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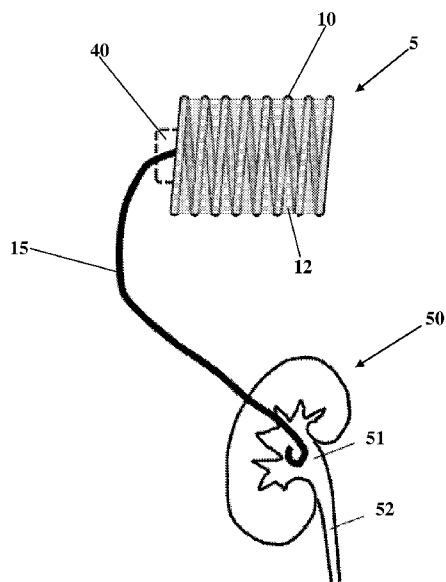


Figure 1

(57) Abstract: A system and method for draining excessive fluid from a body cavity or space. The system comprises an implantable fluid penetrable chamber comprising a frame covered by a fluid permeable mesh configured to enable fluids to penetrate therethrough. The system further comprises a catheter connected at a first end to one of said chamber sides/walls or penetrates therethrough; and optionally further comprises a pump placed inside or outside of said chamber.

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**CONTINUOUS IMPLANTABLE PERITONEAL DIALYSIS****FIELD OF THE INVENTION:**

The present invention relates to the field of medical instruments. More particularly, the present invention relates to a device and method for assisting disposal of redundant bodily fluids and decreasing the need for dialysis. The present invention is particularly useful for improving the treatment of heart failure.

**BACKGROUND OF THE INVENTION:**

Chronic kidney disease (CKD) and end stage renal disease (ESRD) are highly problematic for many people, as there is a shortage of convenient and/or readily available treatments. For example, dialysis may be performed on patients with failing kidneys to remove substances such as wastes, etc. from the patients' blood, however, often patients must connect to dialysis systems frequently. The need for such frequent dialysis treatments causes inconvenience and significantly reduces the patients' quality of life.

In contrast, for those who have undergone a kidney transplant operation, after the recovery period is complete, the quality of life increases in comparison to those needing dialysis treatment. However, kidney transplant operations are not a ready option for so many in need, due to the fact that the demand for healthy kidneys far exceeds the supply.

There is a substantial need for treating failing kidneys in a fashion that would negatively impact the patient's

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quality of life much less than frequent dialysis but would also be available to many persons in need at lower costs than that of kidney transplants. Even if for some patients a new treatment would not completely eliminate the need for dialysis, it could significantly reduce the frequency of the dialysis treatments.

US8012118 relates to a wearable dialysis system and method for removing uremic waste metabolites and fluid from a patient suffering from renal disease.

US5902336 relates to an implantable ultrafiltration device for removing low to medium molecular weight solutes and fluids from the blood of a patient experiencing renal failure. The device includes a pump having an inlet and an outlet; a first component for forming a first fluid flow path between the patient's vascular system and the pump inlet; a filter interposed in the first fluid flow path, the filter being permeable to water and substantially impermeable to blood cells and proteins; and a second component for forming a second fluid flow path between the pump outlet and the patient's bladder, wherein the pump, the first and second components, and the filter are all constructed to be surgically implanted in the patient's body.

US 2013/0253409 relates to a device for removing fluid from a first bodily cavity and for directing that fluid into a second bodily cavity while avoiding risks of infection and, in one embodiment, excessive dehydration of the first bodily cavity. The device includes a pump and a reservoir.

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Prior art methods do not provide sufficient treatments for disposal of redundant fluids. It is therefore an object of the present invention to provide a method and means for assisting in the disposal of redundant bodily fluids.

It is a further object of the present invention to provide a method and means for decreasing the use of dialysis treatments.

Another object of the present invention is to treat patients with heart failure that are also in need of fluids removal.

Other objects and advantages of the present invention will become apparent as the description proceeds.

**SUMMARY OF THE INVENTION:**

The present invention relates to a system and method for disposing of redundant body fluids from the body. The present invention system comprises an implantable fluid-penetrable chamber that allows accumulating body fluids near the implant site to penetrate the chamber. The chamber is coupled to (and in fluid communication with) a tube element (e.g. catheter) that leads to a cavity of a urinary system organ or directly out of the body, e.g. through a stoma. The system enables delivering fluid from said chamber to said cavity of a urinary system organ (which leads to disposal) or to said stoma.

According to one embodiment, the urinary system organ is the renal pelvis. The pressure in the renal pelvis is influenced by the ureter. Since the renal pelvis is in

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fluid communication with the chamber, changes of the pressure in the renal pelvis lead to corresponding changes in pressure within the chamber. When the pressure in the pelvis becomes lower it leads to suction of fluid from the chamber to the pelvis. According to another embodiment, the urinary system organ is the bladder.

According to an embodiment of the present invention, a pump is also coupled to and in fluid communication with the chamber, and is capable of assisting fluid flow from the chamber to said cavity of a urinary system organ or to said stoma.

Tubular elements such as catheters, can interconnect and couple two or more elements of the system (e.g. chamber, pump) such that said two or more elements are all in fluid communication with each other. Optionally, the pump can attach directly to the chamber.

According to an embodiment of the present invention, the chamber comprises a frame covered by a fluid penetrable mesh. The frame may have various shapes and may comprise (strait or curved) rods or bars or (one or more) wires (or a combination thereof interconnected).

According to one embodiment the frame is a spiral coil with spring-like properties.

The present invention relates to a system comprising  
an implantable fluid penetrable chamber comprising a frame covered by a fluid permeable mesh configured to enable fluids to penetrate therethrough;

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a catheter connected at a first end to one of said chamber sides/walls or penetrates therethrough;

and optionally further comprising a pump placed inside or outside of said chamber.

Preferably, the volume of the chamber is capable of expanding and contracting in response to changes in pressure within the catheter and/or as a result of the activity of the optional pump.

Preferably, the pump is connected between the chamber and the catheter.

Preferably, the pump is a peristaltic pump.

Preferably, the frame is a coil with spring-like properties such that said coil is configured to elastically contract and expand.

Preferably, the coil comprises biocompatible material.

Preferably, the coil is curved in the form of a spiral.

Preferably, the mesh is made of material selected from the group consisting of Teflon, Polypropylene, Polyester, ePTFE, titanium, omega 3, monocryl, PVDF, hyaluronate and Gortex, acellular collagen, pig collagen, a matrix derived from human dermis and porcine small intestine submucosa.

Preferably, the catheter is a pigtail catheter.

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Preferably, the catheter is a straight catheter comprising an inflatable balloon attached at or near a second end of said catheter.

The present invention relates to a method for draining excessive fluid from a body cavity or space, said method comprising the steps of:

- a) implanting a device within said body cavity or space;  
wherein said device comprises an implantable fluid-penetrable chamber comprising a frame covered by a fluid permeable mesh configured to enable fluids to penetrate therethrough;  
a catheter connected at a first end to one of said chamber sides/walls or penetrates therethrough;  
and optionally further comprising a pump placed inside or outside of said chamber;
- b) positioning the second end of said catheter within the cavity of a urinary system organ;

such that changes in pressure within said catheter and/or changes in pressure exerted within said chamber by said optional pump result in the ingress of fluid from the body cavity or space into said chamber and/or the passage of said fluid from said chamber through said catheter into said urinary system organ cavity.

Preferably, the cavity of a urinary system organ is the renal pelvis.

Preferably, the cavity of a urinary system organ is the urinary bladder.

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Preferably, the body cavity or space is the abdominal cavity.

Preferably, the changes in pressure within the catheter and/or changes in pressure exerted within the chamber by the optional pump result in cyclical changes in the internal volume of the fluid-penetrable chamber, thereby correspondingly assisting the ingress of fluid from the body cavity or space into said chamber, and/or thereby correspondingly assist in the passage of the fluid from said chamber through said catheter into the urinary system organ cavity.

The present invention relates to a method for draining excessive fluid from a body cavity or space, said method comprising the steps of:

- a) implanting a device within said body cavity or space; wherein said device comprises an implantable fluid penetrable chamber comprising a frame covered by a fluid permeable mesh configured to enable fluids to penetrate therethrough; a catheter connected at a first end to one of said chamber sides/walls or penetrates therethrough; and optionally further comprising a pump placed inside or outside of said chamber;
  - b) positioning the second end of said catheter within a stoma in the body wall;
- such that changes in pressure within said catheter and/or changes in pressure exerted within said chamber by said optional pump result in the ingress of fluid from the body cavity or space into said chamber and/or the passage of



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said fluid from said chamber through the said body wall stoma connected to the second end of the catheter.

Preferably, the body cavity or space is the abdominal cavity.

Preferably, the changes in pressure within the catheter and/or changes in pressure exerted within the chamber by the optional pump result in cyclical changes in the internal volume of the fluid-penetrable chamber, thereby correspondingly assisting the ingress of fluid from the body cavity or space into said chamber, and/or thereby correspondingly assist in the passage of the fluid from said chamber through said catheter into the urinary system organ cavity.

The present invention relates to a system comprising

- an implantable fluid penetrable chamber comprising a frame covered by a fluid permeable mesh configured to enable fluids to penetrate therethrough;

- a tube element (e.g. catheter) connected at a first end to one of said chamber sides/walls or penetrates therethrough.

The present invention relates to a system comprising

- an implantable fluid penetrable chamber comprising a frame covered by a fluid permeable mesh configured to enable fluids to penetrate therethrough;

- a tube element (e.g. catheter) connected at a first end to one of said chamber sides/walls or penetrates therethrough;

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and further comprising a pump placed inside or outside of said chamber.

**BRIEF DESCRIPTION OF THE DRAWINGS:**

The present invention is illustrated by way of example in the accompanying drawings, in which similar references consistently indicate similar elements and in which:

- Fig. 1 illustrates an embodiment of the present invention wherein one end of the catheter is inserted into the renal pelvis.
- Fig. 2 illustrates an embodiment of the present invention wherein one end of the catheter is inserted into the bladder.
- Fig. 3 illustrates an embodiment of the present invention wherein the chamber coil is curved in the form of a spiral.
- Figs. 4A-4B illustrate images related to the device used in an experiment.

**DETAILED DESCRIPTION OF THE INVENTION:**

In certain medical conditions (including kidney failure) there is excessive fluid accumulation within the body, particularly within the abdominal cavity. The present invention provides means for removal of these fluids from that location and from the body. The removal of these redundant fluids decreases the reliance on kidney activity and decreases the need for dialysis treatment.

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Embodiments of the present invention described herein function as artificial kidneys, which drain waste fluids, electrolytes, urea, and proteins from a patient's internal body cavity, such as the abdominal cavity, and thereby reduce or eliminate altogether the patient's reliance on his/her native kidney and/or dialysis. As explained in more detail below, the invention may be embodied as a device for draining substances from the body.

The present invention relates to a system comprising an implantable fluid-penetrable chamber that allows accumulating body fluids near the implant site to penetrate the chamber by pressure gradient (e.g. produced by an implanted pump or by the ureter peristaltic movement). Preferably, the implantable fluid-penetrable chamber is implanted in the abdominal cavity. A tube or catheter is connected at one end to one of the chamber sides/walls or penetrates through it to a location within the interior of the chamber. The tube or catheter enables transfer of the fluids accumulated in the chamber to different locations in the body that lead to disposal (e.g. urine system). Optionally, the tube or catheter leads out of the body (e.g. via a stoma), for direct disposal of the accumulated body fluids. The present invention is preferably implanted through Laparoscopy, but can also be implanted through other methods known in the art.

The chamber comprises a frame covered by a mesh that enables fluids to penetrate therethrough. The frame preferably comprises biocompatible material. According to one embodiment, the frame is comprised of flat permeable sides covered by meshes. According to another embodiment

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the frame is comprised of interconnected thin straight or curved rods/bars/wires which are covered by meshes forming 3 dimensional shape chambers. Preferably the chamber shapes have large surface areas (e.g. elliptic shape) allowing efficient fluid penetration. The mesh large surface area enables fluid suction therethrough into the chamber from the cavity it is placed within, and from the cavity surrounding tissue that it comes into contact with. The mesh material enables suction of the fluids directly from the tissue without requiring the tissue to first eject the fluid into the cavity. This is a major advantage in cases where treatment is required to dispose of redundant bodily fluids from tissues surrounding body cavities as well as from within the cavities themselves.

The mesh is a fluid permeable mesh such as a synthetic biocompatible mesh. The mesh is preferably made of material selected from the group consisting of Teflon, Polypropylene, Polyester, ePTFE, titanium, omega 3, monocryl, PVDF, hyaluronate and Gortex. The mesh can also be made of biological material such as acellular collagen, pig collagen, a matrix derived from human dermis, porcine small intestine submucosa, etc. Not only do these materials prevent tissue growth on the chamber, they assist in preventing tissue growth on the mesh.

Preferably, the frame comprises a curved bar/wire in the form of a coil.

According to one embodiment, the catheter or tube couples the interior of the chamber to the kidney pelvis. Continuous contractions of the ureter lower the fluid

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pressure within the kidney pelvis, and because the kidney pelvis interior is in fluid communication with the chamber interior by virtue of the catheter or tube, the continuous ureter contractions cause a reduction of pressure in the interior of the chamber. Thus the fluid content in the interior of the chamber flows through the catheter/tube into the interior of the kidney and thence through the ureter, bladder, urethra and is thus ultimately eliminated from the body.

After the ureter stops contracting, the pressure inside the kidney pelvis is relatively low and begins accumulating, fluids start to accumulate therein and the pelvis returns to its (higher) baseline pressure level. The pressure within the interior of the chamber (in fluid communication with pelvis) correspondingly increases.

Especially during the times within the ureter cycle following the ureter acting to reduce pressure within the pelvis (low pressure in pelvis and thus chamber), new fluid waste enters the chamber, thereby returning to the first stage of the cycle.

According to one embodiment of the present invention, the catheter leads from the chamber to the urinary bladder or to another location leading to discharge. The urinary bladder does not contract as the ureter does to create low pressure within the chamber. Therefore a pump is connected between the chamber and the catheter/tube to create low pressure within the chamber and thereby draw the fluid wastes through the catheter/tube for subsequent discharge. The pump is placed outside the chamber (preferably adjacent

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thereto) in fluid connection between the end of the catheter/tube and the interior of the chamber. Optionally, in cases where the end of the catheter ends inside the interior of the chamber, the pump may be placed within the interior of the chamber and is in fluid connection between the end of the catheter/tube and the interior space of the chamber.

According to one embodiment of the present invention, the pump is connected to the chamber on one side and to a catheter on the other side, thus enabling drainage of fluids from the chamber.

The pump capacity of fluid suction and delivery is preferably in the range of 100CC to 5000CC per day. The energy powering the pump can be through a battery within it, potentially rechargeable (e.g. by induction). According to one embodiment the pump is a peristaltic pump. The pump length is usually between 10 mm and 35 mm, and preferably 14 mm. the pump width is usually between 10 mm and 20 mm, and preferably 14 mm. The pump height is usually between 3 mm and 4.2 mm, and preferably 3.5 mm. Example models of appropriate pumps used are piezo actuators (e.g. models mp5, mp6) of "Bartels Mikrotechnik GmbH" company.

According to an embodiment of the present invention, the fluid-penetrable chamber **5** (shown in Fig. 1) comprises a coil **10** with spring-like properties such that the coil elastically contracts and expands (other embodiments may comprise non-elastic coils) wherein the frame is actually the coil **10**. In Fig. 1, the coil **10** is illustrated so that

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the direction of contraction and expansion is horizontal, but the coil (and its contraction and expansion) may be oriented in any direction deemed suitable by medical personnel skilled in the art. According to a preferred embodiment, the fluid-penetrable chamber **5** is implanted within the patient's abdominal cavity.

The coil **10** preferably comprises biocompatible material. The spring constant (or strength of the coil spring), the length, and the diameter of the coil may vary. Specifically, it may be constructed in accordance with factors such as the patient's space available within the abdominal cavity, the forces influencing compression of the coil (such as ureter compressions or an artificial pump, as discussed herein), and the circumferential area desired for waste passage.

The coil **10** is covered with a fluid-permeable mesh **12**, thereby forming chamber **5**, into which abdominal fluid (but not solids) can enter. The mesh **12** prevents bodily tissue from growing on the coil **10** and/or entering the coil **10** interior. The mesh **12** functions as a filter and enables passage of the accumulated fluids therethrough into the interior of the coil **10**, while preventing the entry of anything else, such as tissue.

According to one embodiment, the mesh **12** comprises pig collagen, thereby preventing fibrosis. An example of such mesh is produced by Covidien under the name Permacol™.

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The diameter of the coil **10**, is usually between 2 mm and 20 mm. The length of the coil may vary, usually between 20 cm and 200 cm. The coil may be placed in the body in a folded manner, curved manner, wrapped around portions of it, etc.

According to a preferred embodiment (shown in Fig. 3), the coil **10** is curved in the form of a spiral **70** (curved which emanates from a central point, getting progressively farther away as it revolves around the point). The mesh **12** large surface area (reflected by the large spiral **70** formation) enables fluid suction therethrough into the chamber from the cavity it is placed within, and from the cavity surrounding tissue that it comes into contact with. The spiral **70** is in contact with the cavity walls. The mesh material enables suction of the fluids directly from the tissue without requiring the tissue to first eject the fluid into the cavity. This is a major advantage in cases where treatment is required to dispose of redundant bodily fluids from tissues surrounding body cavities as well as from within the cavities themselves.

The chamber **5** formed by the coil **10** is perforated by a catheter **15** which can transfer fluid therefrom into the urinary system at the location of the kidney pelvis **51** (shown in Fig. 1). According to a preferable embodiment, a pigtail catheter **15** is connected at one end to the interior of the coil **10** and is in fluid communication with the interior of the coil **10**. The other end of catheter **15** is implanted within the patient's renal pelvis **51**.

According to another embodiment, a straight catheter (not shown) is used instead of the pigtail catheter **15**. An



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inflatable balloon is attached to the straight catheter near the end in the renal pelvis, for fixation and for preventing the straight catheter from slipping away from its intended position within the renal pelvis.

In use, the coil **10** may be compressed to decrease its length and then implanted into the patient's abdominal cavity. According to one embodiment, when no external forces are acting on the coil **10**, it returns to its resting conformation by means of expanding. This expansion increases the space in the coil's interior. As the coil expands, the pressure within its internal space becomes reduced such that the fluid pressure within the coil **10** becomes less than that of the fluid pressure outside the coil **10**, and this pressure gradient causes fluid wastes, etc., in the abdominal cavity to be drawn into the low-pressure coil cavity (through the pores in the surrounding mesh). As the coil continues to expand, more fluid wastes enter the coil **10** interior.

With reference to Fig. 1, continuous contractions of the ureter **52** lower the fluid pressure within the kidney pelvis **51**. Because the kidney pelvis **51** interior is in fluid communication with the coil **10** interior by virtue of the pigtail catheter **15**, the continuous ureter **52** contractions correspondingly reduce the pressure within the coil **10**, thereby causing the fluid content in the interior of the coil **10** to flow through the pigtail catheter **15**, into the interior of the kidney **50**, and thence through the ureter **52**, bladder and urethra and is thus discharged from the body. The pressure "suction" from the pelvis (or from the pump) causes coil **10** to contract.

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When the ureter **52** stops contracting, the pressure inside the kidney pelvis **51** starts to accumulate and returns to its (higher) baseline pressure level. The pressure within the interior of chamber **5** (in fluid communication with pelvis **51**) correspondingly increases, hence coil **10** expands. During the times within the ureter cycle following the ureter **52** acting to reduce pressure within renal pelvis **51** (and thus within the coil **10**), the pressure starts to accumulate and the coil **10** expands. New fluid waste enters therein, thereby returning to the first stage of the cycle.

A compressible coil is used in this embodiment, because the compressibility reduces the strain on the ureter **51**. As described above, the coil **10** is compressed to decrease its length and then implanted into the patient's abdominal cavity. However, even if the coil **10** were implanted in the abdominal cavity in its extended state, the ureter **52** would cause it to contract due to lowering the interior pressure of the pelvis **51**, and then the fluid would flow from coil **10** to the kidney **50** interior and the coil **10** would begin to accumulate fluid wastes again.

Even though the pressure differences caused by the ureter **51** function affects the discharge flow, a pump **40**, may optionally be connected to both catheter **15** and coil **10** for assisting in reducing the pressure within the interior of coil **10**, thus assisting in delivering the fluid out of coil **10** and to the pelvis **51**.

According to another embodiment, the chamber **5** formed by the coil **10** is perforated by the pigtail catheter **15** which

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can transfer fluid therefrom into the urinary system at the location of the urinary bladder **60**, as illustrated in Fig. 2. One end of catheter **15** is connected to the chamber **5** interior (or side wall) and the other end other end of catheter **15** is implanted within the interior of bladder **60**. The urinary bladder **60** does not contract as the ureter **52** does to create low pressure within the coil **10**. Therefore a pump **40**, is connected between the coil chamber **5** and the catheter (at the end of the catheter that is adjacent or within the coil **10**) to create low pressure within the coil and thereby draw the fluid wastes into the bladder for subsequent discharge through the urethra.

According to another embodiment (not shown), a catheter is connected at one end to the to the chamber **5** interior (or side wall) while its other end leads out of the patient's body through a stoma, allowing direct disposal of the fluid wastes accumulated in the chamber out of the body. According to one embodiment a pump is connected to the catheter and chamber as explained hereinabove creating the low pressure within the coil (as in the previously described embodiments) causing the waste fluids to be drawn out of the chamber and out of the body. A bag may be strapped to the patient for receiving the waste fluids to enable the patient's easy mobility.

The present invention further relates to a method for draining excessive fluid from a body cavity or space, said method comprising the steps of:

a) implanting a device (as explained hereinabove) within said body cavity or space;

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wherein said device (preferably) comprises an implantable fluid- penetrable chamber comprising a frame covered by a fluid permeable mesh configured to enable fluids to penetrate therethrough;

a catheter/tube connected at a first end to one of said chamber sides/walls or penetrates therethrough;

and optionally further comprising a pump placed inside or outside of said chamber;

b) positioning the second end of said catheter/tube within the cavity of a urinary system organ;

such that changes in pressure within said catheter/tube and/or changes in pressure exerted within said chamber by said optional pump result in the ingress of fluid from the body cavity or space into said chamber and/or the passage of said fluid from said chamber through said catheter/tube into said urinary system organ cavity.

Preferably, the cavity of a urinary system organ is the renal pelvis.

Preferably, the cavity of a urinary system organ is the urinary bladder.

Preferably, the body cavity or space is the abdominal cavity.

Preferably, the changes in pressure within the catheter and/or changes in pressure exerted within the chamber by the optional pump result in cyclical changes in the internal volume of the fluid-penetrable chamber, thereby correspondingly assisting the ingress of fluid from the body cavity or space into said chamber,

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and/or thereby correspondingly assist in the passage of the fluid from said chamber through said catheter into the urinary system organ cavity.

According to a preferred embodiment of the present invention, negative pressure caused by the pump or by the pelvis (e.g. after the ureter contraction) causes contraction in internal volume of the chamber (in case of the coil - contraction of the coil) assisting the passage of the fluid from the chamber through the catheter into the urinary system organ cavity. The negative pressure also assists the ingress of fluid from the body cavity or space into the chamber.

The present invention further relates to a method for draining excessive fluid from a body cavity or space, said method comprising the steps of:

a) implanting a device (as explained hereinabove) within said body cavity or space;

wherein said device (preferably) comprises an implantable fluid penetrable chamber comprising a frame covered by a fluid permeable mesh configured to enable fluids to penetrate therethrough;

a catheter connected at a first end to one of said chamber sides/walls or penetrates therethrough;

and optionally further comprising a pump placed inside or outside of said chamber;

b) positioning the second end of said catheter within a stoma in the body wall;

such that changes in pressure within said catheter and/or changes in pressure exerted within said chamber by said

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optional pump result in the ingress of fluid from the body cavity or space into said chamber and/or the passage of said fluid from said chamber through the said body wall stoma connected to the second end of the catheter.

Preferably, the body cavity or space is the abdominal cavity.

Preferably, the changes in pressure within the catheter and/or changes in pressure exerted within the chamber by the optional pump result in cyclical changes in the internal volume of the fluid-penetrable chamber, thereby correspondingly assisting the ingress of fluid from the body cavity or space into said chamber, and/or thereby correspondingly assist in the passage of the fluid from said chamber through said catheter into the urinary system organ cavity.

### **Example**

The following example demonstrates the theoretical concept of the device performance in small animals.

An experiment was performed with rats using the present invention. Fig. 4A is an image of the device used in the experiment comprising a membrane mesh and a supporting spiral coil. Fig. 4B is an image of the rat with the device two weeks past implantation, a vein-flow was inserted and extracellular fluids were removed.

The efficiency of the present invention device was evaluated in four (4) rats, two weeks after implantation.

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Table 1 summarizes the experimental results for 3 hr of fluids removal, in which  $16 \pm 6$  mL/day/Kg were retained. Based on these preliminary results, we assume that for an average adult weighting 70Kg the present invention device could drain 1.1 L/day. It should be noted, that the fluids composition (i.e., potassium, phosphor, urea, creatinine, albumin) is analogous to rat 4 blood tests.

Table 1. Summary of device's efficiency in rats.

	Rat 1	Rat 2	Rat 3	Rat 4	Average	Blood test Rat 4
Weight [kg]	0.420	0.320	0.350	0.376	0.367±0.042	
CC/3Hrs	0.400	0.600	1.000	0.800	0.700±0.258	
L/Day/Kg	0.008	0.015	0.023	0.017	0.016±0.006	
L/Day/70Kg	0.533	1.050	1.600	1.191	1.094±0.440	
Diameter [cm]	0.4	0.4	0.4	0.4		
Length [cm]	6	5	5	3		
Potassium [mmol/L]	12.7	5.3	5.8	7.000	7.700±3.409	6.5
Phosphor [mg/dL]	9.7	6.8	8.7	9.800	8.750±1.392	9
Urea [mg/dL]	37.6	37.4	34.9	44.900	38.700±4.312	50.9
Creatinine [mg/dL]	0.3	0.36	0.35	0.410	0.355±0.045	0.46
Albumin [g/dL]	2.6	3.1	3.5	3.1	3.075±0.369	3.9
70kg	Urea blood	Output 2 L/day	Extracellular fluids		Per dialysis [gr]	Weekly [gr]
Urea potential	100	2				14
Urea hemodialysis	100		35		22.75	68.25



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Having thus described exemplary embodiments of the invention, it will be apparent that various alterations, modifications, and improvements will readily occur to those skilled in the art. For example, although embodiments are described above in which a device for draining substances from the body is implanted within a patient's abdominal cavity, in other embodiments a device may be implanted subdermally, in the retroperitoneum, or in the pleural cavity, as non-limiting examples. The present invention may be implanted in other body cavities or spaces. Another example variation of embodiments described above involves constructing the fluid penetrable chamber without the separate mesh but instead in such a way that tissue cannot penetrate the chamber exterior but fluids can. Further example variations of embodiments described above involve treating conditions such as cancer, cardiac insufficiency (e.g. DHF in advanced stages), or ascites due to liver cirrhosis, that is, conditions in which their treatments involve fluid drainage.

While some of the embodiments of the invention have been described by way of illustration, it will be apparent that the invention can be carried into practice with many modifications, variations and adaptations, and with the use of numerous equivalents or alternative solutions that are within the scope of a person skilled in the art, without departing from the spirit of the invention, or the scope of the claims.

**CLAIMS**

1. A system comprising

an implantable fluid penetrable chamber comprising a frame covered by a fluid permeable mesh configured to enable fluids to penetrate therethrough;

a catheter connected at a first end to one of said chamber sides/walls or penetrates therethrough;

and optionally further comprising a pump placed inside or outside of said chamber.

2. The system according to claim 1, wherein the volume of the chamber is capable of expanding and contracting in response to changes in pressure within the catheter and/or as a result of the activity of the optional pump.

3. The system according to claim 1, wherein the pump is connected between the chamber and the catheter.

4. The system according to claim 1, wherein the pump is a peristaltic pump.

5. The system according to claim 2, wherein the frame is a coil with spring-like properties such that said coil is configured to elastically contract and expand.

6. The system according to claim 5, wherein the coil comprises biocompatible material.

7. The system according to claim 5, wherein the coil is curved in the form of a spiral.

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8. The system according to claim 1, wherein the mesh is made of material selected from the group consisting of Teflon, Polypropylene, Polyester, ePTFE, titanium, omega 3, monocryl, PVDF, hyaluronate and Gortex, acellular collagen, pig collagen, a matrix derived from human dermis and porcine small intestine submucosa.

9. The system according to claim 1, wherein the catheter is a pigtail catheter.

10. The system according to claim 1, wherein the catheter is a straight catheter comprising an inflatable balloon attached at or near a second end of said catheter.

11. A method for draining excessive fluid from a body cavity or space, said method comprising the steps of:

a) implanting a device within said body cavity or space; wherein said device comprises an implantable fluid-penetrable chamber comprising a frame covered by a fluid permeable mesh configured to enable fluids to penetrate therethrough;

a catheter connected at a first end to one of said chamber sides/walls or penetrates therethrough;

and optionally further comprising a pump placed inside or outside of said chamber;

b) positioning the second end of said catheter within the cavity of a urinary system organ;

such that changes in pressure within said catheter and/or changes in pressure exerted within said chamber by said optional pump result in the ingress of fluid from the body cavity or space into said chamber and/or the passage

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of said fluid from said chamber through said catheter into said urinary system organ cavity.

12. The method according to claim 11, wherein the cavity of a urinary system organ is the renal pelvis.

13. The method according to claim 11, wherein the cavity of a urinary system organ is the urinary bladder.

14. The method according to claim 11, wherein the body cavity or space is the abdominal cavity.

15. The method according to claim 11, wherein the changes in pressure within the catheter and/or changes in pressure exerted within the chamber by the optional pump result in cyclical changes in the internal volume of the fluid-penetrable chamber,  
thereby correspondingly assisting the ingress of fluid from the body cavity or space into said chamber,  
and/or thereby correspondingly assist in the passage of the fluid from said chamber through said catheter into the urinary system organ cavity.

16. A method for draining excessive fluid from a body cavity or space, said method comprising the steps of:

a) implanting a device within said body cavity or space;  
wherein said device comprises an implantable fluid penetrable chamber comprising a frame covered by a fluid permeable mesh configured to enable fluids to penetrate therethrough;  
a catheter connected at a first end to one of said chamber sides/walls or penetrates therethrough;

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and optionally further comprising a pump placed inside or outside of said chamber;

b) positioning the second end of said catheter within a stoma in the body wall;

such that changes in pressure within said catheter and/or changes in pressure exerted within said chamber by said optional pump result in the ingress of fluid from the body cavity or space into said chamber and/or the passage of said fluid from said chamber through the said body wall stoma connected to the second end of the catheter.

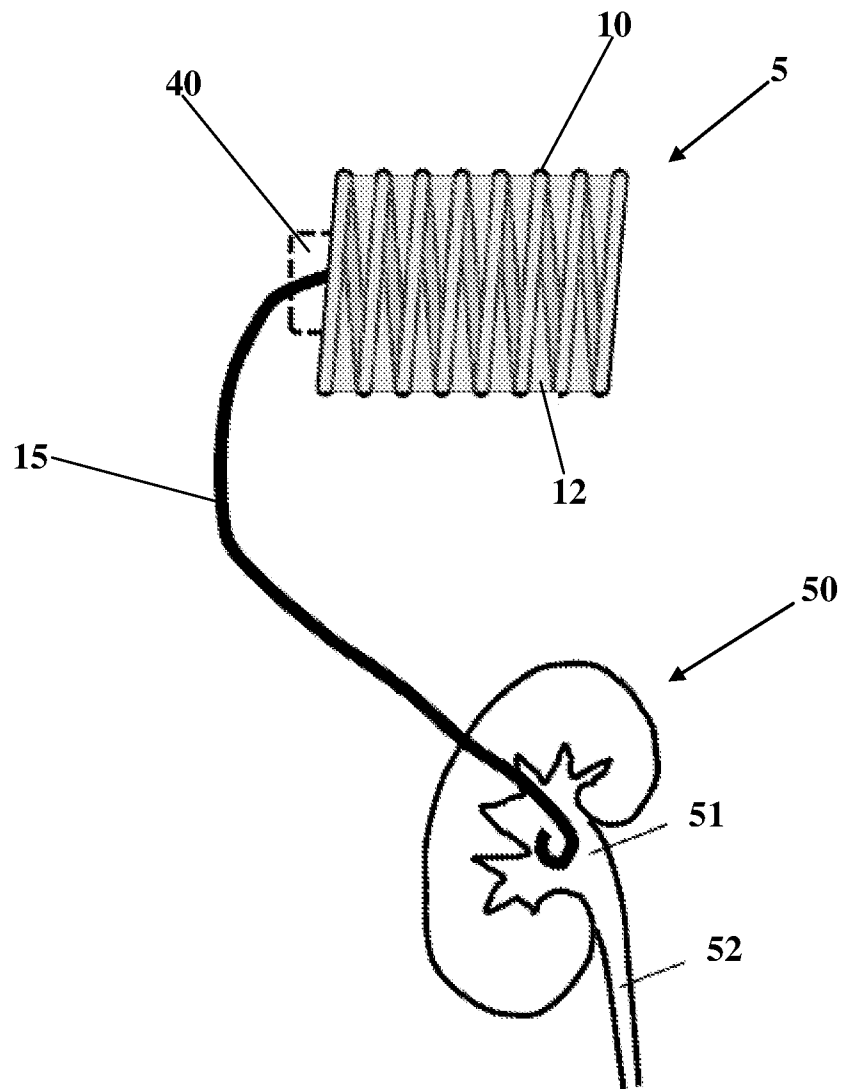
17. The method according to claim 16, wherein the body cavity or space is the abdominal cavity.

18. The method according to claim 16, wherein the changes in pressure within the catheter and/or changes in pressure exerted within the chamber by the optional pump result in cyclical changes in the internal volume of the fluid-penetrable chamber,

thereby correspondingly assisting the ingress of fluid from the body cavity or space into said chamber,

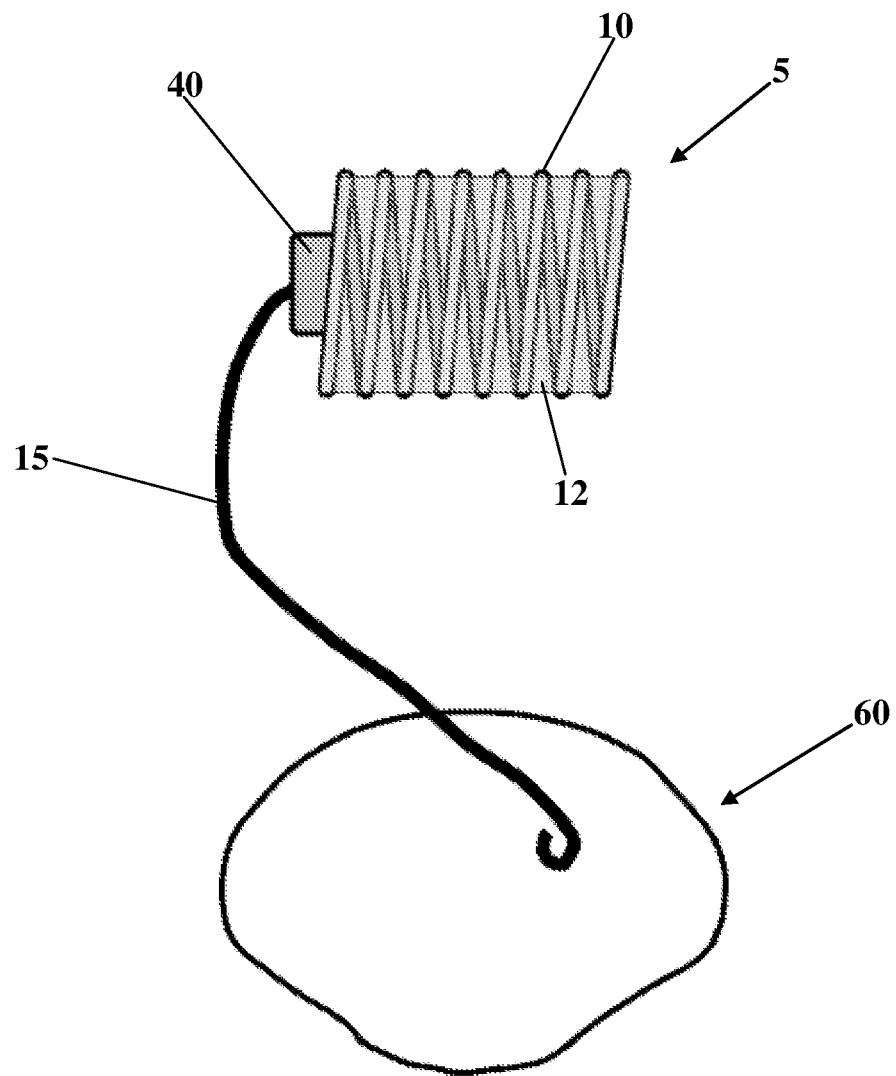
and/or thereby correspondingly assist in the passage of the fluid from said chamber through said catheter into the urinary system organ cavity.

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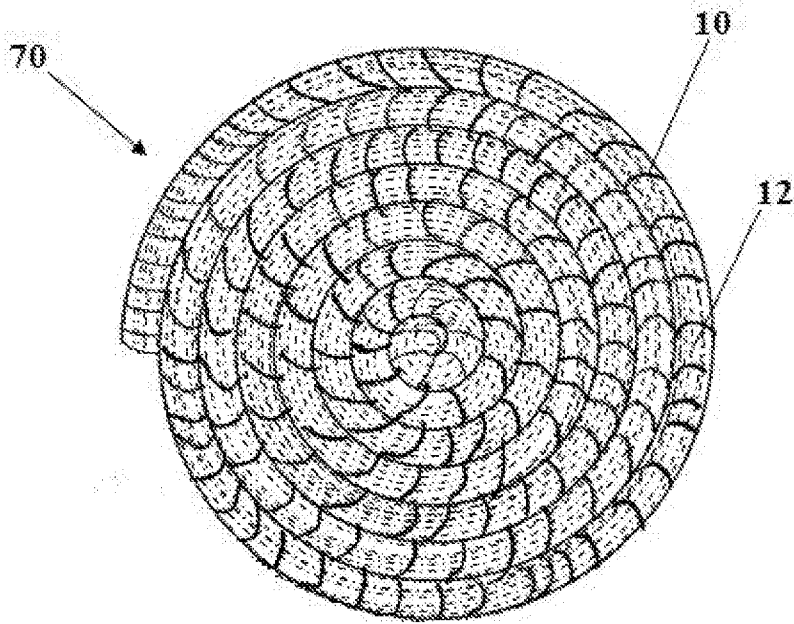
**Figure 1**

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**Figure 2**

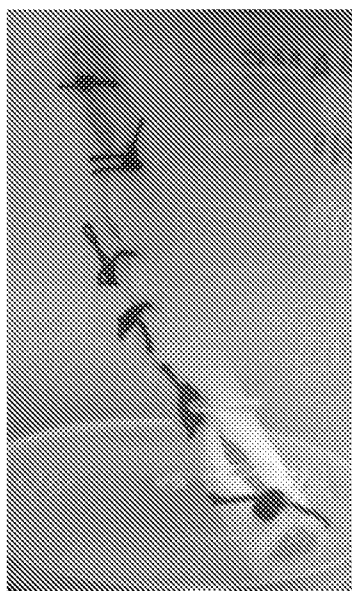
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**Figure 3**



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**Figure 4A**



**Figure 4B**

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/IL2015/050598

## A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - A61M 1/28 (2015.01)

CPC - A61M 1/284 (2015.09)

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)

IPC(8) - A61M 1/14, 1/28 (2015.01)

CPC - A61M 1/14, 1/28, 1/284, 27/002 (2015.09)

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

USPC - 604/28, 29, 93.01; 623/11.11, 23.64, 23.65  
(keyword delimited)

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

Orbit, Google Patents, Google Scholar.

Search terms used: peritoneal, dialysis, artificial kidney, mesh, coil, catheter, balloon, chamber, enclosure, contain, vessel, storage, tank, receptacle, permeable, porous, penetrable, absorb, absorp, fluid removal

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4,437,856 A (VALLI) 20 March 1984 (20.03.1984) entire document	1, 2, 9, 10
Y		5-7, 15, 18
X	US 2014/0148754 A1 (SOYKAN et al) 29 May 2014 (29.05.2014) entire document	1, 3, 4, 8, 11-14, 16, 17
Y		15, 18
Y	US 3,707,967 A (KITRILAKIS et al) 02 January 1973 (02.01.1973) entire document	5-7

☐ 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

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"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

"&amp;" document member of the same patent family

Date of the actual completion of the international search

30 September 2015

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