(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 3 057 112 B1

(12) # EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention of the grant of the patent:
20.05.2020 Bulletin 2020/21

(51) Int Cl.:
H01F 27/14 *(2006.01)*

(21) Application number: **15155155.3**

(22) Date of filing: **16.02.2015**

(54) **Oil transformer**

Öltransformator

Transformateur à huile

(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:
17.08.2016 Bulletin 2016/33

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- **BERNT BJERKREIM ET AL: "Ormen Lange Subsea Compression Pilot", OFFSHORE TECHNOLOGY CONFERENCEM,, no. OTC 18969, 30 April 2007 (2007-04-30), pages 1-11, XP007921105,**

EP 3 057 112 B1

Printed by Jouve, 75001 PARIS (FR)

Description

[0001] The invention is related to an oil transformer according to the preamble of claim 1.

[0002] A transformer of this kind is known from EP 2 169 690 A1. Further GB 945,688 A shows an expansion vessel placed in a metal casing. US 2014/240 901 A1 shows a CSC container comprising a transformer and heat exchangers above the transformer but within this container. BERNT BJERKREIM ET AL, "Ormen Lange Subsea Compression Pilot", OFFSHORE TECHNOLOGY CONFERENCEM, no. OTC 18969, 30 April 2007 (20070430), on pages 1 - 11, XP007921105 shows a subsea separator module and US 2008/196920 A1 shows a compensation device directly mounted on a switch.

[0003] It is known, that transformers, reactors and other electrical devices used in HV transmission networks of for example 380kV are typically arranged within an oil filled vessel. The oil is on one hand insulation medium and on the other hand cooling medium. An expansion vessel is fluidic connected with the oil filled vessel in order to handle the thermal expansion of the oil which arises during operation of the respective HV component, for example an oil transformer. In the frame of this invention the wording "transformer" has also to be seen as synonym for a reactor and the wording "oil" covers also comparable insulation fluids such as Ester. Typically cooling means are foreseen for cooling the oil transformer, mainly heat exchangers, in particular an oil air heat exchanger or an oil water heat exchanger, or radiators which might be arranged as a radiator battery.

[0004] An HV oil transformer might have a rated power of several 100MVA, a weight of several 100t, a height of for example 6m and above and a length of 12m and above. Thus the transportation of such an oil transformer from the factory to site is a challenging task. In order to facilitate transportation, the attached components such as cooling means and expansion vessel are transported separately and assembled together with the main part of the oil transformer on site.

[0005] Disadvantageously within the state of the art is that the attached components are normally individually designed with respect to individual requirements for the respective oil transformer. Thus the attached components typically differ in size and shape so that as well their transport as their assembly on site is rather individual and time consuming therewith. Also seismic requirements, for example with respect to groundwork and a stable arrangement, have to be fulfilled when assembling the components to be attached on site.

[0006] The objective of the invention is to provide an oil transformer with attached components, which are easier to transport and to easier assemble on site.

[0007] The problem is solved by an oil transformer according to independent claim 1. CSC means Container Safety Convention wherein the standards related thereto are described for example in ISO 668.

[0008] Basic idea of the invention is to modularize the components to be attached to an oil transformer, for example an expansion vessel or the like. All modules have in common, that they are designed in that way, that they can be transported exactly like a CSC container. A module comprises a mechanical supporting structure with outer dimensions like a CSC container and a component of an oil transformer fixedly integrated therein.

[0009] CSC containers are a widely known and standardized transportation medium. A CSC container complies with standardized dimensions, for example a standardized length of 6,058m or 12,192m, wherein the height amounts 2,591 m and the width 2,438m. A transport by ships, trucks or train to any location in the world is possible without any problem. Thus the transportation of the components to be attached to an oil transformer is facilitated therewith compared to the transportation in bulky cases as it is common now.

[0010] According to the invention a respective component to be attached to an oil transformer is fixedly integrated in the mechanical supporting structure, which is not only of advantage for an easier transportation, moreover an easier installation on site is enabled therewith. The mechanical supporting structure enables an easy placing on site on the four lower corner points. Any complex groundwork is as less required as a direct assembly with the vessel of the oil transformer. It is also possible to stack the mechanical supporting structures of several modules easily each on each other. Only respective fluidic connections in between the oil filled transformer vessel and the respective mechanical supporting structure have to be mounted on site.

[0011] Typically the mechanical supporting structure is designed in that way, that it has a comparable life cycle than the oil transformer itself, so that the components fixedly integrated in the mechanical supporting structure can permanently remain therein.

[0012] According to the present invention, the mechanical supporting structure of the expansion vessel comprises coupling means at its outer surface which are foreseen as a part of the fluidic connection in between the expansion vessel and the oil filled vessel, The first part of the fluidic connection in between the expansion vessel and the coupling means is integrated in the mechanical supporting structure. So the second part from the coupling means to the oil filled vessel can easily be carried out comparable to a plug and play connection.

[0013] Another embodiment of the invention is defined in dependent claim **2.**

[0014] Integrating also the cooling means into a mechanical supporting structure of same dimensions increases the flexibility of the modular system. If required two or more modules with mechanical supporting structure and fixedly integrated cooling means can be attached to one oil transformer. Due to the identic dimensions the respective mechanical supporting structures respectively modules can be placed side by side or stacked each on each other.

[0015] According to a further embodiment of the invention the at least one cooling means are a heat exchanger, in particular an oil air heat exchanger or an oil water heat exchanger. In this case a fluidic connection in between the heat exchanger and the oil filled vessel is required. A heat exchanger has not necessarily to be placed side by side to the oil filled vessel, but in order to keep the respective fluidic connection as short as possible it would be at least of advantage to place it in close proximity. Optionally pumps or other components which are required to operate the heat exchanger are integrated in the respective module.

[0016] According to a further embodiment of the invention the mechanical supporting structure comprises coupling means at its outer face which are foreseen as a part of a fluidic connection in between the heat exchanger and the oil filled vessel. The first part of the fluidic connection in between the cooling means and the coupling means is integrated in the mechanical supporting structure. So the second part from the coupling means to the oil filled vessel can easily be carried out comparable to a plug and play connection.

[0017] According to another embodiment of the invention the at least one cooling means are one or more radiators. Radiators should be placed at least in close proximity to the oil filled vessel in order to increase the cooling effect of the air flow caused by the radiators. Radiators can be arranged as well with horizontal as with vertical alignment.

[0018] According to another variant of the invention the radiators are divided into two groups, which are foreseen to be operated independently each from each other. This enables an easy adaptation of the cooling power to the actual need for cooling.

[0019] According to the present invention, the mechanical supporting structure comprises at least one hollow bar, which is as well load bearing as foreseen as a part of the fluidic connection in between the expansion vessel and the oil filled vessel. Thus it is possible to reduce the effort for the fluidic connection by integrating the functionality of a pipe into the load bearing hollow bar of the mechanical support structure.

[0020] Another embodiment of the invention is defined in dependent claim 7.

[0021] This increases once again the flexibility of the modular system. Even an empty mechanical supporting structure could be used to lift one or more modules stacked thereon in a suitable height.

[0022] A suitable height for an expansion vessel is above the top of the oil filled vessel. Considering that the height of a transformer might amount 5m and above the mechanical support structure with the expansion vessel could be placed on a stack with two other mechanical supporting structures so that it is in a suitable height. Preferably the supporting structures below could have cooling means integrated therein, but in case that there is only need for one mechanical supporting structure with cooling means the other mechanical supporting structure could be even empty with the only purpose to lift the stack up.

[0023] Thus according to another embodiment of the invention at least two respective mechanical supporting structures are stacked each on each other. According to a further embodiment of the invention the mechanical supporting structure with the expansion vessel is stacked over a respective mechanical supporting structure with cooling means.

[0024] According to another embodiment of the invention at least one supporting structure is arranged side by side to the oil filled vessel, This reduces the length of the fluidic connections to the oil filled vessel and in case of the use of radiators as cooling means the cooling efficiency is increased therewith.

[0025] Further advantageous embodiments of the invention are mentioned in the dependent claims.

[0026] The invention will now be further explained by means of an exemplary embodiment and with reference to the accompanying drawings, in which:

Figure 1	shows an exemplary mechanical support structure,
Figure 2	shows a stack of two mechanical support structures and
Figure 3	shows an exemplary oil transformer.

[0027] Figure 1 shows an exemplary mechanical support structure 10, which is carried out as a truss structure, for example by use of beams respectively hollow beams. The mechanical support structure has the outer shape of a cuboid which is defined by four upper 12 and four lower 14 corner points. The mechanical support structure comprises a base frame 16 which is designed in that way that an integrated component such as an oil filled expansion vessel can be worn. Traverses 18 increase the mechanical stability.

[0028] Figure 2 shows a stack of two mechanical support structures in a sketch 20. A first 22 and a second 24 truss like mechanical support structure are stacked each on each other. The support structures 22, 24 comprise each four upper 26 and four lower 28 corner points.

[0029] Figure 3 shows an exemplary oil transformer 30. A transformer with a transformer core 32 and transformer coils 34 is arranged in a vessel 36 which is filled with oil 38. An HV bushing 40 is foreseen at the top of the vessel 36. A stack of mechanical support structures 46, 48, 50 is foreseen left of the vessel 36. An expansion vessel 42, which is partly filled with oil 44, is integrated in the first mechanical support structure 46. A fluidic connection in between the expansion vessel 42 and the vessel 36 is realized by a first part 52 leading from the expansion vessel 42 to coupling means 54 and by a second part 56 leading from the coupling means 54 to the vessel 36.

[0030] The second mechanical support structure 48 has cooling means 58 integrated therein, in this case a heat exchanger. The heat exchanger comprises several disk like cooling modules which are arranged side by side along the axial length of the mechanical support structure 48. Each cooling module is supplied by a main feed line 64 with oil to be cooled and which is returned after cooling over a main return line 66. Each cooling module has an own feed 60 and return 62 line which are connected to the respective main line 64 respectively 66.

[0031] The third mechanical support structure 50 comprises a fan 68 and control equipment 70, in particular a computer for logging and analyzing measured data of the oil transformer 30. Additionally the stack of the first 46 and second 48 mechanical support structures is lifted up therewith, so that the expansion vessel 42 of the first mechanical support structure is above the top of the vessel 36 therewith. The whole arrangement is placed on a ground floor 72.

List of reference signs

[0032]

10	exemplary mechanical support structure
12	upper corner points
14	lower corner points
16	base frame
18	traverse
20	stack of two mechanical support structures
22	upper mechanical support structure
24	lower mechanical support structure
26	upper corner points of upper mechanical support structure
28	lower corner points of lower mechanical support structure
30	exemplary oil transformer
32	transformer core
34	transformer coil
36	vessel
38	oil
40	HV-bushing
42	expansion vessel
44	oil
46	first mechanical support structure
48	second mechanical support structure
50	third mechanical support structure
52	first part of fluidic connection
54	coupling means
56	second part of fluidic connection
58	cooling means
60	feed line of cooling module
62	return line of cooling module
64	main feed line
66	main return line
68	fan
70	control equipment
72	ground floor

Claims

1. Oil transformer (30), comprising

- a high voltage transformer (32 + 34) arranged in an oil filled vessel (36),
- an expansion vessel (42),
- a fluidic connection (52 + 54 + 56) in between the expansion vessel (42) and the oil filled vessel (36),
- at least one cooling means (58),

wherein the oil transformer (30) further comprises:

- a first module comprising the expansion vessel (42) and a mechanical supporting structure (10, 22, 24, 46) which comprises at least one hollow bar, the expansion vessel (42) being fixedly integrated in the mechanical supporting structure (10, 22, 24, 46) comprising said hollow bar, which has four upper (12, 26) and four lower (14, 28) corner points arranged in the form of a square, wherein the corner points (12, 14, 26, 28) each are in the form of load transfer points, **characterized in that**,
- the corner points (12, 14, 26, 28) are arranged according to the dimensions of a CSC, i.e. Container Safety Convention, container, so that the first module can be transported exactly like a CSC container,
- wherein the mechanical supporting structure has outer dimensions like said CSC container,
- wherein said hollow bar is a load bearing hollow bar, which is as well load bearing as foreseen as a part of the fluidic connection (52 + 54 + 56) in between the expansion vessel (42) and the oil filled vessel (36),
- wherein the functionality of a pipe is integrated into said hollow bar, and
- wherein the mechanical supporting structure (10, 22, 24, 46) comprises coupling means (54) at its outer surface which are foreseen as a part of the fluidic connection (52 + 54 + 56) in between the expansion vessel (42) and the oil filled vessel (36).

2. Oil transformer according to claim 1, wherein the oil transformer (30) further comprises a second module comprising the at least one cooling means (58) and a second mechanical supporting structure, the at least one cooling means (58) being fixedly integrated in the second mechanical supporting structure (10, 22, 24, 48) which has four upper (12, 26) and four lower (14, 28) corner points arranged in the form of a square, wherein the corner points (12, 14, 26, 28) each are in the form of load transfer points and are arranged according to the dimensions of a CSC container, so that the second module can be transported exactly like a CSC container.

3. Oil transformer according to claim 2, wherein the at least one cooling means (58) is a heat exchanger, in particular an oil air heat exchanger or an oil water heat exchanger.

4. Oil transformer according to claim 3, wherein the mechanical supporting structure (10, 22, 24, 48) comprises coupling means at its outer face which are foreseen as a part of a fluidic connection in between the heat exchanger (58) and the oil filled vessel (36).

5. Oil transformer according to claim 2, wherein the at least one cooling means (58) is one or more radiators.

6. Oil transformer according to claim 5, wherein the radiators are divided into two groups, which are foreseen to be operated independently each from each other.

7. Oil transformer according to any of the previous claims, wherein the oil transformer (30) further comprises a third module comprising control equipment and a third mechanical supporting structure, the control equipment being fixedly integrated in the third mechanical supporting structure (10, 22, 24, 50) which has four upper (12, 26) and four lower (14, 28) corner points arranged in the form of a square, wherein the corner points (12, 14, 26, 28) each are in the form of load transfer points and are arranged according to the dimensions of a CSC container, so that the third module can be transported exactly like a CSC container.

8. Oil transformer according to any of previous claims 2-6, wherein at least two respective mechanical supporting structures (10, 22, 24, 46, 48, 50) are stacked each on each other.

9. Oil transformer according to claim 8, wherein a respective mechanical supporting structure (10, 22, 24, 46) with the expansion vessel (42) is stacked over the second mechanical supporting structure (10, 22, 24, 46, 48,) with the at least one cooling means (58).

10. Oil transformer according to any of the previous claims, wherein at least one supporting structure (10, 22, 24, 46, 48, 50) is arranged side by side to the oil filled vessel (36).

Patentansprüche

1. Öltransformator (30), der Folgendes umfasst:

- einen Hochspannungstransformator (32 + 34), der in einem ölgefüllten Behälter (36) angeordnet ist,
- einen Ausdehnungsbehälter (42),
- eine strömungstechnische Verbindung (52 + 54 + 56) zwischen dem Ausdehnungsbehälter (42) und dem ölgefüllten Behälter (36) und
- mindestens ein Kühlmittel (58), wobei

der Öltransformator (30) ferner Folgendes umfasst:

- ein erstes Modul, das den Ausdehnungsbehälter (42) und eine mechanische Tragstruktur (10, 22, 24, 46) umfasst, die mindestens eine Hohlstange umfasst, wobei der Ausdehnungsbehälter (42) in die mechanische Tragstruktur (10, 22, 24, 46), die die Hohlstange umfasst, fest integriert ist, und die vier obere (12, 26) und vier untere (14, 28) Eckpunkte, die in Form eines Quadrats angeordnet sind, besitzt, wobei die Eckpunkte (12, 14, 26, 28) jeweils die Form von Lastübertragungspunkten aufweisen, **dadurch gekennzeichnet, dass**
- die Eckpunkte (12, 14, 26, 28) gemäß den Abmessungen eines CSC-Containers, d. h. eines Containers gemäß dem Containersicherheitsübereinkommen, derart angeordnet sind, dass das erste Modul genau wie ein CSC-Container transportiert werden kann, wobei
- die mechanische Tragstruktur Außenabmessungen wie der CSC-Container besitzt,
- die Hohlstange eine tragende Hohlstange ist, die sowohl tragend als auch als Teil der strömungstechnischen Verbindung (52 + 54 + 56) zwischen dem Ausdehnungsbehälter (42) und dem ölgefüllten Behälter (36) vorgesehen ist,
- die Funktionalität eines Rohrs in die Hohlstange integriert ist und
- die mechanische Tragstruktur (10, 22, 24, 46) an ihrer Außenseite Kopplungsmittel (54) umfasst, die als ein Teil der strömungstechnischen Verbindung (52 + 54 + 56) zwischen dem Ausdehnungsbehälter (42) und dem ölgefüllten Behälter (36) vorgesehen sind.

2. Öltransformator nach Anspruch 1, wobei der Öltransformator (30) ferner ein zweites Modul umfasst, das das mindestens eine Kühlmittel (58) und eine zweite mechanische Tragstruktur umfasst, das mindestens eine Kühlmittel (58) in die zweite mechanische Tragstruktur (10, 22, 24, 48), die vier obere (12, 26) und vier untere (14, 28) Eckpunkte besitzt, die in Form eines Quadrats angeordnet sind, fest integriert ist, wobei die Eckpunkte (12, 14, 26, 28) jeweils die Form von Lastübertragungspunkten aufweisen und gemäß den Abmessungen eines CSC-Containers angeordnet sind, derart, dass das zweite Modul genau wie ein CSC-Container transportiert werden kann.

3. Öltransformator nach Anspruch 2, wobei das mindestens eine Kühlmittel (58) ein Wärmetauscher, insbesondere ein Öl/Luft-Wärmetauscher oder ein Öl/Wasser-Wärmetauscher ist.

4. Öltransformator nach Anspruch 3, wobei die mechanische Tragstruktur (10, 22, 24, 48) Kopplungsmittel an ihrer Außenseite umfasst, die als ein Teil einer strömungstechnischen Verbindung zwischen dem Wärmetauscher (58) und dem ölgefüllten Behälter (36) vorgesehen sind.

5. Öltransformator nach Anspruch 2, wobei das mindestens eine Kühlmittel (58) ein oder mehrere Kühler sind.

6. Öltransformator nach Anspruch 5, wobei die Kühler in zwei Gruppen unterteilt sind, die dazu vorgesehen sind, unabhängig voneinander betrieben zu werden.

7. Öltransformator nach einem der vorhergehenden Ansprüche, wobei der Öltransformator (30) ferner ein drittes Modul umfasst, das ein Steuergerät und eine dritte mechanische Tragstruktur umfasst, wobei das Steuergerät in die dritte mechanische Tragstruktur (10, 22, 24, 50), die vier obere (12, 26) und vier untere (14, 28) Eckpunkte besitzt, die in Form eines Quadrats angeordnet sind, fest integriert ist, wobei die Eckpunkte (12, 14, 26, 28) jeweils die Form von Lastübertragungspunkten aufweisen und gemäß den Abmessungen eines CSC-Containers derart angeordnet sind, dass das dritte Modul genau wie ein CSC-Container transportiert werden kann.

8. Öltransformator nach einem der vorhergehenden Ansprüche 2-6, wobei mindestens zwei mechanische Tragstrukturen (10, 22, 24, 46, 48, 50) aufeinandergestapelt sind.

9. Öltransformator nach Anspruch 8, wobei eine entsprechende mechanische Tragstruktur (10, 22, 24, 46) mit dem Ausdehnungsbehälter (42) über die zweite mechanische Tragstruktur (10, 22, 24, 46, 48) mit dem mindestens einen Kühlmittel (58) gestapelt ist.

10. Öltransformator nach einem der vorhergehenden Ansprüche, wobei mindestens eine Tragstruktur (10, 22, 24, 46, 48, 50) neben dem ölgefüllten Behälter (36) angeordnet ist.

Revendications

1. Transformateur à huile (30), comprenant:

• un transformateur à haute tension (32 + 34) disposé dans un récipient rempli d'huile (36),
• un vase d'expansion (42),
• une liaison fluidique (52 + 54 + 56) entre le vase d'expansion (42) et le récipient rempli d'huile (36),
• au moins un moyen de refroidissement (58),

ce transformateur à huile (30) comprenant en outre :

• un premier module comprenant le vase d'expansion (42) et une structure de support mécanique (10, 22, 24, 46) qui comprend au moins une barre creuse, le vase d'expansion (42) étant intégré de manière fixe dans cette structure de support mécanique (10, 22, 24, 46) comprenant ladite barre creuse, qui a quatre points de coin supérieurs (12, 16) et quatre points de coin inférieurs (14, 28) disposés sous la forme d'un carré, ces points de coin (12, 14, 26, 28) étant chacun sous la forme de points de transfert de charge,

<u>caractérisé en ce que</u>

• les points de coin (12, 14, 26, 28) sont disposés en fonction des dimensions d'un conteneur CSC, c'est-à-dire Convention sur la sécurité des conteneurs, de manière à ce que le premier module puisse être transporté exactement comme un conteneur CSC,
• la structure de support mécanique ayant des dimensions extérieures comme ledit conteneur CSC,
• ladite barre creuse étant une barre creuse porteuse de charge, qui est aussi porteuse de charge comme prévu comme faisant partie de la liaison fluidique (52 + 54 + 56) entre le vase d'expansion (42) et le récipient rempli d'huile (36),
• la fonctionnalité d'un tuyau étant intégrée dans ladite barre creuse, et
• la structure de support mécanique (10, 22, 24, 46) comprenant des moyens de liaison (54) au niveau de sa surface extérieure qui sont prévus comme faisant partie de la liaison fluidique (52 + 54 + 56) entre le vase d'expansion (42) et le récipient rempli d'huile (36).

2. Transformateur à huile selon la revendication 1, ce transformateur à huile (30) comprenant en outre un deuxième module comprenant l'au moins un moyen de refroidissement (58) et une deuxième structure de support mécanique, l'au moins un moyen de refroidissement (58) étant intégré de manière fixe dans la deuxième structure de support mécanique (10, 22, 24, 48) qui a quatre points de coin supérieurs (12, 26) et quatre points de coin inférieurs (14, 28) disposés sous la forme d'un carré, ces points de coin (12, 14, 26, 28) étant chacun sous la forme de points de transfert de charge et étant disposés en fonction

des dimensions d'un conteneur CSC, de manière à ce que le deuxième module puisse être transporté exactement comme un conteneur CSC.

3. Transformateur à huile selon la revendication 2, dans lequel l'au moins un moyen de refroidissement (58) est un échangeur de chaleur, en particulier un échangeur du chaleur huile-air ou un échangeur de chaleur huile-eau.

4. Transformateur à huile selon la revendication 3, dans lequel la structure de support mécanique (10, 22, 24, 48) comprend des moyens de liaison au niveau de sa surface extérieure qui sont prévus comme faisant partie d'une liaison fluidique entre l'échangeur de chaleur (58) et le récipient rempli d'huile (36).

5. Transformateur à huile selon la revendication 2, dans lequel l'au moins un moyen de refroidissement (58) consiste en un ou plusieurs radiateurs.

6. Transformateur à huile selon la revendication 5, dans lequel les radiateurs sont divisés en deux groupes, qui sont prévus pour être utilisés indépendamment l'un de l'autre.

7. Transformateur à huile selon l'une quelconque des revendications précédentes, ce transformateur à huile (30) comprenant en outre un troisième module comprenant un matériel de commande et une troisième structure de support mécanique, ce matériel de commande étant intégré de manière fixe dans la troisième structure de support mécanique (10, 22, 24, 50) qui a quatre points de coin supérieurs (12, 26) et quatre points de coin inférieurs (14, 28) disposés sous la forme d'un carré, ces points de coin (12, 14, 26, 28) étant chacun sous la forme de points de transfert de charge et étant disposés en fonction des dimensions du conteneur CSC, de manière à ce que le troisième module puisse être transporté exactement comme un conteneur CSC.

8. Transformateur à huile selon l'une quelconque des revendications précédentes 2 à 6, dans lequel au moins deux structures de support mécanique (10, 22, 24, 46, 48, 50) sont empilées chacune l'une sur l'autre.

9. Transformateur à huile selon la revendication 8, dans lequel une structure de support mécanique respective (10, 22, 24, 46) avec le vase d'expansion (42) est empilée au-dessus de la deuxième structure de support mécanique (10, 22, 24, 46, 48) avec l'au moins un moyen de refroidissement (58).

10. Transformateur à huile selon l'une quelconque des revendications précédentes, dans lequel au moins une structure de support mécanique (10, 22, 24, 46, 48, 50) est disposée côte à côte avec le récipient rempli d'huile (36).

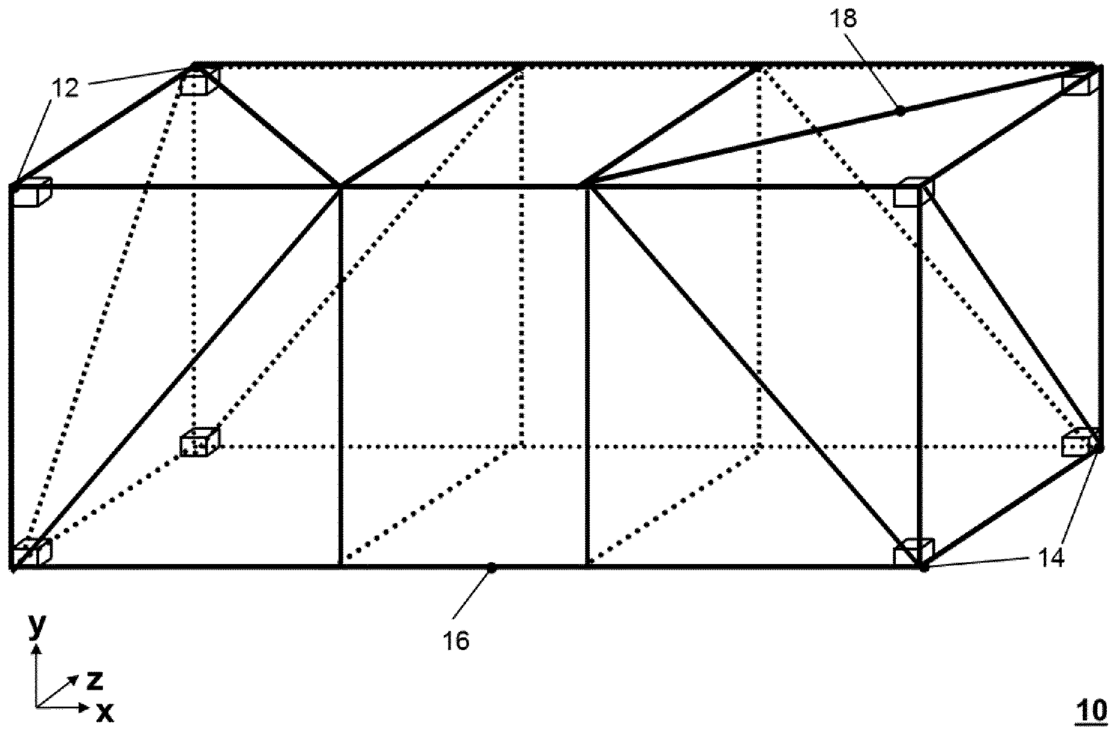

Fig. 1

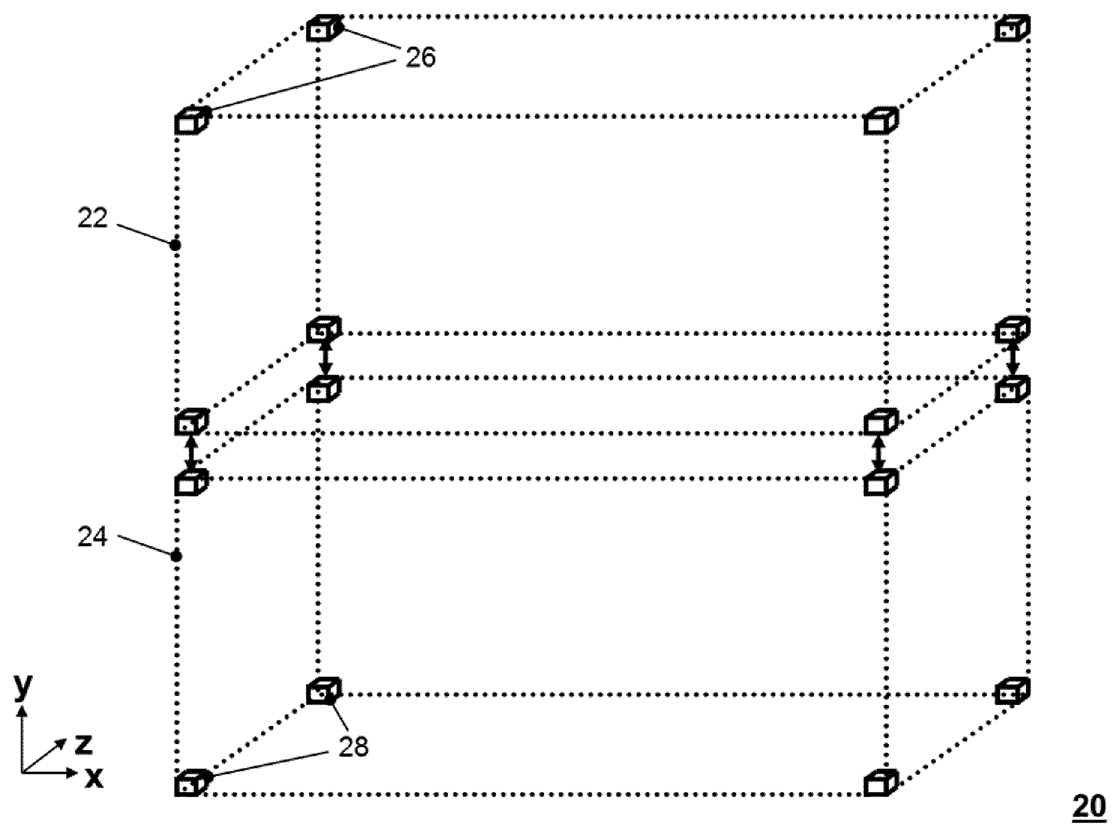

Fig. 2

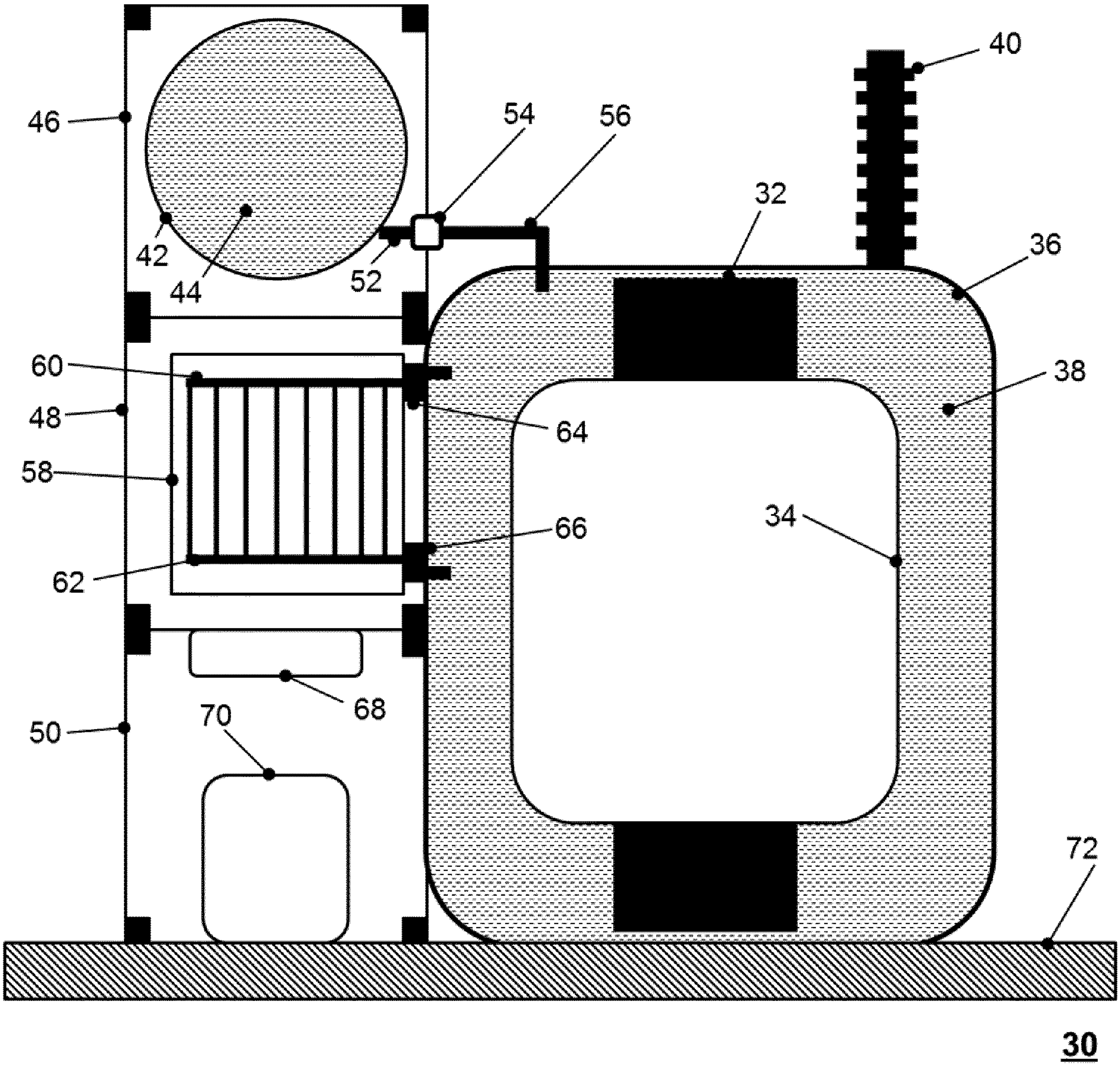

Fig. 3

REFERENCES CITED IN THE DESCRIPTION

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