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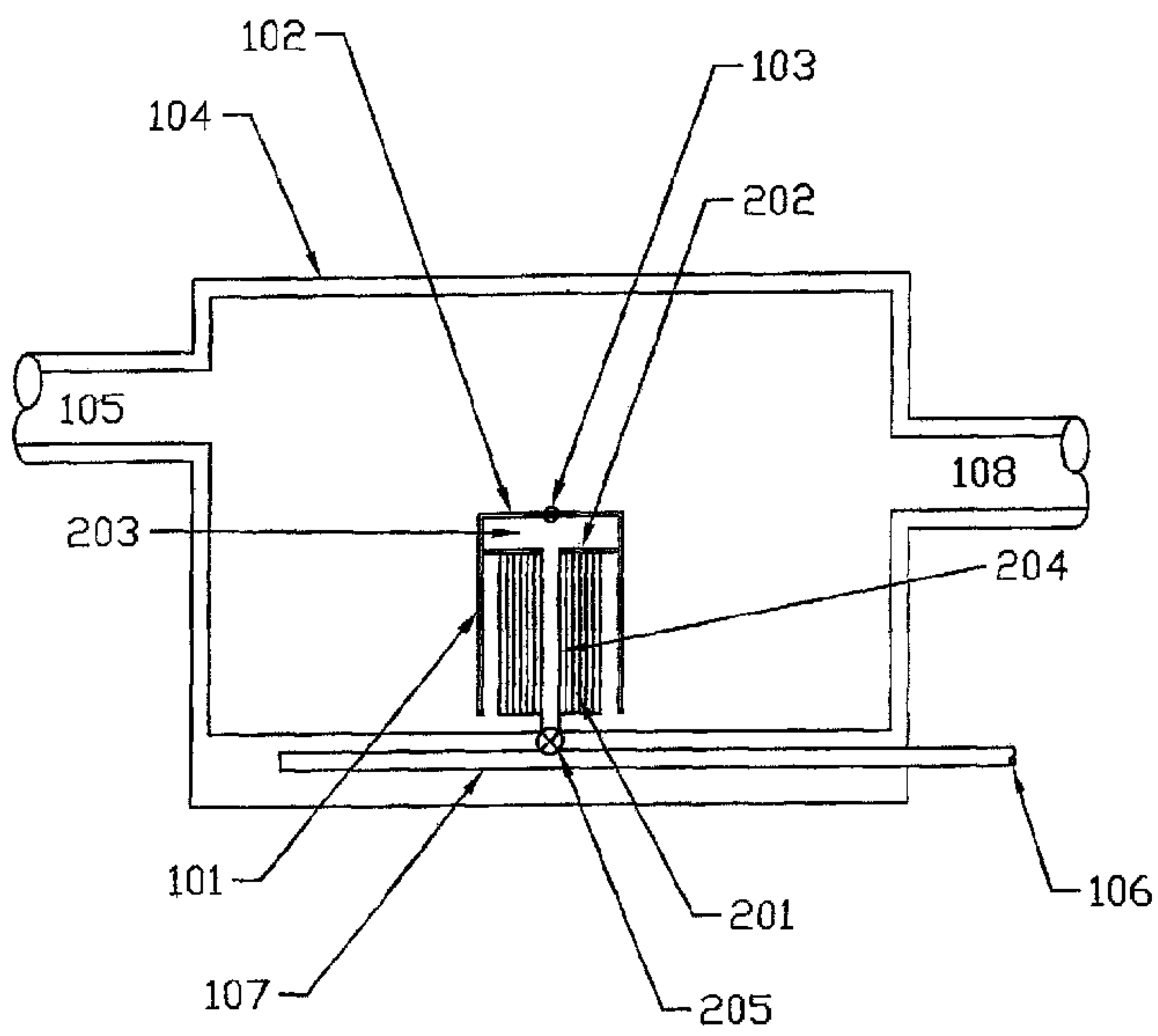
(54) **Titre : SYSTEME D'ALIMENTATION D'UN FLUIDE LIQUIDE A TRAVERS UN FILTRE**
(54) **Title: SYSTEM FOR FEEDING A LIQUID FLUID THROUGH A FILTER**



(57) **Abrégé/Abstract:**
A large vault or tank for receiving the runoff water, having one or more small tanks in the large tank (vault). Each small tank is inverted and receives water, from the large tank, at its open lower end. The water entering the small tank rises, as the water level in the large tank rises, and flows upward through a filter. When the water level rises above the top of the filter it enters an outlet tube or pipe and downwardly passes along the center-line of the filter. A float, a valve and a check valve may cause the system to function as a siphon and feed the filtered clean water to an outlet. Alternately the siphoning effect will occur if the inside diameter of said outlet tube is small enough to form a partial vacuum.

ABSTRACT

A large vault or tank for receiving the runoff water, having one or more small tanks in the large tank (vault). Each small tank is inverted and receives water, from the large tank, at its open lower end. The water entering the small tank rises, as the water level in the large tank rises, and flows upward through a filter. When the water level rises above the top of the filter it enters an outlet tube or pipe and downwardly passes along the center-line of the filter. A float, a valve and a check valve may cause the system to function as a siphon and feed the filtered clean water to an outlet. Alternately the siphoning effect will occur if the inside diameter of said outlet tube is small enough to form a partial vacuum.

SYSTEM FOR FEEDING A LIQUID FLUID THROUGH A FILTER

BACKGROUND OF THE INVENTION

This invention was developed by BaySaver Technologies Inc. (BaySaver) a manufacturer of stormwater pollution controls based in Maryland. BaySaver holds U.S. Patents on several different physical separators, including patents #5,746,911 and #6,264,835, both titled "Apparatus for separating a heavy fluid from a light fluid." While physical separators accomplish a great deal and are an important factor in environmental protection, they do not remove dissolved contaminants, nor do they remove sediment particles in the fine silt and clay size range.

Filtration is a proven method of removing dissolved and very fine impurities from a fluid. The most commonly used filter in the stormwater industry is a depth filter. A depth filter uses a media (sand, for example) that the fluid must pass through. The removal is achieved by a combination of two mechanisms: transport and attachment. In a sand filter, the individual grains obstruct the flow of water, forcing the fluid to take a more tortious path through the filter. When this happens, the fluid comes into contact with far more of the media than it would if it were to flow straight through the filter. The fluid, along with the impurities to be removed, is in contact with the individual grains of sand or other filter media. Bringing the contaminants into contact with the filter media is the first stage-the contaminants are *transported* into contact with the filter media.

In order to remove the pollutants from the fluid, the media must have some way of capturing and retaining the contaminant. This can be accomplished in a number of ways, from chemical bonding on reactive media to simple sedimentation in the interstices between the media components. When designed carefully, media filtration is capable of removing large pollutant loads from influent fluid streams. The present invention can be used to remove fine sediments, other entrained pollutants such as oils and grease, and dissolved contaminants from runoff streams. It can also be used to reduce turbidity in the same applications.

The selection of filter media can depend on many factors, including the type of contaminants targeted for removal, the desired flow rates through the filter, the cost and weight of the media, and other factors. While filtration is a proven technology in fields like wastewater treatment, drinking water treatment and industrial processes, it is relatively new in the field of stormwater treatment.

One of the challenges of stormwater management is dealing with the highly variable runoff flow rates, that result from storms. In stormwater applications, treatment devices are subjected to widely varying flow rates, from very slow trickles to the runoff resulting from torrential downpours. To accommodate these variations, many stormwater treatment devices are designed with an internal or external bypass. The bypass allows flows in excess of the intended treatment capacity to pass through the unit untreated, while continuing to treat flows within the intended range. This is a visible technology because of the "first flush" effect in stormwater runoff. During the beginning of a storm event, a "flush" of contaminants is carried off of a site with the first bit of runoff. This flush includes the pollutants that have collected on that site since the last storm, and comprises the majority of the pollution load from each storm event. If the first flush is treated adequately, a majority of the potential contaminants will be removed during that treatment and the subsequent bypass flows during extreme storms will not contain the same heavy pollutant loads.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a plan view of the modular filter cartridge and the cartridge housing assembly.

Figure 2 is a cross sectional view of the modular filter cartridge and the cartridge housing assembly taken along line 2-2 of Figure 1.

Figure 3 is a detail of the rolled filter as indicated in Figure 2.

Figure 4 is a detail of the float valve housed in the center drainage pipe of the invention.

SUMMARY OF THE INVENTION

This invention relates broadly to a system for filtering a fluid, however one specific application of the invention is to remove small particles, including dissolved contaminants, from runoff water. In treating runoff water it is desirable to first remove the large particles of contaminants by gravity separation (see U.S. patents 5,746,911 and/or 6,264,835 by Thomas E. Pank). After the structure of said '911 patent removes the contaminants that are in the form of large particles the runoff water is fed to the present invention (Figures 1 to 4 incl.) for removal of small particles and/or dissolved contaminants.

The present invention employs a large vault or tank for receiving the runoff water. There are one or more small tanks in the large tank (vault). Each small tank is inverted and receives water, from the large tank, at its open lower end. The water entering the small tank rises, as the water level in the large tank rises, and flows upward through a filter. When the water level rises above the top of the filter it enters an outlet tube or pipe and downwardly passes along the center-line of the filter. A float, a valve and a check valve may cause the system to function as a siphon and feed the filtered clean water to an outlet. Alternately the siphoning effect will occur if the inside diameter of said outlet tube is small enough to form a partial vacuum.

While my overall device is primarily for use in cleaning runoff water, various features of the invention have widespread application in the field of filtering; hence many of the claims are not limited to cleaning runoff water.

DETAILED DESCRIPTION OF THE INVENTION

The invention is a modular filter system for stormwater runoff treatment. The filter itself comprises several layers of drainage material and filter material as described in the pending application of Thomas E. Pank, which has been published, see Publication No. U.S. 2005-0178719A-2 dated August 18, 2005. One feature of the invention is a housing for the rolled filter described in said publication. This housing (inverted tank 101) controls the flow through the filter by means of a siphon and a one-way valve in the housing.

A plan view of the modular filter is shown in Figure 1. The modular filter is an inverted tank or vertical pipe 101 with a solid plate 102 closing the top of the pipe. In that solid plate 102 is located a check valve 103 that allows air above a given pressure to escape from the inside of the device upwards to the outside. The valve 103 is configured such that it prevents air from traveling in the opposite direction. The modular filter itself is housed in a vault 104 or similar structure. The vault (large tank) 104 has an inlet means 105 and exit means 106. Inlet means 105 accepts stormwater runoff from an upstream drainage system which may remove large particles from the water, see Pank, U.S. Patent 5,746,911 (not shown) and conveys that water to the modular filter. Once the water has passed through the filter, the treated effluent enters underdrain manifold 107 and is then conveyed to outlet means 106. Outlet means 106 discharges the water to a storm drain outfall not shown. Also present in vault 104 is bypass means 108, which conveys flows that exceed the treatment capacity of the modular filter to a storm drain outfall. This storm drain outfall may be the same outfall that accepts treated effluent from exit means 106, or it may be a different outfall.

Figure 2 shows a cross sectional view of the modular filter along line 2-2 of Figure 1. The vertical pipe 101 is set above the floor of vault 104, allowing water to flow underneath the vertical pipe 101. Within the vertical pipe 101 is the rolled filter 201 as described in said U.S. Patent published patent application of Thomas E. Pank, No. U.S. 2005-0178719-A1, dated August 18, 2005. Rolled filter 201 is capped by perforated plate 202, which is in communication with cavity 203. Cavity 203 is also in communication with drain pipe 204, a vertical pipe that extends downward and connects to underdrain manifold 107. Drain pipe 204 also includes flow restriction 205, which limits the flow rate of water through drain pipe 104 and into underdrain manifold 107. Cavity 203 is closed at the top by said plate 102, which contains check valve 103.

Figure 3 shows in detail the rolled filter of said published U.S. Patent Application No. U.S. 2005-0178719-A1. The filter comprises three or more linked layers of material, and is assembled by rolling the several assembled layers in a single unit. The three layers include an inlet means 301 which is closed at its top end and, which is open at the bottom and allows water to flow upwards into the rolled filter. A filter media layer 302, typically contains sand, charcoal, or other granular material. An outlet means 303, which is closed at its bottom end, and open at the top, and allows water to leave the rolled filter. The layers are separated by permeable barriers 304.

Figure 4 shows a float valve used to control the flow through the filter cartridge. Valve ball 402 is seated in valve seat 403. Valve ball 402 is connected to float 401 by linkage 404 such that, when float 401 is raised, valve ball 402 is raised at the same time.

The invention may be assembled, with a single modular filter, as shown in Figure 1, or with an array of modular filters, each of which is connected to the underdrain manifold.

OPERATION OF THE INVENTION

When water enters vault 104 through inlet means 105, it begins to accumulate within structure 104. As more water flows into the vault, the water level continues to rise until it is above the bottom of vertical pipe 101. Under these conditions, the water level is the same in both the vault itself and the vertical pipe 101, as well as within inlet means 301 of the rolled filter unit. When the water level in the vault 104 reaches the level of perforated plate 202, there is sufficient hydraulic pressure to begin flow through rolled filter 201. Water flows from inlet means 301 horizontally through permeable barrier 304 and into filter media layer 302. From filter media layer 302, the water continues horizontally through permeable barrier 305 and into outlet means 303. In outlet means 303, the water flows upwards through perforated plate 202 and into cavity 203.

When the water enters cavity 203 it displaces the air inside the cavity, which is allowed to leave through check valve 103. The water immediately flows into drain pipe 204, where it flows downward toward float valve ball 402 and valve seat 403. If drain pipe 204 is not full, the flow is stopped by the closed float valve, and the water level in drain pipe 204 rises. When the water in drain pipe 204 is of sufficient level, it forces float 401 upward by buoyant force. Float 401 is connected to ball 402 by linkage 404; the rising of float 401 also causes ball 403 to rise, opening the valve. At this point, the water flows through the float valve, past flow restriction 205, and into underdrain manifold 107. When the flow through the filter unit exceeds the limit of flow restriction 205, the water level in cavity 203 begins to rise further. As the water level in cavity 203 rises, more air is displaced through check valve 103, until cavity 203 is entirely filled with water. If the water level in vault 104 exceeds the elevation of bypass means 108, the water above the elevation enters bypass means 108 and is conveyed away from the vault. The float 401 and the valve are optional and may be omitted.

The filter continues operating in this manner as long as water is being delivered to it at a sufficient flow rate through inlet means 105. When the influent flow rate drops or the influent flow stops, the water level in vault 104 begins to fall. The water level within vertical pipe 101 and cavity 203, however, does not drop. Because the air has been evacuated from cavity 203 and because drain pipe 204 is flowing full due to the limitation of flow restriction 205, a siphon effect will continue to draw water from vault 104, through the rolled filter 201, into cavity 203 and drain pipe 204. Flow will continue in this fashion until the water level in vault 104 drops below the bottom of vertical pipe 101.

When the water level in vault 104 falls below the bottom of vertical pipe 101, air flowing under vertical pipe 101 will replace the water in cavity 203, breaking the siphon effect. When the siphon is broken, the water in drain pipe 204 will drain, and the lowering water level will cause float 401 and ball 402 to fall. Ball 402 will settle in seat 403, cutting off effluent flow through the filter. The water in the inlet layer 301 of rolled filter 201 will immediately drain out of the filter and empty into vault 104. Water within the filter media layer 302 will pass through permeable barrier 304, into inlet layer 301, and then out into vault 104; water in outlet layer 303 will pass through permeable barrier 305 into filter media layer 302, through permeable barrier 304, into inlet layer 301, and then out into vault 104. The last drainage pattern from outlet layer 303 through the filter media and back into vault 104 will also act as a backwash, cleaning some amount of contaminants off of the filter media 302. This backwash establishes filter porosity thereby increasing longevity of the filter and long term efficiency. The water remaining in vault 104 will stay in that vault until the next time it rains, at which point the system will begin operation again.

As stated above the runoff water entering inverted tank 102 first enters input layer 301 and then flows horizontally through filter media layer 302. In view of the very large surface area of the layers of the spiral filtering system, the present invention can very efficiently clean large amounts of runoff. Further, the central tube 204 in combination with the filter described enables very efficient treatment and delivery of the water.

As stated above the filtering media typically includes a vertical layer of sand in the shape of a spiral, which is a major improvement over usual sand filters.

The siphon effect draws down the standing water in the inverted tank 101. This prevents the filter from going anoxic and releasing phosphorus (and other nutrients) as well as preventing a biological film from growing on the filter. Such a film would reduce flow capacity.

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Claims:

1. An apparatus for cleaning a liquid fluid, comprising:

   a first tank for receiving the fluid to be cleaned,

   a second tank located in said first tank, said second tank includes fluid openings throughout its lower end and is closed at its upper end,

   a fluid cleaning device located in said second tank, said fluid cleaning device being spaced below said upper end thereby forming an upper space,

   said fluid cleaning device comprising an input layer forming a first passageway and a filtering layer forming a second passageway,

   said input layer and said filtering layer being contiguous with each other and in the form of a spiral that encircles a conduit, said conduit having one of its ends open to receive fluid from said upper space and forming a vertical third passageway for said liquid fluid, and

   said open lower end of said second tank being an inlet that receives the liquid fluid to be filtered, and from which the liquid fluid passes through said first and second passageways in series.

2. The apparatus as claimed in claim 1, wherein said input layer comprises means for receiving liquid fluid from said lower end of said second tank and feeding such fluid to said filtering layer.

3. The apparatus as claimed in claim 1, in which said second tank has a normally closed check valve which opens when air

pressure in said upper space increases to allow the air to be evacuated from said upper space.

4. The apparatus as claimed in claim 1, having means for controlling the flow through said conduit in accordance with the fluid level above said cleaning device.

5. An apparatus for cleaning runoff water, comprising:

a first tank for receiving the runoff water to be cleaned,

a second tank located in said first tank, said second tank being open at its lower end to receive runoff water from said first tank, said second tank being closed at its upper end,

a water cleaning device located in said second tank and through which the runoff water to be cleaned must pass as the water level rises in said second tank, and

an output conduit for receiving the runoff water that has passed through said water cleaning device and discharging said water, wherein said output conduit is a tube which passes through said water cleaning device, and

wherein said water cleaning device comprising a filtering layer of filtering material in the form of a spiral and positioned so that the runoff water to be filtered passes through said filtering layer, said water cleaning device including a spiral input layer running the length of the spiral filtering layer and which has a lower end that contacts water in said first tank, said spiral input layer feeds that water to said filtering layer, said input layer being sealed in its upper end to thus force the water through said filtering layer of filtering material, and said second tank defines a space above said water cleaning device for enclosing air and water.

6. The apparatus as claimed in claim 5, in which said second tank also has a normally closed check valve which opens when the air pressure downstream of said water cleaning device increases to a given pressure, said second tank being air tight above the water cleaning device except for said check valve and said output conduit.

7. The apparatus as claimed in claim 6, in which said output conduit has means for limiting the flow through said output conduit in accordance with the fluid level above said water cleaning device.

8. The apparatus as claimed in claim 5, wherein:

said water cleaning device further including an spiral output layer running the length of said spiral filtering layer on a side opposite that of said spiral input layer for transporting said water from said filtering layer to said defined space, and

wherein said output conduit discharges said water below the level of said lower end of said spiral input layer, and which cooperates with said spiral output layer, said defined space and said input layer to form a siphon which draws water up from said first tank when the level of said water in said first tank drops from above said closed upper end of said second tank toward said lower end of said spiral input layer, and wherein said water cleaning device backwashes at least a portion of the water cleaning device by passing a portion of said water from said defined space and said output layer backwards through said output layer, said filtering layer and said input layer in series when said siphon breaks as said water level in said first tank falls below said lower end of said input layer.

9. A system for filtering runoff water, comprising:

a first tank for receiving the runoff water to be filtered,

a second tank that is inverted having an upper end and a sidewall extending downwardly from said upper end, said second tank being smaller than said first,

a water cleaning device in said second tank and through which flow of runoff water passes, said water cleaning device having a top side spaced below said upper end thereby forming a space which may receive water that passes through said water cleaning device,

an outlet conduit for discharging water from said space, said outlet conduit extending from said space through said water cleaning device,

wherein said water cleaning device comprising a filtering layer of filtering material in the form of a spiral and positioned so that the runoff water to be filtered passes through said filtering layer, said water cleaning device including a spiral input layer running the length of the spiral filtering layer and which has a lower end that contacts water in said first tank, said spiral input layer feeds that water to said filtering layer, said input layer being sealed in its upper end to thus force the water through said filtering layer of filtering material into said space and said outlet conduit, and

means including said outlet conduit for forming a partial vacuum in said outlet conduit to provide a siphon for pulling runoff water from the first tank generally upward through said water cleaning device to said outlet conduit so that when the siphon stops, the water in said water cleaning device will flow generally downward and back wash said water cleaning device.

10. The system as claimed in claim 9, in which said outlet conduit comprises a pipe extending from said space through said fluid cleaning device, and further including means for limiting the air pressure in said space.

11. The system as claimed in claim 10, in which said fluid cleaning device includes a filtering material comprising sand.

12. The system as claimed in claim 10, further including an output layer forming a vertical passageway between said filtering layer and said upper space.

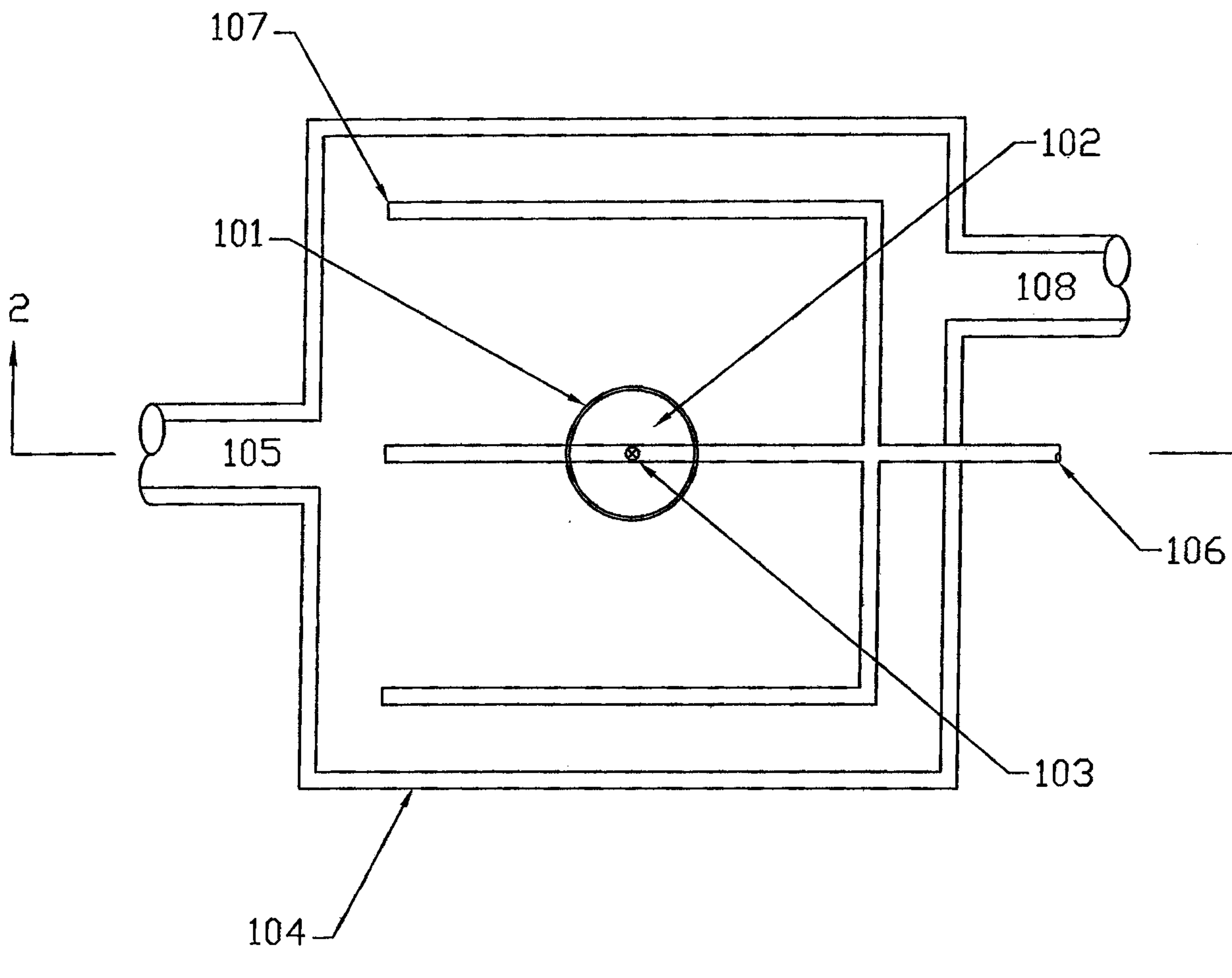


FIGURE 1

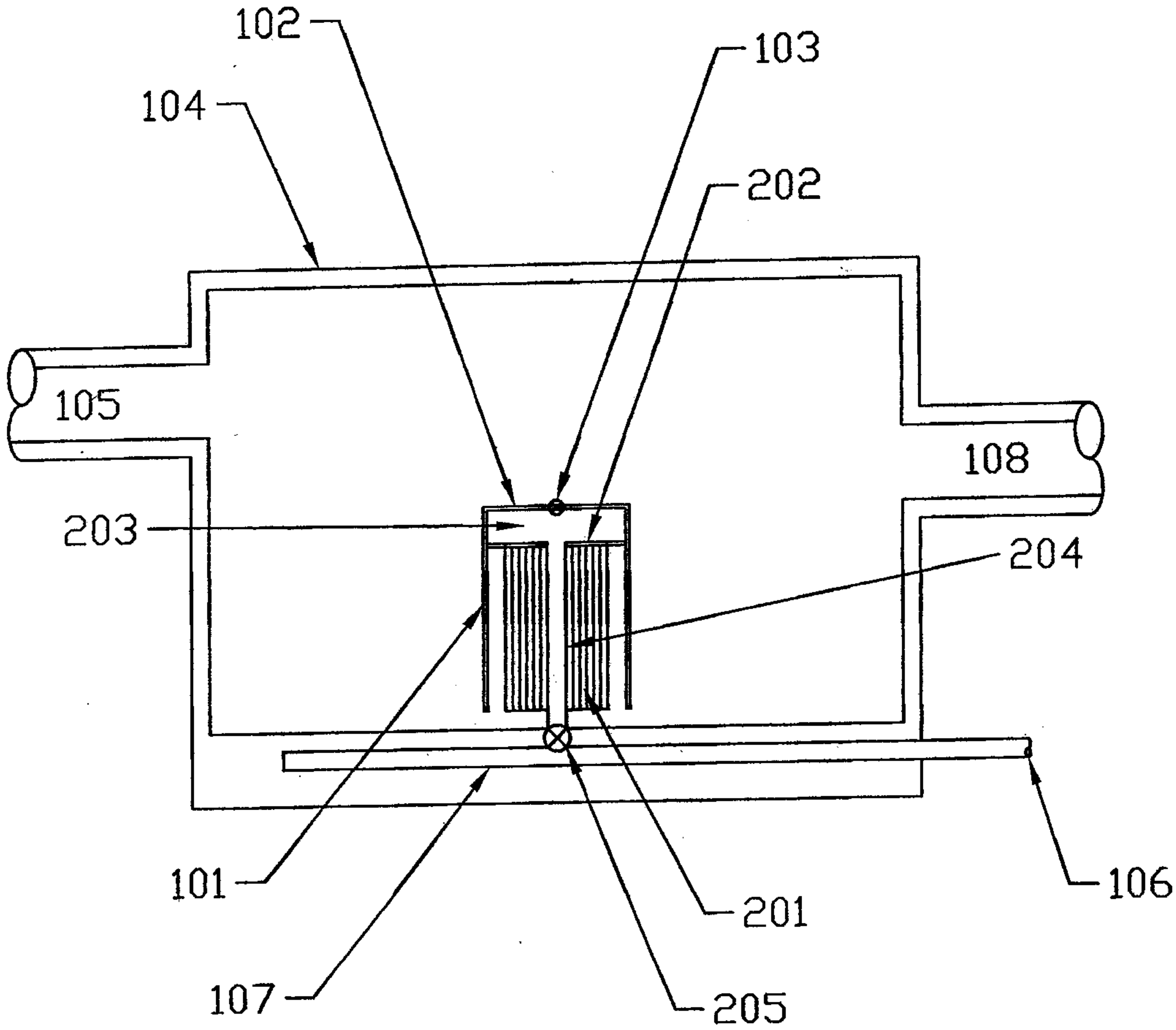


FIGURE 2

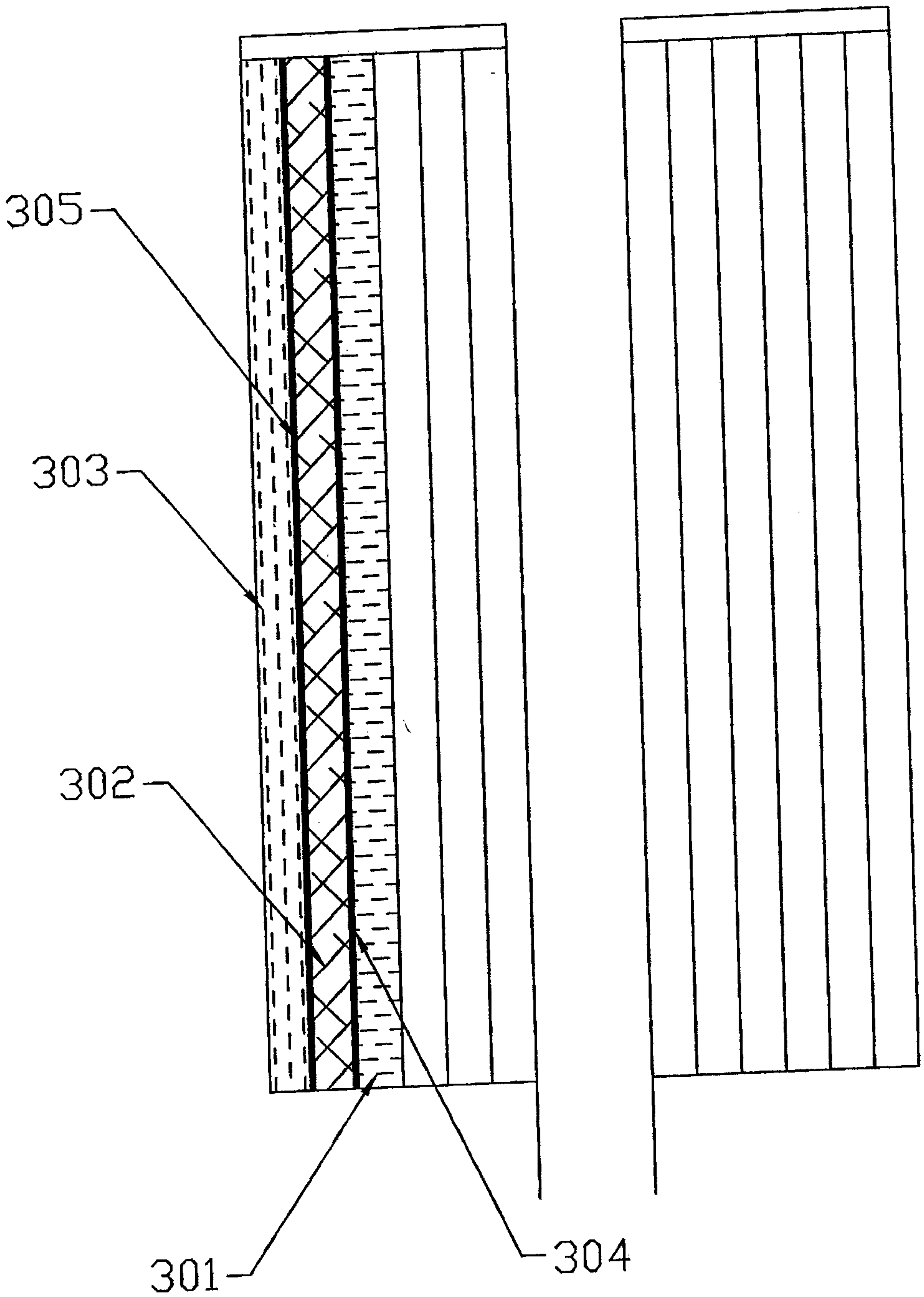


FIGURE 3

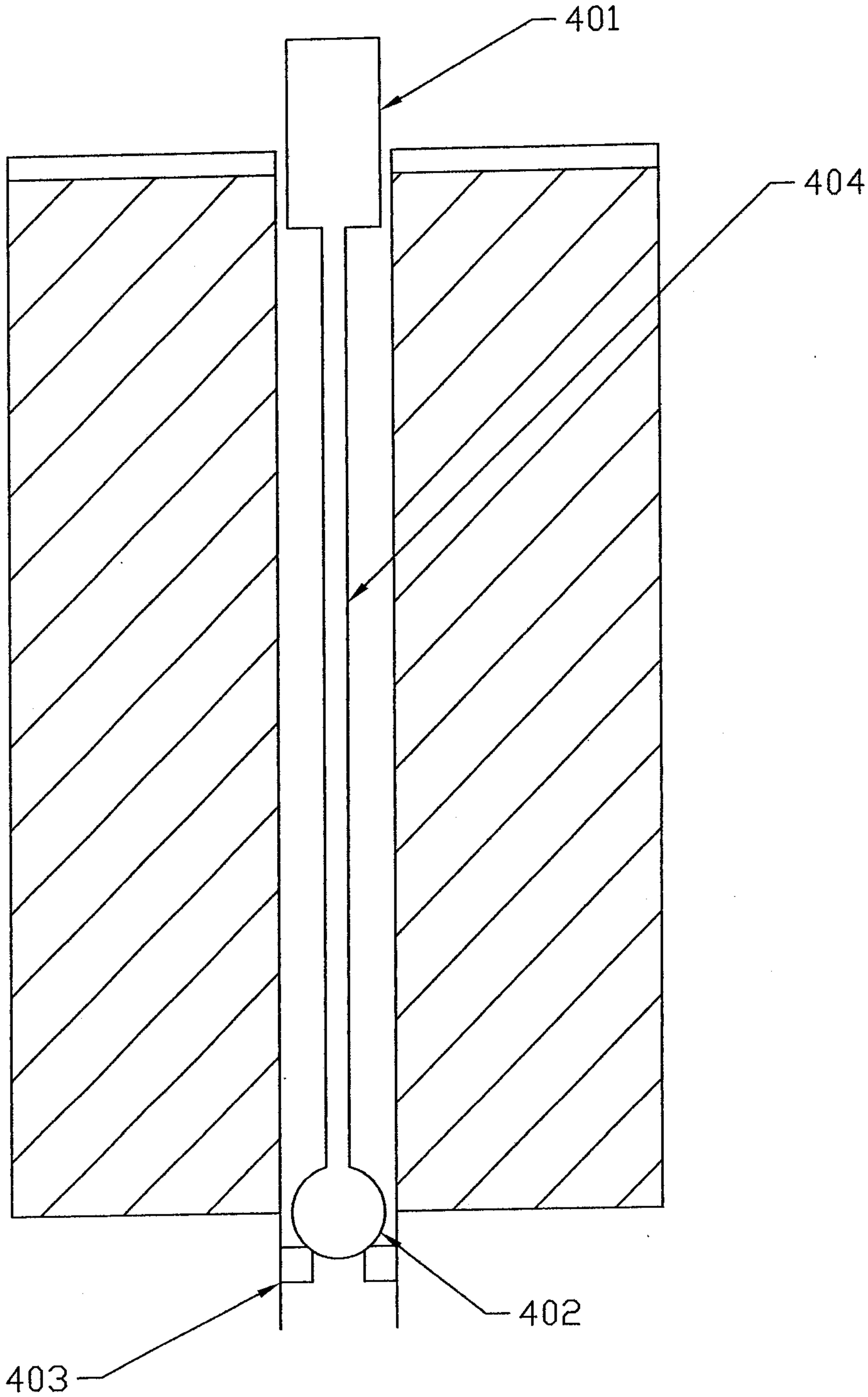
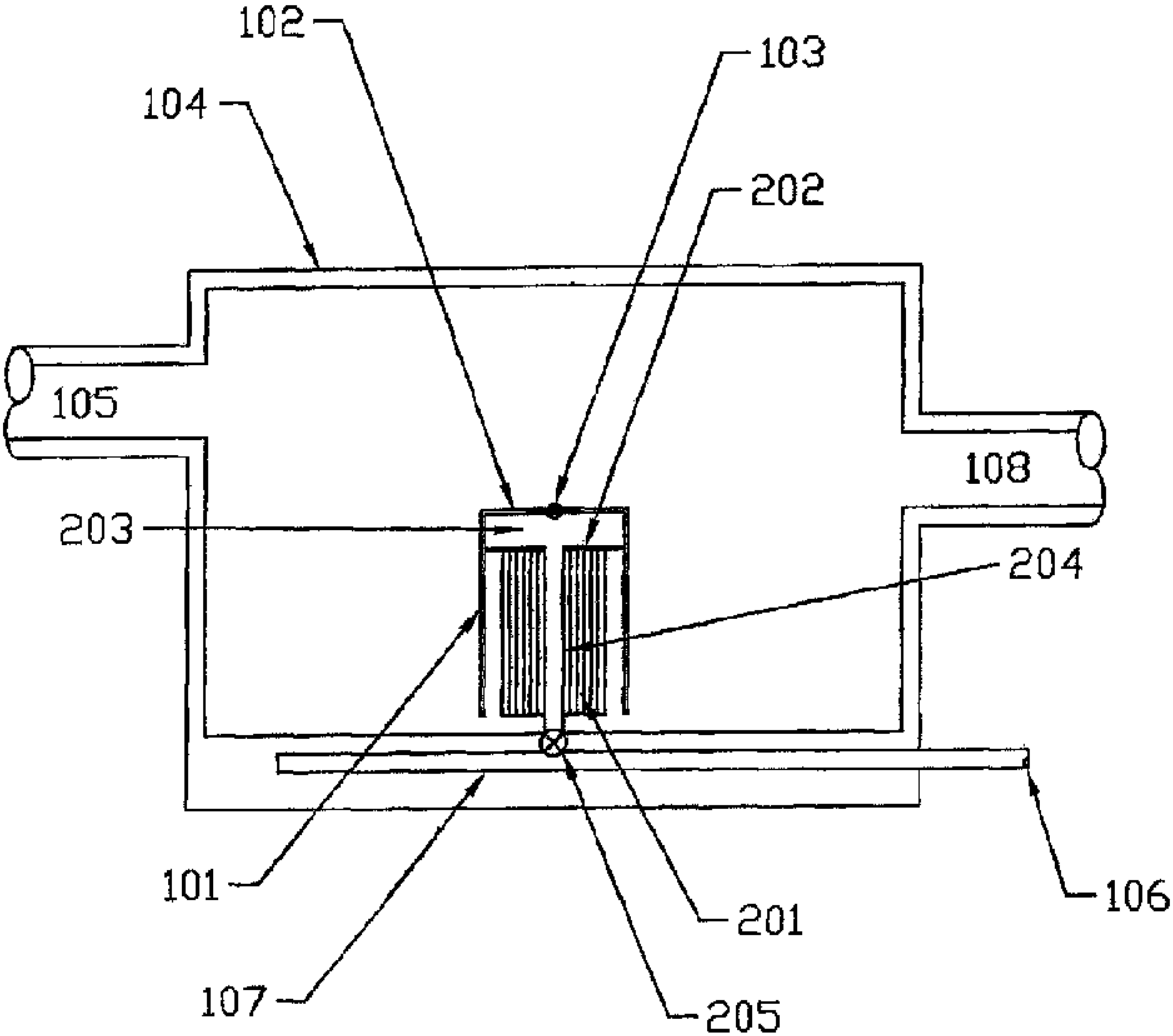


FIGURE 4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