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(54) **A rotor assembly and a heat/energy recovery unit having a rotor assembly**

(57) The invention relates to a rotor assembly and a heat/energy recovery unit having a rotor assembly in which inlet air (I) is heated to supply air (S) by using thermal energy of discharge air (D) such that the discharge air (D) is cooled to outlet air (O). The heat/energy recovery unit having a rotor assembly comprises: a rotor (1), an inlet plenum (14) for conducting inlet air (I) to the rotor (1), a supply plenum (15) for receiving supply air (S) from the rotor (1), a discharge plenum (16) for conducting discharge air (D) to the rotor (1), an outlet plenum (17) for receiving outlet air (O) from the rotor (1), a circumferential sealing unit (2, 6), a first axial sealing unit (4, 7), and a second axial sealing unit (5, 10). The sealing units (2, 6; 4, 7; 5, 10) are provided with a pressure balancing volume (8, 9) between the plenums (14, 15, 16, 17), said pressure balancing volume (8, 9) allowing an air leakage between the opposing plenums (14, 15); (16, 17), through the side surfaces (24), (25) of the rotor (1).

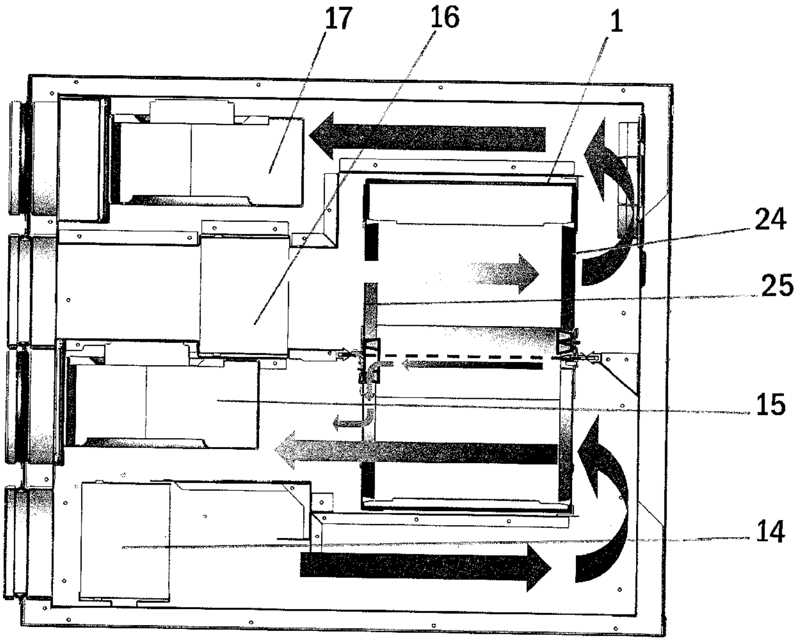

Fig. 9

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Description

FIELD OF THE INVENTION

[0001] The present invention relates to the field of ventilation technology and equipment for ventilation, and more particularly to a rotor assembly and a heat/energy recovery unit having a rotor assembly.

BACKGROUND OF THE INVENTION

[0002] A heat/energy recovery unit having a rotor assembly, otherwise known as rotary air-to-air heat exchanger or heat/enthalpy wheel is a regenerative heat exchanger where a mass made of corrugated channels rotates through airstreams. Adjacent supply and exhaust air streams each flow through half of the wheel in a counter flow direction. A heat/energy recovery unit having a rotor assembly offers high efficiency heat recovery and is a common choice of heat exchanger in a ventilation unit.

[0003] In the following, the prior art will be described with reference to the accompanying drawings of Figures 1 to 5, of which:

Figure 1 shows a conventional rotor assembly for a ventilation unit or a heat/energy recovery unit having a rotor assembly according to the prior art;
Figure 2 shows a schematic view of a heat/energy recovery unit having a rotor assembly according to the prior art;
Figure 3 shows a schematic view of an alternative heat/energy recovery unit having a rotor assembly according to the prior art;
Figure 4 is a graph showing leakage through a heat/energy recovery unit having a rotor assembly according to the prior art; and
Figure 5 is a graph showing leakage through a heat/energy recovery unit having a rotor assembly according to the prior art having a pressure balance damper.

[0004] Figure 1 presents a conventional rotor assembly for a ventilation unit or a heat/energy recovery unit having a rotor assembly according to the prior art. The rotor assembly comprises a rotor 1, a rotor box 2, and divider planes 4, 5 for isolating air streams. A first axial sealing unit 7, also known as transverse seal, is used to isolate the air streams on first side 12 of the rotor 1. Similar second axial sealing unit 10 is provided on the on the second side 13 of the rotor 1. A circumferential sealing unit 6, also known as peripheral seal, is used to form a seal around the outside periphery 3 of the rotor 1 to reduce leakage flow via the internal of the rotor box 2 from the first side 12 of the rotor 1 to the second side 13 of the rotor 1 and vice versa. Instead of the rotor box 2 encasing the rotor, a single plane or plate surrounding the rotor periphery 3 may be used to divide the upstream, first side 12 of the rotor 1, and downstream, second side 13 of the rotor 1, sides of the rotor 1. The rotor 1 has a first side surface 24 on the first side 12 of the rotor and a second side surface 25 on the second side 13 of the rotor 1.

[0005] Figure 2 shows a schematic view of a heat/energy recovery unit having a rotor assembly according to the prior art. Likewise, Figure 3 shows a schematic view of an alternative heat/energy recovery unit having a rotor assembly according to the prior art. There are various pressure zones surrounding the rotor assembly. These pressure zones are shown in figures 2 and 3 and described below. As shown in figures 2 and 3 are shown a conventional prior art heat/energy recovery unit having a rotor assembly unit 30. The rotor unit 30 comprises a rotor 1, an inlet plenum 14 into which fresh outside air is conducted as inlet air I. The inlet air I is conducted to the rotor 1 in which it is heated to supply air S which is received to the supply plenum 15 from the rotor 1. The supply air S is further conducted to a room 32 by using a supply fan 34. From the room 32 air is discharged as discharge air D conducted to discharge plenum 16 of the rotor unit 30. The discharge air D is conducted from the discharge plenum 16 to the rotor 1 in which it is cooled such that it transfers heat to the inlet air I. The cooled discharge air D is received to the outlet plenum 17 as outlet air O and the outlet air is extracted by using discharge fan 36.

[0006] The inlet plenum 14 and the outlet plenum 17 are on the first side 12 of the rotor 1, and the supply plenum 15 and the discharge plenum 16 are on the second side of the rotor 1. The inlet plenum 14 and the outlet plenum 17 as well as the supply plenum 15 and the discharge plenum 16 are isolated or separated from each other by using axial sealing units. A first axial sealing unit comprises the first axial sealing unit 7 and the first axial divider 4 for isolating the inlet plenum 14 from the outlet plenum 17 on the first side of the rotor 1. A second axial sealing unit comprises the second axial sealing unit 10 and the second axial divider 5 on the second side of the rotor 1. Furthermore, a circumferential sealing unit comprises one or two circumferential sealing units 6 and one or two circumferential dividers 2, as shown in figures 2 and 3.

[0007] Inlet air I is taken from the outside at the atmospheric air pressure PA. The air passes through the inlet duct and due to the pressure drop caused by the resistance of the inlet duct has a pressure P1 in the inlet plenum 14. After passing through the rotor 1 the supply air S has a reduced pressure of P2 at the supply plenum 15. From the supply plenum 15 the air is drawn through supply fan 34 and passes through the supply duct to the ventilated room 32. In the room 32 it is assumed that the pressure is that of atmospheric air pressure PA since in normal ventilation installation the pressure is close to that of atmospheric pressure PA. The discharge air D is drawn through the discharge duct and due to the duct losses has a pressure of P3 in the discharge plenum 16. The discharge air D passes through the rotor 1 and due to the resistance of the rotor 1 the outlet air O has a reduced pressure of P4 in the outlet plenum 17. From the outlet plenum 17 the outlet air O is drawn through the discharge fan 36 and is driven through the exhaust duct. A balance damper 38 can be placed between the extract duct and the rotor 1 in the location shown in figures 2 and 3.

[0008] When the rotor 1 is contained within a rotor box 2 then the internal pressure of the rotor box 2 PO is the average of the P1, P2, P3 and P4 pressures when the circumferential sealing units 6 are of the same design, as is shown in figure 2. In the case where the rotor 1 has a single rotor wall and not a rotor box 2, as is shown in figure 3, for there is only one circumferential sealing unit having the circumferential sealing unit 6 between the respective plenums 14, 15 and 16, 17 on the opposing sides 12, 13 of the rotor 1. In the embodiment of figure 3 the rotor box 2 of figure 2 is replaced with circumferential divider extending around the periphery 3 of the rotor 1. Therefore in figure 3 there is only one circumferential sealing unit 6 that separates the pressure P1 in inlet plenum 14 and the pressure P2 in the supply plenum 15. The same applies for the discharge plenum 16 and the outlet plenum 17.

[0009] Figure 4 is a graph showing leakage through a heat/energy recovery unit having a rotor assembly according to the prior art. Figure 4 shows results of calculations, which have been confirmed by testing, are shown in figure 4 for a small ventilation unit, or small heat/energy recovery unit having a rotor assembly, having a brush type axial sealing units 7, 10 and brush type circumferential sealing unit 6 with a rotor 1 of 300mm diameter supplying a balanced ventilation supply of 40 l/s which at the example flow rate has a pressure drop through the rotor 1, ΔProtor, of 80Pa. The graph of figure 4 shows the resultant axial sealing unit 7, 10 leakage rates identified as curve "m" and circumferential sealing unit 6 leakage rate identified as "p". At point (ii), which is assumed the nominal cases for the following examples, the resistances of the discharge ducting of discharge air D and the outlet ducting for inlet air I are the same so that P1 =P3. Since P2 = P1 minus the pressure drop of the rotor 1 ΔProtor then the P2 will have an under pressure against P3 equal to pressure drop of rotor 1, from here on referred to as "ΔProtor" i.e. P2=P1-ΔProtor. The leakage through the axial sealing unit 7, 10 and the circumferential sealing unit 6 are proportional to the pressure difference of ΔProtor. At point (i) the inlet duct resistance for inlet air I is higher than that of the discharge plenum 16 causing the P3 pressure to be increased by 80Pa so that P3-P2=0 so there is no leakage flow. Point (iii) on the diagram is where the discharge air D resistance is increased such that the P1 pressure is increased by 80Pa and the pressure difference is now P3-P2=160Pa. The curve between point i, ii and iii show a range of inlet duct pressure P1 to discharge duct pressure P3 differences.

[0010] Figure 4 is then an example of the leakages through the heat/energy recovery unit having a rotor assembly sealing units 7, 10, 6 with a prior art seal arrangement with no countermeasures, such as balance damper 38, are used to improve this. Throughout the range of pressure range from points (ii) to (iii) the axial seal leakage "m" and circumferential seal leakage "p" are positive indicating that the leakage flow into supply side of the rotor, inlet plenum 14 and supply plenum 15, hence in the wrong direction since this leakage contaminates the air supplied to room 32.

[0011] Figure 5 is a graph showing leakage through a heat/energy recovery unit having a rotor assembly according to the prior art having a pressure balance damper. The above mentioned problem of contamination is partially solved in a prior art solution by using a pressure balance damper 38 to provide in increased pressure loss in the discharge, in discharge plenum 16 and outlet plenum 17, such that the P2 would be greater or equal to P3. Figure 5 shows where the pressure balance damper 38 has been adjusted to give an extra 80Pa pressure loss so that P3-P2=0 (case ii) thus the axial sealing unit 10 and circumferential sealing unit 6 leakages are zero at the nominal flow through the heat/energy recovery unit having a rotor assembly.

[0012] In the range of pressure range from points (i) to (ii) the axial seal leakage "m" and the circumferential seal leakage "p" negative, meaning that the leakage is out of the supply plenum 15. Only between points ii) to iii) is the axial seal leakage "m" and the circumferential seal leakage "p" in towards the supply plenum 15. At point (ii) the axial seal leakage "m" and the circumferential seal leakage "p" is 0%. At point (iii) the axial seal leakage "m" and the circumferential seal leakage "p" 64% of the original leakage.

[0013] One significant disadvantage of applying the extra pressure loss at the discharge side is that the discharge fan 36 is constantly operating against the additional pressure which consumes extra energy and increases the noise emitted from the discharge fan 36. Another disadvantage is the pressure difference across the inlet duct to outlet duct is increased so if the above example P3-P2=0Pa then P1-P4=160Pa which would give the corresponding leakage to the discharge at point (iii) which would increase the flow rate and load on the discharge fan 36.

[0014] A limitation of the rotary heat/energy recovery unit having a rotor assembly is cross contamination or mixing of the two air streams which occur by carryover and leakage across the seals surrounding the rotor and separating the air streams. When ventilating an area with fresh outside air it is often important to minimise the amount of extract air crossing over into the supply fresh air side since the extract air can be contaminated, for example by smells, or which can be very humid.

[0015] Leakage from one air stream to another occurs due to the static air pressure difference between the air streams which drives some air from the higher pressure stream into the lower pressure one. To ensure that there is no leakage from the extract side to the fresh air of the supply side a pressure balance damper of the prior art, is commonly used to create additional under pressure in the extract ducting to ensure that the supply ducting has the greater pressure.

[0016] The disadvantage of this prior art is either that you accept the potentially large leakage rates or that one balances the pressure by increasing pressure losses on the extract ducting side with the pressure balance damper and then accepts the increased loading and hence energy consumption and noise on the extract side fan.

BRIEF DESCRIPTION OF THE INVENTION

[0017] An object of the present invention is thus to provide a method and an arrangement for implementing the method so as to overcome the above problems and to alleviate the above disadvantages.

[0018] The objects of the invention are achieved by a rotor assembly for a heat/energy recovery unit having a rotor assembly, the rotor assembly comprising:

- a rotor arranged to rotate around a rotation axis, the rotor having a first side surface of the rotor on a first side and a second side surface of the rotor on a second side in the direction of the rotation axis;
- a circumferential sealing unit arranged around the periphery of the rotor for isolating the first side and the second side of the rotor;
- a first axial sealing unit on the first of the rotor for dividing the first side of the rotor to two adjacent plenums; and
- a second axial sealing unit on the second side of the rotor for dividing the second side of the rotor to two adjacent plenums,

in which rotor assembly at least one of the sealing units is provided with a pressure balancing volume for balancing the pressure difference over the sealing unit so that the pressure balancing volume of the sealing units allow an air leakage through the side surfaces of the rotor.

[0019] Preferably, the sealing unit has a sealing element and a pressure balancing element provided between the pressure balancing volume and the adjacent plenums or the first and second side of the rotor.

[0020] Preferably, the first axial sealing unit and the second axial sealing unit comprise an axial sealing unit having an axial sealing element between an axial pressure balancing volume and the one plenum and an axial pressure balancing element between an axial pressure balancing volume and other plenum. Alternatively, the circumferential sealing unit comprises a circumferential sealing element between a circumferential pressure balancing volume and the first side of the rotor and a circumferential pressure balancing element between a circumferential pressure balancing volume and the second side of the rotor.

[0021] Preferably, the pressure balancing is arranged to be pressure permeable. Preferably, the pressure balancing element is a brush type sealing element, cloth type sealing element, a narrow gap or diffusion gap. Preferably, the circumferential pressure balancing volume is arranged to extend circumferentially around the periphery of the rotor. Further preferably, the circumferential sealing unit comprises a circumferential divider provided on periphery of the rotor for isolating the first and second side of the rotor, and that the circumferential divider is arranged to the circumferential sealing unit such that the circumferential seal extends between the circumferential divider and the periphery of the rotor.

[0022] Preferably, the axial pressure balancing volume is arranged to extend across a first and second side surface of the rotor on the first and second side of the rotor, respectively.

[0023] Further preferably, the first and second axial sealing unit comprise respectively a first and second axial divider extending in the direction of the rotation axis of the rotor for isolating the two adjacent plenums from each other on the first and second side of the rotor respectively, and that the first and second axial dividers are arranged to the axial sealing units such that the axial seals extend between the axial divider and the side surface of the rotor.

[0024] Furthermore, the objects of the invention are achieved by a heat/energy recovery unit having a rotor assembly in which inlet air is heated to supply air by using thermal energy of discharge air such that the discharge air is cooled to outlet air, the heat/energy recovery unit having a rotor assembly having a rotor unit comprising:

- a rotor for carrying out the heat exchange, the rotor having a first side surface and a second side surface of the rotor;
- an inlet plenum for conducting inlet air to the rotor;
- a supply plenum for receiving supply air from the rotor;
- a discharge plenum for conducting discharge air to the rotor;
- an outlet plenum for receiving outlet air from the rotor;
- a circumferential sealing unit for isolating the inlet plenum from the supply plenum and discharge plenum from the outlet plenum;
- a first axial sealing unit for isolating the inlet plenum from the outlet plenum; and
- a second axial sealing unit for isolating the supply plenum from the discharge plenum,

in which rotor unit at least one of the sealing units is provided with a a pressure balancing volume for balancing the pressure difference over the sealing unit between the adjacent plenums, so that the pressure balancing volume of the sealing units allow an air leakage between the opposing plenums, through the side surfaces of the rotor.

[0025] Preferably, the sealing unit has a sealing element and a pressure balancing element provided between the pressure balancing volume and the adjacent plenums. Preferably, the first axial sealing unit has an axial sealing element between the first axial pressure balancing volume and the inlet plenum and an axial pressure balancing element between a first axial pressure balancing volume and outlet plenum. Preferably, the second axial sealing unit has an axial sealing element between the second axial pressure balancing volume and the discharge plenum and an axial pressure balancing element between a second axial pressure balancing volume and supply plenum.

[0026] Preferably, the circumferential sealing unit comprises a circumferential sealing element between a circumferential pressure balancing volume and the inlet plenum or the outlet plenum and a circumferential pressure balancing element between a circumferential pressure balancing volume and the supply plenum or the discharge plenum. Preferably, the circumferential sealing unit comprises a circumferential divider provided on periphery of the rotor for isolating the first and second side of the rotor, and that the circumferential divider is arranged to the circumferential sealing unit such that the circumferential seal extends between the circumferential divider and the periphery of the rotor.

[0027] Preferably, the first and second axial sealing unit comprise respectively a first and second axial divider extending in the direction of the rotation axis of the rotor for isolating the two adjacent plenums from each other on the first and second side of the rotor respectively, and that the first and second axial dividers are arranged to the first and second axial sealing units such that the first and second axial seals extend respectively between the axial divider and the side surface of the rotor.

BRIEF DESCRIPTION OF THE DRAWINGS

[0028] In the following the invention will be described in greater detail by means of preferred embodiments with reference to the accompanying drawings, in which

Figure 1 shows a conventional rotor assembly for a ventilation unit or a heat/energy recovery unit having a rotor assembly according to the prior art;
Figure 2 shows a schematic view of a heat/energy recovery unit having a rotor assembly according to the prior art;
Figure 3 shows a schematic view of an alternative heat/energy recovery unit having a rotor assembly according to the prior art;
Figure 4 is a graph showing leakage through a heat/energy recovery unit having a rotor assembly according to the prior art; and
Figure 5 is a graph showing leakage through a heat/energy recovery unit having a rotor assembly according to the prior art having a pressure balance damper.
Figure 6 shows a rotor assembly for ventilation unit or heat/energy recovery unit according to the present invention;
Figure 7 shows an axial sealing unit of a rotor assembly for ventilation unit or heat/energy recovery unit according to the present invention;
Figure 8 shows a circumferential sealing unit of a rotor assembly for ventilation unit or heat/energy recovery unit according to the present invention;
Figure 9 shows one embodiment of a ventilation unit and a heat/energy recovery unit having a rotor assembly according to the present invention; and
Figure 10 is a graph showing leakage through the heat/energy recovery unit having a rotor assembly according to the present invention.

[0029] The prior art drawings of Figure 1 to 5 have been presented earlier. In the following, the invention will be described in greater detail by means of preferred embodiments with reference to the accompanying drawings of Figures 6 to 10.

DETAILED DESCRIPTION OF THE INVENTION

[0030] Figure 6 shows a rotor assembly for ventilation unit or heat/energy recovery unit according to the present invention. Figure 6 shows a rotor assembly having a rotor 1 and a first axial sealing unit 7, second axial sealing unit 10 and a circumferential sealing unit 6. Figure 7 shows an axial sealing unit of a rotor assembly for ventilation unit or heat/energy recovery unit according to the present invention.

[0031] Figure 6 and Figure 7A show a first embodiment of the second axial sealing unit 10 of the present invention. It should be noted that the first axial sealing unit 7 is usually identical to the second axial sealing unit 10 and thus it is not shown. The second axial sealing unit 10 comprises a pressure balancing element 22, 26 having a wall portion 26 which together with the second axial divider 5 forms a pressure balancing volume 8. The first and second axial sealing units 7, 10 are provided respectively in connection with the first and second side surfaces 24, 25 of the rotor 1, as shown in figure 6, for sealing the gap between the dividers 4, 5 and the side surfaces 24, 25 of the rotor 1. The first and second axial sealing units 7, 10 are provided with a pressure balancing assembly according to the present invention.

[0032] The first axial sealing unit 7 having a pressure balancing assembly is provided with a sealing element 23 and a pressure balancing element 22, 26 between the pressure balancing volume 8 and the adjacent plenums 14, 17. The first axial sealing unit 7 comprises an axial sealing element 23 between an axial pressure balancing volume 8 and the inlet plenum 14 and a pressure balancing element 22, 26 between an axial pressure balancing volume 8 and outlet plenum 17.

[0033] Respectively, the second axial sealing unit 10 having a pressure balancing assembly is provided with a sealing element 23 and a pressure balancing element 22, 26 between the pressure balancing volume 8 and the adjacent plenums 15, 16. The second axial sealing unit 10 comprises an axial sealing element 23 between an axial pressure balancing volume 8 and the discharge plenum 16 and a pressure balancing element 22, 26 between an axial pressure balancing volume 8 and supply plenum 15.

[0034] The invention is characterised in that the sealing units 7, 10 are arranged at the both sides of the rotor 1, and that the sealing units 7, 10 are or at least one of the said sealing units 7, 10 are provided with a pressure balancing volume 8, and that the pressure balancing volume 8 of the sealing units 7, 10 allow an air leakage through the side surfaces 24, 25 of the rotor 1. The sealing units 7, 10 may be incorporated together with the axial dividers 4, 5 respectively.

[0035] In the first axial sealing unit 4, 7 having a pressure balancing assembly, the air leakage through the rotor 1 flows from the inlet plenum 14 through the pressure balancing volume 8 of the first axial sealing unit 7 with the first side surface 24 of the rotor 1, through the rotor 1 and then through the pressure balancing volume 8 of the first axial sealing unit 7 with the second side surface 25 of the rotor 1, and to the supply plenum 15.

[0036] In the second axial sealing unit 5, 10 having a pressure balancing assembly, respectively, the air leakage through the rotor 1 flows from the discharge plenum 16 through the pressure balancing volume 8 of the second axial sealing unit 10 with the second side surface 25 of the rotor 1, through the rotor 1 and then through the pressure balancing volume 8 of the second axial sealing unit 10 with the first side surface 24 of the rotor 1, and to the outlet plenum 17.

[0037] Figure 8 shows a circumferential sealing unit of a rotor assembly for ventilation unit or heat/energy recovery unit according to the present invention. The circumferential sealing unit 6 comprises a pressure balancing element 21, 27 having a wall portion 27 which together with the circumferential divider 2 forms a circumferential pressure balancing volume 9. The circumferential sealing unit 6 is provided in connection with the periphery 3 of the rotor 1 or the outside edge of first or second side surface 24, 25 of the rotor 1, as shown in figure 8, for sealing the gap between the circumferential divider 2 and the periphery 3 and/or side surfaces 24, 25 of the rotor 1. The circumferential sealing unit 6 is provided with a pressure balancing assembly according to the present invention.

[0038] The circumferential sealing unit 6 having a pressure balancing assembly comprises a circumferential sealing element 20 between a circumferential pressure balancing volume 9 and the first side 12 of the rotor 1 and a circumferential pressure balancing element 21, 27 between a circumferential pressure balancing volume 9 and the second side 13 of the rotor 1. Thus the circumferential sealing element 20 is between the circumferential pressure balancing volume 9 and the inlet plenum 14 or the outlet plenum 17, and the circumferential pressure balancing element 21, 27 is between the circumferential pressure balancing volume 9 and the supply plenum 15 or the discharge plenum 16.

[0039] The invention is characterised in that the sealing units 6 are arranged at the both sides of the rotor 1, and that the sealing units 6 are or at least one of the said sealing units are provided with provided a pressure balancing volume 9, and that the pressure balancing volume 9 of the sealing units 6 allow an air leakage through the side surfaces 24, 25 of the rotor 1. The sealing units 6 may be incorporated together with the circumferential divider 2.

[0040] In the inlet/supply side of the circumferential sealing unit 2, 6 having a pressure balancing assembly, the air leakage through the rotor 1 flows from the inlet plenum 14 through the pressure balancing volume 9 of the circumferential sealing unit 6 with the first side surface 24 of the rotor 1, through the rotor 1 and then through the pressure balancing volume 9 of the circumferential sealing unit 6 with the second side surface 25 of the rotor 1, and to the supply plenum 15.

[0041] Respectively, in the discharge/outlet side of the circumferential sealing unit 2, 6 having a pressure balancing assembly, the air leakage through the rotor 1 flows from the discharge plenum 16 through the pressure balancing volume 9 of the circumferential sealing unit 6 with the second side surface 25 of the rotor 1, through the rotor 1 and then through the pressure balancing volume 9 of the circumferential sealing unit 6 with the first side surface 24 of the rotor 1, and to the outlet plenum 17.

[0042] Figures 7A, 7B, 7C, 8A, 8B and 8C show different kinds of embodiments of the pressure balancing volume 8, 9, the sealing elements 20, 23 and the pressure balancing elements 22, 26, 21, 27. The pressure balancing elements 22, 26, 21, 27 are arranged to be pressure permeable such that allow the pressure of the adjacent plenums 14, 15, 16, 17 to balance. Thus the sealing elements 20, 23 and the pressure balancing elements 22, 26, 21, 27 may be provided as brush type sealing element, cloth type sealing element, a narrow gap or diffusion gap. The narrow gap may be provided with the axial divider 4, 5 or with the circumferential divider 2 or with the wall portions 26, 27 of the pressure balancing elements 22, 26, 21, 27 defining the pressure balancing volume 8, 9. The narrow gap is thus provided between the side surface 24, 25 or the periphery of the rotor 1 and the divider 4, 5, 2 or the wall portion 26, 27 of the pressure balancing elements 22, 26, 21, 27. The narrow gap provides a high resistance to the hinder leakage flow.

[0043] The circumferential pressure balancing volume 9 is arranged to extend circumferentially around the periphery 3 of the rotor 1 or the outside edge of the side surface 24, 25 of the rotor 1. Thus the circumferential sealing unit 6 is arranged to the circumferential divider 2 such that the circumferential seal extends between the circumferential divider 2 and the periphery 3 of the rotor 1.

[0044] The axial pressure balancing volume 8 is arranged to extend across a first and second side surface 24, 25 of the rotor 1 on the first and second side 12, 13 of the rotor 1, respectively. Thus the axial sealing units 7, 10 are arranged to the first and second axial dividers 4, 5 such that the axial sealing units 7, 10 extend between the axial divider 4, 5 and the side surface 24, 25 of the rotor 1.

[0045] The axial pressure balancing volume 8 is arranged such that it sits offset from the rotation axis 11 and the circumferential pressure balancing volume 9 is arranged such that it covers an area of the side surface 24, 25 of the rotor 1. In a preferred embodiment of the axial pressure balancing volume 8 the cross sectional area of axial pressure balancing volume extends across the full side surface 24, 25 of the rotor 1. In a preferred embodiment of the circumferential pressure balancing volume 9 the cross sectional area of the circumferential pressure balancing volume 9 follows circumferentially around the periphery 3 of the rotor. The cross section of the pressure balancing volume 8, 9 may be may be rectangular, triangular, polygonal, circular, oval or any other shape. The overall volume of the pressure balancing volume 8, 9 may be chosen according to the application and the parameters of the rotor 1 and the heat/energy recovery unit having a rotor assembly. Thus the pressure balance volume 8, 9 can take any form such as to create a suitable pressure balancing effect.

[0046] Figure 9 shows one embodiment of a ventilation unit and a heat/energy recovery unit having a rotor assembly according to the present invention. The ventilation unit and a heat/energy recovery unit having a rotor assembly according to the present invention comprises a rotor 1, said rotor having a first side surface 24 and a second side surface 25, and an inlet plenum 14, a supply plenum 15, a discharge plenum 16, and an outlet plenum 17. In Figure 9 the main air flows are indicated by thicker arrows. Also in Figure 9 the air leakage through the first axial sealing unit 4, 7 is indicated by narrower arrows. In the first axial sealing unit 4, 7, the air leakage through the rotor 1 flows from the inlet plenum 14 through the pressure balancing volume 8 of the first axial sealing unit 7 with the first side surface 24 of the rotor 1, through the rotor 1 and then through the pressure balancing volume 8 of the first axial sealing unit 7 with the second side surface 25 of the rotor 1, and to the supply plenum 15. The air leakages through second axial sealing unit 5, 10 or through the circumferential sealing unit 2, 6 is not shown in Figure 9.

[0047] In the ventilation unit and the heat/energy recovery unit having a rotor assembly according to the present invention the sealing units 7, 10, 6, are arranged at the both sides of the rotor 1, so that the sealing units 7, 10, 6 are or at least one of the said sealing units are provided with a pressure balancing volume 8, 9. The sealing units 7, 10, 6 may be incorporated together with the dividers 4, 5, 2, respectively. With the help of the solution according to the present invention the pressure balancing volume 8, 9 of the sealing units 4, 7, 5, 10, 2, 6 allow an air leakage through the side surfaces 24, 25 of the rotor 1. This air flow in the right direction as this leakage does not contaminate the air supplied to room 32. The solution according to the present invention actually partially solves the problem of contamination due to the balanced pressure over the sealing unit 4, 7, 5, 10, 2, 6.

[0048] Figure 10 is a graph showing leakage through the rotary heat/energy recovery unit having a rotor assembly according to the present invention. Analysis and test results of the present invention, shown in figure 10, present that reduction in the axial seal leakage is very similar to that of the prior art where a pressure balancing damper 38 is used to minimise the flow leakage, as shown in figure 5. The leakage through the circumferential sealing unit 6 is actually decreased by 25 to 50 % in the solution of the present invention in relation to the prior art when a pressure balance damper 38 is used.

[0049] The solution of the present invention uses a pressure balancing volume and a pressure balancing element to complement the existing seals in the rotor assembly. The rotor assembly of a heat/energy recovery unit having a rotor assembly functions such that inlet air is heated to supply air by using thermal energy of discharge air such that the discharge air is cooled to outlet air. In other words inlet air is heated by discharge air in the rotor assembly of the heat/energy recovery unit having a rotor assembly such that the inlet air becomes heated supply air and the discharge air becomes cooled outlet air. The rotor assembly comprises an inlet plenum on the first side of the rotor for conducting inlet air to the rotor, a supply plenum on the second side of the rotor for receiving supply air from the rotor, a discharge plenum on the second side of the rotor for conducting discharge air to the rotor and an outlet plenum on the first side of the rotor for receiving outlet air from the rotor.

[0050] The rotor assembly is further provided with a circumferential sealing unit for isolating the inlet plenum from the supply plenum and discharge plenum from the outlet plenum, in other words for isolating the first side of the rotor from the second side of the rotor. The rotor assembly further comprises a first axial sealing unit on the first side of the rotor for isolating the inlet plenum from the outlet plenum and a second axial sealing unit on the second side of the rotor for isolating the supply plenum from the discharge plenum. In the present invention the mentioned sealing units are provided with a pressure balancing volume for balancing the pressure difference over the sealing unit and for allowing an air leakage through the side surfaces of the rotor.

[0051] The pressure balancing volume is provided to the sealing unit between the adjacent plenums. The sealing unit is further provided with sealing elements and pressure balancing elements provided between the pressure balancing volume and the adjacent plenums. Thus there is a sealing element between one plenum and the pressure balancing volume and a pressure balancing element between the other plenum and the pressure balancing volume. The pressure balancing elements are provided such that they are at least partly pressure permeable for balancing the pressure difference between the adjacent plenums in the pressure balancing volume. The pressure balancing volume of the seals allow an air leakage through the side surfaces of the rotor. This air flow in the right direction as this leakage does not contaminate the air supplied to room. The solution according to the present invention actually partially solves the problem of contamination due to the balanced pressure over the sealing unit.

[0052] The present invention has the advantage that it provides a similar function as the pressure balancing damper without the associated disadvantages since no or reduced resistance needs to be supplied to the extract ducting. Furthermore, using the pressure balancing volume of the present invention decreases or prevents the leakage problems in connection with the rotor assembly of a heat/energy recovery unit having a rotor assembly.

[0053] It will be obvious to a person skilled in the art that, as the technology advances, the inventive concept can be implemented in various ways. The invention and its embodiments are not limited to the examples described above but may vary within the scope of the claims.

Claims

1. A rotor assembly for a heat/energy recovery unit having a rotor assembly, the rotor assembly comprising:

   - a rotor (1) arranged to rotate around a rotation axis (11), the rotor (1) having a first side surface (24) of the rotor (1) on a first side (12) and a second side surface (25) of the rotor (1) on a second side (13) in the direction of the rotation axis (11);
   - a circumferential sealing unit (2, 6) arranged around the periphery (3) of the rotor (2) for isolating the first side (12) and the second side (13) of the rotor (1);
   - a first axial sealing unit (4, 7) on the first (12) of the rotor (2) for dividing the first side (12) of the rotor (2) to two adjacent plenums (14, 17); and
   - a second axial sealing unit (5, 10) on the second side (13) of the rotor (2) for dividing the second side (13) of the rotor (2) to two adjacent plenums (15, 16),

   characterized in that at least one of the sealing units (2, 6; 4, 7; 5, 10) is provided with a pressure balancing volume (8, 9) for balancing the pressure difference over the sealing unit (2, 6; 4, 7; 5, 10) so that the pressure balancing volume (8, 9) of the sealing units (2, 6; 4, 7; 5, 10) allow an air leakage through the side surfaces (24), (25) of the rotor (1).

2. A rotor assembly according to claim 1, **characterized in that** the sealing unit (2, 6; 4, 7; 5, 10) has a sealing element (20, 23) and a pressure balancing element (21, 27; 22, 26) provided between the pressure balancing volume (8, 9) and the adjacent plenums (14, 17; 15, 16) or the first and second side (12, 13) of the rotor (1).

3. A rotor assembly according to claim 1 or 2, **characterized in that** the first axial sealing unit (4, 7) and the second axial sealing unit (5, 10) comprise an axial sealing unit (7, 10) having an axial sealing element (23) between an axial pressure balancing volume (8) and the one plenum (14, 16) and an axial pressure balancing element (22, 26) between an axial pressure balancing volume (8) and other plenum (15, 17).

4. A rotor assembly according to claim 1 or 2, **characterized in that** the circumferential sealing unit (2, 6) comprises a circumferential sealing element (20) between a circumferential pressure balancing volume (9) and the first side (12) of the rotor (1) and a circumferential pressure balancing element (21, 27) between a circumferential pressure balancing volume (9) and the second side (13) of the rotor (1).

5. A rotor assembly according to any one of claims 2 to 4, **characterized in that** the pressure balancing element (22, 26; 21, 27) is arranged to be pressure permeable.

6. A rotor assembly according to any one of claims 2 to 5, **characterized in that** the pressure balancing element (22, 26; 21, 27) is a brush type sealing element, cloth type sealing element, a narrow gap or diffusion gap.

7. A rotor assembly according to any one of claims 1 to 6, **characterized in that** the circumferential pressure balancing volume (9) is arranged to extend circumferentially around the periphery (3) of the rotor (1).

8. A rotor assembly according to claim 7, **characterized in that** the circumferential sealing unit (2, 6) comprises a circumferential divider (2) provided on periphery (3) of the rotor (1) for isolating the first and second side (12, 13) of the rotor (1), and that the circumferential divider (2) is arranged to the circumferential sealing unit (2, 6) such that the circumferential seal extends between the circumferential divider (3) and the periphery (3) of the rotor (1).

9. A rotor assembly according to any one of claims 1 to 8, **characterized in that** the axial pressure balancing volume (8) is arranged to extend across a first and second side surface (24, 25) of the rotor (1) on the first and second side (12, 13) of the rotor (1), respectively.

10. A rotor assembly according to claim 9, **characterized in that** the first and second axial sealing unit

(4, 7; 5, 10) comprise respectively a first and second axial divider (4, 5) extending in the direction of the rotation axis (11) of the rotor (1) for isolating the two adjacent plenums (14, 17; 15, 16) from each other on the first and second side (12, 13) of the rotor (1) respectively, and that the first and second axial dividers (4, 5) are arranged to the axial sealing units (4, 7; 5, 10) such that the axial seals extend between the axial divider (4, 5) and the side surface (24, 25) of the rotor (1).

11. A heat/energy recovery unit having a rotor assembly in which inlet air (I) is heated to supply air (S) by using thermal energy of discharge air (D) such that the discharge air (D) is cooled to outlet air (O), the heat/energy recovery unit having a rotor assembly having a rotor unit (30) comprising:

- a rotor (1) for carrying out the heat exchange, the rotor (1) having a first side surface (24) and a second side surface (25) of the rotor (1);
- an inlet plenum (14) for conducting inlet air (I) to the rotor (1);
- a supply plenum (15) for receiving supply air (S) from the rotor (1);
- a discharge plenum (16) for conducting discharge air (D) to the rotor (1);
- an outlet plenum (17) for receiving outlet air (O) from the rotor (1);
- a circumferential sealing unit (2, 6) for isolating the inlet plenum (14) from the supply plenum (15) and discharge plenum (16) from the outlet plenum (17);
- a first axial sealing unit (4, 7) for isolating the inlet plenum (14) from the outlet plenum (17); and
- a second axial sealing unit (5, 10) for isolating the supply plenum (15) from the discharge plenum (16),

characterized in that at least one of the sealing units (2, 6; 4, 7; 5, 10) is provided with a a pressure balancing volume (8, 9) for balancing the pressure difference over the sealing unit (2, 6; 4, 7; 5, 10) between the adjacent plenums (14, 17); (15, 16), so that the pressure balancing volume (8, 9) of the sealing units (2, 6; 4, 7; 5, 10) allow an air leakage between the opposing plenums (14, 15); (16, 17), through the side surfaces (24), (25) of the rotor (1).

12. A heat/energy recovery unit having a rotor assembly according to claim 11, **characterized in that** the sealing unit (2, 6; 4, 7; 5, 10) has a sealing element (20, 23) and a pressure balancing element (21, 27; 22, 26) provided between the pressure balancing volume (8, 9) and the adjacent plenums (14, 17; 15, 16).

13. A heat/energy recovery unit having a rotor assembly according to claim 11 or 12, **characterized in that** the first axial sealing unit (4, 7) has an axial sealing element (23) between the first axial pressure balancing volume (8) and the inlet plenum (14) and an axial pressure balancing element (22, 26) between a first axial pressure balancing volume (8) and outlet plenum (17).

14. A heat/energy recovery unit having a rotor assembly according to any one of claims 11 to 13, **characterized in that** the second axial sealing unit (5, 10) has an axial sealing element (23) between the second axial pressure balancing volume (8') and the discharge plenum (16) and an axial pressure balancing element (22, 26) between a second axial pressure balancing volume (8') and supply plenum (15).

15. A heat/energy recovery unit having a rotor assembly according to any one of claims 11 to 14, **characterized in that** the circumferential sealing unit (2, 6) comprises a circumferential sealing element (20) between a circumferential pressure balancing volume (9) and the inlet plenum (14) or the outlet plenum (17) and a circumferential pressure balancing element (21, 27) between a circumferential pressure balancing volume (9) and the supply plenum (15) or the discharge plenum (16).

16. A heat/energy recovery unit having a rotor assembly according to any one of claims 11 to 15, **characterized in that** the circumferential sealing unit (2, 6) comprises a circumferential divider (2) provided on periphery (3) of the rotor (1) for isolating the first and second side (12, 13) of the rotor (1), and that the circumferential divider (2) is arranged to the circumferential sealing unit (2, 6) such that the circumferential seal extends between the circumferential divider (3) and the periphery (3) of the rotor (1).

17. A heat/energy recovery unit having a rotor assembly according to any one of claims 11 to 16, **characterized in that** the first and second axial sealing unit (4, 7; 5, 10) comprise respectively a first and second axial divider (4, 5) extending in the direction of the rotation axis (11) of the rotor (1) for isolating the two adjacent plenums (14, 17; 15, 16) from each other on the first and second side (12, 13) of the rotor (1) respectively, and that the first and second axial dividers (4, 5) are arranged to the first and second axial sealing units (4, 7; 5, 10) such that the first and second axial seals extend respectively between the axial divider (4, 5) and the side surface (24, 25) of the rotor (1).

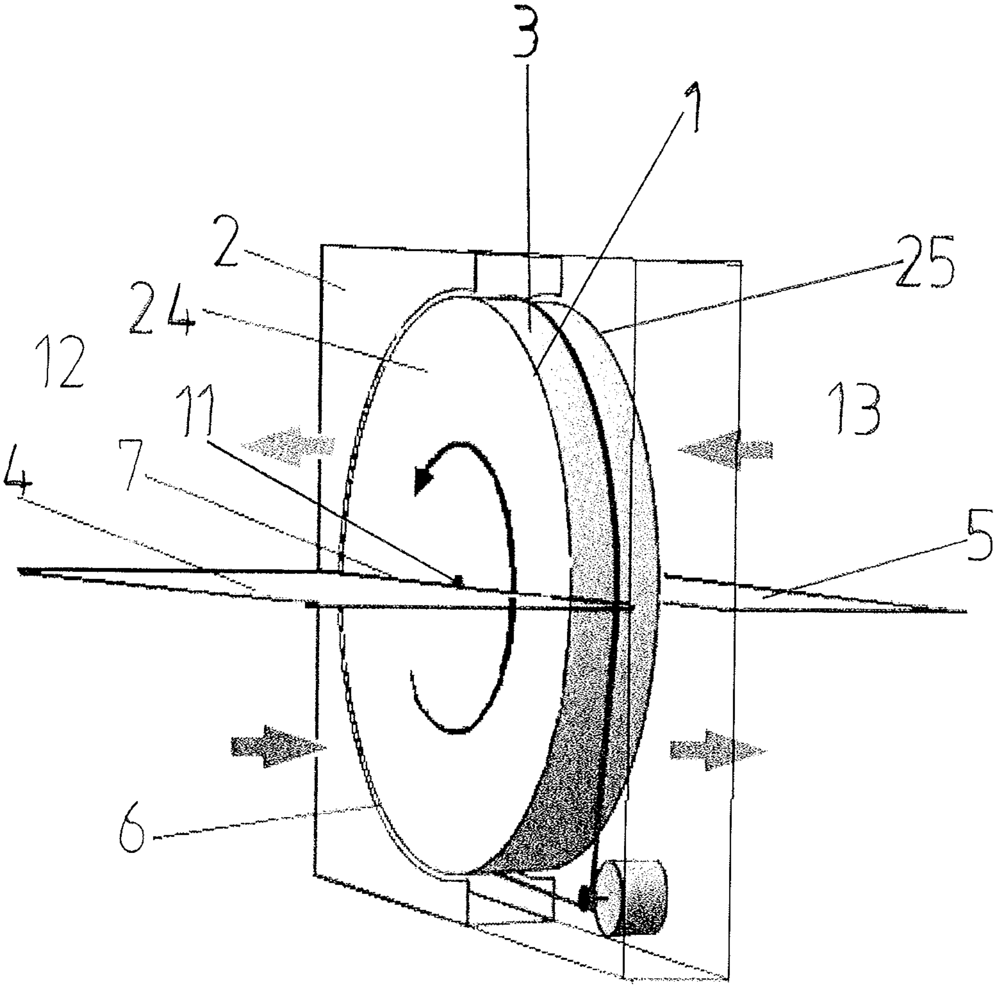


Fig. 1

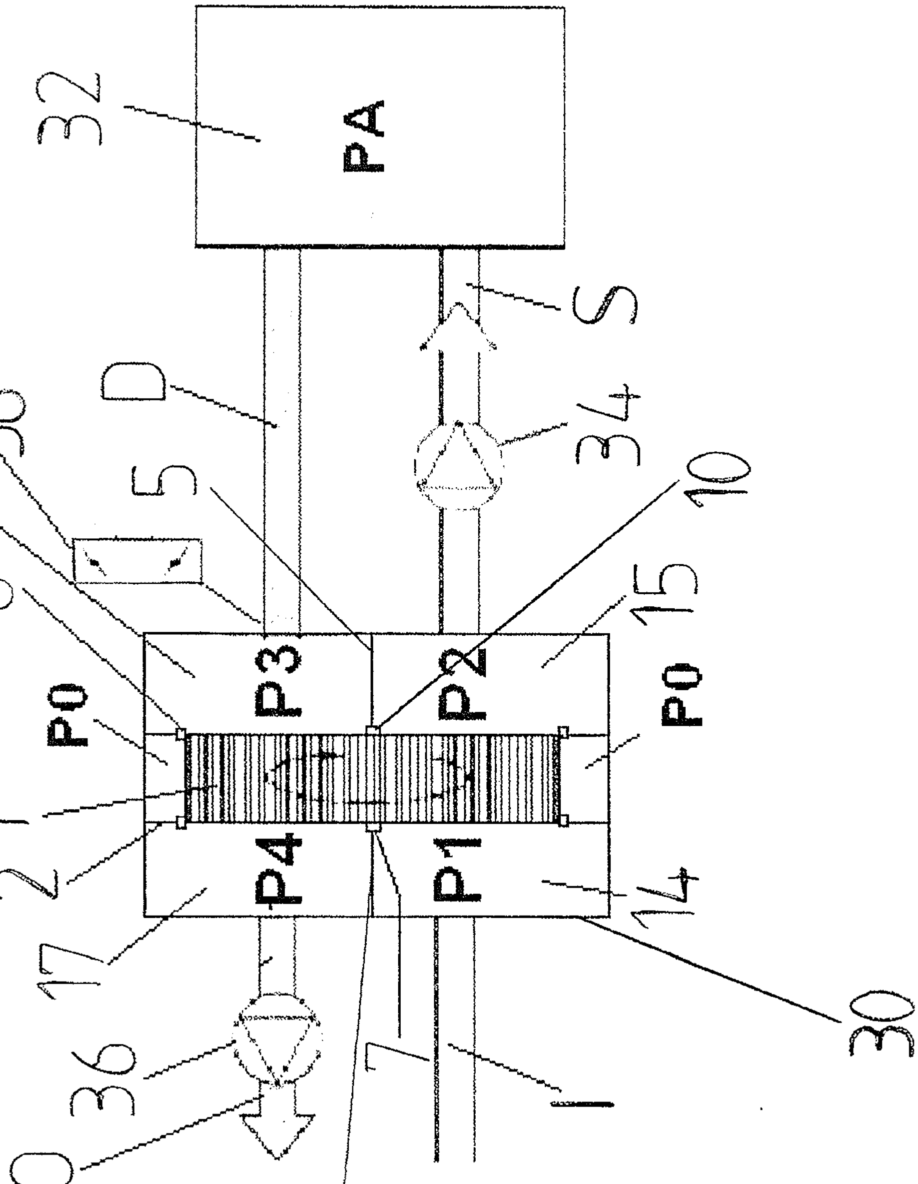


Fig. 2

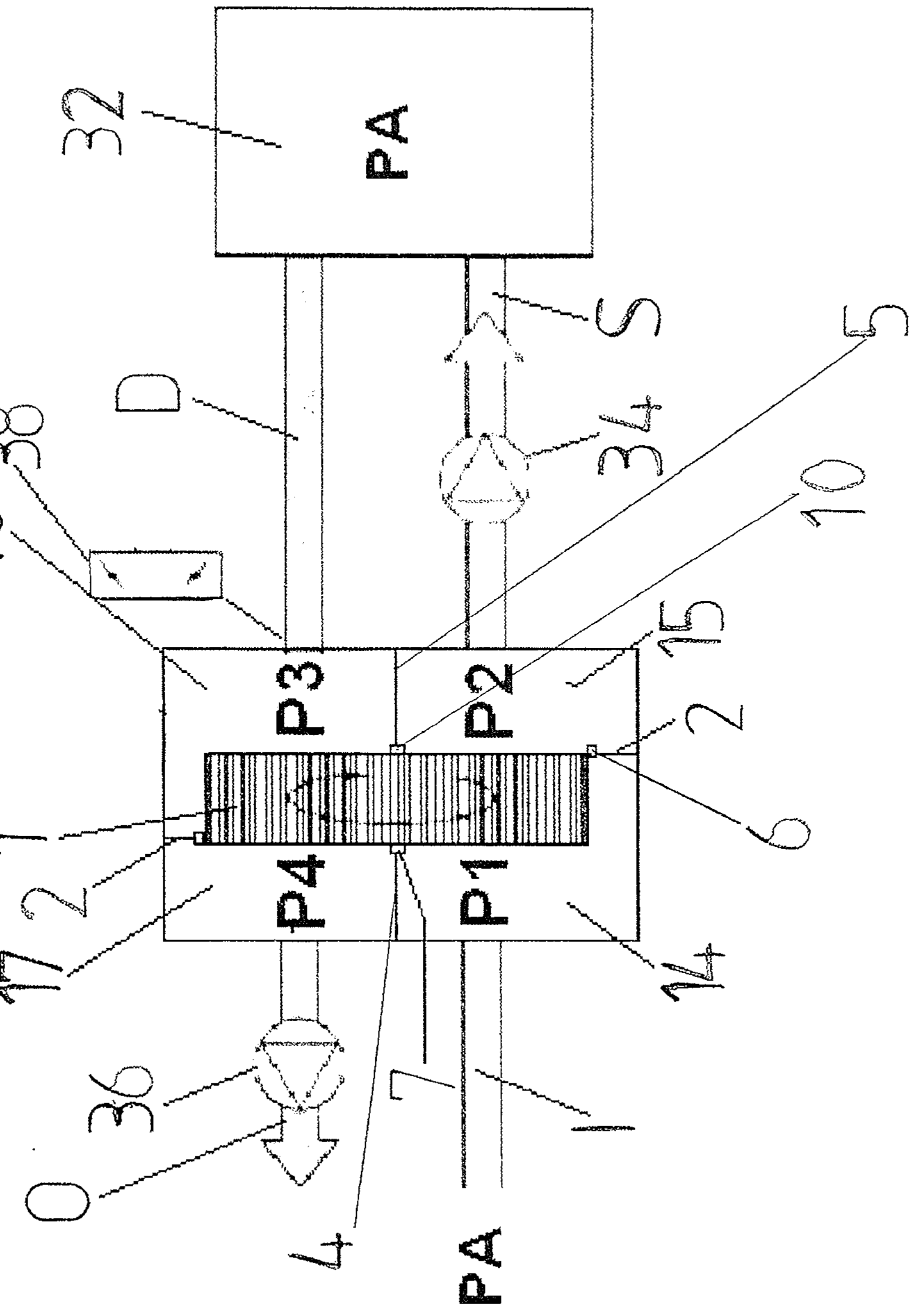
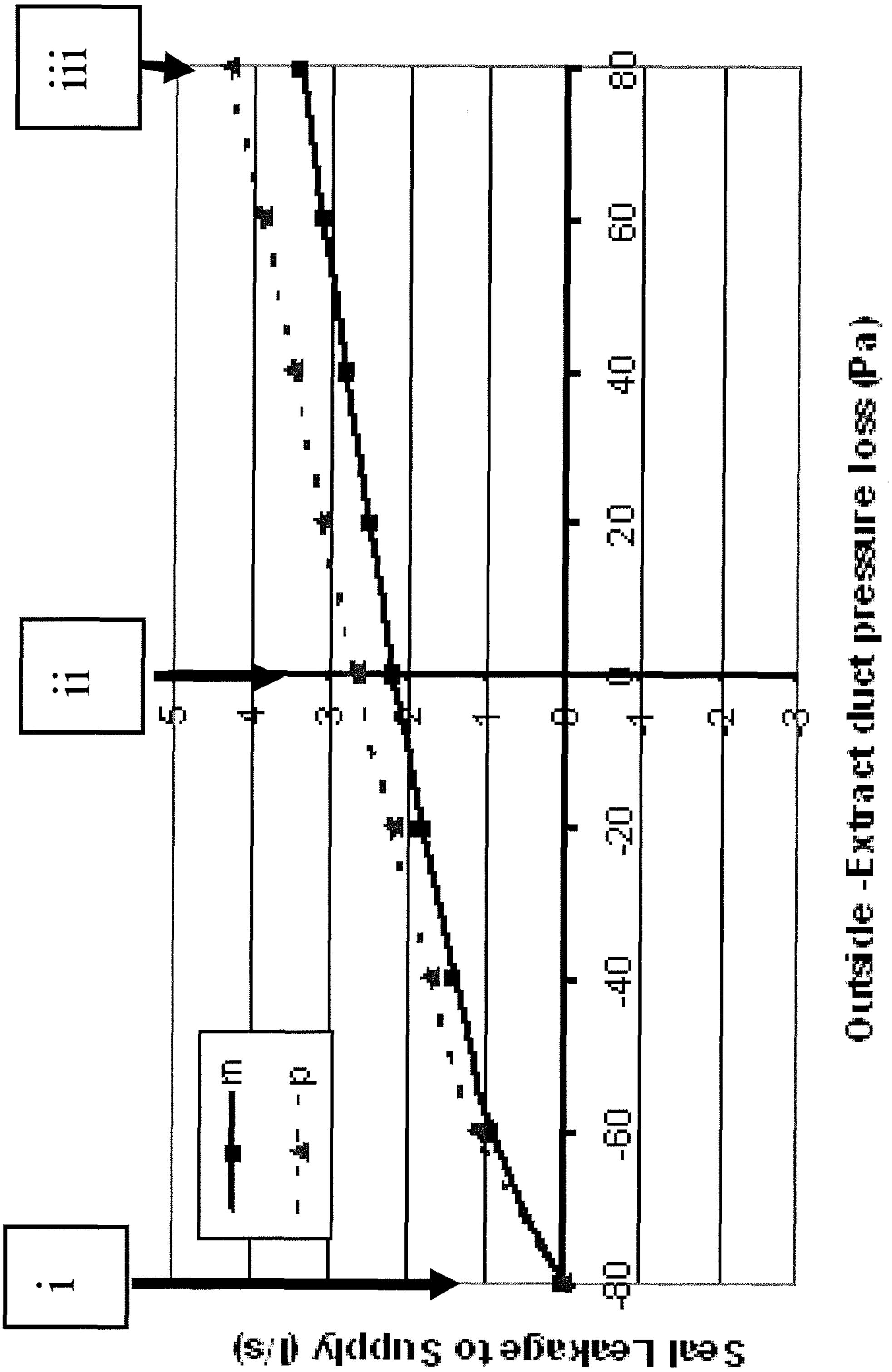


Fig. 3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-3
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60
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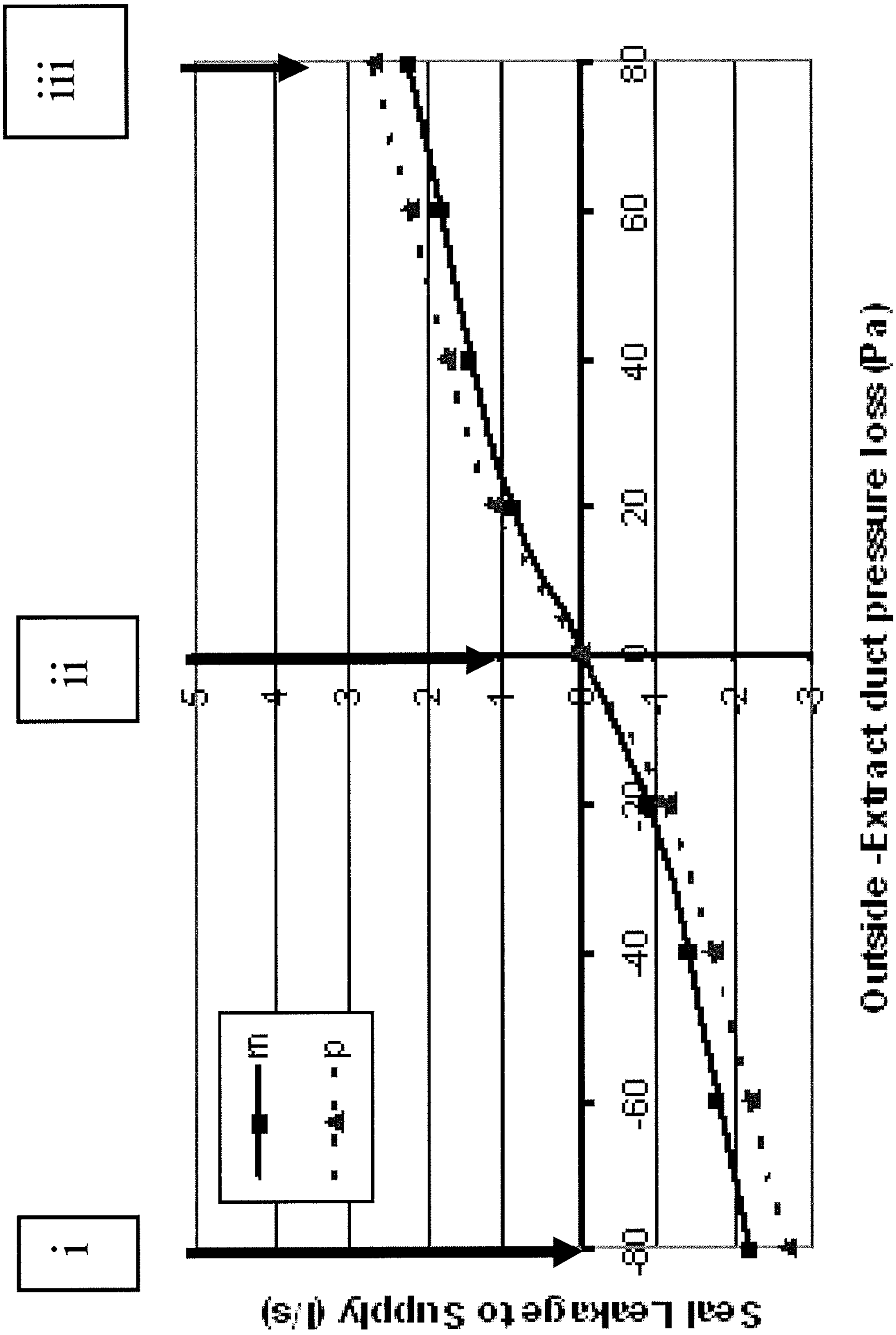
Seal Leakage to Supply (l/s)
Outside -Extract duct pressure loss (Pa)

Fig. 4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Seal Leakage to Supply (l/s)
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Fig. 5

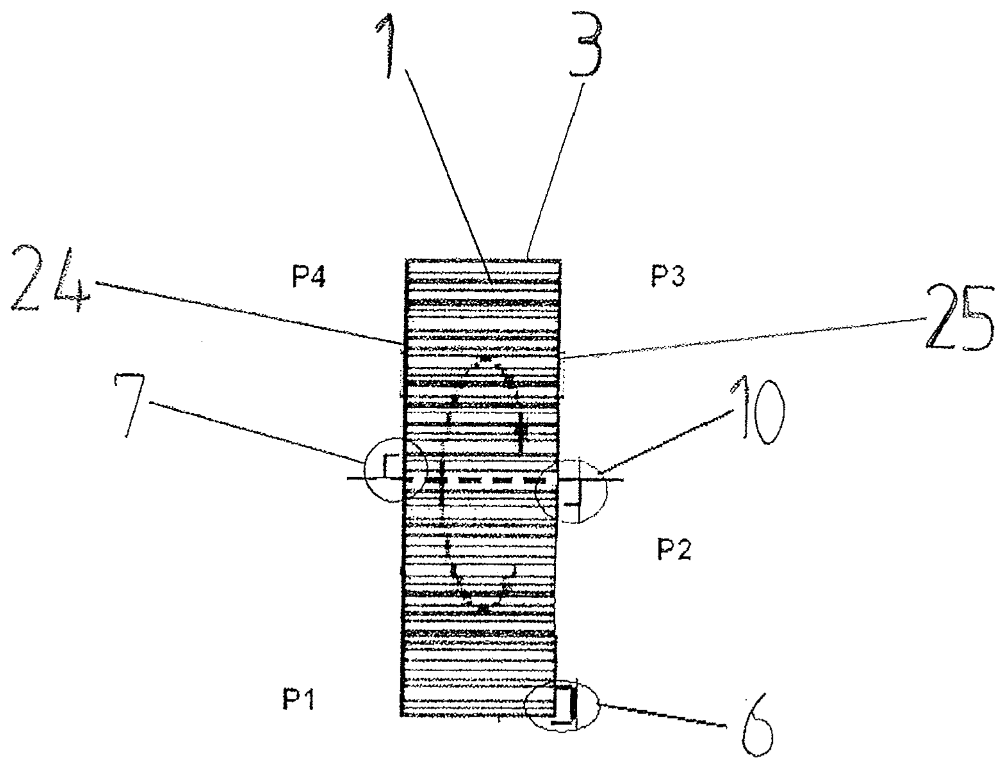

Fig. 6

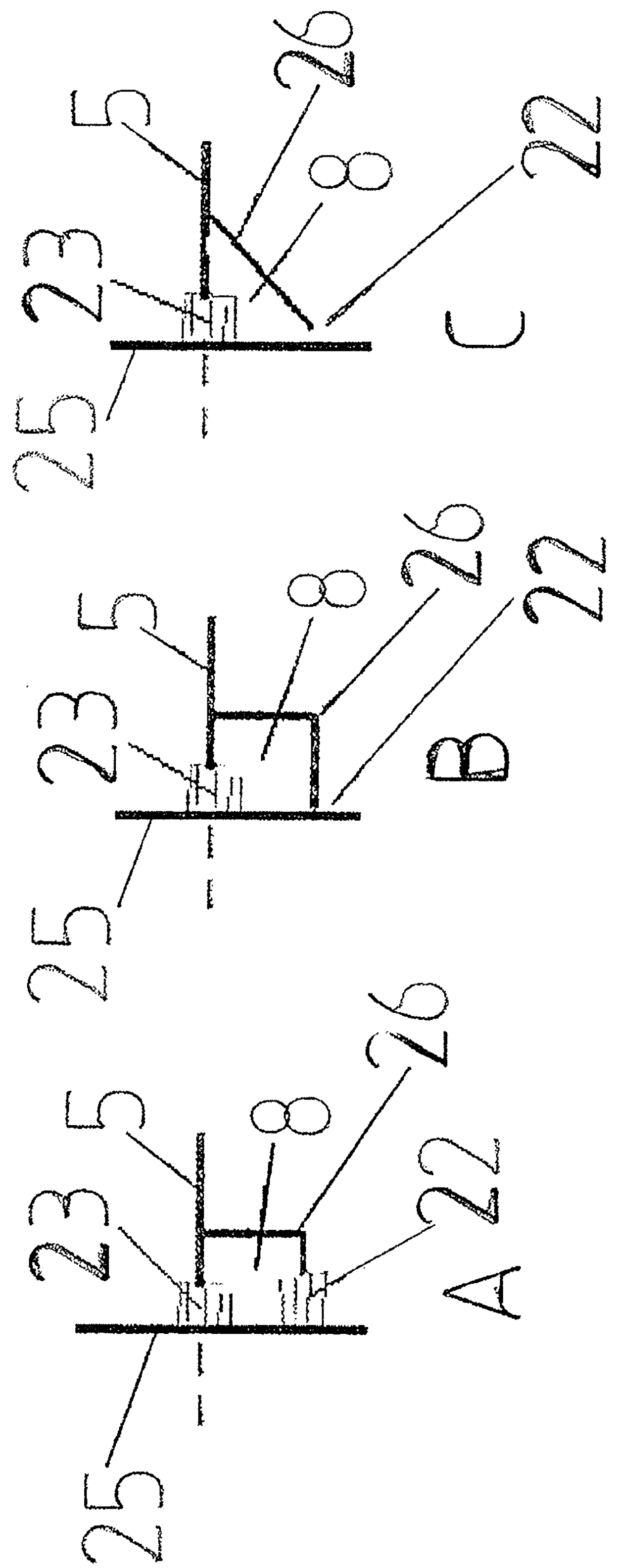

Fig. 7

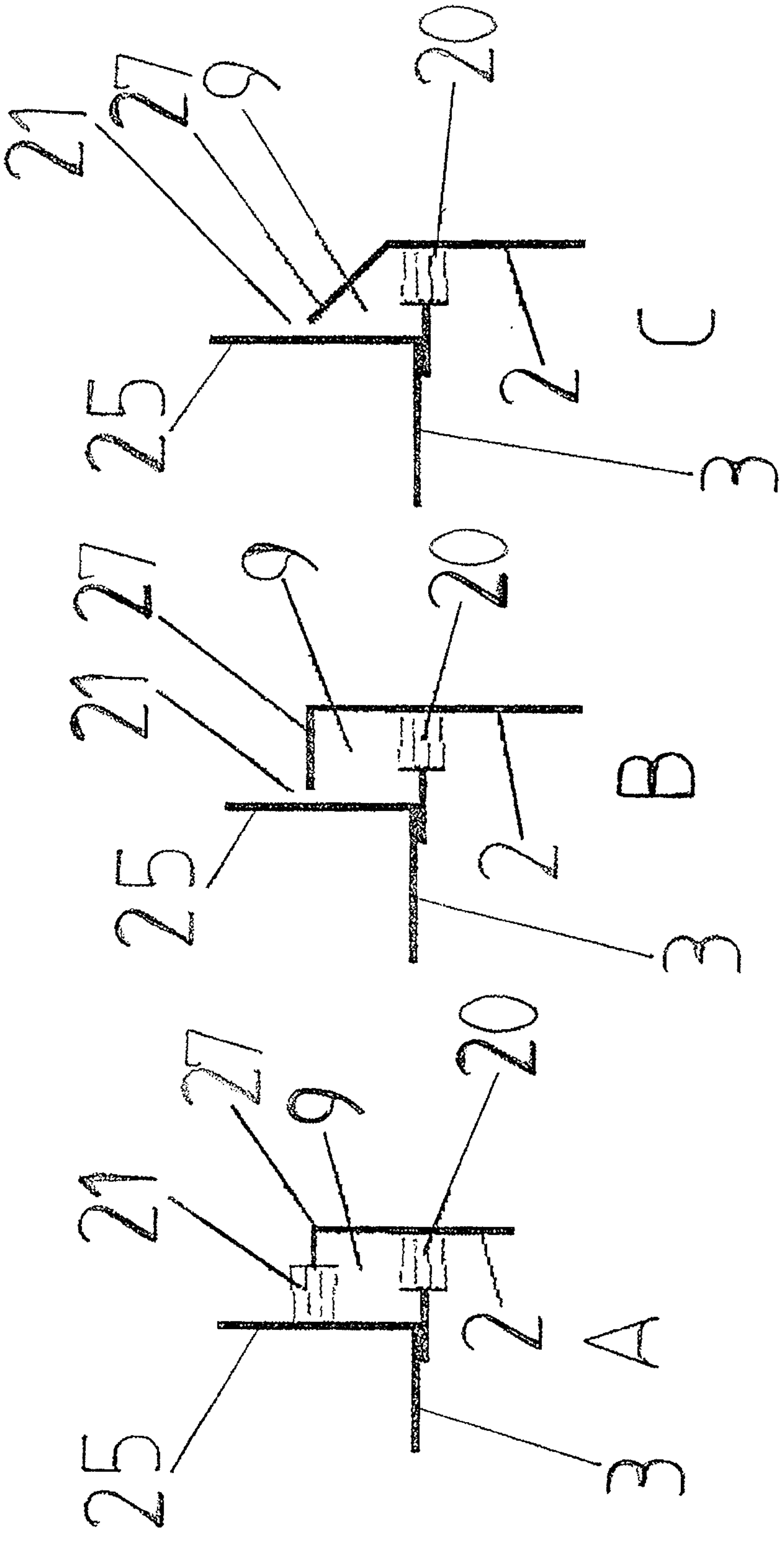

Fig. 8

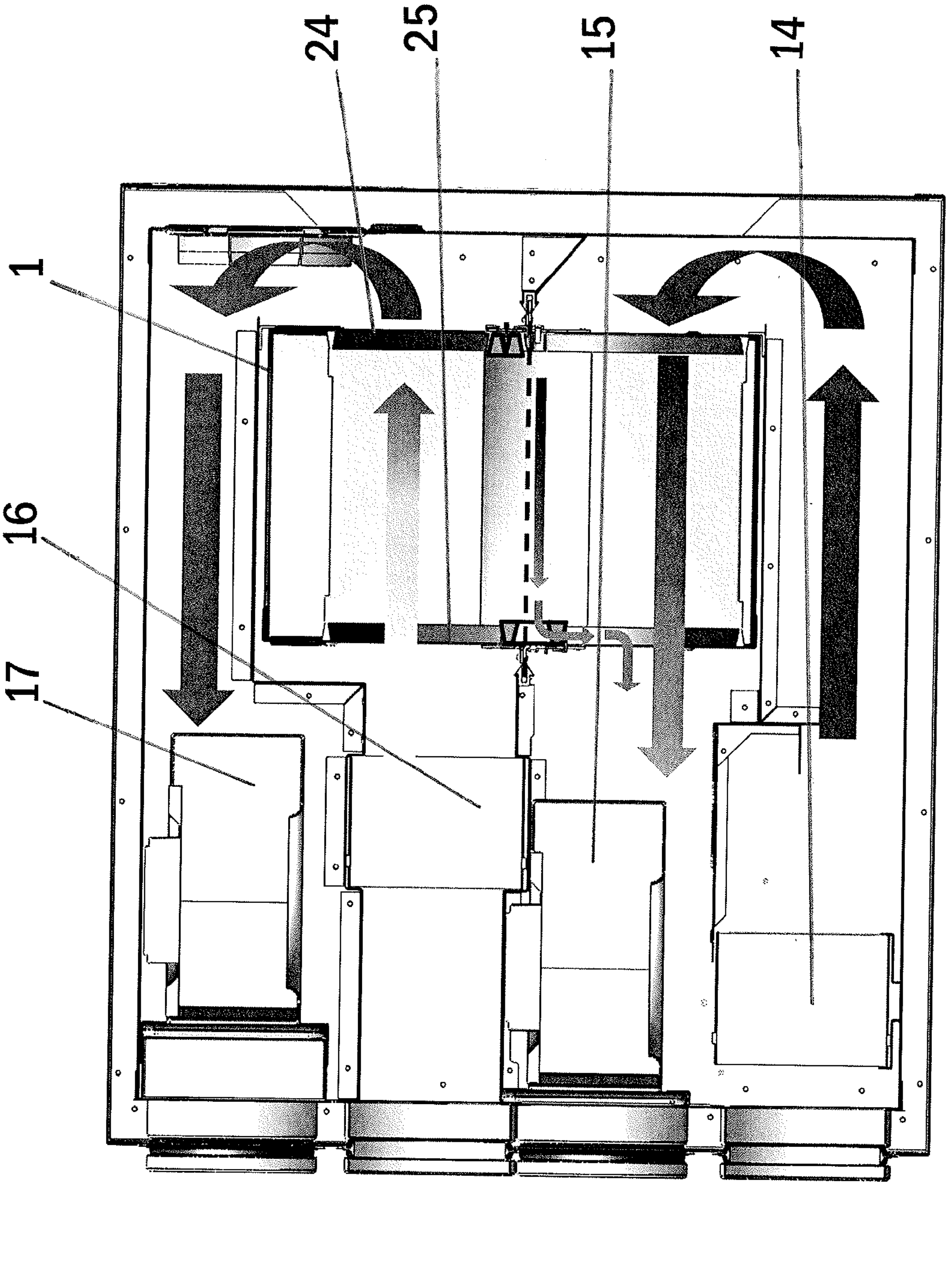

Fig. 9

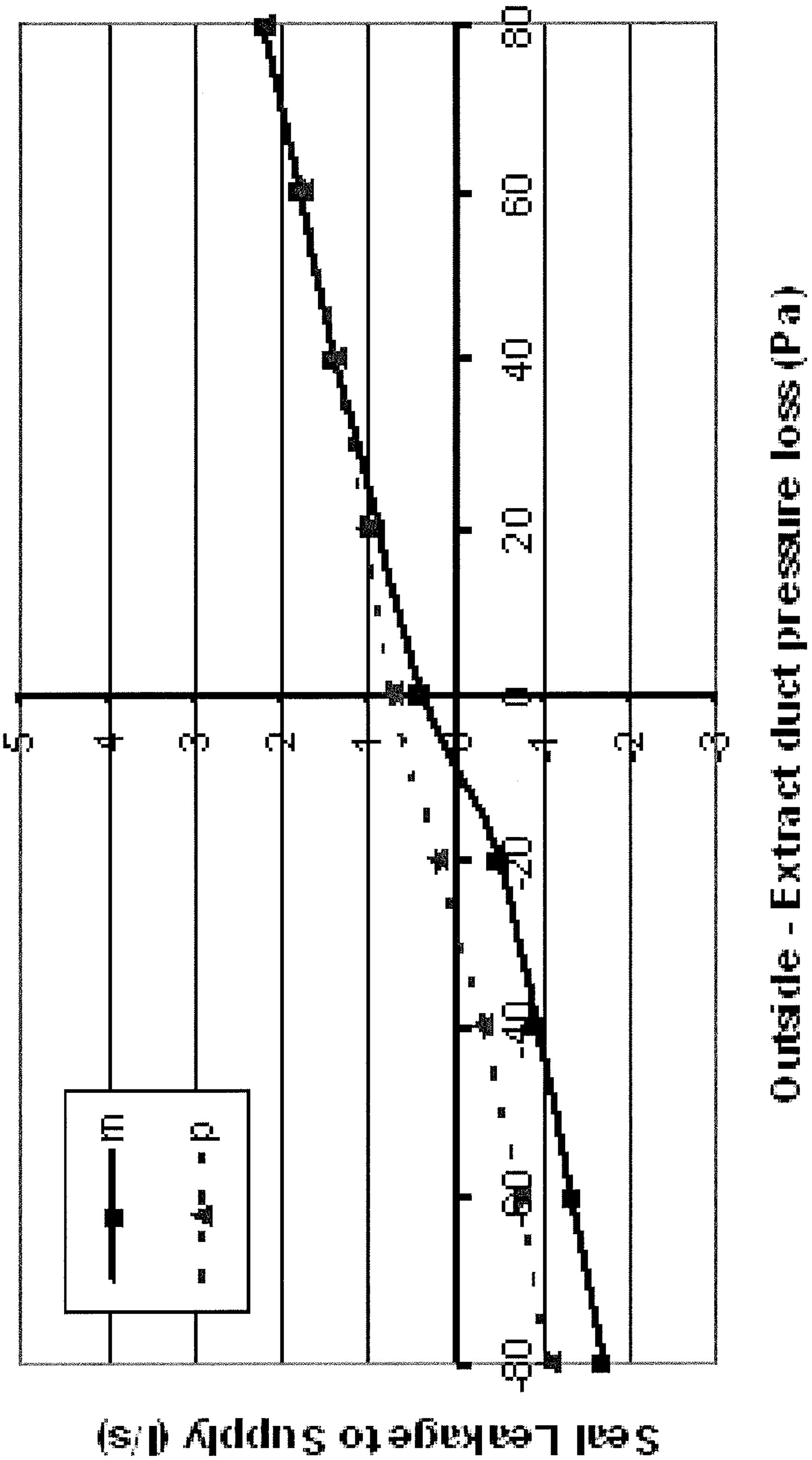
Seal Leakage to Supply (l/s)
Outside - Extract duct pressure loss (Pa)
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Fig. 10

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EUROPEAN SEARCH REPORT

Application Number
EP 11 18 1948

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The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	18 April 2012	Bain, David

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18-04-2012

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