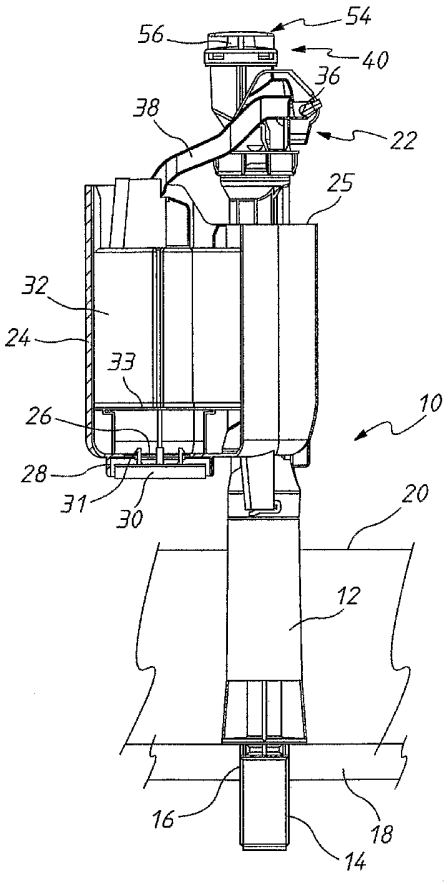
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[Continued on next page]

(54) Title: A CISTERN INLET VALVE ASSEMBLY



(57) Abstract: A cistern inlet valve assembly (10). The valve assembly (10) includes a mechanical valve (22) adapted for mounting with the interior of a cistern (18). The valve (22) has an inlet (43) adapted to receive water from a pressurised water source and an outlet (49) adapted to provide the received water to the cistern interior. A bucket (24) is adapted for mounting at a predetermined height in the cistern interior. The bucket (24) has an upper opening (23) to its interior and a lower drain opening (26). A first float (30) is provided beneath the drain opening (26) and a second float (32) having a lower opening (33) within the bucket (24). The valve assembly (10) also includes a cam (36) adapted for movement causing opening and closing of the mechanical valve (22) and a lever (38) adapted to move the cam (36) in response to movement of the second float (33).

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A CISTERN INLET VALVE ASSEMBLY

Field of the Invention

The present invention relates to a cistern inlet valve assembly.

The valve assembly is used to control the flow of water during refilling of a toilet cistern (known as a 'flushtank' in the United States) after flushing.

Definition

As used hereinafter in this specification, the expression 'mechanical valve' refers to a valve that relies on mechanical force to hold the valve closed against a source of pressurised fluid at the valve inlet. As used hereinafter in this specification, the expression 'hydraulic valve' refers to a valve that utilizes the inlet fluid pressure itself to hold the valve closed.

Background of the Invention

Environmental concerns and water usage restrictions have led to many households and other buildings treating and re-using water. This is commonly referred to as 'grey water' and is stored in tanks before being supplied back to the household via a pump. Many households also collect rainwater, which is similarly stored in a tank and returned to the household via a pump. These pumped water sources are generally supplied at a pressure of about 100 to 400kPa, whereas household mains water supply is often supplied at a pressure of about 400 to 1400kPa. Grey water is often substituted for mains water supply for non-drinking uses including flushing toilets and watering gardens.

Many known cistern inlet valves vary the volume of water they admit to a cistern relative to the supplied inlet water pressure. These valves do not allow a cistern to perform optimally if the water supply to the cistern is switched between mains and pumped. In particular, cisterns with a mechanical inlet valve installed for use with relatively high mains water pressure may have poor pan clearance performance when supplied with relatively low pumped water pressure. Further, cisterns installed for use with pumped water pressure can overflow when supplied with mains water pressure.

Further, when a cistern inlet valve assembly uses a mechanical valve, the valve closure force changes with inlet water supply pressure. Accordingly, a mechanical valve initially configured for low supply pressures, can have valve closure difficulties at high supply pressures. Moreover, it can be difficult to get adequate closing force on the mechanical valve at high inlet supply pressures (eg. 2000kPa) without the use of very long lever arm and float arrangements, which require increased cistern size and/or undesirable cistern proportions.

A cistern inlet valve assembly that uses a hydraulic valve can be problematic in not closing at low supply pressures. Additionally, hydraulic valves are complicated, and thus expensive, and rely on small pilot and control channels that are prone to blockage.

It is also a requirement for cistern inlet valves to have back-siphonage protection so that any water in the cistern (which may be contaminated) cannot be drawn back into the mains water supply if a negative pressure is applied to the inlet valve. Back-siphon protection in many known valves have hitherto relied on an elastomeric component deforming or moving to obstruct ports to atmosphere or open the flow path during the fill cycle of the valve and then returning to its original position after the fill cycle. These have been found to degrade and cease to function correctly due to chemical attack from dosing agents used in the cistern's water. The use of higher quality, more chemically resistant, elastomeric seal material is expensive.

It is an object of the present invention to provide a cistern inlet valve assembly that substantially overcomes or at least ameliorates one or more of the above deficiencies and, in a preferred form, is: able to provide constant cistern fill volumes at relatively high and relatively low inlet water supply pressures; relatively inexpensive to manufacture; and incorporates robust back-siphonage protection.

Summary of the Invention

Accordingly, the present invention provides a cistern inlet valve assembly, the valve assembly including:

a mechanical valve adapted for mounting with a cistern interior, the valve having an inlet adapted to receive water from a pressurised water source and an outlet adapted to provide the received water to the cistern interior;

a bucket adapted for mounting at a predetermined height in the cistern interior; the bucket having an upper opening to its interior and a lower drain opening;

a first float beneath the drain opening;

a second float having a lower opening within the bucket;

a cam adapted for movement causing opening and closing of the mechanical valve; and

a lever adapted to move the cam in response to movement of the second float.

During initial filling of the cistern, the first float is lifted by the rising water to seal the bucket's lower drain opening. During further filling, water overflows into the bucket via its upper opening and, when the bucket is filled above the second float's lower opening, the second float is raised relative to the bucket thereby causing the lever to act on the cam to cause closure of the mechanical valve.

During emptying of the cistern, the first float falls away from sealing the bucket drain opening when the water level in the cistern fall beneath the first float, whereafter the second float falls relative to the bucket thereby causing the lever to act on the cam and cause opening of the mechanical valve.

The ratio of the length of the lever to the stroke of the cam is preferably between about 20:1 and 40:1, most preferably about 28.5:1.

The bucket and the cam are preferably mounted on an inlet stem which is itself mounted to the cistern. The inlet stem is preferably hollow and has an interior duct with a first end in fluid communication with the pressurised water source and a second end in fluid communication with the inlet of the mechanical valve. The cam is preferably mounted, most preferably pivotally mounted, on the opposite side of the inlet stem to the bucket.

The valve assembly preferably also includes a back-siphon preventing valve, most preferably mounted atop the inlet stem. The back-siphon preventing valve preferably includes a housing with at least one opening to atmosphere, a sealing face in fluid communication with the opening(s) and a substantially rigid valve member, with a complimentary sealing face, therein. The valve member is preferably adapted to rise and fall to respectively close and open the sealing faces. The valve member preferably also occludes the inlet stem water outlet in the fallen position. The rising of the valve member

is preferably in response to sufficient inlet water pressure acting on its underside. The falling of the valve member is preferably in response to gravity, in the absence of sufficient inlet water pressure acting on its underside.

Brief Description of the Drawings

Preferred embodiments of the invention will now be described, by way of examples only, with reference to the accompanying drawings in which:

Fig. 1 is a partially cross-sectional side view of a cistern inlet valve assembly according to a first embodiment of the invention, during initial refilling of a cistern;

Fig. 2 is an enlarged cross-sectional view of the assembly shown in Fig. 1;

Fig. 3 is a side-view of the assembly shown in Fig. 1 partway through refilling of the cistern;

Fig. 4 is a side-view of the assembly shown in Fig. 1 after refilling of the cistern;

Fig. 5 is an enlarged cross-sectional side-view of the valve assembly shown in Fig. 4;

Fig. 6 is a top view of the valve assembly shown in Fig. 4;

Fig. 7 is a top view of the valve assembly shown in Fig. 1; and

Fig. 8 is an enlarged cross-sectional side-view of the cistern inlet valve assembly according to a second embodiment of the invention, during initial refilling of a cistern.

Detailed Description of the Preferred Embodiments

Figs. 1 to 7 show a cistern inlet valve assembly 10 according to a first embodiment of the invention. Referring firstly to Fig. 1, the valve assembly 10 has a hollow inlet stem 12 adapted for installation in a substantially vertically orientation. The inlet stem 12 has a threaded connector 14 at its lower end. The connector 14 passes through an opening 16 in

a cistern 18 and is secured thereto by a nut (not shown), as will be described in more detail below. The water level in the cistern 18 is indicated by line 20.

The valve assembly 10 has a mechanical valve, indicated generally by the reference numeral 22, mounted near the upper end of the inlet stem 12. The valve 22 shall be described in more detail below. The valve assembly 10 also has a bucket 24 mounted to the stem 12. The bucket 24 has an upper opening 25 and a lower drain opening 26 in its underside, the latter surrounded by an annular flange 28. A first float 30 is retained within the flange 28 by prongs 31 that loosely snap-engage through the opening 26. A second float 32, having a lower opening 33, is positioned substantially within the bucket 24. The second float 32 is restrained against lateral movement within the bucket 24 but is able to move up and down relative to the bucket 24.

As best shown in Fig. 2, the valve assembly 10 also includes a cam 36, pivotally mounted on an axle 37, on the opposite side of the stem 12 to the bucket 24. The cam 36 acts on the mechanical valve 22 and is fixed to a lever, in the form of float arm 38, which extends to the top of the second float 32. The positioning of the axle 37 on the opposite side of the stem 12 to the bucket 24 increases the length of the lever 38 thereby increasing the lever advantage it provides to the cam 36.

The valve assembly 10 also has a back-siphonage protection valve, indicated generally by the reference numeral 40, which will also be described in more detail below.

As best shown in Fig. 2, the mechanical valve 22 has an inlet port 42 in fluid communication with a hollow interior duct 43 in the inlet stem 12. The valve 22 also has a rubber diaphragm 44 and a follower, in the form of plunger 46, which is driven by the cam 36 to move the diaphragm 44 towards and away from the port 42. A strainer 47 and a spiral flow restrictor 48 are also positioned within the duct 43.

The valve 22 also has an outlet 49, which leads to an overflow spigot 50. The back-siphonage protection valve 40 includes a valve member, in the form of moving poppet 52, over the upper end of the overflow spigot 50. The poppet 52 has an upper sealing face 53, as best seen in Fig. 5. The poppet 52 is restrained by a housing, in the form of cap 54, that has openings 56 to atmosphere therein. The openings 56 are adjacent to an opening 57 that defines a lower sealing face, as is also best seen in Fig. 5.

The basic steps in the assembly and installation of the valve assembly 10 shall now be described. Firstly, the poppet 52 is positioned over the spigot 50 and the cap 54 is clipped in position over the poppet 52. The valve diaphragm 44 is then placed adjacent the outlet 49 and the plunger 46 positioned against the diaphragm 44. The restrictor 48 is then placed on the strainer 47 and they are both pushed into the inlet stem 12. The float arm 38 is then connected to the axel 37. The float 32 in then placed inside the bucket 24 and the first float 30 is clipped into the bucket's drain hole 26. The bucket 24 is positioned on the inlet stem 12 with the float arm 38 positioned on, and engaged with, the top of the second float 32. The valve assembly 10 can then be installed in a cistern 18 by placing a seal (not shown) over the threaded end 14 of the inlet stem 12 and placing the threaded end 14 through the hole 16 in the base of the cistern 18. A nut (not shown) is then screwed up the threaded end 14 against the underside of the cistern 18. A water supply is then connected to threaded end 14, as is well understood by persons skilled in the art.

The operation of the valve assembly 10 shall now be described. Figs. 1 and 2 show the valve assembly 10 during initial refilling of the cistern 18 after flushing. The weight of the float 32 causes it to fall to its lowermost position, under the influence of gravity. The end of the float arm 38 adjacent the second float 32 similarly falls to its lowermost position, and thus moves the cam 36 to a position which allows the plunger 46 to move and the valve 22 to open.

Supplied water (either from a mains or pump supply) enters the duct 43 in the inlet stem 12 via the threaded connector 14, as indicated by arrow 70, and proceeds through the strainer 47, as indicated by arrows 72. The water then circulates around the spiral flow restrictor 48, as indicated by arrow 74, which reduces its speed and noise. The water then flows from the restrictor 48 to the valve port 42 and then from the valve port 49 to the outlet spigot 50, as indicated by arrow 75. The pressure of the water at the inlet port 42 also assists in retracting the valve diaphragm 44 to a position allowing water flow through the port 42. The water overflows from the spigot 50, as indicated by arrows 76, and flows into the cistern 18 to refill the cistern 18. The water flows along the exterior of the inlet stem 12, which reduces splashing and noise.

The water overflowing from the spigot 50 also forces the poppet 52 upwards and out of sealing contact of the upper end of the spigot 50.

Fig. 3 shows the valve assembly 10 when the water level 20 has passed the underside of the bucket 24. This results in the float 30 being moved upwardly against the underside of the bucket 24 to seal the drainhole 26. At this stage in the filling of the cistern 18, the bucket 24 and second float 32 are unchanged from their position in Fig. 1 and the valve 22 therefore remains fully open.

Figs. 4 and 5 shows the valve assembly after the water level has reached the top of the bucket 24 and then overflowed over the opening 25 and filled the interior of the bucket 24. The filling of the bucket 24 causes the second float 32 to rise. This drives the end of float arm 38 on top of the second float 32 upwards and rotates the cam 36 to a position causing the plunger 46 to force the valve diaphragm 44 against the inlet port 42. This stops the flow of inlet water through the valve 22. It is important to note that the valve 22 is closed solely in response to the water level being sufficient to overflow into the bucket 24, which is advantageously independent of supply pressure. As a result, the valve 22 will always close at a constant height (i.e. the height of the opening 25), and thus produce a constant fill volume, regardless of whether the inlet water is supplied from mains, is gravity fed or is from a pumped supply (e.g. a grey water supply).

When the cistern 18 is flushed the water level begins to drop. As the water level falls, the float 30 falls away from the underside of the bucket 24 thereby allowing water to exit the drain opening 26. As the water in the bucket 24 drains, the second float 32 begins to fall towards the position shown in Fig. 1. This causes the float arm 38 and the cam 36 to open the valve 22 by allowing the diaphragm 44 to move away from the inlet port 42.

Figs. 4 and 5 also show the valve assembly 10 after filling of the cistern but before a flush. As there is no water flowing through the outlet spigot 50 the poppet 52 falls away from the cap 54 onto the top of the spigot 50. This moves the upper sealing face 53 of the poppet 52 away from the lower sealing face 57 of the cap 54, which allows air to enter the inlet stem 12 via the openings 56, as indicated by arrows 78. As a result, if a negative pressure is applied to the inlet connection 14 of the valve assembly 10, as indicated by arrow 79, it will only draw air from atmosphere through the openings 56 rather than drawing potentially contaminated water from the cistern interior into the mains supply. The poppet 52 is preferably made from a relatively inexpensive, rigid plastic material (e.g. acetal) which is resistant to chemical degradation.

Other advantages of the valve assembly 10 include it being relatively simple and robust in nature due to the use of a mechanical valve and being relatively inexpensive to manufacture due to it being primarily made from easily assembled, injection moulded, plastic components.

Fig. 8 shows a cistern inlet valve assembly 80 according to a second embodiment of the invention. The valve assembly 80 is similar to that of the valve assembly 10 and like features have been indicated with like reference numerals. However, in the valve assembly 80, the poppet 52 and the cap 54 are replaced by a nozzle 82 connected to the outlet spigot 50.

The valve assembly 80 is suitable for use with a cistern having an associated hand basin. For example, the basin can be formed as a depression in the lid of the cistern and have a drain opening into the cistern interior. Alternatively, a remote basin can be used which has a drainline connected to the cistern interior.

When a cistern having the valve assembly 80 is flushed, the refilling water flowing through the mechanical valve 22 is directed through the outlet 82 to a spout on the basin (not shown), which allows a user to wash their hands. The water used in washing the user's hands then flows into the cistern interior in a similar fashion to that previously described until filling is achieved and the valve closes. This reduces water usage, as a separate volume of water is not required for filling the cistern and for washing a user's hands.

Although the invention has been described with reference to preferred embodiments, it would be appreciated by a person skilled in the art that the invention may be embodied in many other forms. For example, although the cistern inlet valve assemblies shown have a bottom-entry water inlet, the valve assembly is also suitable for use with a top or a side entry water inlet.

Claims:

1. A cistern inlet valve assembly, the valve assembly including:

a mechanical valve adapted for mounting with a cistern interior, the valve having an inlet adapted to receive water from a pressurised water source and an outlet adapted to provide the received water to the cistern interior;

a bucket adapted for mounting at a predetermined height in the cistern interior; the bucket having an upper opening to its interior and a lower drain opening;

a first float beneath the drain opening;

a second float having a lower opening within the bucket;

a cam adapted for movement causing opening and closing of the mechanical valve; and

a lever adapted to move the cam in response to movement of the second float.

2. A cistern inlet valve assembly, the valve assembly including:

a mechanical valve adapted for mounting with a cistern interior, the valve having an inlet adapted to receive water from a pressurised water source and an outlet adapted to provide the received water to the cistern interior;

a bucket adapted for mounting at a predetermined height in the cistern interior; the bucket having an upper opening to its interior and a lower drain opening;

a first float beneath the drain opening;

a second float having a lower opening within the bucket;

a cam adapted for movement causing opening and closing of the mechanical valve; and

a lever adapted to move the cam in response to movement of the second float,

wherein:

during initial filling of the cistern, the first float is lifted by the rising water to seal the bucket's lower drain opening;

during further filling, water overflows into the bucket via its upper opening and, when the bucket is filled above the second float's lower opening, the second float is raised relative to the bucket thereby causing the lever to act on the cam to cause closure of the mechanical valve; and

during emptying of the cistern, the first float falls away from sealing the bucket drain opening when the water level in the cistern fall beneath the first float, whereafter the

second float falls relative to the bucket thereby causing the lever to act on the cam and cause opening of the mechanical valve.

3. The assembly claimed in claim 1 or 2, wherein the ratio of the length of the lever to the stroke of the cam is between about 20:1 and 40:1.

4. The assembly claimed in claim 3, wherein the ratio of the length of the lever to the stroke of the cam is about 28.5:1.

5. The assembly claimed in any one of the preceding claims, wherein the bucket and the cam are mounted on an inlet stem which is itself mounted to the cistern.

6. The assembly claimed in claim 5, wherein the inlet stem is hollow and has an interior duct with a first end in fluid communication with the pressurised water source and a second end in fluid communication with the inlet of the mechanical valve.

7. The assembly claimed in claim 6, wherein the cam is mounted on the opposite side of the inlet stem to the bucket.

8. The assembly claimed in claim 7, wherein the cam is pivotally mounted on the opposite side of the inlet stem to the bucket.

9. The assembly claimed in any one of the preceding claims, wherein the valve assembly also includes a back-siphon preventing valve.

10. The assembly claimed in claim 9, wherein the back-siphon preventing valve is mounted atop the inlet stem.

11. The assembly claimed in claim 9 or 10, wherein the back-siphon preventing valve includes a housing with at least one opening to atmosphere, a sealing face in fluid communication with the opening(s) and a substantially rigid valve member, with a complimentary sealing face, therein.

12. The assembly claimed in claim 11, wherein the valve member is adapted to rise and fall to respectively close and open the sealing faces.

13. The assembly claimed in claim 12, wherein the valve member occludes the inlet stem water outlet in the fallen position.

14. The assembly claimed in claim 13, wherein the rising of the valve member is in response to sufficient inlet water pressure acting on its underside.

15. The assembly claimed in claim 13, wherein the falling of the valve member is in response to gravity, in the absence of sufficient inlet water pressure acting on its underside.

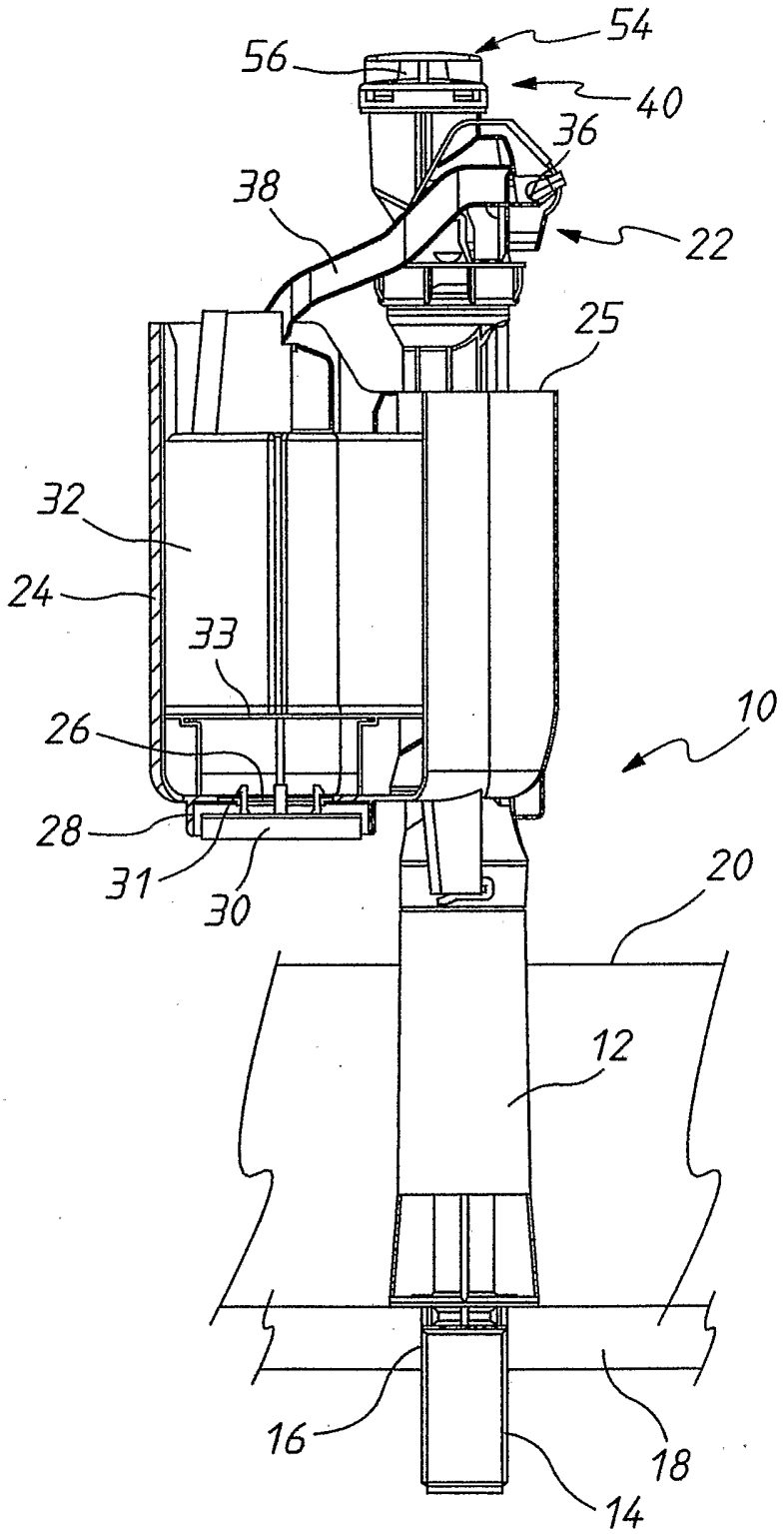


FIG. 1

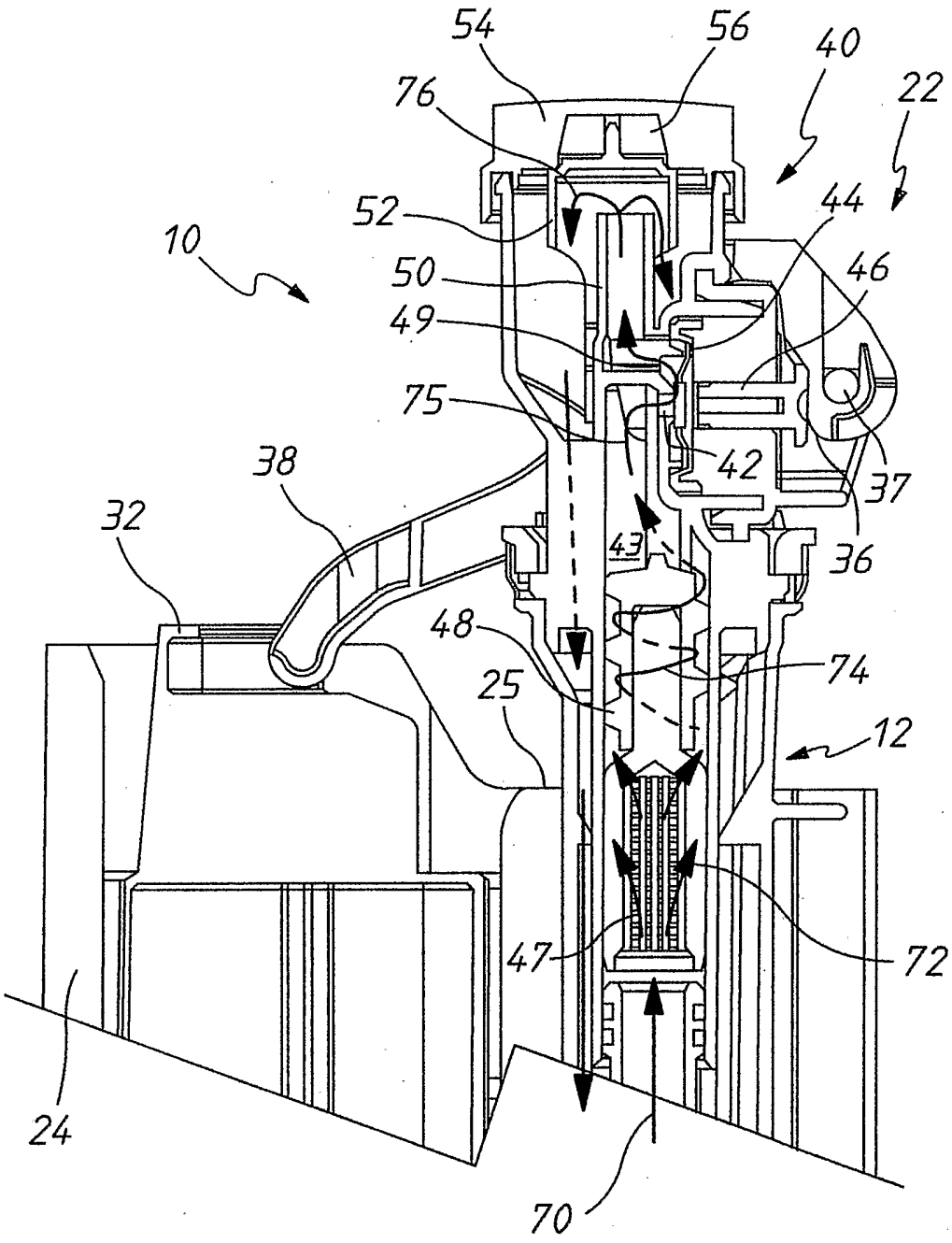

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FIG.2

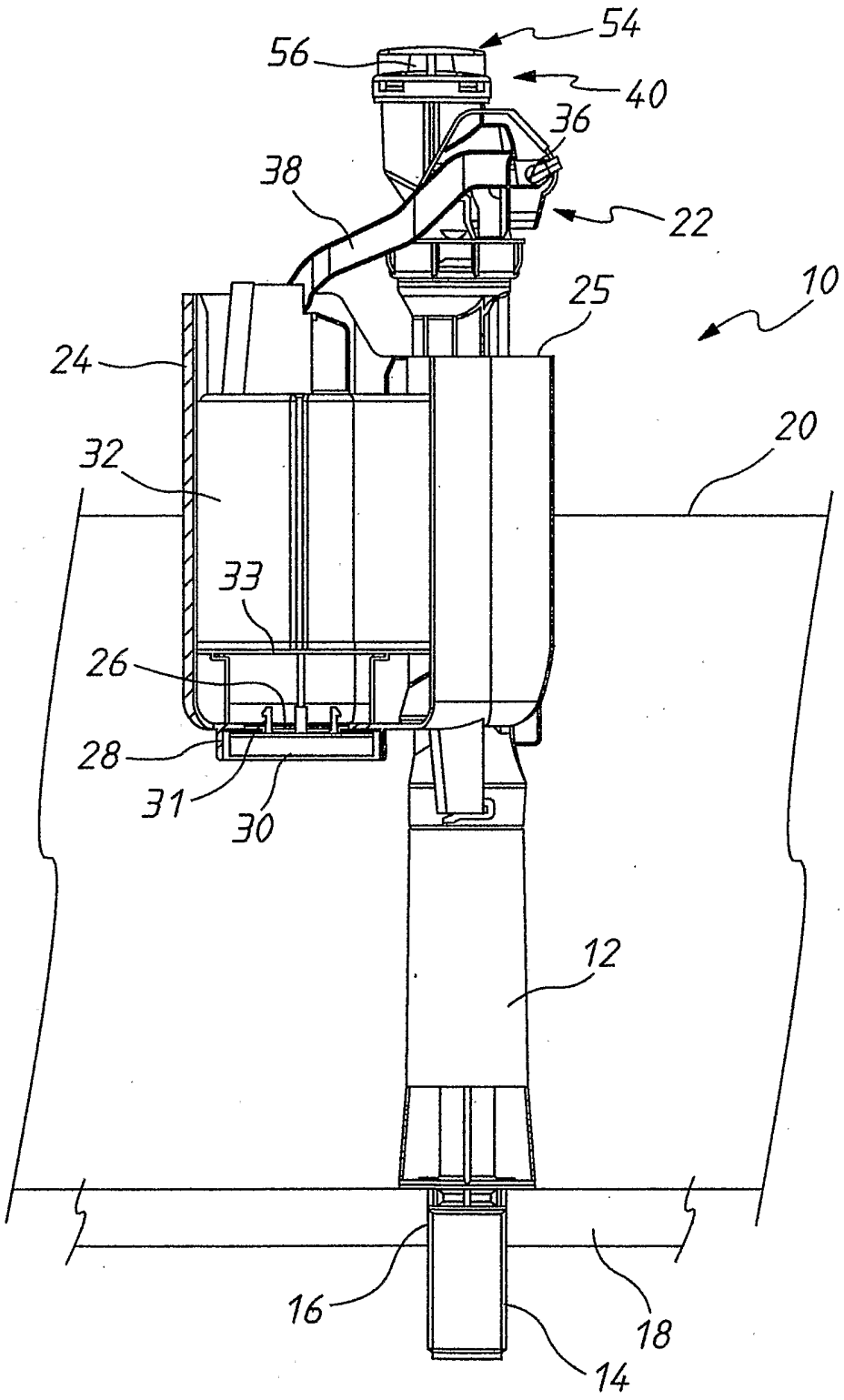


FIG.3

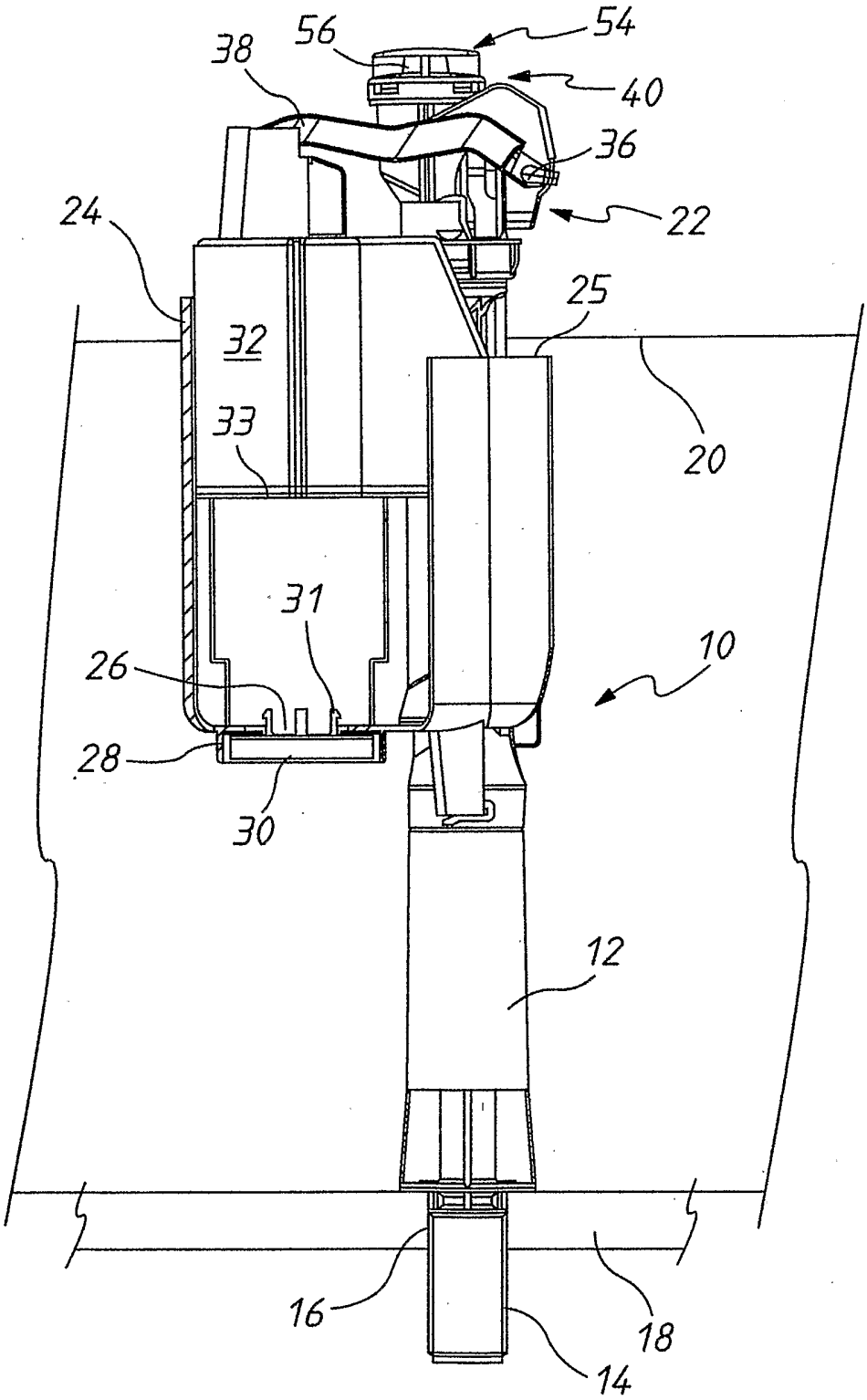


FIG.4

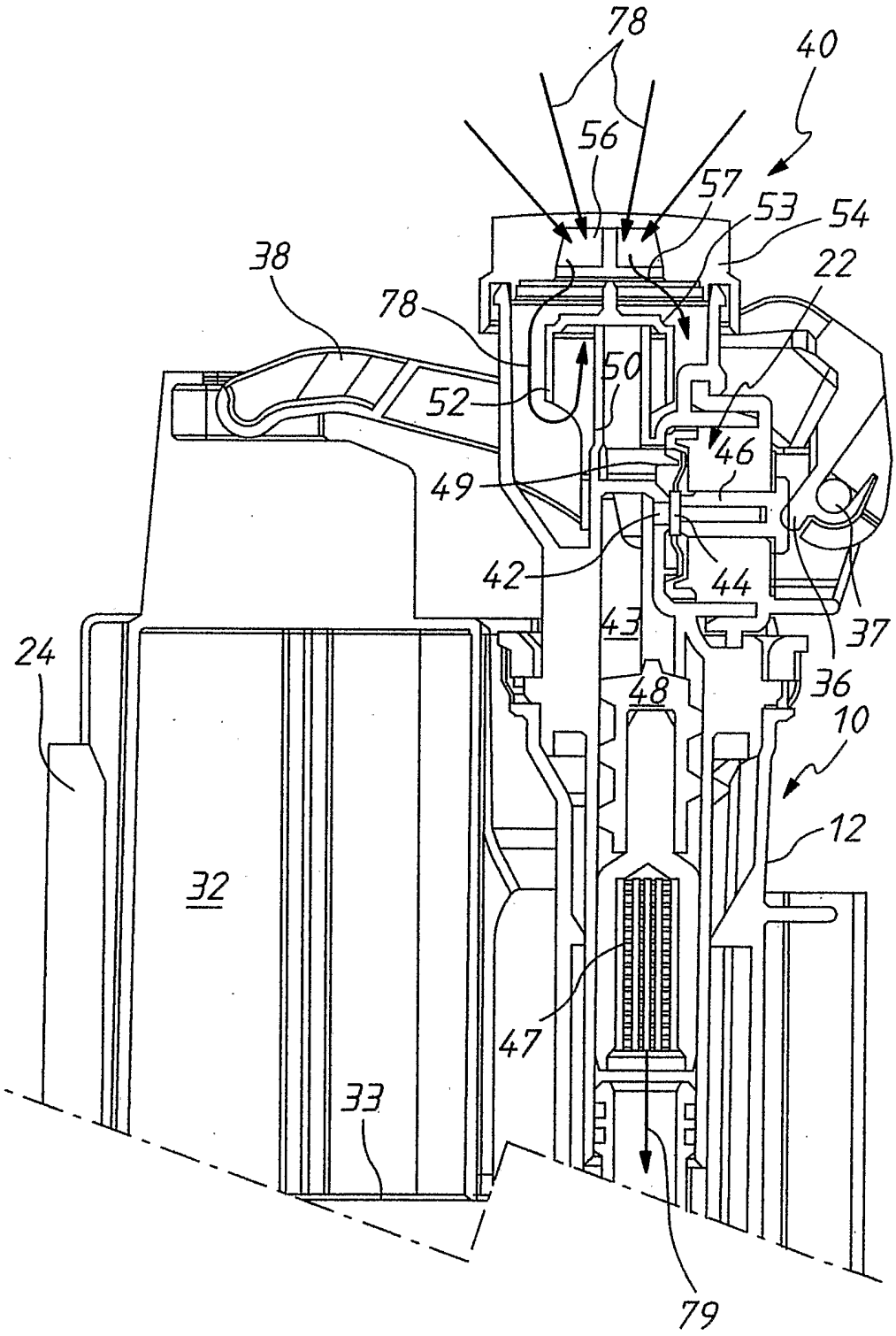

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FIG.5

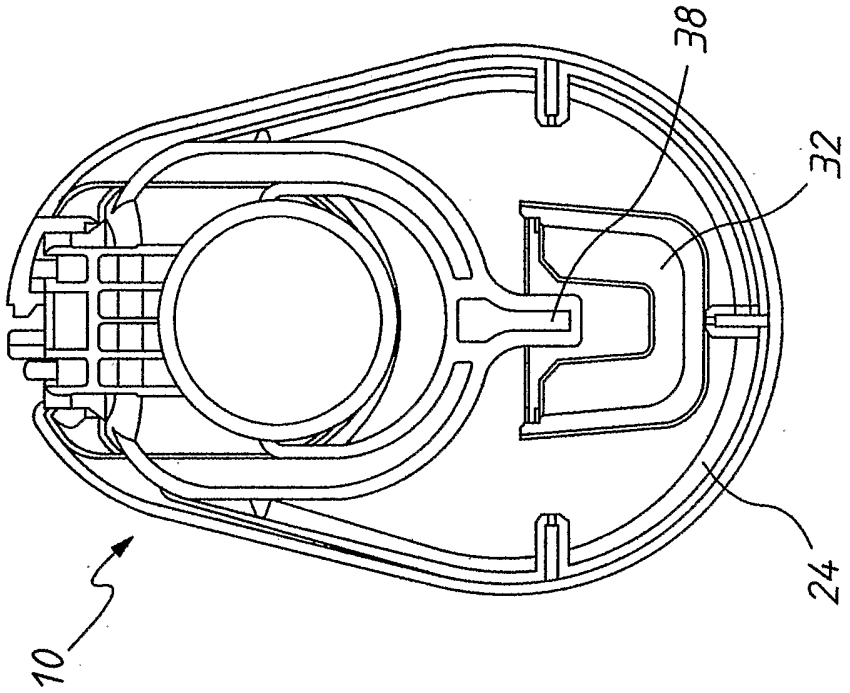


FIG.7

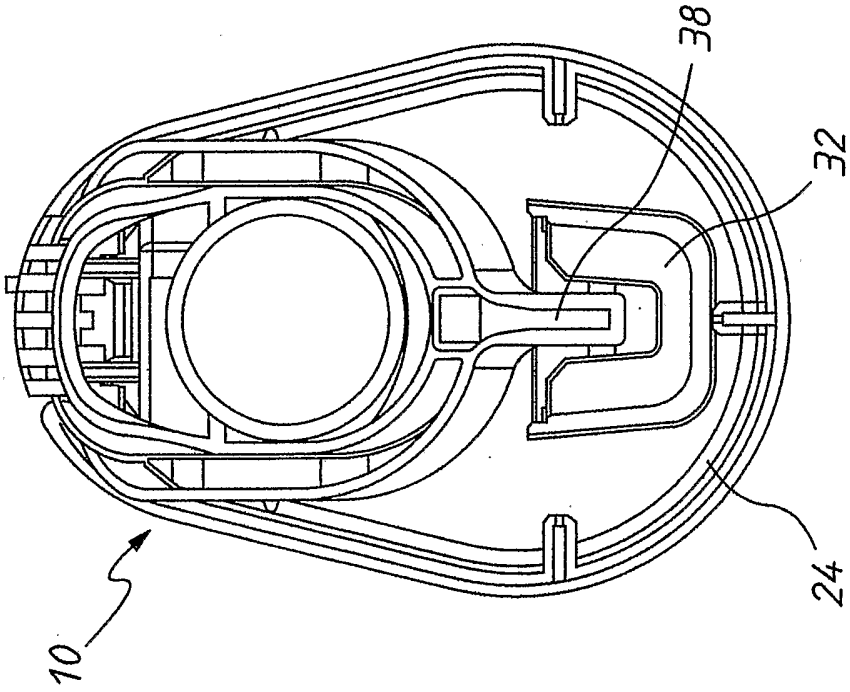


FIG.6

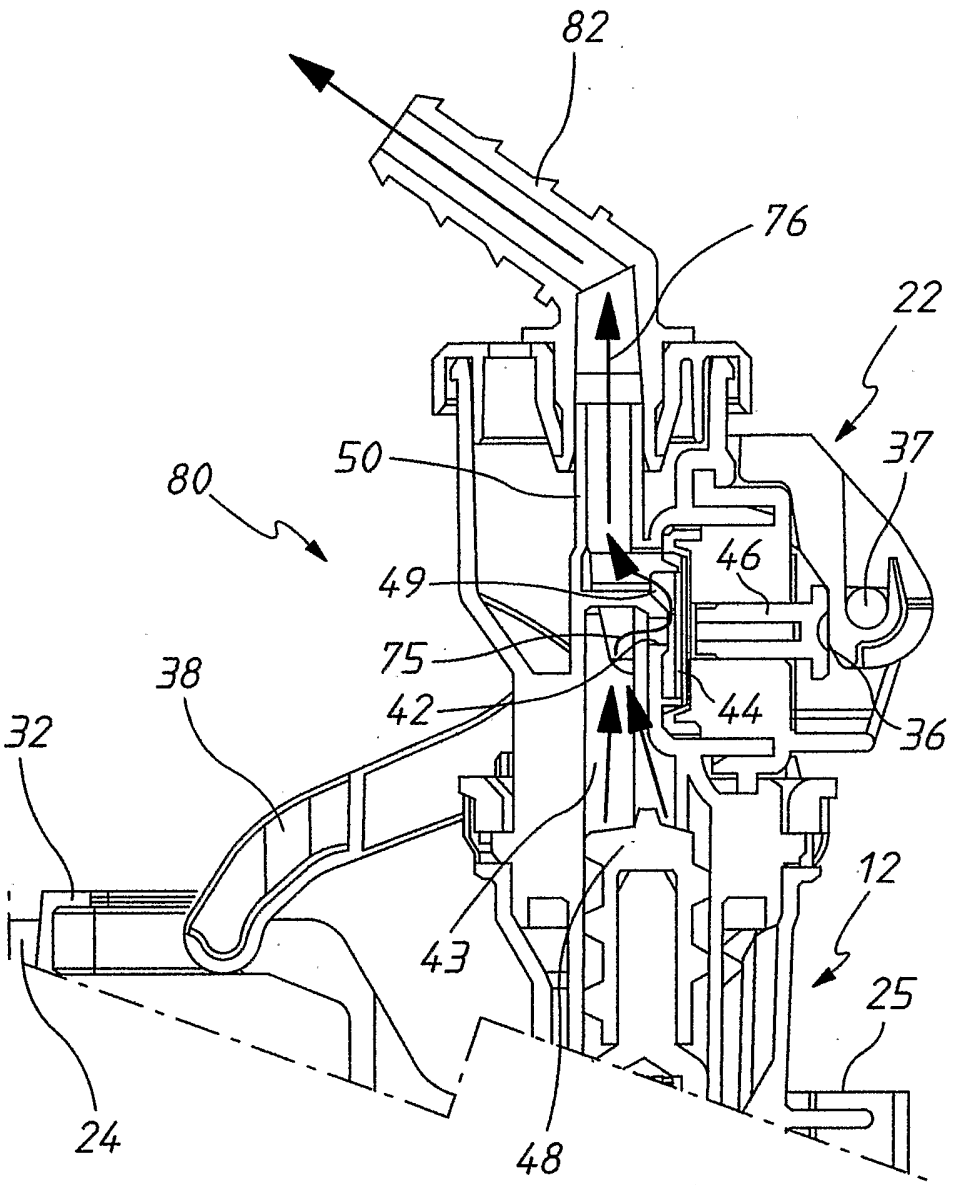


FIG.8

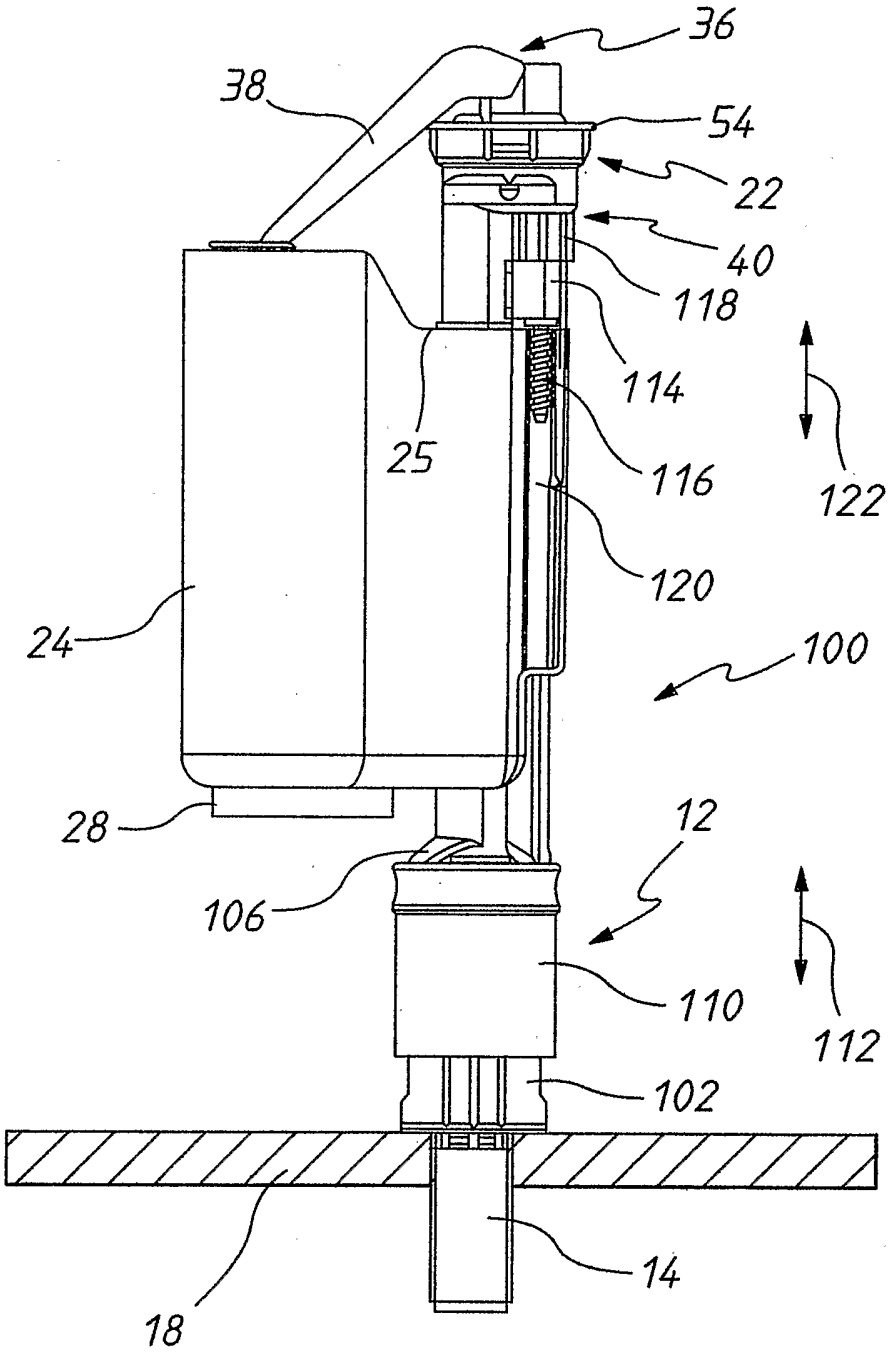

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FIG. 9

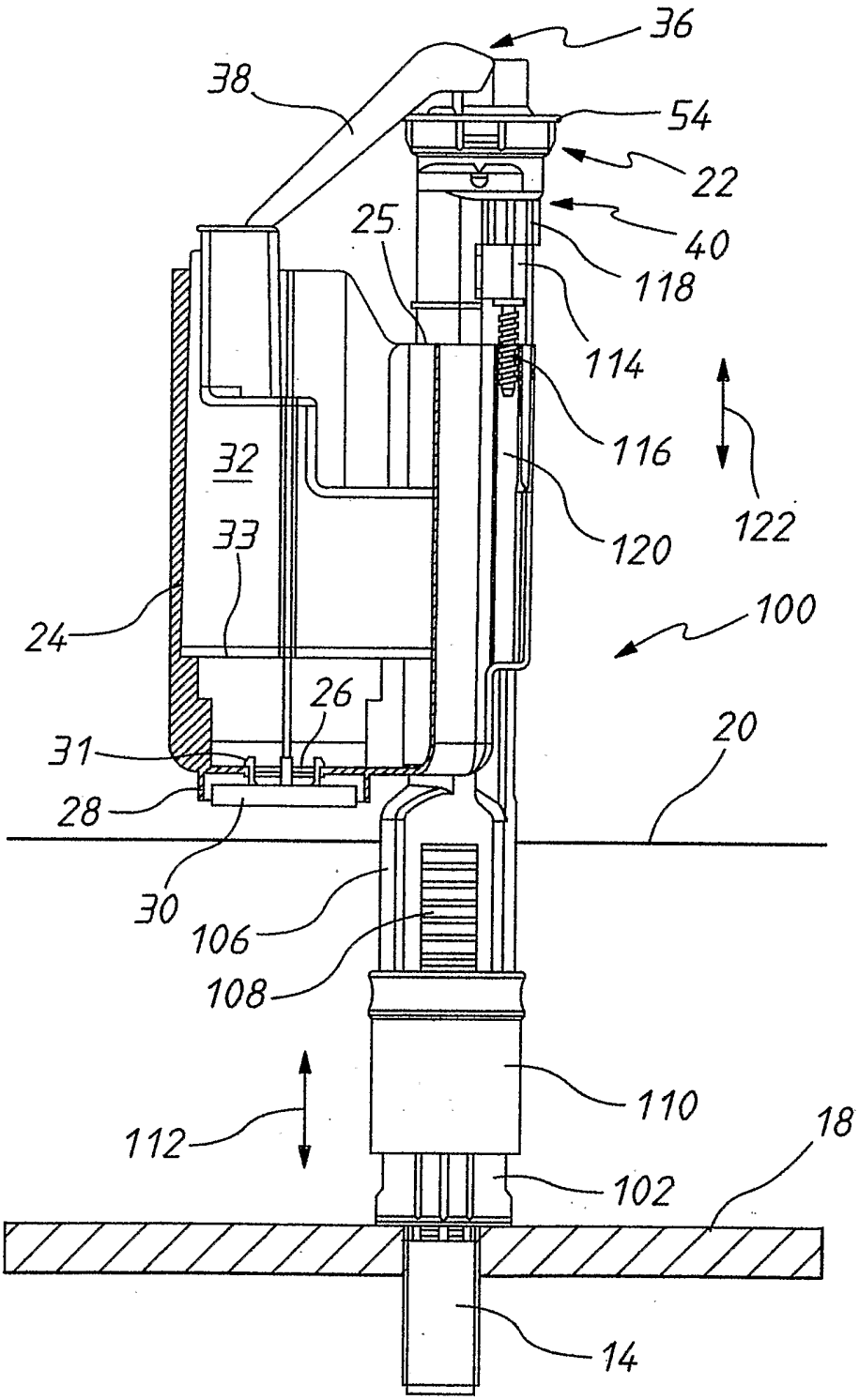

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FIG. 10

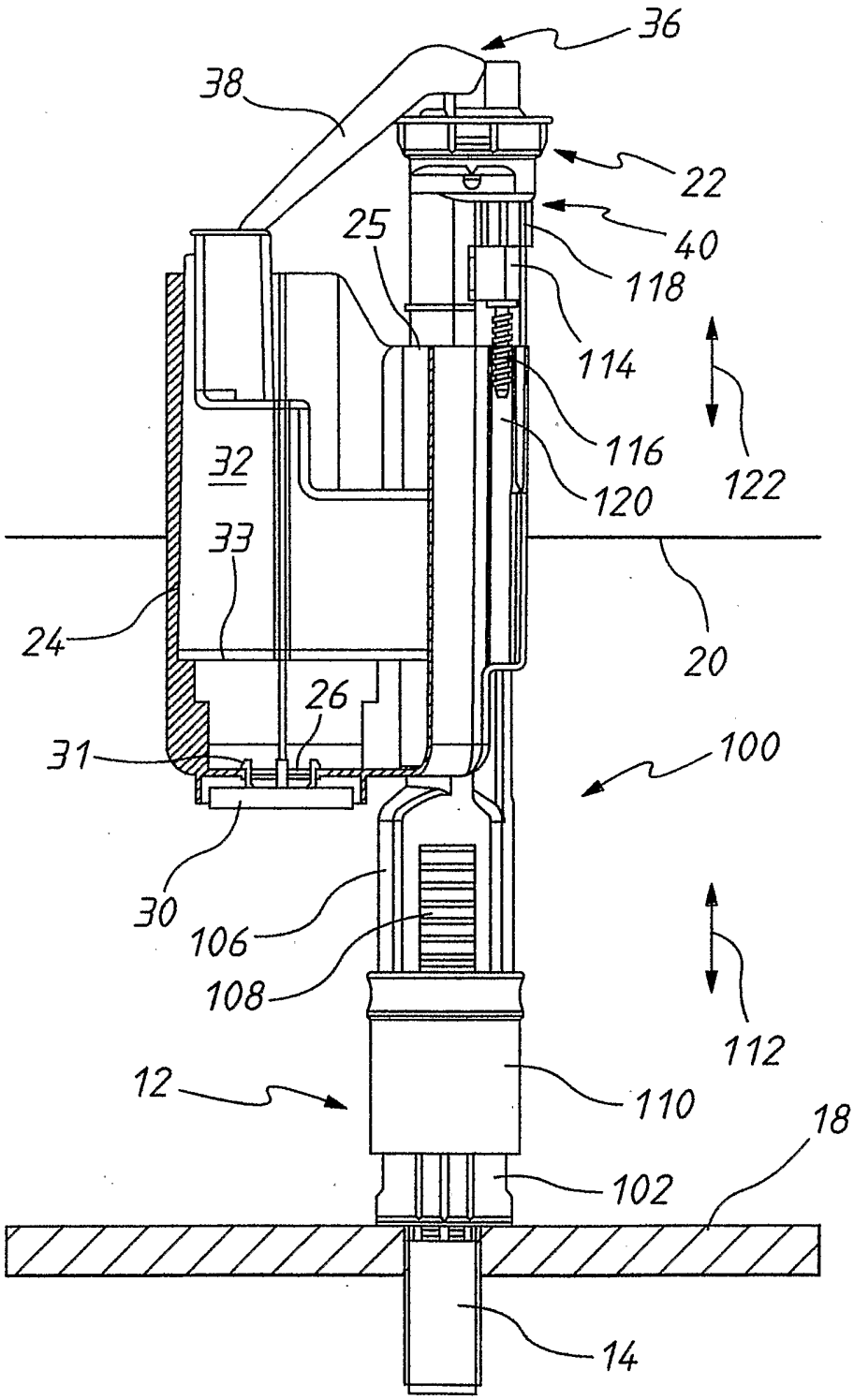

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FIG. 11

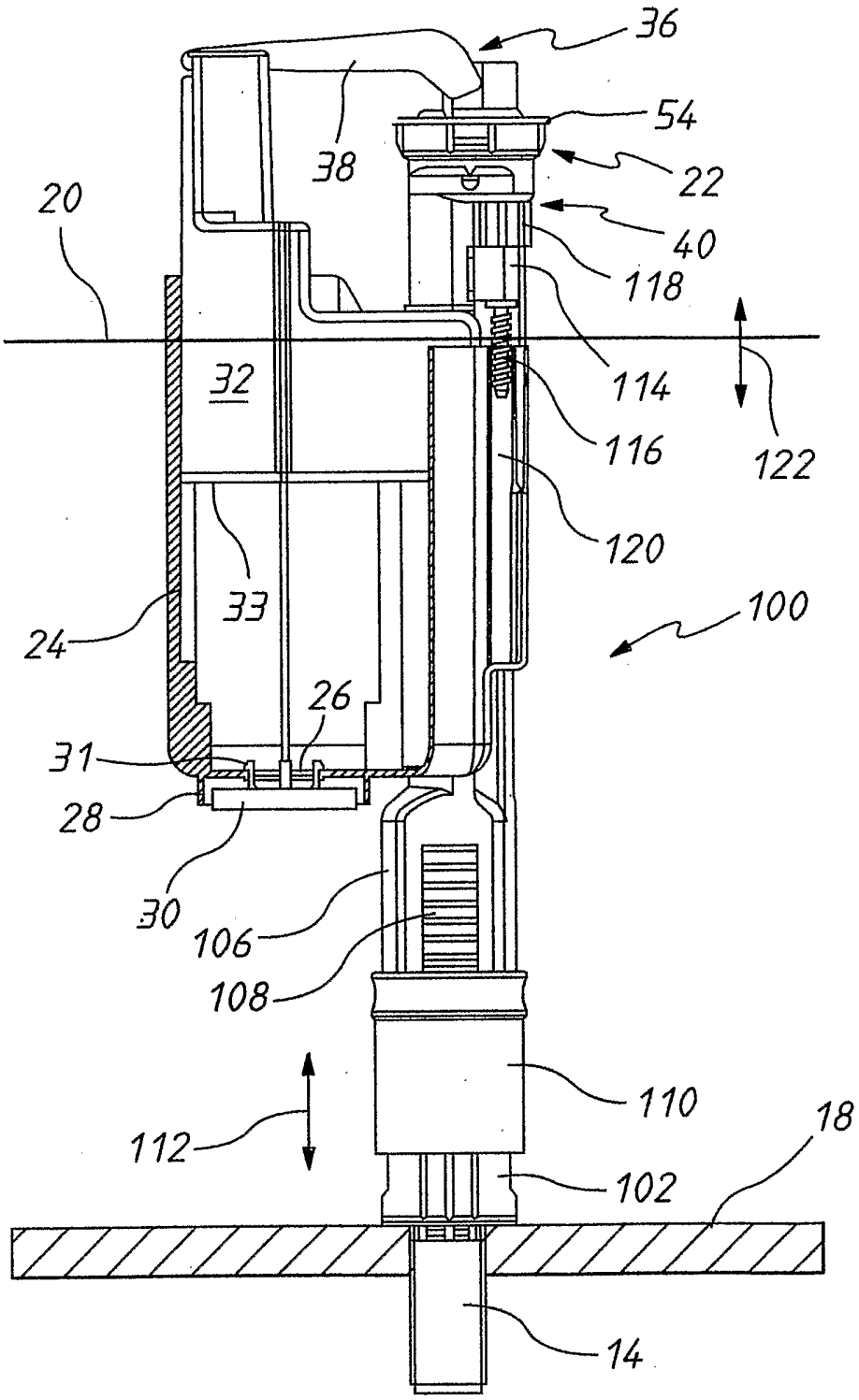

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FIG. 12

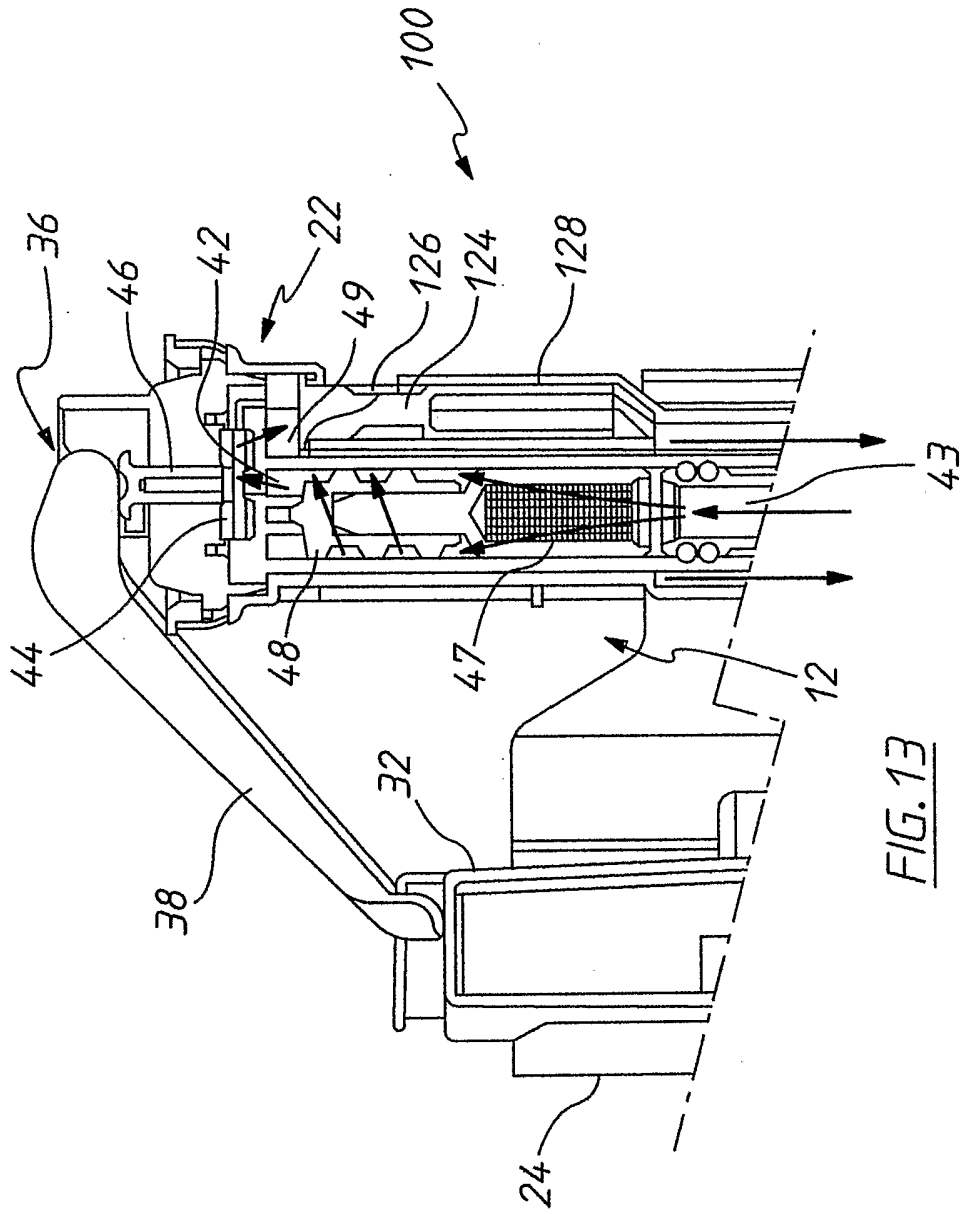


FIG. 13

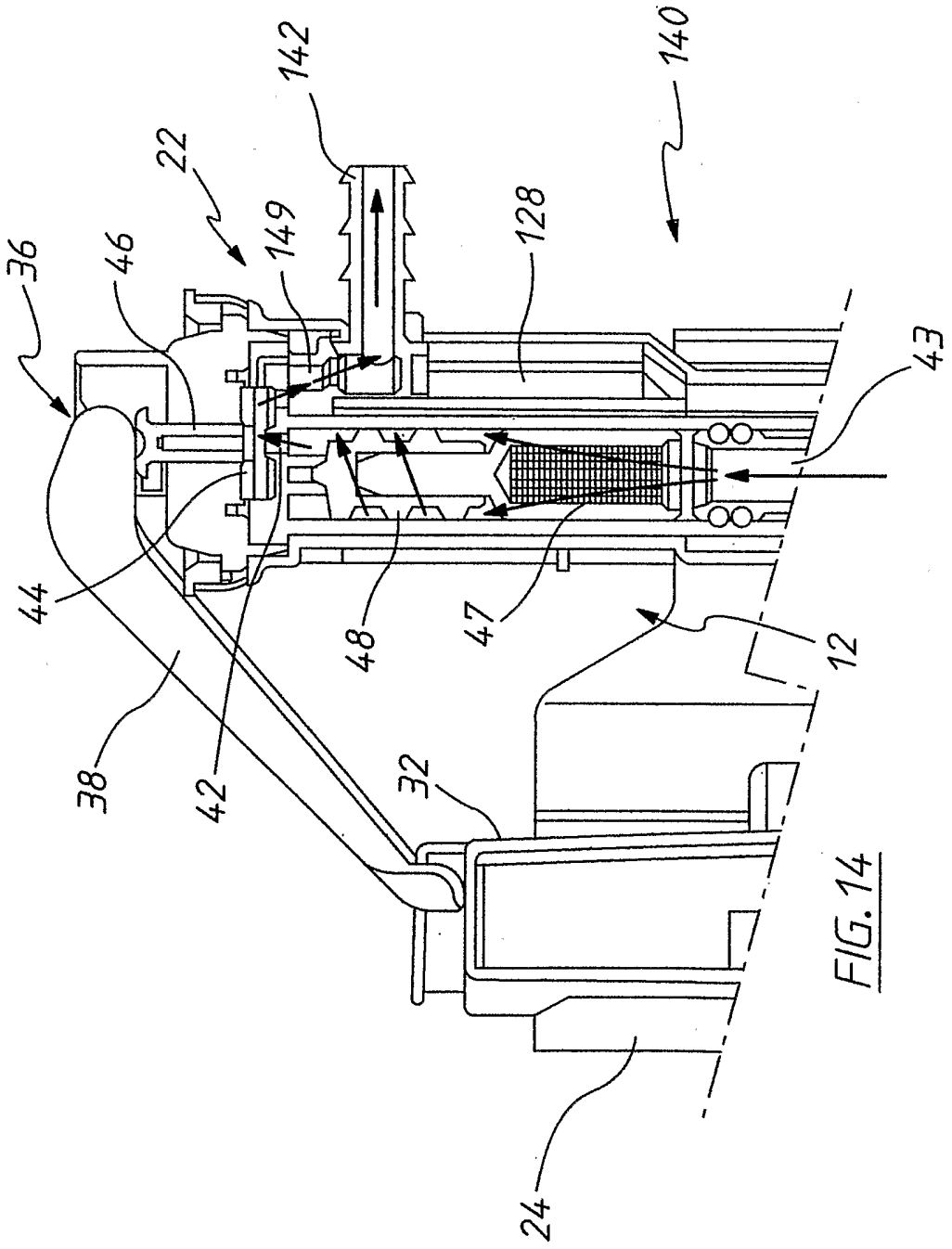


FIG. 14

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2006/000143

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl.
E03D 1/33 (2006.01) ***F16K 31/22*** (2006.01)
E03D 1/36 (2006.01) ***F16K 31/26*** (2006.01)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
Derwent file dwpi: E03D, F16K and keywords, float, bucket, container, vessel, storage, valve and like terms.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	GB 1408697 A (HYKON-PATENT AG) 1 October 1975. All document.	
A	AU 30277/95 A (CAROMA INDUSTRIES Ltd) 21 March 1996. All document.	
A	EP 704581 A (CAROMA INDUSTRIES Ltd) 3 April 1996. All document.	
A	WO 1996/016234 A (DFCU Pty Ltd) 30 May 1996. All document.	
A	WO 1999/020850 A (JACKSON) 29 April 1999. All document.	

☐ Further documents are listed in the continuation of Box C ☒ See patent family annex

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
22 March 2006	24 MAR 2006
Name and mailing address of the ISA/AU	Authorized officer
AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaustralia.gov.au Facsimile No. (02) 6285 3929	**DAVID LEE** Telephone No : (02) 6283 2107

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/AU2006/000143

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member					
GB	**1408697**	AU	56166/73	BE	800045	CH	574021
		DE	2326877	JP	49049445	LU	67673
		NL	7307160	SE	360417	US	3934276
AU	30277/95	NZ	**272862**				
EP	704581	AU	**32974/95**	CN	**1127822**	IN	**184278**
		JP	**8135838**	NZ	**272984**	US	**5742951**
WO	1996/016234	AU	38980/95				
WO	1999/020850	AU	95478/98	GB	2330398		

Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.

END OF ANNEX