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(71) Applicant: **Captech S.r.l.**
10129 Torino (IT)

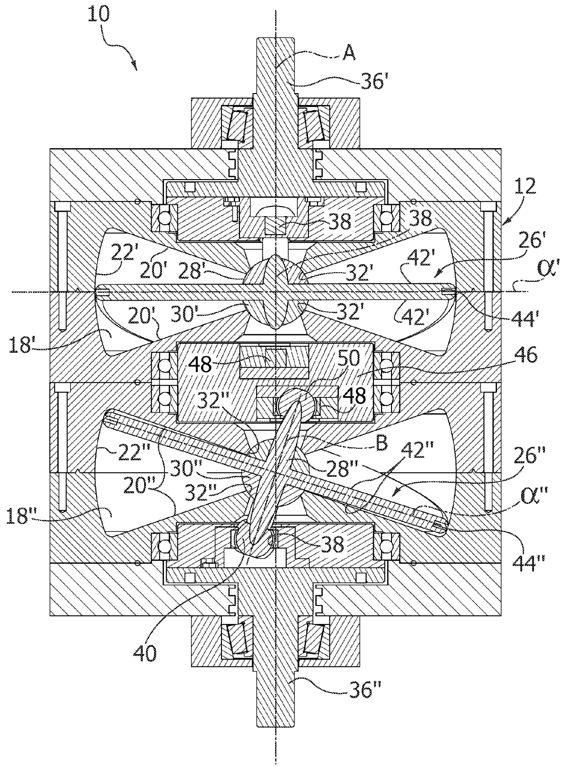
(72) Inventors:
- **Balbo Di Vinadio, Aimone**
  10050 Chiusa San Michele (Torino) (IT)
- **Pancaldi, Edoardo**
  10050 Chiusa San Michele (Torino) (IT)

(74) Representative: **Marchitelli, Mauro**
Via Maria Vittoria 18
10123 Torino (IT)

(54) **Oscillating-disk fluid machine**

(57) A fluid machine comprising:
- a casing (12) having a first chamber (18') and a second chamber (18"), which have rotational symmetry about a common main axis (A), wherein said first and second chambers (18', 18'') are provided, respectively, with a first inlet opening (14') and a second inlet opening (14'') and a first outlet opening (16') and a second outlet opening (16'') for a flow of fluid, the first outlet opening (16') being connected to the second inlet opening (14");
- a diaphragm (24) fixed with respect to the casing (12), which extends within said chambers (18', 18'') and separates the first inlet opening (14') from the first outlet opening (16') and the second inlet opening (14") from the second outlet opening (16");
- a first disk (26') and a second disk (26') housed in said chambers (18', 18''), said disks (26', 26'') having respective shafts (28', 28'') with disk axes (B', B") inclined with respect to said main axis (A), each of said disks (26', 26") being able to oscillate in the respective chamber (18', 18") in such a way that each disk axis (B', B") performs a motion of precession about said main axis (A), wherein the disk axes (B', B") are angularly staggered with respect to one another; and
- an interconnection member (46), which can turn with respect to the casing (12) about the main axis (A) and has two eccentric spherical seats (48) angularly staggered with respect to one another that are engaged by respective spherical members (50) arranged at respective ends of said shafts (28', 28").

FIG. 3



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Description

Field of the invention

[0001] The present invention relates to oscillating-disk fluid machines.

[0002] By the term "fluid machines" are meant machines designed to produce mechanical energy (such as, for example, turbines or motors) that use the energy of a flow of fluid in motion or else machines that use mechanical energy (such as, for example, pumps or compressors) to set in circulation or to compress a flow of fluid. In either case, the flow of fluid can be liquid or gaseous.

[0003] In particular, the invention regards a fluid machine equipped with at least one oscillating disk, which is mobile in a cavity with rotational symmetry with a motion of precession.

Description of the known art

[0004] Fluid machines having an oscillating disk that is mobile with a motion of precession are known, for example, from the documents Nos. GB1103271, WO02/14800, GB2115490, and GB1178399.

[0005] Machines of this type comprise a casing having a chamber with rotational symmetry about a main axis, a diaphragm fixed with respect to the casing that separates an inlet opening from an outlet opening for a flow of fluid, and a disk housed in said chamber having a median plane that divides the chamber into two sections, where the disk has a disk axis orthogonal to said median plane and inclined with respect to said main axis and where the disk has a radial slit through which said diaphragm extends.

[0006] In operation, the flow of fluid that traverses said chamber causes an oscillation of the disk so that the disk axis performs a movement of precession about said main axis. The movement of precession is such that the disk axis describes a conical surface coaxial to the main axis and having its vertex located at the centre of the disk. During said movement of precession the disk does not turn about its own axis.

[0007] It has been noted that in oscillating-disk fluid machines of this type the torque on the output shaft varies according to a periodic law during the cycles of oscillation of the disk, with the result that the output shaft and the transmission members connected thereto are subjected to impulsive stresses that cause vibrations.

[0008] This problem becomes particularly serious in the case of high-power machines, where the impulsive stress due to the cyclic fluctuation of the torque could jeopardize operation of the machine.

Object and summary of the invention

[0009] The object of the present invention is to provide an oscillating-disk fluid machine that can be used with high powers without incurring in the problems of known solutions.

[0010] According to the present invention, said object is achieved by an oscillating-disk fluid machine having the characteristics forming the subject of Claim 1.

Brief description of the drawings

[0011] The present invention will now be described in detail with reference to the attached drawings, given purely by way of non-limiting example, wherein:

- Figure 1 is a perspective view of a fluid machine according to the present invention;
- Figure 2 is a plan view of the machine of Figure 1; and
- Figure 3 is a cross section according to the line III-III of Figure 2.

Detailed description of an embodiment of the invention

[0012] With reference to the figures, designated by 10 is a fluid machine according to the present invention. The fluid machine 10 can operate with liquid or gaseous fluids and can likewise operate both as turbine or motor and as pump or compressor.

[0013] The fluid machine 10 comprises a stationary casing 12, defined in which are a first chamber 18' and a second chamber 18" that communicate with respective first and second inlet openings 14', 14" and with respective first and second outlet openings 16', 16" for the flow of fluid. The first outlet opening 16' communicates with the second inlet opening 14" via a duct 17.

[0014] With reference to Figure 3, the chambers 18', 18" both have a rotational symmetry about a common main axis A. Each chamber 18', 18" is defined between two contact walls 20', 20" and a spherical side surface 22', 22''.

[0015] In the example illustrated, the contact surfaces 20', 20" are conical surfaces with axis coinciding with the main axis A. As an alternative, the contact surfaces 20', 20" can be plane and orthogonal with respect to the main axis A, as described in a simultaneous patent application filed in the name of the present applicant. Both of the spherical surfaces 22 have the respective centres on the axis A.

[0016] With reference to Figure 2, a diaphragm 24 fixed with respect to the casing 12 extends in the chambers 18', 18" and separates the openings 14', 16' and 14" 16" from one another.

[0017] With reference to Figure 3, the fluid machine 10 comprises a first disk 26' and a second disk 26" housed inside the respective chambers 18', 18". Each disk 26', 26" has a respective median plane α', α'' that divides the respective chamber 18', 18" into two opposite sections, each of which is comprised between one side of the disk 26', 26" and the respective contact wall 20', 20''. Each disk 26', 26" has a respective disk axis B', B'' orthogonal to the respective median plane α', α''. The disk axes B', B" are inclined by a constant angle with respect to the main axis A and are staggered with respect to one another, for example by 90°.

[0018] Each disk 26', 26" has two contact surfaces 42', 42" symmetrical with respect to the median plane α. In the example illustrated the contact surfaces 42', 42" are parallel with respect to one another and orthogonal to the respective disk axis B. As an alternative, the contact surfaces 42', 42" may be conical, as described in a simultaneous patent application filed in the name of the present applicant. On the outer rim of each disk 26', 26" there can be provided an annular seat 44', 44" for a seal that acts on the respective spherical side surface 22', 22''. With reference to Figure 1, each disk 26', 26" has a respective radial slit 34', 34", extending through which is the diaphragm 24 that separates the openings 14', 16', 14", 16" from one another.

[0019] Each disk 26', 26" has a respective shaft 28', 28" sharing the disk axis B', B''. Each shaft 28', 28" extends through a respective spherical central portion 30', 30" fixed with respect to the respective disk 26', 26" and mounted oscillating between two opposed spherical seats 32', 32" formed at the centre of the respective contact walls 20', 20".

[0020] With reference to Figure 3, the machine 10 comprises a first rotating member 36' and a second rotating member 36'', which turn both with respect to the casing 12 about the main axis A. Each of the two rotating members 36', 36" has a respective spherical seat 38, eccentric with respect to the axis of rotation A. Each spherical seat 38 is engaged in such a way that it can be turned by a respective spherical member 40 set at the respective end of the shaft 28', 28" of the disks 26', 26''. In the representation of Figure 3, the spherical member 40 of the shaft 28' is not visible given that the plane of section is staggered with respect to the axis of the shaft 28'.

[0021] The fluid machine 10 moreover comprises an interconnection member 46, which is coaxial to the rotating members 36', 36" and can turn with respect to the casing 12 about the main axis A. The interconnection member 46 has two eccentric spherical seats 48 angularly staggered with respect to one another, which are engaged by respective spherical members 50 (just one of which is visible in the representation of Figure 3) arranged at the respective ends of the shafts 28', 28".

[0022] In operation, a flow of fluid enters from the first inlet opening 14', traverses the first chamber 18', exits from the first outlet opening 16', enters the second inlet opening 14", traverses the second chamber 18", and exits from the second outlet opening 16''.

[0023] The flow of fluid causes an oscillation of the disks 26', 26'', which occurs with a movement of precession of the axes B', B" about the main axis A. The movement of precession of the disks 26', 26" takes place without rotation of the disks 26', 26" about the respective axes B', B''. Rotation of the disks 26', 26" about the axes B', B'' can be prevented by the contact between one edge of the grooves 34', 34" and the diaphragm 24, or else means can be provided designed to prevent rotation of the disks 26', 26" about the axes B', B'', said means being arranged between the outer rims of the disks 26', 26" and the casing 12, as described in a simultaneous patent application filed in the name of the present applicant.

[0024] The motion of precession of the disks 26', 26" produces, by means of the spherical couplings 38, 40, rotation of the rotating members 36', 36" about the main axis A. The motion of precession of the disks 26', 26" moreover produces, by means of the spherical couplings 48, 50, rotation of the interconnection member 46 about the axis A.

[0025] The fact that the disks 26', 26" are connected to one another by means of the interconnection member 46 causes the instantaneous torque on the rotating members 36', 36" to be equal to the sum of the torques produced by the disks 26', 26" .

[0026] The disks 26', 26" are staggered with respect to one another by an angle equal to the phase offset between the maximum instantaneous torque and the minimum instantaneous torque of each disk 26', 26" , which in the case under examination is equal to 90°. In the steps in which the torque on the first disk 26' is minimum or close to the minimum, the torque on the second disk 26" is maximum or close to the maximum, and vice versa. Consequently, the instantaneous torque on the rotating members 36', 36" remains close to a constant value. In this way, any vibration due to the oscillations of torque on the output members 36', 36" are prevented.

[0027] The fluid machine 10 can also operate as pump or compressor. In this case, the vibrations due to a variation of the resistant torque on the disks 26', 26" are prevented.

[0028] Of course, without prejudice to the principle of the invention, the details of construction and the embodiments may vary widely with respect to what has been described and illustrated herein, without thereby departing from the scope of the invention, as defined by the ensuing claims.

Claims

1. A fluid machine comprising:

   - a casing (12) having a first chamber (18') and a second chamber (18"), which have rotational symmetry about a common main axis (A), each of said chambers (18', 18'') having a spherical side wall (22', 22'') and two contact walls (20', 20"), wherein said first and second chambers (18', 18'') are provided respectively with a first inlet opening (14') and a second inlet opening (14") and a first outlet opening (16') and a second outlet opening (16") for a flow of fluid, the first outlet opening (16') being connected to the second inlet opening (14");
   - a diaphragm (24) fixed with respect to the cas-

ing (12), which extends within said chambers (18', 18'') and separates the first inlet opening (14') from the first outlet opening (16') and the second inlet opening (14") from the second outlet opening (16");

- a first disk (26') housed in said first chamber (18') and a second disk (26'') housed in said second chamber (18"), each of said disks (26', 26") having a respective median plane (α', α") that divides the respective chamber (18', 18'') into two sections, said disks (26', 26") having respective shafts (28', 28") with disk axes (B', B") orthogonal to respective median planes (α', α'') and inclined with respect to said main axis (A), each of said disks (26', 26'') being able to oscillate in the respective chamber (18', 18'') in such a way that each disk axis (B', B'') performs a motion of precession about said main axis (A), wherein the disk axes (B', B") are angularly staggered with respect to one another; and
- an interconnection member (46), which can turn with respect to the casing (12) about the main axis (A), the interconnection member (46) having two eccentric spherical seats (48) angularly staggered with respect to one another that are engaged by respective spherical members (50) arranged at respective ends of said shafts (28', 28").

2. The fluid machine according to Claim 1, comprising a first rotating member (36') and a second rotating member (36'') that both turn with respect to the casing (12) about the main axis (A), each of said rotating members (36', 36'') having a respective spherical seat (38) eccentric with respect to the main axis (A) engaged in such a way that it can be turned by a respective spherical member (40) set at one end of a respective shaft (28', 28'').

3. The fluid machine according to Claim 1, wherein said disks (26', 26") are staggered with respect to one another by an angle equal to the phase offset between the maximum instantaneous torque and the minimum instantaneous torque of each disk (26', 26'').

FIG. 1

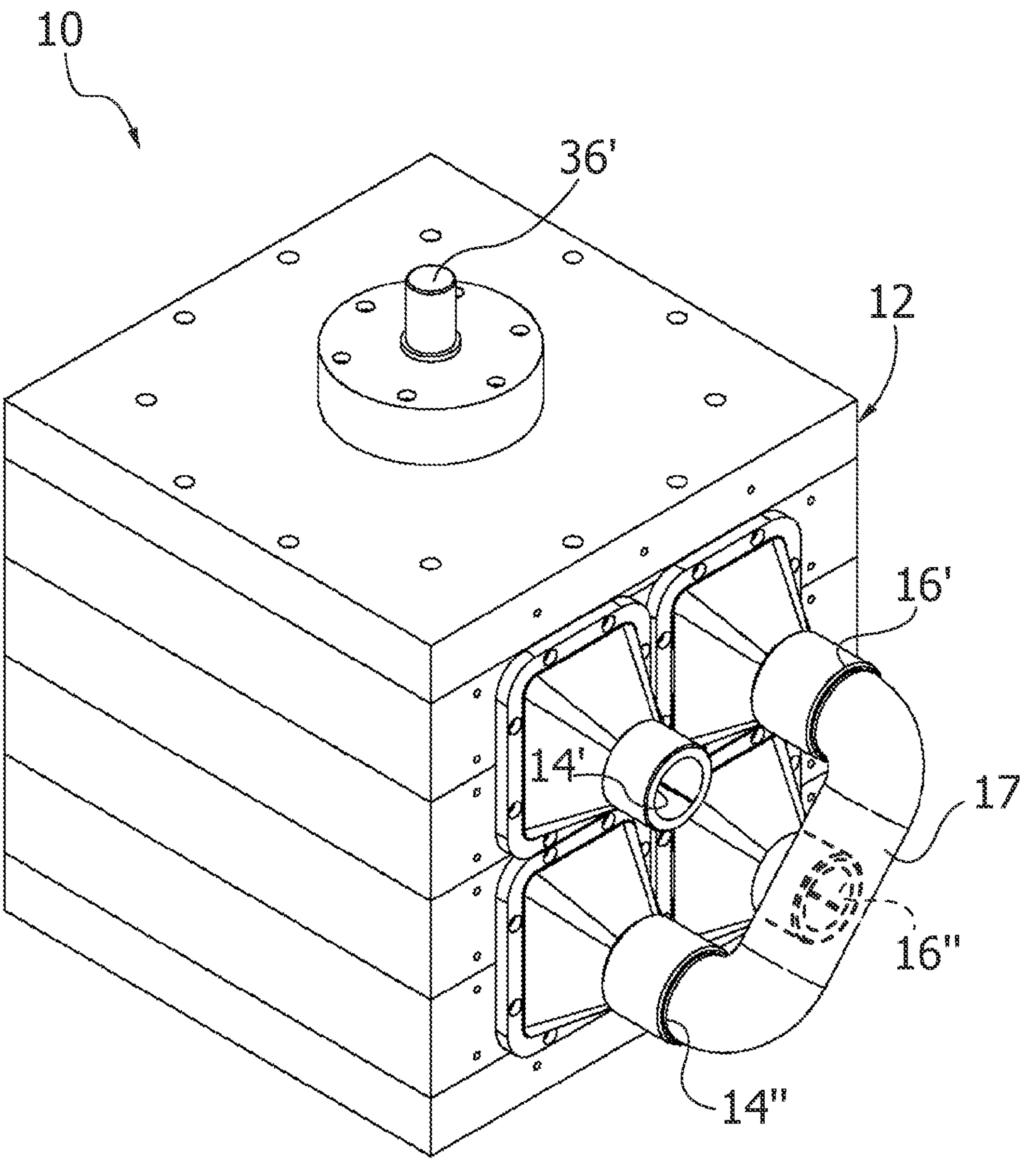


FIG. 2

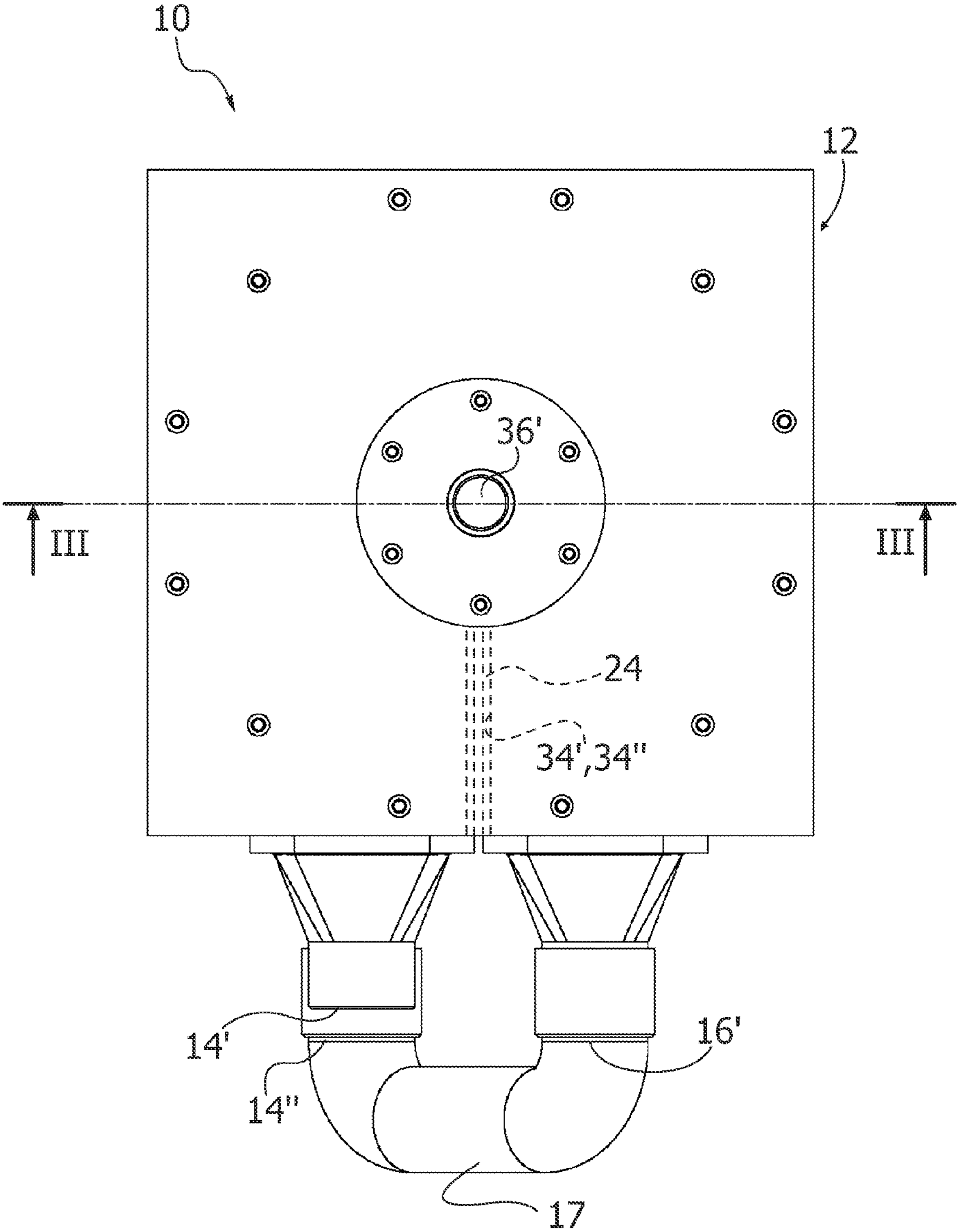
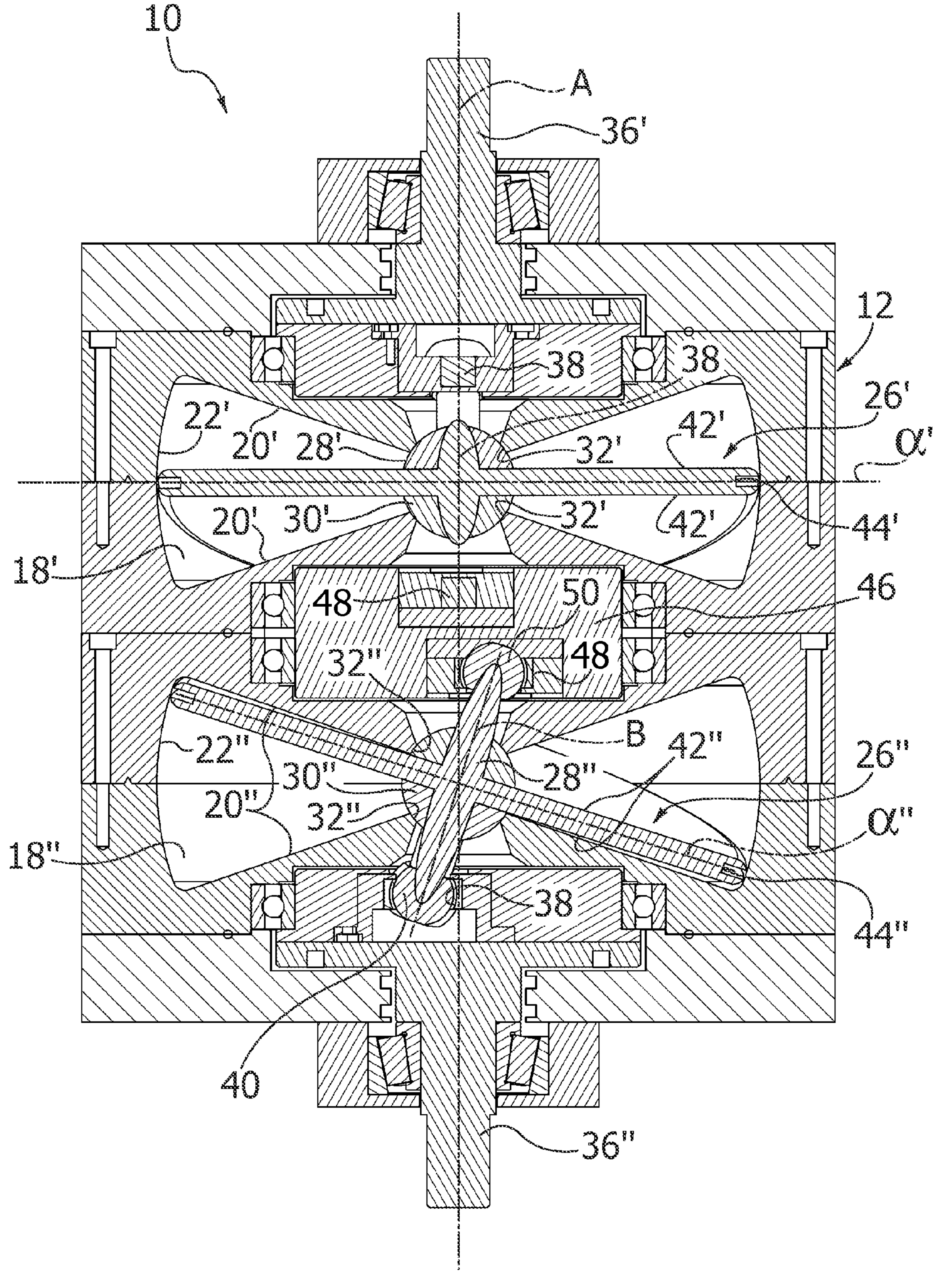


FIG. 3


10
A
36'
12
38
38
26'
22'
20'
28'
32'
42'
α'
20'
30'
32'
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α''
18''
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40
36''

REFERENCES CITED IN THE DESCRIPTION

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