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(54) **HEAT EXCHANGER ASSEMBLY**

WÄRMETAUSCHERBAUGRUPPE

ENSEMBLE ÉCHANGEUR DE CHALEUR

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EP 4 113 045 B1

Description

[0001] This invention relates to a heat exchanger assembly to be immersed in a fluid comprising an arrangement of shells wherein the shells are in fluid communication with each other and closed at both ends, forming a heat exchange chamber, while between the shells there are spaces open at both ends through which the fluid in which the exchanger is immersed flows freely, and the assembly is fitted with supply means that feed another fluid into the shells, and with drain means that drain said fluid from the shells. WO 2012/125586 A1, for instance, discloses a heat exchanger assembly with the features of the preamble of claim 1.

[0002] Various types of shell and shell-and-tube heat exchangers are disclosed in the state of the art. Shell heat exchangers wherein shells are in fluid communication with each other and closed at both ends, with spaces being provided between said shells. The first fluid flows through the shells forming a heat exchange chamber, while the second fluid flows in the spaces between the shells. Through this arrangement, one fluid transfers heat to another fluid. The disadvantage of this heat exchange system is that the fluid on both sides of the metal sheet formed by shells creates a boundary layer. This layer prevents efficient heat exchange. Accordingly, such exchangers are often put into motion, e.g. made to rotate around their axis or made to vibrate, to facilitate the flow of fluids and the transfer of heat, and to prevent the build-up of deposits on the walls of the exchanger. The movement of the exchanger causes the boundary layer to "become detached", resulting in the exchanger being cleaned.

[0003] GB656647A discloses a rotary exchanger mounted on a shaft. The exchanger is set into rotary motion to facilitate the flow of fluids through the exchanger and the transfer of heat. A cylindrical core closed at both ends, on which a spiral duct separating the two exchange chambers is mounted, runs through the exchanger casing, with both chambers being located on the outer side of the core. Both ends of the rotating shaft are hollow and designed to supply the fluid to the exchanger and drain the fluid into one of the ducts, while the other fluid is fed into and discharged through stub pipes in the casing.

[0004] JPS54114851A discloses a rotary exchanger mounted on a shaft. The shaft is hollow and designed to supply the medium to certain chambers of the exchanger.

[0005] GB1239320A discloses a shell exchanger with a hollow rotating shaft extending therethrough, the shaft being the only rotating element. A spiral element is fastened to the shaft to move the material within the chamber adjacent to the shaft, with scratch-off elements for cleaning the outer wall of the crystallising material being fastened to said shaft. The hollow shaft allows users to regulate the contact pressure of the scratch-off elements by applying a required level of pressure.

[0006] US3621506A discloses a similar device, also provided with a hollow rotating shaft to which scratch-off elements are attached.

[0007] US3835922A discloses a device wherein a cylindrical rotor is mounted around the rotating shaft (the hollow cylindrical chamber with flattened areas). Scratch-off elements are fastened to the rotor, as in the previous two patent disclosures. The rotor is designed to have a large diameter so that higher speeds of the scratch-off elements can be achieved.

[0008] The object of the present invention is to increase the efficiency of existing devices by:

- facilitating the flow of fluid to improve the heat exchange and how the exchanger surface is cleaned.
- reducing loads on the bearings in shaft-based devices to increase their durability,
- stiffening the construction design to make it more efficient and durable.

[0009] The present invention relates to a heat exchanger assembly to be immersed in a fluid. The heat exchanger comprises an arrangement of shells wherein the shells are in fluid communication with each other and closed at both ends, forming a heat exchange chamber. Between the shells, there are spaces open at both ends through which the fluid in which the exchanger is immersed flows freely. The assembly is fitted with supply means that feed another fluid into the shells, and with drain means that drain said fluid from the shells (3). According to the invention, the heat exchanger assembly comprises:

- a central shaft rotatably supported at both ends,
- a cylindrical chamber arranged around the shaft, said cylindrical chamber being permanently and hermetically fixed around the shaft and rotating with the shaft, and filled with air, and
- a driving unit for moving the exchanger assembly,

wherein the shells are arranged and permanently fixed around the cylindrical chamber and rotating with the shaft and the with the cylindrical chamber, while the shaft, the cylindrical chamber and the shells are arranged concentrically.

[0010] Preferably, the exchanger assembly comprises one, two or three shells.

[0011] Also preferably, the shells are fluidly coupled in pairs, each pair forming a heat exchange chamber.

[0012] Also preferably, the shells are connected via perforated partition walls.

[0013] It is also preferable if the shells are closed at both ends using ring-shaped lids.

[0014] Preferably, the cylindrical chamber has manifolds at its ends, which are connected to the arrangement of shells via radially arranged supply pipes. There are six

supply pipes in the preferred embodiment.

[0015] Preferably, the arrangement of shells is arranged around the cylindrical chamber by means of radial connectors. There are preferably four such connectors.

[0016] Also preferably, the supply means comprise a stub supply pipe, a main supply pipe and distribution pipes.

[0017] Also preferably, the drain means comprise collecting pipes, a main drain pipe and a stub drain pipe.

[0018] Also preferably, the driving unit constitutes an electric motor that swings the shaft forward and backward. The swinging movement is preferably within a range of ±15° over a time period of approx. 1s.

[0019] The driving unit equally preferably constitutes a vibration motor. The vibration motor is preferably adapted to move the exchanger relative to axis of the shaft with a frequency of approx. 17 Hz and an amplitude of approx. 2 mm. Preferably, the exchanger assembly is provided with a frame with a mounting plate on which a vibration motor is mounted.

[0020] The subject of the invention is shown in the embodiments of the invention in the drawing in which Fig. 1 shows a perspective view of one embodiment of the present invention wherein the exchanger assembly is placed in the tub, Fig. 2 shows a perspective view of the tub with the assembly according to the same embodiment in the longitudinal section, Fig. 3 shows a perspective view of the exchanger assembly in the same embodiment, Fig. 4 shows a cross-sectional view of the exchanger assembly in the same embodiment, Fig. 5 shows a longitudinal section of the exchanger assembly in the same embodiment, Fig. 6 shows a perspective view of another embodiment of the invention wherein the exchanger assembly is placed in the tub, Fig. 7 shows a perspective view of the tub together with the exchanger assembly according to the same embodiment in the longitudinal section, Fig. 8 shows a schematic axial view of the movement of the exchanger in the same embodiment, Fig. 9 shows a perspective view of the exchanger assembly in the same embodiment, Fig. 10 shows a cross-sectional view of the exchanger in the same embodiment.

[0021] The drawings show embodiments of the present invention wherein it is common to all the embodiments that the invention is a heat exchanger assembly which is immersed in a fluid. The heat exchanger assembly comprises an arrangement of shells 3 wherein the shells 3 are in fluid communication with each other and closed at both ends, forming a heat exchange chamber. Between the shells, there are spaces 3a open at both ends through which the fluid in which the exchanger is immersed flows freely. The above features are best seen in Figs. 2, 4, 7, 10. Fig. 1 further shows that the exchanger is placed in the tub (W), i.e. immersed in a fluid such as wastewater.

[0022] As shown in Figs. 3, 9 (and partially in other figures), the assembly is fitted with supply means 6,7,10a that feed another fluid into the shells 3, and with drain means 8,9,10 that drain said fluid from the shells 3.

[0023] The invention is characterised in that it comprises

- a central shaft 11 rotatably supported at both ends (as shown in Figs. 2, 3, 5, 7, 9, 11),
- a cylindrical chamber 1 arranged around the shaft 11 (as shown in Figs. 2, 4, 5, 7, 11), said cylindrical chamber 1 being permanently and hermetically fixed around the shaft 11 and rotating with the shaft 11, filled with air, and
- a driving unit 100 for moving the exchanger assembly, best seen in Figs. 1, 2, 6, 7, 8).

[0024] The shells 3 are arranged and permanently fixed around the cylindrical chamber 1 and rotating with the shaft 11 and the cylindrical chamber 1, while the shaft 11, the cylindrical chamber 1 and the shells 3 are arranged concentrically.

[0025] The exchanger assembly may comprise one or more shells 3, the most preferred number of shells 3 being one, two or three. Figs. 1-5 show an embodiment with three shells 3 (one of the preferred embodiments of the exchanger assembly wherein a motor is provided that swings the shaft forward and backward), while Figs. 6-10 show an embodiment with only one shell 3 (the preferred embodiment of the exchanger assembly wherein a vibration motor is provided). In the preferred embodiment, shells 3 are separated using perforated partition walls 4, as shown in the embodiment of, among others, Fig. 2, and - equally preferably - are closed at both ends using ring-shaped lids 5 (Fig. 3).

[0026] In one embodiment, the cylindrical chamber 1 has manifolds 2a at its ends, which are connected to the arrangement of shells 3 via radially arranged supply pipes 7, preferably there are six supply pipes 7 (Fig. 3).

[0027] In one embodiment, the arrangement of shells 3 is mounted around the cylindrical chamber 1 by means of radial connectors 3,4, preferably four (Figs. 3,4).

[0028] According to the embodiment of the present invention shown in Fig. 7, the supply means 6,7,10a comprise a stub supply pipe 10a, a main supply pipe 6 and distribution pipes 7.

[0029] According to an embodiment of the present invention, e.g. the one shown in Fig. 2, the drain means (8,9,10) comprise collecting pipes 8, a main drain pipe 9 and a stub drain pipe 10.

[0030] In the embodiment shown in Figs. 1-5, the driving unit 100 constitutes an electric motor that swings the shaft 11 forward and backward. Preferably, the electric motor 100 is adapted to swing the shaft 11 forward and backward within a range of ±15° over a time period of approx. 1s.

[0031] In the embodiment shown in Figs. 6-10, the driving unit 100 constitutes a vibration motor. Preferably, the vibration motor 100 is adapted to move the exchanger

relative to axis of the shaft 11 with a frequency of approx. 17 Hz and an amplitude of approx. 2 mm (Δu); the arrow in Fig. 10 indicates the direction of the vibrations. In the embodiment shown, the exchanger assembly is preferably provided with a frame 101 with a mounting plate 102 on which a vibration motor 100 is mounted.

[0032] The exchanger assembly, e.g. intended for use in laundry activities, can be installed in the chamber (tub) W, which is also a supporting structure for the heat exchanger and the drive system with motor 100, and a tank for a fluid therein, e.g. wastewater, from which heat is received. The frame structure of the tub can be formed by a frame welded from steel profiles, while tank Z (shown in Fig. 1), which forms an initial buffer for the flow from wastewater and receives the filtered water from the laundry, can be installed in the upper part of the frame. The water is fed into the tub through tubing by gravity (not shown). The system can be provided with means for preventing overflow. The motor 100, in an embodiment of the present invention wherein said motor makes the shaft swing forward and backward, can be mounted on the shorter side wall of tub W, as shown in Figs. 1-2. In an embodiment of the invention wherein vibration motor 100 is provided, said motor can be mounted above the exchanger assembly, e.g. using frame 101 with mounting plate 102, as clearly seen in Figs. 6-8.

[0033] As already mentioned, once the exchanger is set in motion, a boundary layer "becomes detached", which prevents efficient heat transfer. The exchanger is cleaned when it moves. In the present invention, a cylindrical air-filled chamber mounted on the shaft and moving therewith moves relative to the fluid in the exchanger so that the stream of fluid runs parallel to the axis of said chamber.

[0034] If the exchanger rotated, as it is disclosed in the prior art, a driving force similar to that of the mixer would arise from the friction between the walls of the exchanger and the fluid (e.g. wastewater) and the fluid would circulate as a result of the exchanger chamber rotating. The disadvantage of this is that the driving force behind the heat exchange is the difference in relative speed (affecting the alpha coefficient, which is essential to heat exchange). Horizontal movement of the wastewater results from the fact that the reservoir (e.g. a tub) housing the exchanger is fitted with an inlet at one side and an outlet at the other side. Since all elements are arranged horizontally, the fluid also flows horizontally. The container is additionally fitted with a perforated partition to direct and redirect the wastewater in particular directions. The flow of the fluid is determined by the geometry of the heat exchanger. Since the element operates under pressure, in the present invention, the chamber arranged around the shaft "takes away" a significant part of the load, which is essential to energy (heat) recovery. The casing is typically made of stainless steel, which performs poorly in heat exchangers due to its low lambda value - the rate at which heat passes through a material. This can be improved by increasing the heat exchange surface by making the metal sheet thicker (water pressure hazard). The disadvantage of such a solution is an increase in weight. Therefore, the central chamber arranged around the shaft is essential to the present invention.

[0035] The chamber also cleans itself as a result of the movement due to the inertial force of the fluid. Another function of the chamber is that supporting points (bearings) of the exchanger as a whole are less loaded due to the buoyancy of said chamber. Given that the heat exchange surface is often very large, the pressure load can be around 1000T. The construction design must be strong, which requires the use of a fairly thick sheet of considerable weight. Under certain conditions, the central chamber on the shaft can take up to 300 kg away from the shaft, resulting in the construction design being less loaded.

[0036] The invention is not limited to the embodiments described. A person skilled in the art could make modifications to the invention as long as these modifications are within the scope defined by the claims.

Claims

1. A heat exchanger assembly to be immersed in a fluid comprising a shell (3) arrangement having at least one shell (3) that is closed at both ends and forms a heat exchange chamber and a number of spaces (3a) respective to the number of shells (3), placed adjacent and radially inside of each shell (3), through which the fluid in which the exchanger is immersed flows freely, and the assembly is fitted with supply means (6,7,10a) that feed another fluid into the shell (3), and with drain means (8,9,10) that drain said fluid from the shell (3), comprising:

    - a central shaft (11) rotatably supported at both ends,
    - a cylindrical chamber (1) arranged around the shaft (11), said cylindrical chamber (1) being permanently and hermetically fixed around the shaft (11) and rotating with the shaft (11), and filled with air, and
    - a driving unit (100) for moving the exchanger assembly,

    characterised in that the spaces (3a) respective to the number of shells (3) are open at both ends and **in that** the shell (3) arrangement surrounds and is permanently fixed around the cylindrical chamber (1) and rotating with the shaft (11) and with the cylindrical chamber (1), while the shaft (11), the cylindrical chamber (1) and the shell (3) are arranged concentrically.

2. The exchanger assembly according to claim 1 **characterised in that** it comprises one shell (3).

3. The exchanger assembly according to claim 1 **characterised in that** it comprises at least two shells (3), the shells (3) being in fluid communication with each other and together forming a heat exchange chamber.

4. The exchanger assembly according to claim 3 **characterised in that** it comprises three shells.

5. The exchanger assembly according to claim 1 **characterised in that** it comprises an even number of shells (3) that are fluidly coupled in pairs, each pair forming a heat exchange chamber.

6. The exchanger assembly according to one of claims 3-5 **characterised in that** the shells (3) are connected via perforated partition walls (4).

7. The exchanger assembly according to claim 1 **characterised in that** the shells (3) are closed at both ends with ring-shaped lids (5).

8. The exchanger assembly according to claim 1 **characterised in that** the cylindrical chamber (1) has manifolds (2a) at its ends, which are connected to the shell (3) arrangement via radially arranged supply pipes (7).

9. The exchanger assembly according to claim 8 **characterised in that** there are six supply pipes (7).

10. The exchanger assembly according to claim 1 **characterised in that** the shell (3) arrangement is mounted around the cylindrical chamber (1) by means of radial connectors (2).

11. The exchanger assembly according to claim 10 **characterised in that** there are four radial connectors (2).

12. The exchanger assembly according to claim 1 **characterised in that** supply means (6,7,10a) comprise a stub supply pipe (10a), a main supply pipe (6) and distribution pipes (7).

13. The exchanger assembly according to claim 1 **characterised in that** drain means (8,9,10) comprise collecting pipes (8), a main drain pipe (9) and a stub drain pipe (10).

14. The exchanger assembly according to claim 1 **characterised in that** the driving unit (100) constitutes an electric motor that swings the shaft (11) forward and backward.

15. The exchanger assembly according to claim 14 **characterised in that** the electric motor (100) is adapted to swing the shaft (11) forward and backward within a range of ±15° over a time period of approx. 1s.

16. The exchanger assembly according to claim 1 **characterised in that** the driving unit (100) constitutes a vibration motor.

17. The exchanger assembly according to claim 16 **characterised in that** the vibration motor (100) is adapted to move the exchanger relative to axis of the shaft (11) with a frequency of approx. 17 Hz and an amplitude of approx. 2 mm.

18. The exchanger assembly according to claim 16 **characterised in that** it is provided with a frame (101) with a mounting plate (102) on which a vibration motor (100) is mounted.

Patentansprüche

1. Eine Wärmetauscher-Anordnung zum Eintauchen in Flüssigkeit mit einem Mantelsystem (3) mit mindestens einem Mantel (3), das an seinen beiden Enden geschlossen ist und eine Wärmeaustauschkammer und eine Anzahl von Räumen (3a), abhängig von der Anzahl der Mäntel (3) bildet, die anliegend und radial innerhalb des jeden Mantels (3) angeordnet sind, durch die die Flüssigkeit, in der der Tauscher eingetaucht ist, frei fließen kann, wobei das System mit Zulaufmitteln (6, 7, 10a), die eine weitere Flüssigkeit in den Mantel (3) einspeisen, und mit Ablaufmitteln (8, 9, 10), die die Flüssigkeit aus dem Mantel (3) abführen, ausgestattet ist, umfassend:

   - eine zentrale Welle (11), die an ihren beiden Enden drehbar gelagert ist,
   - eine zylindrische Kammer (1), die um die Welle (11) herum angeordnet ist, wobei die zylindrische Kammer (1), dauerhaft und hermetisch um die Welle (11) herum befestigt ist und sich mit der Welle (11) dreht, und mit Luft gefüllt ist und
   - eine Antriebseinheit (100) zum Bewegen der Wärmetauscher-Anordnung,

   dadurch gekennzeichnet, dass die Räume (3a) entsprechend der Anzahl der Mäntel (3) an den beiden Enden geöffnet sind und dass das Mantelsystem (3) die zylindrische Kammer (1) umgibt und dauerhaft daran befestigt ist und sich zusammen mit der Welle (11) und der zylindrischen Kammer (1) dreht, während die Welle (11), die zylindrische Kammer (1) und der Mantel (3) konzentrisch angeordnet sind.

2. Die Wärmetauscher-Anordnung nach Anspruch 1, **dadurch gekennzeichnet, dass** sie einen Mantel (3) umfasst.

3. Die Wärmetauscher-Anordnung nach Anspruch 1, **dadurch gekennzeichnet, dass** sie mindestens zwei Mäntel (3) umfasst und die Mäntel (3) miteinander in Fluidkommunikation sind und zusammen eine Wärmeaustauschkammer bilden.

4. Die Wärmetauscher-Anordnung nach Anspruch 3, **dadurch gekennzeichnet, dass** sie drei Mäntel umfasst.

5. Die Wärmetauscher-Anordnung nach Anspruch 1, **dadurch gekennzeichnet, dass** sie eine gerade Anzahl von Mänteln (3) umfasst, die miteinander paarweise in Fluidverbindung sind, wobei jedes Paar eine Wärmeaustauschkammer bildet.

6. Die Wärmetauscher-Anordnung nach einem der Ansprüche 3 - 5, **dadurch gekennzeichnet, dass** die Mäntel (3) über perforierte Trennwände (4) miteinander verbunden sind.

7. Die Wärmetauscher-Anordnung nach Anspruch 1, **dadurch gekennzeichnet, dass** die Mäntel (3) an ihren beiden Enden mit ringförmigen Deckeln (5) verschlossen sind.

8. Die Wärmetauscher-Anordnung nach Anspruch 1, **dadurch gekennzeichnet, dass** die zylindrische Kammer (1) an ihren Enden Kollektoren (2a) aufweist, die über radial angeordnete Zulaufrohre (7) an das Mantelsystem (3) angeschlossen sind.

9. Die Wärmetauscher-Anordnung nach Anspruch 8, **dadurch gekennzeichnet, dass** sie sechs Zulaufrohre (7) umfasst.

10. Die Wärmetauscher-Anordnung nach Anspruch 1, **dadurch gekennzeichnet, dass** das Mantelsystem (3) mithilfe radialer Verbinder (2) um die zylindrische Kammer (1) herum montiert ist.

11. Die Wärmetauscher-Anordnung nach Anspruch 10, **gekennzeichnet durch** vier radiale Verbinder (2).

12. Die Wärmetauscher-Anordnung nach Anspruch 1, **dadurch gekennzeichnet, dass** die Zulaufmittel (6, 7, 10a) einen Zulaufstutzen (10a), ein Zulauf-Hauptrohr (6) und Verteilrohre (7) umfassen.

13. Die Wärmetauscher-Anordnung nach Anspruch 1, **dadurch gekennzeichnet, dass** die Ablaufelemente (8, 9, 10) Sammelrohre (8), ein Ablauf-Hauptrohr (9) und einen Ablaufstutzen (10) umfassen.

14. Die Wärmetauscher-Anordnung nach Anspruch 1, **dadurch gekennzeichnet, dass** die Antriebseinheit (100) ein Elektromotor ist, der die Welle (11) vorwärts und rückwärts schwingt.

15. Die Wärmetauscher-Anordnung nach Anspruch 14, **dadurch gekennzeichnet, dass** der Elektromotor (100) so ausgelegt ist, dass er die Welle (11) vorwärts und rückwärts in einem Bereich von ±15° innerhalb der Zeit von ca. 1 s schwingen kann.

16. Die Wärmetauscher-Anordnung nach Anspruch 1, **dadurch gekennzeichnet, dass** die Antriebseinheit (100) ein Vibrationsmotor ist.

17. Die Wärmetauscher-Anordnung nach Anspruch 16, **dadurch gekennzeichnet, dass** der Vibrationsmotor (100) so ausgelegt ist, dass er den Tauscher relativ zur Achse der Welle (11) mit einer Frequenz von ca. 17 Hz und einer Amplitude von ca. 2 mm bewegen kann.

18. Die Wärmetauscher-Anordnung nach Anspruch 16, **dadurch gekennzeichnet, dass** sie mit einem Rahmen (101) mit einer Montageplatte (102) versehen ist, auf der der Vibrationsmotor (100) montiert ist.

Revendications

1. Ensemble échangeur de chaleur à immerger dans un fluide, comprenant un agencement de coques (3) ayant au moins une coque (3) fermée aux deux extrémités et formant une chambre d'échange thermique, et un nombre d'espaces (3a) respectif au nombre de coques (3), placées adjacement et radialement à l'intérieur de chaqune de coques (3), par laquelle circule librement le fluide dans lequel l'échangeur est immergé
et l'ensemble étant équipé de moyens d'alimentation (6,7,10a) qui introduisent un autre fluide dans la coque (3), et de moyens d'évacuation (8,9,10) qui évacuent ledit fluide de la coque (3), comprenant :

   - un arbre central (11) supporté de manière rotative aux deux extrémités,
   - une chambre cylindrique (1) disposée autour de l'arbre (11), ladite chambre cylindrique (1) étant fixée de façon permanente et hermétique autour de l'arbre (11) et tournant avec l'arbre (11), et remplie d'air, et
   - une unité d'entraînement (100) pour mouvoir l'ensemble échangeur,

   caractérisé en ce que les espaces (3a) correspondant au nombre de coques (3) sont ouverts aux deux extrémités **et en ce que** l'agencement de coques (3) entoure et est fixé en permanence autour de la chambre cylindrique (1) et tourne avec l'arbre (11) et avec la chambre cylindrique (1), tandis que l'arbre (11), la chambre cylindrique (1) et la coque (3) sont disposés de manière concentrique.

2. Ensemble échangeur selon la revendication 1 **caractérisé en ce qu'**il comprend une coque (3).

3. Eensemble échangeur selon la revendication 1 **caractérisé en ce qu'**il comprend au moins deux coques (3), les coques (3) étant en communication fluidique l'une avec l'autre et formant ensemble une chambre d'échange de chaleur.

4. Ensemble échangeur selon la revendication 3 **caractérisé en ce qu'il** comprend trois coques.

5. Ensemble échangeur selon la revendication 1 **caractérisé en ce qu'**il comprend un nombre pair de coques (3) qui sont couplées fluidiquement par paires, chaque paire formant une chambre d'échange de chaleur.

6. Ensemble échangeur selon l'une des revendications 3-5, **caractérisé en ce que** les coques (3) sont reliées par des cloisons perforées (4).

7. Ensemble échangeur selon la revendication 1 **caractérisé en ce que** les coques (3) sont fermées aux deux extrémités par des couvercles (5) en forme d'anneau.

8. Ensemble échangeur selon la revendication 1, **caractérisé en ce que** la chambre cylindrique (1) comporte des collecteurs (2a) à ses extrémités, qui sont reliés à la coque (3) par des tuyaux d'alimentation (7) disposés radialement.

9. Ensemble échangeur selon la revendication 8, **caractérisé en ce qu'**il y a six tuyaux d'alimentation (7).

10. Ensemble échangeur selon la revendication 1 **caractérisé en ce que** l'agencement de coques (3) est monté autour de la chambre cylindrique (1) au moyen de connecteurs radiaux (2).

11. Ensemble échangeur selon la revendication 10 **caractérisé en ce qu'**il y a quatre connecteurs radiaux (2).

12. Ensemble échangeur selon la revendication 1 **caractérisé en ce que** les moyens d'alimentation (6, 7, 10a) comprennent un tuyau d'alimentation secondaire (10a), un tuyau d'alimentation principal (6) et des tuyaux de distribution (7).

13. Ensemble échangeur selon la revendication 1 **caractérisé en ce que** les moyens d'évacuation (8, 9,1 0) comprennent des tuyaux collecteurs (8), un tuyau d'évacuation principal (9) et un tuyau d'évacuation secondaire (10).

14. Ensemble échangeur selon la revendication 1 **caractérisé en ce que** l'unité d'entraînement (100) constitue un moteur électrique qui fait pivoter l'arbre (11) vers l'avant et vers l'arrière.

15. Ensemble échangeur selon la revendication 14 **caractérisé en ce que** le moteur électrique (100) est adapté pour faire osciller l'arbre (11) vers l'avant et vers l'arrière dans une plage de $\pm 15°$ sur une période de temps d'environ 1s.

16. Ensemble échangeur selon la revendication 1 **caractérisé en ce que** l'unité d'entraînement (100) constitue un moteur vibrant.

17. Ensemble échangeur selon la revendication 16 **caractérisé en ce que** le moteur vibrant (100) est adapté pour mouvoir l'échangeur par rapport à l'axe de l'arbre (11) avec une fréquence d'environ 17 Hz et une amplitude d'environ 2 mm.

18. Ensemble échangeur selon la revendication 16 **caractérisé en ce qu'**il est pourvu d'un cadre (101) avec une plaque de montage (102) sur laquelle est monté un moteur vibrant (100).

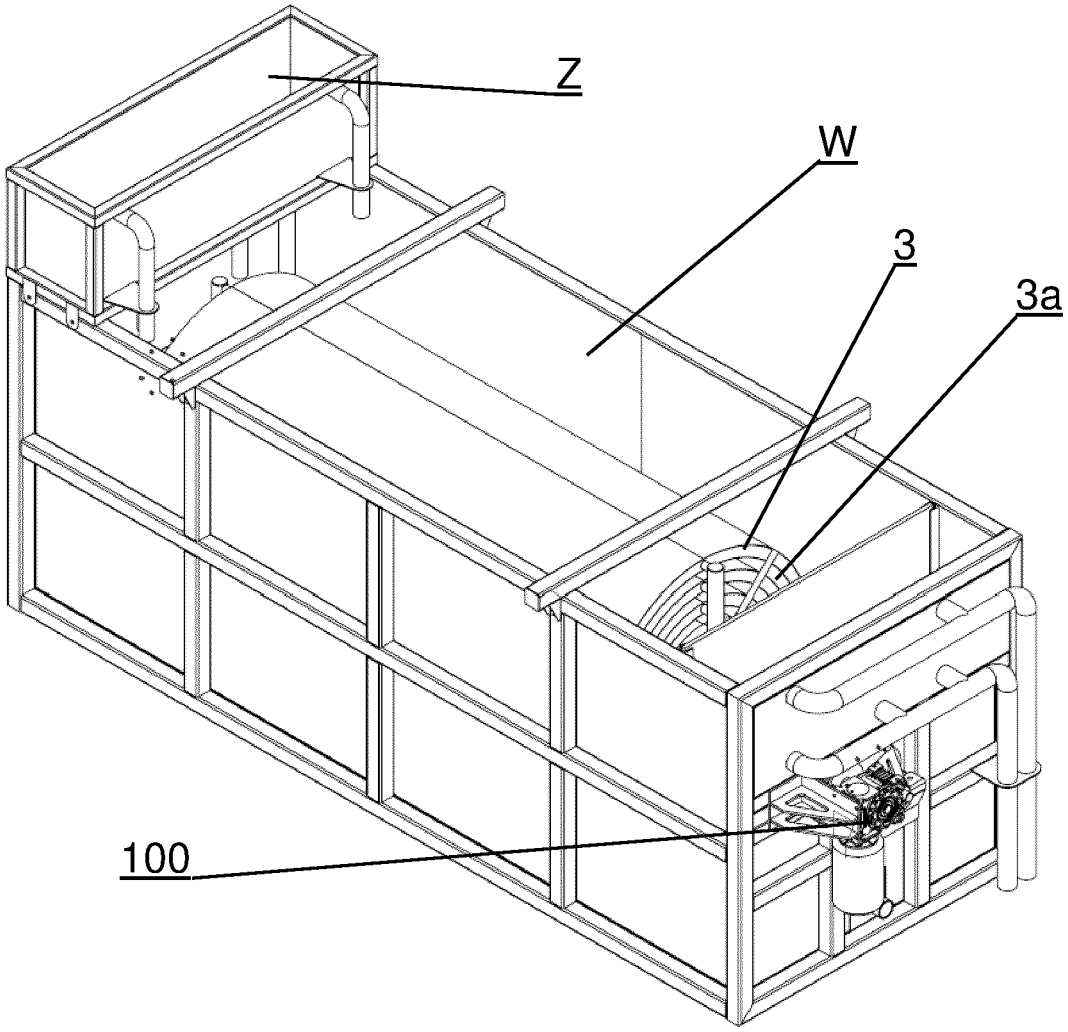

Fig. 1

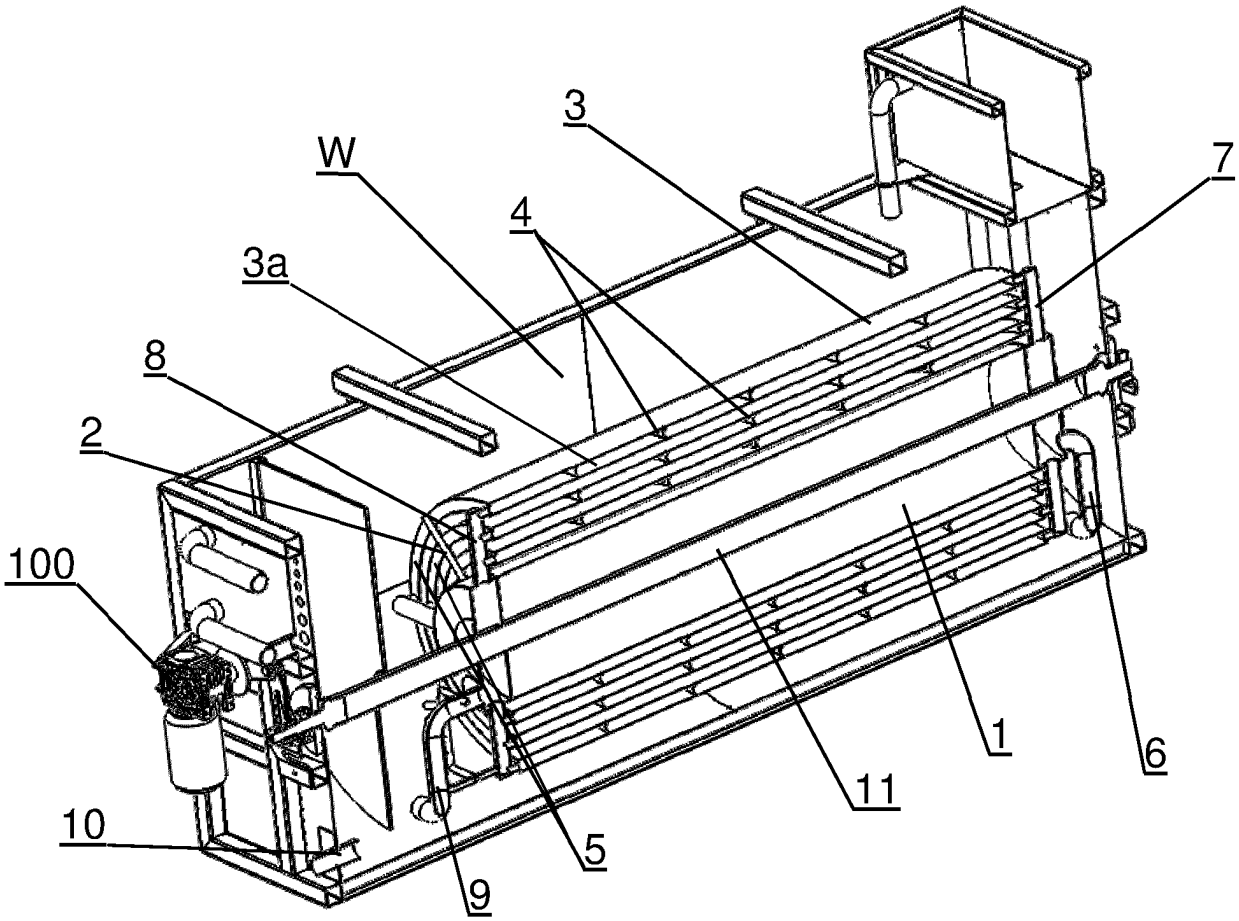

Fig. 2

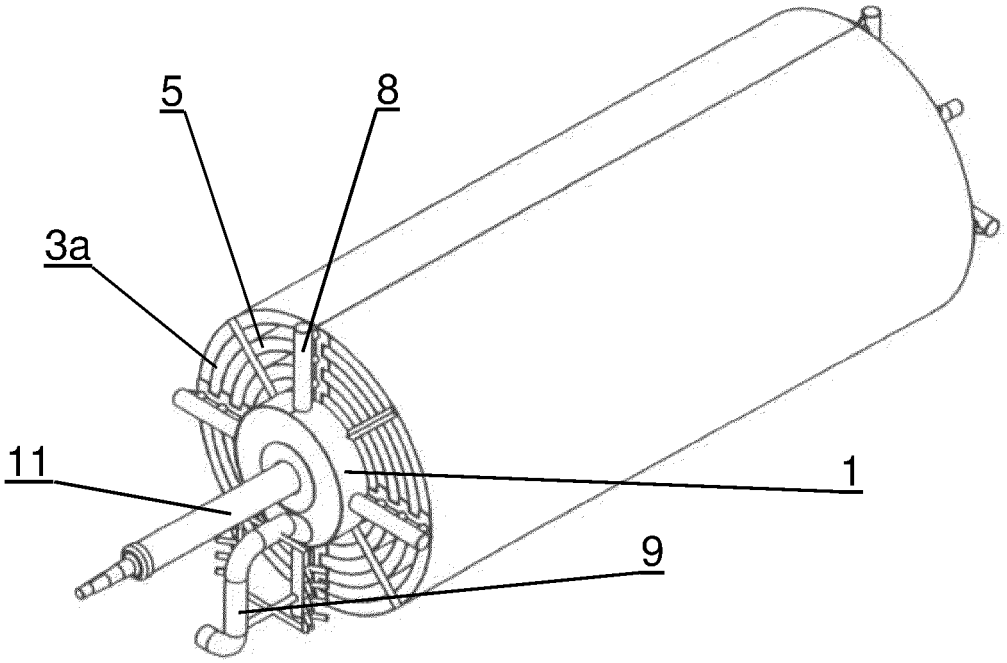

Fig. 3

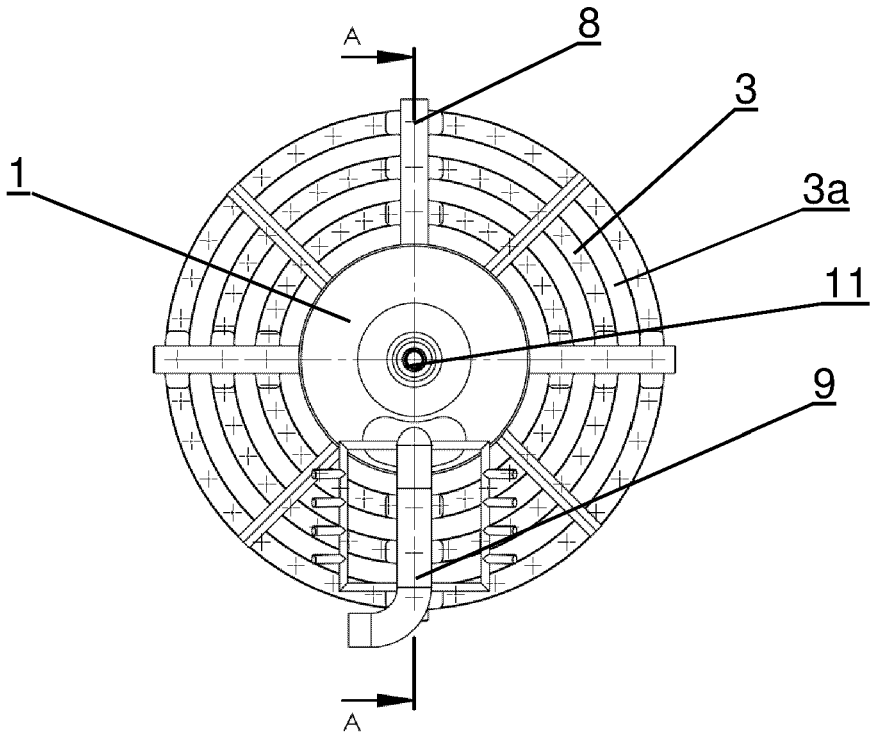

Fig. 4

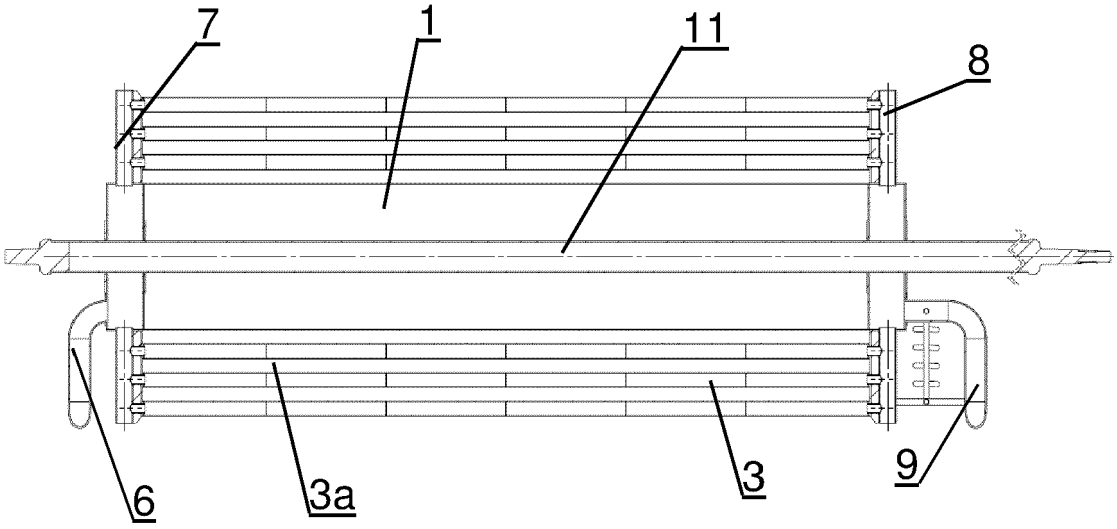

Fig. 5

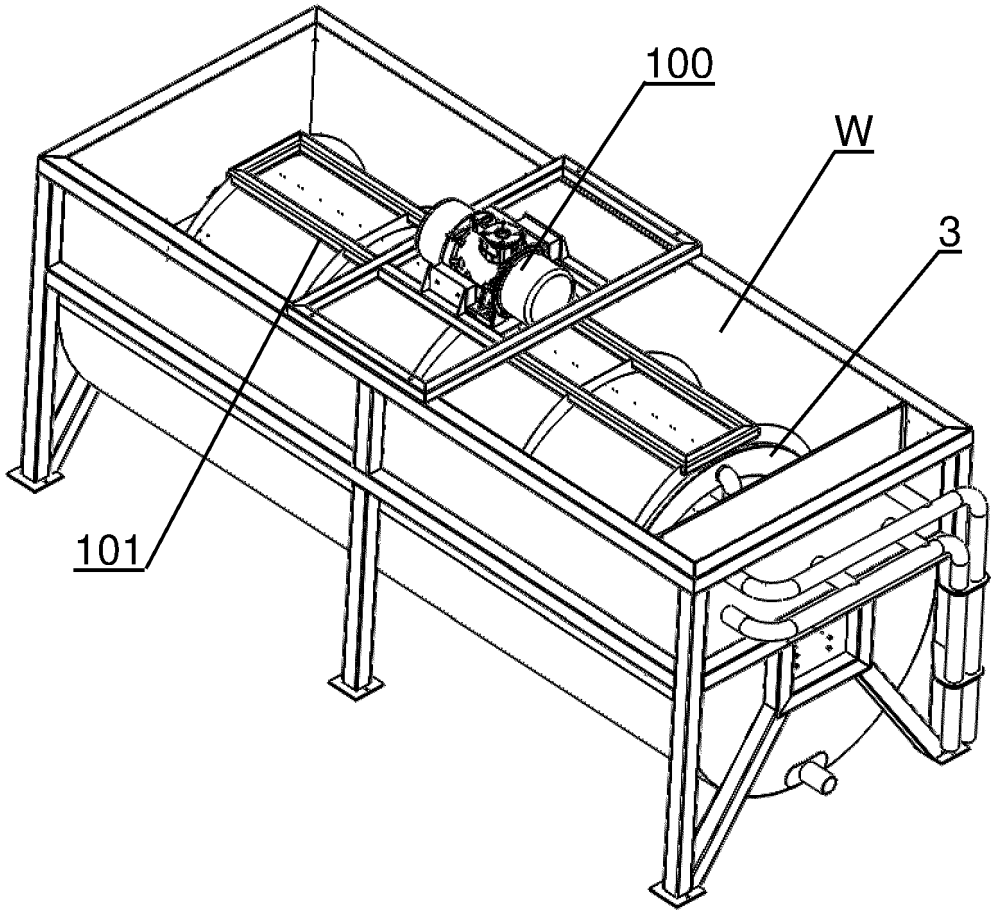

Fig. 6

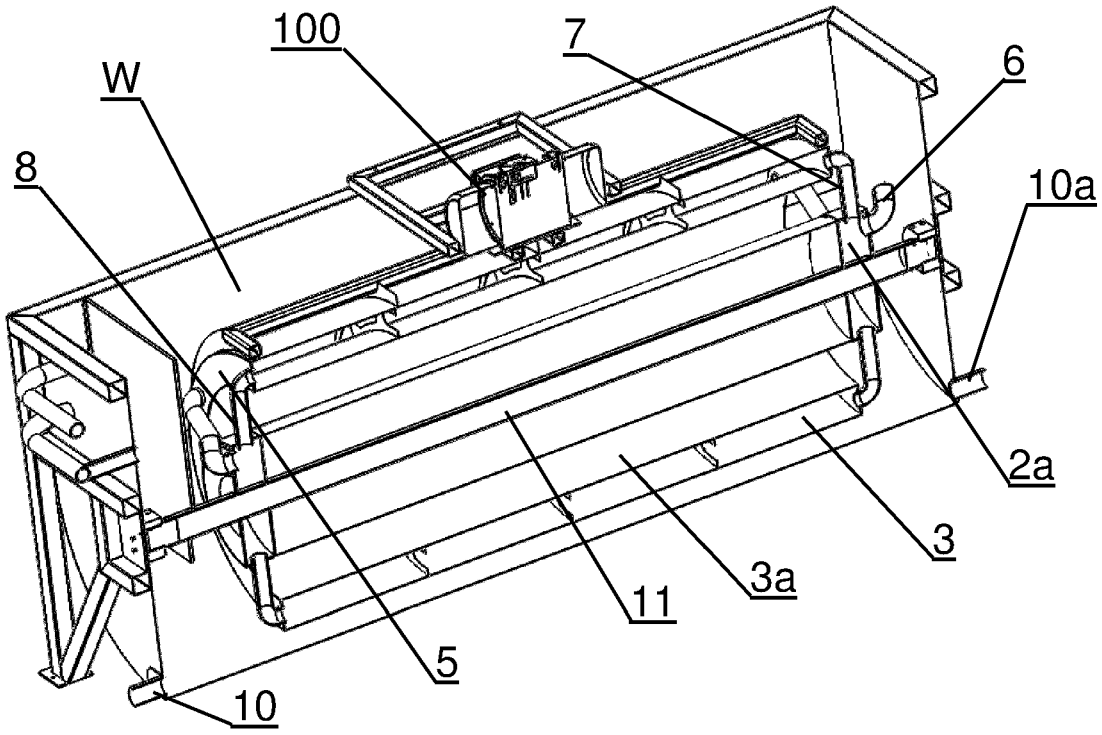

Fig. 7

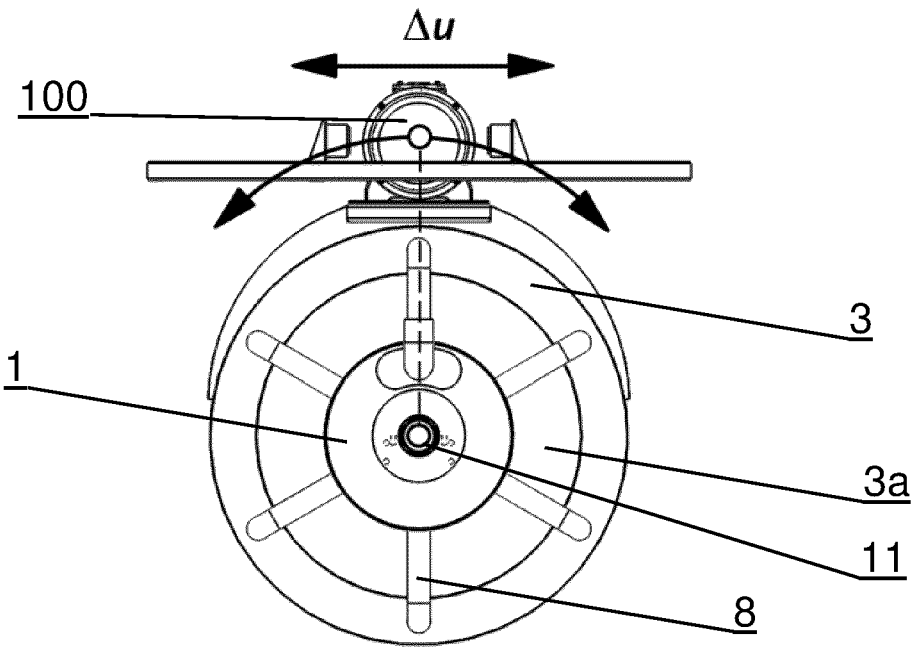

Fig. 8

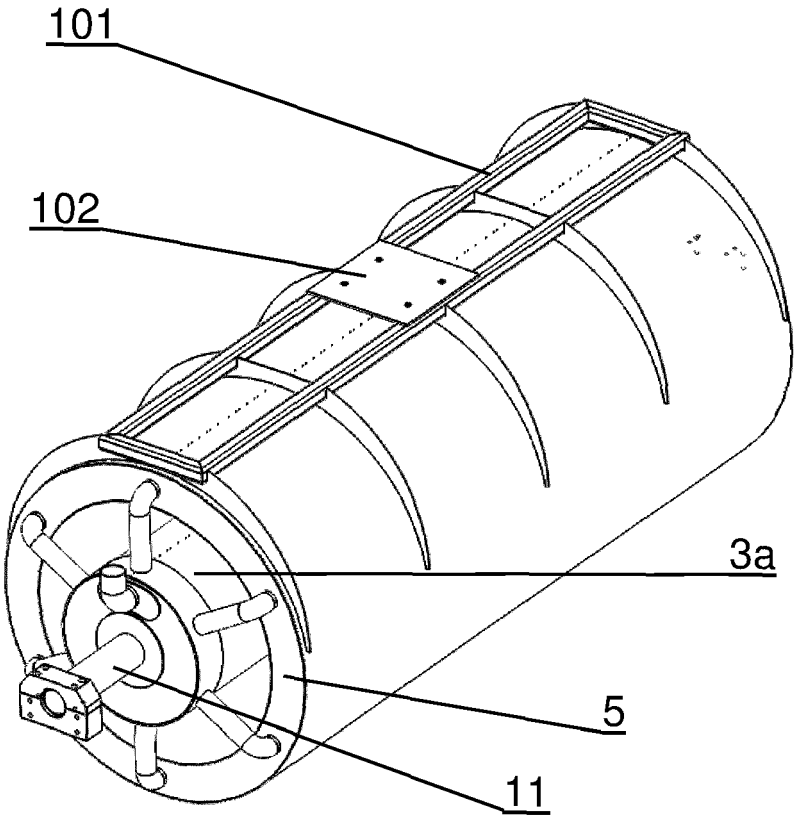

Fig. 9

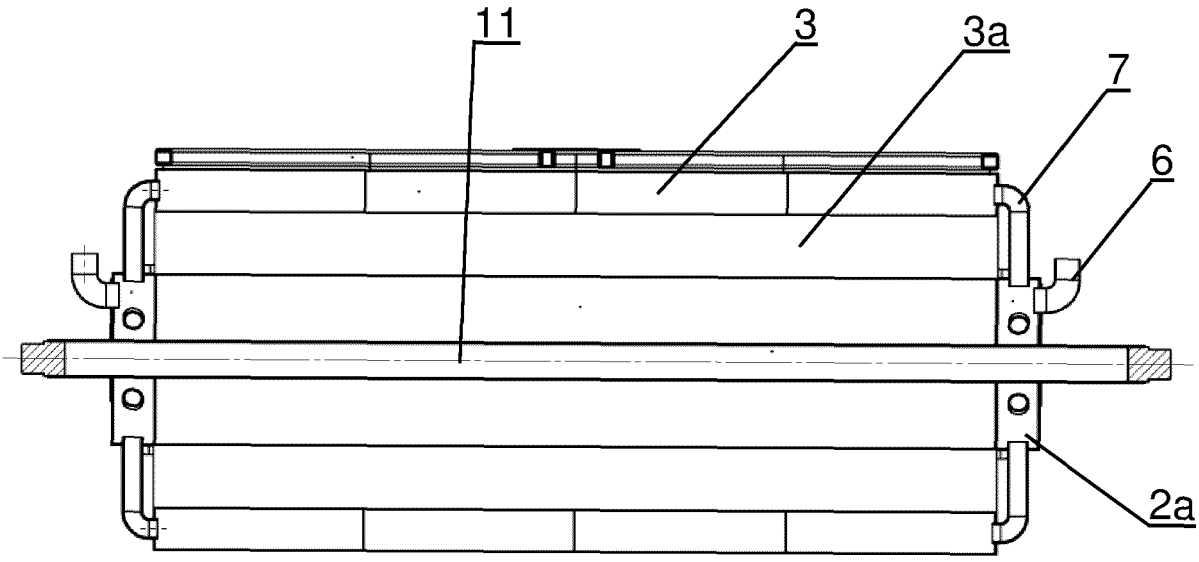

Fig. 10

REFERENCES CITED IN THE DESCRIPTION

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