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(54) **CONTROLLED CAVITATION DEVICE**

(57) The present invention relates to a cavitation device (10) with a shaft (11), a housing (20), a rotor (30), a fluid inlet conduit (24) and a fluid outlet conduit (25). The inlet direction (B-B) of the inlet axis (B) of the fluid inlet conduit (24) is perpendicular to the axial direction (X-X) of the rotor axis (X) of the shaft (11), the outlet direction (C-C) of the outlet axis (C) of the fluid outlet conduit (24) is perpendicular to the axial direction (X-X). The inlet and outlet ports (22, 23) of the housing (20) are positioned at an axial position spaced apart from the rotor (30).

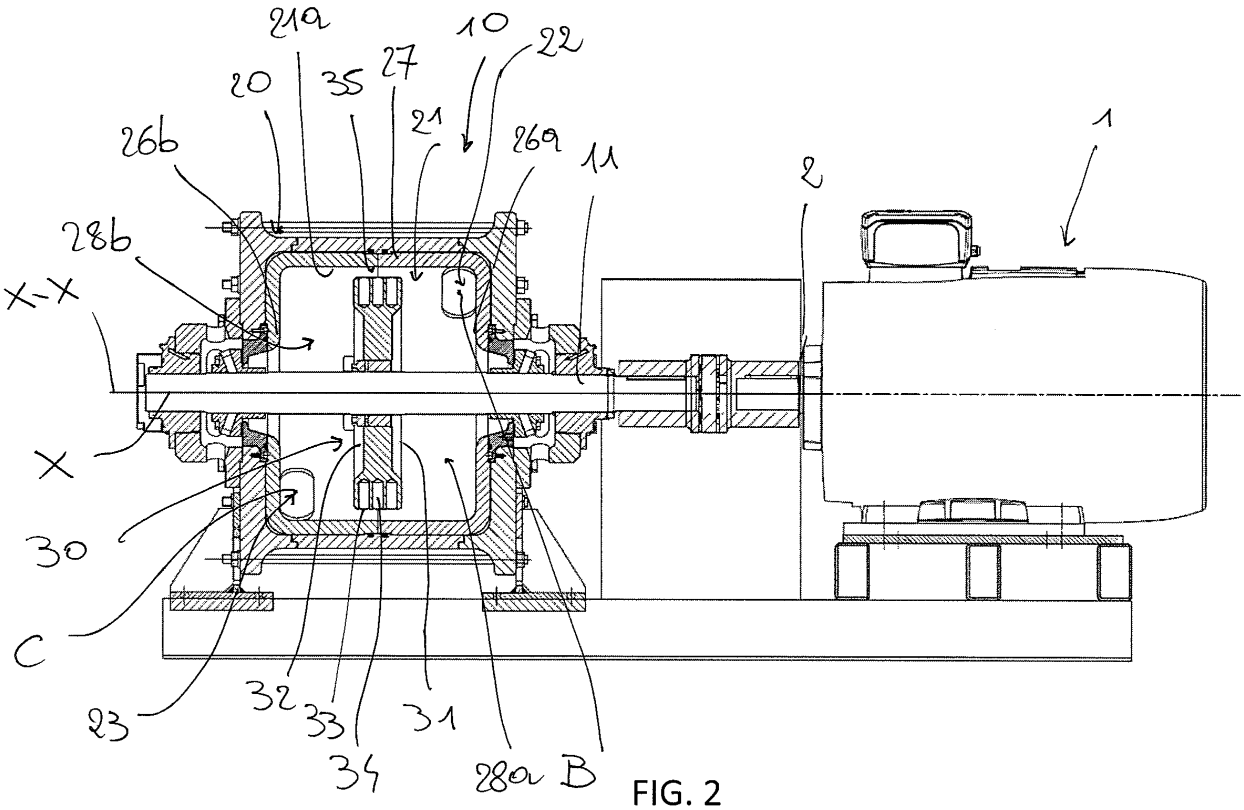

FIG. 2

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Description

TECHNICAL FIELD

[0001] The present invention relates to a controlled cavitation device.

BACKGROUND OF THE INVENTION

[0002] A cavitation device is disclosed in EP 610914. This device comprises a housing defining a chamber formed by a cylindrical side wall and a pair of end plates, a shaft passing through an axis of the chamber and a rotor mounted on the shaft within the chamber so as to rotate with the shaft.

[0003] The rotor has a surface toward the side wall provided with uniformly-spaced inwardly-directed recesses or bores at a selected angle. These recesses produce turbulence of fluid within a cavitation zone defined between the rotor and the inner surface of the chamber.

[0004] This device comprises also an inlet port for the introduction of fluid into the space between the rotor and the inner surface of the chamber and an outlet port for the removal of treated fluid. A first and a second fluid connections are connected to the inlet and outlet ports which are oriented axially or radially in the two proposed embodiments.

[0005] A different cavitation device is disclosed in EP 1289638. In this device an inlet port is axially provided on either side of the housing in order to equalize the hydraulic pressure on the rotor and an outlet port is radially provided in the housing in the cylindrical wall of the housing to communicate with the cavitation zone in a region of the rotor intermediate or between the arrays of bores.

[0006] The position of the outlet port ensures that the entire volume of the gas/liquid mixture traverses at least one of the arrays of bores and thus moves through the cavitation zone prior to exiting the housing.

[0007] The cavitation devices mentioned above suffer of problem when treating abrasive fluids, such as biological fluid, manure, sewage, waste, mud any other fluid which incorporates solid particles that may create friction.

[0008] In fact, with the cavitation devices of the prior art, the fluid must vary suddenly its direction and speed when enters and/or exits the chamber of the housing. This change of the direction and speed of the fluid causes wear of the inlet and outlet ports.

[0009] In view of the above prior art, the object of the present invention is to provide a cavitation device where the direction and speed of the fluid entering and exiting the chamber of the housing is controlled thereby preventing damage of the inlet and outlet ports.

SUMMARY OF THE INVENTION

[0010] According to the present invention, this purpose is fulfilled by a cavitation device according to claim 1.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] The characteristics and advantages of the present invention will appear from the following detailed description of one practical embodiment, which is given as a non limiting example with reference to the annexed drawings, in which:

- figure 1 shows a top view of a cavitation device according to the present invention,
- figure 2 shows a section view of the cavitation device of figure 1 along the section line A-A,
- figure 3 shows a front view of the cavitation device of figure 1,
- figure 4 shows a further section view of the cavitation device of figure 1 along the section line A-A,
- figure 5 shows a perspective view of the cavitation device of figure 1.

DETAILED DESCRIPTION

[0012] Referring to the appended figures, figure 1 shows a cavitation device 10 coupled with an electric motor 1 to define a cavitation apparatus 100.

[0013] The cavitation device 10 comprises a shaft 11, a housing 20 and a rotor 30.

[0014] The shaft 11 extends along an axial direction X-X and is configured to be coupled with the electric motor 1. In particular, the electric motor 1 comprises a driving shaft 2 coupled with the shaft 11 of the cavitation device 10 through transmission means 3 to put in rotation the shaft 11.

[0015] The housing 20 defines a cylindrical chamber 21 having a inner cylindrical surface 21a and has a fluid inlet port and 22 and a fluid outlet port 23.

[0016] Preferably, the housing 20 has one single fluid inlet 22 and one single fluid outlet 23.

[0017] The rotor 30 is arranged within the cylindrical chamber 21 of the housing 20 and is mounted on the shaft 11 to rotate about a rotor axis X extending along the axial direction X-X.

[0018] A fluid inlet conduit 24 is coupled to the fluid inlet port 22 for supplying fluid into the cylindrical chamber 21 of the housing 20. This fluid inlet conduit 24 has an inlet axis B extending along an inlet direction B-B.

[0019] A fluid outlet conduit 25 is coupled to the fluid outlet port 23 for receiving fluid from the cylindrical chamber 21 of the housing 20. This fluid outlet conduit 25 has an outlet axis C extending along an outlet direction C-C.

[0020] The housing 20 comprises a first side wall 26a and a second side wall 26b axially spaced from the first side wall 26a along the axial direction X-X.

[0021] The housing 20 comprises also a cylindrical body 27 extending axially between the first side wall 26a and the second side wall 26b and joining the first and second side walls 26a, 26b. The cylindrical body 27 and the first and second side walls 26a, 26b define the cylindrical chamber 21 of the housing 20.

[0022] The rotor 30 comprises a first side surface 31 and a second side surface 32 axially spaced from the first side surface 31 along the axial direction X-X.

[0023] The rotor 30 comprises also a cylindrical peripheral surface 33 extending axially between the first side surface 31 and the second side surface 32 and joining the first and second side surfaces 31, 32.

[0024] The radial distance between rotor axis X and the cylindrical peripheral surface 33 defines the rotor radius R of the rotor 30.

[0025] The axial distance between the first side surface 31 and the second side surface 32 defines the axial extension of the rotor 30.

[0026] At least two arrays of bores 34 are formed in the cylindrical peripheral surface 33. In the example shown in the figures, the rotor 30 comprises three arrays of bores. The bores 34 of each array of bores are arranged in a row extending around the cylindrical peripheral surface 33.

[0027] Each bore 34 extends radially into the rotor 30 from the cylindrical peripheral surface 33.

[0028] A cavitation zone 35 is defined between the cylindrical peripheral surface 33 of the rotor 30 and the inner cylindrical surface 21a of the cylindrical chamber 21 of the housing 20.

[0029] The cylindrical chamber 21 comprises an inlet cylindrical chamber 28a formed between the first side surface 31 and the first side wall 26a and an outlet cylindrical chamber 28b formed between the second side surface 32 and the second side wall 26b.

[0030] The fluid inlet port 22 is positioned in the housing 20 to introduce fluid into the inlet cylindrical chamber 28a at an axial position spaced apart from the first side surface 31 of the rotor 30.

[0031] The fluid outlet port 23 is positioned in the housing 20 to receive fluid from the outlet cylindrical chamber 28b at an axial position spaced apart from the second side surface 32 of the rotor 30.

[0032] Preferably, the axial distance between the fluid inlet port 22 and the first side surface 31 of the rotor 30 is equal to or greater than the axial extension of the rotor 30..

[0033] Preferably, the axial distance between the fluid outlet port 23 and the second side surface 32 of the rotor 30 is equal to or greater than the axial extension of the rotor 30.

[0034] The inlet direction B-B of the inlet axis B is perpendicular to the axial direction X-X of the rotor axis X and the outlet direction C-C of the outlet axis C is perpendicular to the axial direction X-X of the rotor axis X.

[0035] Preferably, the fluid inlet conduit 24 and the fluid outlet conduit 25 are arranged on the stator 20 such that the fluid supplied through the fluid inlet port 22 and delivered through the fluid outlet port 23 follows within the cylindrical chamber 21 a helical path. The inlet axis B and the outlet axis C are substantially tangential to this helical path.

[0036] With this arrangement of the inlet an outlet axes B and C relative to the rotor axis X and thanks to the axial position of the fluid inlet and outlet ports 22, 23, it is possible to control the tangential speed of the fluid supplied into the housing 20 and received from the housing 20 reducing any effect of suction and delivery.

[0037] The inlet cylindrical chamber 28a and the outlet cylindrical chamber 28b make available two chamber so that, in use, the mass of fluid axially arranged before the rotor 30, in the inlet cylindrical chamber 28a, and after the rotor 30, in the outlet cylindrical chamber 28b, guarantee a rotational inertia which opposes the axial speed of the fluid, with respect to the radial and tangential speed set by the speed of the rotor 30.

[0038] As a consequence, the axial speed of the fluid is independent from the speed of the rotor 30 and the cavitation is thereby controlled.

[0039] This arrangement is extremely advantageous with abrasive fluids, however it can be used with benefit also with non-abrasive fluids and for mixing liquid-liquid, liquid-gas and liquid solid supplied through the fluid inlet conduit 24.

[0040] According to one embodiment, the inlet port 22 is positioned in the housing 20 to introduce fluid into the inlet cylindrical chamber 28a at an axial position adjacent to the first side wall 26a of the housing 20 and the outlet port 23 is positioned in the housing 20 to receive fluid from the outlet cylindrical chamber 28b at an axial position adjacent the second side wall 26b of the housing 20.

[0041] According to a preferred embodiment, the fluid inlet conduit 24 and the fluid outlet conduit 25 are positioned such that the inlet axis B and the outlet axis C are parallel to and proximate to respective tangential directions to the cylindrical peripheral surface 33 of the rotor 30 or to respective tangential directions to the inner cylindrical surface 21a of the cylindrical chamber 21 of the stator 20.

[0042] More preferably, the fluid inlet conduit 24 and the fluid outlet conduit 25 have respective first portions 24a, 25a facing a respective plane, in the example a same plane P', passing through the rotor axis X and parallel to the corresponding inlet axis B and outlet axis C and opposite second portions 24b, 25b. The second portions 24b, 25b of the fluid inlet conduit 24 and the fluid outlet conduit 25 join the stator 20 substantially tangentially to the inner cylindrical surface 21a of the cylindrical chamber 21 of the stator 20.

[0043] In the example shown in the figures, the inlet axis B and the outlet axis C are parallel.

[0044] According to one embodiment, the distance between the outlet axis C and the rotor axis X along a direction Y-Y perpendicular to the outlet axis C and the rotor axis X ranges between 70% and 100% the rotor radius R.

[0045] The same applies to the distance between the inlet axis B and the rotor axis X along a direction Y-Y perpendicular to the inlet axis C and the rotor axis X which ranges between 70% and 100% the rotor radius R.

[0046] In particular, the inlet axis B and the outlet axis

C intersect a plane P passing through the rotor axis X and perpendicular to the inlet and outlet axes B, C at a distance D from the rotor axis X between 70% and 100% the rotor radius R.

[0047] Preferably, the housing 20 comprises two lateral portions 20a, 20b defined at opposite sides relative to the plane P passing through the rotor axis X and perpendicular to the inlet and outlet axes B, C.

[0048] In the example shown in the figures, the fluid inlet port 22 and the fluid outlet port 23 are positioned on one of the two lateral portions 20a, 20b, namely in the lateral portion 20a.

[0049] Those skilled in the art will obviously appreciate that a number of changes and variants may be made to the arrangements as described hereinbefore to meet incidental and specific needs.

[0050] For example, unless otherwise imposed by evident technical limitations, any feature described in a preferred embodiment may be clearly used in another embodiment, with appropriate adaptations.

[0051] All the changes will fall within the scope of the invention, as defined in the following claims.

Claims

1. A cavitation device (10) comprising:

- a shaft (11) configured to be coupled with motor means (1), said shaft (11) extending along an axial direction (X-X),
- a housing (20) defining a cylindrical chamber (21) having a inner cylindrical surface (21a), said housing having a fluid inlet port (22) and a fluid outlet port (23),
- a rotor (30) arranged within said cylindrical chamber (21) of said housing (20) and mounted on said shaft (11) to rotate about a rotor axis (X) extending along said axial direction (X-X),
- a fluid inlet conduit (24) coupled to said fluid inlet port (22) for supplying fluid into said cylindrical chamber (21), said fluid inlet conduit (24) having an inlet axis (B) extending along an inlet direction (B-B),
- a fluid outlet conduit (25) coupled to said fluid outlet port (23) for receiving fluid from said cylindrical chamber (21), said fluid outlet conduit (23) having an outlet axis (C) extending along an outlet direction (C-C),

wherein:

- said housing (20) comprises:
    - a first side wall (26a) and a second side wall (26b) axially spaced from said first side wall (26a),
    - a cylindrical body (27) extending axially between said first and second side walls (26a, 26b) and joining said first and second side walls (26a, 26b),
- said rotor (30) comprises:
    - a first side surface (31) and a second side surface (32) axially spaced from said first side surface (31),
    - a cylindrical peripheral surface (33) extending axially between said first and second side surfaces (31, 32) and joining said first and second side surfaces (31, 32),
    - at least two arrays of bores (34) formed in said cylindrical peripheral surface (33), the bores (34) of each array of bores being arranged in a row extending around said cylindrical peripheral surface (33), each bore (33) extending radially into said rotor (30) from said cylindrical peripheral surface (33),
- said cylindrical chamber (21) comprises an inlet cylindrical chamber (28a) formed between said first side surface (31) and said first side wall (26a) and an outlet cylindrical chamber (28b) formed between said second side surface (32) and said second side wall (26b),
- a cavitation zone (35) is defined between said cylindrical peripheral surface (33) of the rotor (30) and said inner cylindrical surface (21a) of the cylindrical chamber (21) of the housing (20),

characterized in that:

- said inlet direction (B-B) of said inlet axis (B) is perpendicular to said axial direction (X-X) of said rotor axis (X),
- said outlet direction (C-C) of said outlet axis (C) is perpendicular to said axial direction (X-X) of said rotor axis (X),
- said inlet port (22) is positioned in said housing (20) to introduce fluid into said inlet cylindrical chamber (28a) at an axial position spaced apart from said first side surface (31) of the rotor (30),
- said outlet port (23) is positioned in said housing (20) to receive fluid from said outlet cylindrical chamber (28b) at an axial position spaced apart from said second side surface (32) of the rotor (30).

2. The cavitation device (10) according to claim 1, wherein:

- said inlet port (22) is positioned in said housing (20) to introduce fluid into said inlet cylindrical chamber (28a) at an axial position adjacent said first side wall (26a) of the housing (20),
- said outlet port (23) is positioned in said housing (23) to receive fluid from said outlet cylindrical chamber (28b) at an axial position adjacent said second side wall (26b) of the housing (20).

3. The cavitation device (10) according to claim 1 or 2, wherein:

- said fluid inlet conduit (24) and said fluid outlet conduit (25) are arranged on the stator (20) such that the fluid supplied through said fluid inlet port (22) and delivered through said fluid outlet port (23) follows within the cylindrical chamber (21) a helical path.

4. The cavitation device (10) according to claim 3, wherein:

- said inlet axis (B) and said outlet axis (C) are substantially tangential to said helical path.

5. The cavitation device (10) according to any of claims 1 to 4, wherein:

- said fluid inlet conduit (24) and said fluid outlet conduit (25) are positioned such that said inlet axis (B) and said outlet axis (C) are parallel to and proximate to respective tangential directions to said cylindrical peripheral surface (33) of the rotor (30).

6. The cavitation device (10) according to any of claims 1 to 5, wherein:

- said fluid inlet conduit (24) and said fluid outlet conduit (25) are positioned such that said inlet axis (B) and said outlet axis (C) are parallel to and proximate to respective tangential directions to said inner cylindrical surface (21a) of the cylindrical chamber (21) of the housing (20).

7. The cavitation device (10) according to any of claims 1 to 6, wherein:

- said fluid inlet conduit (24) and said fluid outlet conduit (25) have respective first portions (24a, 25a) facing a respective plane passing through said rotor axis (X) and parallel to the corresponding inlet axis (B) and outlet axis (C) and opposite second portions (24b, 25b),
- said second portions (24b, 25b) of the fluid inlet conduit (24) and the fluid outlet conduit (25) join the stator (20) substantially tangentially to the inner cylindrical surface (21a) of the cylindrical chamber (21) of the stator (20).

8. The cavitation device (10) according to any of claims 1 to 7, wherein:

- the distance (D) between the outlet axis (C) and the rotor axis (X) along a direction (Y-Y) perpendicular to said outlet axis (C) and said rotor axis (X) ranges between 70% and 100% the radial distance (R) between said rotor axis (X) and said cylindrical peripheral surface (33) of the rotor (30).

9. The cavitation device (10) according to any of claims 1 to 8, wherein:

- the distance (D) between the inlet axis (B) and the rotor axis (X) along a direction (Y-Y) perpendicular to said inlet axis (B) and said rotor axis (X) ranges between 70% and 100% the radial distance (R) between said rotor axis (X) and said cylindrical peripheral surface (33) of the rotor (30).

10. The cavitation device (10) according to any of claims 1 to 9, wherein:

- said inlet axis (B) intersects a plane (P) passing through said rotor axis (X) and perpendicular to said inlet and outlet axes (B, C) at a distance (D) from said rotor axis (X) between 70% and 100% the radial distance (R) between said rotor axis (X) and said cylindrical peripheral surface (33) of the rotor (30).

11. The cavitation device (10) according to any of claims 1 to 10, wherein:

- said outlet axis (C) intersects a plane (P) passing through said rotor axis (X) and perpendicular to said inlet and outlet axes (B, C) at a distance (D) from said rotor axis (X) between 70% and 100% the radial distance (R) between said rotor axis (X) and said cylindrical peripheral surface (33) of the rotor (30).

12. The cavitation device (10) according to any of claims 1 to 11, wherein:

- the axial distance between the fluid inlet port (22) and the first side surface (31) of the rotor (30) is equal to or greater than the axial distance between the first side surface (31) and the second side surface (32) of the rotor (30).

13. The cavitation device (10) according to any of claims 1 to 12, wherein:

- the axial distance between the fluid outlet port (23) and the second side surface (32) of the rotor (30) is equal to or greater than the axial distance between the first side surface (31) and the second side surface (32) of the rotor (30).

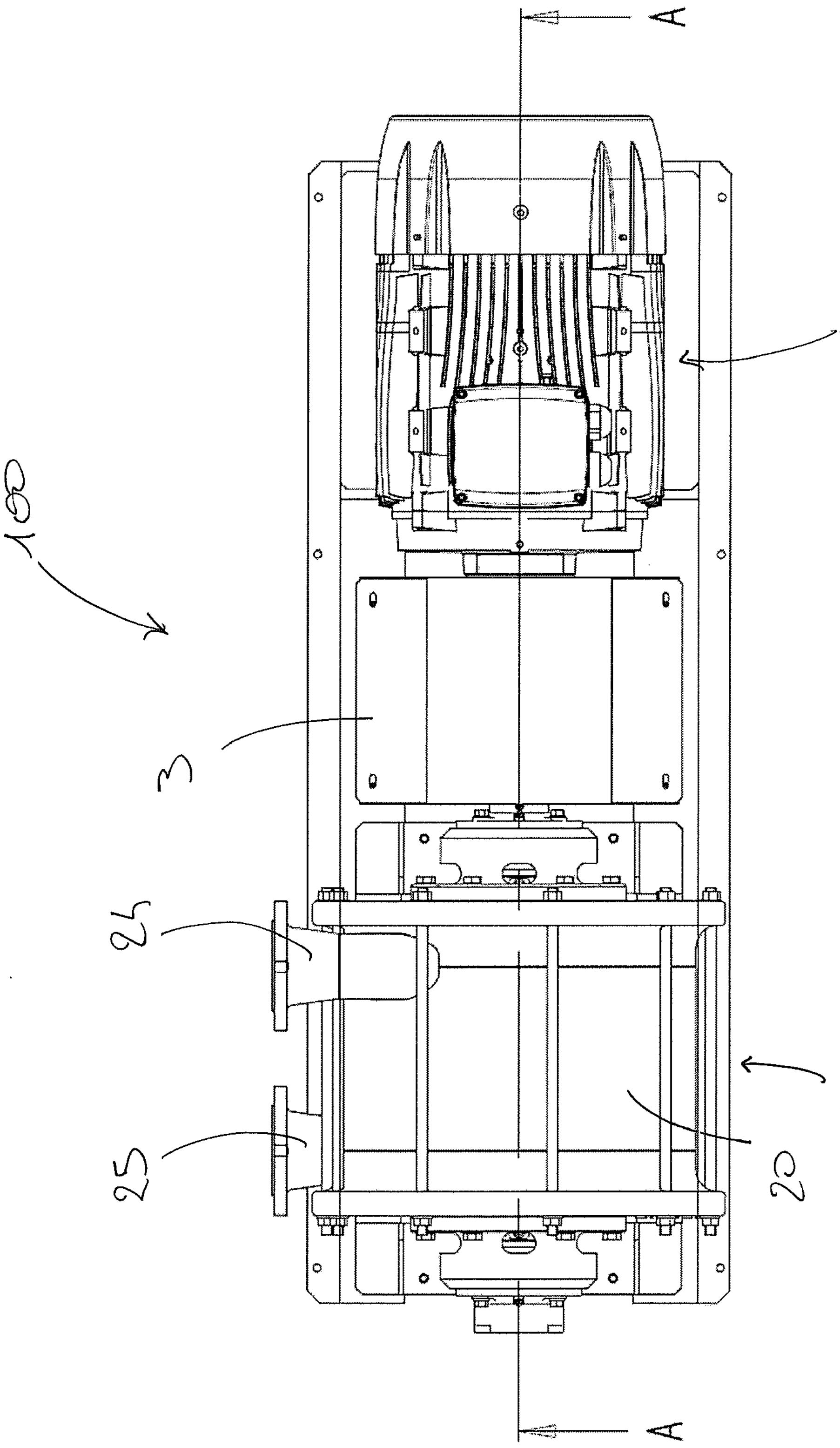

FIG. 1

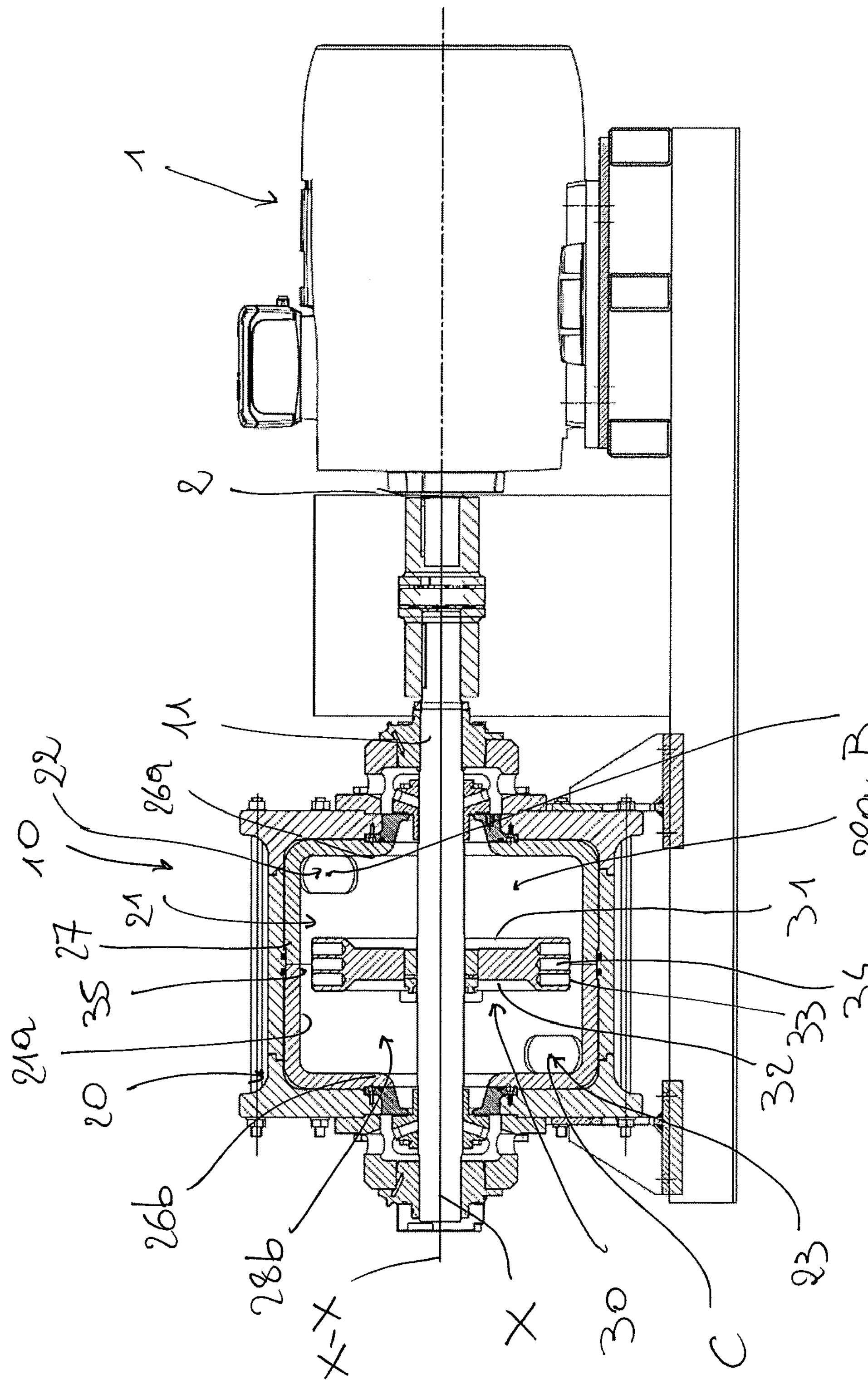

FIG. 2

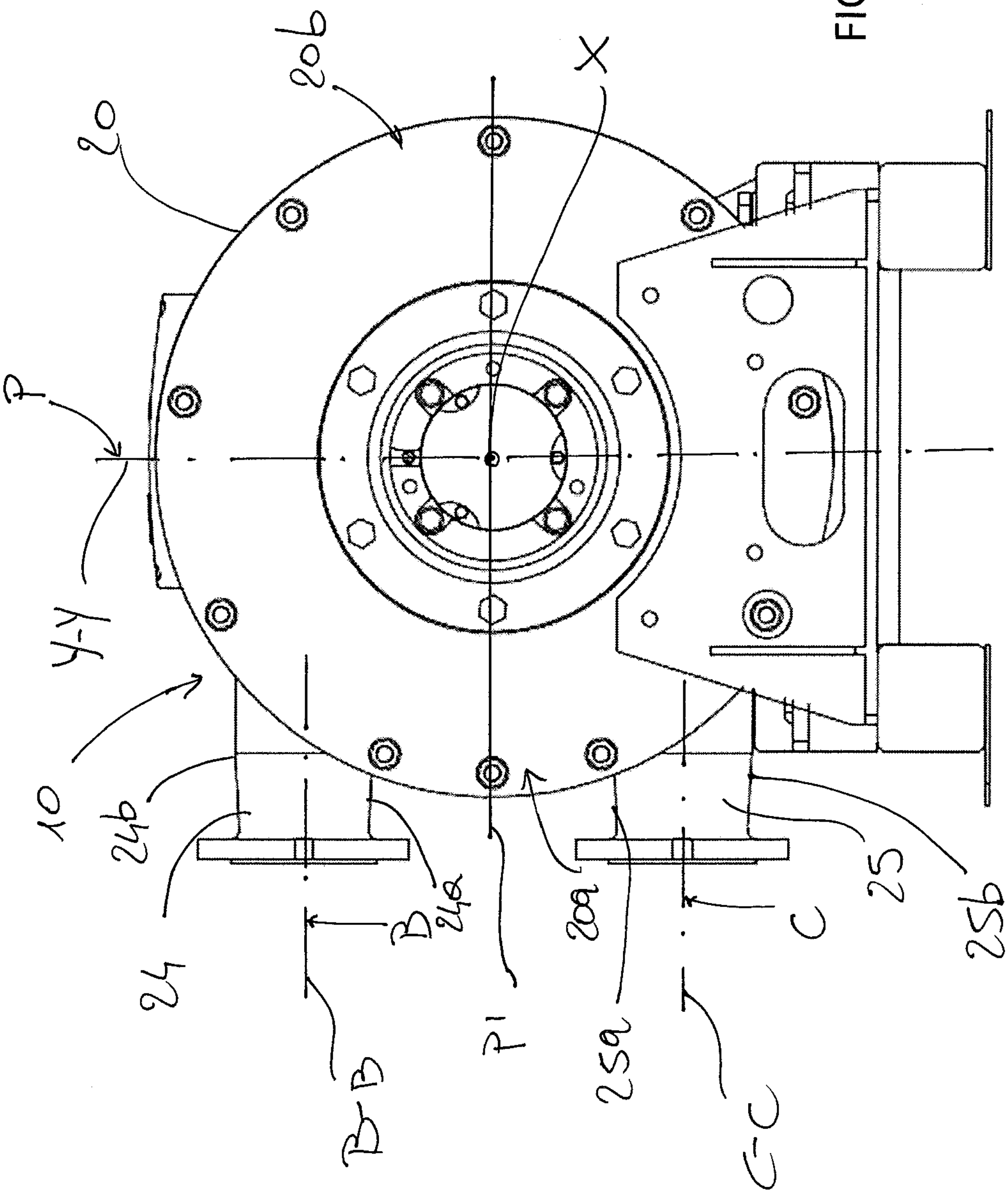

FIG. 3

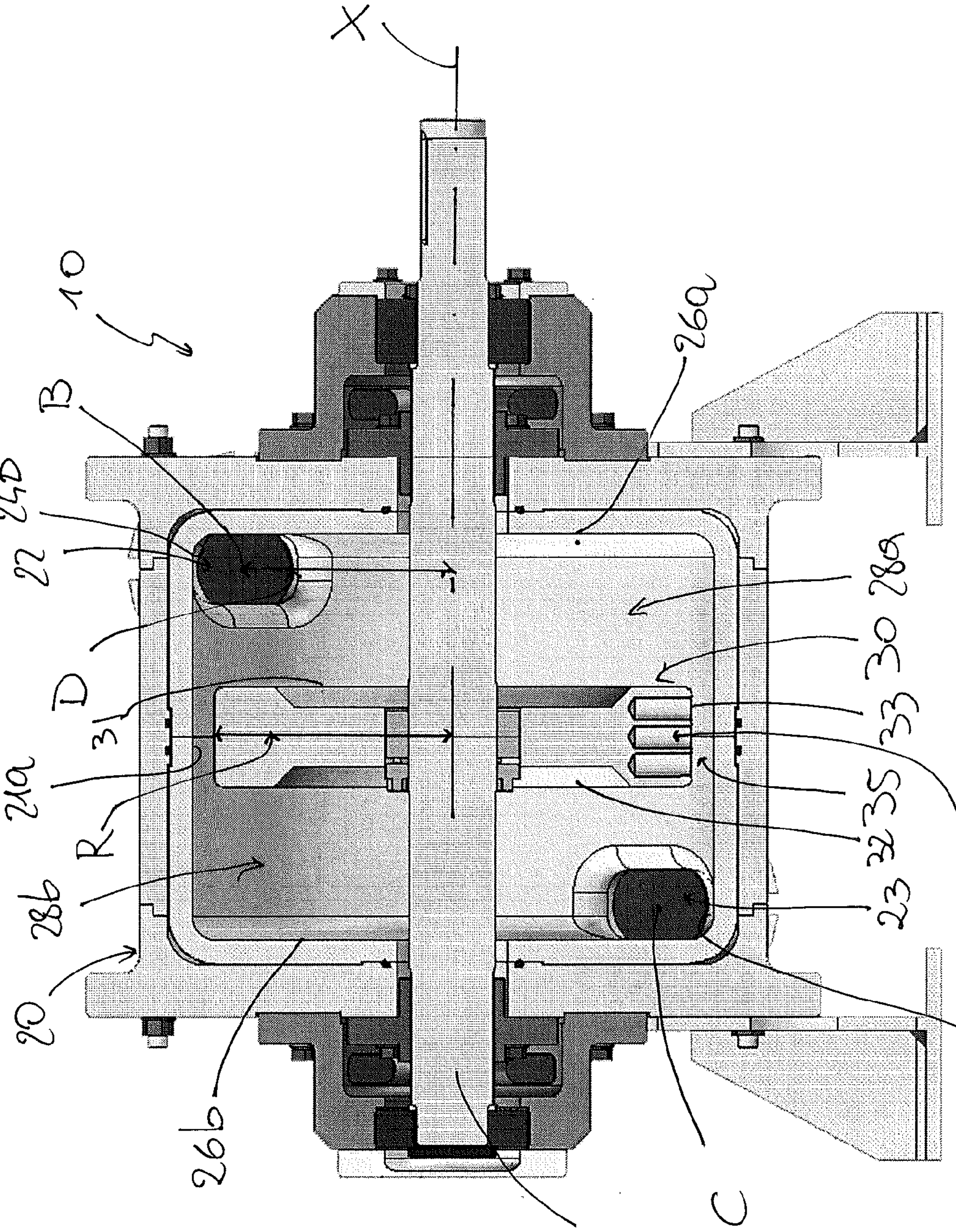

FIG. 4

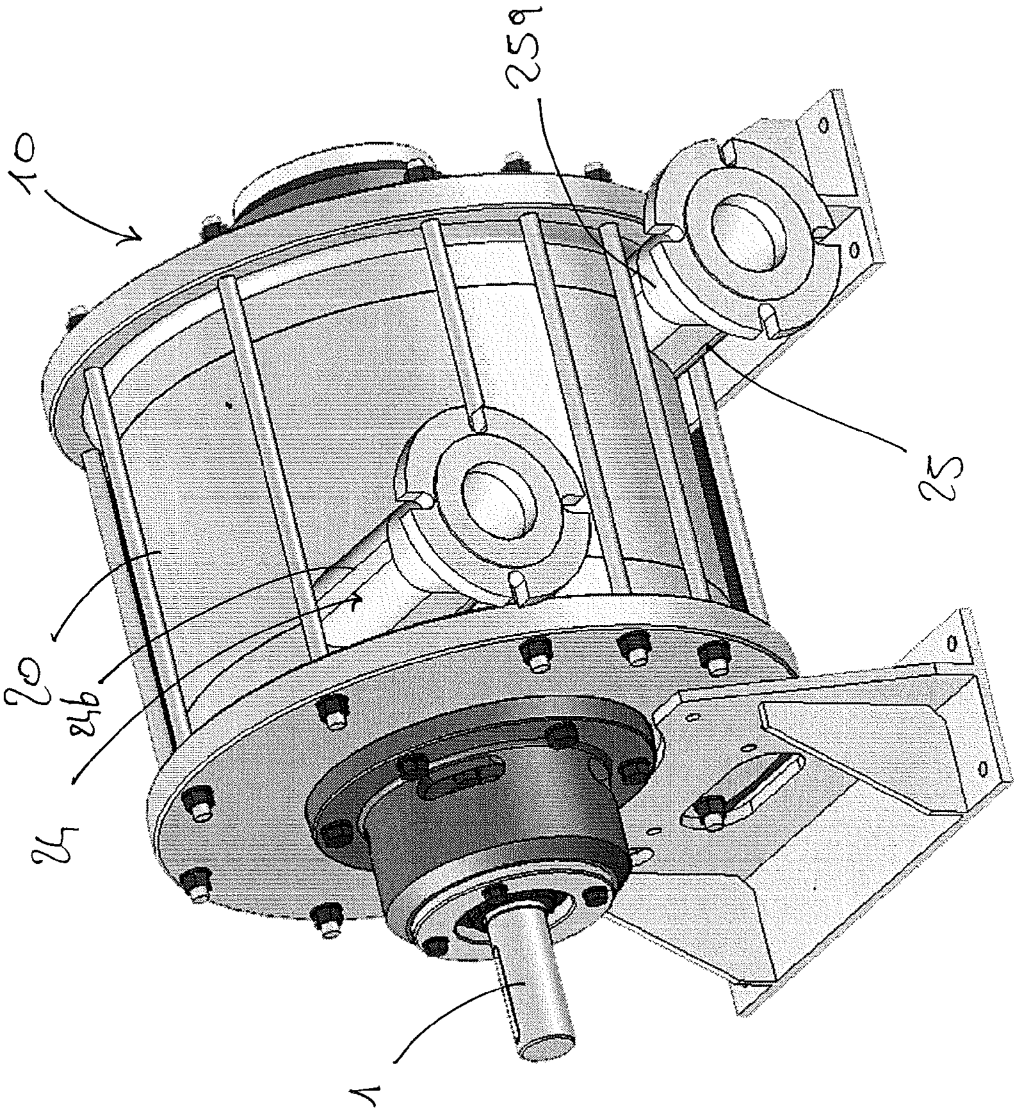

FIG. 5

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EUROPEAN SEARCH REPORT

Application Number
EP 15 16 9737

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2011/081384 A1 (ARCHAMBEAU GREGORY J [US] ET AL) 7 April 2011 (2011-04-07) * figures 4-13 * * paragraphs [0204], [0208], [0243] - [0246], [0255] - [0257] * -----	1-11	INV. B01F7/00
X	WO 93/12872 A1 (STACHE HEINO [DE]) 8 July 1993 (1993-07-08) * figures 1-5 * * claim 1 * -----	1-11	

TECHNICAL FIELDS SEARCHED (IPC)

B28B
B01F

The present search report has been drawn up for all claims

2

Place of search	Date of completion of the search	Examiner
The Hague	10 November 2015	Voltz, Eric

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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10-11-2015

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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