

**ROTOR FOR CENTRIFUGAL SEPARATOR WITH SOUND DAMPING
RADIAL OPENINGS**

The present invention concerns a rotor for a centrifugal separator. This rotor is arranged to rotate during operation around a rotational axis in a space in the centrifugal separator in contact along its outside with a gas present in the space. Inside itself the rotor forms at least one chamber and at least one passage, which with a central axis extends radially outwardly from the chamber to the outside of the rotor and connects the chamber with the space outside the rotor. The chamber and the passage are arranged to normally intermittently during operation be through-flown by a component separated in the rotor.

In order not to have the chamber and the passage clogged and not to have the through-flowing separated component causing a non-acceptable wear of the rotor body by erosion, the chamber and the passage in many rotors of known centrifugal separators have a complicated shape, which they obtain by an expensive disc mill cutting operation on both the inside and the outside of the rotor body.

During operation rotors of this kind furthermore generate sound, which in many cases exceeds the sound level which can be accepted. This is particularly the case for rotors, which rotate at a relatively high number of revolutions. An often significant part of the occurrent sound is generated in chambers and passages of said kind. This sound is excited by the gas, usually in the form of air, which is located in the space, when during operation of the rotor, it passes the openings towards the space of the passages. The frequencies of the generated sound, the pressure waves, is controlled

by the geometric shape and dimensions of the chamber and the passages.

5 In DE 1 298 449 a simpler design of passages of this kind in a centrifugal separator is shown. In the rotor known hereby a number of passages in the shape of circular cylindrical holes, which are distributed around the rotational axis and radially directed, connects a chamber, which is formed inside the rotor and surrounds
10 the rotational axis, with the space outside the rotor. By designing the chamber and the passages in this manner the manufacturing cost can be reduced considerably.

15 However, it is very easy for gas, which is located in circular cylindrical holes of this kind, to be excited in the same manner as the gas in an organ pipe by a gas, passing by the opening of the hole and be set in oscillation and thereby generate sound at a certain frequency.

20 The object of the present invention is to accomplish a rotor of the kind initially described at low manufacturing costs for a centrifugal separator having a chamber and at least one passage, which are so designed
25 that a separated component can flow through the same without a risk of clogging or wear and so that gas, which during operation is located in the chamber and the passage, is not set in oscillation and generates sound.

30 This is accomplished by the present invention by designing the passage with a radially outer portion, which extends radially inwardly from the outside of the rotor, and which perpendicular to the central axis of the passage has a cross-section, which in a plane
35 perpendicular to the rotation axis through the central

axis has an extension which continuously decreases by the distance from the outside of the rotor to a radially inner cross-section, which has a certain extension in this plane and from the outside of the rotor is located
5 at a distance along the central axis, which at least is one third of the extension in said plane of the radial inner cross-section, and that the extension of the cross-section of the passage, at the outside of the rotor in the plane is between four and nine thirds of
10 the extension of the radially inner cross-section in said plane.

In a predetermined embodiment of the invention the radial outer portion of the passage has a circular
15 cross-section.

The radial outer portion of the passage then can either have a spherical shape with a centre, through which the central axis extends, or a conical shape around an axis
20 of symmetry, which coincides with the central axis.

In a modified embodiment of the invention the radial outer portion of the passage has an elliptic cross-section, the major axis of the ellipse being directed in
25 the circumferential direction.

In another embodiment of the invention the passage in the plane perpendicular to the rotational axis through the central axis radially inwardly has a continuously
30 from the outside of the rotor decreasing extension perpendicular to the central axis on both sides of the central axis.

In a further embodiment of the invention the passage
35 also comprises a radial inner circular cylindrical

portion, which is located radially inside the radially outer portion of the passage.

5 In a suitable embodiment of the invention the passage is straight and directed completely radially but as an alternative it can be straight and radially outwardly
10 seen be directed backwardly in the rotation direction.

In the following the invention will be described more
10 closely with reference to the attached drawings, in which

figure 1 schematically shows a centrifugal separator (partly in an axial section), which is provided with a
15 rotor according to the invention,

figure 2 shows a radial section through a portion of a rotor according to an embodiment of the invention,

20 figure 3 shows a radial section through a portion of a rotor according to another embodiment of the invention,

figure 4 shows a radial section through a portion of a rotor according to an alternative embodiment of the
25 invention,

figure 5 shows a view radially from the outside of a detail of the rotor according to a modified embodiment of the invention,
30

figure 6 shows a diagram of the frequency spectrum of the sound level for sound generated during operation of passages in rotors of the kind previously known,

figure 7 shows a diagram of the frequency spectrum of the sound level for sound generated during operation of other passages in a rotor, and

- 5 figure 8 shows a diagram of the frequency spectrum of the sound level for sound generated during operation of passages in a rotor according to the present invention.

The centrifugal separator shown in figure 1 has a
10 rotor 1, which is supported by and driven by a driving shaft 2. The rotor 1 is surrounded by a stationary casing 3, which forms a space 4, in which the rotor 1 during operation rotates in contact with the air or other gas, which is located in the space 4, along its
15 outside. Inside itself the rotor 1 forms a separation chamber 5, in which a stack of separation discs 6 is arranged. Between these separation discs 6 the main centrifugal separation during operation takes place, a specific light component, which is separated out of a
20 supplied liquid mixture of components flows radially inwardly while a specific heavier separated component in the form of a liquid or a sludge flows radially outwardly and is accumulated in the radially outermost part of the separation chamber 5.

25 When needed or at equal time periods all or part of the content of the separation chamber 5 is thrown out through a passage 7, which extends with a central axis radially through the wall 8 of the rotor 1, by opening
30 an annular gap 9 surrounding the rotational axis between a rotor cover 10 and an axially movable valve slide 11. Between the gap 9 and the passages 7 there is a chamber 12 arranged, which is delimited by the rotor wall 8, the rotor cover 10 and the valve slide 11.

The passage 7 has a radially outer portion 13, which extends radially inwardly from the outside of the rotor 1. Perpendicular to the central axis of the passage this outer portion 13 has a cross-section, which in a plane perpendicular to the rotational axis through the central axis has an extension, which continuously decreases by the distance from the outside of the rotor 1 to a radially inner cross-section. This radially inner cross-section has a certain extension in the plane and is located at a distance along the radially directed central axis from the outside of the rotor 1, which at least is one third of the extension of the inner cross-section in this plane. At the outside of the rotor the extension of the cross-section of the passage 7 in the plane is five thirds of the extension of the radially inner cross-section.

In the example shown in figure 1 of a rotor 1 according to the invention the passage also comprises a radially inner portion 14, which connects to the radially outer portion 13 at said radially inner cross-section from where it extends radially inwardly to the chamber 12 in a way such that this chamber 12 communicates with the space 4 outside the rotor 1 via the passage 7. The radial inner portion 14 is circular cylindrical while the radial outer portion 13 in this example is frusto-conical with the apex directed radially inwardly. The central axis of the passage 7 is straight and extends completely radially in the rotor.

Figure 2 shows in more detail the passage 7 shown in figure 1 seen in a radial section through the central axis of it.

Figure 3 shows another example of how a passage 15 can be designed seen in a radial section through its central axis, which also in this example is straight and extends totally radially in the rotor. This passage 15 has a spherical radial outer portion 16 and a circular cylindrical radially inner portion 17.

In the example shown in figure 4 of a design of a passage 18 seen in a radial section through its central axis the central axis is straight but seen radially outwardly directed backwardly in the rotational direction, which is indicated with an arrow A. As the passage 7 shown in figures 1 and 2 this passage 18 has a radially outer frusto-conical portion 19 and a radially inner circular cylindrical portion 20.

Figure 5 shows a view radially from the outside of a modified passage 21, which is designed with a radially outer portion 22 with an elliptic cross-section, the major axis of the ellipse being oriented in the circumferential direction.

In order to illustrate the technical effect of the present invention the figures 6-8 show diagram of the measured frequency spectrum of the sound level for three different designs of passages of this kind.

In figure 6 the frequency spectrum of the sound level for circular cylindrical passages is shown without any radially outer portion of the kind, which the passages in a rotor according to the present invention have according to the above.

In figure 7 there is shown a frequency spectrum with a sound level for circular cylindrical passages, which in

the same way as the passage in the rotor according to the present invention has a radially outer portion, which extends radially inwardly from the outside of the rotor, and perpendicular to the central axis of the passage has a cross-section, which in a plane perpendicular to the rotational axis through the central axis has an extension, which continuously decreases by the distance from the outside of the rotor to a radially inner cross-section, which has a certain extension in this plane but is located from the outside of the rotor at a distance along the central axis, which is shorter than one third of the extension of the radially inner cross-section in said plane.

From these two diagrams it is evident that the generated sound has a basic back noise level, to which a number of excited tones are added. From the diagram in figure 7 it is also evident that tones of this kind is excited and added to the back noise level even if the passage or the passages are provided with a short radially outer portion of this kind.

The diagram in figure 8 shows that if a passage is designed in the way the passage in a rotor according to the present invention is, in which the radial cross-section of the passage is located at a distance from the outside of the rotor, which at least is one third of the extension of the radial inner cross-section in the plane perpendicular to the rotational axis through the central axis, the excitation of tones are reduced so substantially that only the back noise level of the sound remains.

Claims

1. Rotor for a centrifugal separator, which rotor (1) is arranged during operation to be rotatable around a rotational axis in a space (4) in the centrifugal separator in contact along its outside with a gas present in the space (4), the rotor forming inside itself at least one chamber (12) and at least one passage (7, 15, 18, 21), which with a central axis extends radially outwardly from the chamber (12) to the outside of the rotor and connects the chamber (12) with the space (4) outside the rotor, the chamber (12) and the passage (7, 15, 18, 21) being arranged during operation to be through-flown by a component separated in the rotor,

c h a r a c t e r i z e d i n

that the passage (7, 15, 18, 21) comprises a radially outer portion (13, 16, 19, 22), which extends radially inwardly from the outside of the rotor, and which has a cross-section perpendicular to the central axis of the passage (7, 15, 18, 21), the cross-section having an extension in a plane perpendicular to the rotational axis through the central axis, which continuously decreases by the distance from the outside of the rotor (1) to a radial inner cross-section, which has a certain extension in this plane and is located from the outside of the rotor at a distance along the central axis, which at least is one third of the extension of the radial inner cross-section, and that the extension of the cross-section of the passage (7, 15, 18, 21) at the outside of the rotor in the plane is between four and nine thirds of the extension of the radial inner cross-section in said plane.

2. Rotor according to claim 1, wherein said outer portion (13, 16, 19) of the passage (7, 15, 18) has a circular cross-section.
- 5 3. Rotor according to claim 2, wherein said outer portion (16) of the passage (15) has a spherical shape with a centre, through which the central axis extends.
- 10 4. Rotor according to claim 2, wherein said outer portion (13, 19) of the passage (7, 18) has a conical shape around an axis of symmetry, which coincides with the central axis.
- 15 5. Rotor according to any of the claims 1 or 2, wherein said radially outer portion (22) of the passage (21) has an elliptic cross-section with the major axis of the ellipse being directed essentially in the circumferential direction.
- 20 6. Rotor according to any of the previous claims, wherein the passage (7, 15, 18, 21) in said plane has an extension perpendicular to the central axis that decreases radially inwardly from the outside of the rotor along this portion of the passage (7, 15, 18, 21)
- 25 continuously on both sides of the central axis.
- 30 7. Rotor according to any of the previous claims, wherein the passage (7, 15, 18, 21) also comprises a radially inner circular cylindrical portion (14, 17, 20), which is located radially inside the radially outer portion (13, 16, 19) of the passage (7, 15, 18, 21).
- 35 8. Rotor according to any of the previous claims, wherein the passage (7, 15, 21) is straight and directed completely radially.



9. Rotor according to any of the claims 1-7, wherein the passage (18) is straight and seen radially outwardly is directed backwardly in the rotational direction.



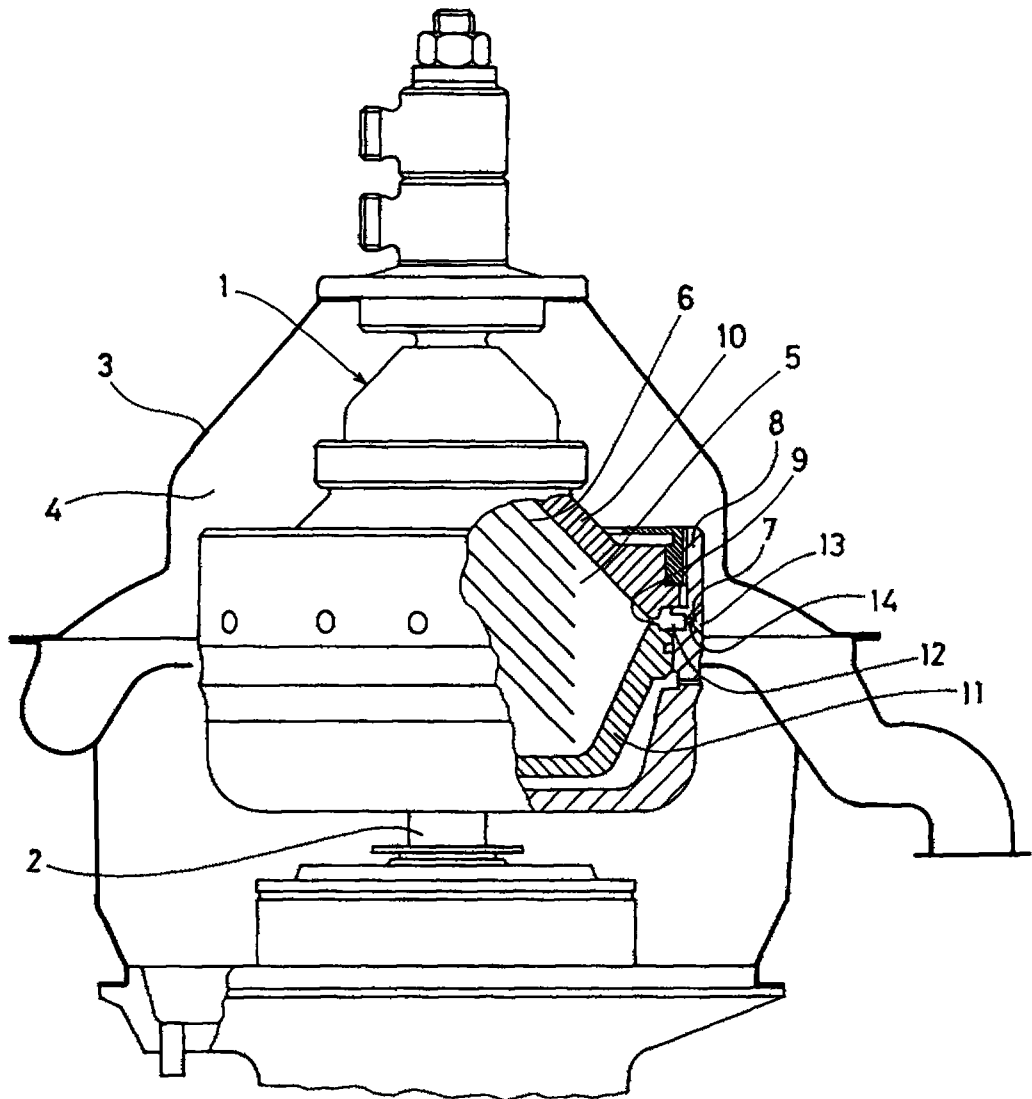


Fig.1

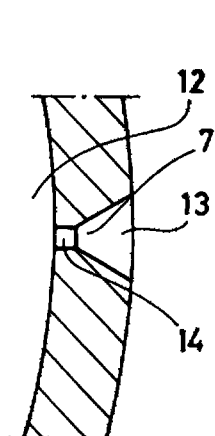


Fig. 2

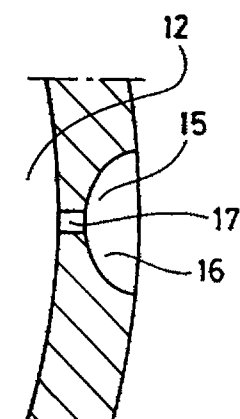


Fig. 3

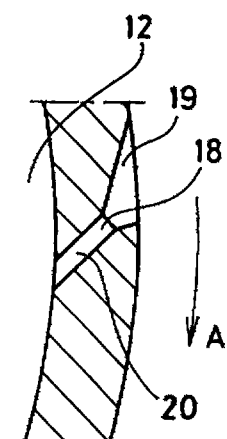


Fig. 4

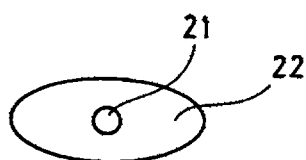
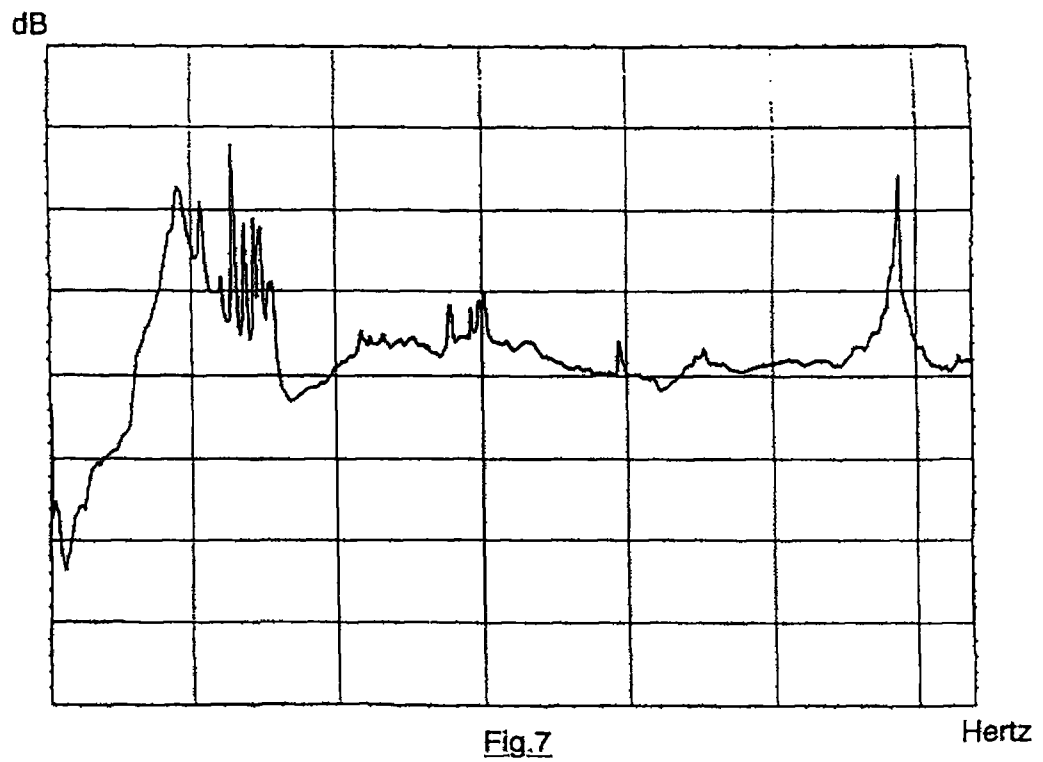
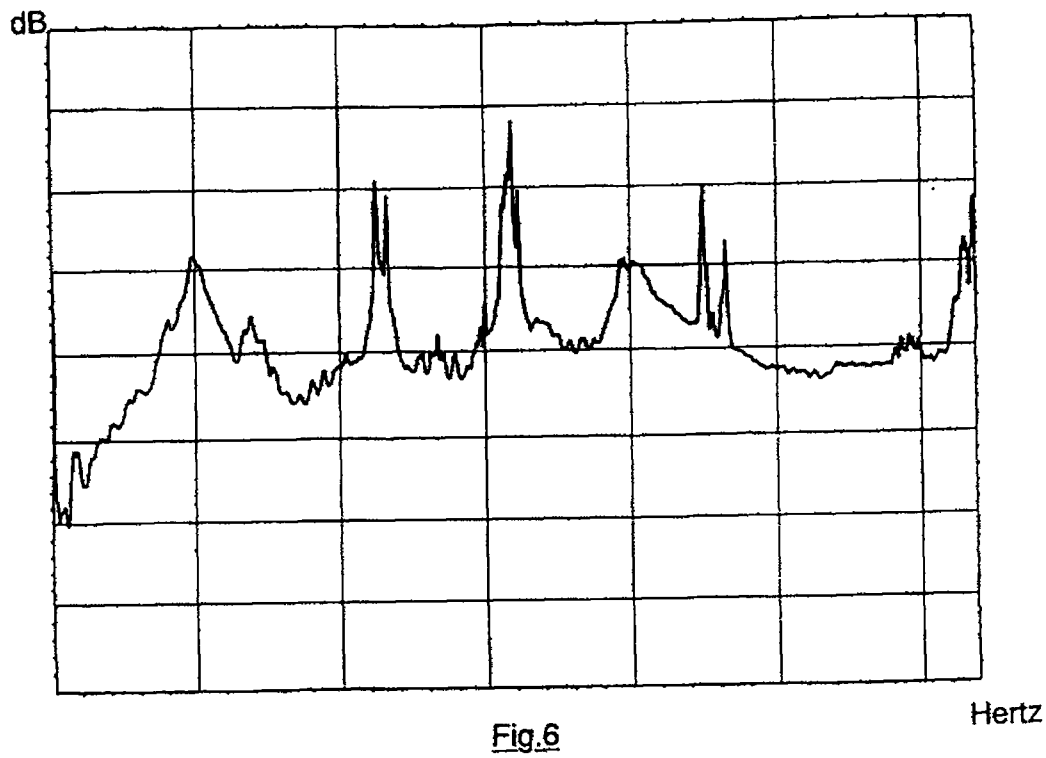
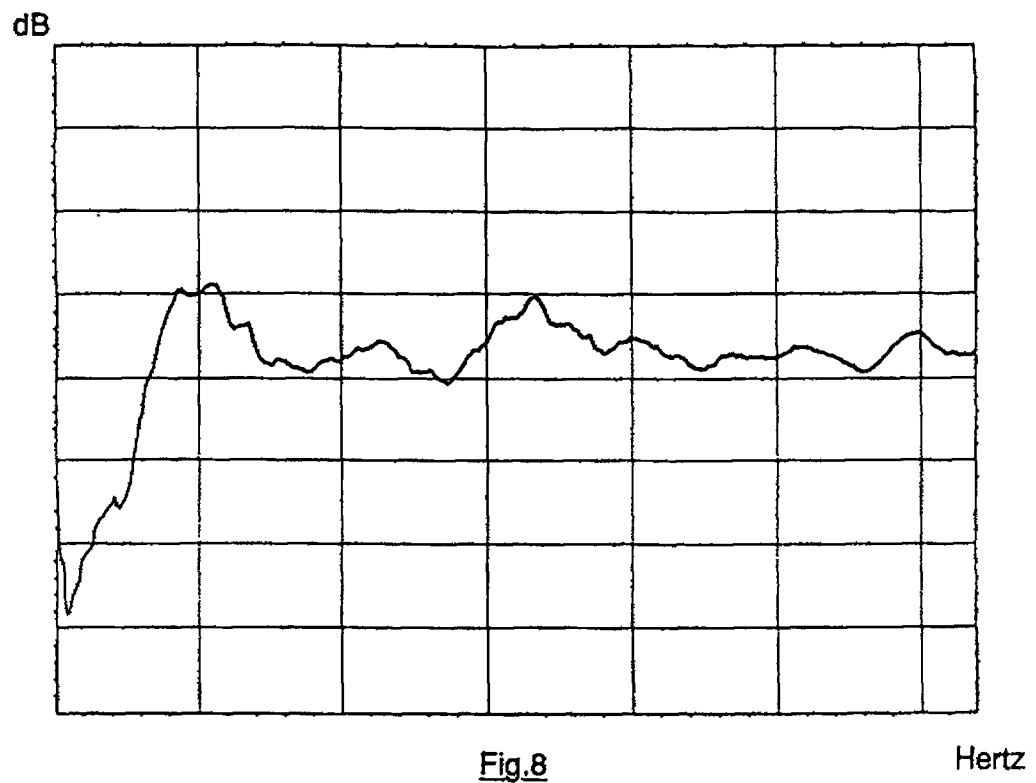


Fig. 5

3/4



4/4



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WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification ⁶ : B04B 1/10, 7/08	A1	(11) International Publication Number: WO 97/18900 (43) International Publication Date: 29 May 1997 (29.05.97)
(21) International Application Number: PCT/SE96/01463 (22) International Filing Date: 13 November 1996 (13.11.96) (30) Priority Data: 9504100-0 17 November 1995 (17.11.95) SE (71) Applicant (for all designated States except US): ALFA LAVAL AB [SE/SE]; Hans Stahles väg, S-147 80 Tumba (SE). (72) Inventor; and (75) Inventor/Applicant (for US only): BJÖRKSTRÖM, Rolf [SE/SE]; Tröskverksvägen 62, S-125 34 Älvsjö (SE). (74) Agent: CLIVEMO, Ingemar; Alfa Laval AB, S-147 80 Tumba (SE).	(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, HU, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, TJ, TM, TR, TT, UA, UG, US, UZ, VN, ARIPO patent (KE, LS, MW, SD, SZ, UG), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG). Published With international search report.	
(54) Title: ROTOR FOR CENTRIFUGAL SEPARATOR WITH SOUND DAMPING RADIAL OPENINGS		
(57) Abstract		
Rotor for a centrifugal separator, which rotor (1) during operation rotates in a space (4) and inside itself forms a chamber (12) and a passage (7), which extends radially outwardly from the chamber (12) to the outside of the rotor (1). In order to accomplish at low costs such a rotor (1), in which gas present in the chamber (12) and in the passage (7) does not generate sound, the passage (7) in the rotor is designed with a radially outer portion (13), which extends radially inwardly from the outside of the rotor (1), and which has a cross section perpendicular to the central axis of the passage (7), which in a plane perpendicular to the rotation axis through the central axis has an extension, which continuously decreases by the distance from the outside of the rotor (1) to a radially inner cross section, which has a certain extension in this plane and from the outside of the rotor (1) is located at a distance along the central axis, which at least is one third of the extension of the radially inner cross section in said plane, and that the extension of the cross section of the passage (7) at the outside of the rotor (1) in the plane is between four and nine thirds of the extension of the radially inner cross section in said plane.		