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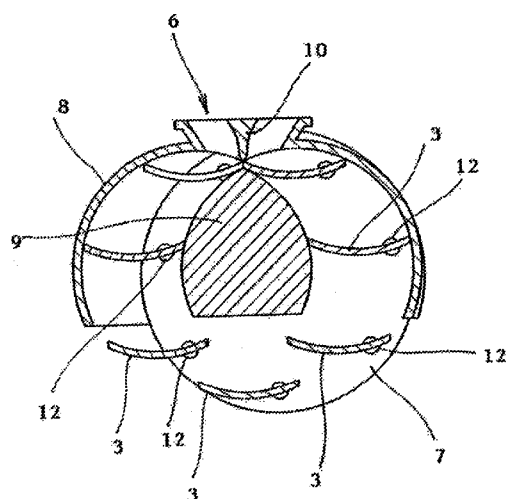


Fig. 6

(57) Abstract: The compressor (1) for the transport of gases is fitted with a vane wheel (2) enclosed in a cover (4). The cover (4) is equipped with at least one entry duct (5) and at least one exhaust duct (6). The bases (7) of the vane wheel (2) are not axially aligned and their axes (o) of rotation are parallel. The vanes (3) are arranged between the bases (7) and are tiltable to be able to adapt to the non-axial alignment of the bases (7) of the vane wheel (2). In addition, the compressor (1) is fitted with at least two compression barriers (8, 9) arranged on the opposite sides with regard to the outer and inner rims of the vanes (3) to form the compression space between at least two consecutive vanes (3), and the inlet of the exhaust duct (6) is fitted with the separator (10).

Compressor

Field of the Invention

The invention concerns a compressor for the compression and transport of gases.

Background of the Invention

So far, Root's type superchargers and superchargers with a side intake duct for the compression and transport of gases have been known. The Root's type superchargers operate on the principle of cycloidal-shaped rotating pistons that pump gas at the the supercharger inlet and exhaust it at the supercharger outlet. The cycloidal shape of the pistons ensures that the pistons complement one another at any phase of the cycle. Among the disadvantages of the Root's type supercharger are the discontinuity of the output pressure, where gas at the outlet of the supercharger pulsates, and the sensitivity to the temperature of the driven gas, where a higher temperature of the driven gas may result in the piston material expansion causing friction, and last but not least, the absence of the option to operate the supercharger in the reversing mode allowing the supercharger to be used as a gas turbine.

As far as the structural design of superchargers with a side intake duct is concerned, such superchargers comprise a cover with a hollow vane wheel mounting. The side intake duct for the transport of gas through the core of the vane wheel is arranged on the side of the vane wheel in the direction of its rotation axis, while the cover is equipped with the tangential duct for the flow of gas being transported from the supercharger. The gas is driven by turbulent flow generated by the vane wheel vanes. A supercharger with a side intake duct is suitable for the transport of hot gases and gases with a low content of impurities, e.g. for ventilation of mining activities. Among the disadvantages of superchargers with a side intake duct is the fact that the gas is not compressed, which means that the required exhaust pressure is not reached until a high rotational speed of the vane wheel. This results in a high noise level, a higher energy consumption and a faster wear of the moving components

of the supercharger. Another disadvantage of superchargers with a side intake duct is their ineffective reversing operation.

Common disadvantages of known superchargers include their low operating pressure being approximately 0.3 MPa and either impossible or very limited reversing operation.

Another item of the state of the art for the compression and transport of gases is compressors. Compared to superchargers, compressors attain a higher pressure of the compressed and transported gas. Compressors can be divided into positive displacement compressors and dynamic compressors based on the principle of their operation. Positive displacement compressors increase gas pressure by decreasing its volume, while dynamic compressors make gas flow and transform the energy of the gas into its higher pressure.

Among the known solutions of compressors are rotary vane compressors whose advantages include reversing operation, due to which they can be operated as e.g. a gas turbine. Rotary vane compressors are equipped with a vane wheel enclosed in a cover with entry and exhaust ducts that is connected to a shaft coupled with a source of mechanical energy. Among the disadvantages of the known rotary vane compressors is the necessity to start up the vanes up to high rotational speeds.

The purpose of the invention is to provide a compressor attaining the maximum output pressure at a lower rotational speed of the vane wheel and being capable of operation also in the reversing mode as a gas turbine.

Summary of the Invention

The set goal has been resolved by the design of the compressor according to the present invention described below.

The compressor for the transport of gases comprises a vane wheel fitted with vanes to drive gas when the vane wheel rotates and a cover delimiting the operating volume and

safeguarding the moving components of the compressor. The compressor cover is equipped with at least one gas entry duct and at least one gas exhaust duct.

The invention is based on the fact that the vane wheel has two bases that are not axially aligned but whose axes of rotation are parallel. When the vane wheel rotates, both bases rotate in a synchronous manner, each around its own axis of rotation. The position of the rotation axes during the vane wheel rotation does not change in any manner. Between the bases vanes for gas driving are mounted. The vanes are fixed between the bases with the possibility of rotation around their axes of fixation allowing them to tilt to the constant position within the framework of their full trajectory when they are driven by the vane wheel. In addition, the compressor is fitted with at least two compression barriers and a separator allowing the compression space to be defined. The compression space is delimited by the barriers, separator and vanes that enter the compression space. The external compression barrier is arranged before the exhaust duct in the direction of the vane wheel rotation and is situated along at least a part of the trajectory of the outer rims of the vanes. The internal compression barrier is arranged before the exhaust duct in the direction of the vane wheel rotation and is situated along at least a part of the trajectory of the inner rims of the vanes. The separator is arranged at the inlet of the exhaust duct. In addition, the internal compression barrier and the separator delimit the opening for the exit of the vanes from the compression space.

The synchronous movement of the non-axially aligned bases and the movable mounting of the vanes make it possible for the vanes to keep the same position during their movement around the circumference of the circle and when they enter the space between the compression barriers the gas becomes enclosed between the vanes that go one after another. By a gradual rotation of the vane wheel the volume between the vanes decreases thus increasing the pressure in the gas being transported. When attaining the inlet of the exhaust duct the gas leaves the compressor and the vane passes through the opening between the separator and the internal compression barrier. Selection of the number of vanes in the compressor allows the vanes to join one another fluently when passing the opening thus preventing the compressed gas from leaking through the opening.

In a preferred embodiment of the compressor according to the present invention the external compression barrier can move towards the inlet of the exhaust duct to change the pressure of the gas being transported. By moving the external compression barrier further towards the inlet of the exhaust duct the size of the volume between two consecutive vanes decreases, which increases the pressure of the gas being exhausted. The external compression barrier can be part of the cover, or it can be created in the compressor independently of the compressor cover.

In a preferred embodiment of the compressor according to the present invention the length of the external compression barrier along the trajectory of the outer rims of the vanes is adjustable to be able to change the size of the compression space. The quantity of gas enclosed between the vanes going one after another is affected by the time necessary for the consecutive vanes to get between the compression barriers. By changing the length of the external compression barrier the time of enclosing the gas being transported between the vanes can be controlled. In combination with adjusting the size of the inlet of the exhaust duct it is possible to optimally set the operating parameters of the compressor.

In a preferred embodiment of the compressor according to the present invention the bases around the circumference on the near sides are fitted with perpendicular pins to mount the vanes with the pins for both bases arranged in an alternating manner where the pitch of the bases is longer than the pins. Due to the fact that the pins are shorter than the pitch between the bases, damage of one base caused by the pin of the other base is eliminated. Using pins is easy in terms of design and very effective for the given application.

In a preferred embodiment of the compressor according to the present invention the pins are fixed in bearings that are integrated in the vane wheel bases or attached to them. As far as manufacture is concerned, it is easier to integrate bearings into the bases or to fix them thereto compared to integrating them into the openings for inserting pins formed in the rims of the vanes.

In a preferred embodiment of the compressor according to the present invention the bases of the vane wheel are fitted with oil channels opened into the bearings. Thanks to the oil channels and the action of centrifugal force the bearings lubrication is very easy.

In a preferred embodiment of the compressor according to this invention pins are attached to the vane wheel bases in a fixed manner and bearings for the pivotal mounting of the vanes onto pins are integrated in the vanes, or alternatively, bearings are attached to the vanes. The advantage of this solution rests in the fact that the pins can be simply welded onto the bases by which manufacture is further simplified.

In a preferred embodiment of the compressor according to the present invention the cross-section of the vanes is U-shaped. A U-shape increases the strength of the vanes which are then more resistant to applied stress.

In a preferred embodiment of the compressor according to the present invention the internal compression barrier is fitted with at least one compensating channel. The compensating channel allows the gas being compressed to leak into the ambient environment from the non-working space delimited by the internal compression barrier and the vane. This reduces energy losses related to the operation of the compressor.

Among the advantages of the invention is the capability of creating the required working pressure also at lower rotational speeds of the vane wheel along with the fact that the compressor can work in the reversing mode as a gas turbine. The invention can be employed instead of steam turbines that generate turbulences with consequent undesirable warming. In addition, the invention operated in the reversing mode does not need to be supplied with high-speed steam whose energy would remain unused in the compressor. Also the fact that the invention can be used to replace turbochargers in combustion engines, or if two inventions are coupled to make a system where one pushes the gas while the other decompress it allowing any gas to be burnt in the resulting space thus replacing the internal combustion turbine that has losses due to turbulences generated by the gas passing along the vanes, can be regarded as preferred. In addition, the invention can be preferably used in

systems designed to acquire energy from low differences between temperatures in the environment, such as a reversible heat pump.

Explanation of Drawings

The present invention will be explained in detail by means of the following figures where:

- Fig. 1 shows the rotary vane compressor according to the state of the art,
- Fig. 2 shows a plan view of the vane wheel of the compressor according to the present invention,
- Fig. 3 shows an axonometric view of the vane wheel of the compressor according to the present invention,
- Fig. 4 shows a graphic representation of the principle of the operation of vanes for the compressor according to the present invention in the compression space,
- Fig. 5 shows the A-A section of the compressor of Fig. 4,
- Fig. 6 shows the section passing through the half-plane of the compressor with a visible arrangement of vanes,
- Fig. 7 shows the axonometric view of the partly uncovered compressor,
- Fig. 8 shows the vane at the beginning of passing the opening between the internal compression barrier and the separator,
- Fig. 9 shows the enclosing of the compression space by a vane entering space between the external and internal compression barriers,
- Fig. 10 shows a vane half-way through its passage through the opening between the internal compression barrier and the separator,
- Fig. 11 shows a detail of vanes passing through one after another the opening between the internal compression barrier and the separator,
- Fig. 12 shows the ultimate position where one vane follows the other in the opening between the internal compression barrier and the separator.

An Example of the Invention Embodiment

It shall be understood that the specific cases of the invention embodiments described and depicted below are provided for illustration only and do not limit the invention to the examples provided here. Persons skilled in the art will find or, based on routine experiments, will be able to provide a greater or lesser number of equivalents to the specific embodiments of the invention which are described here. Also such equivalents will be included in the scope of the following patent claims.

Fig. 1 shows the compressor 1 with the entry duct 5 and the exhaust duct 6 according to the state of the art. In addition, the compressor 1 comprises the cover 4 and vane wheel 2 enclosed inside the cover 4. When the vane wheel 2 is started, turbulent flow is generated on the vanes 3 and the gas is drawn by the entry duct 5 of the vane wheel 2 vanes and then it is driven out of the compressor 1 by the exhaust duct 6.

Fig. 2 shows the vane wheel 2 of the compressor 1 designed according to the present invention. The vane wheel 2 does not have the rotation axes o of its bases 7 axially aligned and the rotation axes o of the bases 7 of the vane wheel 2 remain parallel. The mutual distance of the rotation axes o equals to the size of the radius of the bases 7 of the vane wheel base 2, or the distance is shorter.

For the sake of clarity, Fig. 2 shows only one vane 3, but in reality the vane wheel 2 has its vanes 3 arranged around the entire circumference at equal distances as shown in Fig. 6, so that the vanes 3, when the vane wheel 2 rotates, follow one another in the opening between the separator 10 and the internal compression barrier 9, see Fig. 11 and Fig. 12. The vanes 3 rotate around the axes u of the mounting.

Along the circumference of the bases 7 of the vane wheel 2 pins 11, aligned with the axes u of the mounting, have been formed; the axes are perpendicular to the bases 7 of the vane wheel 2. The pins 11 belonging to one base 7 do not touch the opposite base 7. The vane 3 is fitted on the pins 11. The pin 11 is inserted in the opening of the vane 3 and makes it possible for the vane 3 to move and tilt when the vane wheel 2 rotates.

The pin 11 can be welded onto the base 7, in which case the bearings 12 allowing the vane 3 to be tilted are mounted in the opening of the vane 3, or the base 7 can be fitted with integrated bearings 12 or bearings 12 welded-on from the outer side of the base 7, and the pins 11 are firmly attached to the vanes 3. In addition, lubrication of the bearings 12 integrated in the bases 7 can be ensured using oil channels.

Fig. 3 shows the vane wheel 2 in the axonometric and partially transparent projection. For the sake of clarity, Fig. 3 shows the only vane 3 as in the case of Fig. 2. The shape of the vane 3 is selected in a manner allowing the vane 3 to smoothly pass the exit opening of the compression space and minimize any leakage. The vanes 3 can have the shape of a half of the sphere.

Fig. 4 shows the principle of the vanes' 3 behaviour in the compression space of the compressor 1. As the vane wheel 2 rotates the individual vanes 3 arrange in a manner that decreases the volume of the gas being transported between the vanes 3 going one after another, until the gas being transported is exhausted into the exhaust duct 6. The volume S₁ delimited by the vanes 3 is smaller than the volume S₂ delimited by the previous vanes 3, which increases pressure in the gas being transported even at a slower rotation of the vane wheel 2 of the compressor 1 manufactured according to the present invention. Once the gas is exhausted into the exhaust duct 6 the vane 3 swivels, so that it can longitudinally pass through the opening formed between the separator 10 and the internal compression barrier 9.

The compression ratio of the compressor 1 is set by a change in the size of the intake opening and the exhaust opening represented in Fig. 4 by the sectors α and β . For this reason, the length of the external compression barrier 8 is adjustable.

Fig. 8 through 9 show the behaviour of the vanes 3 when the vane wheel 2 rotates. Fig. 11 and 12 show a detail of the opening between the separator 10 and the internal compression barrier 9. It can be seen that the internal compression barrier 9 is fitted with a compensating channel 13, through which the compressed gas is leaking from the loss volume delimited by the vanes 3 going one after another and the internal compression barrier 9.

Industrial Applicability

The compressor according to the present invention can be widely used in the industrial sector, such as air-conditioning systems, vacuum cleaners, and ventilation. In addition, the invention can replace e.g. steam turbines or for example turbochargers of combustion engines.

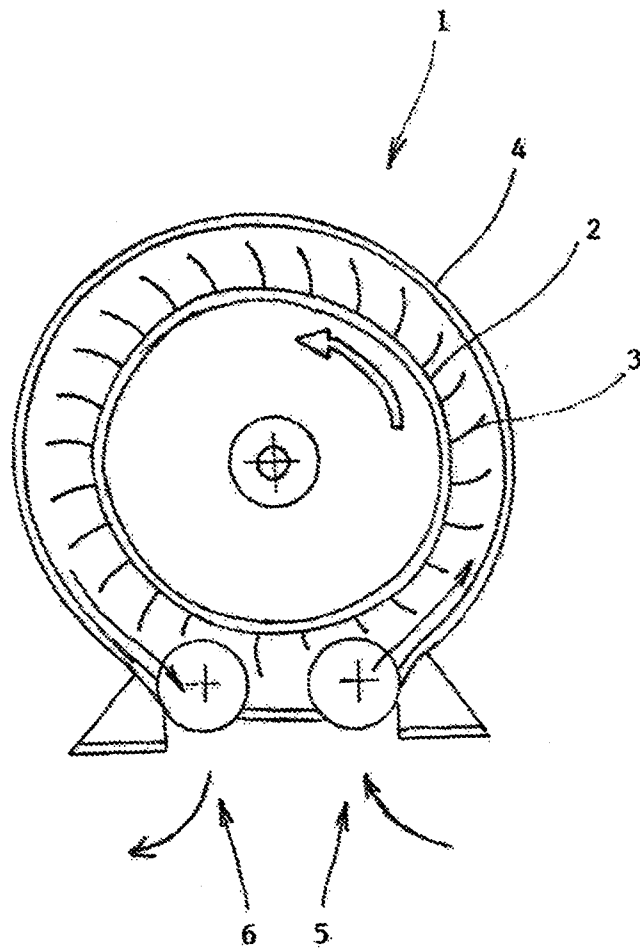
Overview of the Positions

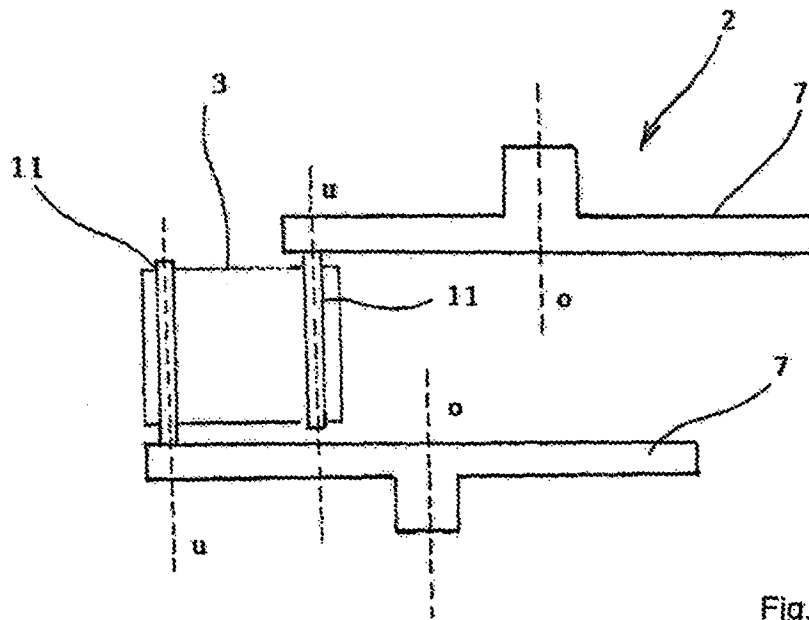
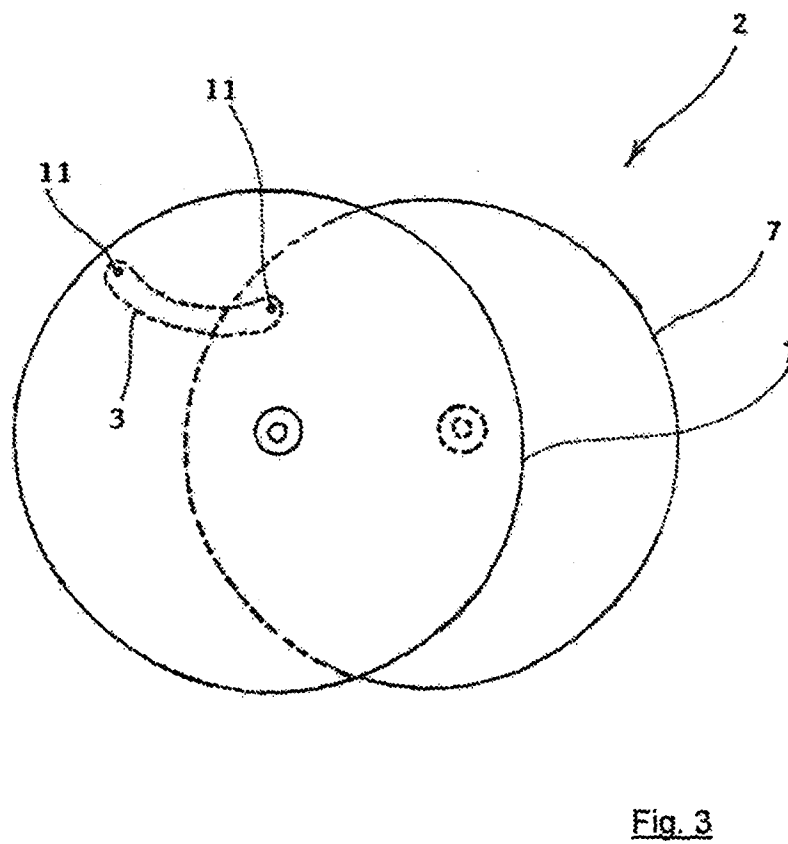
- 1 compressor
 - 2 vane wheel
 - 3 vane
 - 4 cover
 - 5 entry duct
 - 6 exhaust duct
 - 7 vane wheel base
 - 8 external compression barrier
 - 9 internal compression barrier
 - 10 separator
 - 11 pin
 - 12 bearing
 - 13 compensating channel
-
- o rotation axis of the vane wheel base
 - u axis of the vane mounting

CLAIMS

1. The compressor (1) for the transport of gases consisting of the vane wheel (2) fitted with vanes (3) to drive gas when the vane wheel (2) rotates, and of the cover (4) to delimit the working space and safeguard the moving parts of the compressor (1), which is equipped with at least one entry duct (5) for gas intake to the compressor (1) and at least one exhaust duct (6) to drive gas out of the compressor (1), **characterized in that** the bases (7) of the vane wheel (2) are not axially aligned and their rotation axes (o) are parallel, the vanes (3) are attached between the bases (7) of the vane wheel (2) with the possibility of rotation around the axes (u) of their mounting allowing their tilting with the rotation of the vane wheel (2), and the compressor (1) is equipped with at least two compression barriers (8, 9) and the separator (10) to create the compression space where the external compression barrier (8) is arranged before the entry duct (6) in the direction of the vane wheel (2) rotation around at least a part of the trajectory of the outer rims of the vanes (3), the internal compression barrier (9) is arranged before the exhaust duct (6) in the direction of the vane wheel (2) rotation around at least a part of the trajectory of the inner rims of the vanes (3), and the separator (10) is arranged in the inlet of the exhaust duct (6), where the internal compression barrier (9) and the separator (10) delimit the opening for the exit of the vanes (3) out of the compression space.
2. The compressor according to claim 1, **characterized in that** the external compression barrier (8) is movable towards the inlet of the exhaust duct (6) to change pressure.
3. The compressor according to any of claims 1 or 2, **characterized in that** the length of the external compression barrier (8) is adjustable along the trajectory of the outer rims of the vanes (3) to change the size of the compression space.
4. The compression according to any of claims 1 through 3, **characterized in that** the bases (7) are fitted with perpendicular pins (11) along the circumference on the near sides for fitting the vanes (3), where the pins (11) on both bases are arranged in an alternating manner, and the pins (11) are shorter than the pitch of the bases (7).

5. The compressor according to claim 4, **characterized in that** the pins (11) are attached to the bearings (12) which are integrated in the bases (7) of the vane wheel (2), or they are attached to the bases (7).
6. The compressor according to claim 5, **characterized in that** oil channels opened into the bearings (12) are created in the bases (7) of the vane wheel (2).
7. The compressor according to claim 4, **characterized in that** the pins (11) are attached to the bases (7) of the vane wheel (2) in a fixed manner and the vanes (3) include integrated bearings (12) for the pivotal mounting of the vanes (3) onto the pins (11), or the bearings (12) are attached to the vanes (3).
8. The compressor according to any of claims 1 through 7, **characterized in that** the vanes (3) have a U-shaped cross section.
9. The compressor according to any of claims 1 through 8, **characterized in that** the internal compression barrier (9) is equipped with at least one compensating channel (13) to reduce pressure.

Fig. 1



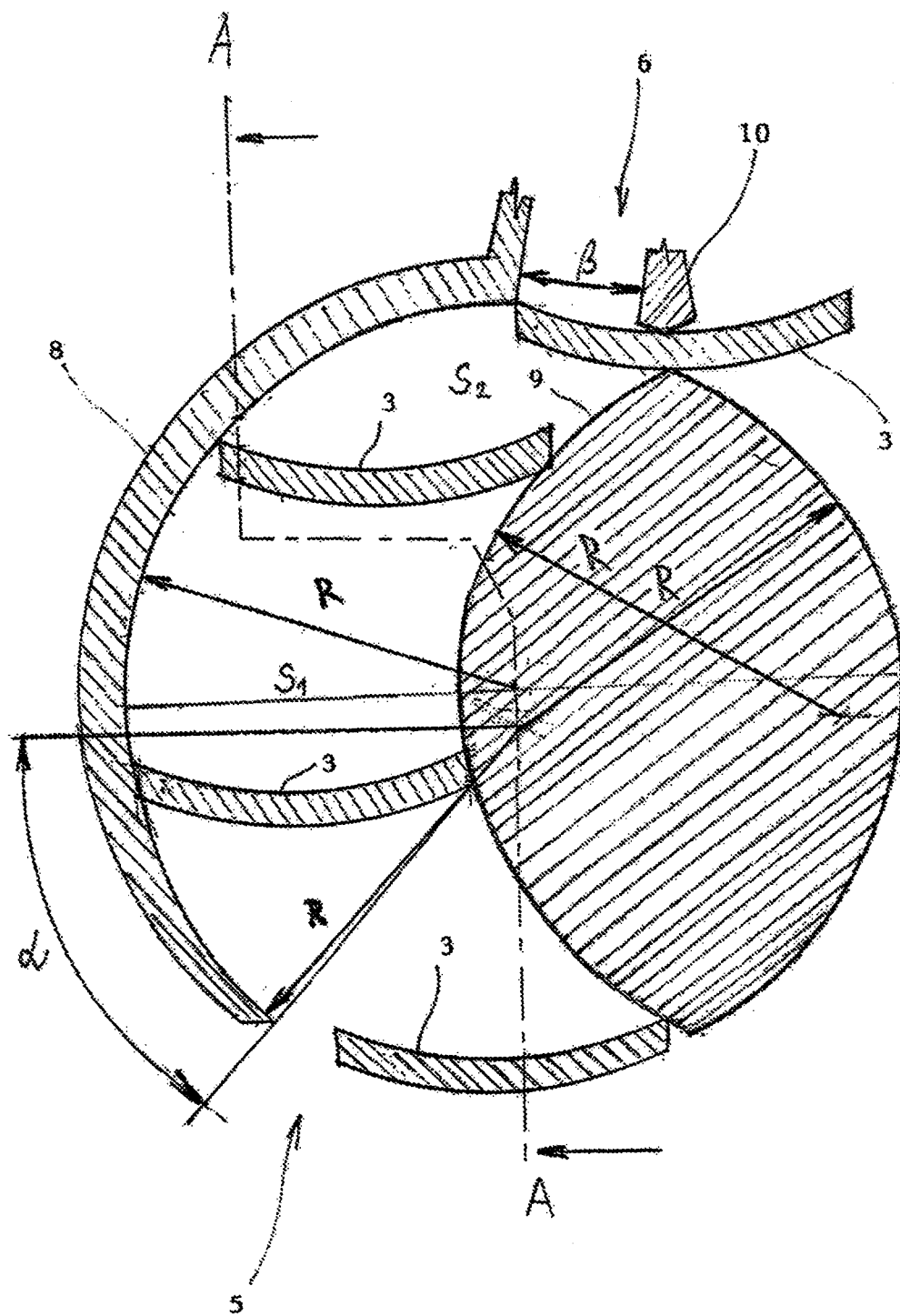
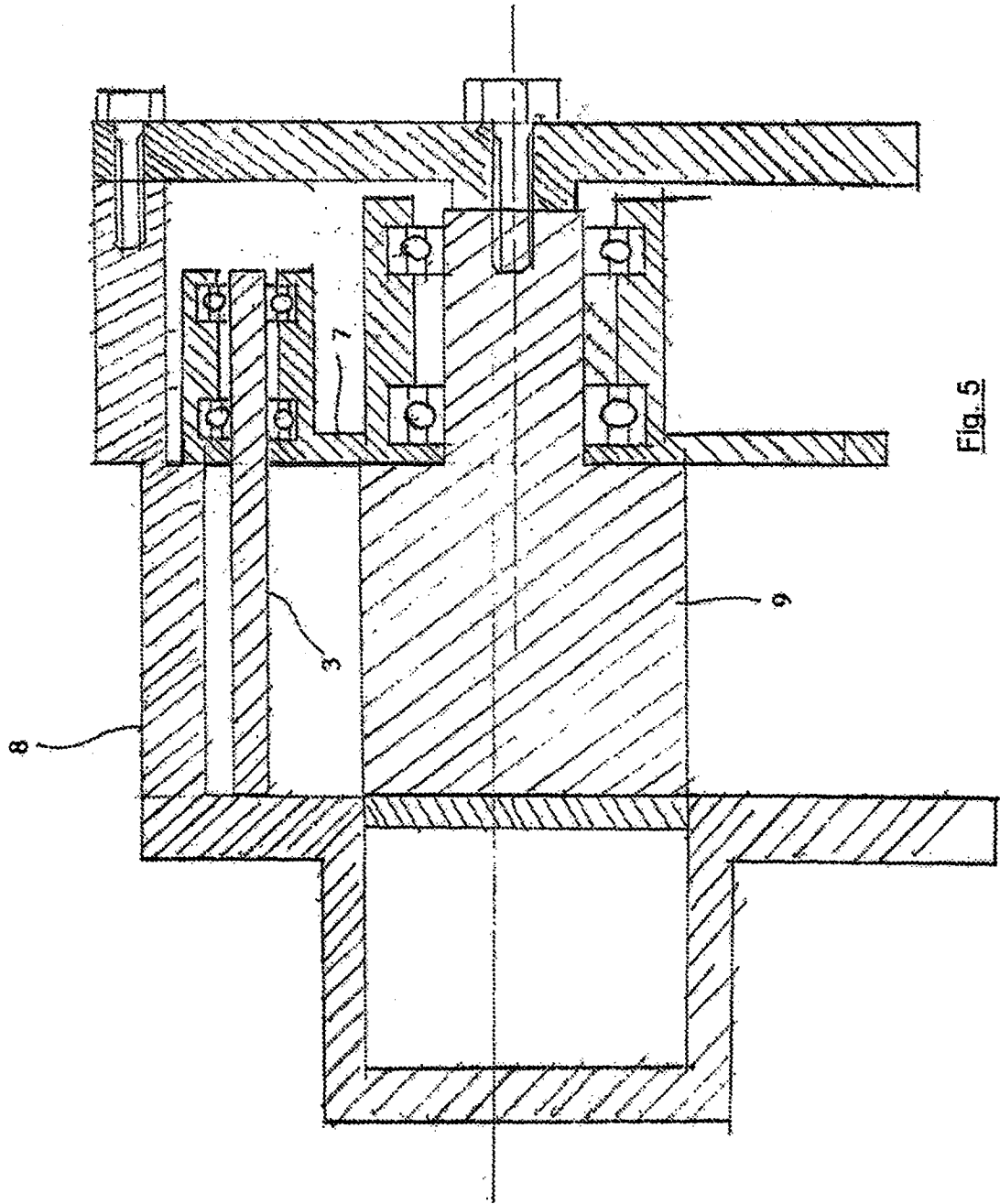


Fig. 4

A--A



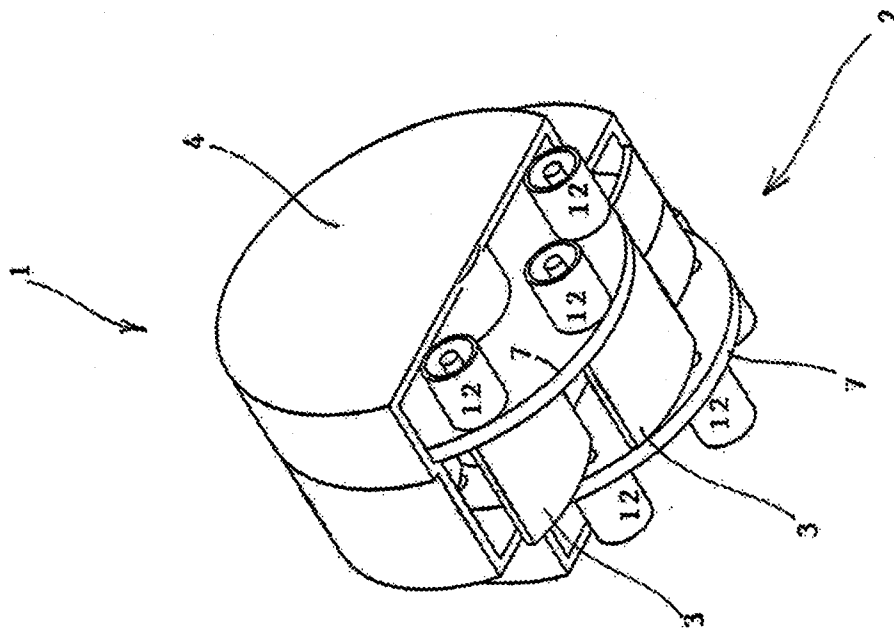


Fig. 6

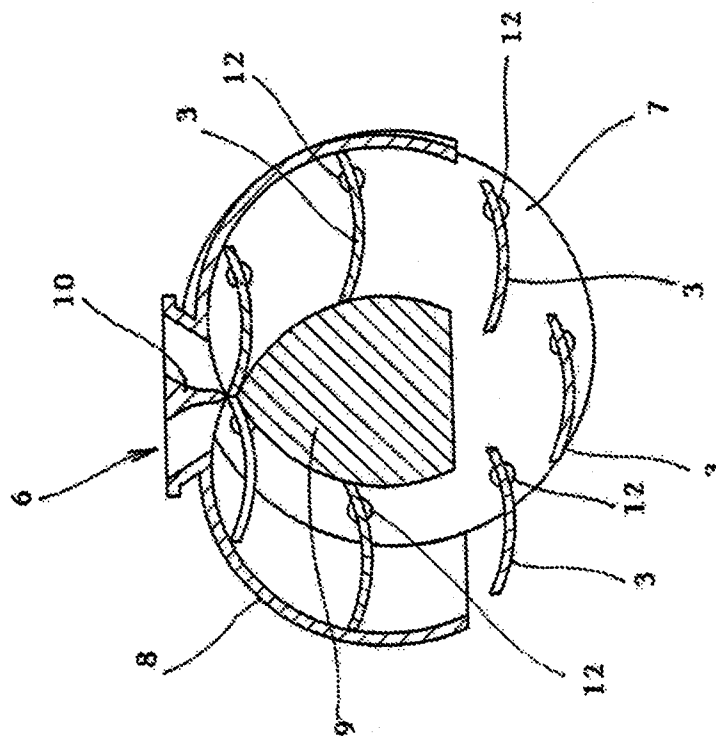


Fig. 7

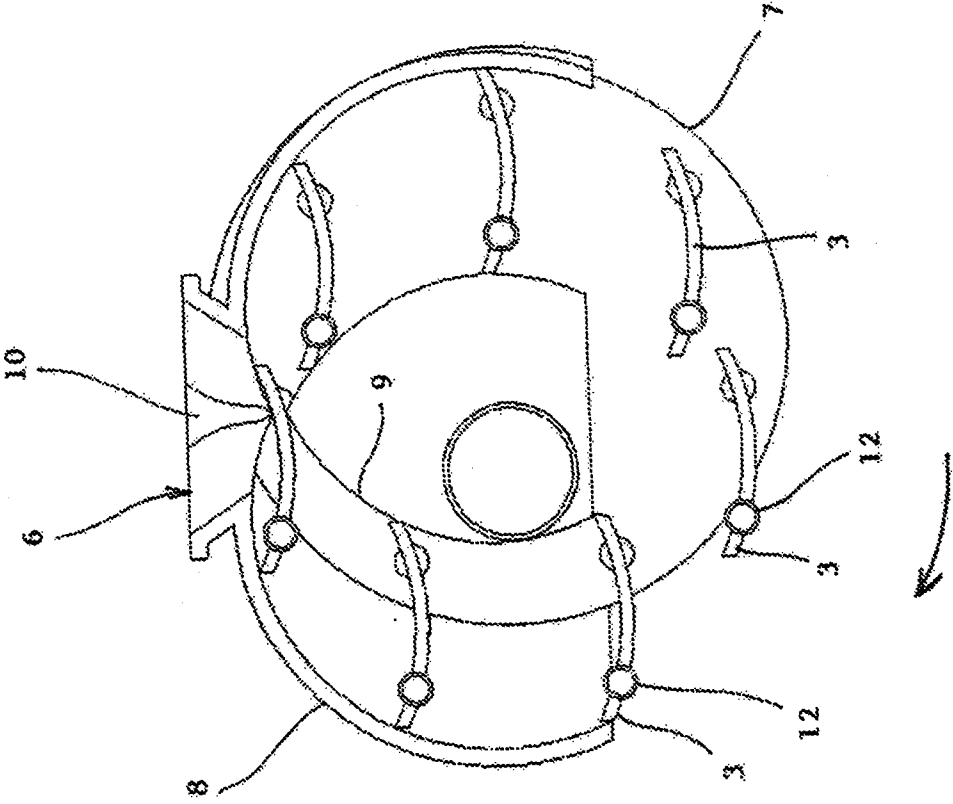


Fig. 8

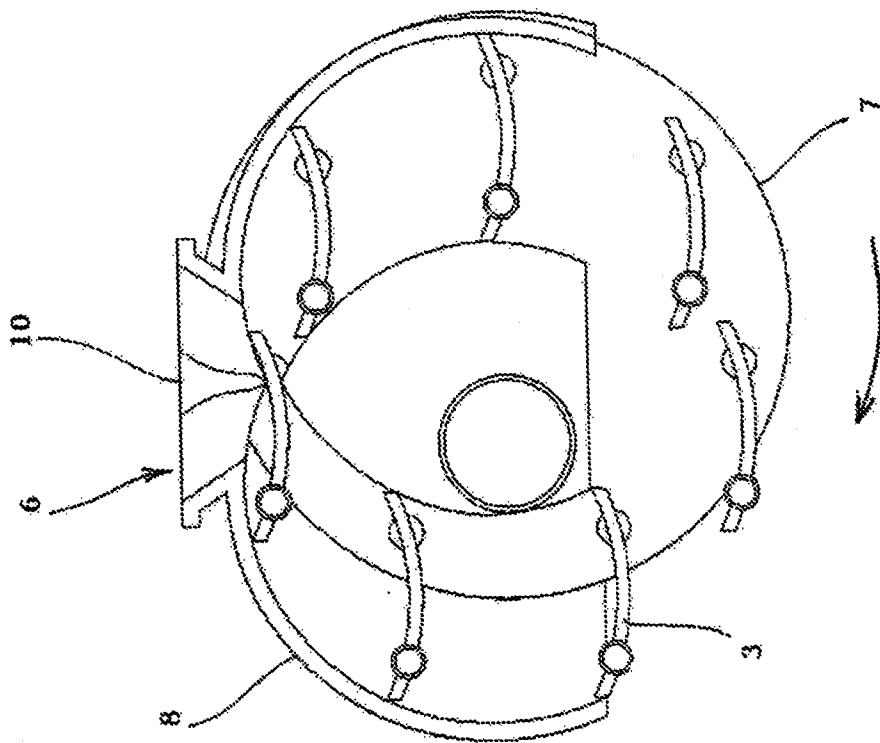


Fig. 9

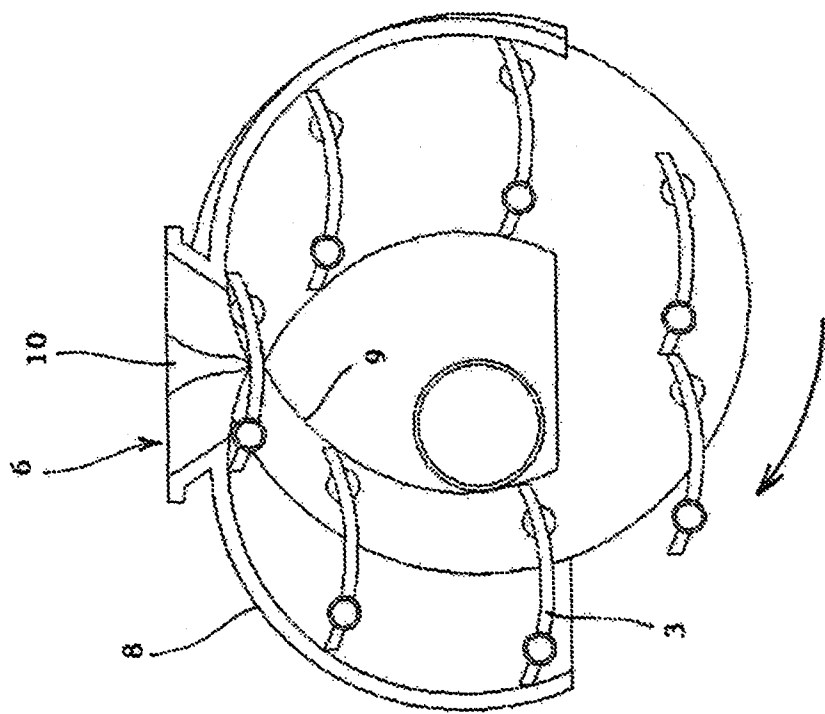


Fig. 10

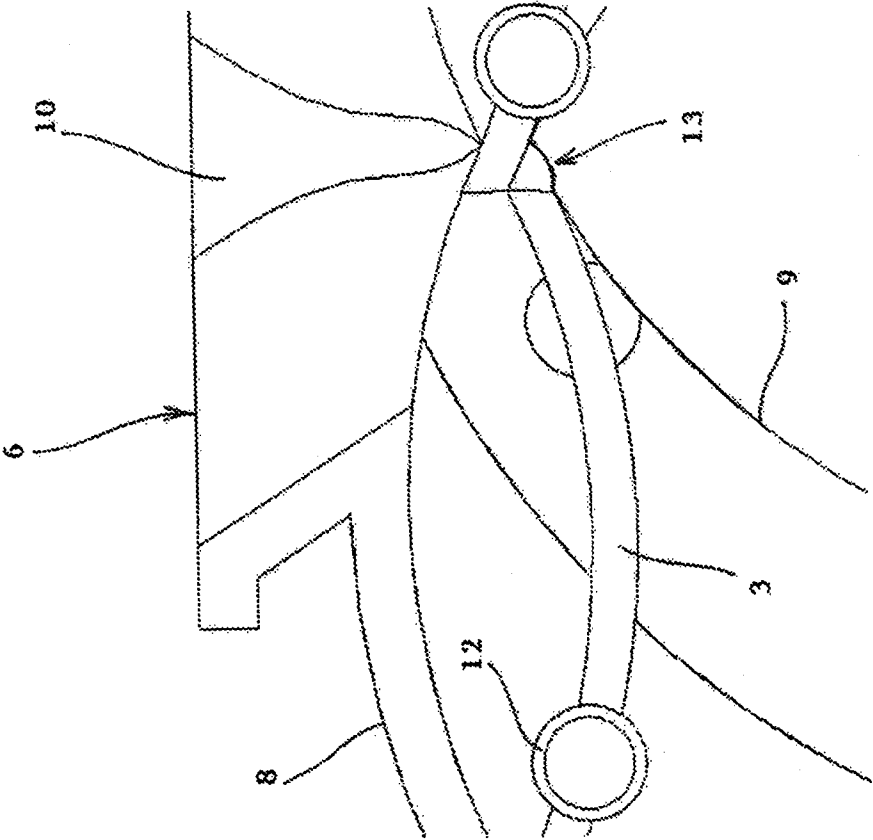


Fig. 11

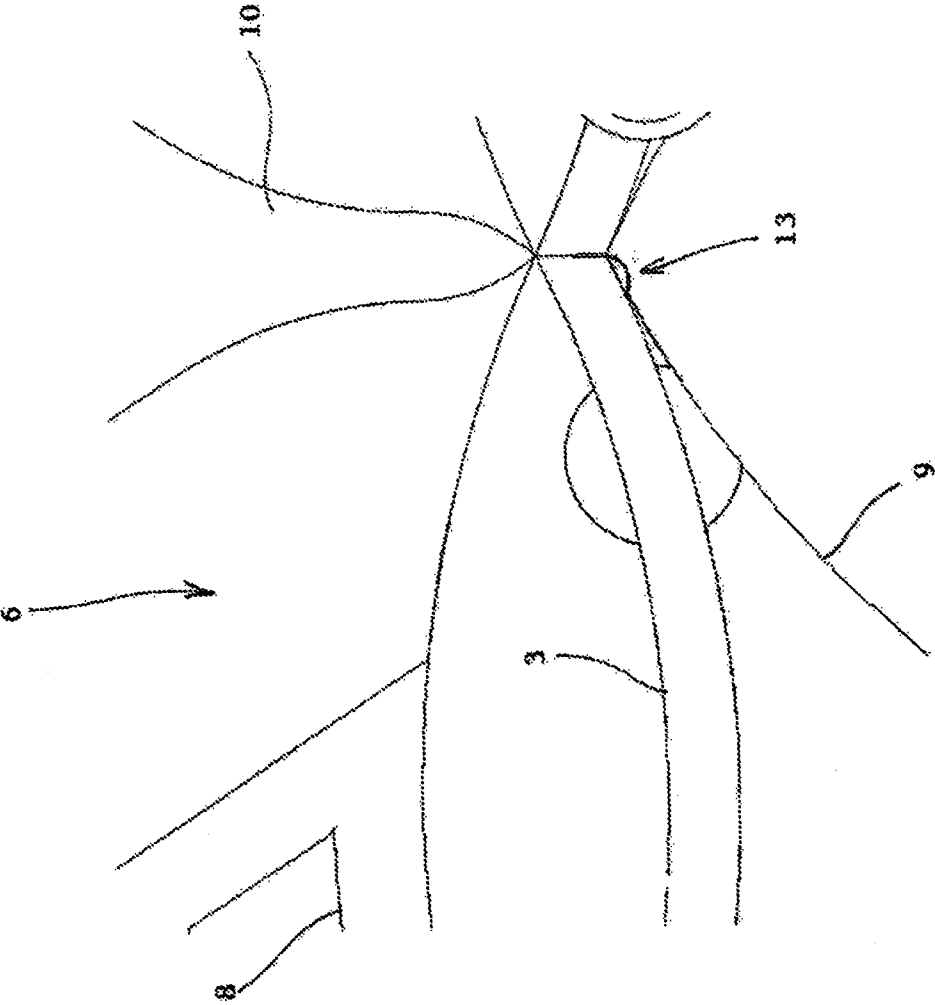


Fig. 12