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(54) LIQUID-TO-GAS SHELL HEAT EXCHANGER

(57) The invention relates to a liquid-to-gas shell heat exchanger (1) containing an elongated shell (2), the central section of which (21) is on both sides closed by heads (22). In this shell (2) an inlet aperture (31) and an outlet aperture (32) for the heated medium are made, being mutually interconnected by a conduit (33) of the heated medium arranged in the inner space of the heat exchanger (1), whereby in this shell (2) an inlet aperture (41) and an outlet aperture (42) for the heating medium are also made. The inlet aperture (41) for the heating medium is created in the head (22) of the shell (2) of the heat exchanger (1).

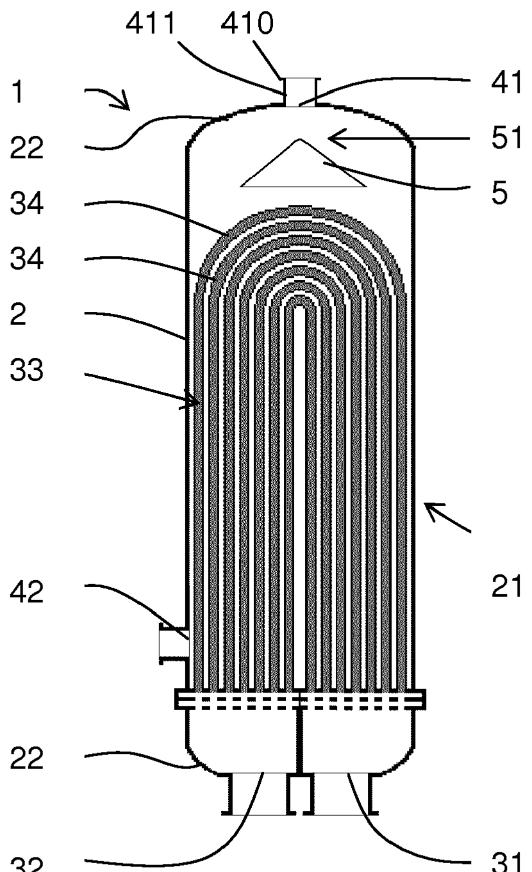

Fig. 3a

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Description

Technical Field

[0001] The invention relates to a liquid-to-gas shell heat exchanger which contains a shell the central part of which is closed by heads on both sides.

Background Art

[0002] The present day known liquid-to-gas shell heat exchangers contain a cylindrical shell elongated in one direction and usually vertically oriented, which is closed by (usually) rounded heads. In the central cylindrical section of the shell (Fig. 2a) or in its rounded head (Fig. 1a), an inlet aperture and outlet aperture for heated medium (usually liquid, e.g. water) are made. They are interconnected through the medium conduit formed by a length-oriented (Fig. 2a), resp. height-oriented (Fig. 1a) bunch of pipes situated in the inner space of the exchanger. The inlet aperture (or apertures) and the outlet aperture for the heating medium (usually gas, e.g. steam) are then always made in the central cylindrical part of the shell and a conduit of the heating medium is created by free spaces in the inner space of the exchanger. The disadvantage of this system consists namely in the fact that situating the inlet aperture for the heating medium in the cylindrical part of the shell significantly limits its maximum diameter, so if a bigger amount of the heating medium is supplied, it is necessary to make at least two inlet apertures in the shell of the exchanger and to branch its conduit appropriately. Another disadvantage of this design rests in an unsuitable movement of the heating medium in the inner space of the exchanger, because the medium enters it perpendicularly to the free space between the shell of the exchanger and the conduit of the heated medium, thus its flow is broken by the conduit of the heated medium immediately after its entry into the inner space of the heat exchanger. Because of that, the heating medium does not reach all the free spaces of the exchanger inner space evenly.

[0003] The aim of the invention is to eliminate the disadvantages of the state- of-the-art technology and to design a liquid-to-gas shell heat exchanger which would eliminate the state-of-the-art technology disadvantages.

Principle of the invention

[0004] The aim of the invention is achieved by a liquid-to-gas shell heat exchanger, which contains an elongated shell, the central part of which is closed by heads on both sides, whereby in the shell, inlet and outlet apertures for the heated medium are made, being interconnected by a conduit of the heated medium arranged in the inner space of the heat exchanger, and the inlet and outlet apertures for the heating medium, the principle of which consists in the fact that the inlet aperture for the heating medium is created in the head of the shell of the heat exchanger. Thanks to this arrangement, the diameter of the inlet aperture for the heating medium can be up to identical with the diameter of the shell of the heat exchanger, making it possible to supply any amount of the heating medium necessary without the need to increase its speed and/or to branch its conduit. The heating medium, at the same time, enters the inner space of the exchanger designed in this way in the direction of the orientation of the free spaces between the shell and the conduit of the heated medium, and therefore it fills these spaces faster and more evenly.

[0005] For the prevention of excessive erosion of the conduit of the heated medium by the effect of the heating medium, especially in cases when steam is used as a heating medium, a deflector is preferably arranged in the inner space of the heat exchanger opposite the inlet aperture for the heating medium.

[0006] In the most advantageous embodiment, this deflector is axially symmetrical - it has, for example, a shape of a cone or of a jacket of a cone, because in this case it ensures an even supply of the heating medium into the inner space of the heat exchanger. In other embodiments, its outer surface can be cranked and/or rounded for the required directing of the heating liquid.

[0007] For the reduction of the heating medium circumfluence loss, this deflector has preferably a spherically rounded apex.

[0008] In any embodiment, the deflector is preferably arranged coaxially with the inlet aperture for the heating medium.

[0009] If the deflector is formed by a hollow body, e.g., in a shape of a jacket of a cone, it is advantageous if at least one through-hole is made in it, or if the deflector consists of at least two segments separated by a gap. This ensures that the supplied heating medium quickly gets into its inner space and, due to this, the whole inner space of the heat exchanger is heated faster and more evenly.

[0010] In another advantageous embodiment, at least one directing element is provided on the outer surface of the deflector, for example, a lamella, etc., for directing the movement of supplied heating medium.

[0011] The deflector can be, if necessary, supported by at least one auxiliary deflector. It can be, for example a deflector in the shape of a cone or of a jacket of a cone, which is situated between the deflector and the inlet aperture for the heating medium, or an auxiliary deflector in the shape of a jacket of truncated cone without bases, which may overlap at least a part of the outer surface of the deflector.

[0012] For the connection of the heat exchanger with the conduit of the heating medium, the inlet aperture for the heating medium is from the outer side of the shell equipped with a socket with a flange. Preferably, this socket widens in the direction into the inner space of the heat exchanger and, thanks to this, reduces the speed of the heating medium entering the inner space of the exchanger.

Description of Drawings

[0013] In the enclosed drawings Fig. 1 schematically represents a sectional view of one embodiment of a vertically oriented liquid-to-gas shell heat exchanger known from the state of the art, Fig. 1b represents a sectional view of one embodiment of a vertically oriented liquid-to-gas shell heat exchanger according to the invention, Fig. 2a represents a sectional view of one embodiment of a horizontally oriented liquid-to-gas shell heat exchanger known from the state of the art, Fig. 2b represents a sectional view of one embodiment of a horizontally oriented liquid-to-gas shell heat exchanger according to the invention, Figs. 3a to 3d show sectional views of four other embodiments of a vertically oriented liquid-to-gas shell heat exchanger according to the invention., Fig.4 represents a visualization of a part of the inner space of the liquid-to-gas shell heat exchanger according to the invention in the first example of embodiment, and Fig. 5 represents a visualization of a part of the inner space of the liquid-to-gas shell heat exchanger according to the invention in the second example of embodiment.

Examples of embodiment

[0014] The principle of the shell heat exchanger according to the invention will be further on explained taking into account the construction of the present-day liquid-to-gas shell heat exchangers represented in Fig. 1 a and Fig. 2a, and six embodiments of a high-pressure heater, which is used, for example, in power plants to heat feed water with steam taken from the steam turbine represented in Figs. 1b, 2b, 3a to 3d., 4 and 5. The principle presented can be used even for any other liquid-to-gas shell heat exchanger regardless of its purpose and orientation.

[0015] The known shell heat exchanger **1** (Fig.1a and Fig. 2a) contains an elongated shell **2,** the central cylindrical part **21** of which is closed by a rounded head **22** on each side. In the central cylindrical part **21** (Fig. 2a) or in the rounded head **22** (in the vertical arrangement of the heat exchanger **1** usually in its lower rounded head **22 -** Fig.1a) are made an inlet aperture **31** and an outlet aperture **32** for the heated medium (usually liquid), which are mutually interconnected by a conduit **33** of the heated medium composed of a known bunch of pipes **34** situated in the inner space of the heat exchanger **1,** the conduit being height-oriented (Fig. 1a) or length-oriented (Fig. 2a). Besides this, in the central cylindrical part **21** of the shell **2** an outlet aperture **42** and at least one inlet aperture **41** for the heating medium are made.

[0016] The inlet aperture **41** for the heating medium (usually gas) in the shell heat exchanger **1** according to the invention is in contrast to similar known heat exchangers **1** situated in one of the rounded heads **22** of its shell **2.** If the shell heat exchanger **1** is vertically oriented, the inlet aperture **41** for the heating medium is preferably situated in its upper rounded head **22** (Fig. 1b). If the shell heat exchanger **1** is oriented horizontally and the inlet aperture **31** and the outlet aperture **32** for the heated medium are situated in the central cylindrical part **21** of its shell **2,** the entry aperture **41** for the heating medium can be situated in any of the rounded heads **22** (Fig. 2a), but preferably in the head **22** to which the heated medium moves in its conduit **33** because in this case the effectiveness of the heat exchange between the heating and heated media is increased. If in the case of the horizontally oriented heat exchanger the inlet aperture **31** and/or the outlet aperture **32** for the heated medium is situated in one of its rounded heads **22,** the inlet aperture **41** for the heating medium is preferably situated in the opposite head **22.**

[0017] The diameter of the thus arranged inlet aperture **41** for the heating medium can be substantially identical to the diameter of the heat exchanger **1** shell **2,** which allows supply of substantially any required amount of the heating medium without the necessity to increase its speed and/or branch its conduit. Another advantage of this design consists in the fact that the heating medium enters the inner space of the heat exchanger **1** in the direction of the orientation of free spaces between the shell **2** and pipes **34** of the conduit **33** of the heated medium, therefore the heating medium fills these spaces faster and more evenly.

[0018] The outlet aperture **42** for the heating medium is situated in any part of the shell **2** of the heat exchanger **1,** preferably in its central cylindrical part **21.** However, in embodiments not represented it can be arranged even in the opposite rounded head **22.**

[0019] The inlet aperture **41** for the heating medium is preferably on the outer side of the shell **2** of the heat exchanger **1** equipped with a socket **410** with a flange **411** and if it is necessary to reduce the speed of the heating medium at the moment of its entry into the inner space of the heat exchanger **1,** the socket 410 can widen in the direction into the inner space of the heat exchanger **1.** The socket **410** thus shaped helps to direct the supplied heating medium into the free spaces in the inner space of the heat exchanger **1.**

[0020] Especially in embodiments in which water steam (which can contain little drops of water) is used as a heating medium, its advantageous if in the inner space of the heat exchanger **1,** opposite the inlet aperture **41** for the heating medium, a deflector **5** is placed, which directs the supplied heating medium into the free spaces between the shell **2** and pipes **34** of the conduit **33** of the heated medium and, at the same time, it protects the conduit **33** of the heated medium from the direct impact of the heating medium and the erosion related. This deflector **5** can generally be of any shape, however, the deflector **5** having an axially symmetrical shape - for example, a shape of a jacket of a cone, oriented in the way that it widens in the direction from the inlet aperture **41** for the heating medium, appears as the most suitable. Several embodiments of a heat exchanger **1** with the deflector **5** of this kind are schematically represented in Figs. 3a to 5. In an advantageous embodiment the deflector **5** shaped in this way has a spherically rounded apex **51,** which contributes to its more advantageous circumfluence by heating medium.

[0021] For an even distribution of the heating medium in the inner space of the heat exchanger **1** it is advantageous if the deflector **5** is situated coaxially with the inlet aperture **41** for the heating medium.

[0022] In other variants of embodiments, the deflector **5** can be supplemented by another element or elements of any shape for directing the supplied heating medium and/or for the protection of the inner surface of the shell **2** of the heat exchanger **1** from erosion caused by the heating medium. Such an element is, for example, an auxiliary deflector **6,** which, in the embodiment represented in Fig. 3b, is in the shape of a jacket of a truncated cone without bases and is situated outside the deflector **5,** preferably coaxially with it. If necessary, the auxiliary deflector **6** can be arranged in such a manner that it overlaps at least a part of the outer surface of the deflector **5** (Fig. 3b). Thus, the outer surface of the deflector **5** and the inner surface of the auxiliary deflector **6** constitute together a directing channel **56** or, on the contrary, without any overlap of the deflector **5.** In principle, the auxiliary deflector **6** thus shaped usually has a bigger conicalness (i.e. the angle between the surface line and the base) than the deflector **5,** but, if necessary, for example, due to the inner arrangement of the heat exchanger **1,** its conicalness can be equivalent or smaller.

[0023] In the embodiment represented in Fig. 3c, the auxiliary deflector **6** has a shape of a jacket of a cone and is (in the direction of the supplied heating medium) placed before the deflector **5,** whereas it is preferably situated coaxially with it. The diameter of the auxiliary deflector **6** in its widest part is smaller than the diameter of the deflector **5** in its widest part. In the embodiment represented, the auxiliary deflector **6** has the same conicalness as the deflector **5,** but in other not represented embodiments, it can have a different conicalness - bigger or smaller. To achieve a suitable circumfluence by the heating medium the auxiliary deflector **6** has preferably a spherically rounded apex **61** or it can have the shape of a jacket of a truncated cone with the upper base. If necessary, the deflector **5** and the auxiliary deflector **6** can be arranged in such a manner that the deflector **5** partially enters the cavity of the auxiliary deflector **6.**

[0024] In other not represented embodiments, the auxiliary deflector **6** can be formed by another element, e.g. by a plane, rounded and/or cranked board.

[0025] In another embodiment, the deflector **5** can be supported by two auxiliary deflectors **6**, when, e.g., one of them has a shape of a jacket of a cone and is arranged before it (as in the embodiment represented in Fig. 3c) and the other has a shape of a jacket of a truncated cone without bases and is arranged outside the deflector **5** (e.g. as in the embodiment represented in Fig. 3b), and if necessary, it can overlap at least a part of the outer surface of the deflector **5**.

[0026] In other not represented embodiments, the deflector **5** can be designed in any other way, whereby it can have, for example, a shape of (a jacket of) a cone, (a jacket of) a truncated cone with the upper base, (a jacket of) a spire, (a jacket of) a frustum with the upper base, etc. or its surface may be rounded inwards or outwards and/or cranked. Fig. 3d represents an example of embodiment of the heat exchanger **1** in which the deflector **5** has a shape of a jacket of a cone, whereas its conicalness sharply changes along its height, while its lower part **53** is of greater conicalness than its upper part **52.** This embodiment of the deflector **5** is very advantageous because the supplied heating medium copies its shape in its movement, and so it is directed towards the free spaces of the inner space of the shell **2,** and the part of it which falls onto the inner surface of the shell **2** of the heat exchanger impacts it at a low speed and under a small angle, thereby reducing its erosive effect. In other not represented embodiments, the conicalness of the conical deflector **5** may be modified in a different way, whereby the deflector **5** can be formed by a cone, the diameter of which is continuously rising (and in some part possibly even sharply or continuously declining).

[0027] In the case of large shell heat exchangers **1** it is advantageous to create at least one through-aperture in the deflector **5,** or to create the deflector **5** from several segments **54** with at least one gap **55** between them (see, e.g., Fig. 4), which allows penetration of the heating medium into the cavity of the deflector **5** and thanks to this, the whole inner space of the heat exchanger **1** is filled with the heating medium and is heated faster and more evenly.

[0028] Furthermore, on the surface of the deflector **5** oriented opposite the supplied heating medium, it is possible to arrange at least one directing element, such as lamellas **7**, etc., (Figs. 4 and 5) which direct the movement of the heating medium into the free space of the heat exchanger **1** or influence its movement in another desired manner. In addition, the lamellas **7** can be used for mounting the deflector **5** in the inner space of the shell heat exchanger **1**.

[0029] Analogically to the above described, it is possible to make a heat exchanger **1** in another shape embodiment when, for example, its heads do not necessarily have to be rounded but can be plane and/or its central part need not be necessarily cylindrical.

[0030] The advantageous cylindricity of the deflector **5** or its upper part **52** is in all embodiments 25 to 50°, most preferably 40 to 50°. The advantageous conicalness of the lower part **53** of the deflector **5** (in the deflector represented in Fig. 3d) is 55 to 75°, the most advantageously 65 to 75°. For the reduction of pressure losses it is also advantageous if the transition between the upper part **52** of the deflector **5** and the lower part **53** of the deflector **5** is formed by rounding.

List of **references**

[0031]

1 shell heat exchanger
2 shell of the heat exchanger
21 central part of the shell of the heat exchanger
22 head of the shell of the heat exchanger
31 inlet aperture for the heated medium
32 outlet aperture for the heated medium
33 conduit of the heated medium
34 pipe of the conduit of the heated medium
41 inlet aperture for the heating medium
42 outlet aperture for the heating medium
5 deflector
51 apex of the deflector
52 upper part of the deflector
53 lower part of the deflector
54 segment of the deflector
55 gap between the segments of the deflector
56 directing channel
6 auxiliary deflector
61 apex of the auxiliary deflector
7 lamella

Claims

1. A liquid-to-gas shell heat exchanger (1) containing an elongated shell (2), the central part (21) of which is on both sides closed by heads (22), whereby in this shell (2) an inlet aperture (31) and an outlet aperture (32) for a heated medium are made, being mutually interconnected by a conduit (33) of the heated medium arranged in the inner space of the heat exchanger (1), whereby in this shell (2) an inlet aperture (41) and an outlet aperture (42) for the heating medium are made, **characterized by that** the inlet aperture (41) for the heating medium is created in the head (22) of the shell (2) of the shell heat exchanger (1).

2. The shell heat exchanger (1) according to Claim 1, **characterized by that** in the inner space of the heat exchanger (1) a deflector (5) for the heating medium is arranged opposite the inlet aperture (41).

3. The shell heat exchanger (1) according to Claim 2, **characterized by that** the deflector (5) is axially symmetrical.

4. The shell heat exchanger (1) according to Claims 2 or 3 **characterized by that** the deflector (5) has a shape of a cone or of a jacket of a cone.

5. The shell heat exchanger (1) according to Claim 4, **characterized by that** the deflector (5) has a spherically rounded apex (51).

6. The shell heat exchanger (1) according to any of Claims 2 to 5, **characterized by that** the deflector (5) is arranged coaxially with the inlet aperture (41) for the heating medium.

7. The shell heat exchanger (1) according to any of Claims 2 to 6, **characterized by that** the outer surface of the deflector (5) is cranked and/or rounded.

8. The shell heat exchanger (1) according to any of Claims 2 to 7, **characterized by that** at least one through-hole is made in the deflector (5) or the deflector (5) is made up of at least two segments (54) separated by a gap.

9. The shell heat exchanger (1) according to any of Claims 2 to 8, **characterized by that** on the outer surface of the deflector (5) at least one directing element for directing the movement of the heating medium is arranged.

10. The shell heat exchanger (1) according to any of Claims 2 to 9, **characterized by that** an auxiliary deflector (6) is arranged between the deflector (5) and an inlet aperture (41) for the heating medium.

11. The shell heat exchanger (1) according to Claim 10, **characterized by that** the auxiliary deflector (6) has a shape of a cone or of a jacket of a cone.

12. The shell heat exchanger (1) according to any of Claims 2 to 9, **characterized by that** outside the deflector (5) is mounted an auxiliary deflector (6), which has a shape of a truncated cone without bases.

13. The shell heat exchanger (1) according to Claim 12, **characterized by that** the auxiliary deflector (6) overlaps at least a part of the outer surface of the deflector (5) and between the outer surface of the deflector (5) and the inner surface of the auxiliary deflector (6) a directing channel (56) is created.

14. The shell heat exchanger (1) according to any of Claims 1, 2, 6 or 10, **characterized by that** the inlet aperture (41) for the heating medium is on the outer surface of the shell (2) of the heat exchanger (1) equipped with a socket (410) with a flange (411).

15. The shell heat exchanger (1) according to Claim 14, **characterized by that** the socket (410) widens in the direction towards the inner space of the heat exchanger (1)

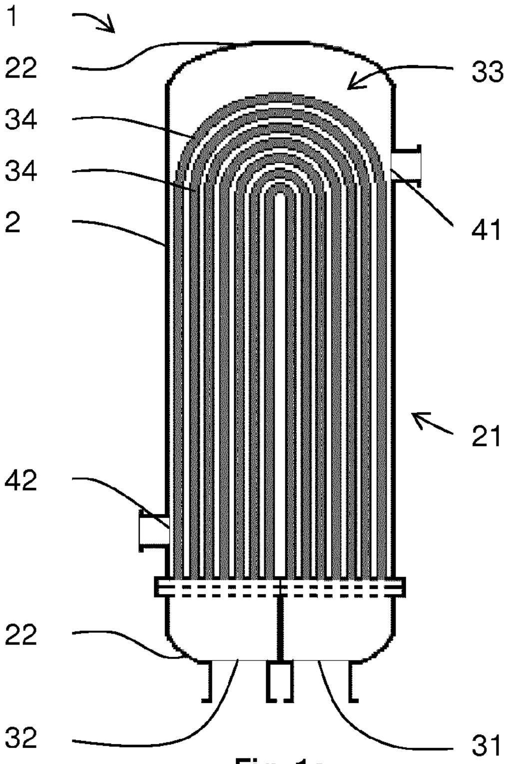

Fig. 1a

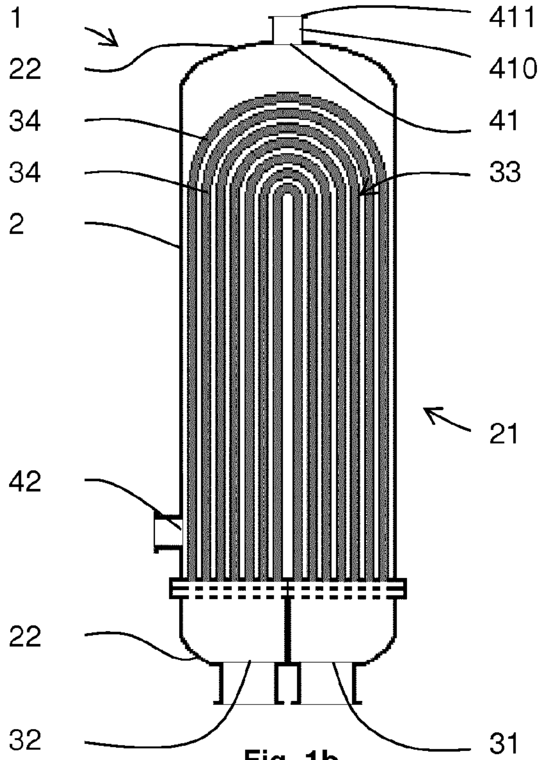

Fig. 1b

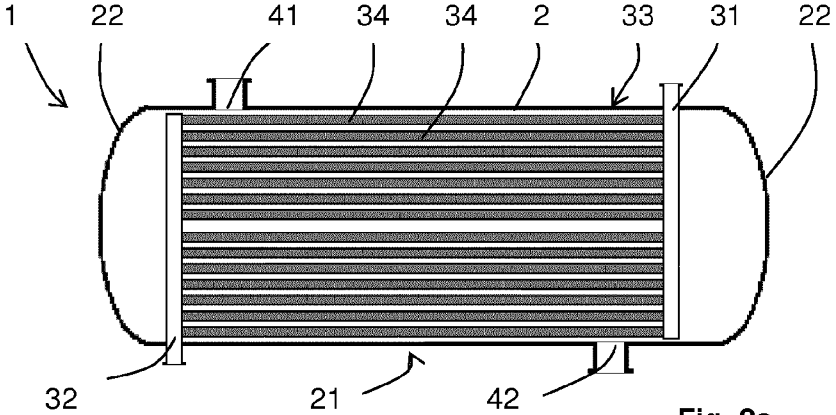

Fig. 2a

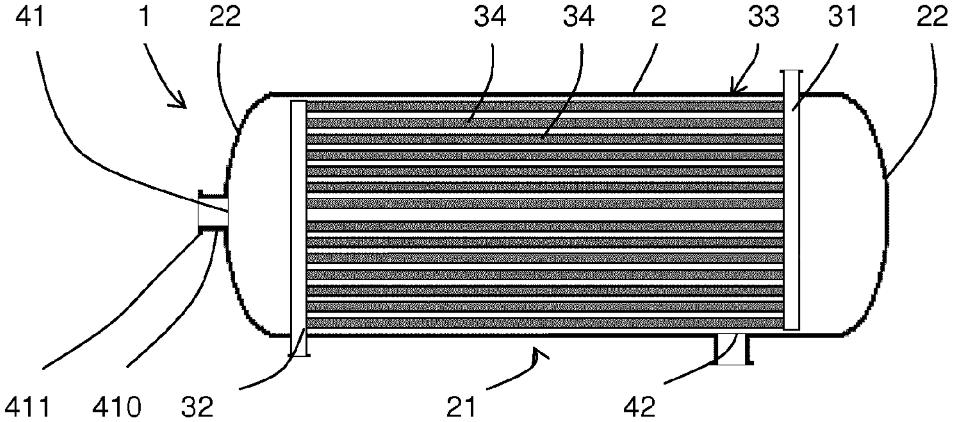

Fig. 2b

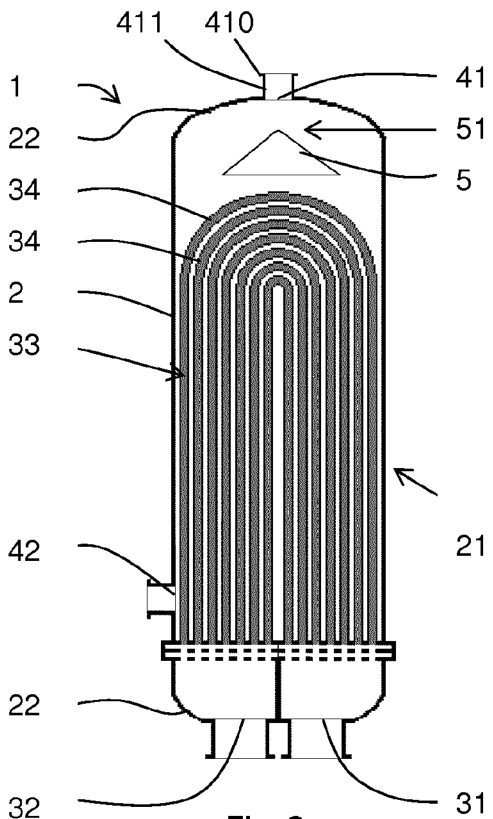

Fig. 3a

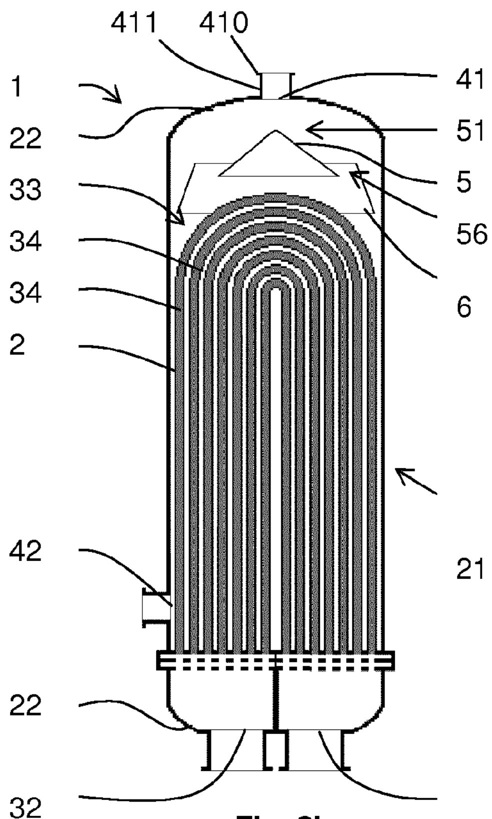

Fig. 3b

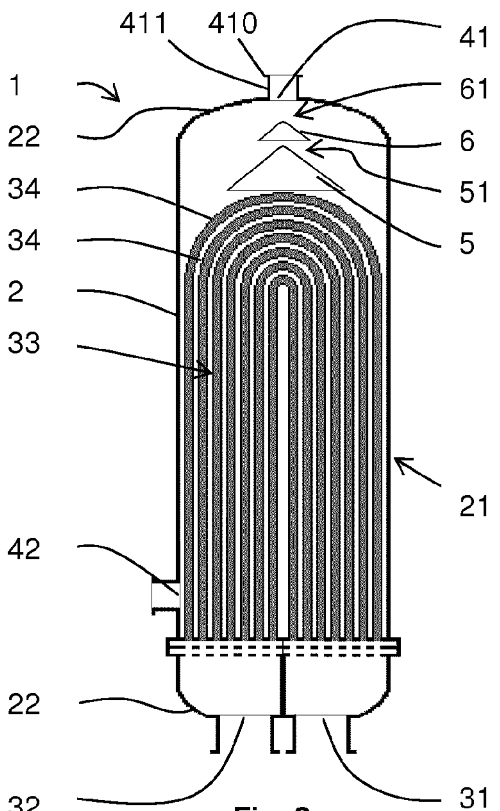

Fig. 3c

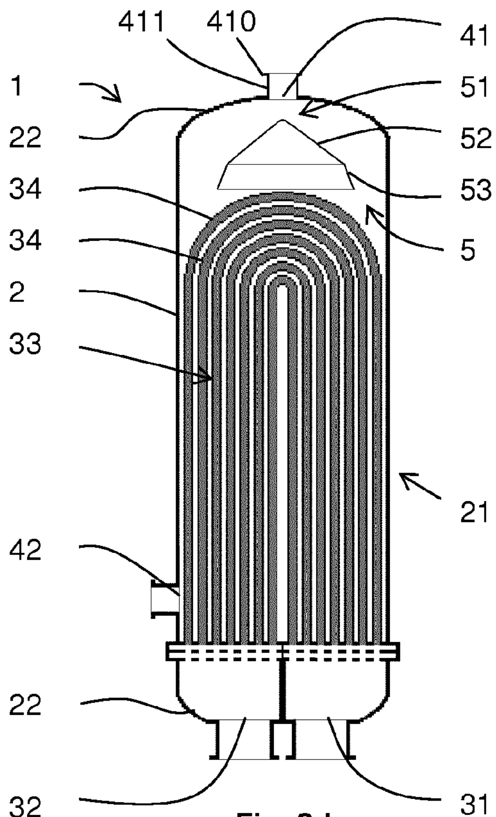

Fig. 3d

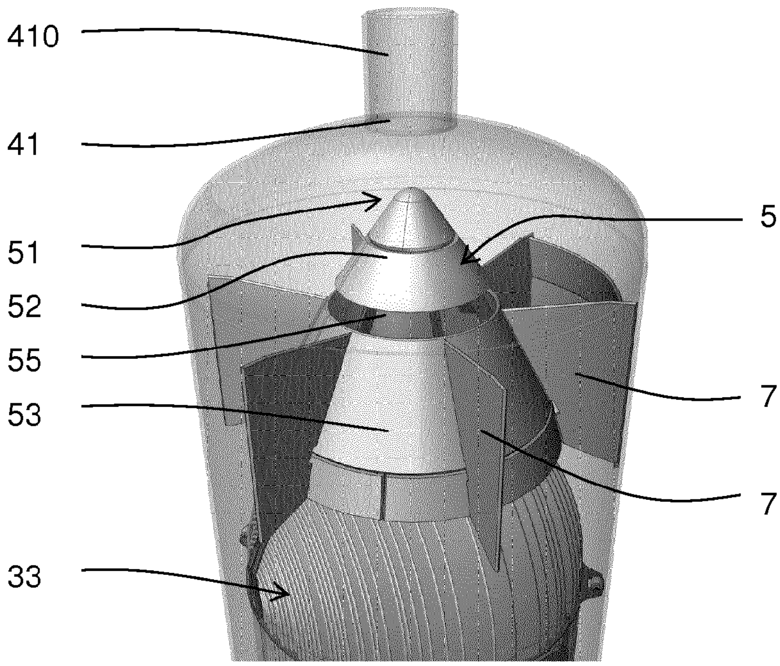

Fig. 4

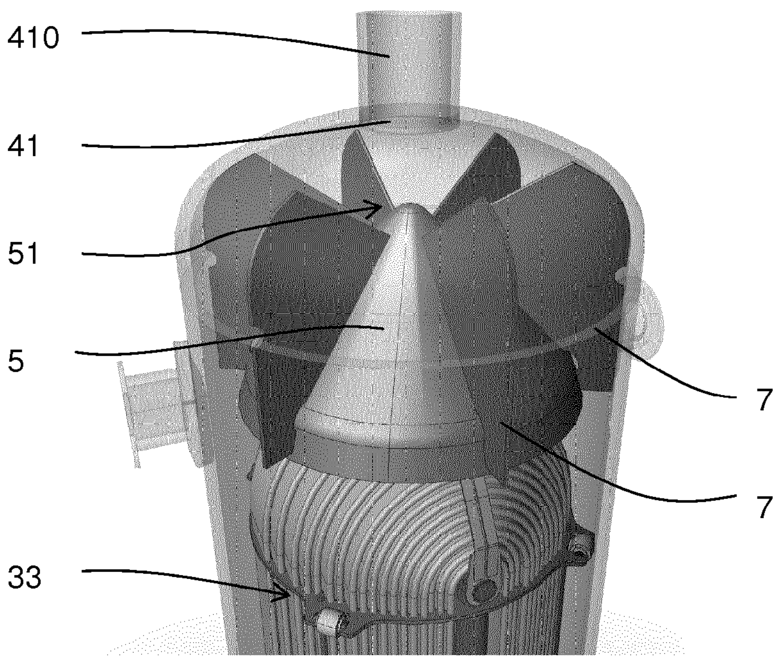

Fig. 5

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EUROPEAN SEARCH REPORT

Application Number
EP 16 18 5637

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A	US 3 180 405 A (NELSON HINDE JAMES) 27 April 1965 (1965-04-27) * figure 1 *	2-14	

TECHNICAL FIELDS SEARCHED (IPC)

F28D
F28F

The present search report has been drawn up for all claims

2

Place of search	Date of completion of the search	Examiner
Munich	15 November 2016	Bloch, Gregor

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 16 18 5637

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