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(54) **ROTARY REGENERATIVE HEAT EXCHANGER AND A METHOD FOR OPERATING SUCH HEAT EXCHANGER**

UMLAUFENDER REGENERATIVER WÄRMETAUSCHER UND VERFAHREN ZUM BETREIBEN
EINES UMLAUFENDES REGENERATIVES WÄRMETAUSCHERS

ECHANGEUR DE CHALEUR ROTATIF A REGENERATION ET SON MODE D'UTILISATION

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(73) Proprietor: **ABB AIR PREHEATER, INC.**
Wellsville, NY 14895-0372 (US)

(72) Inventor: **WESTERLUND, Dag**
S-175 73 Järfälla (SE)

(74) Representative: **Waldinger, Ake**
Svenska Rotor Maskiner AB
Box 15085
104 65 Stockholm (SE)

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WO-A-93/19339 **WO-A-94/01730**
WO-A-95/01541 **DE-C- 973 548**
SE-A- 9 302 301 **US-A- 3 122 200**
US-A- 3 232 335 **US-A- 3 499 480**

- **PATENT ABSTRACTS OF JAPAN, Vol. 5, No. 83, M-71; & JP,A,56 030 588 (NISSAN JIDOSHA K.K.), 27 March 1981.**

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Description

[0001] The present invention in a first aspect relates to a rotary regenerative heat exchanger of the kind specified in the preamble of claim 1 and in a second aspect to a method for operating such heat exchanger as specified in the preamble of claim 8.

[0002] SE 176 375 discloses a rotary regenerative heat exchanger with a support in the form of rolling bodies, mounted in the outer ends of sector-shaped plates closed to both ends of the rotating part and rolling on a flange along the periphery at the top and bottom end of the rotor.

[0003] It was therethrough intended that a constant clearance should be possible to be maintained between the ends of the sector-shaped plates and the top and bottom end, respectively. The environment for the rollers, however, was found to be too severe. The bearings of the rollers were worn out rapidly and dirt and particles were by the rolling adhered on the flanges and the surfaces of the roller with break downs as a consequence.

[0004] It has been suggested to replace the rollers by sliding shoes as disclosed in JP, A, 63-315 891. These sliding shoes are made of ceramics in order to attain a high wear resistance. However, problems will occur if the sliding shoe becomes somewhat slanting due to mounting inaccuracy and/or thermal deformations. There will in such cases be a risk that the sliding shoe will contact the flange by only a small part of its sliding surface with unacceptable high contact pressure as a consequence. Furthermore some kind of external lubrication of the sliding surfaces is required or considerable friction losses has to be accepted.

[0005] In WO94/01730 an improvement is disclosed by using sliding shoes of carbon or graphite instead of ceramic sliding shoes. Such a sliding shoe eliminates the drawbacks with a sliding shoe of ceramics. In particular graphite has excellent lubrication properties and like carbon has an ability to maintain the flanges of the rotating body clean when adhering a lubricating layer of carbon or graphite on the flanges. The abrasion of the sliding shoe also secures a correct contact with parallel contact surfaces so that the contact takes place on the complete sliding shoe surface. Carbon and graphite also have a good acceptance of the high temperature and the acid environment that are present. By the abrasion of the sliding shoes they will gradually be consumed and have to be replaced. The degree of abrasion, however, will vary widely, so that one or more sliding shoes might be worn down so much that the clearance reaches zero, whereas other sliding shoes will be almost unaffected. Each sliding shoe therefore is adjustable in a direction perpendicular to the contact surface. A similar solution is disclosed in WO95/00809, in which there is provided a measuring rod adjacent to the sliding shoe, which measuring rod is directed parallel to the adjustment direction. The measuring rod from a resting position can be momentarily brought in contact with the related flange

and indicates when the size of the clearance requires advancement of the sliding shoe a distance so that the initial clearance is restored.

[0006] Another solution is disclosed in SE 9302301-8 in which the abrasion problems are overcome in that the sliding shoe is sliding on a gas cushion created by the supply of pressure gas between the sliding shoe and a flange on the rotor. Abrasion thereby is avoided in that there will be no contact between the sliding shoe and the flange. A further heat exchanger where a sliding shoe is sliding on a gas cushion is known by WO-A-9 501 541.

[0007] Arrangement of the sliding shoes hovering on air cushions, however, increases the costs. Each shoe will be more sophisticated and thereby circumstantial to manufacture, and gas piping has to be connected to each individual sliding shoe.

[0008] Common to all the above discussed arrangements of the supports, the contacting as well as the contact-free types, is that at least two individual supports are provided for each sector plate.

[0009] The reason for that is to secure a steady supporting of the sector plate and avoid tilting thereof. One single support at the middle of the outer periphery of the plate should theoretically be enough since the plate at its inner end is supported by two pivot connections to the fixed centre plate. Due to flexibility of the movable sector plate and/or thermal deformation there will in practice, however, be a risk for the outer edges of the plate to tilt and hit against the rotor, when there is only one support.

[0010] However, when using the contact-free type of sliding shoe, which is more expensive than the traditional type, there is a desire to reduce the number of such sliding shoes.

[0011] The object of the present invention therefore is to attain a regenerative heat exchanger of the kind in question in which the number of sliding shoes is as small as possible.

[0012] This has according to the present invention been achieved in that a rotary regenerative heat exchanger of the kind specified in the preamble of claim 1 has got the features specified in the characterizing portion of that claim and in another aspect in that a method as specified in the preamble of claim 8 includes the measures specified in the characterizing portion of that claim.

[0013] The device according to the invention thus deviates from the traditional concept of using two or more supports for the sector plate, when supports of the non-contacting type are used. The problem of avoiding tilting is overcome in that the support is elongated so that the outer part of the sector plate is stabilized in the circumferential direction.

[0014] By using only one contact-free support for each sector plate the number of devices for establishing gas cushions is reduced to the half, which lowers the manufacturing and maintenance costs and reduces the

risk for failure. Due to the elongated shape, the air cushion will have a larger circumferential extension, and the area of the air cushion can be increased. Thereby a sufficient raising force from the air cushion can be attained at a lower pressure of the supplied gas in comparison with a conventional pair of circular air cushions. Since the requirement on the pressure level of the gas source thus will be lower, the running costs for the gas supply is reduced.

[0015] The angular extension of the front surface preferably is more than half the angular extension of the sector plate in order to attain a sufficiently stabilized support by the air cushion and it should preferably be symmetrically located.

[0016] Preferably the gas outlet has a corresponding elongated shape, whereby a uniform distribution of the gas is promoted.

[0017] These and other advantageous embodiments are specified in the dependent claims.

[0018] The invention will be further explained through the following detailed description of a preferred embodiment thereof and with reference to the accompanying drawings, of which

fig. 1 is a partial axial section through a first preferred embodiment of the invention,
fig. 2 is a view taken along line II-II of fig. 1,
fig. 3 is a view similar to that of fig. 2, illustrating a second embodiment of the invention,
fig. 4 is a view similar to that of fig. 2, illustrating a third embodiment of the invention,
fig. 5 is a schematic section along line V-V of fig. 2, and
fig. 6 is a view similar to that of fig. 5, illustrating a fourth embodiment of the invention.

[0019] The heat exchanger illustrated in fig. 1 is of conventional type having a stationary casing 1 and a cylindrical rotor 2 containing the regenerative mass 3. The rotor has a hub 4 and an upper fixed sector shaped centre plate 5 with a movable sector plate 6 pivotally connected thereto and corresponding lower fixed centre plate 7 and movable sector plate 8. The two sets of plates 5, 6 and 7, 8 have the function to seal against the upper and lower ends of the rotor 2 as tight as possible and thereby separate the heat exchanging media flowing to and from the rotor through axial openings connected to media ducts (not shown).

[0020] For that purpose the radially outer ends of each of the movable sector plates 6, 8 are provided a device, which device forms support means 10 for maintaining a certain clearances between the ends of the sector plates 6, 8 and an upper and lower annular edge flange 12 attached to the rotor along its upper and lower peripheries, each flange having an outer circumferentially continuous end surface 61 for co-operation with a front surface 62 connected to each of the devices 10.

[0021] In fig. 2 the sector plate 6 is seen from the out-

side and co-operates with the end surface 11 of the rotor end flange 9. Through a sleeve 15 pressure gas is supplied to a sliding shoe forming gas cushion means with a front surface facing the end surface 11 of the flange 9. The front surface 12 of the sliding shoe is arc-shaped and limited by two concentric circular arcs 14 and 15. The sliding shoe is symmetrically arranged in relation to a symmetry line 19 of the sector plate 6 and extends along the flange 9 about two thirds of the angular extension of the sector plate. The gas supplied through the sleeve 15 is distributed through channels in the sliding shoe to an arc-shaped groove 16 in the front surface 12 of the sliding shoe, and creates an air cushion between the front surface 12 of the sliding shoe and the end surface 11 of the flange 9. Although only one gas cushion supports the sector plate 6 the support will be stable and without risk for tilting due to the elongated shape of the gas cushion.

[0022] Fig. 3 illustrates the support 10 through a section therethrough. The arc-shaped sliding shoe 17 is rigidly attached to the sector plate 6 and projects a short distance from the internal surface 28 of the sector plate 6.

[0023] In the front surface 12 of the sliding shoe 17 the groove 16 forming the gas outlet means extends along almost the entire length of the front surface. Through a plurality of channels 27 the groove 16 communicates with the opposite side of the sliding shoe. This side is covered by a closure member 18 of the same shape as the sliding shoe 17. The closure member has a gas inlet opening 25 and a distribution groove 26 through which the inlet opening 25 and the channels 27 communicate. A circular sleeve 15 is attached to the closure member 18 around the gas inlet opening 25, which sleeve extends out through a circular hole in the casing 1, and the opposite end of the sleeve 15 is through a gas conduit 23 connected to a pressure gas source 22. Between a flange 20 attached to the sleeve 15 and the casing 1 a sealing bellow 21 is provided, so that a predetermined axial force will be applied downwards on the plate 6 due to the spring effect of the bellow 21.

[0024] In operation pressure gas flows through conduit 23, the interior 24 of the sleeve 15, the inlet opening 25, the distribution groove 26 and the channels 27 to the groove 16. The pressure of the gas keeps the front surface 12 of the sliding shoe 17 raised from the end surface 11 of the flange 9 against the action of the force from the bellow 21, so that the gas is allowed to escape through these surfaces, thereby creating the elongated air cushion.

[0025] Fig. 6 illustrates an alternative embodiment of the support 10, in which the front surface 12" co-operating with the end surface 11 of the flange 9 is formed by a part of the inner surface 28 of the sector plate 6. The clearance S between the sector plate 6 and the end flange thereby will be more narrow. In order to avoid contact between the plate 6 and the flange the groove 12' extends circumferentially almost to the ends of the sec-

tor plate so that the air cushion will receive a corresponding extension.

[0026] Figs. 3 and 4 illustrate alternative shapes of the front surface 12', 12'', respectively. In fig. 3 the front surface 12' is rectangular, limited by two straight lines 13', 14', and in fig. 4 the front surface is crescent-shaped, limited by two non-concentric circular arcs 13'', 14''.

Claims

1. Rotary regenerative heat exchanger having a substantially cylindrical rotor (2) mounted in a casing (1), which rotor (2) at at least one of its ends is provided with a circumferentially continuous external end surface (11), and which casing (1) is provided with plates (5, 6, 7, 8) at at least one of said rotor ends in an orientation substantially perpendicular to the axis of said rotor (2) and closed to the related rotor end, said plates (5, 6, 7, 8) including movable sector plates (6, 8), each said sector plate (6, 8) being affected by a resultant axial force towards the related rotor end and being provided with support means (10) for maintaining a certain clearance (S) between said sector plates (6, 8) and the related rotor end, said support means (10) including gas cushion means (17), each said gas cushion means (17) having a front surface (12) facing said end surface (11), said front surface (12) having gas outlet means (16), said gas outlet means communicating through gas conduit means (23, 24, 25, 26, 27) with a pressurized gas source (22) of a pressure sufficient to establish a gap between said front surface (12) and said end surface (11) against the action of said axial force, thereby creating a gas cushion between said front surface (12) and said end surface (11) as said gas escapes from said gas outlet means (16) through said gap, characterized in that the support means (10) of at least one of said sector plates (6, 8) consists of one single gas cushion means (17) and that the front surface (12) of said gas cushion means has an elongated shape, having its longer extension directed circumferentially along said end surface (11).
2. Rotary regenerative heat exchanger according to claim 1, wherein said front surface (12) is radially limited by two concentric circular arcs (13, 14) and having substantially a sausage-shape.
3. Rotary regenerative heat exchanger according to claim 1, wherein said front surface (12') is radially limited by two parallel straight lines (13', 14'), and having a substantially rectangular shape.
4. Rotary regenerative heat exchanger according to claim 1, wherein said front surface (12'') is radially limited by two non-concentric circular arcs (13'', 14'')

and having substantially a crescent-shape.

5. Rotary regenerative heat exchanger according to any of claims 1 to 4, wherein the angular extension of said front surface (12) is more than half the angular extension of said sector plate (6, 8), and said front surface (12) is symmetrically located relative to a radial symmetry (19) line in the plane of said sector plate (6, 8).
6. Rotary regenerative heat exchanger according to any of claims 1 to 5, wherein said gas outlet means (16) is a groove extending in the longitudinal direction of said front surface (12).
7. Rotary regenerative heat exchanger according to claim 1 or 2, wherein said front surface (12'') is a part of the internal surface (28) of said sector plate (6, 8).
8. A method for operating a rotary regenerative heat exchanger to maintain a certain clearance (S) between one end of a substantially cylindrical rotor (2) of the heat exchanger and a movable sector plate (6, 8) located closed to said rotor end in an orientation substantially perpendicular to the axis of said rotor (2), said rotor end having a circumferentially continuous end surface (11), said rotor (2) being mounted in a casing (1) and said sector plate (6, 8) being connected to said casing and being affected by a resultant axial force towards said rotor end, said clearance (S) being maintained by supplying gas to support means (10) on said sector plate (6, 8) said support means (10) including gas cushion means (17) having a front surface (12) with gas outlet means (16) and facing said end surface (11), the pressure of said supplied gas being sufficient to establish a gap between said front surface (12) and said end surface (11) against the action of said axial force, thereby creating a gas cushion between said front surface (12) and said end surface (11) as said gas escapes from said gas outlet means (16) through said gap, characterized by supplying said gas to one single support means (10) and arranging said single support means (10) to form an elongated gas cushion, having its longer extension directed circumferentially along said end surface (11).

Patentansprüche

1. Rotierender, regenerativer Wärmetauscher mit einem im wesentlichen zylindrischen Rotor (2), der in einem Gehäuse (1) montiert ist und an wenigstens einem seiner Enden mit einer über den Umfang durchgängigen äußeren Endfläche (11) versehen ist, wobei das Gehäuse (1) an wenigstens einem der Rotorenden mit Platten (5, 6, 7, 8) mit im we-

- sentlichen senkrecht zur Achse des Rotors (2) liegender Ausrichtung nahe des zugehörigen Rotorendes versehen ist, die bewegliche Sektorplatten (6, 8) aufweisen, die durch eine resultierende Axialkraft in Richtung des zugehörigen Rotorendes beaufschlagt und zur Aufrechterhaltung eines bestimmten Spiels (S) zwischen den Sektorplatten (6, 8) und dem zugehörigen Rotorende mit Stützmitteln (1C) versehen sind, die Gaskissenmittel (17) aufweisen, die jeweils eine Frontfläche (12) besitzen, die der Endfläche (11) zugewandt ist und Gasauslaßmittel (16) aufweist, die durch Gasleitungsmittel (23, 24, 25, 26, 27) mit einer Druckgasquelle (22) mit einem Druck in Verbindung stehen, der ausreichend ist, um einen Spalt zwischen der Frontfläche (12) und der Endfläche (11) gegen die Wirkung der Axialkraft aufzubauen, wodurch ein Gaskissen zwischen der Frontfläche (12) und der Endfläche (11) entsteht, da das Gas aus den Gasauslaßmitteln (16) durch den Spalt austritt, **dadurch gekennzeichnet**, daß die Stützmittel (10) wenigstens einer der Sektorplatten (6, 8) aus einzelnen, alleinigen Gaskissenmitteln (17) bestehen und daß die Frontfläche (12) der Gaskissenmittel eine Langform besitzt, deren längere Erstreckung über den Umfang entlang der Endfläche (11) ausgerichtet ist.
2. Rotierender, regenerativer Wärmetauscher nach Anspruch 1, **dadurch gekennzeichnet**, daß die Frontfläche (12) durch zwei konzentrische Kreisbögen (13, 14) radial begrenzt ist und im wesentlichen eine Wurstform besitzt.
3. Rotierender, regenerativer Wärmetauscher nach Anspruch 1, **dadurch gekennzeichnet**, daß die Frontfläche (12') radial durch zwei parallele, gerade Kanten (13', 14') begrenzt ist und eine im wesentlichen rechteckige Form besitzt.
4. Rotierender, regenerativer Wärmetauscher nach Anspruch 1, **dadurch gekennzeichnet**, daß die Frontfläche (12'') radial durch zwei nicht konzentrische Kreisbögen (13'', 14'') begrenzt ist und im wesentlichen eine Sichelform besitzt.
5. Rotierender, regenerativer Wärmetauscher nach einem der Ansprüche 1 bis 4, **dadurch gekennzeichnet**, daß die Winkelerstreckung der Frontfläche (12) mehr als die Hälfte der Winkelerstreckung der Sektorplatte (6, 8) beträgt und die Frontfläche (12) symmetrisch mit Bezug auf eine radiale Symmetrielinie (19) in der Fläche der Sektorplatte (6, 8) angeordnet ist.
6. Rotierender, regenerativer Wärmetauscher nach einem der Ansprüche 1 bis 5, **dadurch gekennzeichnet**, daß die Gasauslaßmittel (16) aus einer Nut bestehen, die sich in der Längsrichtung der

Frontfläche (12) erstreckt.

7. Rotierender, regenerativer Wärmetauscher nach Anspruch 1 oder 2, **dadurch gekennzeichnet**, daß die Frontfläche (12''') ein Teil einer inneren Fläche (28) der Sektorplatte (6, 8) ist.
8. Verfahren zum Betreiben eines rotierenden, regenerativen Wärmetauschers, um ein bestimmtes Spiel (S) zwischen einem Ende eines im wesentlichen zylindrischen Rotors (2) des Wärmetauschers und einer nahe des Rotors angeordneten beweglichen Sektorplatte (6, 8) in einer Richtung im wesentlichen senkrecht zur Achse des Rotors (2) aufrechtzuerhalten, wobei das Rotorende eine über den Umfang durchgängige äußere Endfläche (11) besitzt, der Rotor (2) in einem Gehäuse (1) montiert ist, die Sektorplatte (6, 8) mit dem Gehäuse verbunden und durch eine resultierende Axialkraft in Richtung des Rotorendes beaufschlagt ist, und das Spiel (S) durch Zuführen von Gas zu an der Sektorplatte (6, 8) befindlichen Stützmitteln (10) aufrechterhalten wird, die Gaskissenmittel (17) mit einer der Endfläche (11) zugewandten Frontfläche (12) mit Gasauslaßmitteln (16) aufweist, wobei der Druck des zugeführten Gases ausreichend ist, einen Spalt zwischen der Frontfläche (12) und der Endfläche (11) gegen die Wirkung der Axialkraft aufzubauen, wodurch ein Gaskissen zwischen der Frontfläche (12) und der Endfläche (11) erzeugt wird, da das Gas von den Gasauslaßmitteln (16) durch den Spalt ausströmt, **dadurch gekennzeichnet**, daß das Gas einzelnen, alleinigen Stützmitteln (10) zugeführt wird und diese einzelnen Stützmittel (10) so angeordnet werden, daß sie ein langförmiges Gaskissen bilden, dessen längere Erstreckung über den Umfang entlang der Endfläche (11) ausgerichtet ist.

Revendications

1. Echangeur de chaleur rotatif à régénération comportant un rotor essentiellement cylindrique (2) monté dans une enveloppe (1), lequel rotor (2) à au moins l'une de ses extrémités, est muni d'une surface d'extrémité externe continue suivant la circonférence (11), et laquelle enveloppe (1) est munie de plaques (5, 6, 7, 8) à au moins une desdites extrémités du rotor suivant une orientation pratiquement perpendiculaire à l'axe dudit rotor (2) et rapprochée de l'extrémité de rotor associée, lesdites plaques (5, 6, 7, 8) comprenant des plaques en secteur mobiles (6, 8), chaque dite plaque en secteur (6, 8) étant affectée par une force axiale résultante en direction de l'extrémité de rotor associée et étant munie d'un moyen de support (10) afin de conserver un certain espacement (S) entre lesdites plaques en secteur

- (6, 8) et l'extrémité de rotor associée, ledit moyen de support (10) comprenant un moyen de coussin de gaz (17), chaque dit moyen de coussin de gaz (17) présentant une surface avant (12) en regard de ladite surface d'extrémité (11), ladite surface avant (12) comprenant un moyen de sortie de gaz (16), ledit moyen de sortie de gaz communiquant par l'intermédiaire d'un moyen de conduite de gaz (23, 24, 25, 26, 27) avec une source de gaz sous pression (22) d'une pression suffisante pour établir un interstice entre ladite surface avant (12) et la surface d'extrémité (11) en s'opposant à l'action de ladite force axiale, en créant ainsi un coussin de gaz entre ladite surface avant (12) et ladite surface d'extrémité (11) lorsque ledit gaz s'échappe dudit moyen de sortie de gaz (16) par l'intermédiaire dudit interstice, caractérisé en ce que le moyen de support (10) d'au moins l'une desdites plaques en secteur (6, 8) est constitué d'un seul moyen de coussin de gaz (17) et en ce que la surface avant (12) dudit moyen de coussin de gaz présente une forme allongée, présentant son étendue plus longue orientée suivant la circonférence le long de ladite surface d'extrémité (11).
2. Echangeur de chaleur rotatif à régénération selon la revendication 1, dans lequel ladite surface avant (12) est limitée radialement par deux arcs de cercle concentriques (13, 14) et présente essentiellement la forme d'une saucisse.
 3. Echangeur de chaleur rotatif à régénération selon la revendication 1, dans lequel ladite surface avant (12') est limitée radialement par deux lignes droites parallèles (13', 14'), et présente une forme essentiellement rectangulaire.
 4. Echangeur de chaleur rotatif à régénération selon la revendication 1, dans lequel ladite surface avant (12'') est limitée radialement par deux arcs de cercle non concentriques (13'', 14'') et présente essentiellement la forme d'un croissant.
 5. Echangeur de chaleur rotatif à régénération selon l'une quelconque des revendications 1 à 4, dans lequel l'étendue angulaire de ladite surface avant (12) est supérieure à la moitié de l'étendue angulaire de ladite plaque en secteur (6, 8), et ladite surface avant (12) est située de façon symétrique relativement à une ligne de symétrie radiale (19) dans le plan de ladite plaque en secteur (6, 8).
 6. Echangeur de chaleur rotatif à régénération selon l'une quelconque des revendications 1 à 5, dans lequel ledit moyen de sortie de gaz (16) est une gorge s'étendant suivant la direction longitudinale de ladite surface avant (12).
 7. Echangeur de chaleur rotatif à régénération selon la revendication 1 ou 2, dans lequel ladite surface avant (12''') fait partie de la surface interne (28) de ladite plaque en secteur (6, 8).
 8. Procédé de mise en oeuvre d'un échangeur de chaleur rotatif à régénération de façon à conserver un certain espacement (S) entre une extrémité d'un rotor pratiquement cylindrique (2) de l'échangeur de chaleur et une plaque en secteur mobile (6, 8) située près de ladite extrémité de rotor suivant une orientation essentiellement perpendiculaire à l'axe dudit rotor (2), ladite extrémité de rotor présentant une surface d'extrémité continue suivant la circonférence (11), ledit rotor (2) étant monté dans une enveloppe (1) et ladite plaque en secteur (6, 8) étant reliée à ladite enveloppe et étant affectée par une force axiale résultante en direction de ladite extrémité de rotor, ledit espacement (S) étant conservé en alimentant un gaz vers un moyen de support (10) sur ladite plaque en secteur (6, 8), ledit moyen de support (10) comprenant un moyen de coussin de gaz (17) présentant une surface avant (12) comportant un moyen de sortie de gaz (16) et en regard de ladite surface d'extrémité (11), la pression dudit gaz alimenté étant suffisante pour établir un interstice entre ladite surface avant (12) et la surface d'extrémité (11) en s'opposant à l'action de ladite force axiale, en créant ainsi un coussin de gaz entre ladite surface avant (12) et ladite surface d'extrémité (11) lorsque ledit gaz s'échappe depuis ledit moyen de sortie de gaz (16) par l'intermédiaire dudit interstice, caractérisé par l'alimentation dudit gaz vers un unique moyen de support (10) et l'agencement dudit unique moyen de support (10) de façon à former un coussin de gaz allongé, dont l'étendue la plus longue est orientée suivant la circonférence le long de ladite surface d'extrémité (11).

Fig. 1

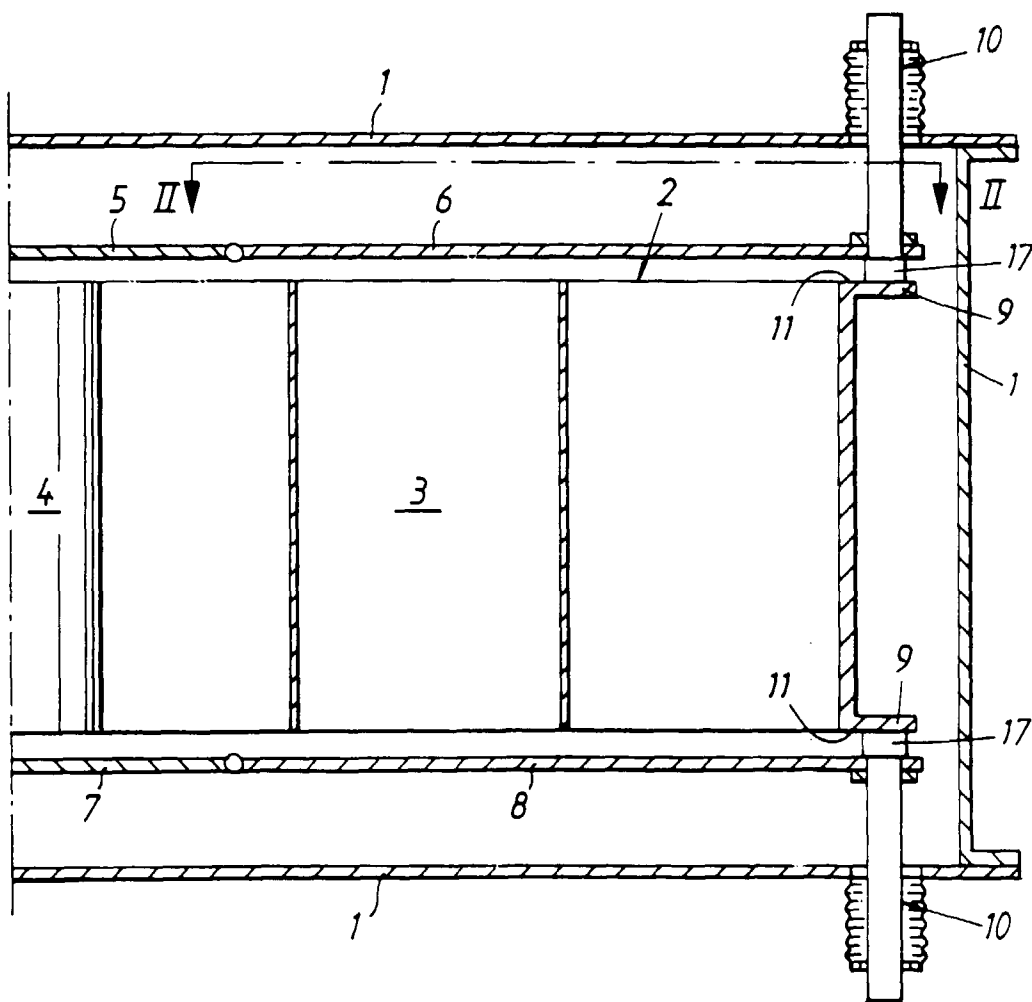


Fig. 2

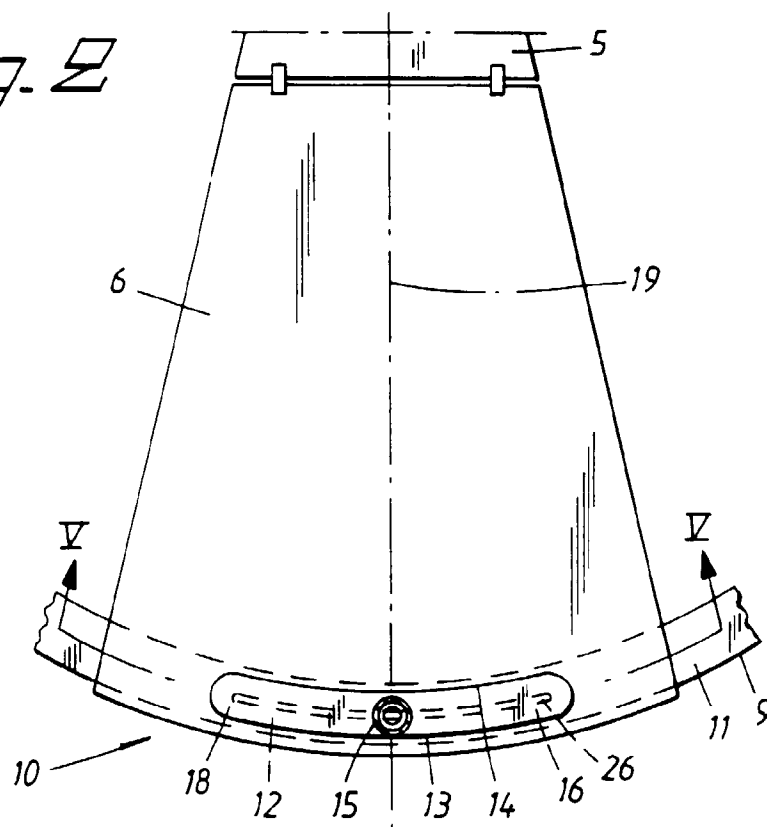


Fig. 3

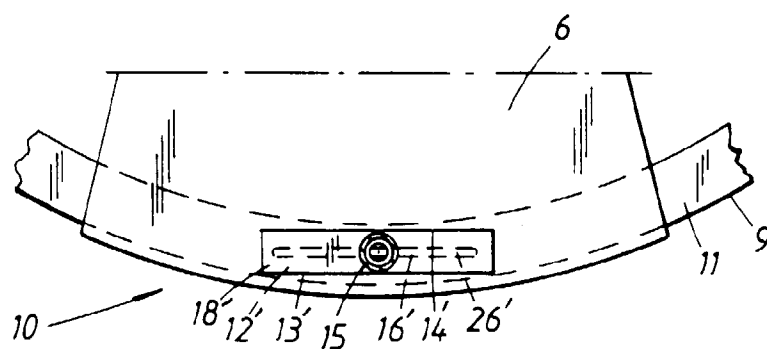


Fig. 4

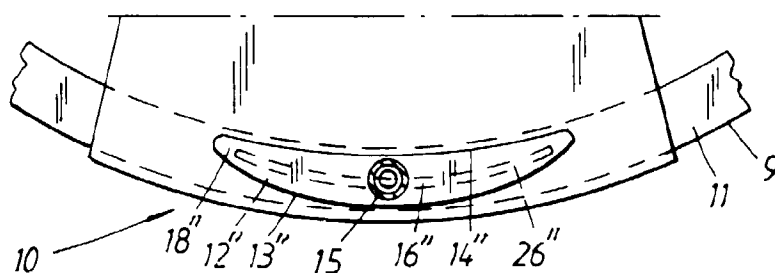


Fig. 5

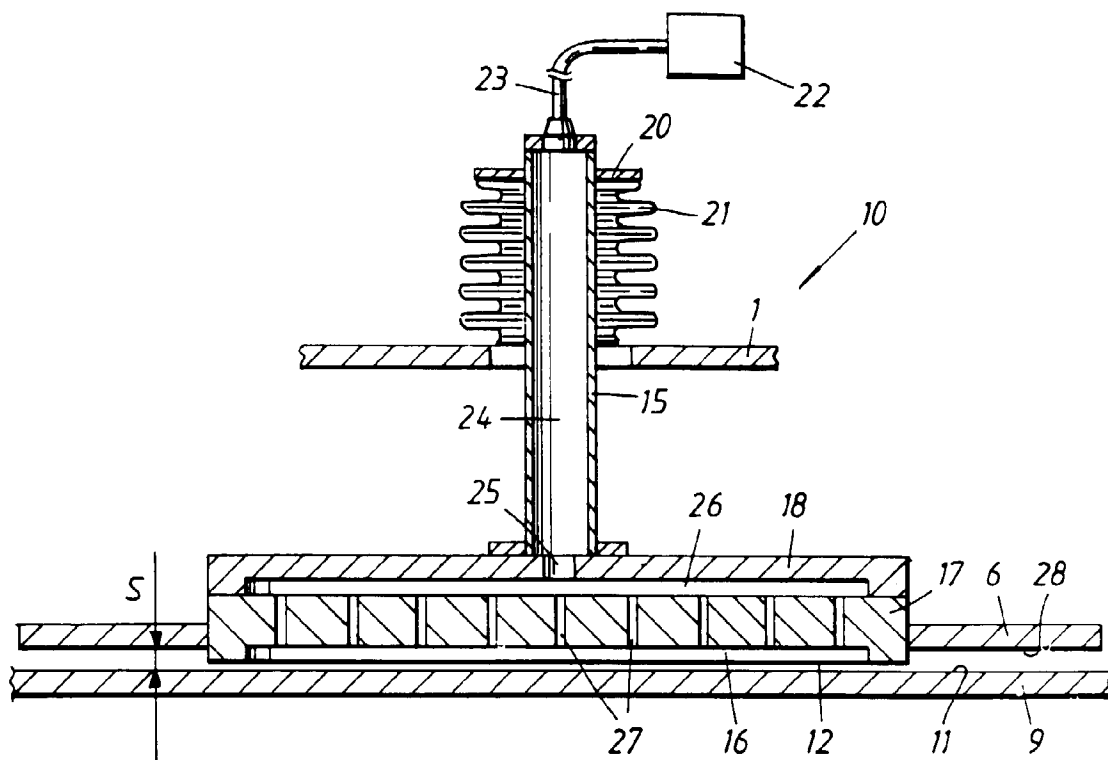


Fig. 6

