

Rotary machine

The present invention relates to a rotary machine in the form of an expander, including a housing having a cavity, inlet and outlet ducts arranged in the housing and communicating with the cavity, a rotor received and supported in the housing and having a rotor axis, one or more vanes movably received in respective grooves in the rotor and where each vane is articulately connected about an axis to one end of a control arm which in the other end is rotatable supported in a shaft having a central axis coincident with the axis extending centrally through the cavity in the housing, which axis is parallel with and spaced apart a distance from the rotor axis, each vane tip describes a cylinder surface sector having its center of curvature in the axis through the joint that connects a vane with a control arm, at least one working chamber which is part of the cavity and is defined between the internal peripheral surface of the housing, the peripheral surface of the rotor and the side surface of at least one vane, where the rotor itself constitute the unit for power output.

The herein described and illustrated rotary machine is especially designed as an expander to be driven by steam.

The rotary machine can also be a thermo dynamical working machine which, after certain modifications, can be used both as compressor, pump, vacuum pump, heat exchanger and combustion engine. The rotary machine can be assembled of equal units and in series such that the machine principle is used both for the compressor unit and the combustion engine unit in a supercharged engine. Already at this stage, it is to be noted that the rotary machine is without any crankshaft and that the machine is supplied or takes out its power directly to/from the rotor.

The present rotary machine is a further development of the machine described in NO 307 668 (WO 99/43926), but still have many similar features and is thus incorporated as a reference.

Known combustion engines of the rotary type are embodied as rotating piston engines (Wankel). Here the rotating piston, which is in the form of a rotor having curved triangular shape, rotates in an annular cylinder chamber. Such combustion engines have, in addition to a complicated configuration, the
5 disadvantage that the rotor has considerable sealing problems against the cylinder wall. In addition, these combustion engines have high fuel consumption.

From DE-3011399 a combustion engine having an engine housing with a
10 working chamber that receives a continuously rotatable rotor, in addition to inlet and outlet for combustion gasses, is known. The rotor is substantially cylindrical and is rotating in an elliptical configured cavity which includes diametrically opposing combustion chambers defined by the rotor surface and the internal surface of the housing forming the cavity. The rotor is designed with radially
15 extending sliding grooves which receive and guide wing pistons able to slide radially in and out in the sliding grooves. The wings are articulated joined via a piston rod to a crank which in turn is part of a journalled crankshaft. When the rotor rotates, the wing pistons will move radially in and out within the sliding grooves due to the fixed journaling to said crank. In this way the first wing set
20 will act within one part of the cavity, i.e. the first combustion chamber, while the second wing set will act in the diametrically opposed chamber.

US patent 4,061,450 shows a rotary pump of the wing type having a stationary housing and a cavity receiving a rotor. The rotor has slit groves in which the
25 respective wings move, but in such a way that the wing tips moves toward and away from the internal peripheral surface of the housing for each rotation of the rotor.

US-patent 4451219 shows a rotary steam engine having two chambers and
30 omit valves. This engine also has two sets of rotor blades having three blades in each set. Each set of rotor blades rotates around its own eccentric point on a stationary common crankshaft within an elliptic motor housing. A rotor of the drum type is centrally mounted within the motor housing and forms two

diametrically opposed radially extending working chambers. The two sets of rotor blades move substantially radially in and out in sliding grooves in the rotor similar to the above described machine. Also here, the wings in their central end are supported in an eccentrically located shaft sub that is fixed. The wings,
5 however, are not articulated, but are in their opposite end tiltable supported in a bearing arranged peripheral in the rotor.

Pumps and compressors of the vane type are also known. US patent 4451218 is related to a vane pump having rigid vanes and a rotor which is eccentrically
10 supported in the pump housing. The rotor has slits through which the vanes radially pass and are guided by. At each side of the sliding openings seals are arranged.

US patent 4385873 shows a rotary machine of the vane type that can be used
15 as a motor, compressor or pump. This also has an eccentrically mounted rotor through which a number of rigid vanes radially pass.

Further examples of the prior art are shown in US 3537432, US 4767295 and
US 5135372.

20 Various objects with the present invention, though somewhat different regarding use and usage, is to provide a rotary machine having high efficiency, the ability to pump multi phase fluids, low fuel consumption and low emissions of polluting materials, like carbon monoxide, nitrous gases and non combusted
25 hydrocarbons.

Moreover, one object with the present invention is to provide a rotary machine of compact construction, i.e. small engine volume and small total volume relative to effect provided.

30 According to the present invention a rotary machine of the introductory said kind is provided, which is distinguished in that the housing is assembled of an internally cylindrical intermediate part interacting with the rotor and the vanes,

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one end cover at each end of the internally cylindrical intermediate part, and that the rotor forms a reel configuration having respective radially extending flange portions which are rotatable together with the vanes, and against which the respective side surfaces of the vanes act.

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In a preferable embodiment the rotor is assembled by two main parts, which parts together form the reel structure configuration. The partition surface between the two main parts will then typically extend in a radial direction.

10 In another embodiment the reel structure configuration can be manufactured in one single piece and then the housing will be assembled by two substantially C-formed housing parts, which parts together form the intermediate housing. This variant will have axially extending partition surfaces. Thus it will be possible to mount the two housing halves over the reel structure configuration when made
15 in one single piece.

In a preferable embodiment the radially extending flange portions have on their circumferential surface a fine clearance relative to the internal circumferential surface of the respective end covers.

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Preferably, the radially extending flange portions on their radially extending surfaces have a fine clearance relative to the internal end surface of the respective end covers.

25 Further, the radially extending flange portions on their radially extending surfaces can have a fine clearance relative to external, opposite radially extending surfaces of the intermediate housing.

Having such surfaces as mentioned that continuously alter direction, the fine
30 clearances between the surfaces will provide a form of touch free labyrinth sealing.

However, it is to be understood that at least one of said fine clearances between said surfaces can have installed one or another form of mechanical seal. One example will be a seal of the type "piston ring" having a split, or of the type metallic piston ring having hooked ends that hook to each other. This type
5 is often used as shaft seals in automatic transmissions.

Preferably the number of vanes can be three or more.

In one suitable embodiment, as here illustrated, the number of vanes is six.
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In one embodiment the vane tips can include sealing means.

Preferably, the vane grooves can include slide bearings that interact with each vane.
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Suitably, the fixed shaft in its free end can be supported and stabilized in the rotor by means of an eccentric adapter.

One exemplified embodiment of the rotary machine according to the invention,
20 will now be described in closer detail with reference to the appended drawings where:

Fig. 1 shows in perspective view the completely assembled rotary machine as a very compact unit,

25 Fig. 2 shows in perspective view the machine according to figure 1 with the parts separated from each other,

Fig. 3 shows in perspective view the rotor alone and with the parts separated from each other,

Fig. 4 shows in perspective view the vanes separated from the rotor,

30 Fig. 5 shows in perspective view one single vane including its control arms,

Fig. 6 shows the vane unit and its journalled shaft and one end cover,

Fig. 7 shows a variant where the intermediate housing is divided in two C-formed parts,

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Fig. 8A shows in perspective view a rotary machine having three vanes as a second embodiment,

Fig. 8B shows in perspective view the rotary unit of the second embodiment,

Fig. 9A shows in perspective view the rotary unit of the second embodiment

5 without the one end cover, and

Fig. 9B shows in perspective view the rotary unit of the second embodiment where the vane unit is pulled out.

Fig. 1 shows an embodiment of a rotary machine according to the invention in
10 the form of an expander 1 ready assembled and in the way it will look like during use. The expander 1 includes a housing 5 that circumscribe a rotor supported within the housing 5. The housing 5 includes an inlet 11 for vapor and an outlet 12 for expanded vapor. An axle or shaft 3 forms power take off and can be connected to other machinery for usage of the energy of the rotary
15 machine.

In order to understand the construction of the rotary machine reference is given to fig. 2 showing the individual parts and how they are assembled to form the expander 1. Reference is also given to NO 307668 (WO 99/43926) to ease the
20 understanding of the mode of operation of the machine.

Again, it is to be noted that this is an embodiment of the machine which is designed as an expander. As mentioned the construction, with various minor modifications and adaptations, can also be used to construct a combustion
25 engine, compressor, heat exchanger or pump as examples. It is further to be noted that the machine is constructed and manufactured with such precision that use of seals shall be at a minimum. The construction material can be different steel grades, but also plastics and Teflon may be well suitable for some applications.

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The expander 1 includes an intermediate housing 5c and first and second end covers 5a, 5b which together enclose a rotor 2. The intermediate housing 5c has an internal cylindrical surface 5d that circumscribe the rotor 2, which rotor 2

in turn is eccentrically located relative to the internal cylindrical surface 5d. The shaft 3 representing the power take off from the rotor 2 is shown on figure 1 and 2. Note that the machine is omit crankshaft and the power is taken out directly from the rotor 2 through the shaft 3. The rotor 2 rotates about a rotary axis A that is different from the longitudinal axis, marked B in fig. 2, of the intermediate housing 5C.

The figures illustrate how the intermediate housing 5c is assembled together with the end covers 5a, 5b by means of a series bolts 10 around the circumference thereof. The internal cylindrical peripheral surface 5d of the intermediate housing 5c circumscribes a cavity 9. The peripheral surface 5d has respective ducts recessed therein that define inlet 11 and outlet 12.

For the further physical structure of the expander 1, and in particular the rotor 2, reference is now made to figure 3, which should be view together with figure 2. Fig. 3 shows the rotor housing made up by two rotor housing halves 2a, 2b and the vane unit 17 of the rotor 2. Each vane unit 17 is in turn made up by six rotor vanes 15a, 15b, 15c etc, see figure 5. Each rotor vane 15a, 15b, 15c etc slideably co-acts with respective radially extending slits 18a formed in the rotor housing 2a, 2b. The side surfaces of the slits 18a support and carry slideably the respective rotor vanes 15a, 15b, 15c etc when the expander is in operation. Under "full throttle", the force acting in the circumferential direction against the respective rotor vanes 15a, 15b, 15c etc, will be substantial and contributes to a tilting or pitching moment in the rotor vanes 15a, 15b, 15c etc about a line along the exit opening of the slit 18a.

The vane unit 17, as clearly shown on fig. 4 and 5, with the parts spaced apart, also show a number of control arms 14a, 14b, 14c etc where two and two are supposed to carry respective rotor vanes 15a, 15b, 15c etc. Each pair of control arms 14a, 14b, 14c etc and the rotor vane 15a, 15b, 15c etc have the same function and they are articulately connected to each other via an axle having an axis C. The control arms 14a, 14b, 14c etc are assembled such that their larger holes are aligned for later assembly to a common shaft 24. When these parts

are mounted together they form the vane unit 17 of the rotor 2 operating on the shaft 24 as clearly illustrated in figure 6.

Each vane tip 15a', 15b', 15c' etc describes a cylinder surface sector having its
5 centre of curvature in the axis C through the joint connecting the vanes 15a, 15b, 15c etc to the control arms 14a, 14b, 14c etc. The idea behind this is that the vane tip, along an imaginary line extending in parallel with the rotor axis A, is at any time to "touch" the internal surface 5d of the intermediate housing 5c, but still not make direct contact with the surface 5d. This imaginary line will
10 "move" back and forth on the vane tip during rotation of the rotor 2 and will at any time describe a cylinder surface which is approximately equal to the internal surface 5d of the housing 5c with difference only in the clearance present between the vane tip and the internal surface 5d of the housing. The clearance between the vane tip and the internal surface 5d shall be as small as practically
15 possible to make it.

Each vane tip 15a', 15b', 15c' etc can also be formed of different material than the vane itself, such as shown on the figures. Each vane tip 15a', 15b', 15c' etc can be in the form of an insert. They can also in some applications be in contact
20 with the surface 5d, and even be spring loaded against the surface 5d.

Reference is again made to fig. 2 which shows that the first end cover 5a also carries a first bearing L_1 which in turn supports the rotor 2 in one end, i.e. via the axle shaft 3 along the axis A and centrally within the end cover 5a.
25 Correspondingly the second end cover 5b is shown carrying a second bearing L_2 that supports the rotor 2 in the opposite end and centrally within the end cover 5b, still along the axis A. It is to be noted that the rotor 2 is not supported in the axle shaft 24, but in the central bearing boss 5b' via the bearing L_2 . The bearing boss 5b' is located concentric internally of the end cover 5b.

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It is further to be understood that the rotor needs to be mounted in the intermediate housing 5c in such a way that the respective housing halves 2a, 2b are displaced towards each other from each side of the intermediate housing

5c. The rotor 2, having the shape of a reel, will have its side or end walls extending beyond the side surfaces of the intermediate housing 5c when the parts are mounted to each other. Thus, only the vane tips 15a', 15b', 15c' etc are located inside the internal surface 5d of the intermediate housing 5c.

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The rotor housing 5 is thus made up by an internally cylindrical intermediate part 5c co-operating with the rotor 2 and the vanes 15a, 15b, 15c etc and respective end covers 5a, 5b at each end of the internally cylindrical intermediate part 5c. The rotor 2 is in turn made up by two main parts 2a, 2b
10 which together form a reel structure configuration having respective radially extending flange portions 2a', 2b' which are rotatable together with the vanes and against which the respective side surfaces of the vanes act.

It is further to be understood that in a practical embodiment the radially
15 extending flange portions 2a', 2b' will on their peripheral surface have fine clearance relative to an internal circumferential surface in the respective end covers 5a, 5b. Further, the radially extending or pointing flange portions 2a', 2b' will on their radially pointing surfaces have fine clearance relative to an internal end surface in respective end covers 5a, 5b. Also the radially pointing flange
20 portions 2a', 2b' have on their radially pointing surfaces fine clearance relative to external opposite radially pointing surfaces on the intermediate housing 5c. Thus it is to be understood that the mentioned fine clearances between the mentioned surfaces provides kind of a contact free labyrinth sealing. It is still possible that in some circumstances, or situations, it will be appropriate to install
25 a suitable physical sealing organ between one or more of the surfaces having said fine clearance. In order to enhance the labyrinth sealing effect, one or more grooves can in addition be formed in the peripheral surfaces of the flange portions 2a', 2b'. Alternatively one or more grooves can be formed internally in the covers 5a, 5b into which the flange portions 2a', 2b' extend and to which
30 said peripheral surface interface.

However, it is to be understood that at least one of said fine clearances between said surfaces in some embodiments can have installed one or another

form of mechanical sealing means. One example can be a seal of the type "piston ring" having a split, or of the type metallic piston ring having hooked ends to be hooked to each other. This type of seal is frequently used as shaft seals in automatic transmissions. "The piston rings" can be spanned against the
5 housing and may form one or more further labyrinths with corresponding grooves in the side or end walls of the reel.

Velocity, temperature, purity requirements and pressure will be factors to determine which type of material that is suitable, but the reel walls are as
10 mentioned already a labyrinth in itself. As already known, the clearances are made as small as possible and are adapted to the substance to be put through.

Fig. 6 shows the axle shaft 24 to be introduced into the vane unit 17 and to journal the respective control arms 14a, 14b and 14c etc. The shaft 24 has the
15 central axis B which is different from the axis A. The figure shows the shaft 24 and a bearing 25 ready for installation on the end of the shaft 24. The bearing 25 is located eccentric in the bearing boss 5b'. The rotor housing covers 5a, 5b are centric relative to the axis A, but eccentric relative to longitudinal axis B of the intermediate housing 5c and the axle shaft 24. At the same time the axle
20 shaft 24 supports each vane 15a, 15b, 15c etc centrically relative to the longitudinal axis B, but eccentrically relative to the longitudinal axis A through the rotor housing.

This means that the vanes 15a, 15b and 15c etc, when considering the vanes in
25 isolation or separately, actually do not move radially neither in nor out, but perform a small nodding or tilting movement about the axis C when the rotor 2 rotates. Since the halves 2a, 2b of the rotor housing is eccentric located relative to the vanes 15a, 15b, 15c etc, i.e. has a different rotary axis than the vanes, the vanes 15a, 15b, 15c etc will apparently move in and out within the grooves
30 18a. With that we obtain, during the rotation of the rotor 2, one chamber behind a vane that expands until it reaches a maximum volume until it again decreases. Further, a very significant result is obtained in that no radially acting mass forces arises that would create imbalances.

As one will understand, the axle shaft 24 is at stand still and is fixedly secured. The duty thereof is to control the vanes 15a, 15b, 15c etc via the control arms 14a, 14b, 14c etc in their relative movement relative to the grooves 18a. Still, it
5 is possible to contemplate a variant where the axle shaft 24 is rotatable or is not "fixed".

Each vane 15a, 15b, 15c etc is as mentioned articulately connected to one end of a control arm 14a, 14b, 14c etc, which in its other end is rotatable journalled
10 in the stationary axle shaft 24. The control arms 14a, 14b, 14c etc do not transfer any working forces, but provides for that each vane 15a, 15b, 15c etc is controlled by forced motion in the guide grooves or slits 18a in the rotor housing 2a, 2b such that the vane tips 15a', 15b', 15c' etc at any time during the rotation of the rotor 2 are tangent (touching without contact) to the internal surface 5d of
15 the intermediate housing 5c.

The cavity 9 can be subdivided in an expansion chamber 9a and an outlet chamber 9b, which chambers are displaced during rotation and are determined by the position of the vanes relative to the inlet 11 and outlet 12.

20 The operation of the rotary machine will now be described and with reference to the drawings. As previously mentioned, the embodiment example shows an expander. A throttling medium such as vapor is supplied to the inlet. The vapor hits a vane tip and experiences expansion and thus is pushing on the vane.

25 Even if the expansion chamber 9a gradually is cut off by a new vane tip emerging, the action surface toward the preceding vane will be larger and thus apply force in same direction. Immediately after the expansion chamber has reached its maximum, the outlet chamber 9b opens up and let the expanded vapor pass out the outlet 12.

30 The period of expansion starts when a vane 15a, 15b, 15c etc passes the inlet duct 11 to the chamber 9a and lasts until the vane opens up for the outlet chamber and the outlet duct 12. As one will understand, that side of the vanes

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15a, 15b, 15c etc facing opposite to the rotation direction R constitutes the pressure side of the expander. Technically considered, the expansion period includes both the filling phase and the expansion phase of a chamber. For the chamber defined by the rotor, housing, vane 15a (in front in rotation) and 15b (last in rotation), the filling phase will start when 15a passes the beginning of the inlet and end when 15b passes the end of the inlet. The expansion phase begins when the filling phase terminates and ends when 15a passes the beginning of the outlet.

10 It is further to be understood that the vane tips perform a "rolling motion" against the internal cylinder surface 5d of the intermediate housing 5c during its revolution with the rotor 2. By one half revolution of the rotor 2, each vane tip has performed one rolling motion between the outer edges of the vane tip arc. Thus the vane tips are rolling one time forth and back during one revolution of
15 the rotor 2.

Reference is now made to fig. 7 showing schematically a rotary machine housing where the intermediate housing 5c' is made up by two substantially C-formed housing parts 5e, 5f. The housing parts 5e, 5f form together a housing
20 having axially extending partition surfaces. It is bolted together in top and in bottom and can with preference be machined subsequent to such assembly such that a finishing fine machining turning and adaption are made before final assembly over a reel structure configuration, which reel then can be made in one single piece, though not necessarily. The inlet and outlet ducts are not
25 drawn.

Fig. 8A – 9B show a second embodiment where the rotor has three vanes only and the circumscribing housing is somewhat simplified. The entire construction of the rotary machine will not be described again, only those parts that deviate
30 from the first embodiment.

Fig. 8A shows the rotary machine 1A, or the expander, in perspective view and where the rotary unit 2A is shown pulled out of the housing 5A. It is also shown

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an outlet duct U internally of the housing 5A, and an inlet hole H with an option to make connection. In fig. 8B the rotor unit 2A is shown in perspective view.

Fig. 9A shows in perspective view the rotary unit 2A in the second embodiment
5 without the first end wall, and where the three vanes $V_1 - V_3$ are shown. In fig. 9B the vane assembly 17A is shown pulled out from the rotary unit 2A.

The rotary machine 1A includes as mentioned the housing 5A having an
internal cylindrical cavity 9A and respective end covers, where one end cover
10 5aA is shown. Inlet and outlet channels or ducts H, U are provided in the housing 5A and are in communication with the cavity 9A. A rotor 2A is received and supported in the housing 5A and have one or more vanes V_1, V_2, V_3 that are moveably received in respective grooves in the rotor 2A. Each vane V_1, V_2, V_3 are articulately connected about one axis CA to one end of a control arm
15 14A, 14B, 14C and in the other end is pivotable supported in an axle shaft having a central axis coincident with the axis extending centrally through the cavity 9A of the housing 5A. Each vane tip describes a cylinder surface sector having its centre of curvature in the axis through the joint connecting one vane V_1, V_2, V_3 with a control arm 14A, 14B, 14C. The rotor 2A is manufactured as a
20 reel structure configuration including respective radially pointing flange portions 2A', 2B'. The flange portions 2A', 2B' are co-rotating with the vanes V_1, V_2, V_3 and the respective end surfaces 15A'', 15B'', 15C'' of the vanes are acting against said flange portions 2A', 2B'. The radially pointing flange portions 2A', 2B' extend beyond the diameter of the cavity within the cylindrical intermediate
25 part of the housing 5A for the creation of a labyrinth seal with respective end covers and the internal cylindrical intermediate part.

P a t e n t c l a i m s

1.

A rotary machine (1) in the form of an expander, comprising a housing (5)
5 having an internally cylindrical cavity (9) and respective end covers (5a, 5b),
inlet and outlet ducts (11, 12) arranged in the housing (5) and communicating
with the cavity (9), a rotor (2) received and supported in the housing (5) and
having a rotor axis (A), one or more vanes (15a, 15b, 15c) movably received in
10 respective grooves (18) in the rotor (2), each vane being articulately connected
about an axis (C) to one end of a control arm (14a, 14b, 14c) and in the other
end being rotatable supported in a shaft (24) having a central axis (B)
coincident with the axis (B) extending centrally through the cavity (9) in the
housing (5), which axis (B) is parallel with and spaced apart a distance (d) from
15 the rotor axis (A), each vane tip describes a cylinder surface sector having its
center of curvature in the axis through the joint that connects a vane (15a, 15b,
15c) with a control arm, at least one working chamber (9a) which is part of the
cavity (9) and is defined between the internal peripheral surface (5d) of the
housing, the peripheral surface (18c) of the rotor (2) and the side surface (15')
20 of at least one vane, wherein the rotor (2) itself constitute the unit for power
output, **characterized in that** the rotor (2) is designed as a reel structure
configuration having respective radially extending flange portions (2a', 2b'),
which flange portions are co-rotatable with the vanes (15a, 15b, 15c), and
against which the respective end surfaces (15a'', 15b'', 15c'') of the vanes act,
and that said radially extending flange portions (2a', 2b') extend beyond the
25 diameter of the cavity of the cylindrical intermediate section (5c) of the housing
to form a labyrinth seal with respective end covers (5a, 5b) at each end of the
internal cylindrical intermediate portion (5c) of the housing.

2.

30 The rotary machine according to claim 1, **characterized in that** the rotor (2) is
made up by two main parts (2a, 2b), which parts together form said reel
structure configuration.

3.

The rotary machine according to claim 1, **characterized in that** the housing (5c') is made up by two substantially C-formed housing parts (5e, 5f), which parts together form a housing having axially extending partition surfaces and are adapted to be mountable over a reel structure configuration made in one piece.

4.

The rotary machine according to any of the claims 1-3, **characterized in that** the radially extending flange portions (2a', 2b') on their circumferential surface have a fine clearance relative to the internal circumferential surface of the respective end covers (5a, 5b).

5.

The rotary machine according to any of the claims 1-4, **characterized in that** the radially extending flange portions (2a', 2b') on their radially extending surfaces have a fine clearance relative to the internal end surface of the respective end covers (5a, 5b).

20 6.

The rotary machine according to any of the claims 1-5, **characterized in that** the radially extending flange portions (2a', 2b') on their radially extending surfaces have a fine clearance relative to external, opposite radially extending surfaces of the intermediate housing (5c).

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7.

The rotary machine according to any of the claims 4-6, **characterized in that** said fine clearances between said surfaces provides a form of touch free labyrinth seal.

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8.

The rotary machine according to any of the claims 4-7, characterized in that at least one of said fine clearances between said surfaces has a mechanical seal, such as of the type "piston ring".

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9.

The rotary machine according to any of the claims 1-8, characterized in that the number of vanes are more than three.

10 10.

The rotary machine according to any of the claims 1-9, characterized in that the number of vanes are six.

11.

15 The rotary machine according to any of the claims 1-10, characterized in that the vane tips include sealing means.

12.

20 The rotary machine according to any of the claims 1-11, characterized in that the vane grooves (18a) include slide bearings (22) that interact with each vane (15a, 15b, 15c).

13.

25 The rotary machine according to any of the claims 1-12, characterized in that the fixed shaft (24) in its free end is supported and stabilized in the rotor (2) by means of an eccentric adapter (25).

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