

(19)



(11)

EP 3 089 179 B1

(12)

EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention
of the grant of the patent:
21.10.2020 Bulletin 2020/43

(51) Int Cl.:
H01F 27/02 ^(2006.01) **H01F 27/33** ^(2006.01)

(21) Application number: **15165796.2**

(22) Date of filing: **29.04.2015**

(54) **ELECTRIC EQUIPMENT ENCLOSURE COMPRISING A DOUBLE WALL FOR NOISE REDUCTION PURPOSE**

GEHÄUSE FÜR ELEKTRISCHE ANLAGE MIT EINER DOPPELWAND ZU
GERÄUSCHMINDERUNGSZWECKEN

BOÎTIER D'ÉQUIPEMENT ÉLECTRIQUE COMPRENANT UNE PAROI DOUBLE USAGE POUR LA
RÉDUCTION DE BRUIT

(84) Designated Contracting States:
**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB
GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO
PL PT RO RS SE SI SK SM TR**

(43) Date of publication of application:
02.11.2016 Bulletin 2016/44

(73) Proprietor: **General Electric Technology GmbH
5400 Baden (CH)**

(72) Inventors:
• **GILLET, Max
75014 Paris (FR)**

• **RÖSNER, Michael
52457 Aldenhoven (DE)**

(74) Representative: **Brevalex
95, rue d'Amsterdam
75378 Paris Cedex 8 (FR)**

(56) References cited:
**WO-A1-2013/182227 GB-A- 444 129
JP-A- S5 740 908 US-A- 1 846 887
US-A- 2 734 096 US-A- 3 260 974**

EP 3 089 179 B1

Note: Within nine months of the publication of the mention of the grant of the European patent in the European Patent Bulletin, any person may give notice to the European Patent Office of opposition to that patent, in accordance with the Implementing Regulations. Notice of opposition shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European Patent Convention).

Description

US1846887A1, WO2013/182227A1 and JP57040908A.

TECHNICAL FIELD

[0001] The invention relates to noise reduction in electrical equipment such as power transformers, shunt reactors, series reactors or the like. This kind of electric equipment comprises an electric system encapsulated in a tank which is filled with dielectric gas for electric isolation or with an insulating fluid such as oil for transformer in order to provide electric isolation and cooling of the system.

STATE OF PRIOR ART

[0002] In this kind of electrical equipment, it can be very important to reduce the level of noise which is generated due to high energy transfer. But this reduction can be practically difficult to obtain, for technical reasons, and due to the fact that the criterion for maximum level of noise which can be emitted is constantly diminished. Finally, demanded maximum noise levels for this kind of equipment are more and more at the limit of feasibility.

[0003] The noise is generated on one hand by the magnetostriction of magnetic material such as magnetic core which is subjected to alternating magnetic induction, and on the other hand by electromagnetic forces.

[0004] The electromagnetic forces apply on parts of the equipment which carry electric currents or eddy currents and which are located inside a magnetic field. Such parts can be windings carrying electric currents, or metallic construction parts which do carry eddy currents as well.

[0005] The harmonic content of frequencies in the noise are multiples of the power-frequency, i.e. the frequency of the power-current which is transferred in the equipment. It appears that especially the low frequencies noise beginning at the double of power-frequency, due to their long wavelengths, is very difficult to diminish.

[0006] Practically, the noise which is generated by the magnetostriction and by the electromagnetic forces is transmitted to the environment of the tank through the structure and through the insulating fluid.

[0007] The methods which are known in the prior art to reduce noise comprise reduction of magnetic induction which increases energy losses, increasing the global size of the transformer which requires more insulating oil and more material since a bigger tank has to be built. It is also possible to design absorbing enclosures, which contain sound absorbing material which is costly, and which requires specific adaptations to fit with external devices attached to tank walls such as radiators or control cabinet.

[0008] In the end, due to the increasing requirements concerning noise reduction for this kind of electric equipment, the solutions described above are unsatisfactory. Examples of prior art housings are known from US3260974A1, US2734096A1, GB444129A,

PRESENTATION OF THE INVENTION

[0009] The invention relates to a housing for an electric apparatus such as a transformer or reactor, comprising an enclosure delimiting an internal space intended to be filled with a medium such as dielectric gas or insulating oil, this enclosure comprising a top part, a bottom part, and a surrounding part surrounding all the internal space, comprising an inner wall and an outer wall arranged to define together a single intermediate volume extending at least all along the surrounding part, this intermediate volume being intended to isolate the noise generated by the electric system contained in the internal space, this housing comprising stiffeners at the inner face of the outer wall, characterized in that these stiffeners comprise each a main plate and a perpendicular plate welded to the main plate, and in that the outer wall is made of panels having their edges welded to the perpendicular plates of the outer stiffeners.

[0010] With this solution, all the noise generated laterally by the equipment is reduced in all horizontal directions in order to fulfill the requirements concerning noise reduction.

[0011] The invention also relates to such a housing, wherein the intermediate volume is evacuated or filled with air at ambient pressure or with other fluid.

[0012] The invention also relates to such a housing, where the outer side of the inner wall and/or the inner side of the outer wall is completely or partially covered with layers of acoustics absorbent material.

[0013] The invention also relates to such a housing, comprising stiffeners to reinforce the inner wall.

[0014] The invention also relates to such a housing, wherein the stiffeners are located at the outer face of the inner wall in order to be located in the intermediate volume.

[0015] The invention also relates to such a housing, wherein the stiffeners of the outer wall comprise a main plate and a perpendicular plate welded to the main plate, and where the outer wall is made of panels having their edges welded to the perpendicular plates of the outer stiffeners.

[0016] The invention also relates to such a housing, comprising at least one mechanical decoupling device mounted between the inner wall and the outer wall to reduce transmission of acoustic vibrations from the inner wall to the outer wall.

[0017] The invention also relates to such a housing, wherein the inner wall and the outer wall comprise each a surrounding edge in the region of their top, and wherein at least one mechanical decoupling device is mounted between the surrounding edge of the inner wall and the surrounding edge of the outer wall.

[0018] The invention also relates to such a housing, wherein the inner wall and the outer wall comprise each a bottom corresponding to the bottom part of the enclosure.

sure, and wherein at least one mechanical decoupling device is mounted between the bottom of the outer wall and the bottom of the inner wall.

[0019] The invention also relates to such a housing, comprising at least one connection passing through the inner wall and the outer wall, at least one of these connections comprising an expansion joint having flanges secured at its extremities, these flanges being fixed respectively to the inner wall and to the outer wall.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020]

Figure 1 shows a first embodiment of the tank according to the invention represented in sectional view in a vertical plane by reference to its position of operation;

Figure 2 shows a second embodiment of the tank according to the invention represented in sectional view in a vertical plane by reference to its position of operation;

Figure 3 shows the tank according to the invention represented in sectional view in an horizontal plane by reference to its position of operation;

Figure 4 is a sectional view of a connection mounted between the two walls of the tank;

Figure 5 shows the structure of the double wall of the tank according to the invention in its surrounding portion in sectional view in a horizontal plane by reference to its position of operation;

Figure 6 shows the structure of the double wall of the tank according to the invention in the top region of its surrounding portion in sectional view in a vertical plane by reference to its position of operation.

DETAILED PRESENTATION OF PARTICULAR EMBODIMENTS

[0021] The basic idea of the invention is to surround completely the lateral area of the tank with a double wall in all its surrounding portion, in order to eliminate the emission of sound in the lateral direction by creating an impedance break in the volume between this inner wall and outer wall.

[0022] As seen in figure 1, a tank 1 according to the invention designed to enclose an electrical active part, made for example of magnetic core and windings which is not shown, comprises an enclosure 2 having a surrounding portion 3 and a bottom portion 4 integral with the surrounding portion 3 to form a base, which is open at its top and closed by a cover 5.

[0023] This enclosure delimits an internal space 6 where the electrical active part which is not shown is to be mounted, this internal space 6 being filled with appropriate dielectric gas or fluid.

[0024] The surrounding portion 3 together with the bottom portion 4 are made of an inside wall 7 and an outside

wall 8, each having a surrounding and a bottom portion. These two walls 7 and 8 are spaced one from the other to delimit together a closed space 9 between them.

[0025] The outer side of the inner wall 7 and/or the inner side of the outer wall 8 can be completely or partially covered with layers of an acoustics absorbent material 10. The material can be mineral fibers, perforated sheets of metallic material or any other material presenting appropriate acoustics absorption coefficient at frequencies of interest.

[0026] The closed space 9 can be filled with air under normal pressure, with an appropriate gas under specific pressure, or it can also be evacuated to be under vacuum.

[0027] The inside wall and the outside wall can be directly fixed to each other by a bolting system or the like. The bolts can be advantageously replaced by flexible couplings elements. But the inside wall and the outside wall can advantageously be fixed one to the other, by means of mechanical decoupling devices 11.

[0028] These mechanical decoupling devices 11 ensure that vibration of the electric system transmitted to the inside wall 7 will not be transmitted to the outside wall 8, or at least strongly reduced. In the case of figure 1, the mechanical decoupling devices 11 are the only link between the inside wall 7 and the outer wall 8, in order to provide a high decoupling level between the two walls, i.e. a high noise insulation.

[0029] In the example of figure 1, it is one single mechanical decoupling device 11 which is mounted between the boarding edge 12 of the top of the inside wall 7 and the boarding edge 13 of the top of the outside wall 8, and this device 11 extends all along these edges 12, 13, on the four sides of the enclosure.

[0030] In the example of figure 2, the tank comprises a plurality of mechanical decoupling devices 11 which are interposed between the bottom part of the inside wall 7 and the bottom part of the outside wall 8, these elements being spaced apart ones from the others.

[0031] Practically, and as seen in figure 2, the edges 12 and 13 of the inside wall 7 and of the outside wall 8 are fixed one to the other, and this connection can be made by flexible coupling elements. Despite the fact that the vibrations can be transmitted from the inside wall 7 to the outside wall 8 through the edges 12, 13, the vibrations of the outside wall are reduced by virtue of the decoupling devices 11.

[0032] As seen in figure 3, the tank comprises a plurality of connections, potentially distributed on the 4 lateral sides of the enclosure. Such connection marked as 14, 16 pass each through the lateral portion 3 of the enclosure, to allow circulation of a dielectric gas or insulating oil. Each connection 14, 16 comprises a respective tubular corrugated expansion joint 17, 18 mounted between the inside wall 7 and the outside wall 8. The connection can also be made with other kinds of soft materials.

[0033] As seen in more details in figure 4, such a expansion joint 17 can be mounted with an inner flange 19

and an outer flange 21 welded each to a corresponding extremity of this joint 17. Each flange 19, 21 surrounds an extremity and extends perpendicular to the main direction of the extremity of the joint.

[0034] Firstly, the inner flange 19 is fixed to the outer face of the inner wall 7 by bolts 22 extending through this flange and screwed in the wall 7 or a corresponding plate welded to it.

[0035] In a second step, an adapter plate 23 is fixed to the outer face of outer wall 8 by bolts 24, to form a connecting portion of this outer wall 8. Then another outer part 26, which can be for example the flange of a valve of the system, is fixed to the adapter plate 23 and to the outer flange 21 by other bolts 27 which cross the outer part 26 and the adapting flange 23 and are screwed in the outer flange 21 of the joint 17.

[0036] Dismounting the joint 17 from the tank is achieved by proceeding in the reverse order.

[0037] These expansion joints 17, 18 also ensure that thermal expansion changing the distance between the inside wall 7 and the outside wall 8 cannot damage the tank, and that the inside wall 7 and the outside wall 8 remain isolated from the transmission of vibrations from the inside wall to the outside wall. In other words these connections are insulated from noise.

[0038] Generally speaking, the walls of the tank are reinforced to withstand the difference of pressure existing between the internal volume, particularly when the intermediate volume is under vacuum. Typically, the internal enclosure of the tank is subjected to static pressure due to internal fluid presence for the inner wall 7, and to the external environment for the outer wall 8.

[0039] Accordingly, the inner wall 7 comprises at its outer face a series of stiffening plates or beams 29 extending perpendicular to this outer face and welded to it in order to improve the rigidity of the inner wall 7, each stiffening plate 29 being spaced apart from the others. The stiffening plates 29 can be replaced by other stiffening elements having the shape of U, which can be filled with high density material.

[0040] The outer wall 8 comprises at its inner but or outer face another series of stiffening plates or beams 31 perpendicular to the inner face and welded to it to improve its rigidity, these stiffening plates being spaced apart from each other.

[0041] All the stiffeners 29, 31 extend preferably inside the volume 9 which is between the inner wall 7 and the outer wall 8, since the stiffeners 29 of the inner wall 7 preferably extend at its outer face and since the stiffeners 31 of the outer wall 8 extend at its inner face, as seen in more detail in figure 5.

[0042] At the top of the base of the enclosure, the enclosure can comprise an outer upper flange 34 welded to the outer wall 8 and which surrounds all the top opening of the base of the enclosure, and an inner upper flange 35 welded to the inner wall 7 and which also surrounds all the top opening of the base enclosure. A decoupling device 11 can be provided between the inner top flange

35 and the outer top flange 34 which extends parallel and at a distance from each other, to ensure that these elements are isolated from each other. Since the hollow space 9 during operation is insulated, it is not necessary to apply anti corrosive coating in this space.

[0043] The inner stiffeners 29 can be first welded to the outer face of the inner wall 7 and to the inner top flange 35 and to a corresponding bottom flange not represented but which is analog to the inner top flange 35. Then the outer stiffeners 31 can be welded to the outer wall 8 and to a bottom flange not shown on the drawings. The outer top flange 34 can be welded to the outer wall, once the stiffeners 31 have been welded to this outer wall.

[0044] According to the present invention, the outer stiffeners have advantageously a T shaped cross section as seen in figure 5, comprising a main plate 32 fixed to a perpendicular plate 33. The main plate 32 extends parallel to the inner stiffeners 29 while the perpendicular plate 33 extends parallel to the outer wall of the tank.

[0045] Thanks to these T shaped outer stiffeners, the outer wall can be welded to the outer stiffeners 31, installed at appropriate positions. Practically, and as seen in figure 5, the outer wall 8 can be made of rectangular panels which are welded to the perpendicular plate 33: each panel has an first edge welded to the outer face of the perpendicular plate 33 of an outer stiffener, and its other edge parallel to this first edge welded to the perpendicular plate of the next outer stiffener. Additionally, the two other edges of each panel can be welded to the top flange and to the bottom flange.

[0046] In the example of figure 6, the cover 5 is applied and fixed against the outer top flange 34 for example by bolts not visible in the figures. Additionally but not exclusively, an o-ring 36 provided in a groove at the top face of the outer top flange 34 ensures appropriate sealing between these two parts.

[0047] This results in a double wall tank which is compact and which can withstand important differences of pressure.

[0048] Since all the surrounding portion of the tank comprises two walls, the emission of noise in the mainly horizontal directions is almost completely cancelled. On the other hand, the top surface of the tank can be equipped with a single wall, in order to radiate vibration energy only vertically since emission of noise in the vertical direction presents smaller environmental impact.

[0049] The mechanical decoupling devices between the inner wall and the outer wall allow to reduce the transmission to the outer wall of the noise generated by electromagnetic forces acting on the inner wall or on the electric system which can be carried by the bottom of the inner wall.

[0050] The use of corrugated pipe section between the inner wall and the outer wall provides the same noise insulation between inner and outer wall. The use of vacuum permits to reach very important noise reduction targets, independently of the frequency radiated.

[0051] Hence, this brings a very competitive solution

to treat low noise frequencies generated by electrical apparatuses (mainly 100Hz and 200Hz for 50Hz electrical networks, 120Hz and 240Hz for 60Hz networks).

Claims

1. Housing (1) for an electric apparatus such as a transformer, comprising an enclosure (2) delimiting an internal space (6) intended to be filled with a medium such as dielectric gas or insulating oil, this enclosure (2) comprising a top part (5), a bottom part (4), and a surrounding part (3) surrounding all the internal space (6), comprising an inner wall (7) and an outer wall (8) arranged to define together a single intermediate volume (9) extending at least all along the surrounding part, this intermediate volume (9) being intended to isolate the noise generated by the electric system contained in the internal space (6), this housing comprising outer stiffeners (31) at the inner face of the outer wall (8), **characterized in that** these outer stiffeners (31) comprise each a main plate (32) and a perpendicular plate (33) welded to the main plate (32), and **in that** the outer wall (8) is made of panels having their edges welded to the perpendicular plates (33) of the outer stiffeners (31).
2. Housing (1) according to claim 1, wherein the intermediate volume is evacuated or filled with air at ambient pressure or with other fluid.
3. Housing according to claim 1 or 2, where the outer side of the inner wall (7) and/or the inner side of the outer wall (8) is completely or partially covered with layers of acoustics absorbent material (10).
4. Housing according to any of the previous claims, comprising inner stiffeners (29) to reinforce the inner wall (7) located at the outer face of the inner wall (7) in order to be located in the intermediate volume (9).
5. Housing according to any of the previous claims, comprising at least one mechanical decoupling device (11) mounted between the inner wall (7) and the outer wall (8) to reduce transmission of acoustic vibrations from the inner wall (7) to the outer wall (8).
6. Housing according to claim 5, wherein the inner wall (7) and the outer wall (8) comprise each a surrounding edge (12, 13) in the region of their top, and wherein the at least one mechanical decoupling device (11) is mounted between the surrounding edge (12) of the inner wall (7) and the surrounding edge (13) of the outer wall (8).
7. Housing according to claim 5, wherein the inner wall (7) and the outer wall (8) comprise each a bottom corresponding to the bottom part (4) of the enclosure

(2), and wherein the at least one mechanical decoupling device (11) is mounted between the bottom of the outer wall (8) and the bottom of the inner wall (7).

8. Housing according to any of the previous claims, comprising at least one connection (14, 16) passing through the inner wall (7) and the outer wall (8), at least one of these connections (14, 16) comprising an expansion joint (17) having flanges (19, 21) welded at its extremities, these flanges being fixed respectively to the inner wall (7) and to the outer wall (8).

Patentansprüche

1. Gehäuse (1) für eine elektrische Einrichtung, wie einen Transformator, das eine Kapselung (2) umfasst, die einen Innenraum (6) begrenzt, der dafür gedacht ist, mit einem Medium wie dielektrischem Gas oder isolierendem Öl gefüllt zu werden, wobei diese Kapselung (2) ein Oberteil (5), ein Bodenteil (4) und ein umlaufendes Teil (3), das den gesamten Innenraum (6) umgibt, umfasst, umfassend eine Innenwand (7) und eine Außenwand (8), die eingerichtet sind, gemeinsam ein einzelnes Zwischenvolumen (9) zu definieren, das sich mindestens entlang des gesamten umgebenden Teils erstreckt, wobei dieses Zwischenvolumen (9) dafür gedacht ist, den Lärm zu isolieren, der von dem elektrischen System erzeugt wird, das in dem Innenraum (6) enthalten ist, wobei das Gehäuse Außenversteifungen (31) an der Innenfläche der Außenwand (8) umfasst, **dadurch gekennzeichnet, dass** diese Außenversteifungen (31) jeweils eine Hauptplatte (32) und eine senkrechte Platte (33), die an die Hauptplatte (32) geschweißt ist, umfassen, und dadurch, dass die Außenwand (8) aus Tafeln hergestellt ist, deren Kanten an die senkrechten Platten (33) der Außenversteifungen (31) geschweißt sind.
2. Gehäuse (1) nach Anspruch 1, wobei das Zwischenvolumen geleert oder mit Luft bei Umgebungsdruck oder einem anderen Fluid gefüllt ist.
3. Gehäuse nach Anspruch 1 oder 2, wo die Außenseite der Innenwand (7) und/oder die Innenseite der Außenwand (8) vollständig oder teilweise mit Schichten von akustisch absorbierendem Material (10) bedeckt ist.
4. Gehäuse nach einem der vorstehenden Ansprüche, umfassend Innenversteifungen (29), um die Innenwand (7) zu verstärken, die an der Außenfläche der Innenwand (7) liegt, um in dem Zwischenvolumen (9) zu liegen.
5. Gehäuse nach einem der vorstehenden Ansprüche,

umfassend mindestens eine mechanische Entkopplungsvorrichtung (11), die zwischen der Innenwand (7) und der Außenwand (8) montiert ist, um eine Übertragung von akustischen Schwingungen von der Innenwand (7) an die Außenwand (8) zu verringern.

6. Gehäuse nach Anspruch 5, wobei die Innenwand (7) und die Außenwand (8) jeweils eine umgebende Kante (12, 13) in dem Bereich derer Oberseite umfassen und wobei die mindestens eine mechanische Entkopplungsvorrichtung (11) zwischen der umgebenden Kante (12) der Innenwand (7) und der umgebenden Kante (13) der Außenwand (8) montiert ist.
7. Gehäuse nach Anspruch 5, wobei die Innenwand (7) und die Außenwand (8) jeweils einen Boden umfassen, der dem Bodenteil (4) der Kapselung (2) entspricht, und wobei die mindestens eine mechanische Entkopplungsvorrichtung (11) zwischen dem Boden der Außenwand (8) und dem Boden der Innenwand (7) montiert ist.
8. Gehäuse nach einem der vorstehenden Ansprüche, umfassend mindestens eine Verbindung (14, 16), die durch die Innenwand (7) und die Außenwand (8) geht, wobei mindestens eine dieser Verbindungen (14, 16) eine Dehnfuge (17) umfasst, die Flansche (19, 21) an ihre Extremitäten geschweißt aufweist, wobei diese Flansche an der Innenwand (7) bzw. an der Außenwand (8) fixiert sind.

Revendications

1. Logement (1) pour un appareil électrique tel qu'un transformateur, comprenant une enceinte (2) délimitant un espace interne (6) destiné à être rempli d'un milieu tel qu'un gaz diélectrique ou une huile d'isolation, cette enceinte (2) comprenant une partie supérieure (5), une partie inférieure (4) et une partie environnante (3) entourant tout l'espace interne (6), comprenant une paroi intérieure (7) et une paroi extérieure (8) agencées pour définir ensemble un volume intermédiaire unique (9) s'étendant au moins tout le long de la partie environnante, ce volume intermédiaire (9) étant destiné à isoler le bruit généré par le système électrique contenu dans l'espace interne (6), ce logement comprenant des raidisseurs (31) au niveau de la face intérieure de la paroi extérieure (8), **caractérisé en ce que** ces raidisseurs extérieurs (31) comprennent chacun une plaque principale (32) et une plaque perpendiculaire (33) soudée à la plaque principale (32), et **en ce que** la paroi extérieure (8) est composée de panneaux présentant leurs bords soudés aux plaques perpendiculaires (33) des raidisseurs extérieurs (31).

2. Logement (1) selon la revendication 1, dans lequel le volume intermédiaire est évacué ou rempli d'air à pression ambiante ou d'un autre fluide.

3. Logement selon la revendication 1 ou 2, où le côté extérieur de la paroi intérieure (7) et/ou le côté intérieur de la paroi extérieure (8) est/sont complètement ou partiellement recouvert/s de couches de matériau d'absorption de l'acoustique (10).

4. Logement selon l'une quelconque des revendications précédentes, comprenant des raidisseurs intérieurs (29) pour renforcer la paroi intérieure (7) se trouvant au niveau de la face extérieure de la paroi intérieure (7) afin de se trouver dans le volume intermédiaire (9).

5. Logement selon l'une quelconque des revendications précédentes, comprenant au moins un dispositif de découplage mécanique (11) monté entre la paroi intérieure (7) et la paroi extérieure (8) pour réduire la transmission de vibrations acoustiques de la paroi intérieure (7) vers la paroi extérieure (8).

6. Logement selon la revendication 5, dans lequel la paroi intérieure (7) et la paroi extérieure (8) comprennent chacune un bord environnant (12, 13) dans la région de leur sommet, et dans lequel l'au moins un dispositif de découplage mécanique (11) est monté entre le bord environnant (12) de la paroi intérieure (7) et le bord environnant (13) de la paroi extérieure (8).

7. Logement selon la revendication 5, dans lequel la paroi intérieure (7) et la paroi extérieure (8) comprennent chacune un fond correspondant à une partie inférieure (4) de l'enceinte (2), et dans lequel l'au moins un dispositif de découplage mécanique (11) est monté entre le fond de la paroi extérieure (8) et le fond de la paroi intérieure (7).

8. Logement selon l'une quelconque des revendications précédentes, comprenant au moins une connexion (14, 16) traversant la paroi intérieure (7) et la paroi extérieure (8), au moins l'une de ces connexions (14, 16) comprenant un joint d'expansion (17) présentant des brides (19, 21) soudées au niveau de ses extrémités, ces brides étant fixées respectivement à la paroi intérieure (7) et à la paroi extérieure (8).

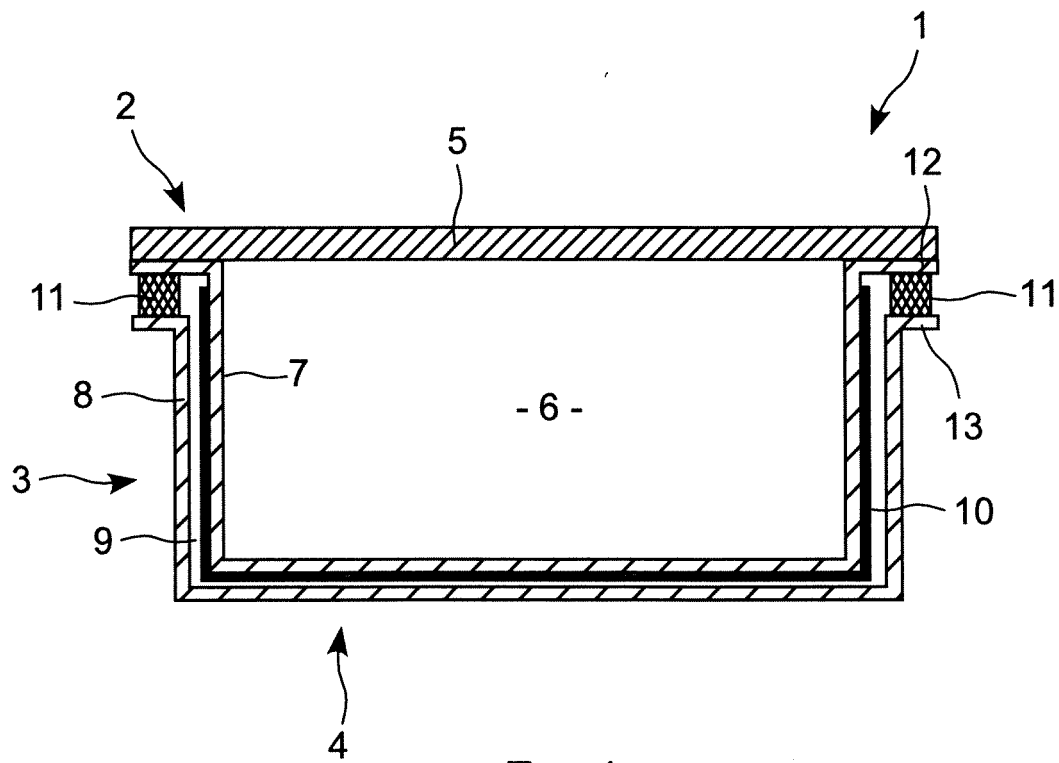


FIG. 1

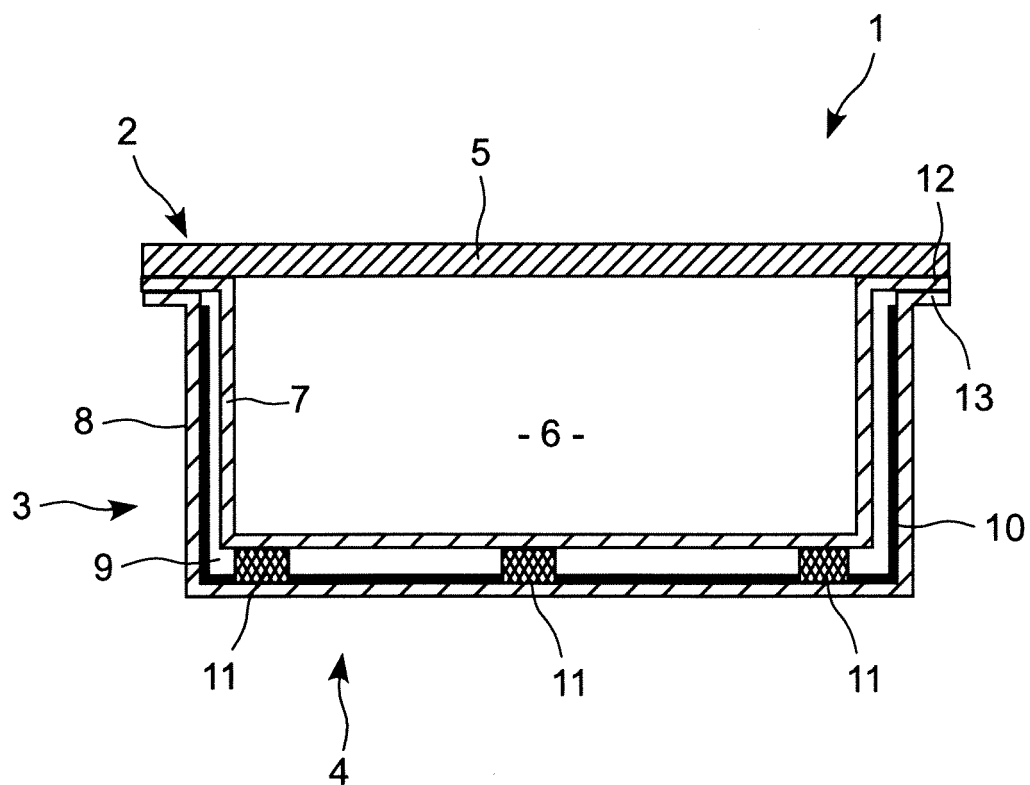


FIG. 2

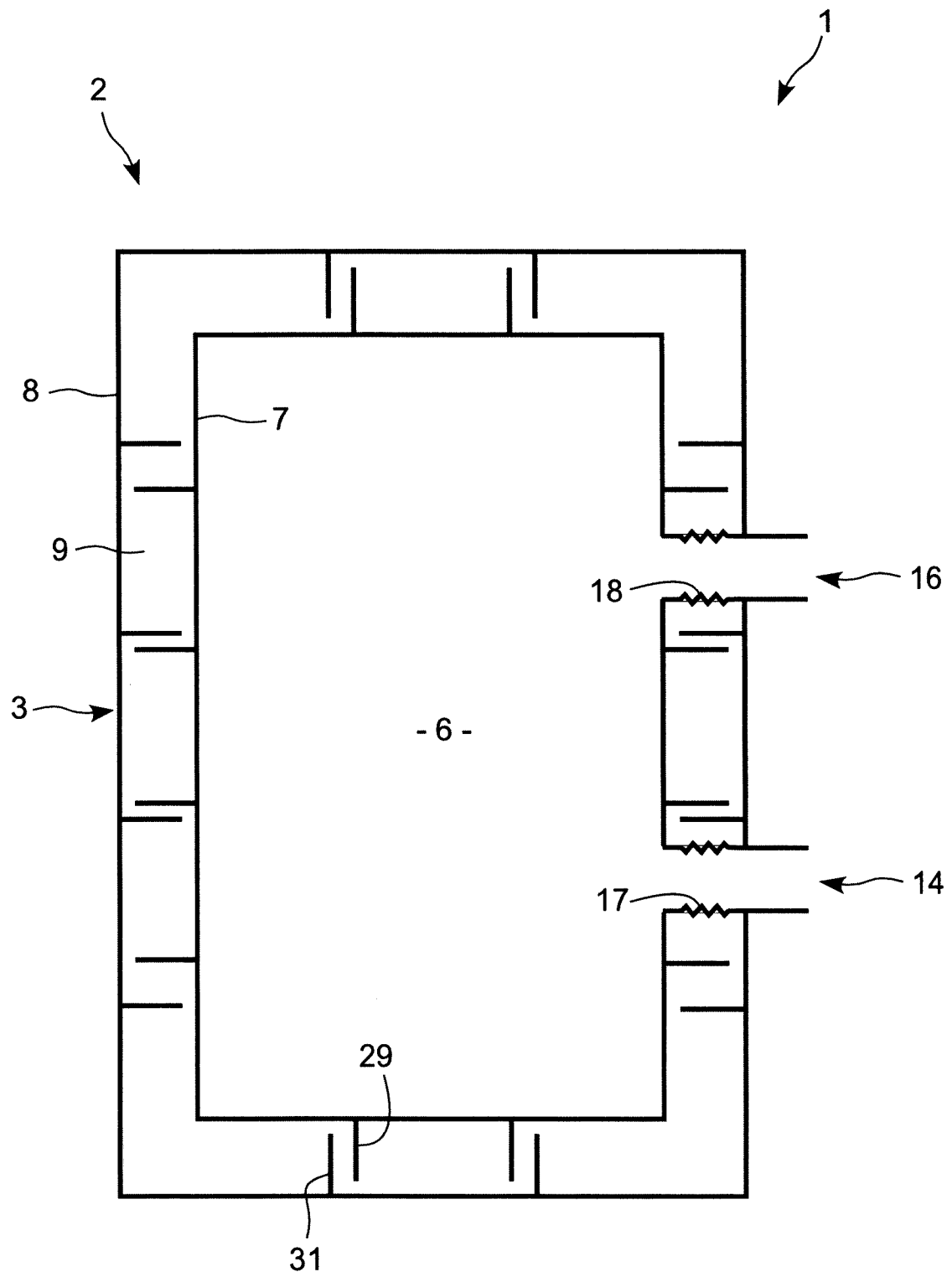


FIG. 3

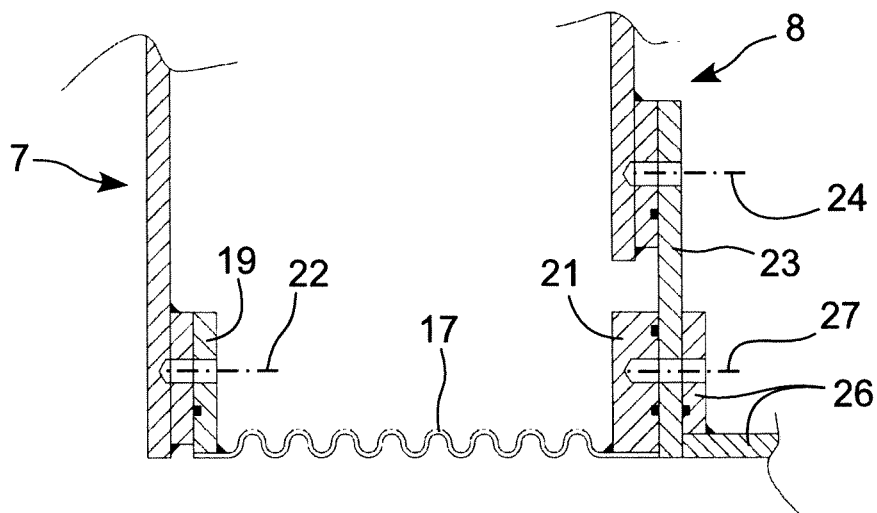


FIG. 4

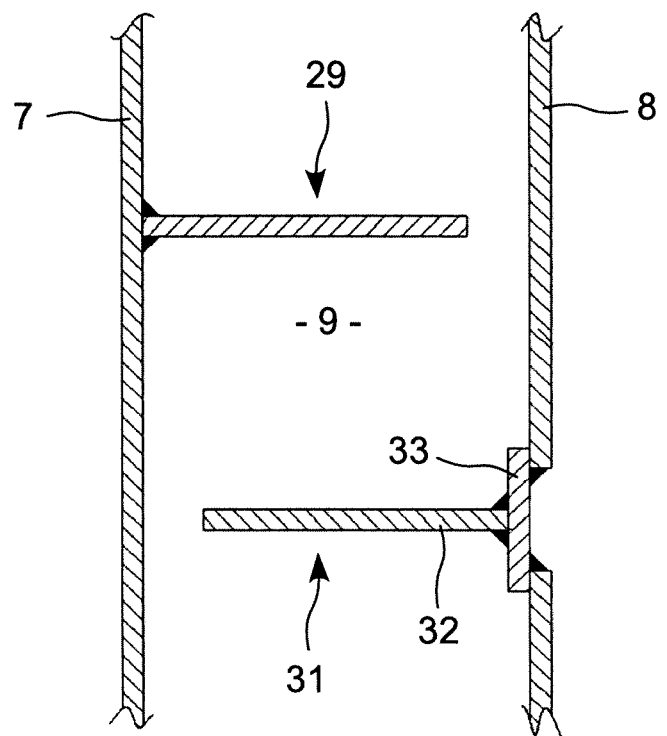


FIG. 5

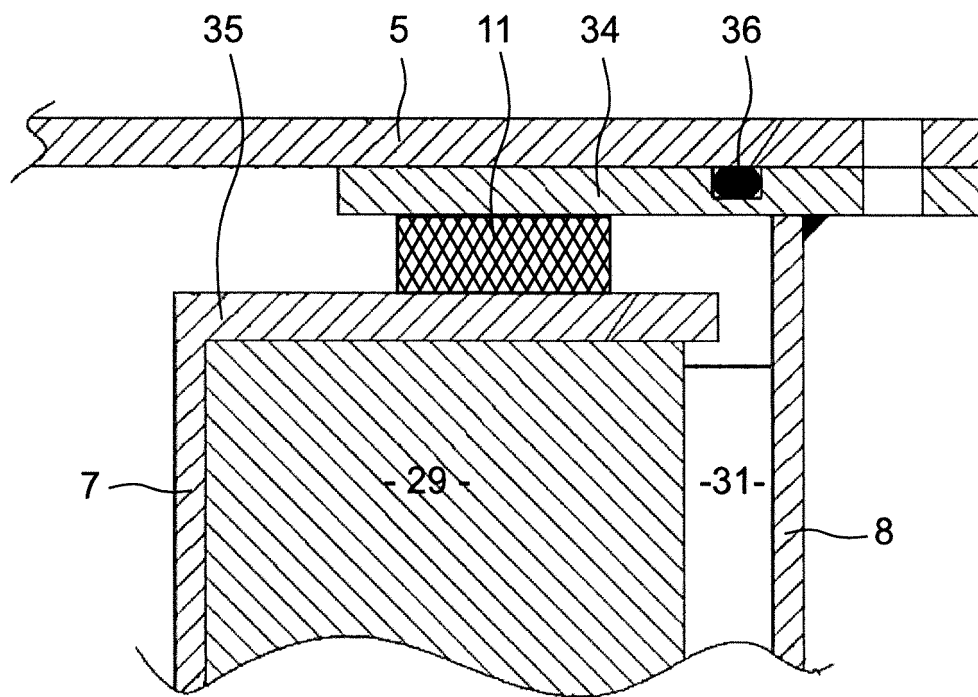


FIG. 6

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- US 3260974 A1 [0008]
- US 2734096 A1 [0008]
- GB 444129 A [0008]
- US 1846887 A1 [0008]
- WO 2013182227 A1 [0008]
- JP 57040908 A [0008]