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**Air cleaning equipment for pharmaceutical,
grocery and biotechnological industries**

The invention concerns an air cleaning machine for the pharmaceutical, grocery and biotechnological industries according to the generic definition in Requirement 1.

It is common knowledge in pharmaceutical, grocery and biotechnological industries, to only deal with relevant products in a clean room of class A standard, or also in clean rooms of classes B, C and D. In these clean rooms, the air to be cleaned is passed through filters, which are arranged in layers in the appropriate clean rooms. The clean air is then channelled along passages of air-exchangers which are guaranteed to be free of outside air devices, which happen to be found outside in the clean room area. These air cleaning machines are expensive to install and develop due to the tubing systems directing the through air and also necessitate a corresponding allowance of space for construction.

The invention shapes the basis of the detail needed to develop the appropriate type of air cleaning machine, in order that the through flow of air with only a simple construction and comprising only compact measurements can undertake the respective room cleaning in a reliable way.

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This detail is made possible in accordance with the air cleaning equipment appropriate for the invention with the recognized characteristics of the requirement 1.

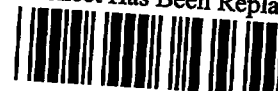
In the scope of the air cleaning equipment suitable for the invention, the ventilator, filter and heat exchanger are all to be placed in one piece of housing. As a result, costly channels needed to transport the flow of air e.g. the return journey of the exhaust air are no longer necessary. The air channeled through the filter comes directly into the clean room, while the exhaust air is transported directly out of the clean room via the heat exchanger. The air cleaning equipment relevant to the invention is consequently simple to develop and construct and does not require a lot of expenditure to be constructed. Due to the nature of the development of the invention, the modular structure of installed air cleaning equipment has only compact dimensions, in order that the cleaning equipment can also be constructed in sites where there is not a lot of room available.

Further characteristics of the invention are covered in the further requirements, the description and the drawings.

The invention is displayed in somewhat more detail on certain of the illustrations where detailed views are provided. It shows

- Fig 1 A perspective illustration of the air cleaning equipment relevant to the invention.
- Fig 2 The air cleaning equipment corresponding to Figure 1 in a plan view.
- Fig 3 A section along the length of line A-A in Figure 2
- Fig 4 A second detailed shape in plan view of air cleaning equipment relevant to the invention.

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- Fig 5** A plan view of a third detailed shape of the air cleaning equipment relevant to the invention.
- Fig 6** A cutaway view of the heat exchanger on a further detailed shape of air cleaning equipment relevant to the invention.
- Fig 7** In an illustration corresponding to Fig 4, a further detailed shape of air cleaning equipment relevant to the invention.
- Fig 8** The air cleaning equipment relating to Fig 7 in an oblique view from underneath.

The air cleaning equipment is intended for use in the pharmaceutical, grocery or also biotechnology markets. The air cleaning unit comes in a modular shape and will be used in clean rooms of classification B, C and D. The air cleaning equipment referred to in Figs 1 to 3 includes a housing 1, in which a single filter/ventilator unit and a heat exchanger are situated next to each other. The heat exchanger 3 described in the following detailed illustrations is advantageously installed as a Cooler. The filter/ventilator unit 2 has a ventilator 4, which sucks out air from the chamber 5, which can be located between the ventilator 4 and and a layer 6 of the housing. Underneath the ventilator 4 lies a filter 7, which is installed in a familiar manner and through which the clean air in the clean room flows.

The filter/ventilator unit 2 is separated from the space 9 space next to the cooler through a partition 8. The partition 8 is designed with an opening 10, which connects the adjacent room 9 with the chamber 5.

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The filter 7 is situated a minimal distance above an air chamber 11, through which the air enters the clean room. The cooler 3 is situated in the area above an exhaust 12, through which the exhaust air flows to cooler 3.

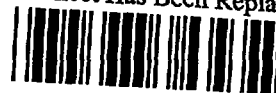
Housing 1 is shown in the particular detailed example in rectangular shape. Naturally however, it could appear in any other shape. Layer 6 and the adjoining side walls of 13 to 16 are made of metal which is an advantage. On the inner side of layer 6, a soundproofing layer can be found.

Ventilator 4 is fixed on a board 16, which typically has a quadratic outline (Fig 2) and normally has soundproofing layers 19, 20 and attachments to side wall 14 and partition 8 in the housing. The soundproof layer 19 is on the inner side of the housing side wall 14, and the soundproof layer 20 is situated on partition 8, which extends from the base of the housing to layer 6 in parallel fashion. The partition 8 is made from metal which is advantageous.

As Fig 3 shows, filter 7 is 'absorbed' by framework 21, whose sides have something of an L-shape. On the side 22 of the framework 21 in the drawing, filter 7 is depicted. Parallel to the side of the outline 22 angled inwardly, the framework also comprises a higher side 23, whose free end 24 is angled upwards and along with the framework 21 is fixed onto the inner sides of the housing side walls 13 to 15 and to the partition 8.

Filter 7 is situated a small distance underneath ventilator 4, so that a space for current flow 25 between itself and the filter

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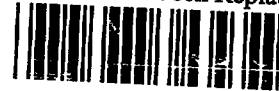


is created. The current space guarantees that the clean air passed through the whole area of filter 7 at the same time.

A directional device 26 is fixed onto the underside of ventilator 4. It is constructed via an even board, which emanates from ventilator 4 on all sides and whose outward edge 28 extends at right angles in an upward direction. The clean air drawn in from ventilator 4, in a manner yet to be described, reaches the circular space 29 between the board edge 28 and the ventilator 4, in which the clean air flows upwards. Since the board edge ends some distance under the load-bearing board 18, the clean air can come out of the circular space 29 and reach the flow space 30 situated between board edge 28 and soundproof layers 19, 20. Inside, the clean air flows into flow area 25, which joins onto flow area 30. From flow area 25, the clean air travels through filter 7 and reaches the air grille 11, into the clean room situated underneath.

The soundproof layer 17 extends over the whole inner side of housing layer 6 so that it is situated in the space 9 immediately adjoining the cooler (Fig 3). In the housing side wall 16, an opening 31 is found, where an airflow nozzle is connected on the outer side, over which exterior air 33 can be directed. Opening 31 is found directly connected to the corresponding soundproof layer 17 and thereby some distance above the cooler 3. The outside air 33 flows at right angles to the exhaust air 34 into the area 9 where the outside air and the exhaust air are mixed. The area 9 can therefore be described as a mixing chamber for the outside air and the exhaust air. From area 9, the mixed air goes through the opening 10 of partition 8 into air chamber 5 between the load-bearing board 18 and the soundproof layer 17 on the side.

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Electrical supply cables 35 for the ventilator 4 as well as electrical cables 36 for cooler 3 run through housing layer 6 and the soundproof layer 17.

The partition 8 subdivides housing 1 into two adjacent areas, of which the side closest to the ventilator is larger than the side 9 closest to the cooler.

The air grille 11 comprises evenly-distributed air openings over its area, to which sloping and parallel dividers are fixed. They extend from the edge of the opening in a slope in the direction of the adjacent area 9 for the cooler 3. Thereby, the flow of air 38 goes first into the clean area found underneath. Because of the dividers, the airflow 38 flows away from area 9 in a sloping direction, in order that this airflow does not immediately flow back over the exhaust air grille to cooler 3.

The exhaust air grille 3 also has evenly-distributed air openings over its area, to which sloping dividers are attached. They are, in any case, parallel and are set against those of grille 11.

During operation of the air cleaning equipment, the filtered air 38 flows through the air grille 11 directly into the clean room. Correspondingly, the exhaust air 34 already partially absorbed flows through exhaust air grille 12 to cooler 3, which it flows through. As a result, the exhaust air 34 is cooled. The cooler 3 lies horizontal and somewhere above filter 7. The exhaust air 34 flows into the cool area 9 upwards and then reaches opening 10 in partition 8 into the air chamber 5 above the ventilator 4. Should the need arise, outside air 33 can be channeled over the air nozzles 32 into the cool area 9, in which the outside air mixes with the cooled exhaust air. In this case, this mixture of air enters through opening

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10 into the air chamber 5. The exhaust air flows into chamber 5 through an opening 40 in the load-bearing board 18 (Fig. 1) in ventilator 4. Load-bearing board 18 locks off the circular area 29 as well as the flow area 30 in an upwards direction against the air chamber 5. The air coming out of ventilator 4 reaches the circular area 29, in which it is then directed upwards by the board edge 28 itself facing upwards. The air then flows through the flow area 30 surrounding the circular area 29 downwards into the flow area 25, which ensures that the airflow entering the area of filter 7 is evenly distributed. As the air 38 travels through filter 7, the air is once again cleaned and filtered in the familiar manner into the clean room.

Instead of the circular area 29, only two parallel flow channels on both sides of the ventilator 4 have been provided for, which extend between the housing sides 13 and 15. In this case, the air extending from ventilator 4 flows over the board edge 28 into the flow area 30.

Since the nature of the air cleaning equipment means that the filter 7 and the cooler 3 are brought together in one unit, an expensive system of further channels to transport the air is not necessary. The air cleaning equipment is constructed as a module, that can be inserted into an opening of a grid layer 41 for example. In Figs 2 and 3, the load bearing rails 42 and 43 situated at right angles to each other from the grid layer are illustrated. It is, however, also possible to fix the module and suspend it from a construction layer and then on the clean room side, lock it onto a suspended ceiling, for example via module dividers.

In the detailed example of Fig 4, the module is displayed symmetrically. The housing 1a has quadratic edges. At the same time, a ventilator 4a is

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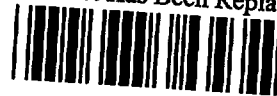


provided on two opposite sides 14a, 16a within the housing 1a. Both ventilators 4a are situated in half the length of the housing side walls 14a, 16a at the same height. They are constructed in the same way as ventilator 4 relevant in Figs 1 to 3.

Underneath both ventilators 4a, a filter 7a is situated, which has right-angled edges. With relevance to the aforementioned detailed shape, the filter 7a extends between the housing side walls 13a, 15a. In addition, filter 7a extends between the housing side walls 14a, 16a and the partitions 8a running parallel to it, which extend between housing side walls 13a, 15a parallel to housing side walls 14a, 16a. The partitions 8a separate the air chamber of the cooler area 9a situated above the ventilators 4a, in which the cooler 3a is situated. It is in any case horizontally laid out in the construction plan and extends, with reference to the previous detailed shape, between the housing side walls 13a, 15a running parallel to each other. In addition, the cooler 3a extends between the partitions 8a running parallel to each other. Underneath cooler 3a the exhaust air grille can be found once more, over which the exhaust air from the clean room in the cooler area 9a flows. As it goes through cooler 3a, the exhaust air is cooled and flows through the openings 10a provided in the partitions 8a into the air chambers in the area above the ventilator 4a. The exhaust air drawn in by the ventilators 4a can be directed and channeled in the same manner, as has been demonstrated by means of Figs 1 to 3. Moreover, this detailed shape is developed in the same way as the detailed examples for Figs 1 to 3.

Fig. 5 shows a detailed shape, in which the housing 1b relevant to the detailed shape on Fig 4 is divided up via the partition 8b. In contrast to the previous detailed shape,

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only one ventilator 4b is provided, which is located in the central area of housing 1b, whereas the locked areas adjacent to it, a cooler 3b is provided. Both coolers 3b are built identically which is an advantage and extend between the housing side walls 13b, 15b opposite each other as well as between the housing side walls 14b, 16b and the partitions 8b lying parallel to these latter. Ventilator 4b is located centrally in housing 1b.

The exhaust air drawn from ventilator 4b flows out of the cooler area 9b through appropriate openings in the partition 8b in the central air chamber, which is situated in the area above ventilator 4b. In the area underneath ventilator 4b, the filter 7b is found, which extends between the opposite housing side walls 13b, 15b as well as the right angle locking and parallel partitions 8b. Moreover, this detailed shape is constructed in the same way as Figs 1 to 3. An air nozzle is provided on one of the housing side walls to channel outside air to the cooler room 9b. An appropriate air nozzle can also be seen in the detailed shape of Fig 4.

Fig 6 shows the possibility of the cooler 3c no longer horizontal but placed underneath and sloping within the cooler area 9c. This sloping section would have the advantage of allowing the cooler 9c to be very narrow, so the relevant housing area 1c would have very compact dimensions. The cooling effect is not impaired in any way by the slope of cooler 3c.

The cooler 13 placed at a slope is fixed using securing rails 44, 45 to the housing base as well as to the housing side wall. Such a cooler, at a slope, can be incorporated into

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several of the previous detailed shapes, causing a reduction in dimensions of the particular module.

In the case of a further (not depicted) detailed shape, the ventilator is situated in the area above the cooler. The exhaust air flows in this case through the exhaust air grille and through the cooler, before it finally enters the ventilator situated there. The air is then directed from here towards the filters, which extend up above the air grilles next to the cooler. The cooler is advantageously centrally positioned and separated via partitions opposite the filter, so that the exhaust air must in any case flow through the cooler and ventilator, before it traverses the filters.

As regards the detailed shapes in Figs 6 and 7, the cooler 3d is situated in area 9d, in which a pre-filter 46 is installed. *It sits in a flow channel 60 for the exhaust air 34. The Filter-Ventilator-Unit 2 is in housing 1d neighbouring the inserted cooler 3d* and also comprises the ventilator 4c, which is suspended from board 18d. With reference to the detailed forms of Figs 1 to 3, the soundproof layers 19d, 20d are provided, which extend from filter 7d outwards to the height of board 18d.

A little distance underneath ventilator 4d, the channeling device 26d is situated, which also has the advantage of being constructed from soundproof material. The air drawn in from air chamber 5d travels downwards out of ventilator 4d and is channeled laterally to the channeling device 26d. The air consequently reaches flow area 30d first and following this into flow area 25d. The flow area 30d is designed as a circular area and is situated in the area between the ventilator 4d, namely the channeling device 26d and the soundproof layers 19d, 20d. The flow area 25d is bordered by the channeling device 26d above. The air flows outwardly from here through filter 7d underneath to an outlet as yet

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undescribed, through which the clean air reaches the clean room found underneath.

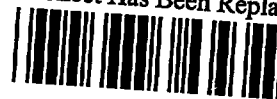
The ventilator 4d, the soundproof layers 19d, 20d, the channeling device 26d and the filter 7d comprise a unified construction 47, which is inserted into housing 1d of the air cleaning equipment. The single unit 47 has a housing 48, to whose side walls, soundproof layers 19d, 20d are affixed. Housing 48 is closed off at the bottom by filter 7d. To the top, housing 48 is closed off via sections of the side walls angled inwards as well as the board 18d attached there. The unit 47 can be pre-mounted and simply inserted into the housing 1d of the air cleaning equipment.

The housing 1d of the air cleaning equipment is positioned on an inbuilt space 49, with which the equipment, as shown by means of Figs 1 to 3, can be fixed onto the grid layer 41 or suspended from a construction ceiling.

The air nozzle 32d is situated at the side wall 14d of the housing 1d. In other words, air nozzle 32d is situated on the side of the Filter-Ventilator-Unit 2 bordered by the cooler 3d. This layout has the advantage that the air flowing through cooler 3d and into air chamber 5d as well as the outside air directed through nozzle 32d is symmetrically drawn out of air chamber 5d by ventilator 4d.

As was shown by means of Figs 1 to 3, the exhaust air 34 flows through the cooler 3d into the area 9d and extends to the opening 10d in air chamber 5d. The air coming out of ventilator 4d is radially channeled by channeling device 26d outside and flows through the flow area 30d into the flow area 25d

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and from there through filter 7d. The flow area 25d ensures that the airflow over the incoming area of filter 7d is evenly distributed. As it goes through filter 7d, the air is cleaned and filtered in the familiar manner before going into the clean room.

On the side wall 16d of housing 1d, a *thermostatic* regulator 50 is found, via which the cooler 3d can be regulated.

Underneath pre-filter 46, a measuring nozzle 51 can be found in area 9d, to which - through a measurement conduit - a *further measuring nozzle* 53 is fixed, which is situated in the area next to ventilator 4d in flow area 30d. The air in flow area 30d can *be measured here, through nozzle gauge 53 by way of a measuring sensor fixed onto nozzle gauge 51*. Moreover, the air underneath filter 7d can be measured using a further (but not illustrated) sensor. The difference in air can be used to make conclusions regarding the pollution or otherwise of filter 7d. It thereby becomes clear, when filter 7d must be cleaned or replaced. With *both* nozzle gauges, it is also possible to determine the particle concentration in the directional air flow before the filter 7d. In particular for the use of the air cleaning machine in a pharmaceutical location, the efficacy of the toxin filters 7d can be checked and verified.

In the area underneath the pre-filter 46, a temperature sensor 54 *in flow channel 60, which acts upon the thermostat 50. Instead of thermostatic regulator, an electrical, namely electrically-powered thermostat is inserted. In addition, a further temperature sensor can be installed in flow channel 60, with which the area temperature can be controlled.*

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The wall 16d of the housing 1d is provided with a nozzle 50, through which according to requirement *part or all of the* exhaust air from an installed air system (not illustrated) can be channeled.

The filtered and cooled air 38 generally comes out into the clean room turbulently. It distributes around the clean room and is drawn out of the clean room by the exhaust air grille and re-cooled via the heat exchanger 3d.

As Fig 8 shows, the exhaust air grille is surrounded on three sides by air grille 11d. The air grille 11d has a U-shape and is fixed with partitions, through which cleaned air is blown into the clean room. The partitions 37d in the individual area of air grille 11d are designed such that the clean air flows in differing directions. In Fig 8, the directions of outward flow of the air are shown via arrows. The partitions are deliberately sloping, so that the air 38 flows at a slope from the neighbouring edge of the housing 1d as it leaves.

As shown by means of the detailed shapes in Figs 1 to 3, the exhaust air grille also has these sloping partitions. ***These partitions can, also in the case of the previously mentioned detailed shapes, be omitted.*** Since the exhaust air grille 12d is located between two sections of the air grille 11d (Fig 8), a box 56 is found inside the air cleaning equipment above the exhaust air grille 12d, which when compared to the exhaust air grille 12d, has the same shape. This box 56, has a sloping wall 57, which extends downwards in a slope. The vertical width of this wall 57 as measured on Fig 7 includes the relevant width of the

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exhaust air grille 12d. Side walls are fixed onto this wall 57, which extend vertically downwards and along the length of the edges 58, 59 (Fig 8) of the exhaust air grille. In this way, the area above the exhaust air grille is technically in flow terms separated from the neighbouring area of air grille 11d, in order that the exhaust air having traversed the exhaust air grille in housing 1d is not able to mix with air 38. The wall sloping downwards is used to direct part *or all* the exhaust air to the pre-filter 46, which protects the toxin filter against excessive pollution.

The air cleaning equipment described comprises small modular units, which can prove an excellent addition to the pharmaceutical, grocery or biotechnological industries. The modules possess self-sufficient features, meaning that an expensive channeling system to transport the exhaust air is not necessary. The inner side of the module is smooth, not only ensuring an uninterrupted flow of air but also easy cleaning of the module. The temperature regulation as well as the airflow regulation of the modules can be controlled by a bus system, i.e. a LON. The module can also be easily mounted in the necessary locations within clean rooms.

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Requirements

1. Air cleaning equipment for the pharmaceutical, grocery, and biotechnological industries, with at least one ventilator, which has as a minimum, a filter installed and which is equipped with at least a heat exchanger, preferably also a cooling device, thereby meaning that the ventilator (4, 4a, 4b, 4d), the filter (7, 7a, 7b, 7d) and the heat exchanger (3, 3a, 3b, 3d) are consequently placed in a common housing (1, 1a, 1b, 1d), that is developed as an installation model.
2. Equipment according to requirement 1,
It is consequently expected that the heat exchanger (3, 3a, 3b) be separated from the ventilator (4, 4a, 4b) and from the filter (7, 7a, 7b) within the housing (1, 1a, 1b) through at least a partition, which must allow a minimum passage, through which the exhaust air (34) travels to the ventilator (4, 4a, 4b).
3. Equipment according to requirement 2,
It is consequently expected that the passage (10, 10a, 10d) lead into an exhaust chamber (5, 5d), which is situated on the entry point of the ventilator (4, 4a, 4b, 4d) as the housing (1, 1a, 1b, 1d) design allows.
4. Equipment according to requirements 1 to 3,
It is consequently expected that the ventilator (4, 4a, 4b, 4d) and



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the heat exchanger (3, 3a, 3b, 3d) be placed in adjacent areas of housing.

5. Equipment according to any of the requirements 1 to 4,
It is consequently expected that the heat exchanger (3a) be placed in a central area of housing (9a).
6. Equipment according to requirement 5,
It is consequently expected that, upon both sides of the centrally-located area of housing (9a), a larger area of housing be provided for, into which a ventilator (4a) with at least an assigned filter (7a) be placed.
7. Equipment according to any of the requirements 1 to 4,
It is consequently expected that the ventilator (4b) be placed in a central area of housing.
8. Equipment according to requirement 7
It is consequently expected that upon both sides of the centrally located area of housing, a larger area of housing (9b) be provided for, into which a heat exchanger (3b) be placed.
9. Equipment according to any of requirements 1 to 8,
It is consequently expected that the area of housing (9, 9a to 9c, 9d) extend between two other parallel-facing housing side partitions (13, 13a, 13b; 15, 15a, 15b).
10. Equipment according to any of requirements 1 to 9,
It is consequently expected that the filter (7, 7a, 7b, 7d) extend between two other parallel-facing housing side partitions (13, 13a, 13b; 15, 15a, 15b).



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11. Equipment according to any of requirements 1 to 10,
It is consequently expected that the housing walls (6, 13 to 16;
13a to 16a; 13b to 16b; 14d, 16d) be at least partly provided
with soundproofing (17, 19, 20; 19d, 20d) on the inner sides.
12. Equipment according to any of requirements 1 to 11,
It is consequently expected that a supply opening (31) for outside
air (33) lead to the space (9, 9a to 9c) occupied by the heat
exchanger (3, 3a to 3c).
13. Equipment according to any of requirements 1 to 11,
It is consequently expected that the space occupied by the heat
exchanger (9d) and at least a supply inlet for outside air (33) be
provided for on the parallel side of the ventilator (4d),
14. Equipment according to any of requirements 1 to 13,
It is consequently expected that the heat exchanger (3, 3a, 3b)
remain perpendicular to the flow direction of the exhaust air (34).
15. Equipment according to any of requirements 1 to 13,
It is consequently expected that the heat exchanger (3c) remain
at an angle to the flow
direction of the exhaust air (34).
16. Equipment according to any of requirements 1 to 15,
It is consequently expected that the outflow outlets for the
incoming air (38) be
installed in such a way, that the through air (38) be directed
away from the opening for the exhaust air.
17. Equipment according to any of requirements 1 to 16,
It is consequently expected that the housing (1, 1a, 1b, 1d) be
mounted



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on a grid layer (41).

18. Equipment according to any of requirements 1 to 16,
It is consequently expected that the housing (1, 1a, 1b, 1d)
suspended from a layer can be mounted.
19. Equipment, especially according to any of requirements 1 to 18,
It is consequently expected that the ventilator (4d) and the filter
(7d) be put together in one single construction (47).
20. Equipment according to requirement 19,
It is consequently expected that the single construction (47) have
at least some soundproof layer (19d, 20d) present.
21. Equipment according any of requirements 19 or 20,
It is consequently expected that the single construction (47)
comprise specially designed directing equipment (26d) for the
through air from the ventilator (4d) which can be shown.
22. Equipment according to any of requirements 19 to 21,
It is consequently expected that the single construction (47) be
insertable into the housing (1d).
23. Equipment according to any of requirements 1 to 22,
It is consequently expected that the outflow outlets for the
through air (38) and the inlet holes for the exhaust air (34) be
provided on the same side of the housing (1, 1a, 1b, 1d).
24. Equipment according to requirement 23,
It is consequently expected that the outflow outlets make up part
of a grille (11, 11d), which at least partially surrounds the inlet
holes of the linked exhaust air grille (12).

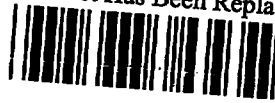


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25. Equipment according to any of requirements 1 to 24,
It is consequently expected that in the flowpath of the exhaust air
(34), in
front of the ventilator (4d), at least a pre-filter (46) be installed.

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