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Description

[0001] This invention relates to centrifugal separation apparatus for separating particulate contaminants from liquids, such as engine lubricants, passed therethrough and in particular relates to rotor containers used within such apparatus to perform the actual separation and retention of such contaminants.

[0002] Centrifugal separators are well known for use within the lubrication systems of vehicle internal combustion engines as efficient means for removing very small particulate contaminants from the constantly recirculated liquid lubricant over a long period of operation. Such centrifugal separators are usually of the self-powered type, in which a separation rotor comprising a canister is supported for rotation about a rotor axis within a housing, the canister being supplied with liquid lubricant at elevated pressure along the axis and said liquid-being forced from the base of the canister (or other peripheral wall) by way of jet reaction nozzles, the reaction to said ejection causing the rotor canister and liquid within it to spin at high speed about the axis and thereby cause solid particles to migrate from the liquid passing through the canister and agglomerate on the peripheral walls thereof. The reaction nozzles are directed substantially tangentially with respect to the rotation axis, at least in a plane orthogonal to the axis, so that jets of liquid which leave the rotor canister are instantaneously tangential to the fastly spinning rotor.

[0003] It will be appreciated that the efficiency of separation is inter alia dependant upon the quantity of liquid lubricant passed therethrough in a given time and the time for which the liquid remains therein in passing through, and also upon the rotation speed of the rotor canister and contained liquid, which is in turn dependant upon the pressure drop between supply and housing and the dimensions of the nozzles, within the constraints of such nozzle dimensions/pressure drops providing sufficient torque to overcome resistance to commencement of, and continuation of, rotation.

[0004] To this end, it is commonplace to have the rotor canister divided internally by way of a radially inwardly extending partition wall which defines an outflow chamber in the vicinity of the reaction nozzles that is distinct from a separation chamber in which said particulate contaminants are separated from the input liquid and retained; the outflow chamber and reaction nozzles are protected from said separated contaminants by a transfer aperture between the chambers at radially inwardly of the partition wall, that is, surrounding the rotation axis.

[0005] It is also known to have formed in the end wall of the rotor canister that bounds the separation chamber, usually the upper wall, an array of radially extending embossed ribs which by their axial extent or length relative to the wall provide strengthening for the canister wall against elevated internal pressures and also provide shallow troughs or channels between adjacent ribs whereby liquid which enters the canister near to said wall can be accelerated by the ribs both in a circumferential direction, that is, the direction about the axis in which the ribs are travelling, and in a radial direction towards the outer peripheral side wall of the canister where circumferential speeds are higher and centrifugal separation forces higher, although this achieves less than satisfactory results in practice.

[0006] Displacing the liquid radially outwardly by such means, and the reasoning behind it, is summarised in Patent Specification No WO-A-96/22835, which explains the observed tendency for such newly injected liquid to follow a radially inner 'short-circuit' path directly to the outflow chamber and not travel radially along the channels to the outer peripheral wall. WO-A-96/22835 also discloses a complex canister structure for improved separation efficiency involving, inter alia, such outwardly radial flow of newly injected liquid by way of an array of channels defined between radially extending strengthening ribs in the chamber end wall, or equivalent radially extending ribs adjacent said wall, including a cone stack which overlies the inlet channels between said ribs or equivalent at the end wall so the liquid cannot follow a short circuit path and must flow radially outwardly for the desired radial length of the channels. The cone stack also includes radially extending ribs which react with liquid returning from the outer peripheral wall in a radially inward direction to translate some of the centrifugal energy thereof into rotational energy of the rotor.

[0007] It may be considered that the liquid flow arrangement thereof and the internal structure it entails is unnecessarily and inappropriately complex, particularly with a view to manufacture of an inexpensive and discardable rotor canister, or, if it is employed, not used to best effect.

[0008] GB-A-732132 describes a rotor canister into which liquid is injected into axially closed channels between radially extending vanes at one end of the canister in order to be accelerated to a radially outer wall, where it can be transferred axially to a chamber having radially extending partitions with which it can react as it flows radially inwardly towards injection nozzles. Bonding the inlet channels axially obviates the above described and disadvantageous short-circuiting between inlet and ejection nozzles, but also leads to a relatively complex construction.

[0009] It is an object of the present invention to provide for a self-powered centrifugal separator a rotor canister construction that achieves improved efficiency over traditional designs whilst being simple and inexpensive to implement. It is also an object of the present invention to provide a self-powered centrifugal separator including such a rotor canister.

[0010] According to a first aspect of the present invention a rotor, for a centrifugal separator, in accordance with the preamble to claim 1 is characterised by the axial discontinuities form boundaries for channels therebetween open in an axial direction and at least some of the axial discontinuities extend also circumferentially such that each is, at a radially outer region circumferentially displaced with respect to a radially inner region in the same circumferential direction as liquid is ejected from the outflow chamber.

[0011] According to a second aspect of the present invention a centrifugal separator for separating particulate contaminants from a liquid supplied thereto comprising a housing enclosure, an axis extending through the housing enclosure in an operationally substantially vertical orientation, and a rotor arranged to receive a liquid at elevated pressure and, in reaction to ejection of the liquid therefrom substantially tangentially, spin about the axis at at least a predetermined minimum speed to effect separation of said contaminant particles from contaminated liquid therein, has said rotor as defined in the preceding paragraph

[0012] Preferably the said outer regions of the axial discontinuities of the rotor canister are displaced circumferentially in a in a direction that is trailing with respect to the rotation direction of the rotor that results from ejection of liquid from the canister.

[0013] The outer regions of the axial discontinuities may, however, in the alternative be displaced circumferentially in a direction that is leading with respect to the rotation direction of the rotor that results from ejection of liquid.

[0014] When such outer regions of the axial discontinuities are displaced in a circumferentially trailing direction the newly injected liquid is subjected to a more gentle acceleration and, notwithstanding the pressure difference between radially inner and outer regions due to rotation, the longer, trailing path between radially inner and outer regions gives rise to an effectively smaller pressure gradient to be overcome and a greater mass/volume flow rate, whilst absorbing less energy from the rotating canister system to accelerate the liquid.

Where such outer regions of the axial discontinuities are displaced in a circumferentially leading direction the newly injected liquid is accelerated and forced to overcome any pressure gradient that exists between radially inner and outer regions of the canister and pass through the canister by way of the outer regions rather than short circuit them, although such acceleration does consume more energy from the rotating canister system than radially straight ribs.

[0015] Embodiments of the invention will now be described by way of example with reference to the accompanying drawings, in which:

Figure 1(a) is a sectional elevation through centrifugal separator in accordance with a first embodiment of the present invention, showing particularly within a housing, and mounted for rotation in a clockwise direction about a vertical axis therethrough, a first embodiment of rotor canister, also in accordance with the present invention, that is defined radially between an outer peripheral side wall and an inner bearing tube and axially between upper and lower end walls and divided by a partition wall into a lower outflow chamber having tangentially directed reaction nozzles in the end wall thereof and an upper inlet and separation chamber that has inlet apertures in the bearing tube and in the upper end wall axial discontinuities in the form of embossed ribs extending radially and also circumferentially in a direction which is trailing with respect to the rotation direction of the rotor that results from liquid ejection form the reaction nozzles,

Figure 1(b) is a perspective view of the rotor canister of Figure 1(a), illustrating the trailing directional nature of the axial discontinuity ribs in the rotor canister end wall,

Figure 1(c) is a cross section through the rotor canister of Figures 1(a) along the line (b)-(b) viewed in the direction towards the upper end wall, the sectional elevation of Figure 1(a) being along the line (a) - (a) of the Figure,

Figure 2 is a cross section view, similar to that of Figure 1(c), of a second embodiment of centrifugal separator canister in which the axial discontinuities comprise an array of full length ribs which each extend between the bearing tube at the radially inner end of the end wall and the radially outer end of said end wall and an array of radially shorter ribs, each disposed between a pair of full length ribs, which extend from the radially outer end of the canister end wall to a termination well short of the axle tube,

Figures 3 and 4 each show in part cross-section views, similar to those of Figures 1(c) and 2, of third and fourth embodiments respectively but wherein the radially inner ends of the axial discontinuity ribs terminate adjacent the bearing tube in a circumferentially trailing direction,

Figure 5 is a cross-section view, similar to Figure 1(c), of a fifth embodiment of rotor canister in which all of the axial discontinuities only extend part way between the radially outer edge of the end wall and the axle tube,

Figure 6 is cross-section view, similar to Figure 5, of a sixth embodiment of rotor canister, in which the axial discontinuities comprise radially inner and outer arrays of short discontinuities, those of the inner array extending substantially straight and radial,

Figure 7 is a cross-section view, similar to Figure 1(c), of a seventh embodiment of rotor canister in which the axial discontinuities comprise alternate depressed and raised embossed regions of the end wall that are circumferentially extensive and substantially equally dimensioned, Figures 8(a) and 8(b) are sectional elevation and cross section views respectively, similar to Figure 1 (a) and 1(c), of an eighth embodiment of rotor canister in which the axial discontinuities are defined on a discrete carrier member overlying the end wall as circumferentially thin vanes,

Figure 9(a) is a sectional elevation through a further embodiment of centrifugal separator in accordance with the present invention including a ninth embodiment of rotor canister, also mounted for clockwise rotation, in which the axial discontinuities are formed of embossed ribs that extend radially and also circumferentially in a direction which is leading with respect to the rotation direction of the rotor, and

Figures 9(b) and 9(c) are perspective views and cross-section views respectively, similar to Figures 1(b) and 1(c), of the rotor canister of Figure 9(a).

[0016] Referring to Figures 1(a) to 1(c) a centrifugal separator 10 of the type used with an automobile internal combustion engine comprises a housing enclosure 11 formed by a base 12 and removable cover 13 and between which base and cover extends, along an operationally substantially vertical axis 14, a fixed axle 15 that serves to retain the cover with respect to the base in a fluid-tight manner. The axle includes a supply duct 16 along a part of its length and provides passage for engine lubricant, delivered thereto at elevated pressure by the engine lubricant pump (not shown), to ports 17 which open into the housing enclosure. The base 12 is shaped such that it provides a gravity drain into the engine sump (not shown) for liquid in the enclosure.

[0017] The axle 15 supports for rotation thereabouts a rotor 20 which comprises a canister for containing the liquid lubricant and, in known manner, is arranged to receive said lubricant from the axle ports at said elevated pressure and eject it from substantially tangentially directed reaction nozzles such that the rotor canister spins at such speed as to effect centrifugal separation of particulate contaminants from the liquid passing therethrough. The rotor canister 20 comprises an outer peripheral wall 21, including axially extending peripheral side wall 22 displaced from the axis 14 and radially extending upper and lower end walls 23 and 24 respectively, and an inner peripheral wall 25 comprising a tubular member fixed to and extending between said end walls. The tubular member 25 is deformed to locate it with respect to through-apertures in the end walls and is arranged to carry bearing bushes 26, 27 at its ends to support the rotor with respect to the axle for rotation thereabout, and is consequently referred to also as a bearing tube. The bearing tube has therein apertures 28_1 , 28_2 ... which direct lubricant delivered by the axle supply duct 16 into the container near to the upper end wall 23 rather than any other part of the housing enclosure.

[0018] The upper end wall 23 and peripheral side wall of the canister are formed integrally from a single sheet of metal drawn into the canister shape and secured to the lower end wall 24 by peripheral folded seam 29.

[0019] The rotor canister 20 furthermore includes an internal partition wall 30 extending radially inwardly from the seam 29, of which it is conveniently a part, in a upwardly converging conical manner. The partition wall 30 serves to divide the canister 20 into an upper inlet and separation chamber 33 in communication with apertures 28_1 , 28_2 , ... and an outflow chamber 34 in communication with reaction nozzles 35 in the end wall 24, and furthermore defines at its radially inner periphery 37, a transfer aperture 38 between the separation and outflow chambers.

[0020] To this extent, the centrifugal separator and rotor canister are conventional.

[0021] The upper end wall 23, that is the end wall opposite to the outflow chamber, has at its internal surface 23_s an array of axial discontinuities 40_1, 40_2 ... formed as embossments pressed at the time of drawing the contained wall to shape, and in particular comprise ribs, raised with respect to the internal surface 23_s of the wall, of relatively narrow cross-section and smooth contour side-to-side, within the constraints of being pressed unidirectionally with drawing of the container wall.

[0022] The ribs extend between the radially inner and outer edges of the end wall, as defined by the junction with the peripheral side wall 22 and bearing tube 25, the ribs having not only a radial component of direction but also a circumferential component as a smooth and consistent curvature along their entire lengths such that at their radially outer regions they are displaced circumferentially with respect to regions inwardly thereof in a direction that is trailing with respect to the rotation direction of the rotor canister that results from ejection of liquid lubricant from the container. Looked at alternatively, the radially outer regions are displaced with respect to the radially inner regions in the same circumferential direction as liquid is ejected from the outflow chamber by way of the reaction nozzles.

[0023] Liquid is supplied to the rotor canister at elevated pressure and enters the separation chamber 33 in the vicinity of the end wall 23 in a substantially radial direction relative to the rotating canister and at least some of it enters the shallow channels 41_1 , 42_2 , ... formed between adjacent ribs 40_1, 40_2, ... where it is acted upon by the ribs to the extent that it is given components of motion both circumferentially about the rotation axis and radially towards the outer peripheral side wall.

[0024] The circumferentially trailing sweep of the axial displacement ribs elongates the effective length of each channel or radial distance to the vicinity of the outer peripheral side wall and subject the liquid to corresponding lower acceleration forces than are seen with straight radial axial displacement ribs.

[0025] The canister, and any liquid already in it, moves in a circumferential direction and relative to which the newly introduced liquid lags. However, instead of the liquid immediately and forcibly encountering circumferentially moving, and radially extending, ribs which apply both circumferential and radial components of motion to the liquid in a short time interval, the liquid encounters circumferentially moving, but trailing, ribs which apply forces to the liquid to change its velocity from principally radial to principally circumferential over a longer flow path. The liquid is subjected to a lower level of acceleration force thereon, which force has to be obtained from the energy of the rotating canister. To this end it would appear that less rotation energy is absorbed from the rotating canister in providing radial movement of the liquid relative to the end wall 23.

[0026] Furthermore, the pressure gradient in the liquid in the direction along the curved path it takes in the channels, that is, following the line of the ribs, is found to be less that with straight radially-extending ribs and thus notwithstanding the lower radial forces applied to the introduced liquid that flows between the ribs, there is less opposition to the flow, and the structure departs from the perceived wisdom that the introduced liquid has to be accelerated forcefully to overcome considerably higher pressure at the radially outer regions if flow is to occur by way of the radially outer regions of the canister chamber rather than along a short-circuit path as discussed above. That is, as the liquid reaches its maximum circumferential velocity at the end of a longer curved path, and with less opposition from a pressure gradient that is smaller than it would be presented with in conventional straight-ribbed design, there is less opposing pressure on the liquid so that it is permitted to follow a path at greater radial distances and for longer whereby the influence of the increased radial distance on separation efficiency is doubly beneficial.

[0027] Preferably, the curvature of the ribs is chosen having regard to the anticipated conditions of operation, namely lubricant supply pressure (which is substantially constant at engine operating speeds), rotor rotation rate and rate of flow through the canister, such that the lubricant input to the separation chamber at apertures 28_1 , 28_2 ... maintains a substantially constant velocity vector as it passes towards the peripheral side wall and changes flow direction from one that substantially radial into the chamber to being substantially circumferential at the peripheral side wall. Furthermore, in keeping with the smooth transition the outer extremities of the ribs are substantially tangential to the edge of the end wall as defined by the peripheral side wall, and the inner extremities may reach the bearing tube substantially perpendicular to the tube, that is radially and in the same direction as new liquid enters the chamber or in a said trailing circumferential direction.

[0028] It will be appreciated that there are a number of ways in which such trailing circumferential curvature of the axial discontinuities may be achieved, both in terms of the shape and disposition of the discontinuities.

[0029] Referring now to Figure 2, which is a cross section view similar to Figure 1(c) of a second embodiment of a rotor canister 50 differing in that in this second embodiment the canister end wall 51 has at its internally facing surface 51_s axial discontinuities comprising an array of full-length ribs 52_1 , 52_2 ..., extending between the radially outer and inner edges of the end wall as described above, and between pairs of adjacent ribs, an array of short ribs 53_1, 53_2 ... which at the outer edge of the end wall conform to the curvature of the full-length ribs but which have their radially inner ends spaced from the radially inner edge of the wall and bearing tube.

[0030] Referring to Figure 3, in a third embodiment 60 seen in cross-section view similar to Figure 1(c), the internal surface 61_s of end wall 61 carries full-length ribs 62_1, 62_2 ... whose curvature is such that at their radially inner extremities they are substantially tangential with respect to the inner edge of the end wall and the bearing tube thereat.

[0031] In Figure 4, in a fourth embodiment 70 that is generally similar to the embodiment 50, the end wall 71 has at its internal surface 71_s full length ribs 72_1 , 72_2 ... which are interspersed with short ribs 73_1 , 73_2 ..., but wherein the full-length ribs terminate substantially tangentially with respect to the bearing tube.

[0032] In a fifth embodiment of rotor canister 80 shown in Figure 5, all of the axial discontinuities at surface 81_s of end wall 81 are formed by radially short ribs, there being a radially inner array 82_1 , 82_2 , 82_3 ... being surrounded by a circumferentially offset radially outer array of ribs 83_1, 83_2, 83_3 .... The extremities of the ribs are shown in radially overlapping relationship but this may be considered optional.

[0033] Referring to Figure 6, in a sixth embodiment of rotor canister 90, the axial displacements formed at the end wall 91 and in the internal (to the canister) surface 91_s thereof comprise an outer array of short ribs 93_1, 93_2 ... corresponding to ribs 83_1 ... and an inner array of short ribs 92_1, 92_2 ... which extend for a short distance in a radial direction with little or no trailing curvature. The radially-inner, straight ribs, guide the liquid that enters the canister in a substantially radial direction to the mainly curved channels 94_1, 94_2, 94_3 ... between adjacent ribs of the outer array.

[0034] In a seventh embodiment of rotor canister 100, shown in Figure 7 also as a cross-section view towards the end wall 101 and its internal surface 101_s, the array of axial discontinuities, indicated generally at 102, take the form of alternate depressed and raised regions 103_1, 103_2 ... and 104_1, 104_2 ... respectively that are circumferentially extensive compared to the ribs described hitherto. The depressed regions 103_1 ... that correspond to the depressed, embossed ribs being substantially equally dimensioned to the non-depressed regions 104_1 ... that correspond to the channels between such ribs.

[0035] It will be appreciated that in all of the above described embodiments the numbers and circumferential widths of the individual axial displacements may vary as desired to achieve different degrees of flow path elongation and dwell time as appropriate for the operating conditions to be met by the rotor canister and centrifugal separator containing it.

[0036] In all of the above, the axial displacements have been described formed by embossment of the rotor canister metal as it is drawn to shape from a blank thereof. It will be appreciated that whereas such displacement formation may be convenient as part of an existing manufacturing procedure, there are alternatives.

[0037] Referring to Figures 8(a) and 8(b) which show sectional elevation and cross-section views respectively, generally similar to those of Figures 1(a) and 1(c), of an eighth embodiment 110 of rotor canister, the upper end wall 111 has a surface 111s facing into the separation chamber and overlying that surface a carrier member 113 on which are carried axial discontinuities 115_1, 115_2 ... extending thereon in said axial, radial and circumferential directions.

[0038] Conveniently, the axial discontinuities are formed by vanes each having thickness in a circumferential direction that is much less than the vane length, and indeed less than the ribs formed by embossment and described above. The vanes may be formed integrally with the carrier member as moulding or casting of, for example, plastics material or metal, or may be stamped and bent out of a sheet of suitable material.

[0039] The numbers, lengths and curvatures of such vanes may take any of the variety of forms described above, varying in circumferential thickness as well as length and curvature. Also, although it is convenient for such vanes to extend in an axial direction, they may be inclined thereto.

[0040] It will be appreciated that axial displacements, particularly in the form vanes which are thin in a circumferential direction, may be formed by discrete shaped bodies of any material secured directly to the internal surface of the end wall rather than a carrier member such as 113.

[0041] It will also be appreciated that although the above described embodiments have featured a centrifugal separator rotor canister in which an inner peripheral wall is defined by an apertured bearing tube 25 that rotates as part of the canister about the axle 15, and which bearing tube conveniently defines the radially inner edge of the end wall 23 from the point of having axial surface projection, the rotor canister man be formed without such tube and with the bearing bushes 26, 27 mounted directly in the canister end walls so that the axle 15 defines a stationery inner wall of the canister and the supply ports 17 open directly into the separation chamber of the canister.

[0042] The above described embodiments have concentrated upon a form of rotor canister in which the axial discontinuities at the end wall adjacent the liquid inlet region exhibit at their radially outer regions a circumferential displacement in a trailing direction.

[0043] Referring to Figures 9(a) to 9(c) these are generally similar to the views of Figures 1(a) to 1(c) but of a further embodiment of centrifugal separator 200 including a ninth embodiment of rotor canister 220. Those parts of the separator housing which correspond to those described above with reference to Figure 1(a) are given like references and not described further. The rotor canister 220 likewise has many parts identical with rotor canister 20 and like references are again used and detailed description omitted. Where the rotor canister does differ is that the axial displacements, in the form of embossed ribs 240_1, 240_2, 240_3 ... have their radially outer regions circumferentially displaced in a direction that is leading, or forward, with respect to the clockwise rotation direction of the canister that results from ejection of the liquid from the outflow chamber.

[0044] The additional acceleration given by such directional ribs to the newly introduced liquid ensures it overcomes radial pressure gradients and spends time at the radially outer regions rather than short-circuiting them. Although such acceleration absorbs energy from the rotating canister system, and therefore reduces the rotation speed and with it the speed-related centrifugal separation efficiency, it may be that the increased radius and dwell time achieved by the accelerated liquid results in improved separation of particulates therefrom, notwithstanding such reduced rotation rate. Alternatively, if an internal structure is employed within the separation chamber, such as the cone stack of the aforementioned WO 96/22835 or a functional equivalent, that recovers energy from the liquid flow to supplement rotation of the rotor canister, the additional degree of acceleration from axial discontinuities with circumferentially leading regions may be achieved at little overall cost of energy absorption from the rotating canister system.

[0045] Whereas in all of the above described embodiments, the axial displacements have been at the upper end wall of the rotor canister separation chamber, and opposite to the outflow chamber at the lower end of the canister, it will be appreciated that if the rotor is designed such that liquid is ejected from an outflow chamber at the operationally upper end of the rotor then the separation chamber inlet apertures will be moved to the lower end wall of the canister and the axial displacements formed at such lower end wall.

[0046] Also, the axial displacements have been described above as continuously and smoothly curved substantially along the whole of their extent; it will be appreciated that the curvature along any component part of length may be very shallow or non-existent, is straight, and/or any axial displacement may, along its radial length, comprise a series of straight or nearly-straight segments inclined with respect to each other so as to give, along the whole length, an effective curvature in said circumferentially trailing direction.

[0047] Although in all of the above embodiments the centrifugal separator has been shown with the rotor committed to rotation about the axle in a clockwise direction and the axial discontinuities circumferentially displaced to suit, it will be appreciated that the rotor canister may be arranged to have the reaction jet nozzles oppositely directed whereby it undergoes rotation in an anti-clockwise direction about the axis, and with the circumferential displacement of the radially outer regions of the axial displacements also oppositely directed from that illustrated.

[0048] It will also be appreciated that the provision of such non-radial axial displacement is not limited to rotor canisters of the sealed or discardable type and may be employed with different types of canister construction that are known in the art and permit dis-assembly for cleaning and the like.

Claims

1. A rotor for a self-powered centrifugal separator (10; 200) comprising a housing enclosure (11), an axis (14) extending through the housing enclosure in an operationally substantially vertical orientation, said rotor being arranged to receive a liquid at elevated pressure and, in reaction to ejection of the liquid therefrom substantially tangentially, spin about the axis at at least a predetermined minimum speed to effect separation of said contaminant particles from contaminated liquid therein, said rotor (20; 50; 60; 70; 80; 90; 100; 110; 220) comprising a canister having

(i) an outer, peripheral wall (21) including a peripheral side wall (22) displaced from the axis (14),
(ii) an internal partition wall (30) extending radially inwardly from the peripheral wall dividing the canister into a separation chamber (33) and an outflow chamber (34) and defining at its radially inner periphery a transfer aperture (38) between the separation and outflow chambers, said separation chamber (33) including an inlet aperture (28_1) to admit contaminated liquid thereto from the rotation axis and the outflow chamber (34) having at least one nozzle (35) spaced radially from said rotation axis to eject liquid from the canister, and
(iii) at the end of the canister opposite the outlet chamber, at the internal surface of an end wall (23; 51; 61; 71; 81; 91; 101; 111) thereof, an array of axial discontinuities each extending radially, and **characterised in that** the axial discontinuities form boundaries for channels therebetween open in an axial direction and at least some of the axial discontinuities extend also circumferentially such that each is, at a radially outer region circumferentially displaced with respect to a radially inner region in the same circumferential direction as liquid is ejected from the outflow chamber (34).

2. A centrifugal separator rotor (60; 70)as claimed in claim 1 **characterised in that** at least some of said axial discontinuities (62; 72) which terminate adjacent the radially inner edge of the end wall extend, at their termination, trailing circumferentially.

3. A centrifugal separator rotor (20; 50; 80; 100; 110; 220) as claimed in claim 1 **characterised by** axial discontinuities (40; 52; 82; 103; 104; 115; 240) which terminate adjacent the radially inner end of the canister end wall in a substantially radial direction.

4. A centrifugal separator rotor (20; 50; 60; 70; 100; 110; 220) as claimed in any one of the preceding claims **characterised in that** at least some of the axial discontinuities (40; 52; 62; 72; 103, 104; 115; 240) extend from adjacent the radially outer edge of the end wall to adjacent the radially inner edge of said end wall.

5. A centrifugal separator rotor (50; 70; 80; 90) as claimed in any one of the preceding claims **characterised in that** at least some of said axial discontinuities (53; 73; 82, 83; 92, 93) extend in said radial direction such that at least one of the radially outer and radially inner ends thereof is spaced from said respective radially outer and radially inner end of the end wall.

6. A centrifugal separator rotor (20; 50; 60; 70; 80; 90; 100; 220) as claimed in any one of the preceding claims **characterised in that** which the axial discontinuities are formed by embossments in the end wall.

7. A centrifugal separator rotor (20; 50; 60; 70; 80; 90; 220) as claimed in claim 6 **characterised in that** said embossments comprise ribs (40; 52, 53; 62; 72, 73; 82, 83; 92, 93; 240) of relatively narrow width in a circumferential direction and raised in height with respect to said container end wall axially internally of the chamber formed by the wall.

8. A centrifugal separator rotor (20; 50; 60; 70; 80; 90; 220) as claimed in claim 7 **characterised in that** the ribs are of substantially uniform width along their length and of such width and axial height as to define strengthening ribs for the said end wall of the container.

9. A centrifugal separator (10; 200) for separating particulate contaminants from a liquid supplied thereto comprising a housing enclosure (11), an axis (14) extending through the housing enclosure in an operationally substantially vertical orientation, and a

rotor arranged to receive a liquid at elevated pressure and, in reaction to ejection of the liquid therefrom substantially tangentially, spin about the axis at at least a predetermined minimum speed to effect separation of said contaminant particles from contaminated liquid therein, **characterised in that** said rotor comprises a rotor (20; 50; 70; 80; 90; 100; 110; 220) according to any one of the preceding claims.

Patentansprüche

1. Ein Rotor für eine selbst angetriebene zentrifugale Trennvorrichtung (10, 200) umfassend eine Gehäuseeinfassung (11), eine Achse (14), die betriebsbereit im wesentlichen vertikal durch die Gehäuseeinfassung verläuft, wobei der Rotor zur Aufnahme einer Flüssigkeit unter erhöhtem Druck angeordnet ist und - auf den im wesentlichen tangentialen Ausstoß der Flüssigkeit reagierend - um die Achse bei einer zumindest. vorherbestimmten Mindestgeschwindigkeit dreht, so dass eine Abscheidung der Schmutzpartikel aus einer verschmutzten Flüssigkeit bewirkt wird, wobei der Rotor (20; 50; 60; 70; 80; 90; 100; 110; 220) einen Behälter aufweist, umfassend

   a) eine äußere Umfangswand (21) mit einer von der Achse (14) versetzten Umfangsseitenwand (22),
   b) eine innere Trennwand (30), die sich radial nach innen von der Umfangswand erstreckt, den Behälter in eine Trennkammer (33) sowie eine Ablaufkammer (34) teilt und an dem radialen Innenumfang eine Übergangsöffnung (38) zwischen Trennkammer und Ablaufkammer definiert, wobei die Trennkammer (33) eine Einlaßöffnung (28_1) aufweist, die eine Beaufschlagung derselben mit verschmutzter Flüssigkeit von der Rotationsachse aus erlaubt, und wobei die Ablaufkammer (34) mindestens eine Düse (35) aufweist, die radial von der Rotationsachse beabstandet ist, so dass die Flüssigkeit aus dem Behälter ausgestoßen werden kann, sowie
   c) eine Anordnung von sich jeweils radial erstreckenden axialen Unterbrechungen, die sich an dem einen Ende des Behälters gegenüber der Auslaufkammer an der Innenseite der einen Endwand (23; 51; 61; 71; 81; 91; 101; 111) befindet und **dadurch gekennzeichnet ist, dass** die axialen Unterbrechungen die Grenzen zwischen den Kanälen bilden, die in axialer Richtung offen sind und zumindest einige der axialen Unterbrechungen sich auch umfangsmäßig erstrecken, dergestalt, dass jede am radialen Außenbereich umfangsmäßig versetzt ist in Bezug auf einen radialen Innenbereich in derselben Umfangsrichtung, wie die Flüssigkeit aus der Ablaufkammer (34) ausströmt.

2. Rotor für eine zentrifugale Trennvorrichtung (60; 70) nach Anspruch 1, **dadurch gekennzeichnet, dass** zumindest einige der axialen Unterbrechungen (62; 72), die an den radialen Innenbereich der Endwand anliegend enden, an ihren Enden am Umfang geführt werden.

3. Rotor für eine zentrifugale Trennvorrichtung (20; 50; 80; 100; 110; 220) nach Anspruch 1, **gekennzeichnet durch** im wesentlichen in radialer Richtung endende axiale Unterbrechungen (40; 52; 82; 103; 104; 115; 240), die an das radial innere Ende der Endwand des Behälters angrenzen.

4. Rotor für eine zentrifugale Trennvorrichtung (20; 50; 60; 70; 100; 110; 220) nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** zumindest einige der axialen Unterbrechungen (40; 52; 62; 72; 103; 104; 115; 240) sich erstrecken von der angrenzenden radialen Außenkante der Endwand bis zu der angrenzenden radialen Innenkante dieser Endwand.

5. Rotor für eine zentrifugale Trennvorrichtung (50; 70; 80; 90) nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** zumindest einige der axialen Unterbrechungen (53; 73; 82; 83; 92; 93) sich in radialer Richtung erstrecken, so dass zumindest eines ihrer radial äußeren und radial inneren Enden von dem jeweils radial äußeren und radial inneren Ende der Endwand beabstandet ist.

6. Rotor für eine zentrifugale Trennvorrichtung (20; 50; 60; 70; 80; 90; 100; 220) nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die axialen Unterbrechungen durch Einprägungen in der Endwand gebildet werden.

7. Rotor für eine zentrifugale Trennvorrichtung (20; 50; 60; 70; 80; 90; 220) nach Anspruch 6, **dadurch gekennzeichnet, dass** die Einprägungen Rippen (40; 52; 53; 62; 72; 73; 82; 83; 92; 93; 240) von in Umfangsrichtung relativ enger Breite umfassen, die erhöht sind in Bezug auf die Behälterendwand, die axial in der Kammer von der Wand gebildet wird.

8. Rotor für eine zentrifugale Trennvorrichtung (20; 50; 60; 70; 80; 90; 220) nach Anspruch 7, **dadurch gekennzeichnet, dass** die Rippen im wesentlichen der Länge nach einheitlich breit sind und so breit und axial hoch sind, dass sie Verstärkungsrippen für die Endwand des Behälters definieren.

9. Eine zentrifugale Trennvorrichtung (10; 200) zur

Abscheidung von Schmutzpartikeln aus einer dieser zentrifugalen Trennvorrichtung zugeführten Flüssigkeit, umfassend eine Gehäuseeinfassung (11), eine Achse (14), die betriebsbereit im wesentlichen vertikal durch die Gehäuseeinfassung verläuft, sowie einen Rotor, der zur Aufnahme einer Flüssigkeit unter erhöhtem Druck angeordnet ist und - auf den im wesentlichen tangentialen Ausstoß der Flüssigkeit reagierend - um die Achse bei einer zumindest vorherbestimmten Mindestgeschwindigkeit dreht, so dass eine Abscheidung der Schmutzpartikel aus einer verschmutzten Flüssigkeit bewirkt wird, **dadurch gekennzeichnet, dass** der Rotor einen Rotor (20; 50; 70; 80; 90; 100; 110; 220) nach einem der vorhergehenden Ansprüchen aufweist.

Revendications

1. Rotor d'un séparateur centrifuge automoteur (10 ; 200) comprenant une enveloppe de boîtier (11), un axe (14) s'étendant à travers l'enveloppe de boîtier selon une orientation fonctionnelle sensiblement verticale, ledit rotor étant disposé de façon à recevoir un liquide à pression élevée et, en réaction à l'éjection du liquide de celui-ci sensiblement tangentiellement, à tourner autour de l'axe à au moins une vitesse minimale prédéterminée pour effectuer la séparation desdites particules contaminantes du liquide contaminé qui s'y trouve, ledit rotor (20 ; 50 ; 60 ; 70 ; 80 ; 90 ; 100 ; 110 ; 220) comprenant un récipient métallique comportant

   (i) une paroi périphérique extérieure (21) comprenant une paroi latérale périphérique (22) déplacée de l'axe (14),
   (ii) une paroi de séparation interne (30) s'étendant radialement vers l'intérieur depuis la paroi périphérique, divisant le récipient métallique en une chambre de séparation (33) et une chambre de décharge (34) et définissant au niveau de sa périphérie radialement intérieure une ouverture de transfert (38) entre les chambres de séparation et de décharge, ladite chambre de séparation (33) comprenant une ouverture d'entrée (28_1) pour laisser passer le liquide contaminé vers celle-ci depuis l'axe de rotation, et la chambre de décharge (34) comportant au moins un éjecteur (35) espacé radialement dudit axe de rotation pour éjecter le liquide du récipient métallique, et
   (iii) à l'extrémité du récipient métallique opposée à la chambre de décharge, au niveau de la surface interne de sa paroi d'extrémité (23 ; 51 ; 61 ; 71 ; 81 ; 91 ; 101 ; 111), un ensemble de discontinuités axiales s'étendant chacune radialement, et **caractérisé en ce que** les discontinuités axiales constituent les limites de gorges s'étendant entre elles et ouvertes selon une direction axiale, et au moins certaines des discontinuités axiales s'étendent également circonférentiellement de sorte que chacune d'elles est déplacée circonférentiellement, au niveau d'une zone radialement extérieure, par rapport à une zone radialement intérieure selon la même direction circonférentielle d'éjection du liquide de la chambre de décharge (34).

2. Rotor de séparateur centrifuge (60 ; 70) selon la revendication 1, **caractérisé en ce qu'**au moins certaines desdites discontinuités axiales (62 ; 72), qui se terminent à proximité du bord radialement intérieur de la paroi d'extrémité, s'étendent circonférentiellement vers l'arrière au niveau de leur extrémité.

3. Rotor de séparateur centrifuge (20 ; 50 ; 80 ; 100 ; 110 ; 220) selon la revendication 1, **caractérisé par** des discontinuités axiales (40 ; 52 ; 82 ; 103 ; 104 ; 115 ; 240) qui se terminent à proximité de l'extrémité radialement intérieure de la paroi d'extrémité du récipient métallique selon une direction sensiblement radiale.

4. Rotor de séparateur centrifuge (20 ; 50 ; 60 ; 70 ; 100 ; 110 ; 220) selon l'une quelconque des revendications précédentes, **caractérisé en ce qu'**au moins certaines des discontinuités axiales (40 ; 52 ; 62 ; 72 ; 103 ; 104 ; 115 ; 240) s'étendent de la proximité du bord radialement extérieur de la paroi d'extrémité à la proximité du bord radialement intérieur de ladite paroi d'extrémité.

5. Rotor de séparateur centrifuge (50 ; 70 ; 80 ; 90) selon l'une quelconque des revendications précédentes, **caractérisé en ce qu'**au moins certaines desdites discontinuités axiales (53 ; 73 ; 82, 83 ; 92, 93) s'étendent selon ladite direction radiale de sorte qu'au moins l'une de leurs extrémités radialement extérieure et radialement intérieure est espacée desdites extrémité radialement extérieure et extrémité radialement intérieure respectives de la paroi d'extrémité.

6. Rotor de séparateur centrifuge (20 ; 50 ; 60 ; 70 ; 80 ; 90 ; 100 ; 220) selon l'une quelconque des revendications précédentes, **caractérisé en ce que** les discontinuités axiales sont façonnées par des bossages dans la paroi d'extrémité.

7. Rotor de séparateur centrifuge (20 ; 50 ; 60 ; 70 ; 80 ; 90 ; 220) selon la revendication 6, **caractérisé en ce que** lesdits bossages comprennent des nervures (40 ; 52, 53 ; 62 ; 72, 73 ; 82, 83 ; 92, 93 ; 240) d'une largeur relativement étroite selon une direction circonférentielle et surélevées en hauteur par

rapport à ladite paroi d'extrémité de récipient axialement à l'intérieur de la chambre formée par la paroi.

8. Rotor de séparateur centrifuge (20 ; 50 ; 60 ; 70 ; 80 ; 90 ; 220) selon la revendication 7, **caractérisé en ce que** les nervures présentent une largeur sensiblement uniforme sur leur longueur et une largeur ainsi qu'une hauteur axiale telles qu'elles définissent des nervures de renforcement pour ladite paroi d'extrémité du récipient.

9. Séparateur centrifuge (10 ; 200) destiné à séparer des contaminants particulaires d'un liquide qui lui est délivré, comprenant une enveloppe de boîtier (11), un axe (14) s'étendant à travers l'enveloppe de boîtier selon une orientation fonctionnelle sensiblement verticale et un rotor disposé de façon à recevoir un liquide à pression élevée et, en réaction à l'éjection du liquide de celui-ci sensiblement tangentiellement, à tourner autour de l'axe à au moins une vitesse minimale prédéterminée pour effectuer la séparation desdites particules contaminantes du liquide contaminé qui s'y trouve, **caractérisé en ce que** ledit rotor comprend un rotor (20 ; 50 ; 70 ; 80 ; 90 ; 100 ; 110 ; 220) selon l'une quelconque des revendications précédentes.

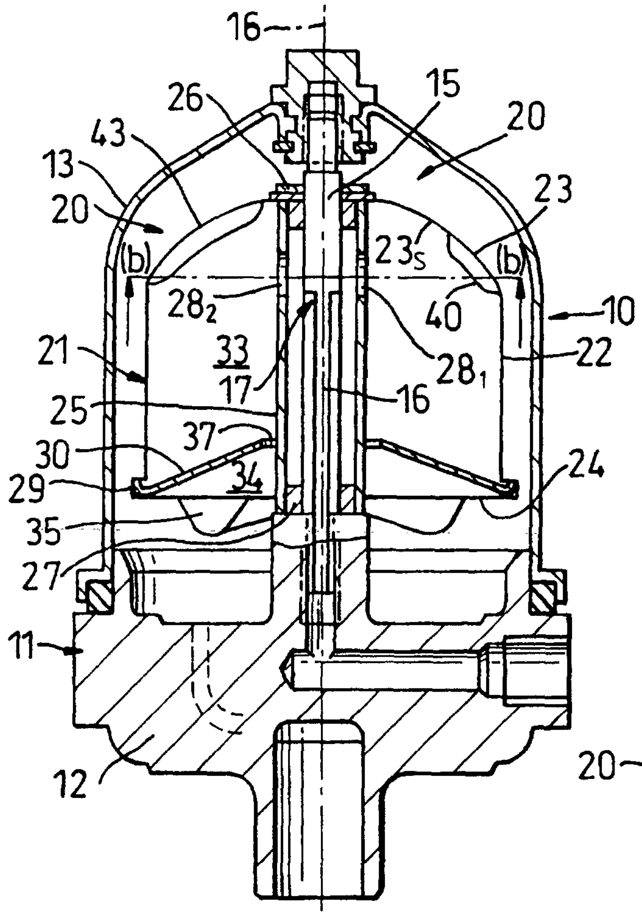

Fig. 1(a)

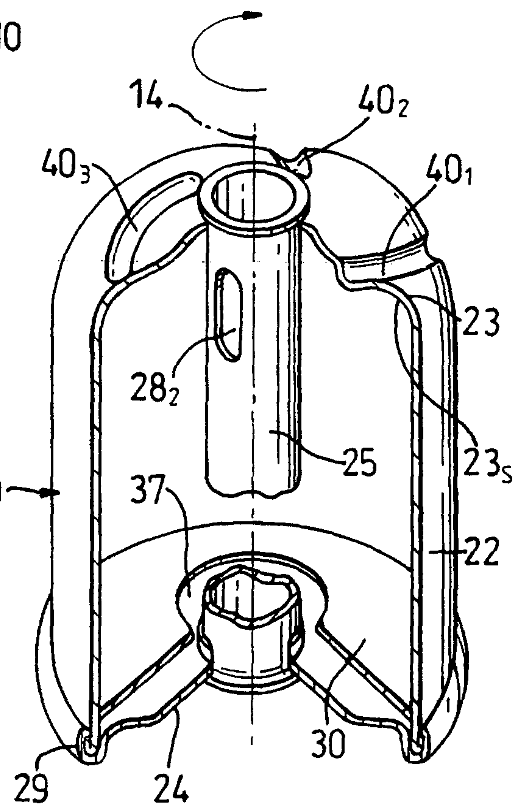

Fig. 1(b)

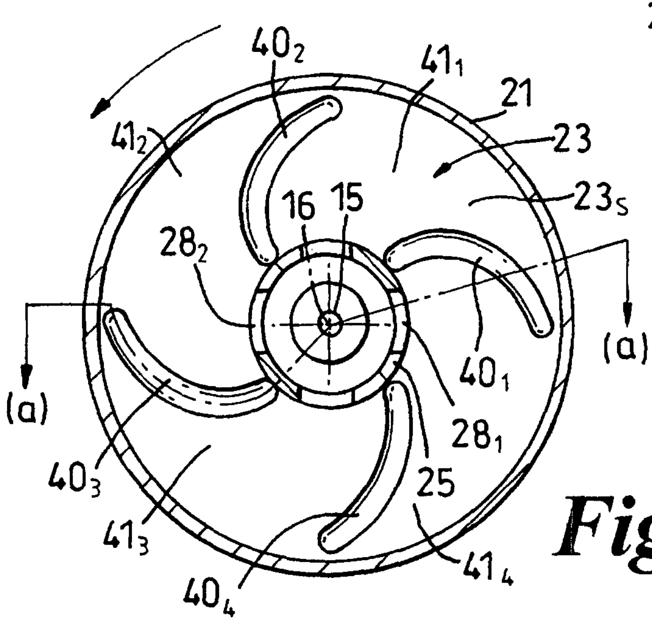

Fig. 1(c)

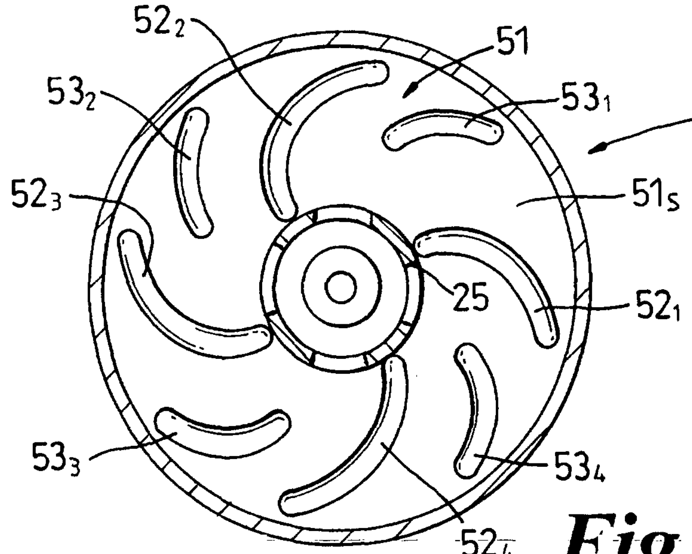

Fig. 2

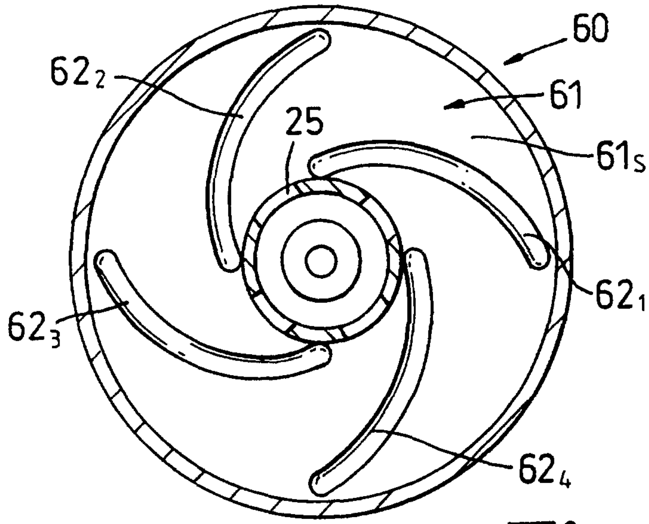

Fig. 3

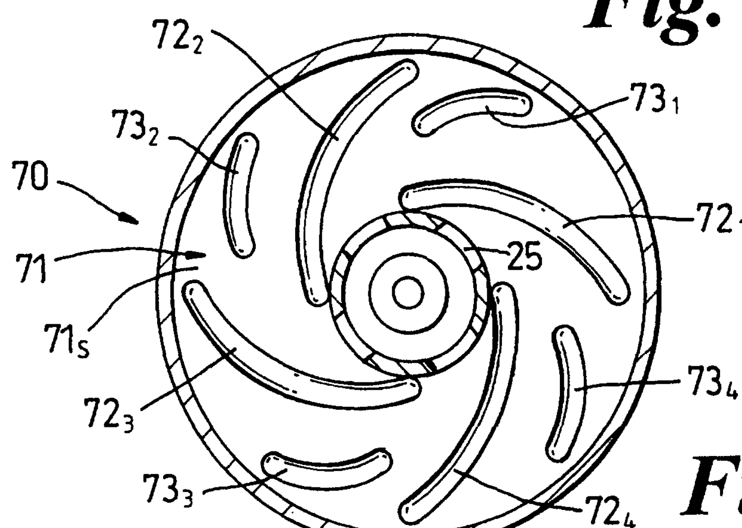

Fig. 4

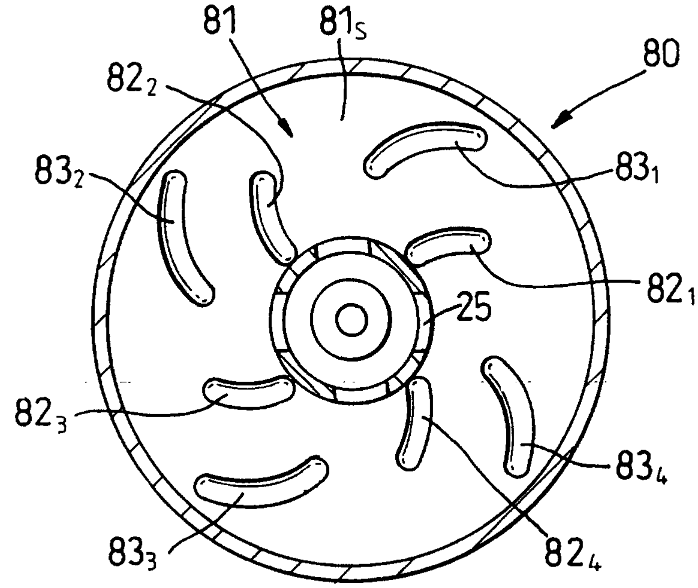
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Fig. 5

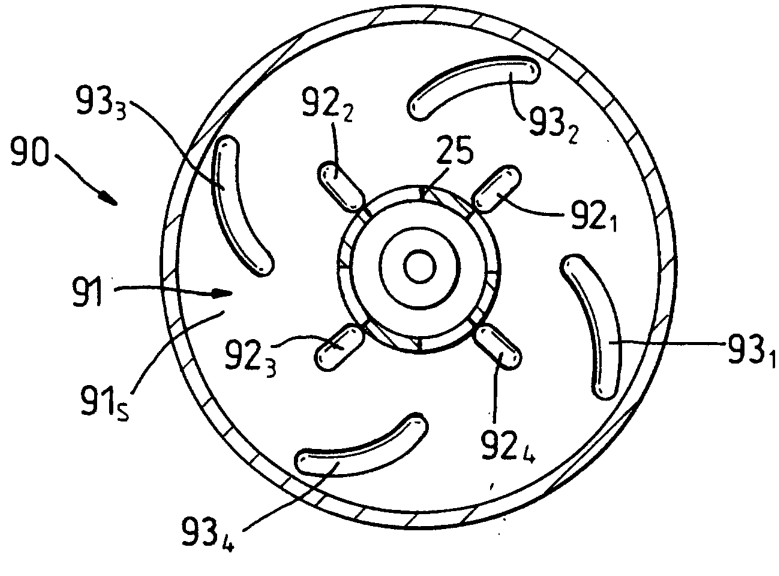
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Fig. 6

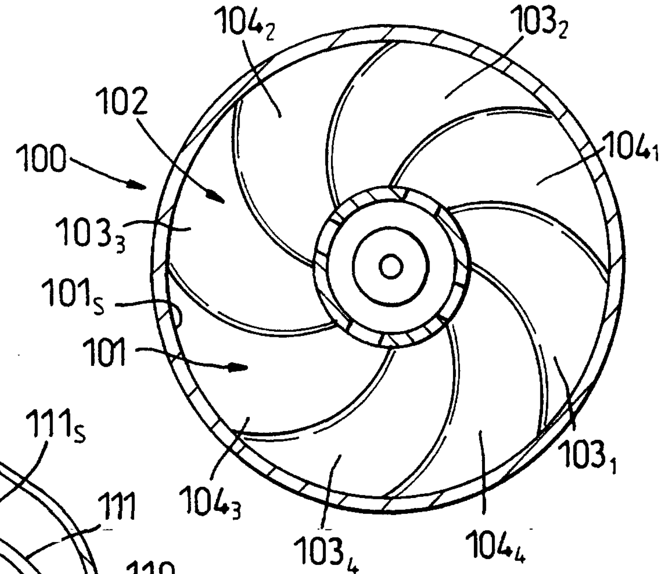

Fig. 7

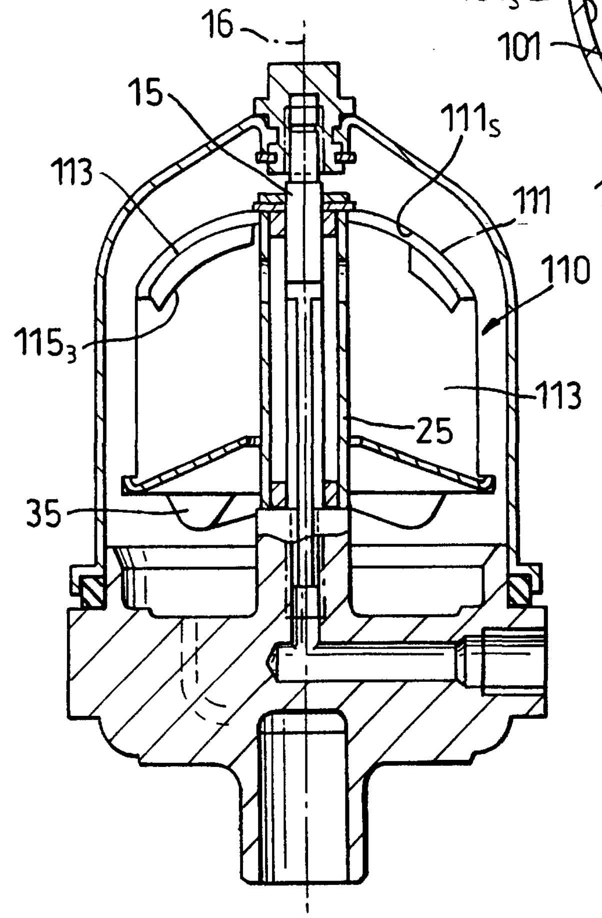

Fig. 8(a)

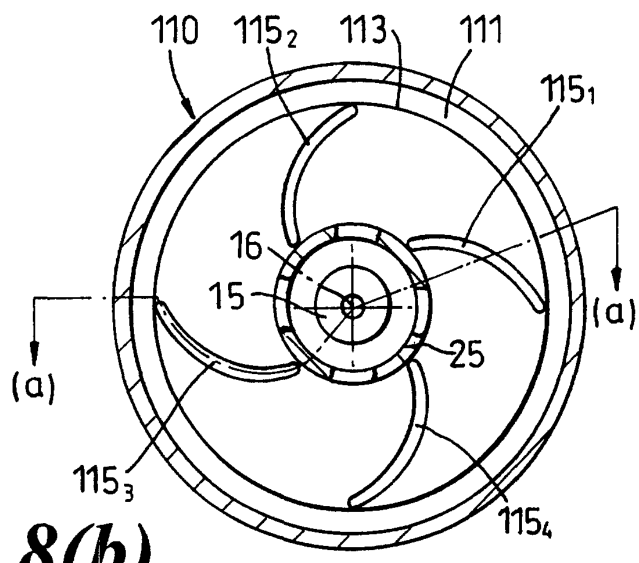

Fig. 8(b)

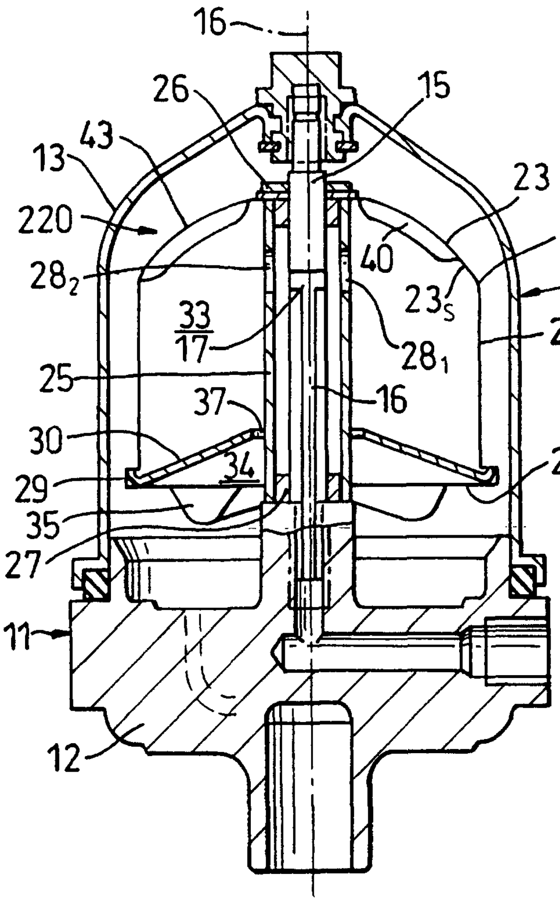

Fig. 9(a)

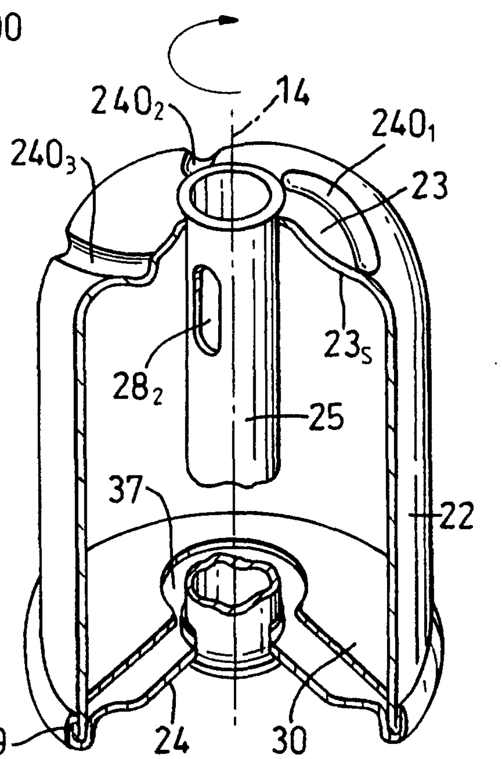

Fig. 9(b)

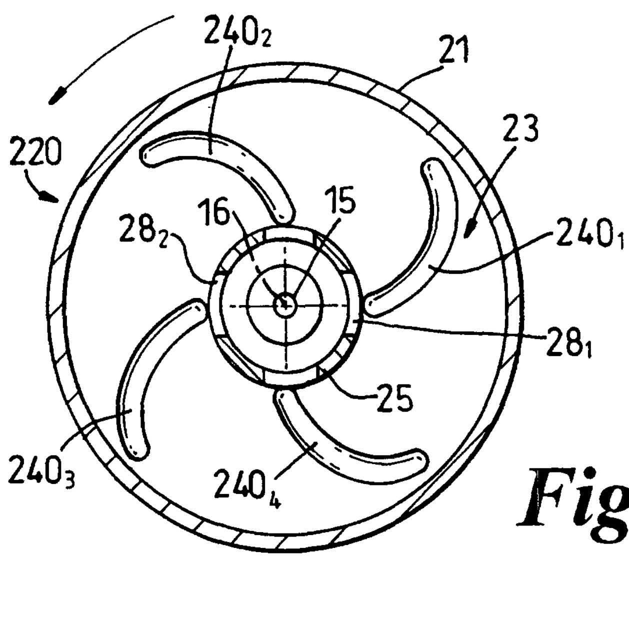

Fig. 9(c)