

(19)



(11)

EP 3 662 096 B1

(12)

EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention
of the grant of the patent:
02.06.2021 Bulletin 2021/22

(51) Int Cl.:
C25B 1/26 (2006.01) C25B 9/015 (2021.01)
C25B 9/19 (2021.01)

(21) Application number: **18738319.5**

(86) International application number:
PCT/EP2018/068637

(22) Date of filing: **10.07.2018**

(87) International publication number:
WO 2019/016028 (24.01.2019 Gazette 2019/04)

(54) **ELECTROCHEMICAL DEVICE PROVIDED WITH STAGNATION CHAMBER**

ELEKTROCHEMISCHE VORRICHTUNG MIT STAUKAMMER

DISPOSITIF ÉLECTROCHIMIQUE POURVU D'UNE CHAMBRE DE STAGNATION

(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
Designated Extension States:
BA
MA TN

(30) Priority: **21.07.2017 IT 201700083520**

(43) Date of publication of application:
10.06.2020 Bulletin 2020/24

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Description

Background of the invention

[0001] The present invention relates to the field of the chemical technology and more in particular to the field of the electrochemical processes as it relates to a particular membrane electrolytic cell characterized by the presence of a stagnation chamber. The device is used in preparing, starting from aqueous solutions with low concentrations of dissolved salts, metastable, oxidizing or reducing substances, to be used in technological processes as replacement of chemically stable reagents.

State of art

[0002] The Japanese patent application Nr. JPS57194273 describes an electrode for producing hydrogen, with low voltage, by means of arranging cation exchange membrane between the anode and the cathode of an electrolytic cell also including porous septa without electrolytic activity not in direct contact with the electrodes.

[0003] The German patent application Nr. DE102011053142 describes an electrolytic cell to produce hydrogen and oxygen from the electrolytic decomposition of water which comprises a housing, electrodes, connected at the poles to a current source, and separated from one another by a membrane which divides into two the electrolytic cell, above the electrolytic cell there is a gas separation chamber, which is useful to separate oxygen and hydrogen from the gas-liquid mixture, and another chamber including a drop separator above the gas separation chamber for the additional purification of water or oxygen. The different chambers are arranged vertically and separated by horizontal partition walls having pores allowing the passage of the liquid-gas mixture and the liquid dropping. The outlet routes of the produced pure hydrogen and oxygen gases lie on the upper cover, on the contrary the inlet and outlet routes for water and electrolysis liquid lie on the lower wall of the cell. Even an additional drop separator could be present, containing catalytic material for an additional purification of water or oxygen, flowing vertically. In the housing, the membrane is arranged at a height so as to obtain a defined distance between the upper portion of the electrolysis chambers and the electrode, and even the electrolysis chambers are separated by membrane walls. The drop separator can include as catalytic material fibres or nickel wires or other catalysing supports such as fibres or ceramic porous bodies. A perforated plate with openings is placed on one side of the anode and/or of the cathode, which has a locking cursor, perforated too and mobile with respect to the perforated plate. An insulating layer and/or a surface heating element is applied to the electrode at the level of the through holes. A membrane filter is placed in the inlet holes of the liquid-gas mixture and the membrane allows the passage of the produced gaseous ox-

xygen and hydrogen and keeps the liquid portion of the mixture.

[0004] The European patent application Nr. EP0922788 describes an electrochemical device for the gas production from aqueous solutions, constituted by two vertical and coaxial cylindrical electrodes arranged between the two bushings characterized by a structure and an arrangement which allows a helical-like motion of the electrolytes inside the electrolytic chambers. This is determined by the presence of tilted channels and helical-like guiding elements in the bushings. In particular the starting solution enters on the lower side and through the helical-like guiding elements moves in the electrolytic chambers towards the upper portion wherein the products outgo through the tilted channels of the upper bushing. In this way the ejection of the liquid and gaseous products is facilitated and it is avoided that a gas stopping area in the electrolytic chambers is formed.

[0005] The herein described devices known in the art are devised with the purpose of purifying and collecting the gaseous products, hydrogen and/or oxygen, obtained by means of the electrochemical devices starting from liquid-gas mixtures.

[0006] In the devices known in the art, in the upper portion of the cathode chamber gaseous areas, mainly made of H_2 , are formed, which if they are not timely removed, lead to considerable energy losses and determine a decrease in the process yield.

[0007] With the purpose of solving the above-mentioned technical problem an electrolytic device was developed, for preparing metastable, oxidizing or reducing substance, starting from aqueous solutions with low concentrations of dissolved salts, which avoids gaseous stagnations so as to determine good yields of the process and a high energy saving.

Object of the invention

[0008] The above-mentioned technical problem is solved by providing the electrochemical device of the present invention comprising two electrodes, a first electrode with tubular shape and circular section, which is the cathode, and a second electrode with tubular shape and circular section too, acting as anode, the latter is arranged inside the cathode and it is coaxial thereto. The two electrodes limit a space divided into two chambers by a membrane wall concentric to the first electrode, the two chambers are the cathode chamber, between the first electrode and the membrane, and the anode chamber, between the second electrode and the membrane wall. The device then has two sealing bushings, arranged at the ends of the two electrodes, wherein the lower bushing has inlet channels of the electrolytes both to the cathode chamber and to the anode chamber, whereas the upper bushing has the outlet channels of the electrolytes from these chambers. Said device at the intersection between the cathode chamber and the outlet channel of the electrolytes from the cathode chamber, has a stagnation

chamber with spheroidal shape opened to the cathode chamber and connected to the outlet channel of the electrolytes from the cathode chamber by a connector pipe. The elements constituting the device have particular geometrical sizes.

[0009] Additional features of the invention will be explained by the detailed following description with reference to the experimental examples, and by the enclosed figures.

Brief description of the figures

[0010]

Figure 1 shows a longitudinal section of the device. 15

Figure 2 shows a longitudinal section of the detail of the stagnation chamber.

Figure 3 shows a three-dimensional representation of the device. 20

Detailed description of the invention

[0011] With reference to figure 1 the electrochemical device 1 of the present invention is described, comprising: 25

two electrodes, a first electrode with tubular shape and circular section (cathode) 2 and a second electrode with tubular shape and circular section (anode) 3, arranged inside the first electrode 2 and coaxial thereto, to form a space between the two electrodes being divided in two chambers by a membrane wall 4 concentric to the first electrode, wherein a cathode chamber 5 is arranged between the first electrode 2 and the membrane wall 4 and an anode chamber 6 is arranged between the second electrode 3 and the membrane wall 4 and 30

two sealing bushings, an upper bushing 7 and a lower bushing 8 arranged at the ends of the two electrodes 2 and 3, wherein the lower bushing 8 has an inlet channel of the electrolytes to the cathode chamber 9 and an inlet channel of the electrolytes to the anode chamber 10 and the upper bushing 7 has an outlet channel of the electrolytes from the anode chamber 11 and an outlet channel of the electrolytes from the cathode chamber 12, 35 wherein

$$0.65 \leq D_d/D_s \leq K/\ln(L) \leq 25 \leq D_b/D_s$$

$$0.6 \leq S_s/S_b \leq 1.9$$

D_b being the internal diameter measurement of the second electrode with tubular shape and cir-

cular section (anode), D_b being from 0.1 D_s to 0.7 D_s ,

D_s being the internal diameter measurement of the first electrode with a tubular shape with circular section (cathode)

D_d being the internal diameter measurement of the membrane wall, D_d being from 0.15 D_s to 0.8 D_s ;

K being the measurement of the distance between the electrodes;

L being the measurement of the distance between the inlet and outlet channels of the electrodes;

S_s being the measurement of the area of the cross section of the cathode chamber;

S_b being the measurement of the area of the cross section of the anode chamber;

a stagnation chamber 13 with spheroidal shape opened to the cathode chamber 5 and positioned at the intersection between the cathode chamber 5 and the outlet channel of the electrolytes from the cathode chamber 12,

and connected with the outlet channel of the electrolytes from the cathode chamber 12 by a connector pipe 14 wherein

$$r < D < 3r;$$

$$d < r < 3d.$$

D being the diameter measurement of the outlet collector of the cathode chamber;

r being the measurement of the radius of the stagnation chamber;

d being the diameter measurement of the connector pipe.

[0012] During the electrochemical activation process, which is performed in the device the present invention relates to, the electrolytes from the inlet channel in the lower bushing enter the lower portion of the (outer) cathode chamber delimited by the wall of the electrode with cylindrical shape and by the ion exchange membrane; from this point they move through the cathode chamber towards the upper bushing wherein they direct towards the outlet channel of the electrolysis products, crossing 50

the stagnation area which characterizes the present invention.

[0013] On the contrary, from the inlet channel the electrolytes move through the inner anode chamber as far as the outlet channel existing in the upper bushing.

[0014] The device is used for the preparation of hypochlorous acid (HOCl) from water and chloride salts.

[0015] The presence of a stagnation area allows the separation between gaseous and electrolyte phase and then it avoids the formation on the upper portion of the cathode chamber, at the upper bushing, of gaseous areas, for example of H₂, which determine a higher consumption of electrical energy.

[0016] In the specific case, the gas, for example H₂, which forms in the stagnation chamber 13 is removed from the cathode chamber 5, by the connector pipe 14.

[0017] In this way, however, the proposed solution does not determine a simple removal of the gaseous area which has formed, but it allows even to keep partially dissolved the gas which has formed in the gaseous area so as to reduce the friction between the electrolytical solution and the material constituting the device, since the contact between the solid phase and the gaseous phase determines a lower friction with respect to the liquid phase-solid phase combination. The reduction in friction between phases determines a reduction in load losses of the electrolytical solution and therefore a wear reduction of the device itself.

[0018] Preferably the membrane wall is an ion exchange membrane.

[0019] In an embodiment of the present invention the lower and upper bushings are sealed by means of seals made of rubber positioned under the ion exchange membrane and the cylinder-shaped electrode, apart from the sealing ring existing around the bar-shaped electrode.

[0020] In an embodiment of the present invention the section of the bar-shaped electrode is uniform to the upper and lower thread of the bushing, which is provided with a coaxial opening for the bar-shaped electrode, with two cables with cylindrical shape to place the ion exchange membrane and the cylindrical electrode.

[0021] In an embodiment of the present invention the electrochemical device is characterized by the following geometrical sizes:

$$D_b = 15.9 \text{ mm}$$

$$D_s = 35.6 \text{ mm}$$

$$D_b/D_s = 0.4466$$

$$D_d = 23.2 \text{ mm}$$

$$D_d/D_s = 0.65168$$

$$K = 9.85 \text{ mm}$$

$$L = 260 \text{ mm}$$

$$\ln(L) = 5.56$$

$$K/\ln(L) = 1.68$$

$$S_s = 401.4248 \text{ mm}^2$$

$$S_b = 224.176 \text{ mm}^2$$

$$S_s/S_b = 1.795$$

$$r = 3.75 \text{ mm}$$

$$d = 2.1 \text{ mm}$$

$$D = 6 \text{ mm}$$

[0022] In the embodiment of the present invention the electrochemical device of the present invention is used for the preparation of hypochlorous acid (HOCl) from water and sodium chloride (NaCl).

Claims

1. An electrochemical device (1) comprising two electrodes, a first electrode with tubular shape and circular section (cathode) (2) and a second electrode with tubular shape and circular section (anode) (3) placed inside the first electrode (2) and coaxial thereto, to form a space between the two electrodes being divided in two chambers by a membrane wall (4) concentric to the first electrode, wherein a cathode chamber (5) is arranged between the first electrode (2) and the membrane wall (4) and an anode chamber (6) is arranged between the second electrode (3) and the membrane wall (4) and two sealing bushings, one upper bushing (7) and one lower bushing (8) arranged at the ends of the two electrodes (2) and (3), wherein the lower bushing (8) has an inlet channel of the electrolytes to the cathode chamber (9) and an inlet channel of the electrolytes to the anode chamber (10) and the upper bushing (7) has an outlet channel of the electrolytes from the anode chamber (11) and an outlet channel of the electrolytes from the cathode chamber (12), wherein

$$65 \frac{D_d}{D_s} \leq \frac{K}{\ln(L)} \leq 25 \frac{D_b}{D_s}$$

$$0.6 \leq \frac{S_s}{S_b} \leq 1.9$$
 Db being the internal diameter measurement of the second electrode with tubular shape and circular section (anode), Db being from 0.1 Ds to 0.7 Ds, Ds being the internal diameter measurement of the first electrode with tubular shape and circular section (cathode), Dd being the internal diameter measurement of the membrane wall, Dd being from 0.15 Ds to 0.8 Ds, K the measurement of the distance between the electrodes, L being the measurement of the distance between the inlet and outlet channels of the electrodes, Ss being the measurement of the

area of the cross section of the cathode chamber, Sb being the measurement of the area of the cross section of the anode chamber;

a stagnation chamber (13) with spheroidal shape opened to the cathode chamber (5) and positioned at the intersection between the cathode chamber (5) and the outlet channel of the electrolytes from the cathode chamber (12),

and connected with the outlet channel of the electrolytes from the cathode chamber (12) by a connector pipe (14) wherein $r < D < 3r$ and $d < r < 3d$, D being the diameter measurement of the outlet collector of the cathode chamber, r being the measurement of the radius of the stagnation chamber, d being the diameter measurement of the connector pipe.

2. The electrochemical device according to claim 1 wherein the membrane wall (4) is an ion exchange membrane.
3. The electrochemical device according to claim 1 wherein the section of the second electrode with tubular shape and circular section (anode) is uniform to the upper and lower thread of the bushing, which is provided with a coaxial opening for the second electrode with tubular shape and circular section (anode), two cables with cylindrical shape to place the membrane wall and the first electrode with tubular shape and circular section (cathode).
4. A use of the device according to anyone of the preceding claims for the preparation of hypochlorous acid (HOCl) from water and chloride salts.

Patentansprüche

1. Elektrochemische Vorrichtung (1), aufweisend zwei Elektroden, eine erste Elektrode mit röhrenförmiger Form und kreisförmigem Querschnitt (Kathode) (2) und eine zweite Elektrode mit röhrenförmiger Form und kreisförmigem Querschnitt (Anode) (3), die innerhalb der ersten Elektrode (2) angeordnet ist und koaxial dazu ist, um einen Raum zwischen den zwei Elektroden zu bilden, der durch eine Membranwand (4) in zwei Kammern geteilt ist, die konzentrisch zur ersten Elektrode ist, wobei eine Kathodenkammer (5) zwischen der ersten Elektrode (2) und der Membranwand (4) angeordnet ist und eine Anodenkammer (6) zwischen der zweiten Elektrode (3) und der Membranwand (4) angeordnet ist und zwei Dichtbuchsen, eine obere Buchse (7) und eine untere Buchse (8), die an den Enden der beiden Elektroden (2) und (3) angeordnet sind, wobei die untere Buchse (8) einen Einlasskanal der Elektrolyte zur Kathodenkammer (9) und einen Einlasskanal der Elektrolyte zur Anodenkammer (10) aufweist und die obere Buchse (7) einen Auslasskanal der Elektrolyte

von der Anodenkammer (11) und ein Auslasskanal der Elektrolyte von der Kathodenkammer (12) aufweist, wobei

$$65 Dd/Ds \leq K/ln(L) \leq 25 Db/Ds$$

$$0.6 \leq Ss/Sb \leq 1.9$$

wobei Db die Innendurchmessermessung der zweiten Elektrode mit röhrenförmiger Form und kreisförmigem Querschnitt (Anode) ist, Db von 0,1 Ds bis 0,7 Ds ist, Ds die Innendurchmessermessung der ersten Elektrode mit röhrenförmiger Form und kreisförmigem Querschnitt (Kathode) ist, Dd die Innendurchmessermessung der Membranwand ist, Dd von 0,15 Ds bis 0,8 Ds ist, K die Messung des Abstands zwischen den Elektroden ist, L die Messung des Abstands zwischen den Einlass- und Auslasskanälen der Elektroden ist, Ss die Messung der Fläche des Querschnitts der Kathodenkammer ist, Sb die Messung der Fläche des Querschnitts der Anodenkammer ist;

eine Stagnationskammer (13) mit kugelförmiger Form, die zur Kathodenkammer (5) geöffnet ist und am Schnittpunkt zwischen der Kathodenkammer (5) und dem Auslasskanal der Elektrolyte von der Kathodenkammer (12) positioniert ist,

und mit dem Auslasskanal der Elektrolyte von der Kathodenkammer (12) durch ein Verbindungsrohr (14) verbunden ist, wobei $r < D < 3r$ und $d < r < 3d$ ist, wobei D die Durchmesser messung des Auslasskollektors der Kathodenkammer ist, r die Messung des Radius der Stagnationskammer ist, d die Durchmesser messung des Verbindungsrohrs ist.

2. Elektrochemische Vorrichtung nach Anspruch 1, wobei die Membranwand (4) eine Ionenaustauschmembran ist.
3. Elektrochemische Vorrichtung nach Anspruch 1, wobei der Querschnitt der zweiten Elektrode mit röhrenförmiger Form und kreisförmigem Querschnitt (Anode) gleichmäßig zum oberen und unteren Gewinde der Buchse ist, die mit einer koaxialen Öffnung für die zweite Elektrode mit röhrenförmiger Form und kreisförmigem Querschnitt (Anode) bereitgestellt ist, zwei Kabel mit zylindrischer Form zur Platzierung der Membranwand und der ersten Elektrode mit röhrenförmiger Form und kreisförmigem Querschnitt (Kathode).
4. Verwendung der Vorrichtung nach einem der vorstehenden Ansprüche zur Herstellung von Hypochlorsäure (HOCL) aus Wasser und Chloridsalzen.

Revendications

1. Dispositif électrochimique (1) comprenant deux électrodes, une première électrode de forme tubulaire et de section circulaire (cathode) (2) et une seconde électrode de forme tubulaire et de section circulaire (anode) (3) placée à l'intérieur de la première électrode (2) et coaxiale à celle-ci, pour former un espace entre les deux électrodes divisé en deux chambres par une paroi de membrane (4) concentrique à la première électrode, dans lequel une chambre de cathode (5) est agencée entre la première électrode (2) et la paroi de membrane (4) et une chambre d'anode (6) est agencée entre la seconde électrode (3) et la paroi de membrane (4) et deux bagues d'étanchéité, une bague supérieure (7) et une bague inférieure (8) agencées aux extrémités des deux électrodes (2) et (3), dans lequel la bague inférieure (8) présente un canal d'entrée des électrolytes vers la chambre de cathode (9) et un canal d'entrée des électrolytes vers la chambre d'anode (10) et la bague supérieure (7) présente un canal de sortie des électrolytes à partir de la chambre d'anode (11) et un canal de sortie des électrolytes à partir de la chambre de cathode (12), dans lequel

$$65 \quad D_d/D_s \leq K/\ln(L) \leq 25 \quad D_b/D_s$$

$$0,6 \leq S_s/S_b \leq 1,9$$

Db étant la mesure du diamètre interne de la seconde électrode de forme tubulaire et de section circulaire (anode), Db allant de 0,1 Ds à 0,7 Ds, Ds étant la mesure du diamètre interne de la première électrode de forme tubulaire et de section circulaire (cathode), Dd étant la mesure du diamètre interne de la paroi de membrane, Dd allant de 0,15 Ds à 0,8 Ds, K la mesure de la distance entre les électrodes, L étant la mesure de la distance entre les canaux d'entrée et de sortie des électrodes, Ss étant la mesure de l'aire de la section transversale de la chambre de cathode, Sb étant la mesure de l'aire de la section transversale de la chambre d'anode ;
une chambre de stagnation (13) de forme sphéroïdale ouverte sur la chambre de cathode (5) et positionnée à l'intersection entre la chambre de cathode (5) et le canal de sortie des électrolytes à partir de la chambre de cathode (12),
et raccordée au canal de sortie des électrolytes à partir de la chambre cathodique (12) par un tuyau de raccordement (14) dans lequel $r < D < 3r$ et $d < r < 3d$, D étant la mesure du diamètre du collecteur de sortie de la chambre de cathode, r étant la mesure du rayon de la chambre de stagnation, d étant la mesure du diamètre du tuyau de raccordement.

2. Dispositif électrochimique selon la revendication 1,

dans lequel la paroi de membrane (4) est une membrane échangeuse d'ions.

3. Dispositif électrochimique selon la revendication 1, dans lequel la section de la seconde électrode de forme tubulaire et de section circulaire (anode) est uniforme par rapport aux filetages supérieur et inférieur de la bague, qui est pourvue d'une ouverture coaxiale pour la seconde électrode de forme tubulaire et section circulaire (anode), deux câbles de forme cylindrique pour placer la paroi de membrane et la première électrode de forme tubulaire et de section circulaire (cathode).
4. Utilisation du dispositif selon l'une quelconque des revendications précédentes pour la préparation d'acide hypochloreux (HOCl) à partir d'eau et de sels de chlorure.

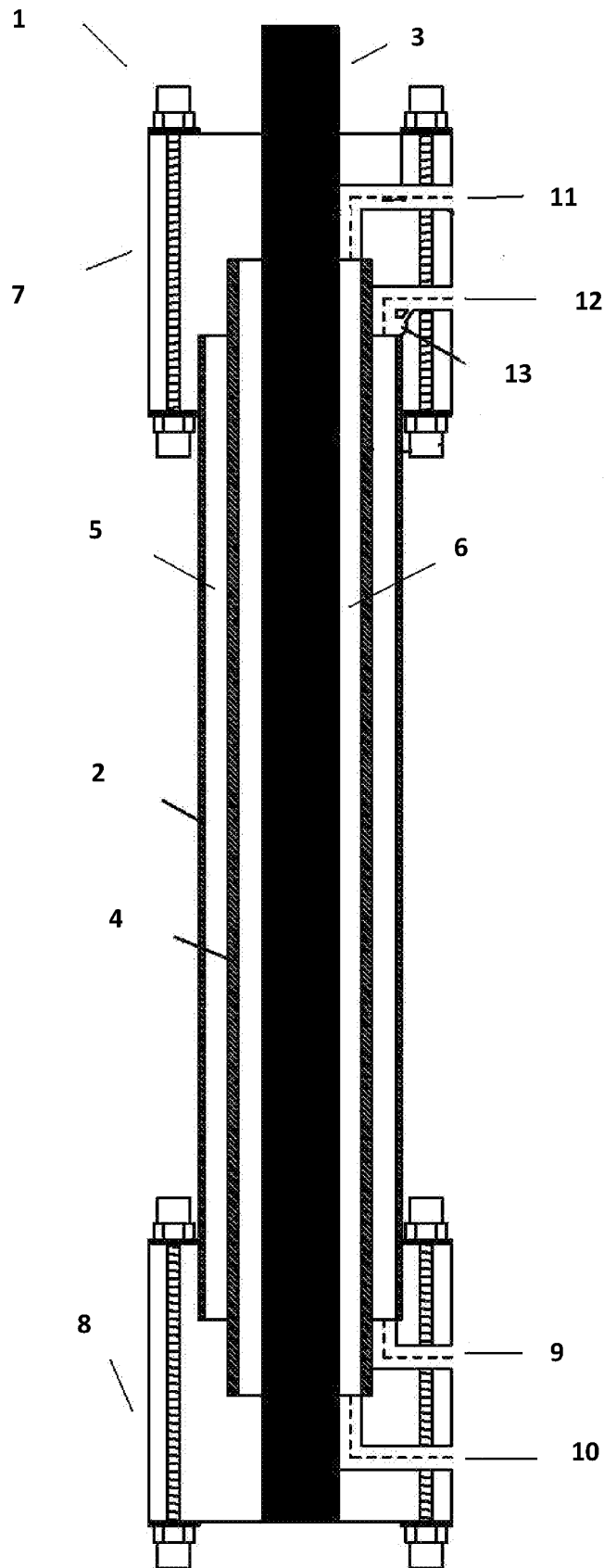


Figure 1

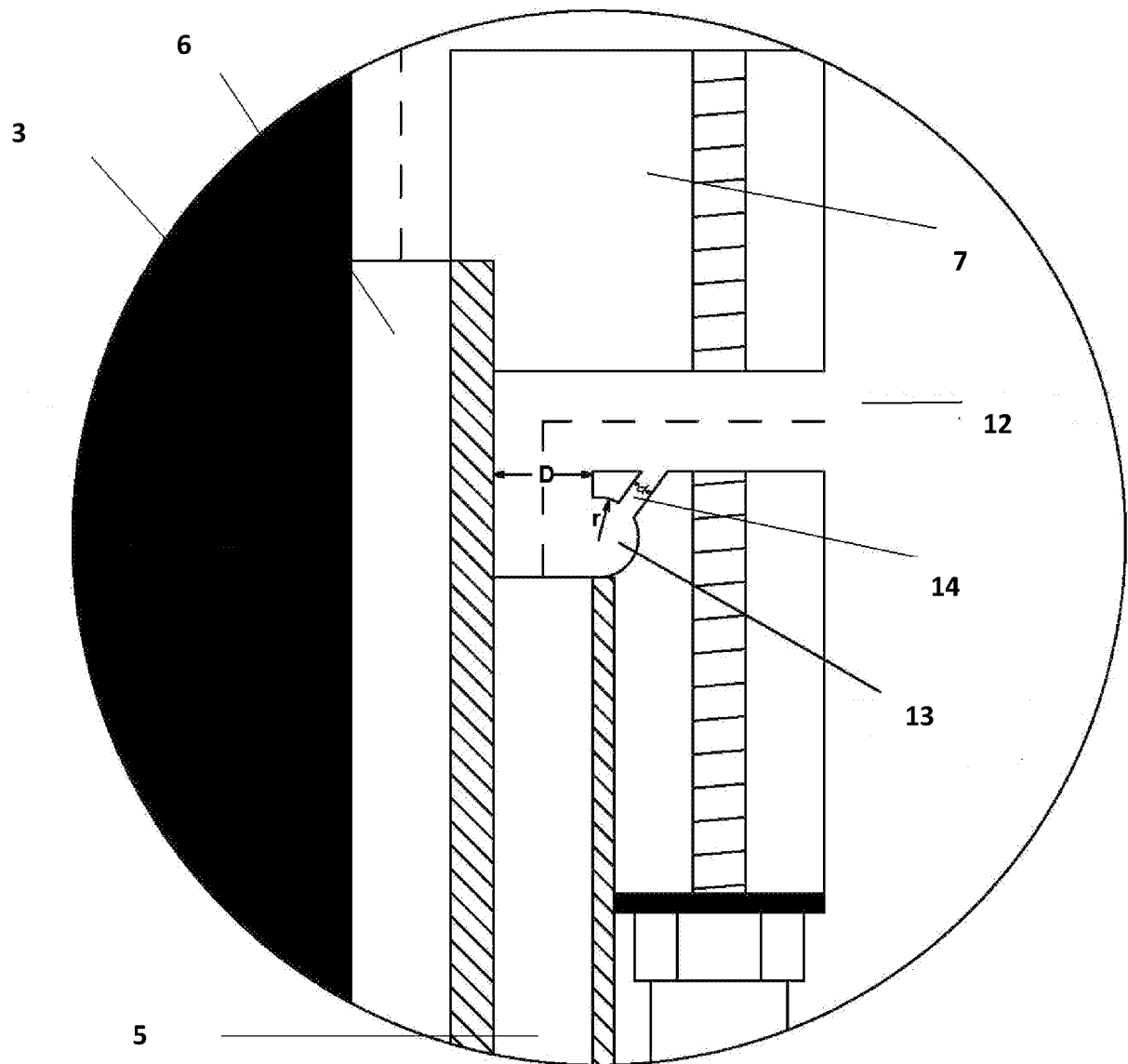


Figure 2

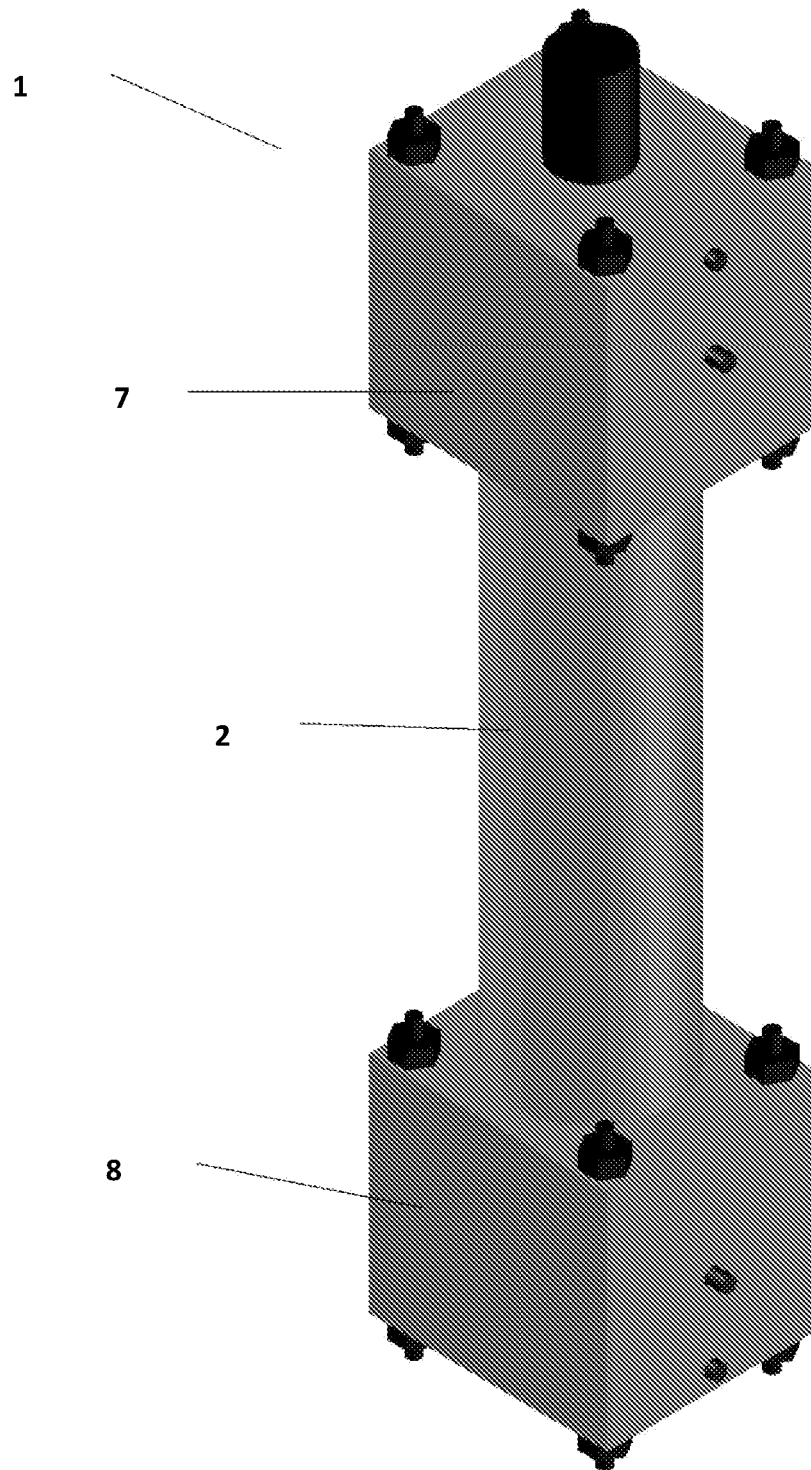


Figure 3

REFERENCES CITED IN THE DESCRIPTION

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