

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization

International Bureau



(10) International Publication Number

WO 2017/037643 A1

(43) International Publication Date

9 March 2017 (09.03.2017)

(51) International Patent Classification:

B01D 46/00 (2006.01)

(21) International Application Number:

PCT/IB2016/055225

(22) International Filing Date:

1 September 2016 (01.09.2016)

(25) Filing Language:

Italian

(26) Publication Language:

English

(30) Priority Data:

102015000047669

1 September 2015 (01.09.2015) IT

(71) Applicant: GEICO SPA [IT/IT]; Via Pelizza Da Volpedo, 109/111, I-20092 Cinisello Balsamo (MI) (IT).

(72) Inventors: COVIZZI, Giampaolo; Geico SPA, Via Pelizza Da Volpedo, 109/111, I-20092 Cinisello Balsamo (MI) (IT). COLOMBAROLI, Paolo; Geico SPA, Via Pelizza Da Volpedo, 109/111, I-20092 Cinisello Balsamo (MI) (IT).

(74) Agents: LAMPIS, Marco et al.; Via Nino Bixio, 7, 20129 Milano (IT).

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM,

AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

**Declarations under Rule 4.17:**

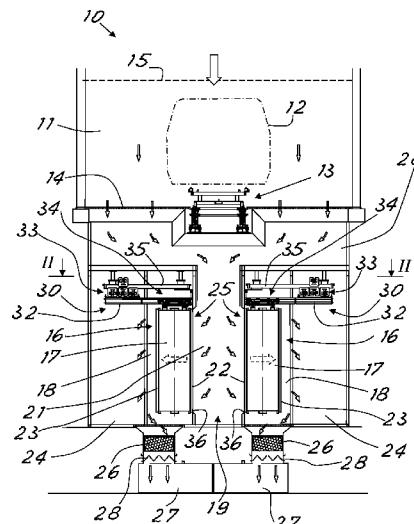
— of inventorship (Rule 4.17(iv))

**Published:**

— with international search report (Art. 21(3))

(54) Title: PAINTING BOOTH WITH AUTOMATIC FILTER SYSTEM

Fig. 1



(57) **Abstract:** A paint-spraying booth (10) comprises a paint-spraying chamber (11) inside which the paint is sprayed and which is provided with an air flow for evacuating the overspray, which is conveyed to at least one filter unit (16) of the booth for filtering and separating the paint overspray from the air flow. The filter unit (16) comprises a plurality of replaceable filter modules (17), each filter module being removably contained inside a housing (18) in the filter unit. An automated system (30) allows removal and transportation of each filter module (17) of the plurality between its housing (18) and a zone (31) for entry/exit of the filter modules into/from the booth.

**Title**

"Painting booth with automatic filter system"

**Description**

The present invention relates to a paint-spraying booth provided with an automated system for changing the filters for eliminating the overspray.

Usually the paint-spraying booths are provided with an air flow which passes through the working zone so as to convey the overspray, namely the nebulized excess paint, outside of the booth. The air drawn in with the overspray must be necessarily purified of the paint before it can be released into the environment or reintroduced into the booth and for this reason the air flow is made to pass through suitable filtering systems.

The systems which use filters become clogged as they get filled with paint and must be regularly replaced. This often results in the booth being non-operative for a considerable period of time. Moreover, the filter changing operations may be complex and difficult for the maintenance personnel who are often obliged to work in "contaminated" zones.

The general object of the present invention is to provide a booth with a filtering system having means for automated replacement of the overspray elimination filters.

In view of this object, the idea which has occurred, according to invention, is to provide a paint-spraying booth comprising a paint-spraying chamber in which the paint is sprayed and which is provided with an air flow for evacuation of the overspray which is conveyed to at least one filter unit of the booth for filtering and separation of the paint overspray from the air flow, the filter unit comprising a plurality of replaceable filter modules, each filter module being removably contained inside a housing in the filter unit, characterized in that it comprises an automated system for removing and transporting each filter module of the plurality between its housing and a zone for entry/exit of the filter modules into/from the booth.

In order to illustrate more clearly the innovative principles of the present invention and its advantages compared to the prior art, an example of embodiment applying these principles will be described below with the aid of the accompanying drawings. In the drawings:

- Figure 1 shows a partially sectioned schematic elevation view of a booth according to the invention;
- Figure 2 shows a schematic plan view of the booth sectioned along the line II-II of Figure 1;
- Figure 3 shows an enlarged, partial, schematic view of an automated system for transporting the filters into the booth according to the invention;

- Figure 4 shows a schematic view similar to that of Figure 1 and showing a possible variation of embodiment of a booth according to the invention.

With reference to the figures, Figure 1 shows a paint-spraying booth according to the invention, denoted generally by 10.

The booth comprises a chamber 11 for spraying objects 12 (for example motor vehicle bodies). The objects to be sprayed are advantageously transported into the chamber 11 by means of a known sequential conveyor system 13.

The chamber 11 is provided with known paint-spraying devices (not shown) which are operated so as to spray the paint onto the surfaces of the object to be painted. Advantageously, the paint-spraying devices may be realized in the form of known robot arms provided with spray guns.

Air for removal of the overspray from the chamber 11 is circulated inside the booth. For example, suitable air circulation fans (not shown) are advantageously provided according to a technique known per se for producing a continuous flow of air through the chamber.

Advantageously, for circulation of the air flow, the floor 14 of the chamber 11 is composed of grilles through which the chamber air is drawn. The ceiling of the chamber is therefore provided with corresponding air inlets 15 so as to have a continuous air flow which passes vertically through the chamber from the top downwards during the paint-spraying operations.

The air flow leaving the chamber 11 is conveyed to at least one filter unit 16 which retains the overspray. The filter unit comprises advantageously a plurality of replaceable filter modules 17, each accommodated inside an associated housing 18 which forms a seat for the filter module and which connects it between the inlet for the air from the chamber and the outlet for discharging the air after filtering.

In particular, advantageously a first passage 21 for entry of the air into the filters and a second passage 24 where the air exits from the filters are provided, with the filter modules of the filter unit being connected in parallel between the entry and exit passages.

In the embodiment shown in Figure 1, the filter units are advantageously two in number, being arranged facing each other in a mirror-image layout relative to a vertical mid-plane of the booth. Advantageously this plane is parallel to the direction of movement of the transportation system 13 which defines the direction of longitudinal extension of the booth.

In the booth embodiment where the air is drawn through the floor 14, the filter unit or units 16 are preferably arranged directly underneath the floor 14.

In the embodiment shown there is advantageously a chamber 19 having a cross-section generally in the form of a T for defining an upper header 20 extending horizontally

underneath the floor 14 for receiving air therefrom and with the vertical part of the T which forms the passage 21 extending along the filter modules for allowing entry of the air into the filters. Inside the passage 21 the inlets 22 of the filter modules present in the respective housings 18 are arranged alongside each other.

The outlets 23 of the filter modules in the respective housings 18 communicate in turn with the passage 24 for evacuation of the filtered air flow. In the embodiment shown, the filter modules have advantageously a parallelepiped form with inlet and outlet arranged on opposite sides and connected in parallel between the inlet passage 21 and the outlet passage 24. The filters may be of various suitable types, for example also of the disposable type made of cardboard.

The passage 24 is advantageously connected (preferably via one or more further filters 26, for example of the "pocket" type) to a duct 27 for evacuating the air from the booth. The duct 27 may definitively evacuate the air externally and/or convey it back into the chamber 11 for recycling of purified air.

Again advantageously, controlled gates 28 may be provided for throttling and/or closing the air flow leaving the filter modules. These gates (as well as the optional further filters 26) may be provided one for each filter module 17 or may be provided for several filter modules 17.

In Figure 1, the air flow into the booth is indicated schematically by means of the arrows.

As can be clearly seen also in Figure 2, the booth according to the invention comprises at least one automated system 30 for removing and transporting each filter module 17 of the plurality between its housing 18 and a zone 31 for entry/exit of the filter modules into/from the booth, for removing a filter module from its housing and transporting it into the entry/exit zone and for removing a filter module from the entry/exit zone and transporting it into an empty housing 18.

The automated system comprises advantageously means which are movable sequentially between the plurality of housings 18 of the filter modules 17 and the zone 31 for entry/exit of the filter modules into/from the booth. Preferably, as can be clearly seen in the figures, these means may comprise a shuttle 32 which travels hung from the rails 33 which extend along the corridor 24 so as to pass sequentially in front of the housings 18 of the filter modules. The shuttle may be moved by means of a motorized-chain system 41.

Further transfer means 34 may be provided for transferring each module between its housing and the shuttle. In particular, as can be clearly seen in Figure 3, these means 34 may comprise for each module a carriage 43 from which the module is hung and which may be transferred on the shuttle 32 by means of a suitable actuator or transfer device 35, thus extracting the

filter module from its housing and transferring it inside the passage 24.

Once the shuttle has loaded the filter module it may be displaced towards the entry/exit zone 31 where the used filter is unloaded from the shuttle and removed from the booth. Similarly, a new filter may be loaded onto the shuttle in the entry/exit zone 31 and transported and inserted into an empty housing 18, with a procedure which is the reverse of that described above for extraction.

The modules may also be moved from and to the entry/exit zone for example by means of a suitable known elevator 42 which picks them up from a store or from a manual loading/unloading zone. Advantageously, in the case of compatible filters, for example made of cardboard, the entry/exit zone may also comprise a suitable compactor device, of the type known per se.

The filter modules have advantageously the inlet side which sealingly adheres with its edge against a circumferential edge 36 of the communication opening 25 between housing 18 and entry passage 21. In this way, it is sufficient to rest the filter against the edge 36 in order to ensure the air tightness and the circulation through the filter of the air flow from the paint-spraying chamber. The sealing contact may be for example ensured by the actuator or transfer device 35 which pushes the filter module inside its housing. Further known automated constraining means may be provided for keeping the module in the operative position.

Means are also provided for closing the opening 25 for entry of the air into the filter modules. Advantageously, in order to realize these means, the entry passage 21 is provided with a movable partition 37 which is motorized (using means known per se and therefore not shown, for example a chain drive system) so as to travel along the passage and close in sequence one of the openings for entry into the filter modules. In this way, when it is required to replace a filter module the partition is displaced so as to close the entrance to this module and the module is then extracted from the housing and transferred onto the shuttle which transports it to the exit zone. Once a new filter module has been introduced into the housing, the partition 37 may return into the rest position (shown in Figure 2c for the left-hand unit).

In order to allow entry and exit of the filter modules into/from the passage 24 without having to interrupt completely the circulation of the air, advantageously a transfer chamber 38 provided with a first door 39 communicating with the passage 24 and a second door 40 communicating with the outside, and in particular the entry/exit zone 31, are provided. In this way, by opening the two doors in an alternating manner using a suitable drive system (not shown), it is possible to transfer the filter modules without the passage 24 communicating with the exterior. The transfer chamber 38 may also be used to house the shuttle 32 when not

in use, closing both the doors 39 and 40 so as to keep it isolated from the air flow present inside the passage 24.

Figure 3 shows in greater detail a possible advantageous embodiment of the system 30 for transportation and replacement of the filters.

In particular, each filter module 17 is hung from an associated carriage 43 which is displaceable along rails 44 arranged on the ceiling of each housing 18 and extending in the direction of extraction/insertion of the module from/into the housing. Advantageously, this direction is transverse to the direction of displacement of the shuttle 32 on its rails 33.

The shuttle 32 comprises in turn rail sections 45 which are aligned with the rails 44 of a housing when the shuttle is transported into the vicinity of this housing. In this way the actuator 35 may displace the filter unit with the carriage 43 from the rails 43 to the rails 45 and vice versa. As can be seen again in Figure 3, the actuator 35 may be a known linear actuator provided with a motorized slider 46 which engages a suitable operating end 47 of the carriage 43 so as to controllably displace it between housing 18 and shuttle 32. Other transfer devices may be imagined by the persons skilled in the art.

Each filter unit comprises advantageously an associated movement system in a mirror-image arrangement relative to the other one.

Although the embodiment with two filter units in a mirror-image arrangement has been found to be particularly advantageous it is nevertheless also possible to use a single filter unit for example when the air flow to be treated is more limited. This is shown for example in Figure 4 where essentially the T-shaped chamber for conveying the air to the filters has filter modules on one side only of the entry passage and therefore is provided with a single filter transportation system. As regards the rest the structure of the paint-spraying booth may be identical to that described above.

At this point it is clear how the predefined objects have been achieved. With a booth according to the invention it is possible to replace the filters cyclically in an automatic manner without having to stop the plant. Since the air flow is divided up by means of the plurality of filters, closing of one filter for removal and replacement thereof does not reduce excessively the air flow during the time needed for the whole operation.

Obviously the description above of an embodiment applying the innovative principles of the present invention is provided by way of example of these innovative principles and must therefore not be regarded as limiting the scope of the rights claimed herein.

For example, as may be now easily imagined by the person skilled in the art, the entry/exit zone may be divided into an entry zone where the new filters arrive and an exit zone where

the used filters are transferred.

Changing of the filters may be performed by means of a manual change command entered by the operator or by means of a cyclical procedure whereby a filter is changed after a certain operating time. Suitable sensors may be provided, these requesting automatic changing of a filter when it is detected that it is clogged up by more than a certain amount. During a complete changing operation, the filter modules may also be sequentially replaced one at a time (or in pairs, in the case of two filter units with associated independent automated systems), until all the filter modules have been completely replaced, without stopping the plant.

In the case of disposable filters made of combustible material a method for high-temperature incineration of the used filters may be envisaged, said method using at least partly as fuel the filter itself and the paint contained in it. In addition to eliminating the filters it is possible to make advantageous use of the combustion for heat recovery from the combustion fumes.

### Claims

1. Paint-spraying booth (10) comprising a paint-spraying chamber (11) in which the paint is sprayed and which is provided with an air flow for evacuation of the overspray which is conveyed to at least one filter unit (16) of the booth for filtering and separation of the paint overspray from the air flow, the filter unit comprising a plurality of replaceable filter modules (17), each filter module being removably contained inside a housing (18) in the filter unit, characterized in that it comprises an automated system (30) for removing and transporting each filter module (17) of the plurality between its housing (18) and a zone (31) for entry/exit of the filter modules into/from the booth.
2. Booth according to Claim 1, characterized in that the automated system (30) comprises a motorized shuttle (32) which is displaceable along the filter modules (17) of the filter unit (16) in order to controllably load/unload the filter modules into/from the housings (18).
3. Booth according to Claim 2, characterized in that the automated system (30) comprises transfer means (34) for controllably displacing a filter module (17) between its housing (18) and the shuttle (32) when the shuttle is transported in the vicinity of the housing.
4. Booth according to Claim 3, characterized in that the transfer means (34) comprise a carriage (43) from which the filter module (17) is hung and which is displaced on rails (44) inside the housing by means of an actuator or transfer device (35).
5. Booth according to Claim 4, characterized in that the motorized shuttle (32) has on it rails for accommodating the shuttle (43), which are aligned with the rails (44) inside the housing for transfer of the carriage between housing and shuttle.
6. Booth according to Claim 1, characterized in that it comprises a first passage (21) for entry of the air from the paint-spraying station into the filter modules (17) and a second passage (24) for exit of the air from the filter modules (17), and the housings (18) are arranged between first and second passages so as to connect the filter modules (17) of the filter unit in parallel with each other.
7. Booth according to Claims 2 and 6, characterized in that the motorized shuttle (32) travels inside the second passage (24).
8. Booth according to Claim 1, characterized in that it comprises a movable partition (37) which travels in sequence along air inlets (22) of the filter modules (17) so as to controllably close the air inlet in a housing (18).
9. Booth according to Claim 2, characterized in that it comprises a transfer chamber (38) for transfer of the filter modules (37) between housings (18) and the entry/exit zone (31), the transfer chamber (38) being provided with a first door (39) communicating with the housings

(18) and a second door (40) communicating with the outside of the booth towards the entry/exit zone (31).

10. Booth according to Claim 1, characterized in that the filter units are two in number and arranged in a mirror-image layout underneath the floor of the paint-spraying chamber.

11. Booth according to Claim 1, characterized in that a chamber (19) with a T-shaped cross-section is provided underneath the floor of the paint-spraying chamber, the horizontal part of the T forming a duct (20) for conveying the air flow which passes through the floor of the paint-spraying chamber and the vertical part of the T which forms a duct (21) inside which inlets (22) of the filter modules (17) emerge.

12. Booth according to Claim 1, characterized in that further filters (26) and/or controlled gates for closing or throttling the exiting air flow are present downstream of the filter modules (17).

1/3

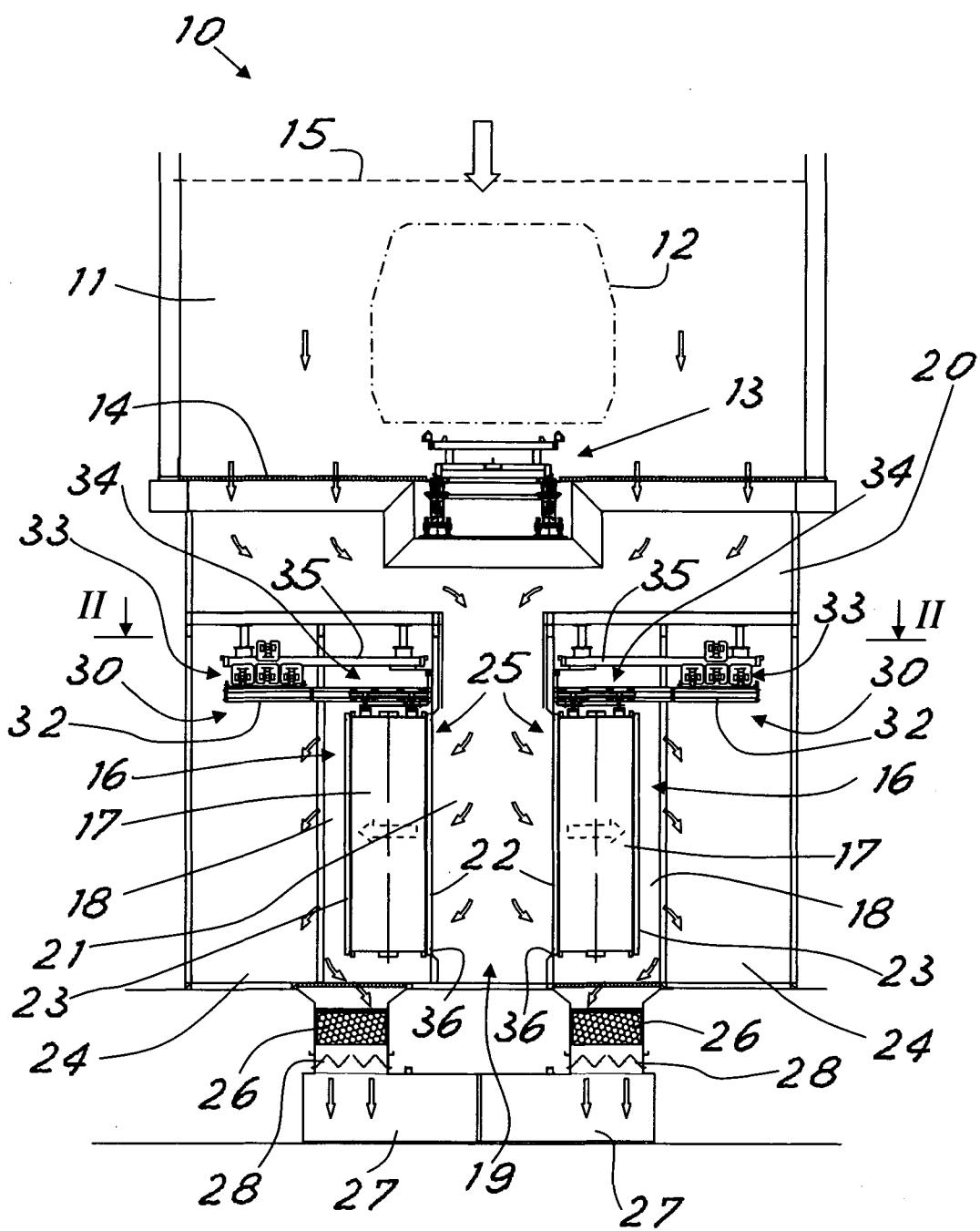


Fig. 1

2/3

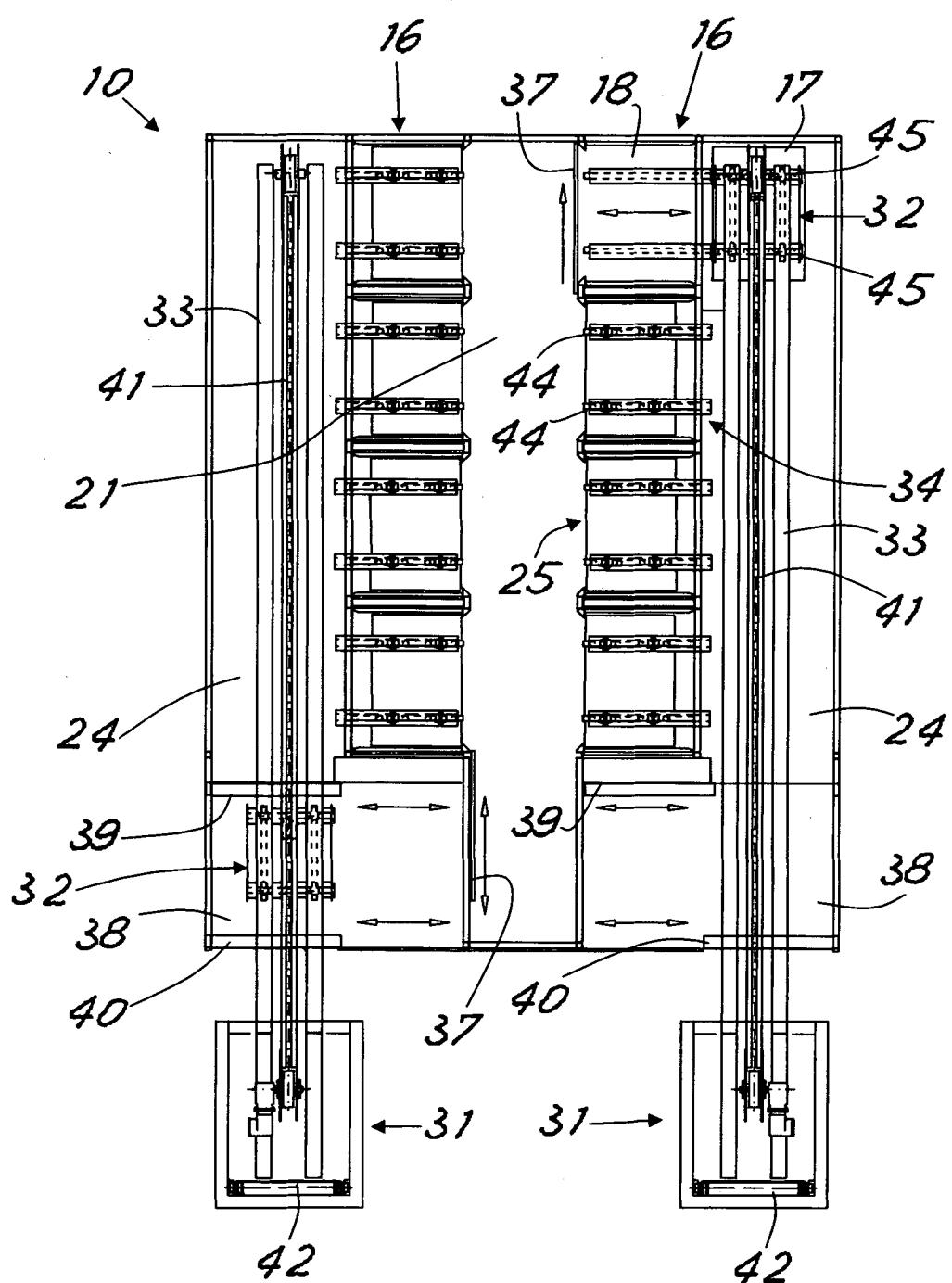


Fig.2

3/3

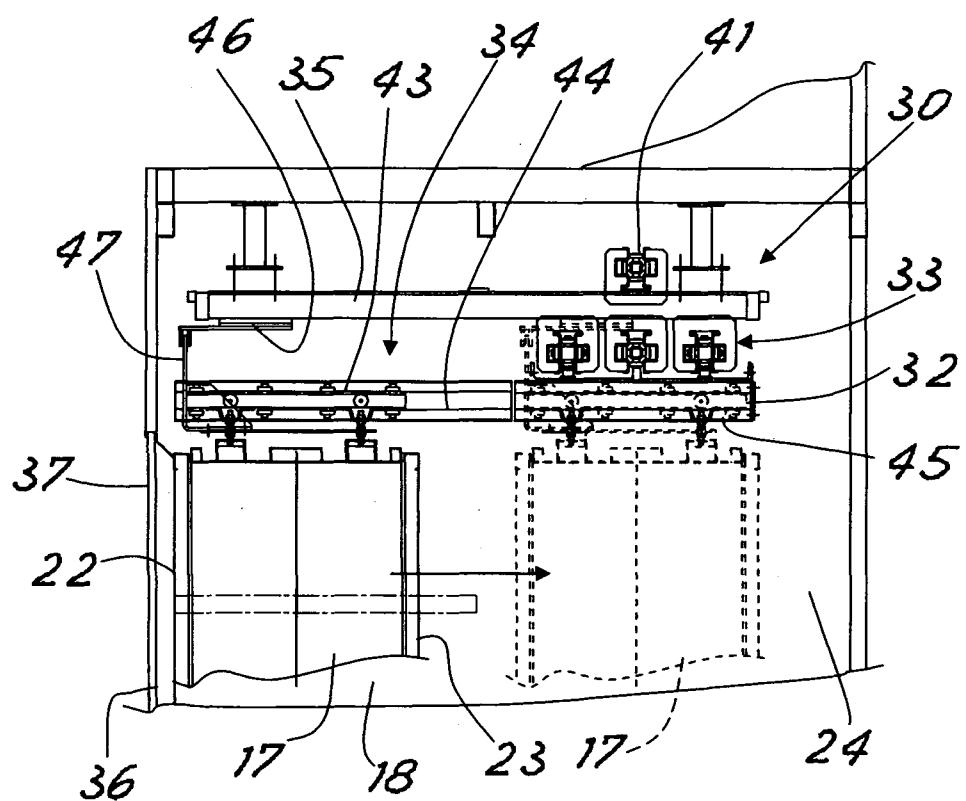


Fig. 3

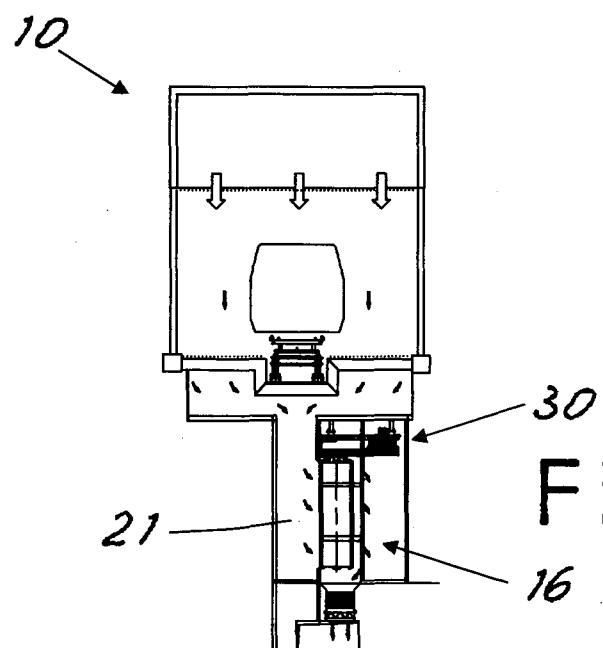


Fig. 4

# INTERNATIONAL SEARCH REPORT

International application No  
PCT/IB2016/055225

**A. CLASSIFICATION OF SUBJECT MATTER**  
INV. B01D46/00  
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)  
B01D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 20 2014 103177 U1 (DÜRR SYSTEMS GMBH [DE]) 13 August 2014 (2014-08-13) paragraphs [0085], [0135], [0136]; figure 1 -----	1-12



Further documents are listed in the continuation of Box C.



See patent family annex.

\* Special categories of cited documents :

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier application or patent but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
4 November 2016	15/11/2016
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer  Eberwein, Michael

**INTERNATIONAL SEARCH REPORT**

Information on patent family members

International application No

PCT/IB2016/055225

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 202014103177 U1	13-08-2014	CA 2929060 A1	07-05-2015
		CN 105705216 A	22-06-2016
		DE 102013222301 A1	07-05-2015
		DE 202014103177 U1	13-08-2014
		EP 3065845 A2	14-09-2016
		KR 20160085283 A	15-07-2016
		US 2016288036 A1	06-10-2016
		WO 2015062976 A2	07-05-2015