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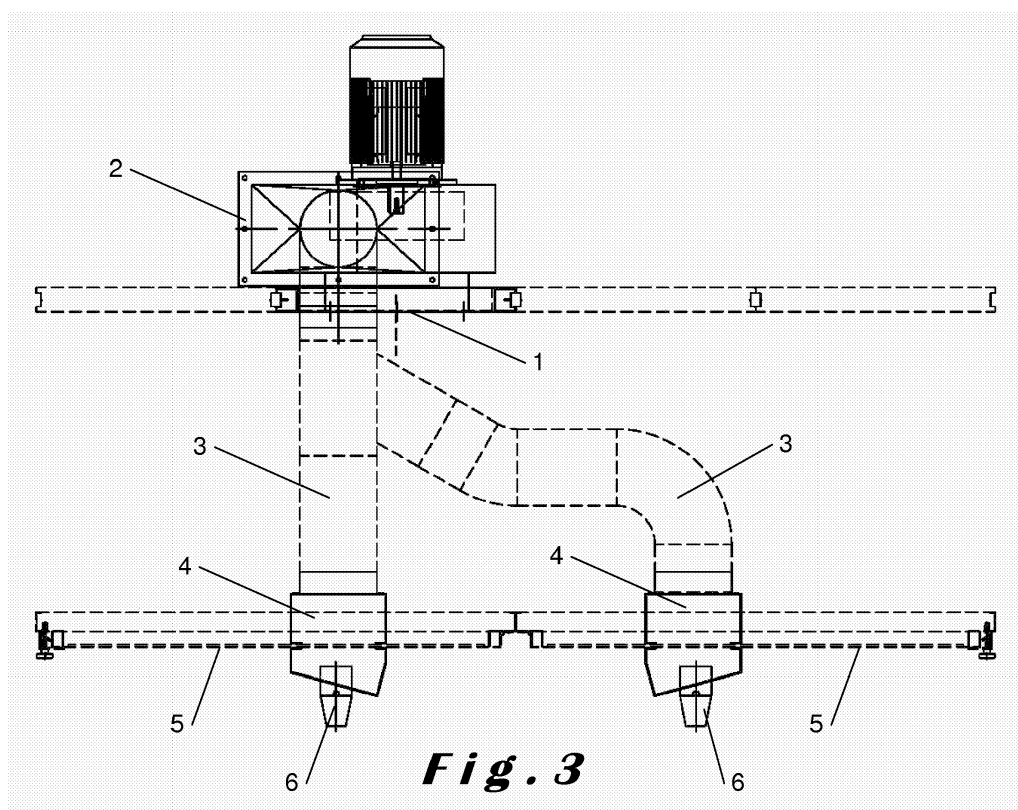
Remarks:

Amended claims in accordance with Rule 137(2) EPC.

(54) **Drying device and method for painted bodies, and device for circulating drying air in such device and method**

(57) The invention relates to a method for drying a painted body by circulating aimed air flows in an enclosure (10) from blowing means (2) outside said enclosure (10); through filter means (5) forming a ceiling surface (40) of said enclosure (10).

The invention also relates to a drying booth (10), respectively an air circulation device for a drying booth, comprising blowing means (2) outside the drying enclosure (10), connected to individually aimed air nozzles (6) with portions of top ceiling filter means (5) interposed between said blowing means (2) and said nozzles (6).



Description

[0001] The invention relates to area of paint cabins (spray booths) for painting objects of various types, more in particular for cars, trucks, trailers, etc.

[0002] Such spray booths or painting cabins involve the following essential features :

- to provide a dust free environment for a high quality painting job
- to extract and filter the paint mist and create an acceptable working environment for the painter
- often designed as 'stand alone' spray booths, distinct from a so called whole painting line

[0003] Most of such spray booths are combined "spray-bake" installations, also called "spray-dry" booths. This means that after a spraying phase, the booth can be switched to drying mode.

The spray mode is the mode during which the operator (painter) or robotized system is spraying the paint on / towards the object. Inlet air temperature and booth temperature are set to approximately 20 °C. "Overspray" and paint mist are extracted through extraction filters and the air is ejected outside the building housing the installation.

[0004] During the subsequent drying mode there is no painting activity, so that airflow can be partly recycled (although this is not a requirement) and temperature is set to approximately 40°C -180°C.

The "flash off" (evaporation of remaining solvents in the paint), involved in this drying operation, and the actual drying itself are significant time and energy (heating) consuming operations.

[0005] Furthermore new paints tend to involve less voc's (volatile organic components) and are partly water based due to environmental regulations.

These new paints thus require more time to dry and the flash-off drying efficiency is more related to the air movement, rather than to the temperature.

[0006] Various systems have been proposed to speed up flash-off and drying.

Some can be incorporated in the construction of a new spray booth.

Some are suitable for "retrofit" installation in existing booths.

The operation of all these systems involves comparable principles :

- during spraying the speed up system for flash-off and drying is switched off; filtered, dust free air is provided to the booth from an air chamber (the so called "plenum") above a set of ceiling filters; the ceiling filters mostly deliver filtered air satisfying the so called EU5 quality standard (i.e. dust particles larger than 10 µm are removed / filtered off).
- in operation (speed up system for flash-off and drying switched on)

+ the air is either drawn from the so called plenum and pre-filtered; additional blower fans push the air into the booth (in the sidewalls of the booth or next to top lights on the ceiling of the booth or in the corners of the booth); or

+ the air is drawn from inside the booth under the ceiling filters; in this case the air is filtered in the same way as in the spraying phase (i.e. through the ceiling filters).

In both instances the purpose is to provide aimed air flows in the enclosure of the booth, by means of air jets / directional nozzles, so that said aimed, high speed, air flows, will move and renew the air layers around the painted object.

[0007] It is indeed the air layers around the painted object which absorb the humidity of the wet paint. By renewing these air layers faster (by means of jet-systems as referred to above) a faster flash-off and drying is achieved.

The known jet-systems thus

either take the air from the plenum (not satisfying EU5 standard because the air is taken prior to the EU5 ceiling filters),

or draw the air from inside the booth (after the ceiling filter) but necessarily involve a (polluting) passage through blowing means (which, inherently, involve a risk of introducing dust particles, such as oil droplets) into the air).

[0008] Typical examples of such known jet-systems have been disclosed in EP 0 690 279 and in EP 0 960 312

[0009] It is the objective of the present invention to overcome the drawbacks of the known systems to speed up flash-off and drying, using aimed air flows provided a paint booth by means of directional nozzles, and to provide an improved system of this type having superior performance.

[0010] The invention there for provides a method for drying a painted body, involving circulating aimed air flows in an enclosure, by means of directional nozzles in the upper part of said enclosure, and removing air from the bottom of said enclosure, wherein air flow to said directional nozzles in said enclosure is provided by blowing means outside said enclosure, through filter means forming at least part of a ceiling surface of said enclosure.

[0011] The expression "aimed air flows" as used in this text refers to air flows (preferably having a velocity of 1 - 5 m/sec on the surface of the objects which are being dried, and most preferably a velocity of 1,5 - 2,5 m/sec) individually directed in selected (fixed or, preferably, capable to be individually oriented) directions, by means of directional nozzles / air jets (which are preferably capable to be individually oriented).

[0012] In a preferred embodiment of the invention air is removed from the enclosure through air evacuation means forming at least part of the floor of said enclosure.

[0013] The invention also specifically provides a new type of drying device for painted bodies, comprising an enclosure with a top ceiling at least partially formed of filter means for incoming air and with a bottom floor at least partially formed of air evacuation means, further comprising aimed air nozzles within said enclosure, which new said drying device more specifically comprises blowing means provided outside said enclosure, connected to said individually aimed air nozzles whereas portions of said top ceiling filter means are interposed between said blowing means and said nozzles.

The aimed air nozzles of the drying device according to the invention must be understood as individually aimed air nozzles, each directed in a selected direction (fixed or, preferably, capable to be individually oriented).

[0014] The drying device according to the invention is most preferably designed as an essentially hermetic enclosure, operating under a pressure (slightly) increased over atmospheric pressure (in order to help avoiding any ingress of dust).

[0015] The invention furthermore specifically provides a new type of device for circulating aimed air flow in a drying booth for painted bodies, with a top ceiling at least partially formed of filter means for incoming air, comprising directional air nozzles positioned within said drying booth and blowing means feeding said directional air nozzles, whereas said blowing means are specifically provided outside said drying booth and connected to said directional air nozzles within said drying booth, and whereas portions of said top ceiling filter means are interposed between said blowing means and said nozzles. The directional air nozzles of the circulation device according to the invention must be understood as individually directed air nozzles, each directed in a selected direction (fixed or, preferably, capable to be individually oriented).

[0016] The circulation device according to the invention can be incorporated in the design of newly build (painting and) drying device, but may very suitably also be provided as a retrofit installation for existing (painting and) drying devices.

[0017] Further features and details of the invention will become apparent from the description of a preferred embodiment of a drying device according to the invention (designed to operate as a painting and drying device), as disclosed here below having reference to the attached drawings in which

[0018] Figure 1 is a side view, partially in section, of a (painting and) drying device / booth, according to the invention, incorporating a device for circulating aimed air flows, according to the invention.

[0019] Figure 2 is a front view, partly in section, of the drying device / booth, and circulation device according to figure 1.

[0020] Figure 3 is an enlarged view of a part of figure 2, specifically showing the details of the device for circulating aimed air flows, according to the invention.

[0021] The painting and drying booth (spray booth)

shown in figures 1 and 2, designated as a whole with reference numeral 10, comprises means for circulating aimed air flows in the spray booth, designated with reference numeral 20, comprising blowing means (2), outside the spray booth 10, connected to directional nozzle devices (4, 6) within the drying booth 10, with portions of ceiling filter means (5) of the spray booth 10 interposed between the blowing means 2 and the nozzle devices 4, 6.

[0022] The drying device 10 / device 20 for circulating aimed air flows, according to the invention, as illustrated in figures 1 - 3, operates in the following manner

[0023] Air is drawn from inside the "plenum", i.e. the air chamber above the painting and drying enclosure (30) of the spray booth 20, separated from the actual painting and drying enclosure 30 by a ceiling 40 comprising a set of ceiling filters 5; the air is heated and pre-filtered but not filtered to EU5 quality. The air is drawn into the blowing means 2 from the plenum 30

via air inlet 1.

[0024] The fan and motor units (blowing means 2) for circulating the air are placed on top or on the side of the spray booth.

In the most common situations (car booths) as illustrated in the drawings, four fan-motor units 2 are provided (on the figures only three motor-fan units are visible, as the two middle units are positioned behind each other, on the view from the front as well as on the side view). Each fan-motor 2 / jets 6 combination will operate for a certain area of the booth.

For example : front of car, back of car one side of car, other side of car.

Each system can be switched on / switched off depending on where the object (car) is to be repaired. For larger objects (busses, trucks, etc.) more than four fans or higher capacity fans and/or more jet / fan combinations can suitably be installed.

[0025] A ducting system (3) leads the air to the air chambers (4) of the nozzle device 4, 6.

[0026] The positions of the jets 6 are selected in such way that the drying exchange effect is maximized. The air velocity in the ducts 3 and the surface (length x width) of the air chambers is calculated such that the crossing speed through the filters is in the optimal range specified for the used type of filters. For EU5 type filters according to the example (designated with reference numeral 5 in the drawings) the specified ideal crossing speed is in the range between 0,2 and 0,4 m/sec.).

Preferably the air speed / air velocity in the air chambers 4 should be such that the velocity of the air exiting the jets 6 provides an air flow on the surface of the objects which are being dried in the range between 1 and 5 m/sec., most appropriately in the range between 1,5 and 2,5 m/sec., in order to achieve said optimal drying exchange effect on the drying surface of the object.

[0027] As can be understood from the above disclosure, the essential novelty of the invention resides in the fact that the (existing) EU5 - ceiling filter is pinched be-

tween the two halves of the air chambers 4 of the nozzle device 4, 6. In other words, the anyway existing ceiling filter of the spray booth is used as filter medium for the jet-system.

[0028] The ceiling filters are most suitably provided in ceiling frames attached to the ceiling structure through a swivel hinge for easy replacement of the filter sheets; "pinching" of the filter 5 between the two halves of an air chamber 4 occurs when setting the hinged ceiling frame in closed position.

Claims

1. Method for drying a painted body, involving circulating aimed air flows in an enclosure, by means of directional nozzles in the upper part of said enclosure, and removing air from the bottom of said enclosure, **characterized in that** air flow to said directional nozzles in said enclosure is provided by blowing means outside said enclosure, through filter means forming at least part of a ceiling surface of said enclosure.
2. Method according to claim 1, **characterized in that** air is removed from the bottom of said enclosure through air evacuation means forming at least part of the floor of said enclosure.
3. Method according to any one of claims 1 and 2, **characterized in that** said aimed air flows are individually directed in selected directions.
4. Method according to claim 3, **characterized in that** said aimed air flows can individually be oriented in a selected direction.
5. Method according to any one of the preceding claims, **characterized in that** said aimed air flows on the surface of the painted body in the range between 1 and 5 m/sec., preferably in the range between 1, 5 and 2, 5 m/sec.
6. Drying device for painted bodies, comprising an enclosure with a top ceiling at least partially formed of filter means for incoming air and with a bottom floor at least partially formed of air evacuation means, further comprising aimed air nozzles within said enclosure, **characterized in that** said drying device comprises blowing means provided outside said enclosure, connected to said individually aimed air nozzles whereas portions of said top ceiling filter means are interposed between said blowing means and said nozzles.
7. Drying device according to claim 6, **characterized in that** said aimed air nozzles are individually aimed air nozzles.

8. Drying device according to claim 6, **characterized in that** said aimed air nozzles are individually aimed air nozzles capable to be individually oriented.
9. Device for circulating aimed air flow in a drying booth for painted bodies, provided with a top ceiling at least partially formed of filter means for incoming air, which circulation device comprises directional air nozzles within said drying booth and blowing means feeding said directional air nozzles, **characterized in that** said circulation device comprises blowing means provided outside said drying booth, connected to said directional air nozzles within said drying booth, whereas portions of said top ceiling filter means are interposed between said blowing means and said nozzles.
10. Circulation device according to claim 9, **characterized in that** said directional air nozzles are each directed in a selected direction and, preferably, able to be individually oriented.
11. Method, respectively drying device, respectively circulation device according to any one of the preceding claims **characterized in that** said blowing means outside said enclosure draw air from a so called plenum area above said enclosure.

Amended claims in accordance with Rule 137(2) EPC.

1. Method for drying a painted body, involving circulating aimed air flows in an enclosure (10), by means of directional nozzles (6) in the upper part of said enclosure (10), and removing air from the bottom of said enclosure, whereas the air flow to said directional nozzles (6) is provided by blowing means (2) outside said enclosure (10), through filter means (5) forming at least part of a surface of said enclosure, **characterized in that** said air flow to said directional nozzles (6) is provided through portions of filter means (5) forming at least part of a ceiling surface (40) of said enclosure (10), interposed between said blowing means (2) and said nozzles (6) by having portions of said ceiling filter means (5) pinched between two parts of a chamber (4) of a nozzle device (4, 6).
2. Method according to claim 1, **characterized in that** air is removed from the bottom of said enclosure through air evacuation means forming at least part of the floor of said enclosure.
3. Method according to any one of claims 1 and 2, **characterized in that** said aimed air flows are individually directed in selected directions.

4. Method according to claim 3, **characterized in that** said aimed air flows can individually be oriented in a selected direction.

5. Method according to any one of the preceding claims, **characterized in that** said aimed air flows on the surface of the painted body have a velocity in the range between 1 and 5 m/sec., preferably in the range between 1, 5 and 2, 5 m/sec.

6. Method according to any one of the preceding claims, **characterized in that** said blowing means (2) outside said enclosure (10) draw air from a so called plenum area (30) above said enclosure.

7. Drying device for painted bodies, comprising an enclosure (10) with a top ceiling at least partially formed of filter means (5) for incoming air and with a bottom floor at least partially formed of air evacuation means, further comprising aimed air nozzles (6) within said enclosure, **characterized in that** said drying device comprises blowing means (2) provided outside said enclosure (10), connected to said individually aimed air nozzles (6) whereas portions of said filter means (5) forming at least part of a ceiling surface (40) of said enclosure (10) are interposed between said blowing means (2) and said nozzles (6), by being pinched between two parts of a chamber (4) of a nozzle device (4,6).

8. Drying device according to claim 7, **characterized in that** said aimed air nozzles are individually aimed air nozzles.

9. Drying device according to claim 7, **characterized in that** said aimed air nozzles are individually aimed air nozzles capable to be individually oriented.

10. Drying device according to any one of claims 7 - 9, **characterized in that** said blowing means (2) outside said enclosure (10) draw air from a so called plenum area (30) above said enclosure.

11. Device (20) for circulating aimed air flow in a drying booth (10) for painted bodies, comprising a top ceiling at least partially formed of filter means (5) for incoming air, and directional air nozzles (6) and blowing means (2) feeding said directional air nozzles (6), **characterized in that** said circulation device (20) comprises blowing means (2) to be provided outside said drying booth (10), connected to said directional air nozzles (2) to be provided within said drying booth (10), whereas portions of said filter means (5) forming at least part of a ceiling surface (40) for said enclosure (10) are interposed between said blowing means (2) and said nozzles (6), by being pinched between two parts of a chamber (4) of a nozzle device (4, 6).

12. Circulation device according to claim 9, **characterized in that** said directional air nozzles are each directed in a selected direction and, preferably, able to be individually oriented.

13. Circulation device according to any one of claims 11 and 12, **characterized in that** said blowing means outside said enclosure draw air from a so called plenum area above said enclosure.

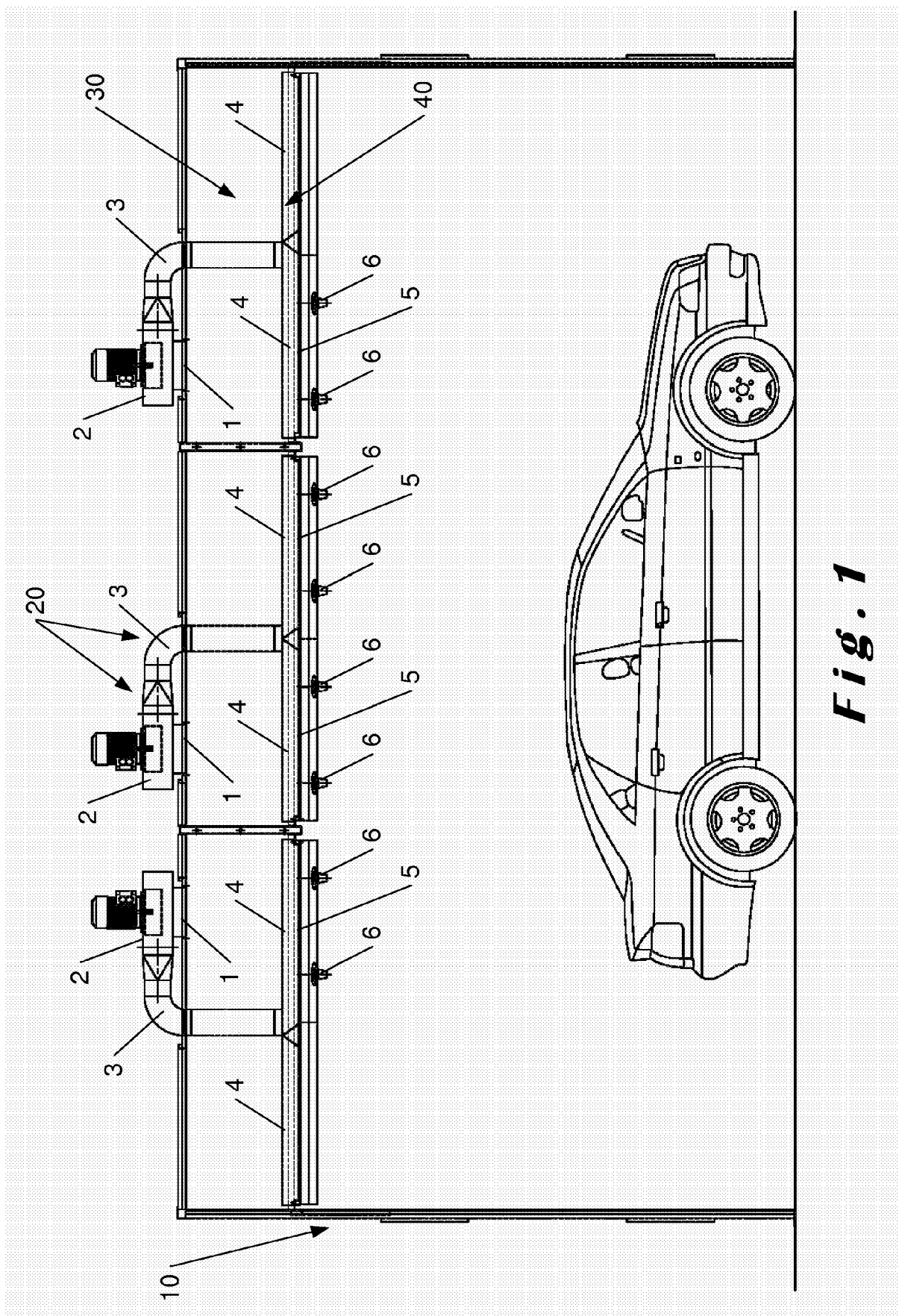


Fig. 1

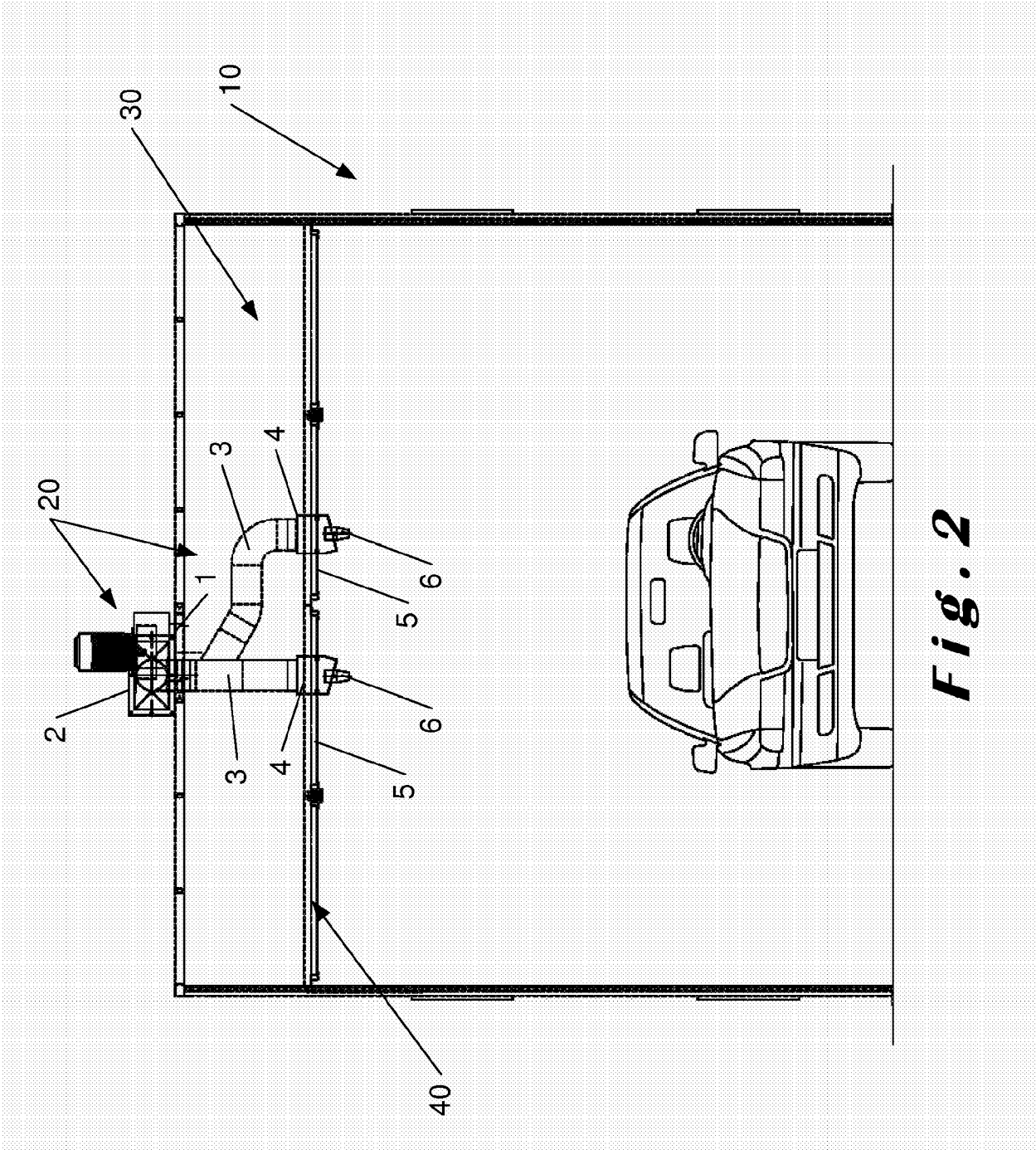


Fig. 2

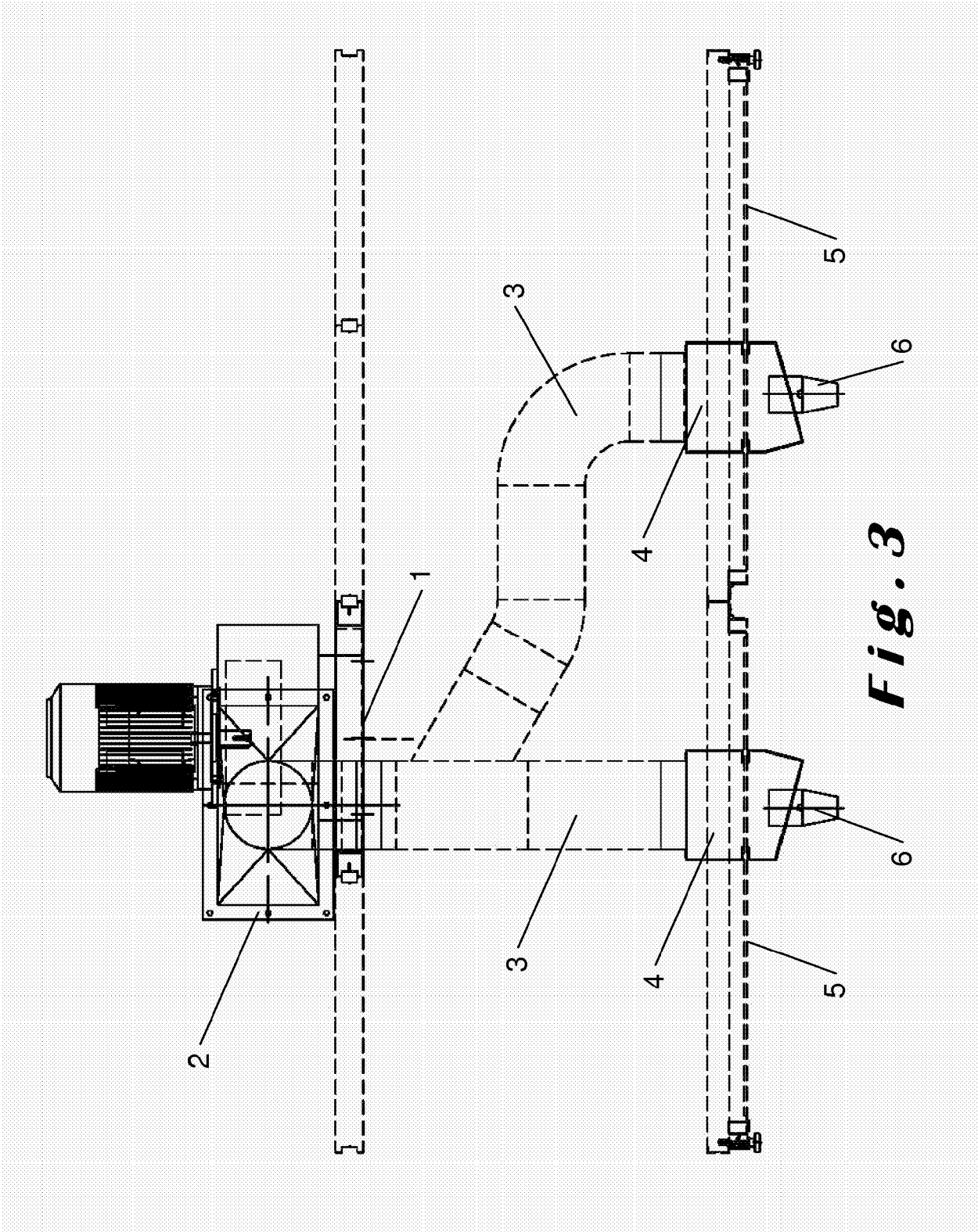


Fig. 3



European Patent
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EUROPEAN SEARCH REPORT

Application Number
EP 07 10 3603

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The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (IPC)
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Place of search		Date of completion of the search	Examiner
The Hague		8 August 2007	GARRIDO GARCIA, M
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EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
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EP 07 10 3603

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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