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(54) FLUID IMPERMEABLE AND THERMALLY INSULATED HOLDER

FLÜSSIGKEITSUNDURCHLÄSSIGEN UND THERMISCH ISOLIERTEN HALTERUNG.

SUPPORT IMPERMÉABLE AUX FLUIDES ET THERMIQUEMENT ISOLÉ

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(56) References cited:

US-A- 3 411 656 US-A- 4 013 189
US-A- 4 170 952 US-A- 6 035 795
US-A- 6 145 690

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Description

[0001] The invention relates to a fluid impermeable thermally insulated holder, which is incorporated in a supporting structure, preferably the hull of a vessel, wherein the wall of the holder seen from inside to outside in the transverse cross-width direction comprises:

a primary fluid barrier layer which is in contact with the fluid contained in the holder, and a primary thermal insulation layer.

[0002] Such holders, incorporated in the structure of a ship, are suitable for the production, storage, loading, transportation by sea or ocean and/or discharging of cold fluids such as liquefied gases, particularly gases with high methane content such as LNG (Liquefied Natural Gas). Sea transportation of LNG at very low temperatures causes evaporation of the LNG at a high rate, necessitating a very good insulation of the liquefied gas during the voyage. Document US 6035795 constitutes the closest prior art.

[0003] It is known that the cargo in transportable tanks of tank lorries and road trucks due to various causes, e.g. by accelerating or speeding up or by braking or decelerating, by high speed in bends; or by swerving caused by (near) collisions, may exhibit an undesired dynamical behaviour which even may result in turning over of the vehicle. This effect is for a major part dependant upon the type of cargo contained in the storage tank, the truck or the tanker. For example free movable (low viscous) liquid will easily be brought into motion when subjected to a sudden manoeuvre of the tanker. De back and forth moving or sloshing of the liquid may supply an additional impulse force thereby accelerating turning over of the tanker or truck. Due to statutory regulations in order to prevent sloshing or oscillating of the liquid in the axial longitudinal or driving direction of the tank, baffle plates are mounted inside holders having a volume above a certain limit. These baffle plates have the disadvantage that they only damp axial liquid movements so that non-axial movement of the liquid, like radial or tangential movement, will not be damped or only to a small extent. Furthermore these plates have their own mass and volume, thereby decreasing the capacity of the holder. Moreover these plates are usually fixedly mounted inside the interior of the holder, so that labour-intensive interiorly mounting, inspection, repair or cleaning will be necessary. Furthermore the fixedly mounted plates inside the holder will transmit a portion of the impulse force and the energy of the oscillating liquid to the holder and the holder wall.

[0004] In tanker ships for transport by water and/or for storage of fluids (liquids and gases) at sea also swinging and sloshing of the liquid may occur due to the swell of the water and bobbing of the ship on the water. Gas tankers such as LNG tankers or carriers generally contain two or more holders in which gas, cooled and condensed to liquid at a temperature of about minus 162 °C at at-

mospheric pressure, is stored and/or transported. The holders can be of the type 'self supporting', usually in the shape of a sphere or can be of the type 'membrane'. The 'membrane' type holder is directly supported by the hull of the vessel and is integrated with the support structure of the vessel. These 'membrane' holders, which are supported by the hull of the vessel, have a lower resistance to the interiorly exerted forces by the sloshing liquid and are therefore less suitable for use at sea.

[0005] Within holders of type 'membrane' the gas to be transported is present at atmospheric pressure in the liquid state as well as in the vapour state. The liquid 'boils' as a result of the supplied energy due to heat conduction from outside and also due to the energy absorbed in the liquid caused by the sloshing or swelling of the liquid cargo. The swinging or rocking of the liquid in the holders of the gas tanker depends on the swell of the water but also on the degree of loading of the gas tanker. When the degree of loading increases, the ship lies deeper into the water so that the natural frequencies and the vibration and swing frequencies of the ship and the cargo in the holders will change. In gas tankers also the effect occurs that the sloshing and rocking of the liquid will lead to energy absorption and thus to evaporation of liquid, requiring additional cooling or otherwise removing the excess energy. In the following, by the term LNG tanker a gas tanker is meant for storage and/or transportation of liquefied gas.

[0006] All these effects make it impossible to fully exploit the capacity of the container and thus reduce the filling rate in general to values between 10% and 75%. This results in operational constraints, particularly with LNG shuttle tankers operating in the spot market, which tankers are not able to discharge or load the commercially desirable or operationally necessary quantities of gas, e.g. because it is impossible to moor to a buoy, due to the prevailing sea conditions, resulting in lost trade. Also in the exploitation of oil and gas fields by using LNG tankers as floating storage near a borehole, a maximum capacity is desired at the greatest possible stability in waves or swell of the water. LNG tankers are also used for so-called 're-gasification' where ambient heat is used to vaporize the cold liquid (natural) gas and to deliver the gas to the customers.

[0007] The liquid gas constitutes a liquid-vapour equilibrium in the holder dependent upon the temperature and the pressure. The pressure and temperature are selected such that under atmospheric conditions the gaseous product in the holder essentially is present as a boiling liquid. The free space above the liquid is therefore completely filled with vapour or gas of the product in liquid state.

[0008] The wall of the fluid impermeable and thermally isolated 'membrane' holder is constructed from several layers. Seen from inside to outside in the transverse cross-width direction firstly a primary fluid barrier layer is applied, which is in contact with the cold fluid. This primary fluid barrier layer is constructed from metal sheets

and/or metal foils and/or metal membranes having a thickness of about 0.1 mm. Because metal expands and shrinks with changes in temperature, complicated connections are necessary between the sheets, and the sheets have to be provided with a zigzag or corrugated structure in order to prevent cracks or tearing. This renders such a primary fluid barrier layer complicated to manufacture and to apply and is therefore expensive. Furthermore the wall of this 'membrane' holder has little ability to receive and absorb shocks and other forces resulting from the sloshing liquid interiorly in the holder.

[0009] It is the object of the invention therefore to provide for an inexpensive fluid impermeable and thermally insulated holder, which can be manufactured at low-cost, and which is able to receive and absorb shocks and other forces exerted by the liquid interiorly in the holder.

[0010] This object is achieved by the invention in providing a wall of the fluid impermeable and thermally insulated holder in which the material of the primary fluid barrier layer is a plastic that is flexible at low temperatures, the plastic being based on polyamide, and wherein the primary thermal insulation layer is a fabric 3D-layer comprising two layers of permeable fabric, which are separated by a web layer or a nonwoven layer of fibres.

[0011] By applying a low-temperature flexible plastic is not necessary to take comprehensive measures to compensate for the expansion and contraction of the primary fluid barrier layer. It appears that a plastic based on polyamides and aromatic polyamides or aramids is particularly well suited for this purpose. These aramids are also known under the trade names Kevlar, Nomex and Twaron. The use of a fabric 3D-layer has the advantage that a high thermal insulation is obtained due to the large percentage of air between the nonwoven fibres and also has the advantage of an improved shock absorbing effect by the nonwoven fibres. This fabric 3D-layer is also known under the trade mark name 3mesh of Müller Textil.

[0012] In a preferred embodiment the primary thermal insulation layer comprises two or more fabric 3D-layers. It is advantageous to configure this primary insulation layer from one fabric 3D-layer, but it is also possible to assemble the insulation layer from two or more fabric 3D-layers, which generally will give rise to lower costs.

[0013] Preferably the holder wall is provided with a secondary thermal insulation layer of a material that will not become rigid or frozen at low temperatures. In particular kapok is selected for the material of the secondary insulation layer. By applying a layer of material such as kapok, which will not freeze or become rigid at the low temperatures employed, an improved shock-proof holder wall is obtained. Kapok is a natural hollow fibre that grows in the fruit of the kapok tree (*Ceiba pentandra*).

[0014] Preferably a secondary fluid barrier layer is provided on the outside of the fabric 3D-layer.

[0015] The embodiment is preferred wherein two secondary fluid barrier layers are provided, each on the outside of a fabric 3D-layer.

[0016] In particular the secondary fluid barrier layers

are fixedly connected -laminated-, with the permeable fabric layer on the outside of the fabric 3D-layer. With these measures easily a second fluid barrier can be installed in the wall of the holder at low cost. The fluid barrier layers can be connected easily in advance with the fibre layers of the fibre 3D-layer at low cost -this is also called lamination-.

[0017] The embodiment is advantageous wherein the nonwoven layer of the fibre 3D-layer of the holder wall is a channel or hollow wall section for transferring a cooling agent. In particular the channel or the hollow wall section extends over the entire circumference of the holder. More in particular the channel or hollow wall section is provided with a supply conduit and a discharge conduit for the cooling agent. By applying fluid barrier layers onto the fabric layers of the 3D-layer of fabric, a channel or cavity or hollow space is arranged in the wall of the holder so that a cooling agent such as nitrogen can be transported, from the supply conduit to the discharge conduit, in order to remove heat leaking from the environment and thereby reduce evaporation of the liquid in the holder. It will be thereby also possible to pressurize the channel or cavity by means of the cooling agent, so that the 3D-layer of fabric acquires a greater stiffness and an increased mechanical strength.

[0018] The invention is further explained by means of a drawing and some embodiments of the wall of the holder, whereby features and other advantages will come forward.

Fig. 1 shows in cross-section an LNG tanker with a hull provided with an impermeable and thermally insulated holder according to the invention,

Fig. 2 shows greater detail of the wall of the holder of Fig. 1,

Fig. 3 is a cross-sectional view of the holder of Fig. 1 provided with a channel for a cooling agent.

[0019] Fig. 1 shows a vessel provided with a holder for storing liquefied gas 4. In this example the vessel shown is designed to be particularly suited for containing a liquefied gas such as LNG (Liquefied Natural Gas). A gas tanker suitable for transporting liquefied gas is hereafter indicated with LNG tanker. The LNG tanker is provided with means and facilities in order to keep the gas liquefied by maintaining the right temperature and pressure within the holder. The fluid impermeable and thermally insulated holder is mounted upon, and incorporated in, the double walled hull 2 of the vessel. The vessel floats in water like a sea 1. The wall 3 of the holder is constructed, seen in transverse cross-width direction, of a number of layers. The wall 3 of the holder is supported by the sidewalls and the bottom sidewall of the vessel hull 2.

[0020] In Fig. 2 the holder wall 3 and the vessel wall 2 are shown in more detail with, seen from left to right in the thickness, cross-width direction: the liquefied gas 4 and the primary fluid barrier layer 5, which is in contact with the liquefied gas 4. Fluid barrier layer 5 is preferably

manufactured from a plastic material that retains its flexibility even at low temperatures such as that of atmospheric LNG at minus 170 °C. Fluid barrier layer 5 consists wholly or mainly of polyamides, such as materials known as nylon. The fluid barrier layer 5 can be either one uniform layer (woven and/or nonwoven) or can either consist of a woven carrier with an impermeable layer on one or on both sides.

[0021] The fluid barrier layer 5 can also be manufactured containing material based on aromatic polyamide plastic. This plastic is also referred to as aromatic polyamides or aramids, which are also known under the trademark names Kevlar, Nomex and Twaron.

[0022] Seen in the (transverse cross-width) thickness direction in Fig.2, to the right of the primary fluid barrier layer 5 a primary thermal insulation layer 6 is provided, preferably based on a 3D-layer of fabric, which is also known under the trademark name '3mesh' of Müller Textil. This fabric 3D-layer contains a core web layer or a core nonwoven fibre-yarn between two layers of open or permeable (woven) fabric. Primary thermal insulation layer 6 may be configured from a single fabric 3D-layer or can consist of two or more 3D-layers of fabric. Between the primary fluid barrier layer 5 and the primary thermal insulation layer 6 a secondary thermal insulation layer 7 can be provided, preferably of a non-freezing material, so that the secondary insulation layer 7 will not be rigid and remains resilient at the low operating temperatures, so that shocks and other forces, exerted by the fluid on this layer, will be adequately received and absorbed. Preferably, for this material kapok is selected, a natural hollow fibre that does not freeze or become rigid at temperatures of minus 170 °C. The holder wall 3 may be provided with a second secondary thermal insulation layer 8, positioned between the primary thermal insulation layer 6 and the (double) vessel wall 2. This insulation layer 8 protects the inner side of the vessel wall 2 -usually metal such as steel- against temperatures that are below the lowest admissible values for that metal. Also, the fabric 3D-layer may be provided with a secondary fluid barrier layer 6a, 6b that is provided on the outside of the permeable fabric. This secondary fluid barrier layer 6a, 6b can be attached by means of bonding, glueing or laminating onto the permeable fabric layer of the fabric 3D-layer 6. The secondary fluid barrier layers 6a, 6b can be provided or laminated also on both outer sides of the fabric 3D-layer 6

[0023] Figure 3 shows an alternative embodiment of the holder wall 3 of the fluid impermeable and thermally insulated holder, provided with a channel or hollow space or cavity for transferring a cooling agent. Preferably nitrogen is selected as cooling agent. When fluid barrier layers 6a, 6b are attached onto the permeable fabric layers of the fabric 3D-layer, the nonwoven layer can be used as fluid channel for the cooling agent such as nitrogen.

[0024] By enabling the cooling agent to flow from the supply conduit 9 to the discharge conduit 10, heat leaking

in from the environment can be removed so that evaporation of the liquid in the container 4 is reduced. By means of the cooling agent it is also possible to provided for excess pressure in the channel or cavity, so that the fabric 3D-layer obtains a greater stiffness and an increased mechanical strength.

Claims

1. Fluid impermeable thermally insulated holder, which is incorporated in a supporting structure (2), preferably the hull of a vessel, wherein the wall (3) of the holder seen from inside to outside in the transverse cross-width direction comprises:

a primary fluid barrier layer (5) which is in contact with the fluid (4) contained in the holder, and a primary thermal insulation layer (6),

characterized in that

the material of the primary fluid barrier layer (5) is a plastic that is flexible at low temperatures, the plastic being based on polyamide, and wherein

the primary thermal insulation layer (6) is a fabric 3D-layer comprising two layers of permeable fabric, which are separated by a web layer or a nonwoven layer of fibres.

2. Holder according to claim 2, wherein the primary thermal insulation layer (6) comprises of two or more fabric 3D-layers.
3. Holder according to claim 1 or 2, wherein the holder wall (3) is provided with a secondary thermal insulation layer (7, 8) of a material that will not become rigid or frozen at low temperatures.
4. Holder according to claim 3, wherein for the material of the secondary insulation layer (7, 8) kapok is selected.
5. Holder according to any one of the preceding claims 1 - 4, wherein a secondary fluid barrier layer (6a, 6b) is provided on the outside of the fabric 3D-layer.
6. Holder according to claim 5, wherein two secondary fluid barrier layers (6a, 6b) are provided, each on the outside of a fabric 3D-layer.
7. Holder according to any one of the preceding claims 5 - 6, wherein the secondary fluid barrier layers (6a, 6b) are fixedly connected -laminated-, with the permeable fabric layer on the outside of the fabric 3D-layer.
8. Holder according to claim 6, wherein the nonwoven layer of the fibre 3D-layer (6) of the holder wall (3)

constitutes a channel or hollow wall section for transferring a cooling agent.

9. Holder according to claim 8, wherein the channel or the hollow wall section extends over the entire circumference of the holder. 5
10. Holder according to claim 8 or 9, wherein the channel or hollow wall section is provided with a supply conduit (9) and a discharge conduit (10) for the cooling agent. 10
11. Holder according to any one of the preceding claims 8 - 10, wherein nitrogen is selected as cooling agent. 15

Patentansprüche

1. Fluidundurchlässige thermisch isolierte Fassung, die in eine Trägerstruktur (2), vorzugsweise einen Schiffsrumpf, integriert ist, wobei die Wand (3) der Fassung in Querrichtung von innen nach außen gesehen umfasst: 20

eine erste Fluidbarrierenschicht (5), die mit dem in der Fassung enthaltenen Fluid (4) in Kontakt steht, und eine erste thermische Isolierschicht (6), **dadurch gekennzeichnet, dass** das Material der ersten Fluidbarrierenschicht (5) ein bei niedrigen Temperaturen flexibler Kunststoff ist und der Kunststoff auf Polyamid basiert, und wobei die erste thermische Isolierschicht (6) eine 3D-Gewebelage ist, die zwei Schichten durchlässigen Gewebes umfasst, die durch eine Faserstoffschicht oder eine Faservlieslage aus Fasern getrennt sind. 25 30 35

2. Fassung nach Anspruch 2, wobei die erste thermische Isolierschicht (6) zwei oder mehr 3D-Gewebelagen umfasst. 40
3. Fassung nach Anspruch 2, wobei die Fassungswand (3) eine zweite thermische Isolierschicht (7, 8) aus einem Material aufweist, das sich bei niedrigen Temperaturen nicht verfestigt oder gefriert. 45
4. Fassung nach Anspruch 3, wobei das Material der zweiten thermischen Isolierschicht (7, 8) aus Kapok gewählt ist. 50
5. Fassung nach einem beliebigen der vorigen Ansprüche 1 - 4, wobei eine zweite Fluidbarrierenschicht (6a, 6b) auf der Außenseite der 3D-Gewebelage vorgesehen ist. 55
6. Fassung nach Anspruch 5, wobei die zwei zweiten Fluidbarrierenschichten (6a, 6b) jeweils auf der Au-

ßenseite der 3D-Gewebelage vorgesehen sind.

7. Fassung nach einem beliebigen der vorigen Ansprüche 5 - 6, wobei die zweiten Fluidbarrierenschichten (6a, 6b) mit der durchlässigen Gewebelage auf der Außenseite der 3D-Gewebelage festgelegt - laminiert - sind
8. Fassung nach Anspruch 6, wobei die Faservlieslage der 3D-Faserlage (6) der Wand (3) der Fassung einen Kanal oder einen hohlen Wandabschnitt zur Durchführung eines Kühlmittels bestimmt.
9. Fassung nach Anspruch 8, wobei der Kanal oder der hohle Wandabschnitt sich über den gesamten Umfang der Fassung erstreckt.
10. Fassung nach Anspruch 8 oder 9, wobei der Kanal oder der hohle Wandabschnitt für das Fühlmittel eine Versorgungsleitung (9) und eine Entsorgungsleitung (10) aufweist.
11. Fassung nach einem beliebigen der vorigen Ansprüche 8 - 10, wobei als Fühlmittel Stickstoff gewählt ist.

Revendications

1. Support thermiquement isolé imperméable aux fluides, lequel support est incorporé dans une structure de support (2), de préférence dans la coque d'un récipient, où la paroi (3) du support vu de l'intérieur vers l'extérieur en direction transversale en coupe comprend ;

une couche primaire de barrière fluide (5) qui est en contact avec le fluide (4) contenue dans le support, et une couche primaire d'isolation thermique (6),

caractérisé en ce que

le matériel de la couche primaire de barrière fluide (5) est un plastique qui est flexible à températures faibles, le plastique étant à base de polyamide, et dans lequel

la couche primaire d'isolation thermique (6) est une couche de tissu en 3D comprenant deux couches de tissu perméable, qui sont séparées par une couche de toile ou une couche de fibre non tissées.

2. Support selon la revendication 2, dans lequel la couche primaire d'isolation thermique (6) comprend deux ou plus couches de tissu en 3D.
3. Support selon la revendication 1 ou 2, dans laquelle la paroi de support (3) est pourvue d'une deuxième couche d'isolation thermique (7,8) d'un matériau qui ne deviendra pas rigide ou gelé à de faibles tempé-

ratures.

4. Support selon la revendication 3, dans lequel pour le matériau de la deuxième couche d'isolation (7,8), le kapok est sélectionné. 5
5. Support selon l'une quelconque des revendications 1 à 4, dans lequel une couche secondaire de barrière de fluide (6a, 6b) est prévue à l'extérieur de la couche de tissu en 3D. 10
6. Support selon la revendication 5, dans lequel deux couches secondaires barrière de fluide (6a, 6b) sont prévues, chacune à l'extérieur de la couche de tissu en 3D. 15
7. Support selon l'une quelconque des revendications 5 à 6, dans lequel les couches secondaires barrière de fluide (6a, 6b) sont assemblées de manière fixe - laminées-, avec la couche de tissu perméable sur l'extérieur de la couche de tissu en 3D. 20
8. Support selon la revendication 6, dans lequel la couche non tissée de la couche 3D en fibres (6) de la paroi du support (3) constitue un canal ou une section de paroi creuse pour transférer un agent de refroidissement. 25
9. Support selon la revendication 8, dans lequel le canal ou la section de paroi creuse s'étend sur la circonférence entière du support. 30
10. Support selon la revendication 8 ou 9, dans lequel le canal ou la section de paroi creuse est pourvu d'un conduit d'alimentation (9) et d'un conduit d'évacuation (10) pour l'agent de refroidissement. 35
11. Support selon l'une quelconque des revendications 8 à 10, dans lequel l'azote est choisi comme agent de refroidissement. 40

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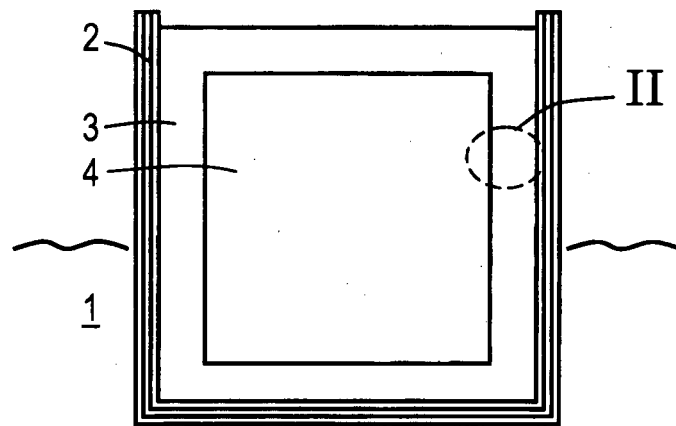


Fig.1

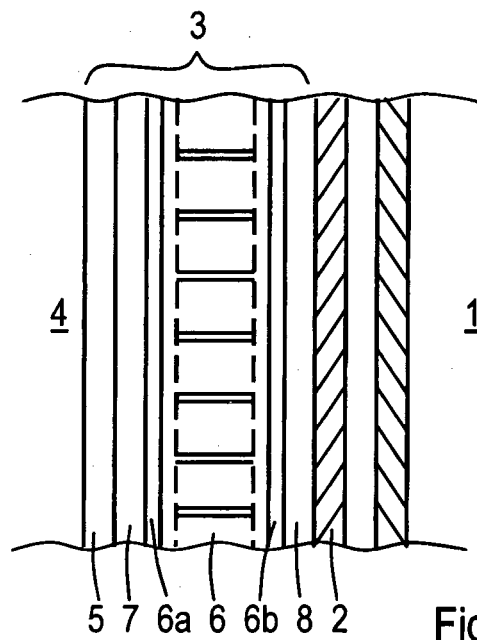


Fig.2

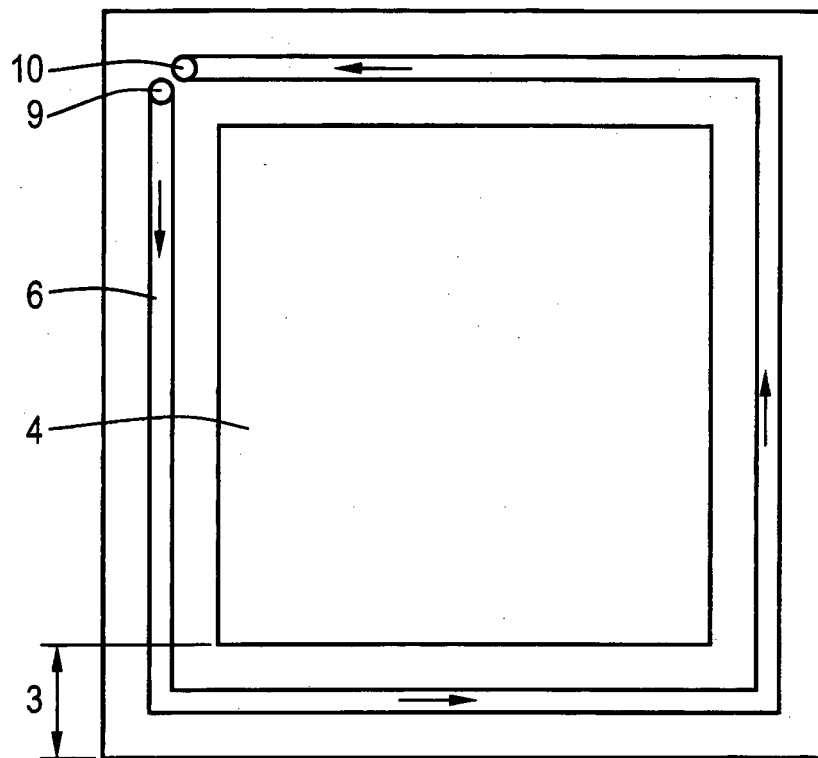


Fig.3

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 6035795 A [0002]