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(54) **Separation unit for fibrous materials and pneumatic bedding material conveying plant comprising such a unit**

(57) A separation unit of fibrous materials, in particular of fibrous materials contained in bedding for animals, to be associated to a bedding-air separation module of a pneumatic bedding conveying plant, comprising:
- a first interface (11a) associable to a first outlet duct (100, 110) of the bedding-air separation module;
- a second interface (12a) associable to a second suction duct (150, 160) of the bedding-air separation module;
- filtering means (9, 10) being interposed between said first interface (11a) and said second interface (12a) and being configured to trap fibrous materials contained in said bedding material. Furthermore, a pneumatic bedding conveying plant comprising a separation unit (1) according to the present invention is described.

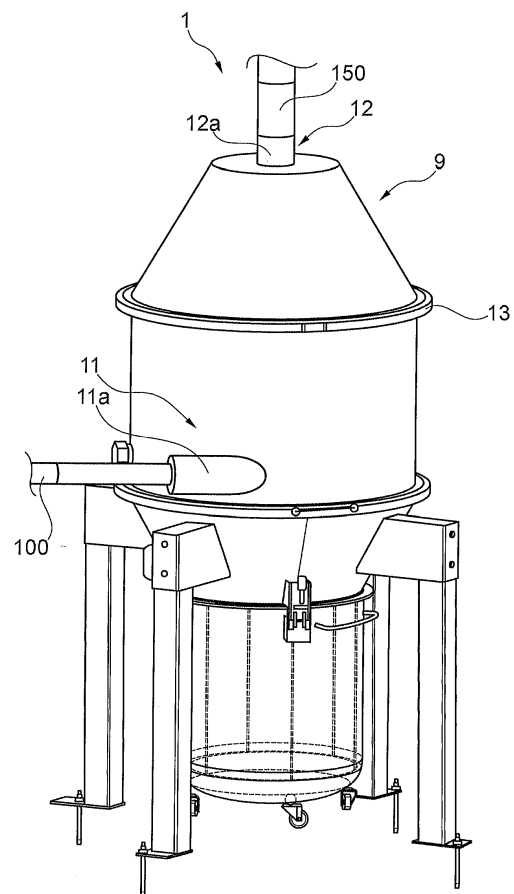


Fig. 1

Description

PRIOR ART

[0001] As known, in the sector of animal facilities for pharmaceutical research, the animals are kept in specific containment trays. Such trays constitute, in practice, the environment in which such animals live, and must therefore be as comfortable as possible, in addition to complying with hygienic requirements. Typically, each tray comprises: a bowl, adapted to contain the animals; a lid for closing the bowl and a trough for housing feed and/or other various accessories.

[0002] A bedding is added on the bottom of the bowl to at least partially absorb the animals' excrements.

[0003] In general, such a bedding comprises wood shavings or other similar material capable of absorbing and retaining humidity.

[0004] The animals kept in the bowls therefore rest on the bedding, and move and perform their normal vital activities on it. In order to improve animal comfort, the bedding has been modified by adding soft consistency fibrous material to the wood shavings, which is known in the sector as "ENRICHMENT".

[0005] This "ENRICHMENT" may consist of: cotton balls, cellulose strips, vegetable or artificial hay, wood shavings and filaments of various nature, vegetable leaves and, in general, agglomerates which create well-being conditions for the animal. Besides adding "ENRICHMENTS", the recent market trend is to suggest different types of bedding and bedding obtained from cellulose, again with the objective of improving excrement absorption and creating a more comfortable environment. For all the described bedding solutions, a sheet of blotting paper on which the bedding is deposited, in turn, may be provided on the bottom of the bowl.

[0006] As mentioned, the bedding allows to collect, and in part absorb, the animals' excrements, and thus must be periodically changed. Lack of care or an insufficient changing frequency may cause diseases in the animals, altering their vital parameters, and consequently distorting the measurements being monitored of interest for the research which is being carried out.

[0007] The changing of the soiled bedding contained in a tray requires to empty the tray into an unloading hopper, to shred the bedding to reduce its size and to suck it into specific collection containers to be finally disposed of as waste. The bedding is conveyed from the unloading hopper to the collection container by means of a pneumatic conveying plant, and therefore a vacuum pump connected to a specific sucking duct is provided.

[0008] The collection container integrates a bedding-air separation module for separating the bedding material from the suction air by means of the vacuum pump. Additionally, a main filtering assembly is provided between the separation module and the sucking duct to prevent portions of bedding material which were not separated during the previous step from coming into contact with

the pump and being scattered into the environment. Furthermore, to reduce the scattering of bedding as much as possible, a HEPA filter may be provided after the filtering unit to abate possible residual dust preventing it from being scattered into the external environment as much as possible.

[0009] As known in the prior art, a first separation module requires the soiled bedding to be sucked and conveyed into a collection container to be later disposed of as waste.

[0010] Such a container is, in general, a closed volume made by means of metal sheet walls, two ducts being provided in one of these walls: the first duct is connected to the soiled bedding unloading hopper, the second duct is connected to the vacuum pump to suck up the soiled bedding within the containment. A main filtering assembly is provided for the aforesaid reasons between the second duct and the vacuum pump, thus externally to the container.

[0011] Alternatively, such plants include the use of a cyclone for separating the bedding. The sucking of the bedding by means of vacuum pump and the separation of the bedding material contained in the sucked air by means of the cyclone is thus provided.

[0012] Such solutions are certainly effective for bedding constituted by wood shavings only or other similar material, in which case the specific weight of such material allows it to fall onto the bottom of the collection container or of the cylindrical collection portion of the cyclone and to be effectively separated from the sucked air, the separation of the materials sucked by the vacuum into the cyclones or into the containers being based on the loss of speed of the material, which by effect of its specific weight and gravity tends to fall downwards and accumulate on the bottom of the collection containers.

[0013] Instead, such separation modules may be ineffective for bedding comprising fibrous materials. Indeed, the added fibrous materials have a very low specific weight, and therefore they tend not to fall onto the bottom of the collection container or of the cylindrical collection portion of the cyclone but to follow the sucked air path and end up in the main filtering assembly, and possibly on the HEPA filter. Such a solution thus leads to a rapid clogging up of the filtering assembly of the traditional type.

[0014] Furthermore, the new materials used for the bedding are, as mentioned, materials having fibrous nature, which tend to bind and compact on the surface of the filtering cartridges, making the later cleaning of the main filter of known type impossible. In order to remove such materials, the usual cleaning method, which consists in blowing a jet of pressurized air onto the filtering assembly from the side opposite to the one on which the dust accumulates to clear the assembly itself, is not sufficient; instead, a more detailed cleaning is needed, which requires to stop the entire plant, with obvious difficulties and lack of productivity that this implies.

SUMMARY

[0015] Consequently, the prior art described in part does not allow to have a pneumatic bedding conveying plant which guarantees good performance and reliability of use without frequent maintenance operations.

[0016] The ever increasing attention to the conditions in which animals are kept in animal facilities leads to an increasingly common use of bedding with the addition of fibrous material.

[0017] In combination with this, above all in laboratories with numerous trays, the amount of soiled bedding which must be eliminated every day is rather high: it is such to clog up the filtering assembly in a short time and a frequent, detailed maintenance of the same is necessary. As mentioned, this operation requires to stop the plant, and this greatly limits plant efficiency as a result of the consequently long downtimes.

[0018] It is the main object of the present invention to make a separation unit for fibrous materials to be applied to separation modules for pneumatic bedding conveying plants which allows to solve the problems illustrated above in simple and cost-effective manner.

[0019] In the scope of this first task, it is a first specific object to make a separation unit which allows to trap the fibrous material preventing it from being conveyed to the filtering assembly.

[0020] A second specific object is to improve the efficiency of the filtering assembly of the traditional type and to reduce the complexity of the cleaning operations needed to restore its functionality.

[0021] A third specific object is to provide a separation unit which may be installed on existing bedding conveying plants and be adapted to the respective different separation modules with which said plants are equipped.

[0022] It is thus the object of the present invention to supply a new, original separation unit intended to be mounted on a bedding conveying plant between a first and second duct present on the separation module of the aforesaid plant to trap possibly contained fibrous materials at the outlet of the separation module.

[0023] These and other objects and advantages, which will be more apparent from the following detailed description of a preferred embodiment of the present invention, are reached by means of a separation device for fibrous materials according to claim 1.

LIST OF FIGURES

[0024] The technical features of the present invention and its advantages will be apparent from the following description, which must be considered in combination with the accompanying drawings, in which:

figure 1 is a perspective view of a first embodiment of a separation unit for fibrous materials according to the present invention;

figure 2 is a further perspective view of the separation

unit for fibrous materials in figure 1, in which some components of the separation device are viewable in particular;

figure 3 shows a top view of the separation device according to the present invention;

figure 4 is a perspective view of the separation unit in figure 1 during a step of maintenance;

figure 5 shows a detail of a filtering assembly of the traditional type on which a separation unit according to a second embodiment of the present invention is mounted;

figure 6 shows a detail of figure 5;

figure 7 shows a detail in side view of figure 6.

DETAILED DESCRIPTION

[0025] The following description and the respective drawings are provided only by way of example of the present invention which may be implemented according to other, different embodiments; furthermore, it must be considered that such figures are diagrammatic and simplified.

[0026] The object of the present invention is designed to be installed in pneumatic bedding conveying plants, for example used in animal facilities.

[0027] Such plants convey the bedding by exploiting air, e.g. conveying it in specific ducts by means of a vacuum pump. These plants are thus provided with bedding-air separation modules for separating the bedding from the air used for conveying. The figures 1 to the 5, described in detail below, refer to a first embodiment of a unit 1 according to the present invention. In particular, such a unit is designed to be installed on bedding conveying plants provided with cyclone bedding-air separation module.

[0028] Figures 6 to the 8, described in detail below, refer to a second different embodiment of a unit 1 according to the present invention. Such a unit is designed to be installed on bedding conveying plants provided with container bedding-air separation module.

[0029] Despite the different application destinations, the different embodiments remain within the same inventive idea, and thus provide a single technical teaching.

[0030] Figure 1 shows the first embodiment of a separation unit of fibrous materials, in particular fibrous materials contained in bedding for animals, intended to be mounted on a bedding-air separation module of a pneumatic conveying plant of the aforesaid bedding and comprising:

- a first interface **11** applied at a first duct **100** of the bedding-air separation module (of the cyclone type, in this case);
- a second interface **12** applied at a second duct **150** of the bedding-air separation module;
- filtering means **9** interposed between said first interface **11** and said second interface **12**, configured to trap fibrous materials contained in the material bed-

ding. As mentioned, the unit **1** in the figure is configured to be applied to a cyclone bedding-air separation module (not shown in figures). In particular, it is set in series, i.e. connected in succession, to the latter. For this purpose, the filtering means **9** of the unit **1** comprise a separation body **13** provided with a fluid inlet **11a** and a fluid outlet **12a** (which are the first interface **11** and the second interface **12**). The inlet **11a** connects to the outlet duct **100** of the cyclone separation module, while the outlet **12a** connects to the duct **150**, which joins the cyclone separation module to the sucking duct of said pneumatic conveying plant. It is worth noting that, for application solutions of cyclone separation modules, the first duct and the second duct typically coincide; indeed, the sucking mouth of the conveying plant (connected to the vacuum pump) is connected directly to the cyclone module outlet.

[0031] Thus, the separation unit according to this first embodiment connects to the outlet **100** of the cyclone module, by means of the inlet **11a** and is connected, in turn, by means of the outlet **12a**, to the sucking mouth **150** of the conveying plant.

[0032] As mentioned, the separation body **13** is set in series with the cyclone module, and thus receives in input an air flow already separated from larger size bedding portions but containing possible fibrous material to be trapped. For this purpose, the body **13** is also designed to exploit the principle underlying separation by cyclone, by integrating specific means capable of trapping the fibrous materials conveyed by the corresponding air flow from the cyclone module outlet.

[0033] Figure 2 shows a preferred embodiment of a separation body **13**. It comprises, in succession:

- an upper portion **14** comprising the aforesaid outlet **12a** which may be connected, in use, to the sucking duct **150** of the pneumatic conveying plant;
- a central portion **15** connected to the upper portion **14** and comprising the fluid inlet **11a** which may be connected, in use, to the outlet **100** of the cyclone bedding-air separation module;
- a filtering grid **18**, applied within either the upper portion **14** or the central portion **15**;
- a lower portion **16** connected to the central portion and adapted to collect the fibrous material trapped by the filtering grid **18**.

[0034] Preferably, the upper portion **14** is truncated cone shaped, the cross section of which increases in direction of the central portion **15** to which it is connected on the bottom, and integrates the fluid outlet **12a** on the upper end.

[0035] The central portion **15** is preferably cylinder shaped, the diameter of which corresponds to the diameter of the base of the truncated cone of the upper portion **14**. In particular, the central portion **15** connects to the

upper portion **14** at the upper junction area **15a**.

[0036] The lower portion **16** is also truncated cone shaped and connects to the cylinder **15** at the lower junction area **15b** of the latter (opposite with respect to the upper junction area **15a**). The cross section of the truncated cone which composes the lower portion **16** reduces in direction opposite to the upper part **16**, i.e. decreases from the lower junction area **15b** downwards.

[0037] As shown again in figure 2, a collection vessel **17**, in which the fibrous material trapped by the grid **18** is deposited, is connected to the lower portion **16**. The vessel **17** is reversibly connected to the lower portion **16** so as to be periodically emptied. Furthermore, it is worth noting that is fixed in sealed manner to the aforesaid lower portion **16** to avoid air leakage and to ensure good sucking efficiency as a consequence. For this purpose, sealing means may be provided at the junction area **17a**: for example a rubber lip on the edge of the vessel **17** to obtain fluid tightness, and hinges for fastening vessel **17** and lower portion **16**. The aforesaid conformation of the body **13** thus allows to receive the air flow from the separation cyclone by means of the inlet **11a** following the suction of the vacuum pump connected to the body **13** itself by means of the outlet **12a**. In particular, the inlet **11a** is integrated in a tangential portion of the outer surface of the central portion **15**. Thus, the input air flow containing the fibrous material travels upwards along a stretch (for example, traveling along the inner wall of the central containment portion **15**), i.e. towards the upper junction area **15a**, goes beyond the grid **18** and exits through the outlet **12a**. The fibrous material is captured by the grid **18** in this manner.

[0038] Figure 3 shows an embodiment of the grid **18** according to the present invention. To effectively capture the fibrous material, such a grid has an appropriately shaped weave, preferably made of perforated metallic mesh or other filtering material of appropriate shape, to trap the filament-like components of the material and let through the air flow, which is separated from the material itself in this manner. Preferably, the grid **18** is applied within the separation body **13** at the upper junction area **15a**, thus has a cross section substantially coinciding with the diameter of the central portion **15**, so as to avoid the undesired passages of air which was not appropriately filtered.

[0039] Furthermore, the grid **18** may comprise sensor means (not shown in the figures) adapted to detect the level of clogging. For example, a probe may be provided which checks the differential pressure level upstream and downstream of the grid **18** and sends an indication when such a level drops underneath a given threshold, indicating an excessive clogging of the grid.

[0040] Additionally, cleaning means may be provided adapted to at least partially clear the fibrous material intercepted by the weave of the grid **18**. Such cleaning means (not shown in figures) may, for example, be vibrating means, suited to induce the detachment of the fibrous material from the grid **18** by shaking the grid itself.

Such cleaning means may, for example, be automatically actuated according to the measurements carried out by the aforesaid sensor means.

[0041] Figure 4 shows a unit according to the present invention in a step of maintenance. The collection vessel **17** is detached from the lower portion **16** to which it is fixed to eliminate the fibrous material it contains, collected therein following the performed filtering operations. Specific detection means may be provided with specific detection means to indicate critical filling levels, such to require the intervention by an operator, at the container **17**. Furthermore, the separation unit according to the present invention comprises a supporting structure **19** which allows to support it, and also preferably to fasten it to the floor of the room where it is installed.

[0042] Preferably, such a structure **19** comprises a plurality of vertical uprights which are fixed to the unit at a first end and to the floor at a second end. Furthermore, the vessel **17** may comprise suitable means to facilitate handling, e.g. a runner or a plurality of jointed wheels, to facilitate the emptying operations, in which the vessel **17** must be detached and handled.

[0043] Figures from 5 to 7 show a second embodiment of a unit **1** according to the present invention intended to be mounted on container bedding-air separation modules. Such container modules comprise a containment chamber **200**, typically prism-shaped and made by means of metal sheet walls. Connection openings to connect to the ducts of the conveying plant are obtained in one of these walls.

[0044] Typically, two openings are present to connect to the bedding emptying duct (the latter is thus connected to a user, such as an unloading hopper) and to the pneumatic conveying duct connected to the vacuum pump for conveying, respectively. It is worth noting that in the aforesaid figures, one of the containment walls **200** is not shown in order to make the applied separation unit **1** clearly visible. A pressure condition is thus generated by means of the pneumatic conveying duct such as to aspirate the bedding which thus flow within the containment chamber **200**. Unit **1** according to the present invention thus comprises: a first interface **11** at the bedding emptying duct **110**, a second interface **12** applied at the sucking duct **160** and filtering means **10** interposed between the first interface **11a** and the second interface **12a**. The second interface **12a** allows to couple the filtering means **10** to the portion of containment chamber **200** on which the access opening to the sucking duct **160** is defined.

[0045] The first interface **11a** is arranged near the access opening to the emptying duct **110** and allows an optimal filtering of the fibrous material contained in the chamber **200**, as will be described in greater detail below.

[0046] Figure 6 shows a second embodiment of the unit **1** according to the present invention. The first interface comprises a partition plate **21** fixed to the wall of the chamber **200** near the emptying duct **110**, while the second interface comprises a supporting frame **22**, also fixed to the wall of the chamber **200**, in all cases differently

from the plate **21** near the sucking duct **160**.

[0047] The filtering means **10**, which in the embodiment shown in the figure comprise a filtering box **28**, are applied to the frame **22**. Preferably, the box **28** comprises an appropriately performed metal surface **29** supported by a plurality of ribs **30**. Figure 6 shows a preferred embodiment of the unit **1**, in which the box **28** is appropriately shaped to guarantee a good filtering of the fibrous material. In the chamber **200**, the heavier component of the bedding material **250** component (for example, the shaving portions) tends to deposit on the bottom **201**, while the fibrous material **260** tends to detach from the bedding **250** and follow the aspirated air flow, i.e. go towards the sucking duct **160**. For this purpose, the box **28** has an arched lower portion (i.e. the portion closest to the bottom **201**) to increase the filtering surface and consequently improve efficiency.

[0048] The plate **21** at the opening for the bedding duct **110** allows to convey the bedding **250** within the chamber **200** and let it fall onto the bottom **201** to then filter only the fibrous material **260** by means of the box **28**. Indeed, the maximum vacuum value produced in the vacuum pump can be identified precisely about the opening of the sucking duct **160**. Furthermore, the opening of the sucking duct **160** is located near the opening for the bedding duct **110**. Such a condition may make the heavier parts of the bedding components be aspirated directly by the duct **160** and deposited on the metal surface **29** of the box **28**, causing rapid clogging up. The presence of the plate **21** prevents this disadvantageous situation, and thus allows to filter only the fibrous material **260** in optimal manner **28**.

[0049] The dimensioning of the filtering box **28** follows this logic in order to optimize the fibrous material filtering. In particular, the weave according to which the holes in the metal surface **29** are arranged, their size and the height at which the box **28** is applied to the wall **201** of the chamber **200** are specifically chosen to optimize the filtering process of the fibrous material **260**. Similarly to the grid **18** of the first embodiment (of figures 1 to 4), the metal surface **29** may integrate sensor means adapted to detect the level of clogging and integrated cleaning means adapted to clear at least partially the fibrous material intercepted according to the methods described above.

Claims

1. Separation unit (1) of fibrous materials, in particular of fibrous materials contained in bedding for animals, to be associated to a bedding-air separation module of a pneumatic bedding conveying plant, comprising:
 - a first interface (11 a) associable to a first outlet duct (100, 110) of said bedding-air separation module;
 - a second interface (12a) associable to a sec-

- ond suction duct (150, 160) of said bedding-air separation module;
- filtering means (9, 10) being interposed between said first interface (11 a) and said second interface (12a) and being configured to trap fibrous materials contained in said bedding material.
2. Unit according to Claim 1, **characterized in that** said filtering means (9) comprise a separation body (13) provided with a fluid inlet (11 a) and with a fluid outlet (12a), suitable to be applied to a cyclone bedding-air separation module, wherein said fluid inlet (11 a) of said body is connected to an outlet (100) of said cyclone bedding-air separation module and said fluid outlet (12a) of said body is connected to the sucking duct (160) of said pneumatic conveying plant.
 3. Unit according to Claim 2, wherein said separation body (13) comprises, in succession:
 - an upper portion (14) comprising said fluid outlet (12a);
 - a central portion (15) connected to said upper portion (14) and comprising said fluid inlet (11 a);
 - a filtering grid (18) inserted in said upper portion (14) or in said central portion (15);
 - a lower portion (16) connected to said central portion (15) and adapted to collect said fibrous material trapped by said grid (18).
 4. Unit according to Claim 3, wherein:
 - said upper portion (14) is truncated cone shaped, comprises said fluid outlet (12a) on its upper end, and wherein the cross section of said truncated cone increases towards a lower end, opposed to said upper end, connected to said central portion (15);
 - said central portion (15) is cylinder shaped and comprises said fluid inlet (11 a) in a tangential portion of its outer surface;
 - said lower portion (16) is truncated cone shaped, and wherein the cross section decreases in a direction opposed to said upper portion (14).
 5. Unit according to any one of Claims 2-4, wherein said filtering grid (18) is fastened inside said body (13) in correspondence of a junction area (15a) between said upper portion (14) and said central portion (15).
 6. Unit according to Claim 1, wherein said filtering means (10) comprise a filtering box (28), said first interface (11 a) comprises a partition plate (21) close to said first duct (110), said second interface (12a) comprises a supporting frame (22) for said box (28) close to said second duct (160).
 7. Unit according to Claim 6, wherein said filtering box (28) comprises a suitably punched surface (29), said surface (29) being supported by a plurality of ribs (30).
 8. Unit according to Claim 6 or 7, wherein said filtering box (28) at least partially surrounds said second duct (160).
 9. Unit according to any one of the preceding Claims, wherein said filtering means (9, 10) comprise sensor means adapted to detect the relative level of clogging.
 10. Unit according to any one of the preceding Claims, wherein said filtering means (9, 10) comprise integral cleaning means adapted to release said fibrous material trapped by said filtering means.
 11. Pneumatic bedding conveying plant of the kind comprising a bedding-air separation module, **characterized in that** it comprises a separation unit of fibrous materials according to any one of the preceding Claims.

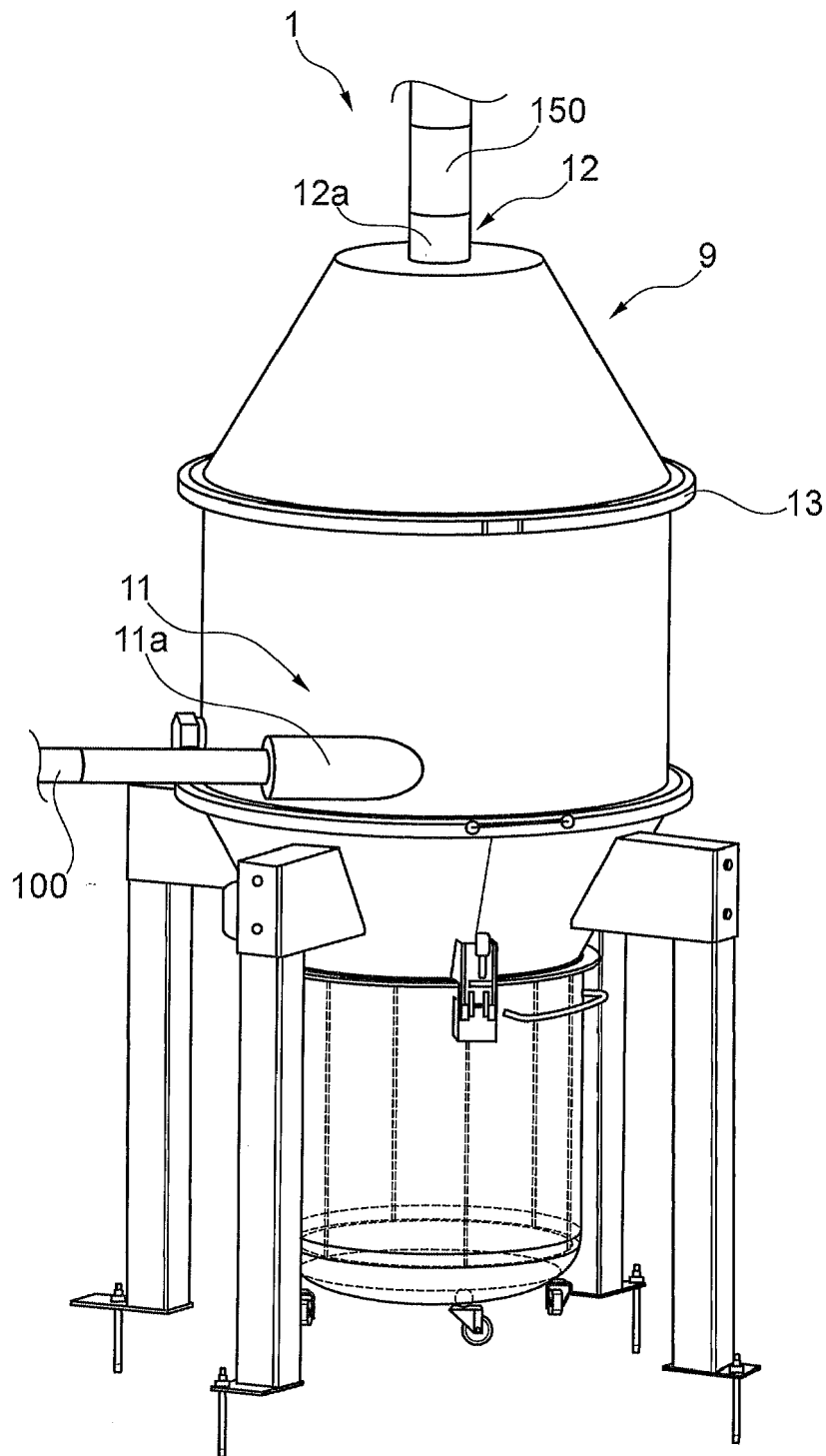


Fig. 1

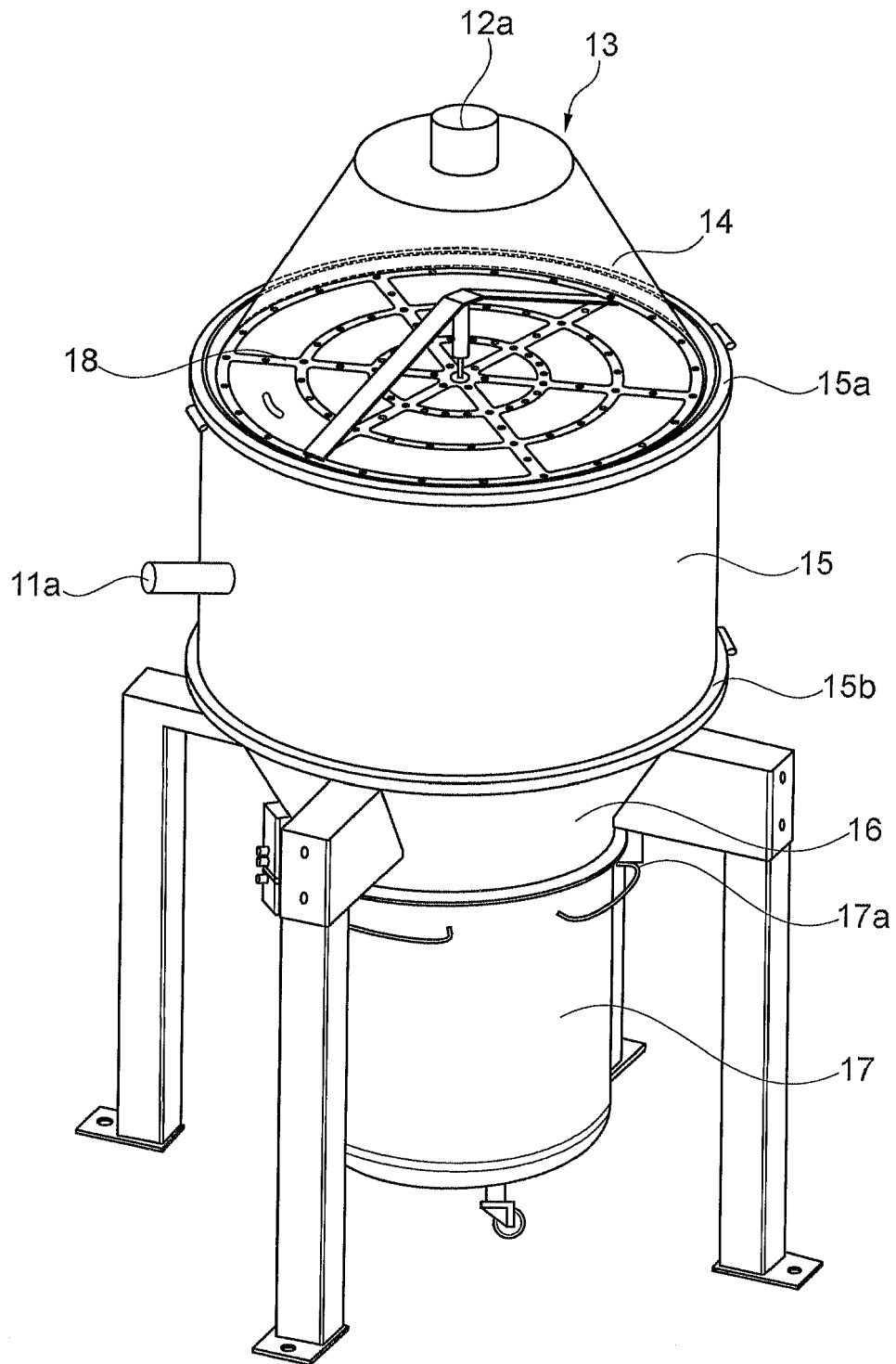


Fig. 2

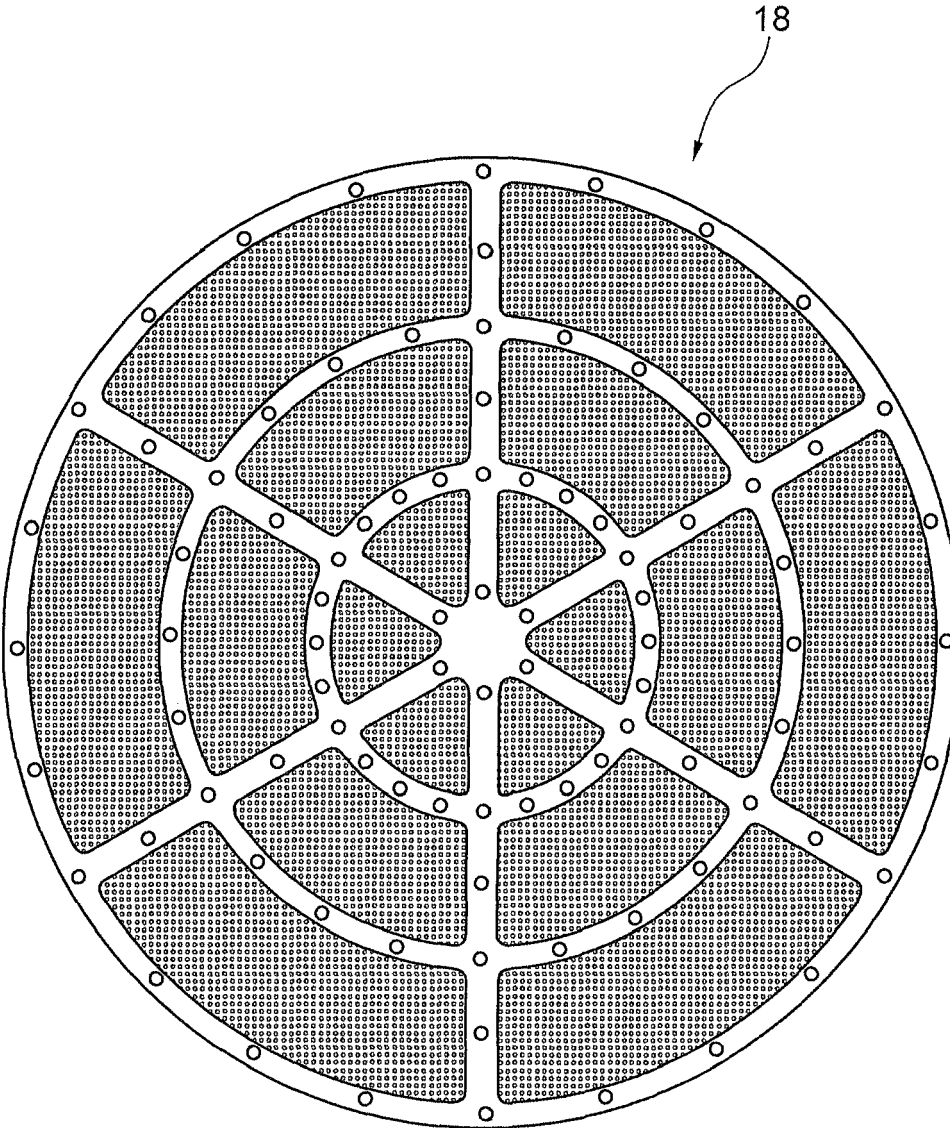


Fig. 3

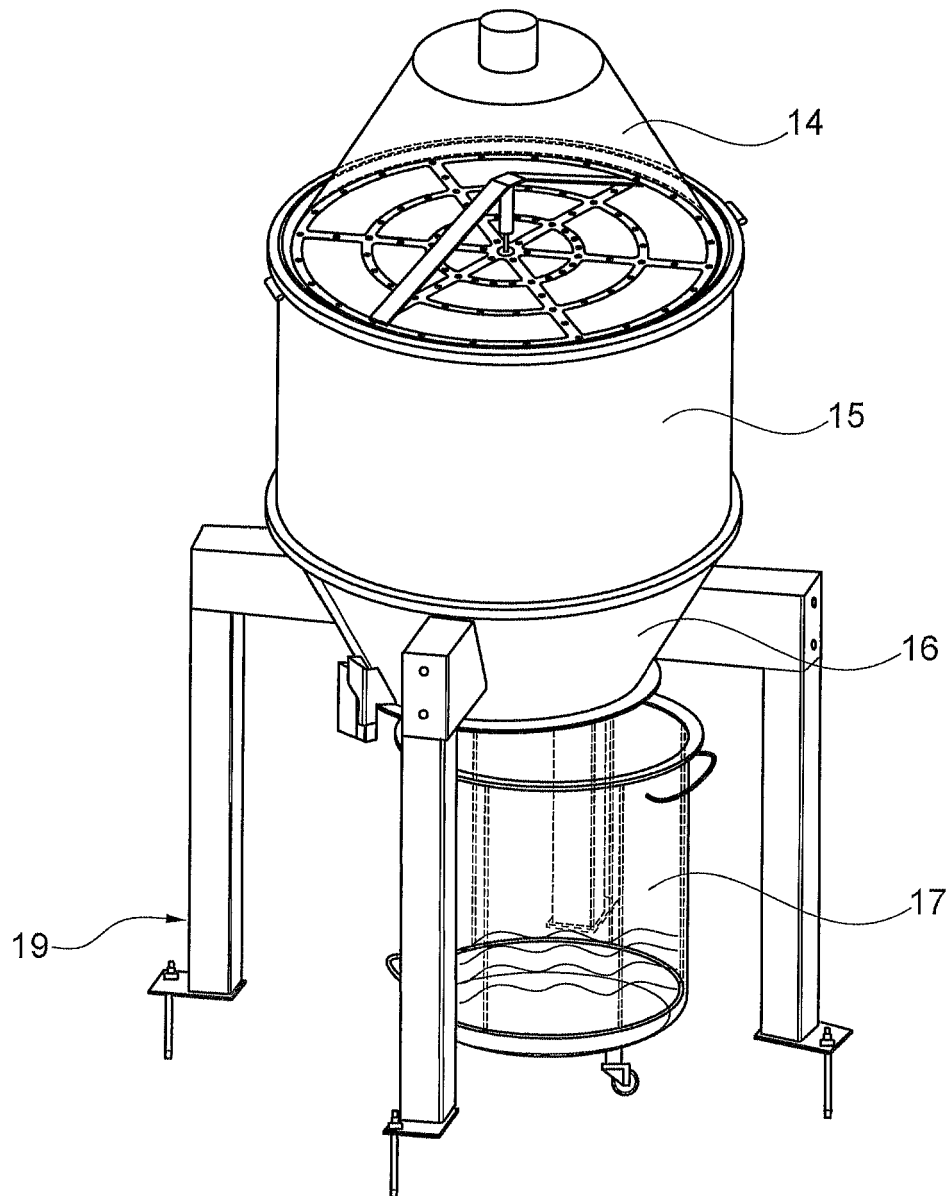


Fig. 4

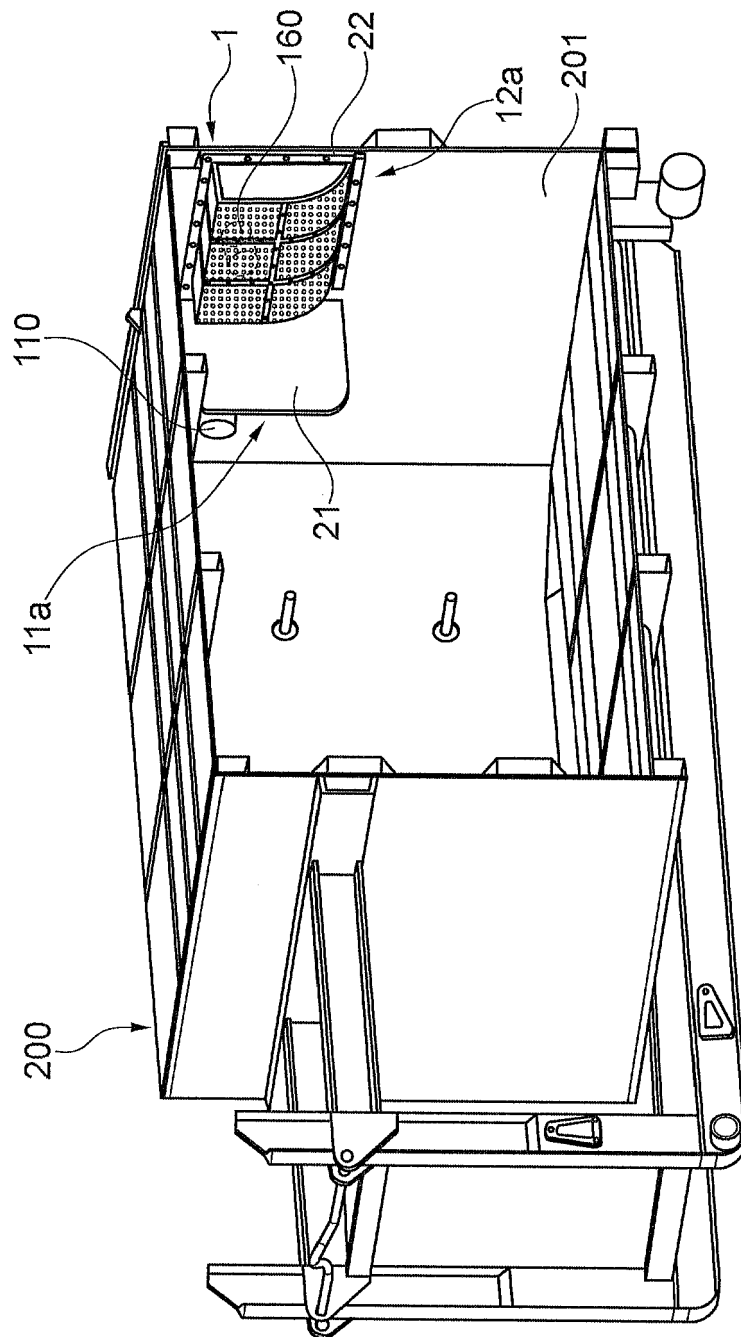


Fig. 5

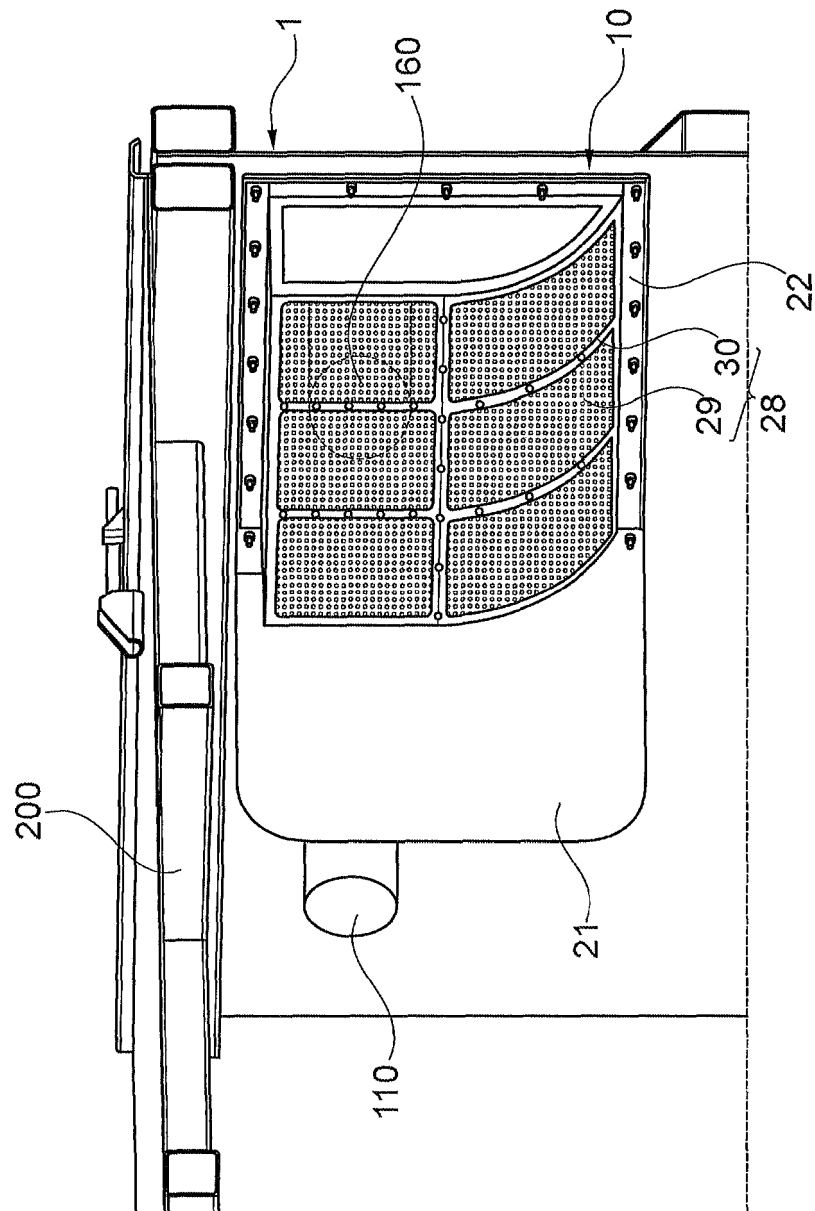


Fig. 6

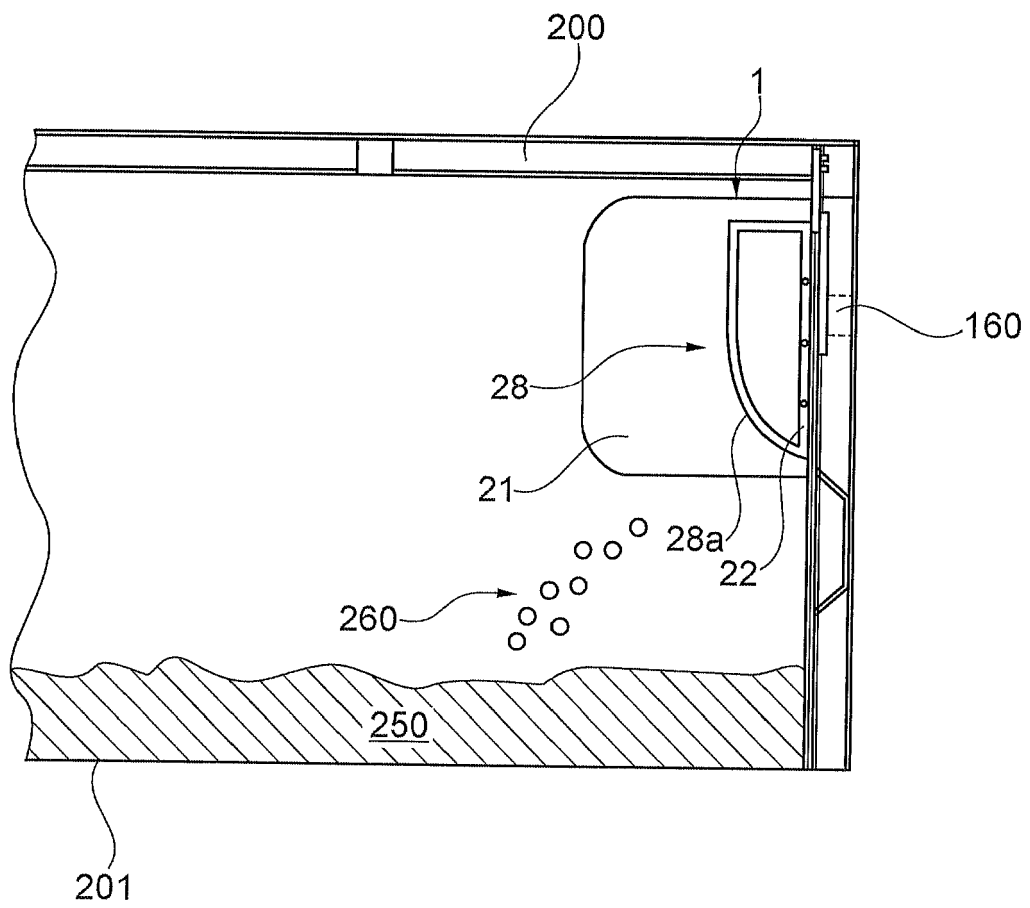


Fig. 7



EUROPEAN SEARCH REPORT

 Application Number
 EP 14 17 3639

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The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 15 September 2014	Examiner Appelt, Lothar
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**ANNEX TO THE EUROPEAN SEARCH REPORT
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EP 14 17 3639

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