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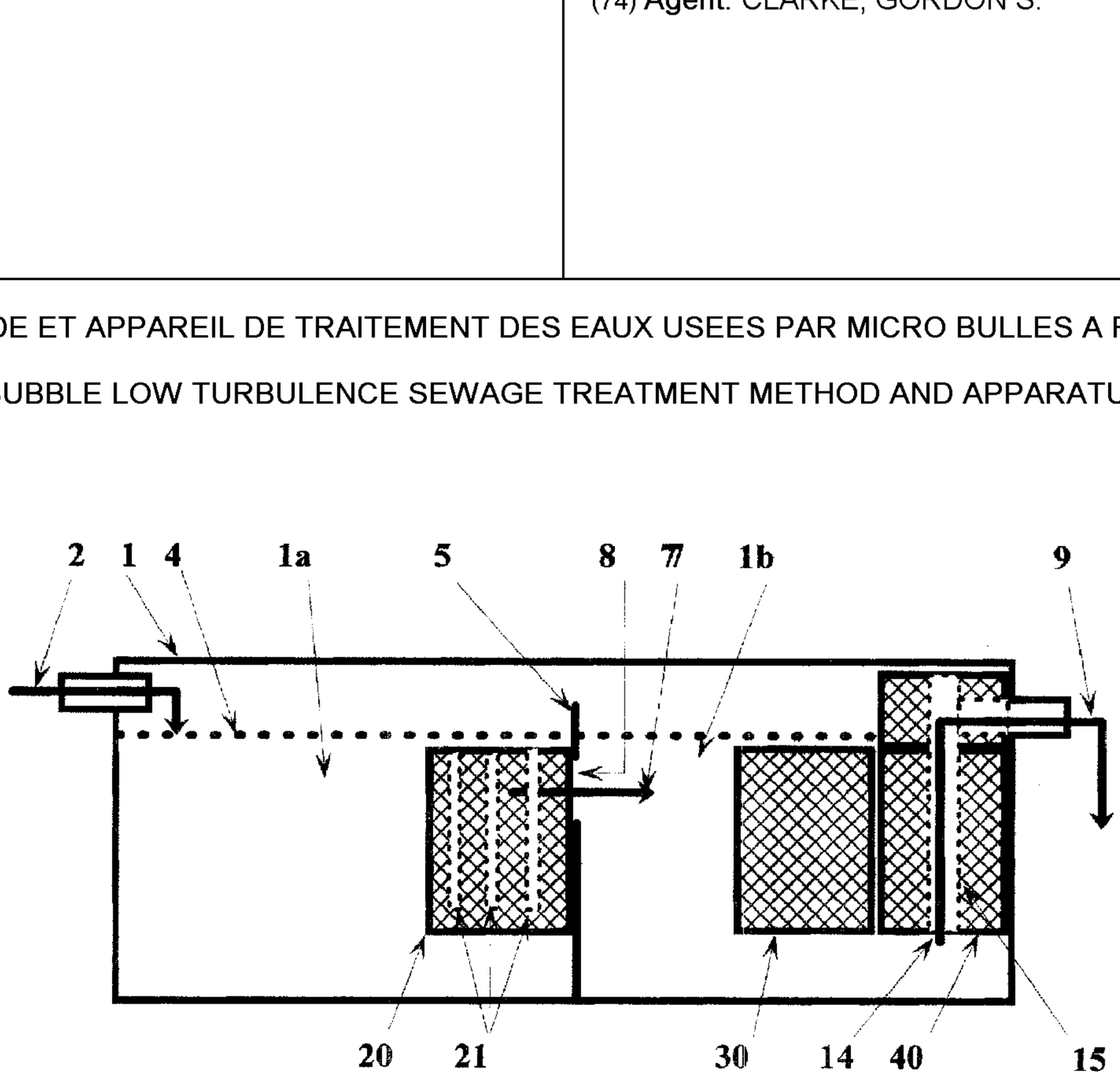
(54) Titre : METHODE ET APPAREIL DE TRAITEMENT DES EAUX USEES PAR MICRO BULLES A FAIBLE TURBULENCE

(54) Title: MICRO BUBBLE LOW TURBULENCE SEWAGE TREATMENT METHOD AND APPARATUS



(57) Abrégé/Abstract:
A method and apparatus for processing raw sewage wastes includes the steps of maintaining a non-turbulent drift-like state of fluid motion in substantially all areas of a septic tank, providing a high surface area for biological growth at least twice the interior surface area of the tank, injecting air into the fluid so as to produce a high volume of micro bubbles, and, ensuring that a preponderance of the micro bubbles have both a high tendency to drift entrained with the moving fluid rather than rise through said fluid and also a high tendency to stick to interior surfaces for extended periods. The motion is provided by air flow within restricted tubular channels. The apparatus comprises a plurality of vertically oriented open filter arrays each comprising a restrained bundle of tubular thin-walled filter elements extending substantially the full length of a respective said array with an irregular interior and exterior surface exposed to the sewage fluid and arranged to abut one another within said bundle. Means for restraining the bundles in both vertical and horizontal directions provides for substantially free drift-like motion of the sewage fluid through said restraining means. The apparatus includes at least one air supply duct arranged within at least one of the filter elements, said air supply duct occupying substantially all of the interior diameter of a respective one of said tubular filter elements and being substantially shorter in length than said array and said tubular element so as to maintain air flow substantially within said respective tubular element, said air supply duct providing an air flow which does not substantially escape said tubular element, adapted to provide a preponderance of sticky micro bubbles entrained within the sewage fluid and which remain entrained and adhered to biological surfaces for extended periods.

Title

Micro Bubble Low Turbulence Sewage Treatment Method and Apparatus

ABSTRACT

A method and apparatus for processing raw sewage wastes includes the steps of maintaining a non-turbulent drift-like state of fluid motion in substantially all areas of a septic tank, providing a high surface area for biological growth at least twice the interior surface area of the tank, injecting air into the fluid so as to produce a high volume of micro bubbles, and, ensuring that a preponderance of the micro bubbles have both a high tendency to drift entrained with the moving fluid rather than rise through said fluid and also a high tendency to stick to interior surfaces for extended periods. The motion is provided by air flow within restricted tubular channels.

The apparatus comprises a plurality of vertically oriented open filter arrays each comprising a restrained bundle of tubular thin-walled filter elements extending substantially the full length of a respective said array with an irregular interior and exterior surface exposed to the sewage fluid and arranged to abut one another within said bundle. Means for restraining the bundles in both vertical and horizontal directions provides for substantially free drift-like motion of the sewage fluid through said restraining means. The apparatus includes at least one air supply duct arranged within at least one of the filter elements, said air supply duct occupying substantially all of the interior diameter of a respective one of said tubular filter elements and being substantially shorter in length than said array and said tubular element so as to maintain air flow substantially within said respective tubular element, said air supply duct providing an air flow which does not substantially escape said tubular element, adapted to provide a preponderance of sticky micro bubbles entrained within the sewage fluid and which remain entrained and adhered to biological surfaces for extended periods.

Title

Micro Bubble Low Turbulence Sewage Treatment Method and Apparatus

Background

Prior art septic systems rely upon long periods of processing of the sewage effluent in large multi-part holding or settling tanks. For residential use a very popular solution has been a 2-part pre-cast concrete tank having an inlet end, a 1st settling partition, a baffle, a 2nd partition and an outlet. These are contained within a rectangular concrete structure with a removable lid, the whole being installed in 1 piece, preferably below ground level. Typically 2 access ports are provided, one for each partition.

The inlet in such systems is arranged to be at a higher level than the outlet level so that the outlet level determines the level of fluid in the tank when in operation. The inlet stream pours into the 1st partition causing agitation of the fluids and some aeration.

During its stay in the 1st partition the sewage undergoes settling of suspended solids and the biological process of waste breakdown begins. Early units provided for quiescent settling with little or no added motion. Thus, lower areas of the tank were subject to anaerobic action while surface areas provided more oxygen and, thus, an aerobic biological breakdown.

Increasing inlet flows cause the sewage fluid to flow through the baffle into the 2nd partition area typically by means of a connection port arranged so as to be somewhat below the level of the fluid. In some

plastic tanks the connection port is replaced with a subsurface baffle over which the fluid flows. This provided a 2-part process.

Prior art efforts to improve the efficiency of such treatment systems included the addition of mechanical agitators alone or combined with aeration systems. These purport to increase mechanical breakdown of particulate material and increased aeration throughout the tank volume for a greater biological effect.

In one such prior art system a slowly rotating electric motor provides a stirring effect in the first partition and also injects a stream of bubbles into the fluid for aeration. The bubbles are driven somewhat downward into the fluid. In such systems a replaceable filter is provided in the 2nd partition.

Another prior art system is shown in US patent 5,484,524 to MacLaren and Tang. In this system a high speed rotating propeller is driven in conjunction with a source of a high volume of air. Operating embodiments show the combination of mechanical agitation and rising air as driving a fluid flow while providing aeration. The biological media is left to its own devices and is separated from the mechanical stirrer.

Another is shown in US patent 6,544,996 to Rebori. This is the same type as shown in US 3,996,599, 3,966,608 and 3,972,965 which provide for a high-flow-rate surface-mounted impeller which draws fluid up an tube for redistribution above a filtration media for downward flow return. The Rebori system as shown in US 6,544,966 combines a collapsible container having continuous vertical walls into which bundles of tubes are inserted around a significantly larger central tube. A high volume of air is injected downwards inside a further significantly small diameter central air supply conduit within the central tube. The high volume

rising air causes a pumping action within the central tube drawing fluid from the lower portions tank to its surface on a continuous basis.

These prior art systems are effective to a point but are prone to mechanical failure as costly electric components are required in a hostile environment resulting in high maintenance requirements and related costs. Failure to attend to regular electrical, mechanical and clean out maintenance results in failure of the septic system, clogged effluent beds and environmental contamination.

Such prior art systems require high amounts of electrical energy on a continuous basis. Failure of the electric supply, by fuse failure or supply failure, results in immediate cessation of the majority of the pumping and aeration action in the tank immediately reducing the effectiveness of the system below its design specifications and raising the risk of treatment failure. The high air volume is problematic as the excess may driven from the system and carry with it noxious processing and treatment odors. Recycling the air may assist but fresh oxygen must be supplied from some source. Additionally, high air volumes, especially outdoor air, reduces fluid temperatures and increase evaporation within the treatment area.

It has been found that overactive agitation in pursuit of particulate breakdown and aeration throughout the fluid is to a large extent counterproductive as the biology is sacrificed by highly turbulent motion in the fluid caused by stirrers and the effect of large air bubbles (which tend to rise quickly irrespective of fluid flow rather than drift for long period). This loss of efficiency results in efforts at producing larger and more complex systems in seeking to overcome the very nature of these systems.

Objects of the Invention

The present invention seeks to overcome the deficiencies of the prior art sewage treatment facilities in a cost effective manner which is simple to manufacture from preexisting components and which provides a long term treatment solution by both method and apparatus.

The present invention seeks to provide a treatment solution which uses only small amounts of electrical energy and is highly tolerant to electrical outages, even lengthy ones as may be common in some countries or areas.

The present invention seeks to provide sufficient aeration, without excess, thereby reducing the possibility of noxious odors escaping from the system and reducing the amount of evaporation from the tank area and, thus, increasing and stabilizing the temperature of the fluid being processed.

The invention provides a method of treatment of sewage effluent which combines a drifting fluid motion within the processing tanks, a predominance of micro bubbles suspended and entrained within the fluid and 'sticking' to all available surfaces and a greatly extended biological processing surface.

The predominance of 'sticky' micro bubbles reduces energy requirements, reduces temperature and evaporation losses in processing areas and requires only low energy use while being highly tolerant to electrical power failures. Thus, noxious odors are all but eliminated and in the event of energy failure the fluid remains highly aerated due to the 'sticky' bubbles which provide for continuous supply of biological processes as they adhere to biological surfaces. Over an extended period the rising action of the 'sticky' bubbles maintains drifting motion in the tank as more fluid is added or not and maintains aeration.

The present invention provides a sewage treatment product which may be readily manufactured from standard components in a low cost and low technology situation, is readily shipped without damage and may be assembled by relatively unskilled labor almost error-free at either retro-fit sites or at original installations. It does not require any alterations in tank design or installation procedures.

The Invention

A method of processing raw sewage wastes includes the steps of maintaining a non-turbulent drift-like state of fluid motion in a septic tank, maintaining the drifting-like fluid motion in substantially all areas of the tank, providing a high surface area for biological growth at least twice the interior surface area of the tank, injecting air into the fluid so as to produce a high volume of micro bubbles, and, ensuring that a preponderance of the micro bubbles have a high tendency to drift entrained with the moving fluid rather than rise through said fluid and also a high tendency to stick to interior surfaces for extended periods.

The invention also provides a method wherein said drift-like fluid motion and said micro bubbles are provided within one or more horizontally confined and vertically oriented substantially tubular channels so as to cause a slow vertical drift within said channels and production of a maximum level of sticky micro bubbles.

The invention also provides a sewage treatment apparatus for use in a septic tank system comprising a plurality of vertically oriented open filter arrays each comprising a restrained bundle of tubular thin-walled filter elements extending substantially the full length of a respective said array, said filter elements having an irregular interior and exterior surface exposed to the sewage fluid and arranged to abut one another within said

bundle, means for restraining said bundle in both vertical and horizontal directions which provides for substantially free drift-like motion of the sewage fluid through said restraining means,

In another embodiment the invention provides a sewage treatment apparatus wherein at least one of said arrays includes at least one air supply duct arranged within at least one of said filter elements, said air supply duct occupying substantially all of the interior diameter of a respective one of said tubular filter elements, said air supply duct being substantially shorter in length than said array and said tubular element so as to maintain air flow substantially within said respective tubular element, said air supply duct providing an air flow which does not substantially escape said tubular element, adapted to provide a preponderance of sticky micro bubbles entrained within the sewage fluid and which remain entrained and adhered to biological surfaces for extended periods.

In another embodiment the sewage treatment apparatus of the invention includes an outlet tube centrally located within said array and adapted for fluid flow from the bottom of said outlet array to the exterior of said tank.

List of Drawings

Figure 1 is a diagrammatic drawing of a prior art concrete tank shown in operating position.

Figure 1a is a cross-section from Figure 1a taken along line A-A in Figure 1a.

Figure 1b is a plan view of the tank of Figure 1a.

Figure 2a is an elevation of the preferred embodiment of the invention within a concrete tank, as in Figures 1, which corresponds to Figure 1b.

Figure 2b is a plan view of the preferred embodiment of Figure 2a.

Figure 3 is a partial cross-section of the filter array of the preferred embodiment.

Figure 4 is an enlarged cross-section of the diffuser filter array of the preferred embodiment.

Figure 5 is a further enlarged view of the micro bubbles of the preferred embodiment.

Figure 6 is a plan view of the filter array of Figures 2.

Figure 7 is a cross-section of the filter array of Figure 6 taken along line D-D.

Figure 8 is a perspective view of the output filter array.

Figure 9 is a plan view of the output array of Figure 8.

Figure 10 is a cross-section of the output array of Figure 9 taken along line E-E.

Figure 11 is a plan view of the hinge clip of the invention.

Figure 12 is an end view of the clip of Figure 11.

Figure 13 is a partial end view of the clip with an array panel installed in place.

Figure 14 is an end view of the clip in fully rotated position retaining a pair of panels in position.

The Preferred Embodiments

A prior art concrete tank is generally indicated as at 1 in Figure 1a in diagrammatic form. Inlet sewage fluids 2 are taken into the tank at inlet pipe 3 generally arranged so as to be above the nominal fluid level 4. Tank 1 is separated into a settling partition 1a and a outlet partition 1b by

a mid-tank baffle 5. In the typical concrete prior art tank baffle 5 extends above the fluid level as at 6 in Figure 1a while in a plastic tank typically baffle 5 is arranged as a weir over which the fluids flows.

Fluid flows as at 7 from partition 1a to outlet partition 1b through connection port 8 all of which is typically below fluid level 4.

Outlet fluid 9 flows as by gravity out of outlet pipe 10 arranged to determine the fluid level 4.

The cross-section of the tank 1 of Figure 1a (taken along line A-A shown in Figure 1b) shows the inlet fluid 2 cascading from inlet pipe 3 into partition 1a, arriving at a level 4 and passing into partition 1b through port 8 as at 7.

Typically a larger proportion of suspended solids precipitate out of the sewage fluid in partition 1a leaving a higher residue level (as at 11) than that in partition 1b (as at level 12).

A plan view of Figure 1a is shown in Figure 1c for ease of reference.

The preferred embodiment of the sewage treatment method and apparatus is shown in Figure 2 in relation to a 2-compartment concrete tank installation of the type depicted in Figures 1.

Generally rectangular filter arrays 20, 30 and 40 are secured into partitions 1a and/or 1b so that the bulk of the active area of each such filter array is below water level 4. Each filter array includes a high surface area of material suitable to the growth and maintenance of a biological filtering medium which adheres to the surfaces of the filter arrays and biologically processes the fluid from raw sewage to clear water effluent over a period of time.

When fabricated from suitable materials the individual arrays may be permitted to float in the fluid but it is preferred that each be secured in

position by any suitable means, not shown. Each such filter array 20, 30 and 40 is arranged so that it extends well into, but not entirely to the bottom of the tank 1. Preferably each array is suspended in the top 2/3 of the fluid.

In single partition situations (not shown) or when a reduced level of fluid processing is required, such as in installations where access is limited, all of the arrays may be placed in the 2nd partition or the outlet partition 1b .

Most preferably an active filter array or diffuser 30 is placed and secured in partition 1a adjacent connection port 8 so that fluid flow 7 is supplied by fluid flows 31a, 31b and 13c through diffuser 30.

A plurality of passive filter arrays 20a, 20b and 20c is most preferably suspended and secured in position within partition 1b, the outlet partition.

Most preferably an outlet filter array 40 is suspended and secured adjacent outlet 10 with its active area below surface 4.

Each filter array 20, 30 and 40 is a vertically oriented bundle of thin-walled corrugated plastic tubes as in Figure 3, a partial cross-section. Each such tube 50 is arranged to extend from upper array surface 58 substantially continuously to lower surface 57 in abutting engagement with adjacent tubes throughout the array. Corrugations 50 provide for an operative tube outer diameter 51 and an operative inner diameter 51 along with a very high surface area per unit length.

Corrugations 53 comprise a series of annular valleys 54 and hills 55 are a preferred continuous along the length of tube 50. Adjacent tubes 50 are preferably arranged so that valleys 54 and hills 55 of adjacent tubes are in corresponding vertical locations to provide for ready fluid flow between the tubes.

Although many different sizes of tubes 50 may be utilized in carrying out the preferred embodiment of the invention an array of 9x9 tubes 50, with each such tube having an outside diameter 51 of about 3.3 cm and an inside diameter of 2.6 cm has been found effective for a typical multi-bathroom house with a 2-partition tank as in Figure 1. Although tubes of differing sizes may be used in any filter array, an array of fixed size tubes aids in efficient and cost effective manufacturing.

Smaller or larger tubes 50 may be effectively used but with reduced efficiency as larger tubes dictate a reduced overall biological surface area while smaller tubes have a higher tendency to become clogged with sewage effluent particles and/or fragments of biological mats which become dislodged.

Each filter array 50 is preferably confined within an open-mesh rectangular structure as shown in Figure 8 for ease of manufacture and shipping and for ease of placement in existing concrete tank 1 situations adjacent port 8 and outlet 10.

Active filter array 20 includes a multiplicity of, most preferably 4, air supply ducts 21 each one of which is centrally located within a corresponding tube 50 and sized for close fitment as at radial dimension C in Figure 4. Most preferably a radial spacing C of about 4-5 millimeters has been found to be effective. In accordance with the method of the invention a limited supply of air as at 59 is provided to supply ducts 21 so as to exit duct 21 and rise predominantly vertically and slowly within tube 50 in the form of a preponderance of sticky micro bubbles. The limited spacing C and the corrugated interior surface of tube 50 as at 53 provide for a breakup of most larger bubbles into the effective sticky micro bubbles of the invention.

Micro bubbles are shown greatly enhanced as at 60 in Figure 4. Air supply 59 is limited so that the lower limit of air in the fluid, shown as at 62 in Figure 4, is above the lower limit 57 of tube 50 by a distance A. With tubes 50 about 75 cm long with an OD of 3.3 cm spacing A is effective at 10 cm. Preferably little or no air escapes below lower limit 57 as it would then be free to rise in unrestricted areas in the form of larger, fast rising bubbles thereby forming a degree of turbulent action and flow. Rising air in the restricted and highly variable vertical channel between duct 21 and tube 50 maintains and causes a high degree of breakdown of air bubbles to the required micro bubble size which are both highly prone to drifting within a sewage treatment fluid and to sticking to any available surface for extended periods of time.

Most preferably each of the 4 ducts 21 may be supplied from a common air source, not shown, which may external to the tank and either outside or inside of any adjacent structures. A slow air flow rate has been found most effective. In larger or smaller installations or where varying degrees of effectiveness are specified the number and location of air ducts 21 may be adjusted accordingly and the diffuser placed within partition 1a or 1b of tank 1.

Alternatively, tube 50 may be discontinuous in some aspect as by a plurality of holes, not shown, provided the formation of suitable micro bubbles is not adversely affected.

Figure 5 shows a typical micro bubble 60 is shown in greatly expanded size for ease of reference. Reduction of diameter B results in a substantial increase in bubble drifting (vs. rising) along with increased stickiness. A cloud or mist of micro bubbles is formed in the sewage fluid in tank 1 and remains suspended or entrained or entrapped for extended periods of as much as or more than several days without any

intervention. As such, the micro bubbles 60 are allowed to drift with, being entrained into, the fluid being treated into all areas of the tank 1, including the lower areas, without mechanical assistance or undue turbulence, and remain entrapped on all surfaces. The result is a quiescent and aerated state of the fluid which allows for both continuous passage of fluid into and from all tank areas and for continuous passage of fluid into and in contact with the biological filtration medium for maximum effectiveness. Preferably all surfaces of the tank 1 and the filter arrays 20, 30 and 40 are covered in micro bubbles which remain for long periods thereby increasing exposure to drifting fluid and remaining available to biological processes.

Figure 6 shows a plan view of the array 30 and diffuser array 20 which includes the ducts 21 shown in Figure 6. Four air ducts 21 are drawn form a single source along ductwork 65 for uniform pressure. Air is driven down duct 21 as at 59 and a mist of micro bubbles rises along restricted pathway 63.

Preferably the array of tubular filter elements in arrays 30, 20, and 40 is contained in a rectangular enclosure formed by 4 vertical side panels 66 joined at the corners by clips 67. Preferably panels 66 have sufficient material to be structurally sound but include a maximum of open spaces over their entire surface so as not to unduly restrict fluid flow in the form of a grid.

Figure 7 shows a cross-section of the array of Figure 6 taken along line D-D. Upper and lower panels 67 are formed in a similar manner to vertical side panels 66 and are preferably formed in conjunction with corners 68 into single end pieces.

In Figure 8 the standard filter array 20 of Figure 2b is extended for use as an output array 40. Preferably side panels 66 are comprised of a

smaller vertical dimension sub-panel 66a and a larger sub-panel 66b which may be twice the height of sub-panel 66a.

Output array 40 includes an empty upper portion 40a and a lower portion configured as a standard filter array but for the large central tube 71 and an output tube 76. For ease of manufacture upper portion 40a may be assembled using smaller sub-panel 66a.

Top and bottom panels 68 include a plurality of holes in their respective vertical sides which are adapted to receive pressure-fit clips or other mechanical fasteners. Structural strength may be increased with the sub-panel assembly by a plurality of corner clips 69 which are adapted to fold around a mating corner between panels 66 and clamp same in position. Additional sub-panel clips may be added as at 75.

Array 40 may additionally be fitted with handles as at 70.

It can be readily seen in Figure 8 that fluid flow along any of the 3 main directions, 73a, 73b and 73c, is not substantially impeded by the array although vertical flow along 73b is isolated from horizontal flow directions 73a and 73c by both the vertical tubes 50 and the horizontal channels created by the matching corrugations.

Figure 9 shows an elevation of the output array 40 and its centrally aligned flow tube 71 which passes through the array from top to bottom. The array 40 is arranged so that the fluid level 4 is at or just below the level of output tube 72 so that increases in level 4 are eventually allowed to flow freely up tube 71 as at 78 and then transversely out tube 72 as output flow 9. An additional filter element 77 may be suspended in tube 71 as required. Preferred installation places output array 40 adjacent the output tube 10 of tank 1 and tube 72 may be integral with output tube 10.

Figures 11 through 14 shown the hinge clip of the invention.

Figure 11 is a plan view of the hinge clip 100 which is preferably formed of molded plastic which is flexible along hinge line 101 but which becomes stronger upon flexion. Spaces 102 and extensions 103 are adapted to match the bars and internal spaces of the grid of panel 66.

Figure 12 shows an end view of the hinge clip of Figure 11. From central hinge line 101 the clip includes a pair of each of structural restraints 106, spacing bars 105 and retention teeth 104 arranged symmetrically outwards from line 101. Panel 66 has a flat surface as at 110 in Figure 13 and panel grids may be inclined as at 111 for ease of production. Bar 105 and tooth 104 are spaced so as to selectively clip panel 66 in place with minimal spacings as at 112 and 113 respectively.

Clip 100 may then be folded about line 101 as at 108 in Figure 13 into a fully operational condition 108a as shown in Figure 14 where sloping contact surfaces 107 of restraints 106 prevent further rotation and, preferably panels 66 come into contact for further structural integrity.

The preferred method of the invention includes the steps of:

1. maintaining a quiescent state of fluid motion in the tank 1, notably by the absence of mechanical stirring apparatus,
2. maintaining a drifting-like motion in substantially all areas of the tank,
3. providing a high surface area for biological growth, in the order of 2-3 times the interior surface area of the tank 1 below water level 4,
4. injecting air into the fluid so as to produce a high volume of micro bubbles, and

5. ensuring that a preponderance of the micro bubbles have a high tendency to drift with the moving fluid rather than rise through said fluid and also to stick to interior surfaces for extended periods.

Drifting motion and micro bubbles are most preferably provided within 1 or more horizontally confined and vertically oriented substantially tubular channels so as to cause a slow vertical drift within said channels and production of a maximum level of sticky micro bubbles.

While the preferred embodiments of the method and apparatus of the invention have been described variations in the design may be made by persons skilled in the art. Particularly and without limitation, tubes 50 may be of non-cylindrical configurations and may be lumpy rather than fully corrugated. Arrays 20, 30 and 40 may be non-rectangular and may contain a variety of shapes and sizes of tubular filter elements particularly where fitment against non-planar surfaces is required.

What I claim is:

1) A method of processing raw sewage wastes including:

a) maintaining a non-turbulent drift-like state of fluid motion in a septic tank,

b) maintaining the drifting-like fluid motion in substantially all areas of the tank,

c) providing a high surface area for biological growth at least twice the interior surface area of the tank,

d) injecting air into the fluid so as to produce a high volume of micro bubbles, and,

e) ensuring that a preponderance of the micro bubbles have a high tendency to drift entrained with the moving fluid rather than rise through said fluid and also a high tendency to stick to interior surfaces for extended periods.

2) A method as claimed in claim 1 wherein said drift-like fluid motion and said micro bubbles are provided within one or more horizontally confined and vertically oriented substantially tubular channels so as to cause a slow vertical drift within said channels and production of a maximum level of sticky micro bubbles.

3) A method as claimed in claim 2 wherein said horizontally confined tubular channels are adjacent the outlet of a first settling partition in a septic tank system.

4) Sewage treatment apparatus for use in a septic tank system comprising:

a) a plurality of vertically oriented open filter arrays each comprising a restrained bundle of tubular thin-walled filter elements extending substantially the full length of a respective said array,

b) said filter elements having an irregular interior and exterior surface exposed to the sewage fluid and arranged to abut one another within said bundle,

c) means for restraining said bundle in both vertical and horizontal directions which provides for substantially free drift-like motion of the sewage fluid through said restraining means,

5) Sewage treatment apparatus as claimed in claim 4 wherein at least one of said arrays includes at least one air supply duct arranged within at least one of said filter elements,

i) said air supply duct occupying substantially all of the interior diameter of a respective one of said tubular filter elements,

ii) said air supply duct being substantially shorter in length than said array and said tubular element so as to maintain air flow substantially within said respective tubular element,

iii) said air supply duct providing an air flow which does not substantially escape said tubular element,

iv) adapted to provide a preponderance of sticky micro bubbles entrained within the sewage fluid and which remain entrained and adhered to biological surfaces for extended periods.

6) Sewage treatment apparatus as claimed in claim 5 wherein at least one of said arrays includes an outlet tube centrally located within said array and adapted for fluid flow from the bottom of said outlet array to the exterior of said tank.

7) Sewage treatment apparatus comprising:

a) a septic tank system with at least 1 partition,

b) a plurality of vertically oriented open filter arrays each comprising a restrained bundle of tubular thin-walled filter elements extending substantially the full length of a respective said array,

c) said filter elements having an irregular interior and exterior surface exposed to the sewage fluid and arranged to abut one another within said bundle,

d) means for restraining said bundle in both vertical and horizontal directions which provides for substantially free drift-like motion of the sewage fluid through said restraining means,

8) Sewage treatment apparatus as claimed in claim 7 wherein at least one of said arrays includes at least one air supply duct arranged within at least one of said filter elements,

a) said air supply duct occupying substantially all of the interior diameter of a respective one of said tubular filter elements,

b) said air supply duct being substantially shorter in length than said array and said tubular element so as to maintain air flow substantially within said respective tubular element,

c) said air supply duct providing an air flow which does not substantially escape said tubular element,

d) adapted to provide a preponderance of sticky micro bubbles entrained within the sewage fluid and which remain entrained and adhered to biological surfaces for extended periods.

9) Sewage treatment apparatus as claimed in claim 8 wherein at least one of said arrays includes an outlet tube centrally located within said

array and adapted for fluid flow from the bottom of said outlet array to the exterior of said tank.

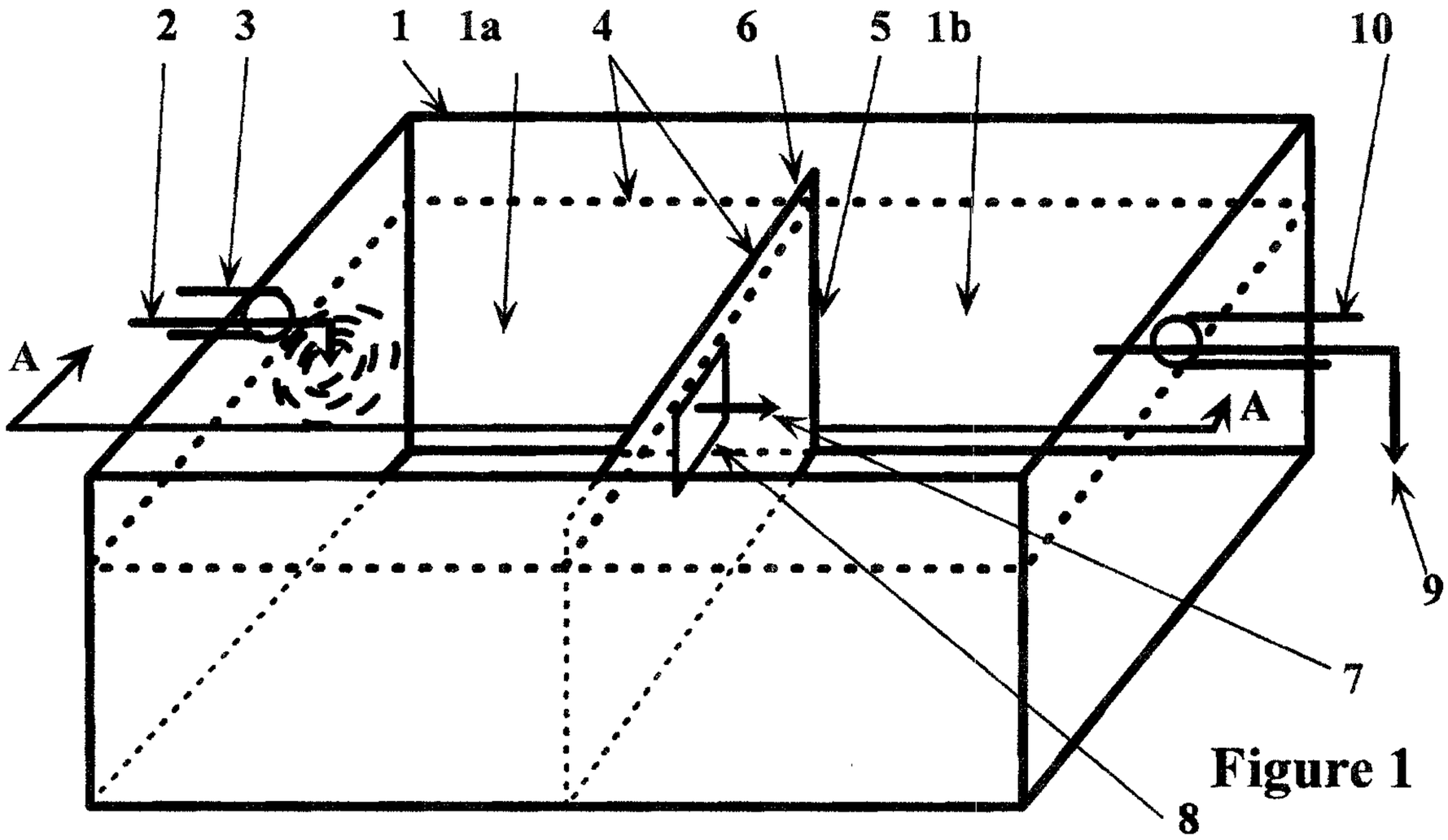


Figure 1

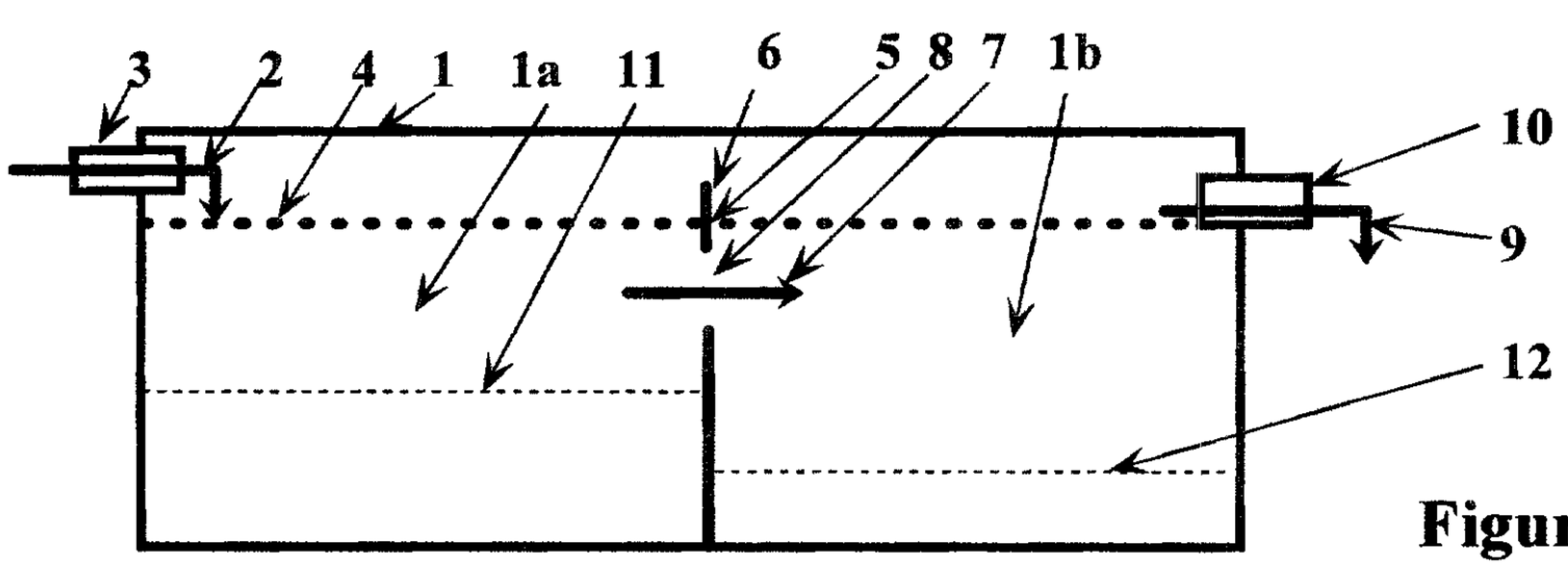


Figure 1a

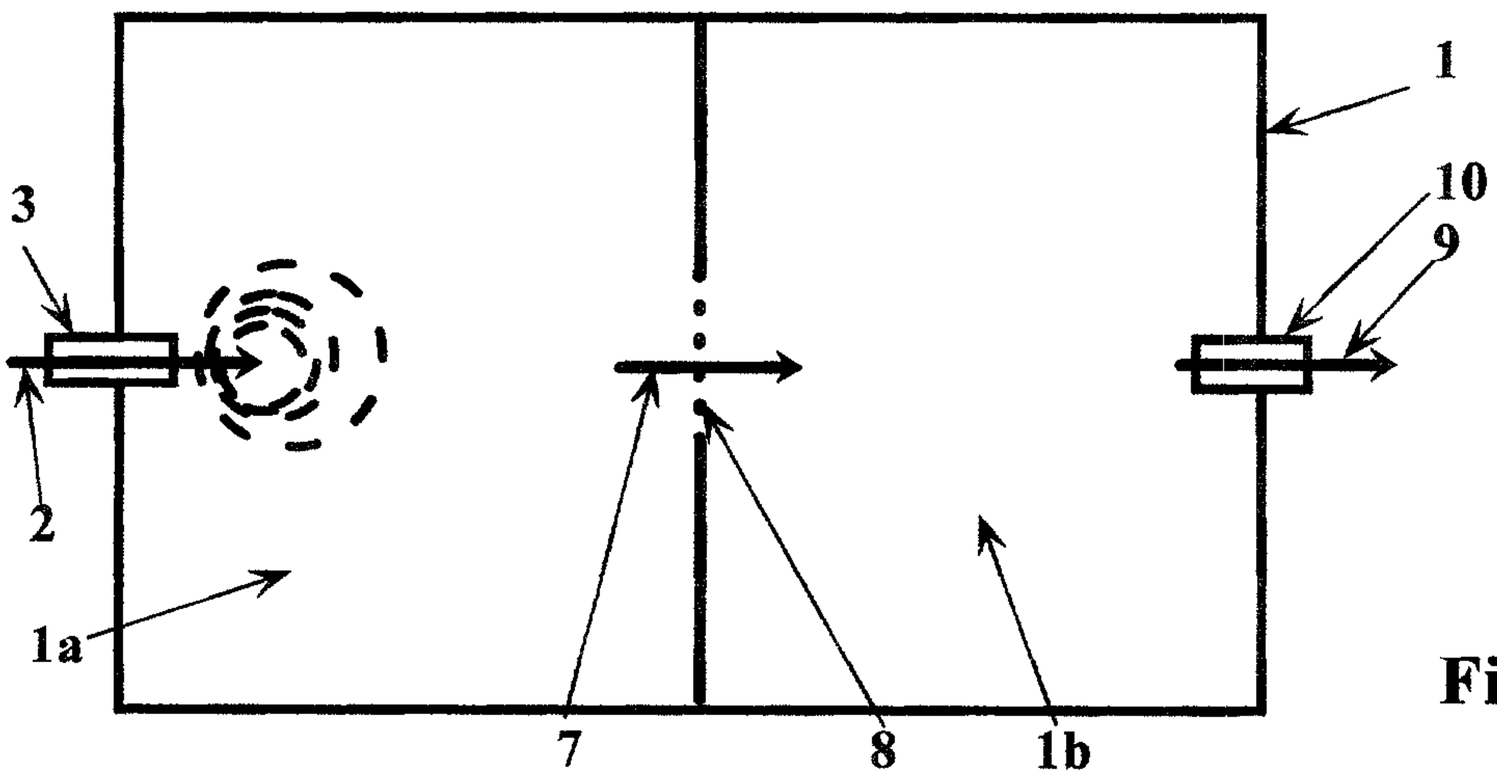


Figure 1b

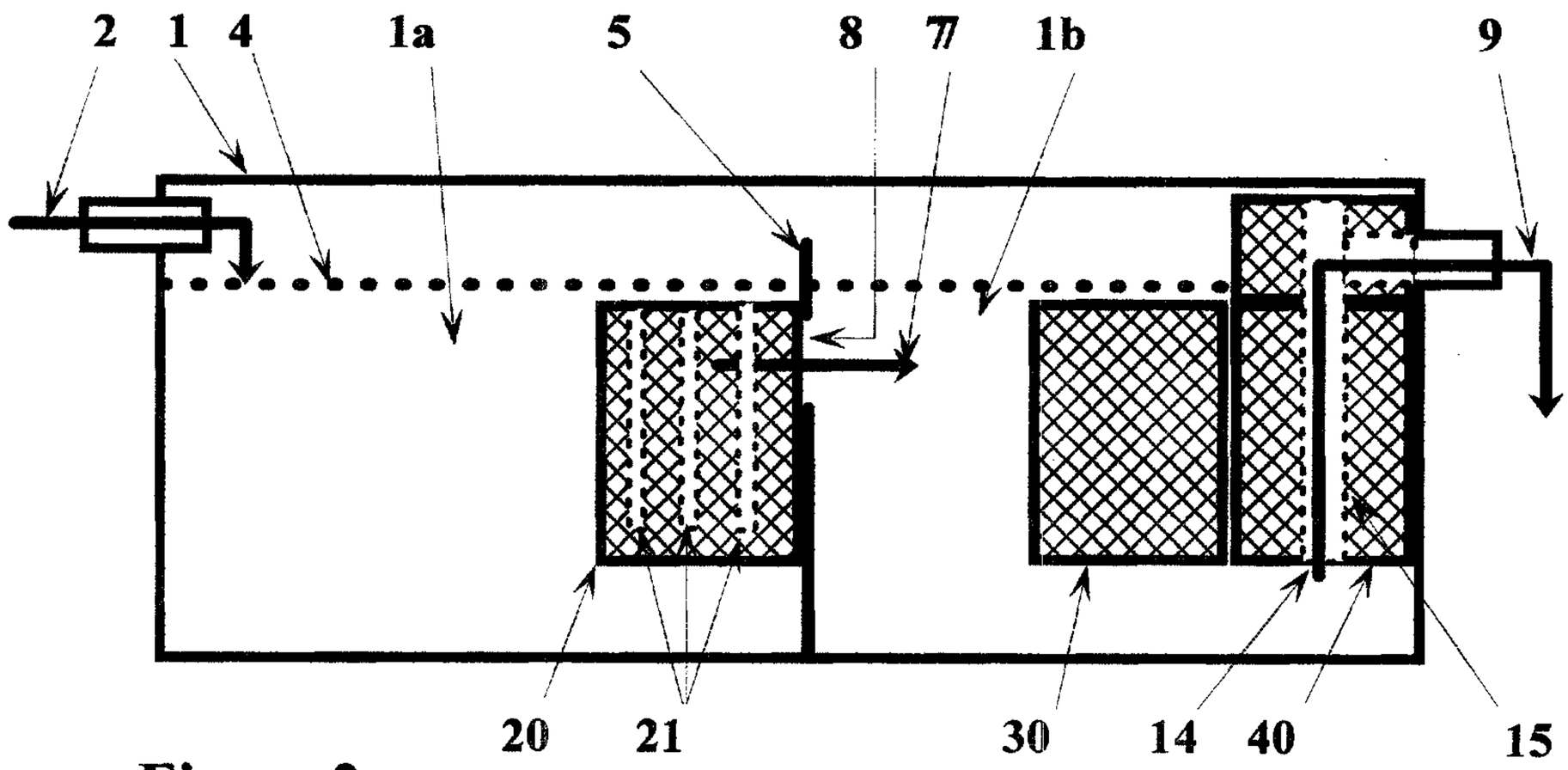


Figure 2a

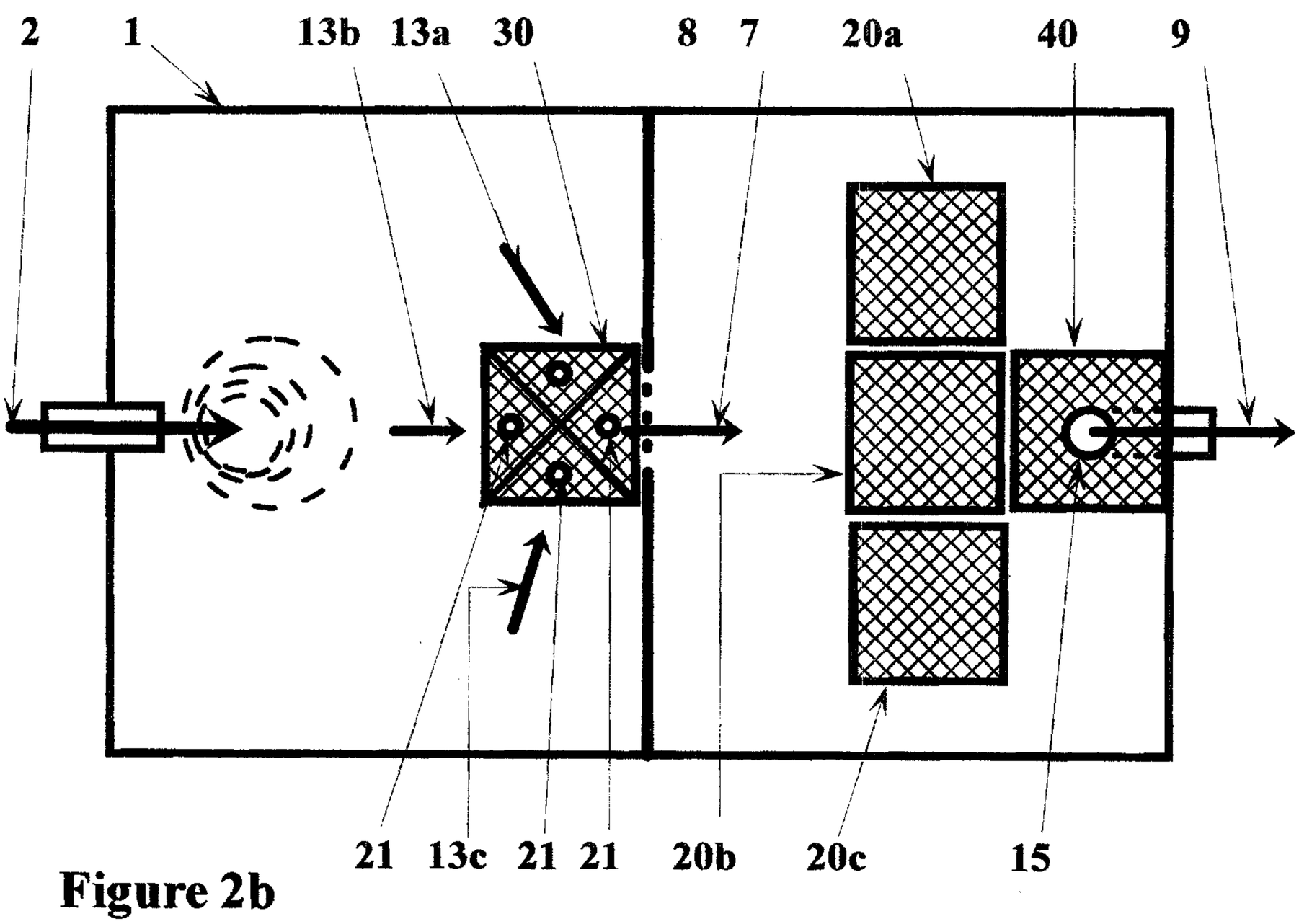


Figure 2b

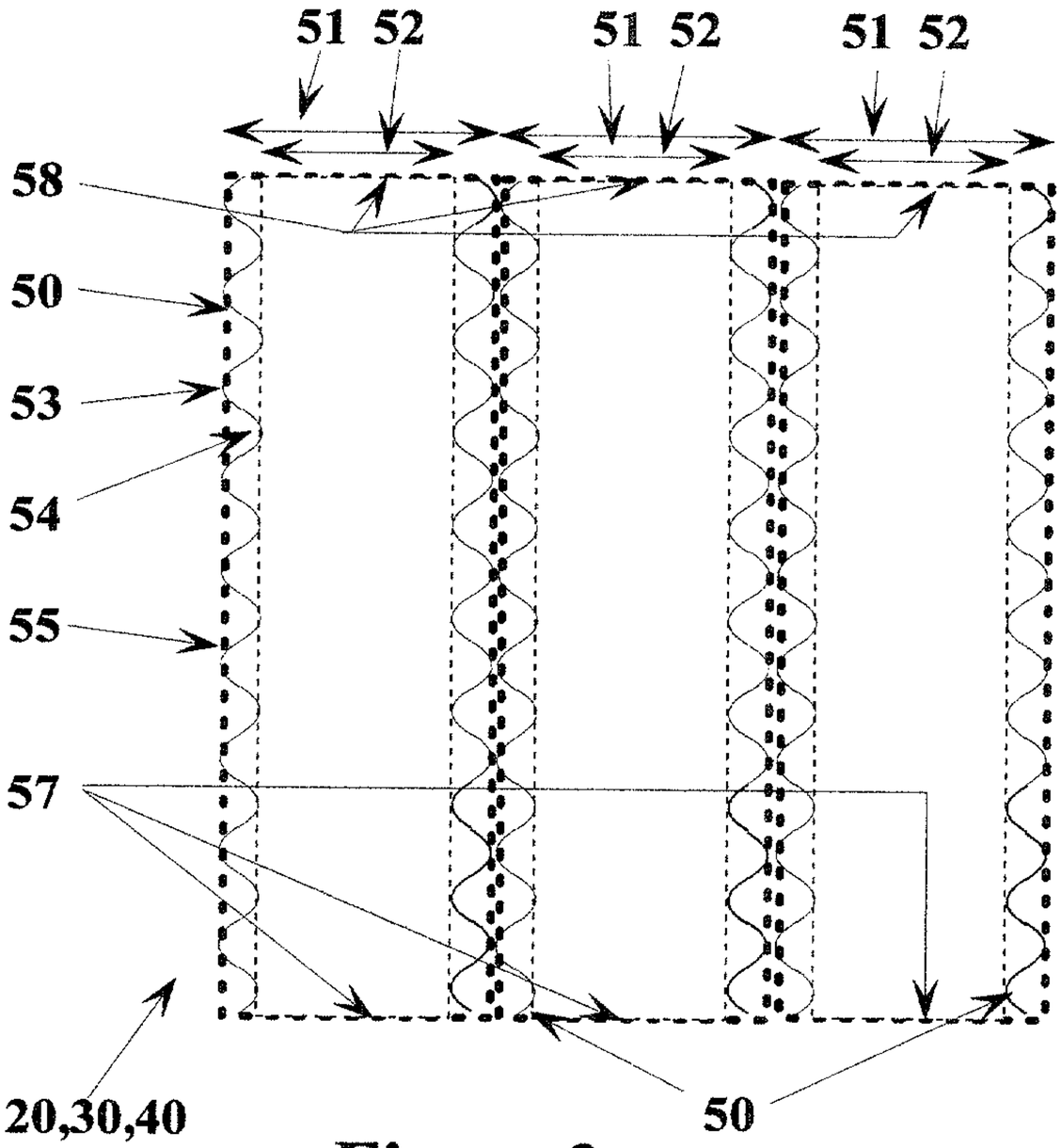


Figure 3

Figure 5

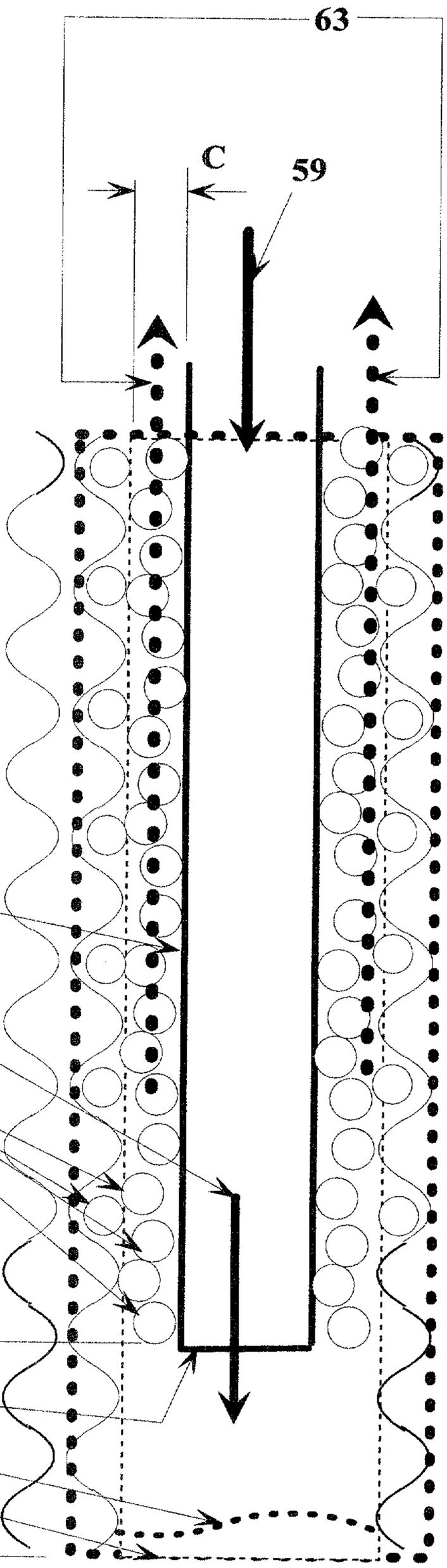


Figure 4

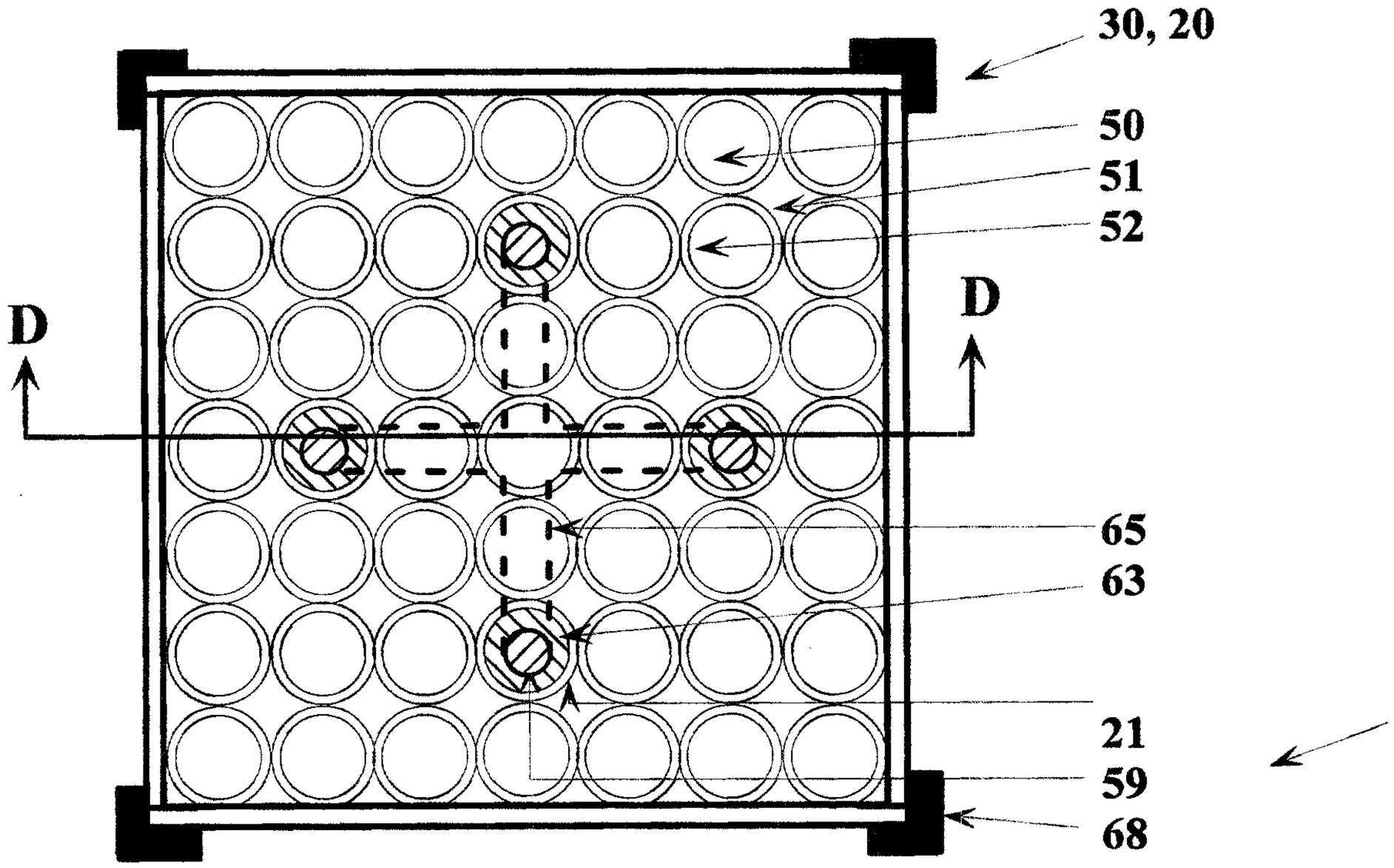
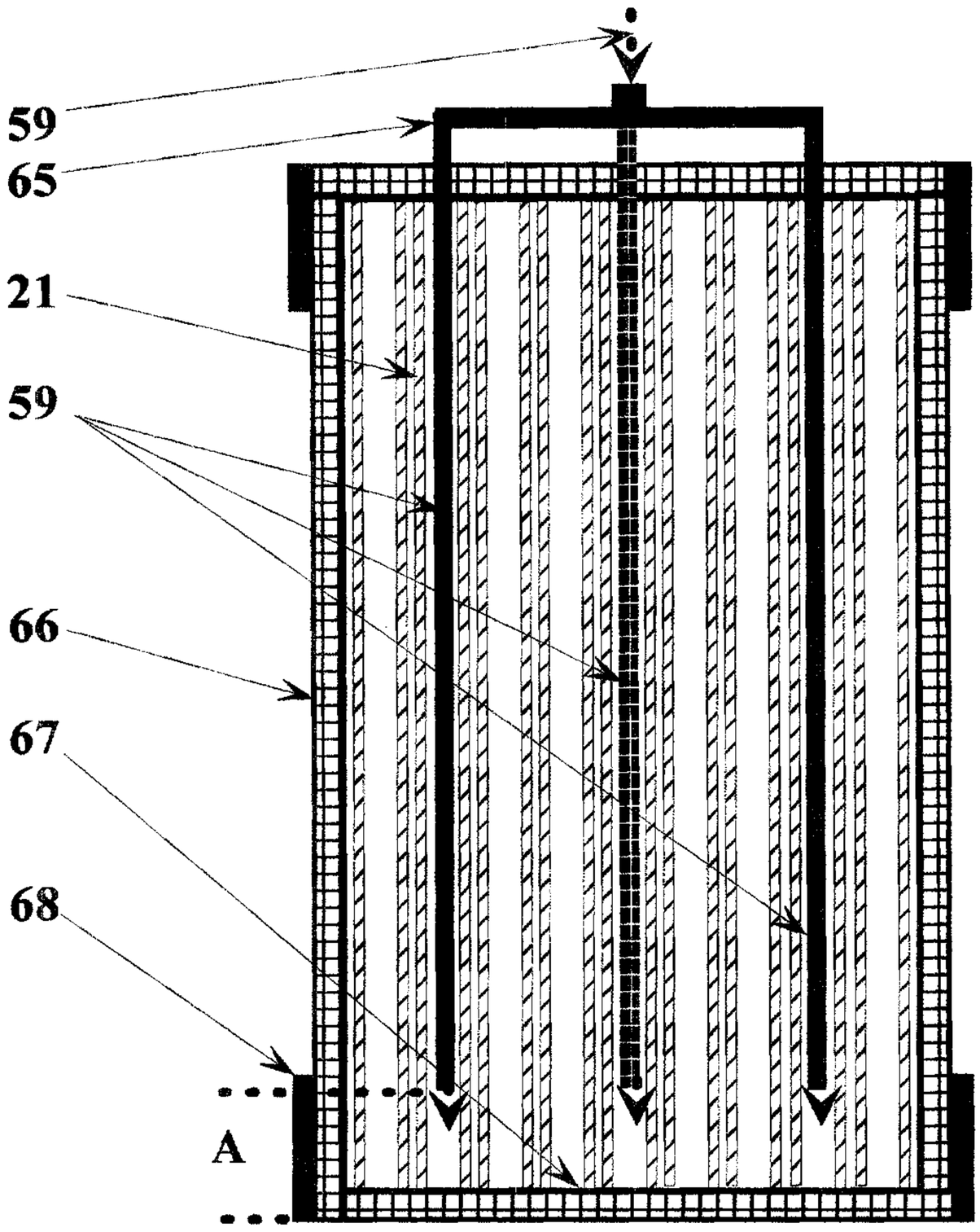


Figure 6



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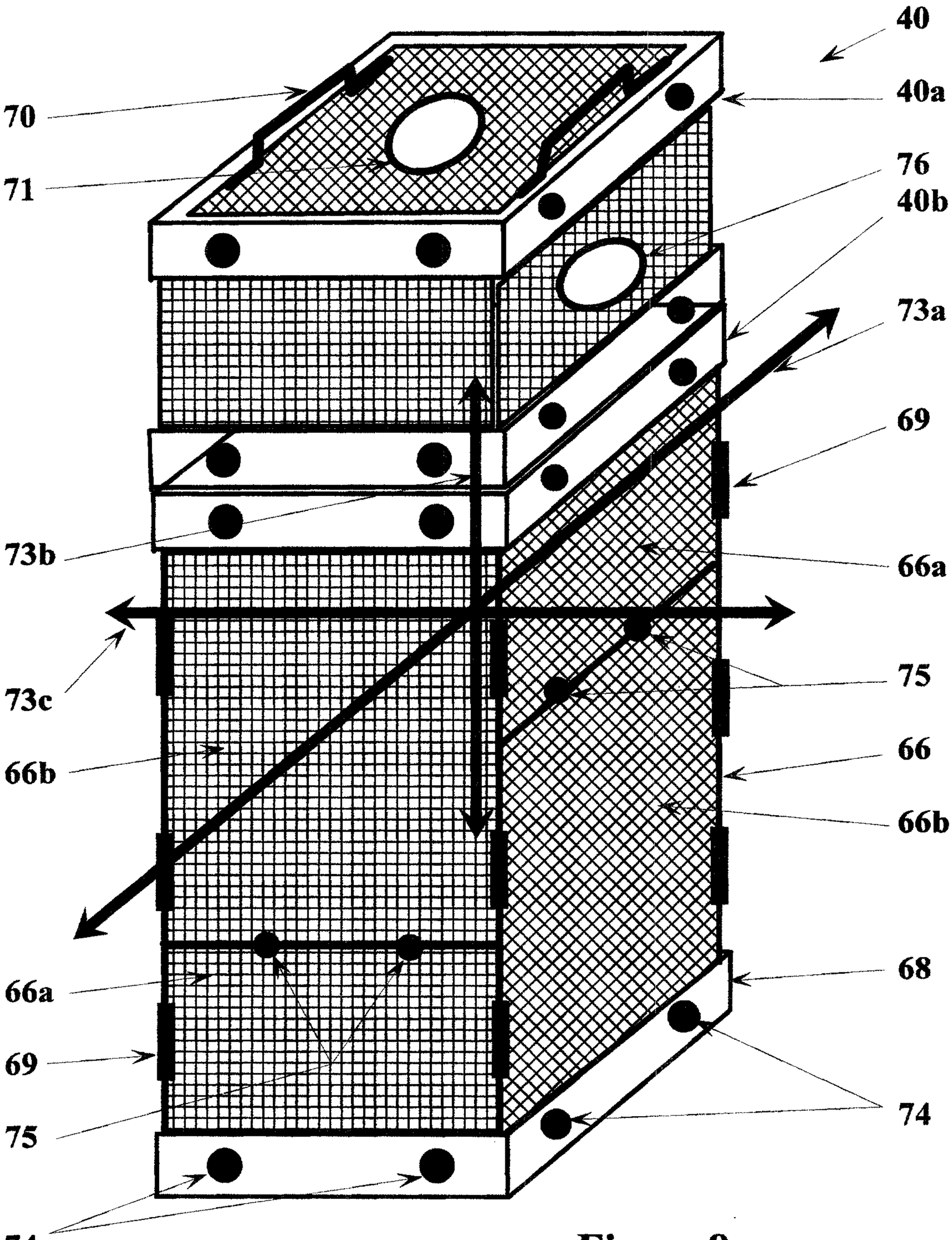
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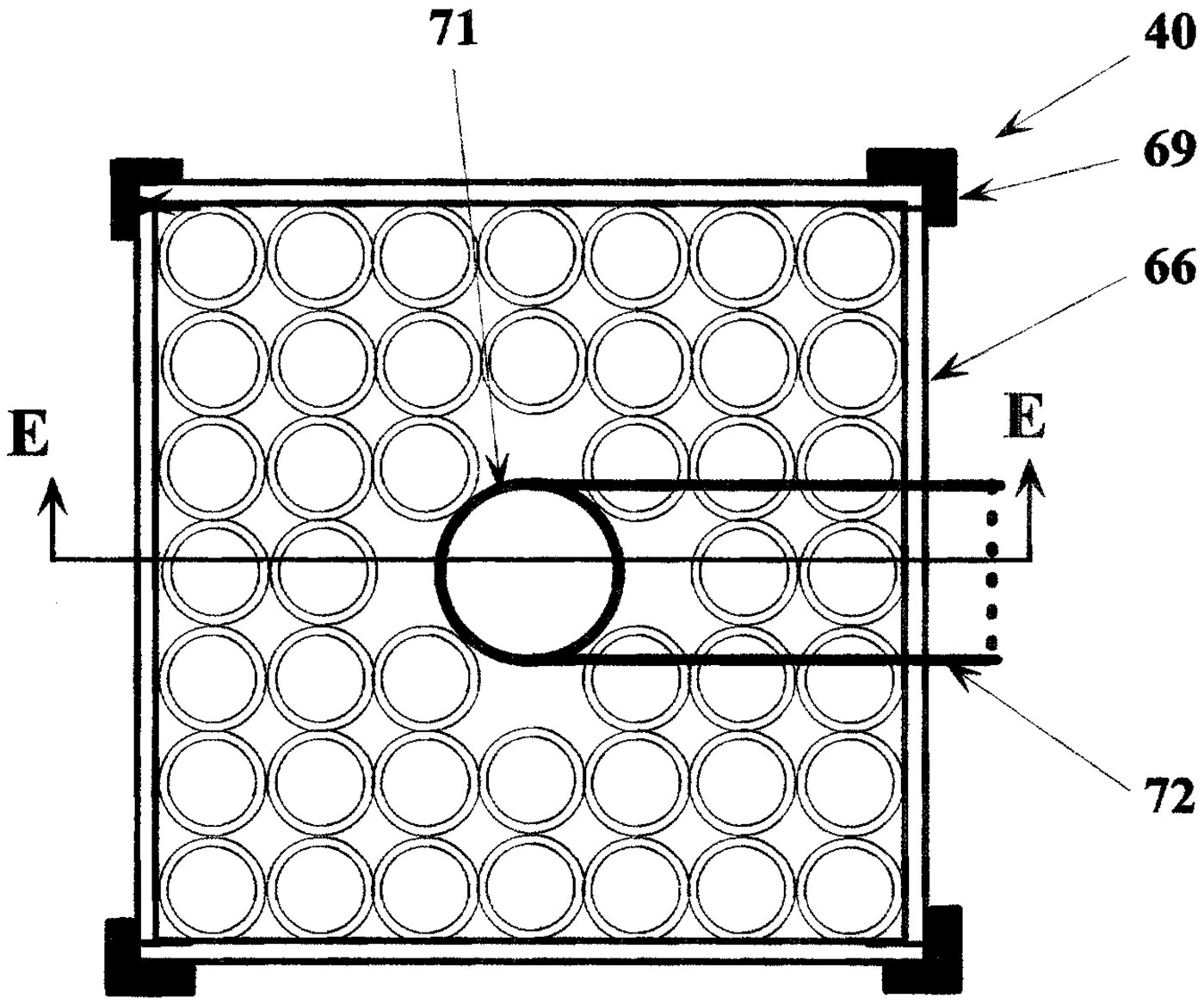
Figure 8



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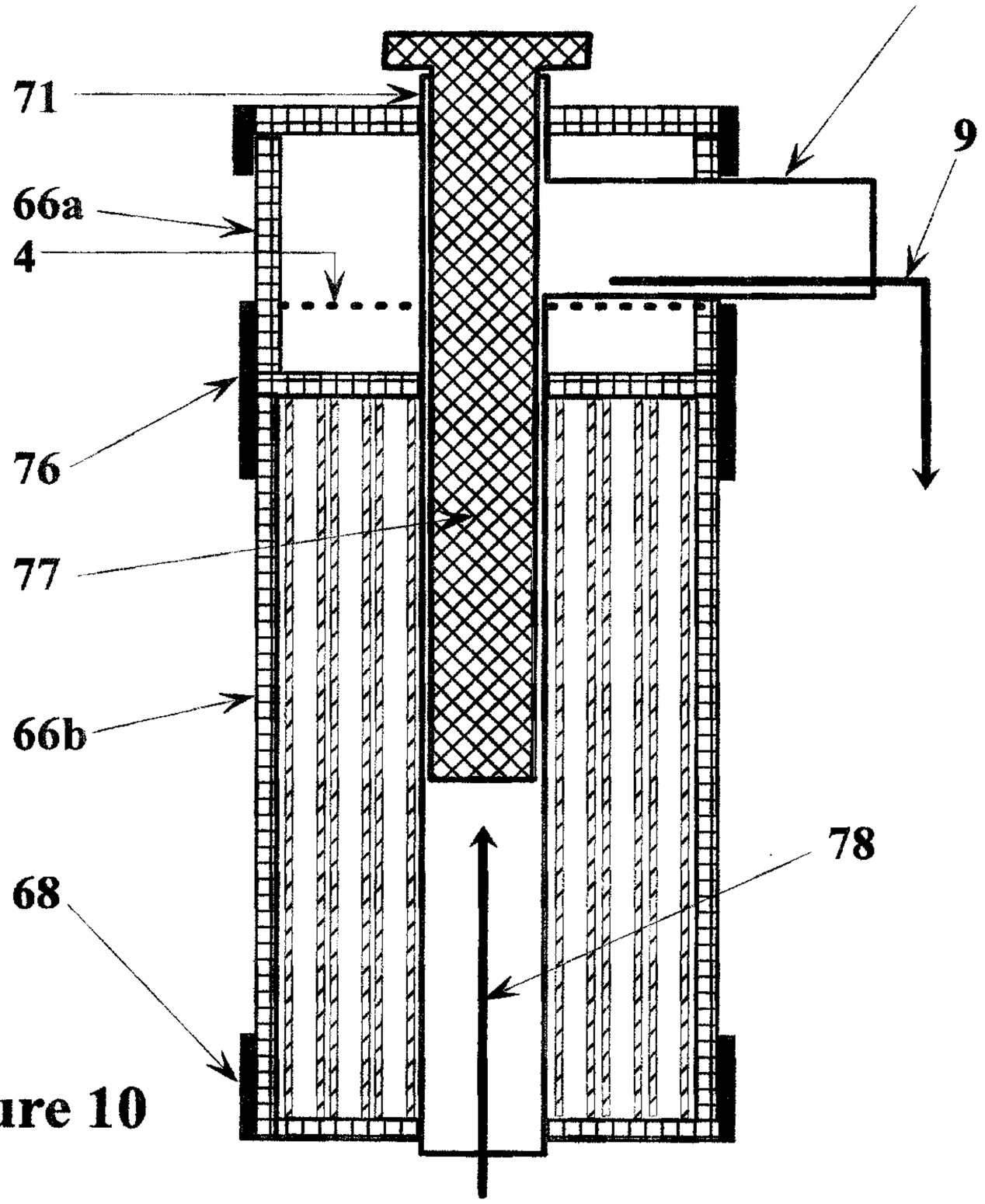


Figure 10

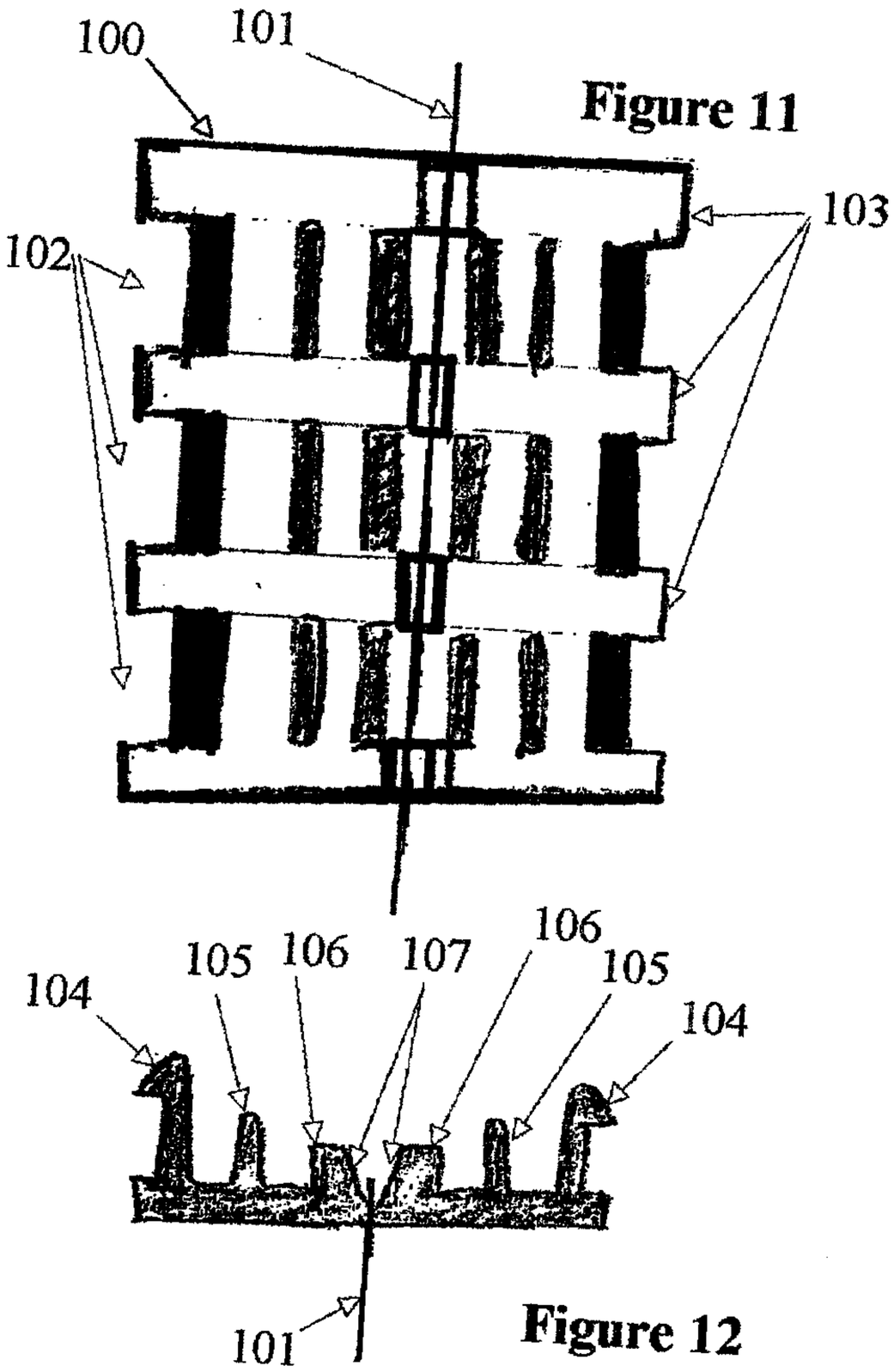


Figure 12

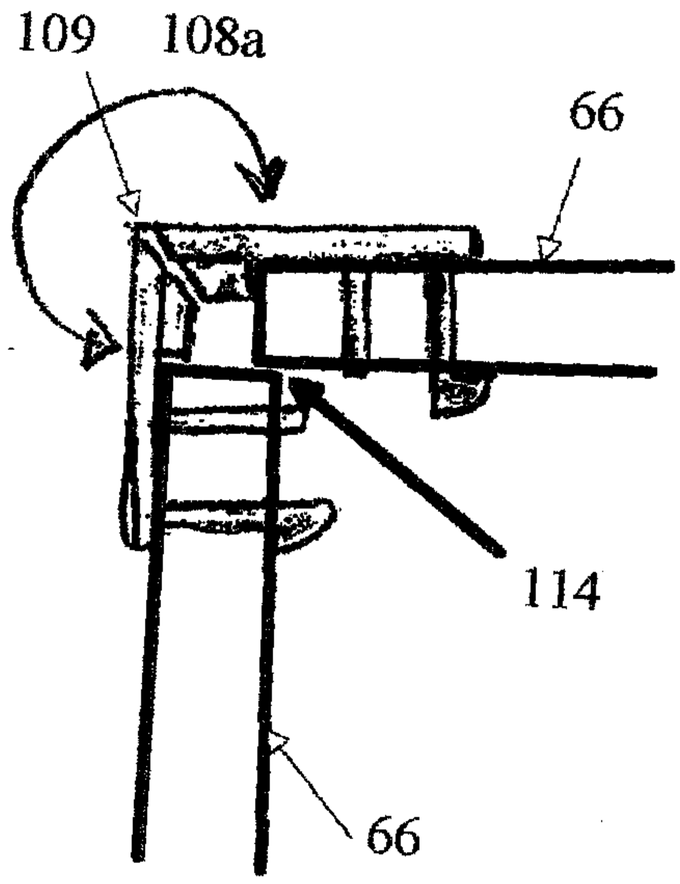


Figure 14

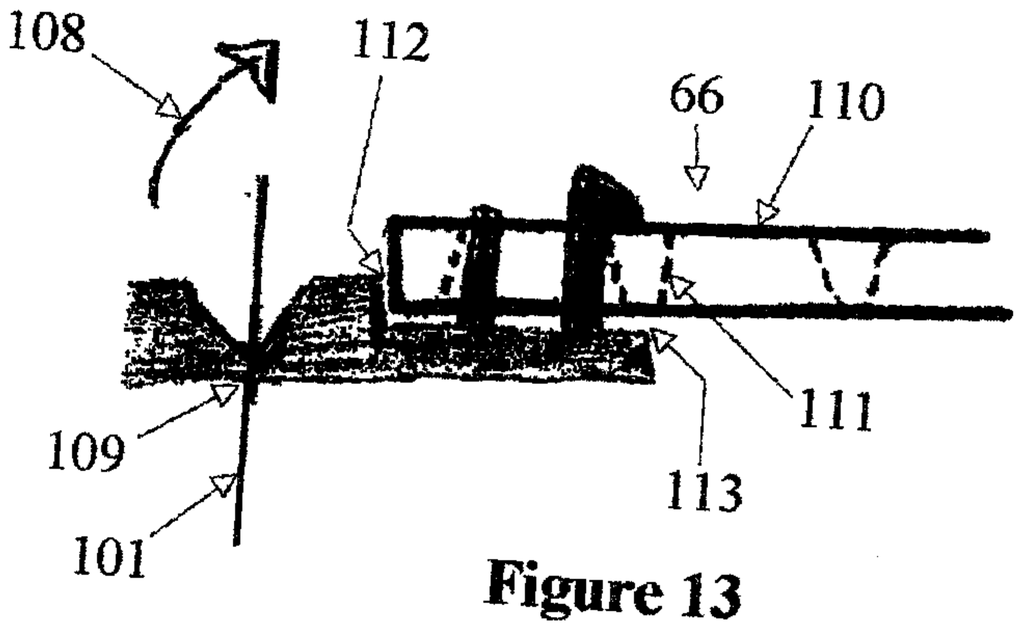
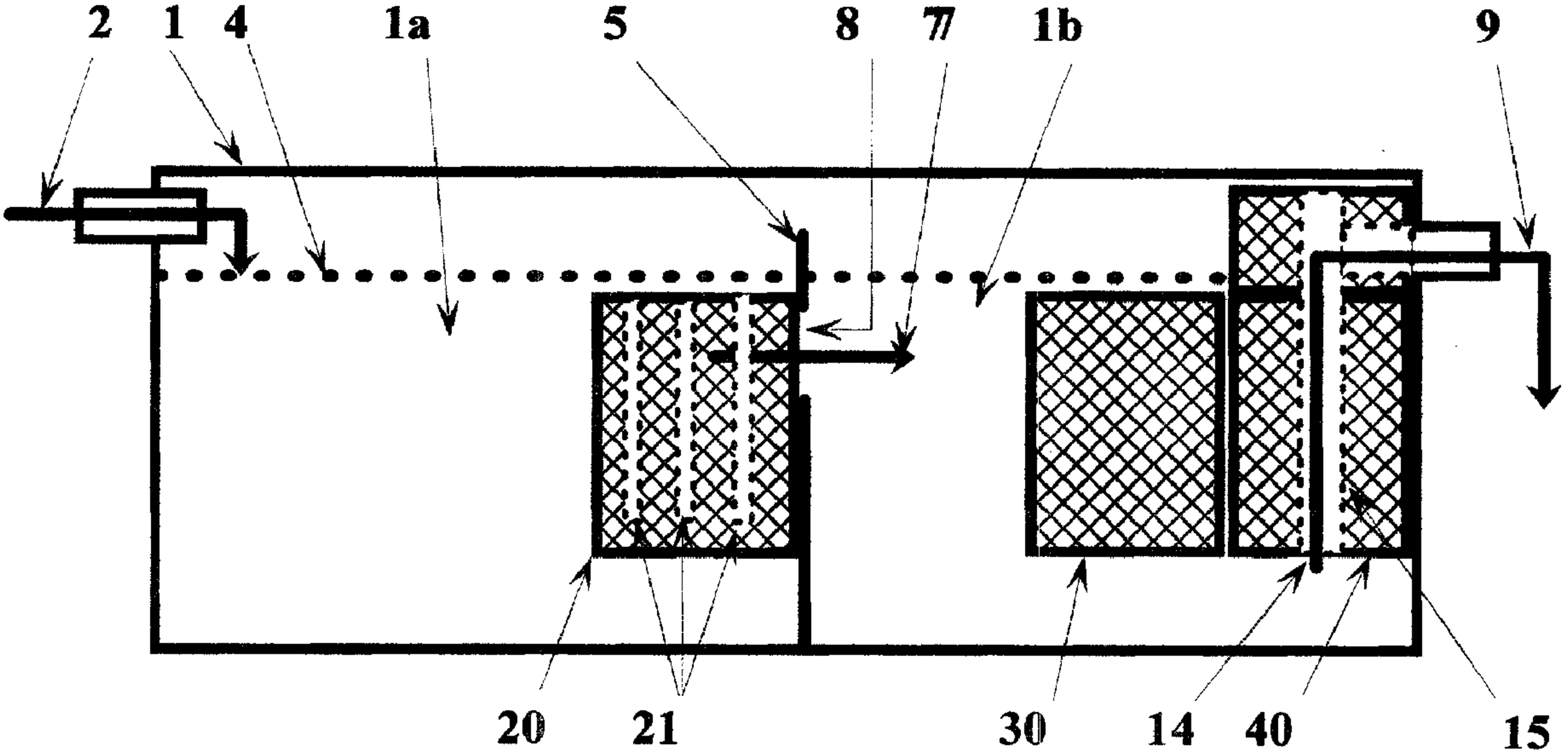


Figure 13

Figure 11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