

(19) **DANMARK**

(10) **DK/EP 3883700 T3**



(12)

**Oversættelse af
europæisk patentskrift**

Patent- og
Varemærkestyrelsen

-
- (51) Int.Cl.: **B 07 B 4/02 (2006.01)** **B 02 C 23/14 (2006.01)** **B 07 B 9/02 (2006.01)**
B 07 B 11/06 (2006.01)
- (45) Oversættelsen bekendtgjort den: **2025-03-31**
- (80) Dato for Den Europæiske Patentmyndigheds bekendtgørelse om meddelelse af patentet: **2025-01-01**
- (86) Europæisk ansøgning nr.: **19808752.0**
- (86) Europæisk indleveringsdag: **2019-11-20**
- (87) Den europæiske ansøgnings publiceringsdag: **2021-09-29**
- (86) International ansøgning nr.: **EP2019081935**
- (87) Internationalt publikationsnr.: **WO2020104528**
- (30) Prioritet: **2018-11-23 DE 102018129538**
- (84) Designerede stater: **AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR**
- (73) Patenthaver: **KHD Humboldt Wedag GmbH, Von-der Wettern-Straße 4a, 51149 Köln, Tyskland**
- (72) Opfinder: **DR. HACHENBERG, Niko, Neichener Straße 26, 51491 Overath, Tyskland**
- (74) Fuldmægtig i Danmark: **Dennemeyer & Associates S.A, P.O. Box 700425, DE-81304 Munich, Tyskland**
- (54) Benævnelse: **PNEUMATISK FORBUNDET FLERLAGS-SIGTE**
- (56) Fremdragne publikationer:
EP-A1- 1 084 769
EP-A1- 1 090 685
WO-A1-2013/079416
CN-U- 202 460 996
DE-B3- 102015 013 892
US-A- 2 294 290

MULTIPLE SEPARATORS WHICH ARE PNEUMATICALLY CONNECTED TO ONE ANOTHER

The invention pertains to a separator for separating granular material into at least one fraction of fine material and one fraction of coarse material, comprising a housing in which a stepped cascade permeable to separating gas is installed at an angle deviating from the horizontal, at least one inflow duct into the housing for separating gas, and at least one outflow duct from the housing for separating gas charged with fine material, wherein opposite the stepped cascade and separated by a separating zone separating slats are disposed one above the other in the manner of Venetian blinds, and wherein above the separating zone on the upper side of the housing a material inlet opening and below the separating zone on the lower side of the housing a discharge opening for the coarse material are disposed.

A known method for separating fine material from separating material is to let the separating material fall over a staircase-like cascade of baffle plates in a closed chamber through which separating air flows and to blow out the fine components through the separating air. The blown-out fine material is discharged from the chamber with the separating air via an outflow duct and the fine material is separated from the separating air flow in a further device. These separators described here are usually referred to as V separators due to their external structure.

The efficiency of the V separators is determined by their geometry. The cascades must not be too flat in order to ensure a sufficient flow of the separating material and also not too steep so that the separating air has enough time to blow out the fine material. A V separator should also not be arbitrarily wide, as a distribution problem could occur across the width of the separator if the V separators are very wide and wider than a cone of material that forms at a corresponding throughput. There are therefore geometric limits to the ideal shape of a V separator.

In order to increase the throughput of a separating material system, it is possible to arrange many individual separators next to each other. These banks of separators work independently of each other and side by side. The total separation capacity of the bank of separators set up in this way is equal to the sum of the separation capacities of the individual separators. In order to supply the individual separators with separating air, it is necessary to connect the individual separators to a (usually) central separating air supply line. This results in problems with pneumatic control, which also occurs on a much smaller scale in air conditioning systems. The separating air flow differs between

the individual separators because the distance between the various individual separators and the central compressor varies. An individual separator located closer to the compressor reduces the pressure in the residual line, so that the individual separators located further away from the compressor operate with a lower separating air pressure. As a result, the separation capacity and also the particle composition of the fine material differ between the individual separators. Although it is also a known method to regulate the separating air supply to the individual separators by means of air flow controllers, regulation via a number of individual separators can no longer be considered trivial, as control oscillations can build up in the line from the compressor to the individual separators, which can cause dynamic air pressure fluctuations in the separating air supply line. In addition to the actual control oscillation caused by the timing element between the actuator and the control element, an air pressure oscillation that is introduced into the control system is superimposed, which builds up in the system itself and can influence the grinding circuit.

European patent application EP 1 090 685 A1 discloses a compact circuit grinding plant within which two cascades are located opposite each other within the same housing. These cascades are not decoupled and tend to cause one cascade to operate with greater pressure loss than the second, as a result of which the cascades operate with different separation capacity and with different separating results. A separator according to the general term of claim 1 is known from this document.

In the Chinese utility model CN 202 460 996 U, individual separators working in parallel are shown which operate with different interconnections. Both separators connected in series and those working in parallel are shown in relation to the separating air.

The German patent specification DE 10 2015 013 892 B3 discloses a double separator in which two successive cascades, each forming its own separating zone, are disposed in a common housing. The two cascades are connected in series in relation to the separating air.

In the European patent application EP 1 084 769 A1, a separator combination consisting of a cascade separator with a rod-cage separator in a common housing is presented. The two separators are connected in series in relation to the separating air.

International patent application WO 2013/079416 A1 also presents a separator combination consisting of a cascade separator with a rod-cage separator in a common housing. The two separators are connected in series in relation to the separating air.

US patent US 2,294,290 A teaches a bank of separators connected in parallel, which are supplied with separating air via a common supply line. In this bank of separators,

the last separator operates at a much lower pressure than the front separators in the separating air supply line.

The object of the invention is therefore to provide a scalable separator which is not tall, so that lifting work is saved, and which does not tend to oscillate, so that it separates a uniform fine material with a constant grain composition from the separating material.

The object according to the invention is achieved by pneumatically connecting to one another at least two individual separators opposite one another are via a common pressure equalization chamber, via which the separating gas flows into the respective inflow ducts of the individual separator. Further advantageous embodiments are given in the sub-claims to claim 1.

According to the idea of the invention, it is therefore provided that a pressure equalization chamber is disposed between more than one individual separator, via which the more than one individual separator is connected to one another. The pressure equalization chamber makes it unnecessary to regulate the individual separating air flow, because the pressure equalization chamber applies the same separating air pressure to each individual separator. The common and central pressure equalization chamber is geometrically connected to each individual separator in the same way, so that no air pressure fluctuations can build up due to different air paths between the different individual separators. This structure allows a large separator to be replaced by a multiple arrangement of interconnected, smaller separators according to the invention. In a preferred embodiment of the separator according to the invention, it is provided that the separating gas resistance, which describes the pressure drop of the separating gas from the inflow duct to the outflow duct at a given separating gas flow, of the at least two individual separators is approximately the same. The separating gas resistance is determined by the cross-section of the individual separator through which the air can flow, the length of the air path that the separating air has to cover in the individual separator and the air routing. The air flow describes whether the separating air is deflected several times or whether it flows in an ideal cylindrical tube. The effects of the geometric shape of a device on its flow resistance are well known to the person skilled in the art, although predictability is not trivial. The comparability of the separating air resistance between the different individual separators reduces the tendency to control oscillations and the tendency to air pressure oscillations in the supply line with separating air and the separating efficiency is equalized.

In a preferred embodiment of the invention, the more than one individual separator is constructed mirror-inverted to each other so that they are opposite each other and show

the same reaction to the inflow of separating air. It is advantageous if the more than one individual separator is always constructed in pairs as mirror images of each other. It is not important whether the individual separators themselves have reflective symmetry or are not mirror symmetrical, i.e. do not have a reflective surface. The pressure equalization chamber of the separator according to the invention can be constructed in different ways. It has proven to be advantageous if the pressure equalization chamber is directly connected to the separating air inlet openings of the more than one individual separator. It can happen that separating material also enters the pressure equalization chamber. This happens due to unwanted malfunctions during operation, deviations from ideal behavior or temporary overload of an individual separator. In order to be able to discharge the separating material from the pressure equalization chamber, it is provided that in a preferred embodiment of the separator, the pressure equalization chamber has its own material discharge opening.

In a further embodiment of the separator according to the invention, it may be provided that the at least two individual separators comprise of, in addition to a discharge opening for fine material, a further discharge opening for medium material fraction. The composition of the fine material can be controlled quite precisely by discharging the medium material fraction.

In order to ensure that the pressure equalization chamber between the more than one individual separator distributes the pressure evenly to the different individual separators, it is provided that the pressure equalization chamber is connected to the inflow ducts of the at least two individual separators via a perforated panel wall or mesh wall. The perforated panel wall or mesh has a low separating airflow resistance. During equalization, the air flow resistance of an individual separator acts as a passive control element with a small but nevertheless noticeable equalizing function of the separating air flow, so that the pressure in the pressure equalization chamber on the more than one individual separator leads to a separating air flow that is as identical as possible between the different individual separators.

In order to ensure a uniform inflow to the more than one individual separator, in a preferred embodiment of the separator it can be provided that the separating gas, which flows via the pressure equalization chamber into the inflow ducts of the at least two individual separators, flows into the pressure equalization chamber exactly in the middle between the at least two individual separators. The geometric center leads to a lower tendency to air pressure oscillations, which have different effects for the different individual separators.

In a first specific embodiment of the invention, it is provided that pairs of separators opposite one another are constructed as a separator bank, which are arranged in pairs one behind the other and are connected to one another with the same pressure equalization chamber. In order to subject the separated fine material to further separation, the outflow duct from the housing of the individual separator for fine material can each be connected to its own rod-cage separator assigned to this individual separator, or the outflow ducts from the housing of more than one individual separator for fine material can be connected in a common rod-cage separator.

The invention will now be explained in greater detail on the basis of the following drawings. In the drawings:

- Fig. 1 shows an openwork view of a V separator from the PRIOR ART,
- Fig. 2 shows a sectional view of a separator according to the invention,
- Fig. 3 shows the separator from figure 2 with additional rod-cage separators,
- Fig. 4 shows an embodiment of the separator according to the invention with a bank assembly,
- Fig. 5 shows a view from above of the separator according to Figure 2 with a cutting line drawn in,
- Fig. 6 shows a view from above of a separator according to the invention in a cross assembly,
- Fig. 7 shows a view from above of a separator according to the invention in a star assembly.

Figure 1 shows a vertical section through V separator 1 for separating granular material into at least one fraction of fine material and one fraction of coarse material from the PRIOR ART. This known V separator has a housing G in which a stepped cascade 8 permeable to separating gas is installed at an angle α deviating from the horizontal. In the drawing, to the right of the stepped cascade 8, there is an inflow duct 3 through which separating gas can flow into the housing G. Granular material to be separated falls onto the stepped cascade via a material inlet opening 2 for sifting material located above the separating zone SZ on the upper side of the housing G, where it trickles over the cascades and is flowed through by the inflowing separating gas from the right. The separating gas flowing into the V separator 1, namely air or hot exhaust gas, leaves the housing G via at least one outflow duct 5a, 5b, wherein the separating gas is charged with fine material, which is itself suspended in the separating gas. Separating slats 7, which are located opposite the stepped cascade 8 and separated by a separating zone SZ and disposed one above the other in the manner of Venetian blinds, direct the

separating flow in a vertical direction, where the material to be separated is separated into fractions of different grain sizes by gravity and the upflowing separating gas. The fine material suspended in the separating gas leaves the V separator 1 via the outflow ducts 5a and 5b. The coarse material falling downwards in the separating gas in the separating zone, on the other hand, falls into a material discharge opening 4 for the coarse material below the separating zone SZ on the lower side of the housing G to the outside, below the V separator. In order to scale the performance of separators, it is provided in the prior art to operate several separators and to supply the inflow ducts 3 of the various V separators with separating gas via a Y line 6 as a supply line, generally via a line with branches. This can lead to problems in maintaining an optimum operating state for each individual V separator if the separating gas pressure in the supply line differs even slightly at the individual V separators.

Figure 2 shows a sectional drawing along the cutting line shown in Figure 5 through a separator 100 according to the invention. According to the present invention, it is provided that at least two individual separators 100', 100" opposite one another are pneumatically connected to one another via a common pressure equalization chamber DAK, via which the separating gas flows into the respective inflow ducts 103', 103" of the at least two individual separators 100', 100", in the exemplary variant shown here, two individual separators 100' and 100", which are both part of the separator 100, are connected to one another via the pressure equalization chamber DAK, wherein the entire opening of the mesh wall 109, 109' present in the inflow ducts is wide enough to form a pressure equalization chamber. As a result, the free cross-section of the inflow ducts 103, 103' is not reduced by a pipe cross-section of a supply line. This has the advantage that no pressure fluctuations can build up and thus the individual separators 100' and 100" can be operated with a synchronous operating state. The pressure equalization chamber between the at least two individual separators is bounded by a roof D, a base B and a rear face R (Figure 4) as well as a front wall not shown here by the cutting line. An inflow duct 103 leads into the pressure equalization chamber, which is disposed as centrally as possible between the individual separators 100' and 100". The individual separators 100' and 100" are similar in design to the V separator of the prior art. These separators separate coarse material into one fraction of fine material and one fraction of coarse material. Both individual separators 100', 100" have a contiguous housing G into which a stepped cascade 108, 108' permeable to separating gas is installed at an angle α deviating from the horizontal. In the drawing between the two stepped cascades 108 and 108' there is an inflow duct 103 through which

separating gas can flow into the pressure equalization chamber DAK. Granular material to be separated falls via a material inlet opening 102, 102" for material to be sifted located above the respective separating zone SZ, SZ' of an individual separator 100', 102" on the upper side of the housing G onto the respective stepped cascade 108, 108', where it trickles over the cascades and is flowed through by the centrally inflowing separating gas. The separating gas flowing into the respective individual separator, namely air or hot exhaust gas, leaves the housing G via at least one outflow duct 105a, 105a', 105b and 105b', wherein the separating gas is charged with fine material which is itself suspended in the separating gas. Separating slats 107, 107' opposite the respective stepped cascade 108, 108' and separated by a separating zone SZ, SZ' and disposed one above the other in the manner of Venetian blinds direct the separating flow in a vertical direction, where the material is separated into fractions of different grain sizes by gravity and the upflowing separating gas. The fine material suspended in the separating gas leaves the respective individual separator 100', 100" via the outflow ducts 105a, 105a' and 105b, 105b'. The coarse material falling downwards in the separating gas in the separating zone, on the other hand, falls into a material discharge opening 104, 104' for the coarse material located below the separating zone SZ, SZ' on the lower side of the housing G to the outside, below the respective individual separator 100', 100".

Figure 3 shows an extension of the separator 100, in which a rod-cage separator 200, 200' is placed on each of the outflow ducts 105a, 105a' in order to further separate the fine material suspended in the separating gas. The proportions shown here between individual separators 100', 100" and rod-cage separators 200, 200' are not to scale. Essentially, the interconnection is shown here. It is possible that each outflow duct 105a, 105a' has its own rod-cage separator assigned to it. Alternatively, it is also possible for the outflow ducts 105a and 105a' to connect and direct the separating gas with fine material suspended therein into a common rod-cage separator.

A particular embodiment of the separator according to the invention is shown in **Figure 4** as separator 300. In this, three rows of pairs of individual separators are disposed in a bank-like arrangement in such a way that a central pressure equalization chamber DAK supplies the six individual separators with separating gas. The pressure equalization chamber DAK is delimited by a base B, a roof D, a rear wall R and a front wall not shown here. The coarse material falling out of the individual separators is transported away via conveyor belts 150 and 150 in order to return it to a separator or grinding circuit.

Figure 5 shows a top view of the separator from Figure 2. In this embodiment of the invention, the pressure equalization chamber DAK has a comparatively large volume compared to the volume of the individual separators, which reduces pressure fluctuations between the two individual separators. The large-volume pressure equalization chamber DAK also makes it possible to pneumatically couple more than two individual separators 100', 100" to one another via a common pressure equalization chamber DAK. In **Figure 6**, two pairs of individual separators 100', 100", 100"', 100'''' are pneumatically coupled together via a cross assembly via a common pressure equalization chamber to form a separator 400. This variant can be further increased so that, as shown in **Figure 7**, as many as 8 individual separators are coupled together in a star-shaped assembly to form a separator 500.

LIST OF REFERENCE NUMERALS

1	V separators	103"	Inflow duct
2	Material inlet opening	104	Material discharge opening
3	Inflow duct	104'	Material discharge opening
4	Discharge opening	104"	Material discharge opening
5a	Outflow duct	105a	Outflow duct
5b	Outflow duct	105a'	Outflow duct
6	Y line	105a"	Outflow duct
7	Separating slat	105a'''	Outflow duct
8	Stepped cascade	105b	Outflow duct
9	Mesh wall	105b'	Outflow duct
		105b''	Outflow duct
100	Separator	105b'''	Outflow duct
100'	Individual separator	107	Separating slats
100''	Individual separator	107'	Separating slats
102	Material inlet opening	108	Stepped cascade
102'	Material inlet opening	108'	Stepped cascade
102''	Material inlet opening	109	Mesh wall
102'''	Material inlet opening	109'	Mesh wall
103	Inflow duct	150	Conveyor belt
103'	Inflow duct	150'	Conveyor belt
200	Rod-cage separator	D	Roof
200'	Rod-cage separator	R	Rear wall
300	Separator	G	Housing
400	Separator	SZ	Separating zone
500	Separator	DAK	Pressure equalization chamber
B	Base		

PNEUMATISK FORBUNDET FLERLAGS-SIGTE

PATENTKRAV

1. Sigte (100, 300, 400, 500) til sigtning af kornet sigtemateriale i mindst en fraktion af fint materiale og i en fraktion af groft materiale, som har
 - et kabinet (G), i hvilket en trappekaskade (108, 108'), som er gennemtrængelig for synsgas, med en vinkel som afviger fra vandret (α) er indbygget,
 - mindst en indløbskanal (103) i kabinettet (G) til synsgas, og
 - mindst en udløbskanal (105a, 105a', 105b, 105b') fra kabinettet (G) til synsgas belastet med fint materiale,hvorved der over for trappekaskaden (108, 108') og gennem en sigtezone (SZ) er anbragt sigterender (107, 107') som er anbragt med skodde-agtig adskillelse, og hvorved der over sigtezone (SZ) på oversiden af kabinettet (G) er anbragt en tilførselsåbning (102, 102', 102'', 102''') til sigtemateriale og under sigtezone (SZ) på undersiden af kabinettet (G) er anbragt en udtræksåbning (104, 104') til sigtemateriale til det grove materiale, hvorved mindst to enkelte sigter (100', 100'', 100''', 100''''), der ligger over for hinanden er pneumatisk forbundet via et fælles trykludligningskammer (DAK), via hvilket synsgassen strømmer ind i de pågældende indløbskanaler (103', 103'') på de mindst to enkelte sigter (100', 100'', 100''', 100''''), kendetegnet ved at trykludligningskammeret (DAK) begrænses af et tag (D), en bund (B) og en bagflade (R) samt en forreste væg og hvorved trykludligningskammeret (DAK) er forbundet med indløbskanalerne (103) på de mindst to enkelte sigter (100', 100'', 100''', 100''''), via en væg med en perforeret plade eller gittervæg (109, 109').
2. Sigte ifølge krav 1, kendetegnet ved, at synsgassens modstand, der beskriver trykfaldet på synsgassen fra indløbskanalen (103, 103') til udløbskanalen (105a, 105a', 105a'', 105a''', 105b, 105b', 105b'', 105b''') i en enkelt sigte (100', 100'', 100''', 100''') ved en fastsat

synsgasstrøm, er cirka lige stor i de mindst to enkelte sigter (100', 100", 100"', 100''').

3. Sigte ifølge krav 1, kendetegnet ved, at de mindst to enkelte sigter (100', 100", 100"', 100''') er opbygget spejlvendt og er opbygget identisk ud over den spejlvendte opbygning.
4. Sigte ifølge et af kravene 1 til 3, kendetegnet ved, at trykudligningskammeret (DAK) har sin egen udtræksåbning (104") til sigtemateriale.
5. Sigte ifølge et af kravene 1 til 4, kendetegnet ved, at de mindst to enkelte sigter (100', 100", 100"', 100''') ud over en udløbskanal (105a, 105a') til synsgas med fint materiale har en yderligere udløbskanal (105b, 105b') til en fraktion af mellemmateriale.
6. Sigte ifølge et af kravene 1 til 5, kendetegnet ved, at synsgassen, der strømmer via trykudligningskammeret (DAK) ind i indløbskanalerne (103, 103') på de mindst to enkelte sigter (100', 100", 100"', 100'''), strømmer præcist midt mellem de mindst to enkelte sigter (100', 100", 100"', 100''') ind i trykudligningskammeret (DAK).
7. Sigte ifølge et af kravene 1 til 6, kendetegnet ved, at par af enkelte sigter (100', 100", 100"', 100'''), der ligger over for hinanden er opbygget som sigte-batteri, som ligger parvis bag hinanden og er forbundet til hinanden med det samme trykudligningskammer (DAK).
8. Sigte ifølge et af kravene 1 til 6, kendetegnet ved, at

par af sigter, der ligger over for hinanden, er anbragt i en cirkel, hvorved de forskellige par af enkelte sigter (100', 100", 100''', 100''''') er anbragt i en kryds- eller stjerneformet geometri.

9. Sigte ifølge et af kravene 1 til 8, kendetegnet ved, at udløbskanalerne (105a, 105a') på det mindst to enkelte sigter (100', 100", 100''', 100''''') til synsgas belastet med fint materiale, hver især er forbundet med en sigte med stavkurv (200) eller med en fælles sigte med stavkurv.

Fig. 1

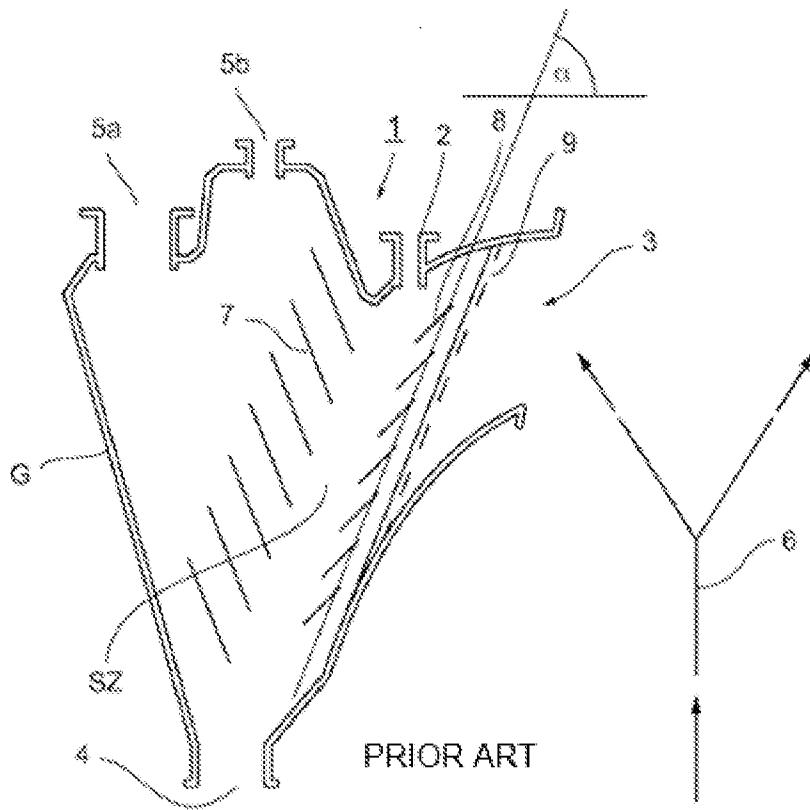
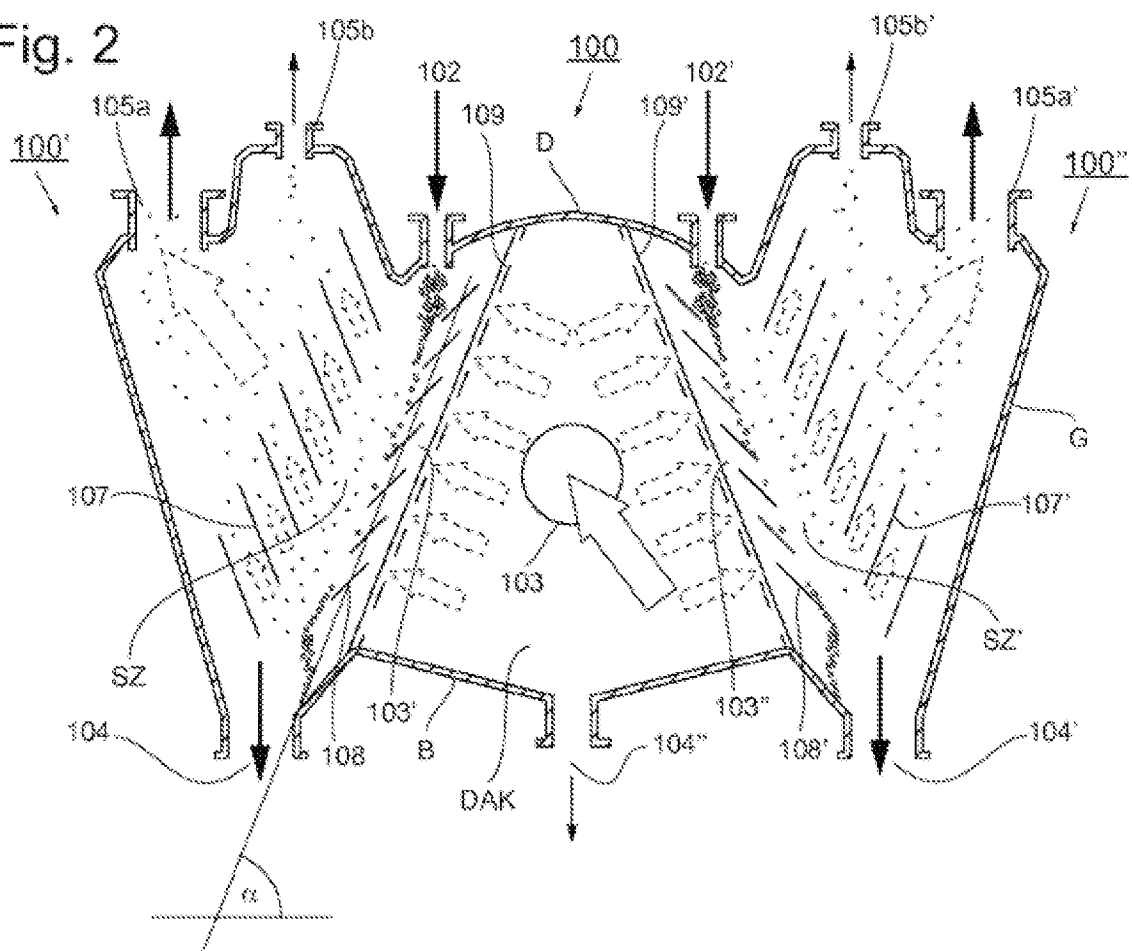


Fig. 2



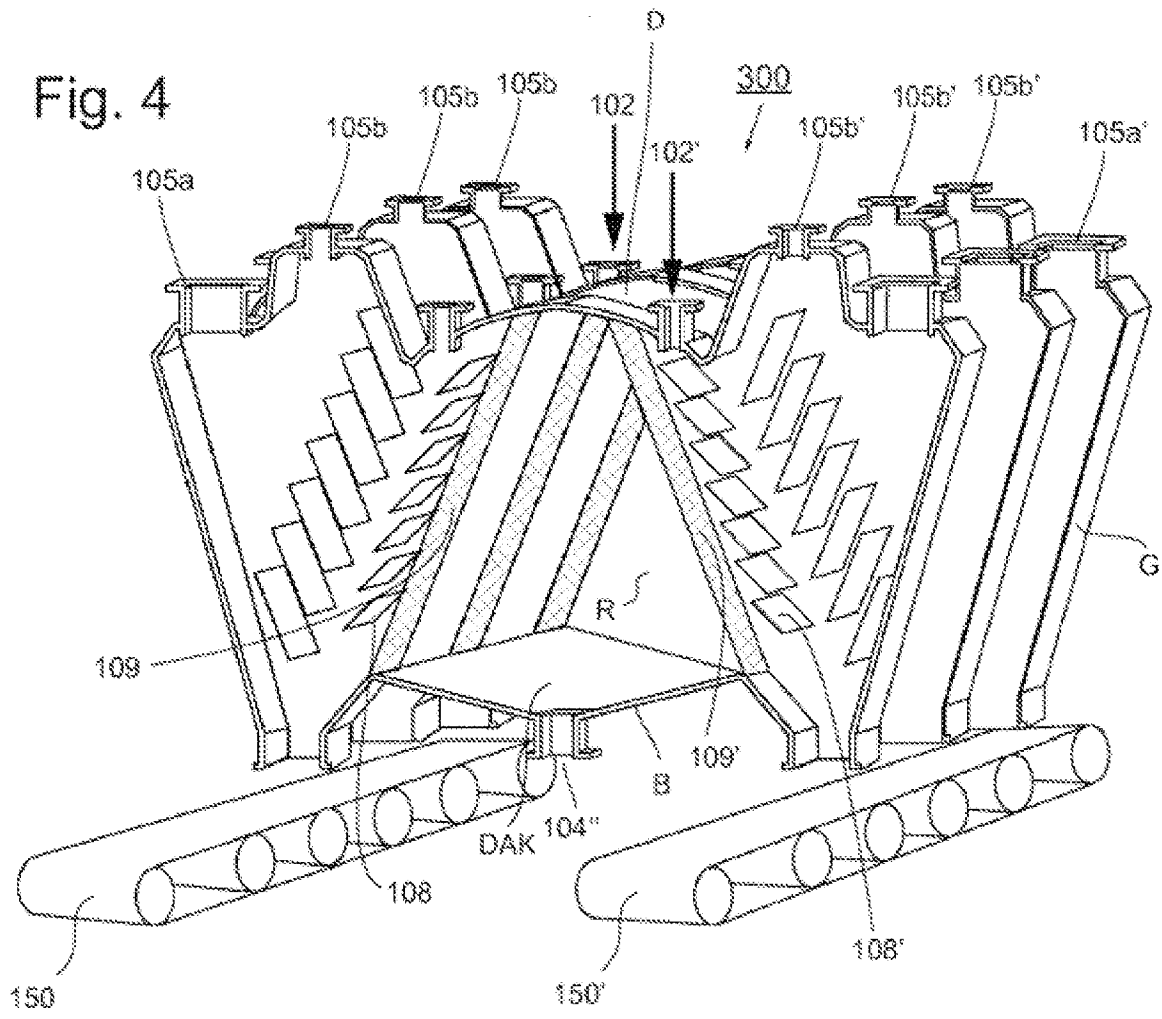


Fig. 5

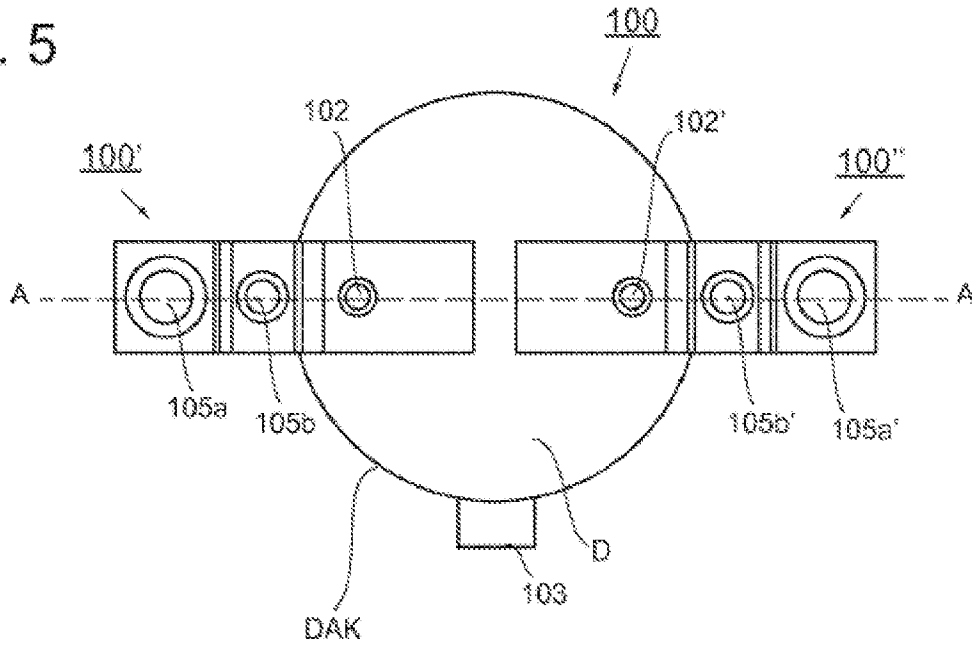


Fig. 6

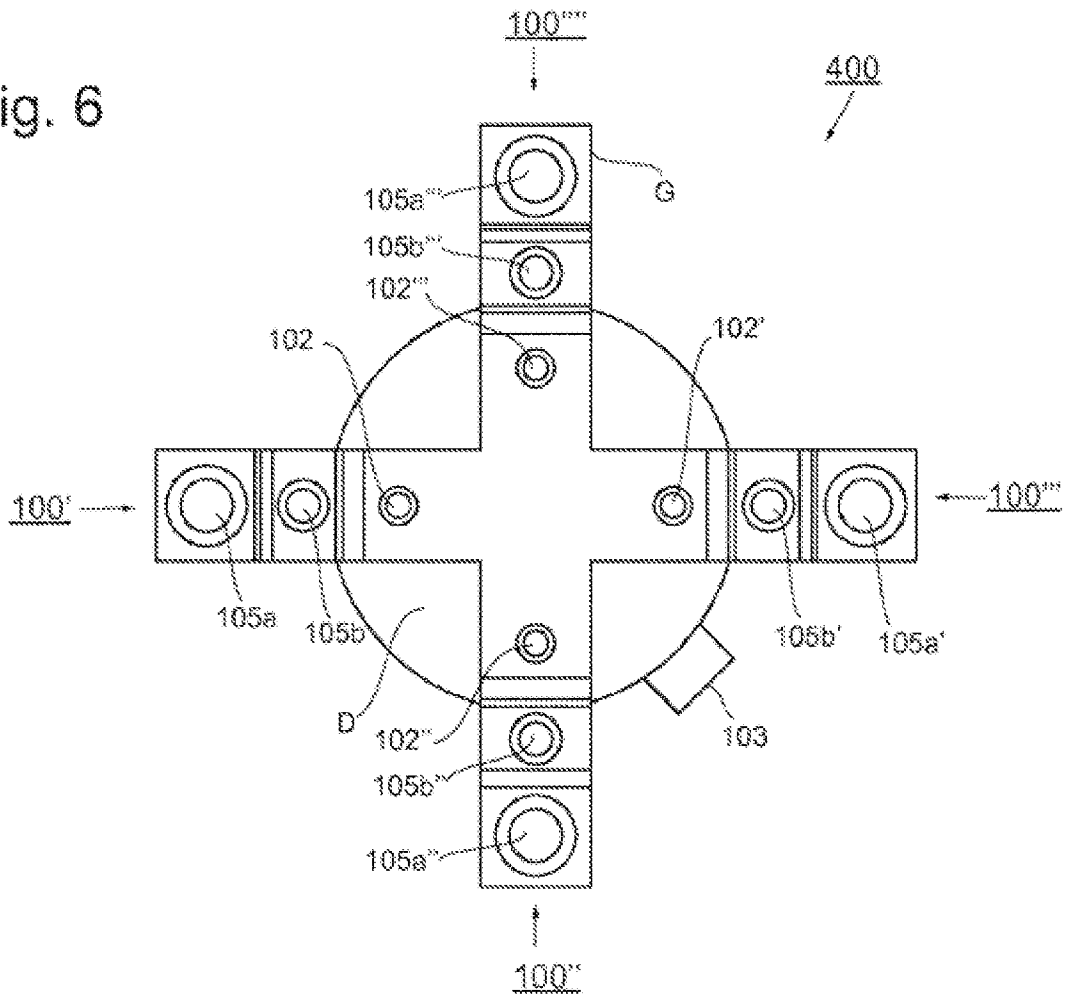


Fig. 7

