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(54) **A method for maintenance of an exhaust air ductwork and an apparatus for accessing an exhaust air ductwork**

(57) The present invention relates to the field of field of air ventilation systems and air conditioning systems used e.g. in homes, in businesses, in hotels, in passenger vessels and in hospitals, and more particularly to a method for maintenance of an exhaust air ductwork and an apparatus for accessing an exhaust air ductwork. An apparatus for accessing an exhaust air ductwork whilst said exhaust air ductwork is in use according to the present invention has a suction chamber suitable for fitting airtight around an outlet valve of an exhaust air duct, which suction chamber has at least one airtight lead-in (5), (9), through which at least one airtight lead-in (5), (9) the exhaust air ductwork can be accessed, a pair of airtight arranged work gloves (10) suited for manual removal of the outlet valve of an exhaust air duct, an air pressure measurement device (11) suited for measuring the air pressure of the exhaust air duct, and a connection (6) for an adjustable suction fan, which connection (6) has an adjustable valve (7) suited for regulating the suction air pressure of the exhaust air duct when said suction fan is not in use.

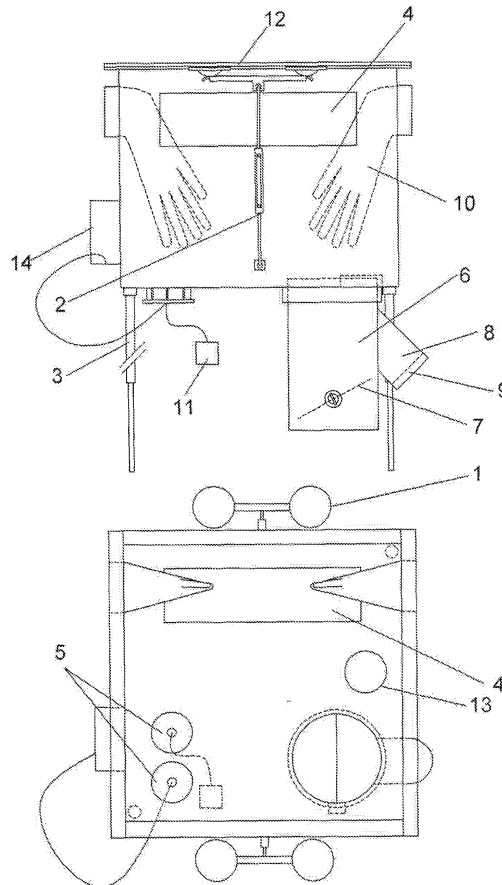


Fig. 2

Description

FIELD OF THE INVENTION

[0001] The present invention relates to the field of air ventilation systems and air conditioning systems used e.g. in homes, in businesses, in hotels, in passenger vessels and in hospitals, and more particularly to a method for maintenance of an exhaust air ductwork and an apparatus for accessing an exhaust air ductwork.

BACKGROUND OF THE INVENTION

[0002] Air ventilation systems and air conditioning systems have been long used in homes and businesses to provide fresh air to premises. Typically fresh air is taken from outside and distributed to each room through supply inlet valves. In most applications the outside air is filtered and/or conditioned to ensure fresh air to premises. As there is fresh air coming in through supply inlet valves the exhaust air ductwork of air ventilation system is used to carry the used air from the premises to outside. The exhaust air ductwork is an essential part of the air ventilation system and needs to be kept clean in order to ensure a proper flow of air.

[0003] In commonly used cleaning and maintenance methods of the exhaust air ductwork all the components of the air ventilation system or the air conditioning system i.e. the supply fans and the air conditioners as well as the exhaust fans are to be turned off during the cleaning and maintenance.

[0004] Typical exhaust air ductwork consists of main exhaust ducts leading air from the premises to outside and branch exhaust ducts leading air to the main exhaust ducts. The exhaust air ductwork cleaning and maintenance operation is typically started from the branch exhaust ducts and then carried out towards the main ductwork. In typical cleaning methods the entire exhaust air ductwork has to be cleaned at one time as the impurities from the branched ducts are conveyed towards the main ductwork during the cleaning operation.

[0005] Especially in larger ventilation and air conditioning applications it is very problematic to have the exhaust air ductwork cleaned and maintained as this would require to have the components of the ventilation and air conditioning applications to be turned off and to be kept turned off for the length of the cleaning and maintenance process of the entire exhaust air ductwork.

[0006] For example, passenger vessels used in non-stop cruise traffic typically stay at port only for a short time necessary for the outgoing passengers to disembark and for the incoming passengers to embark. With these vessels the maintenance intervals are typically years and maintenance duration is typically only few days. Therefore due to time pressure proper exhaust air ductwork maintenance is often found impossible to be carried out. In larger ventilation and air conditioning applications it is usually found that the detail drawings on the exhaust air

ductwork as installed are not available. This makes the planning of the exhaust air ductwork maintenance even more difficult.

[0007] In critical ventilation and air conditioning applications such as for example in hospitals and in precision industrial applications there is a demand for the ventilation and air conditioning applications to be always turned on. In such critical applications there is often a need to clean some parts of the exhaust air ductwork more often than the mandatory maintenance intervals dictate. Nowadays, the commonly used cleaning and maintenance methods of the exhaust air ductwork rely on connecting of a suction fan to the main exhaust duct. This usually requires some temporary changes to existing structures.

[0008] In a main exhaust duct the air flow and air flow volume are typically greater than in a branch exhaust duct. Greater air flow and air flow volume prevents impurities from sticking into the walls of the main exhaust ductwork. It is often found that most of the impurities in the exhaust air ductwork are cumulated in the walls of the branch exhaust ductwork.

[0009] In the branch exhaust ductwork the speed and volume of the air flow is usually kept low due to the desired convenience and noise level. Impurities are easily collected to the branch exhaust ducts of the exhaust air ductwork due to low air flow and flow volume and also due to dust and moisture. For example in toilet or in shower as the moist air is lead into a branch exhaust duct, the surface of the duct becomes wet and dust easily accumulates into the wet branch exhaust duct surface. This could easily be seen by removing the outlet valve of the exhaust air duct.

[0010] However, the removal of an outlet valve of an exhaust air duct in order to check the status of a branch exhaust duct is not suitable while the ventilation and air conditioning applications are running. This would lead to an uncontrolled growth of the air flow volume in said branch exhaust duct and the impurities in said branch exhaust duct would be conveyed to the main exhaust duct. Subsequently the air flow volume in other branch exhaust ducts would substantially diminish and would even cause a risk of backward air flow. This is highly unacceptable especially in critical ventilation and air conditioning applications. For example in a hospital the air flow from one room to another room always opens possibilities for spreading of diseases.

[0011] Commonly used prior art cleaning and maintenance methods of the exhaust air ductwork have proven not to be satisfactory especially in critical ventilation and air conditioning applications. There is a clear demand in the market for a method for maintenance of an exhaust air ductwork and an apparatus for accessing an exhaust air ductwork whilst said exhaust air ductwork is in use.

BRIEF DESCRIPTION OF THE INVENTION

[0012] An object of the present invention is thus to provide a method and an apparatus for implementing the

method so as to overcome the above problems and to alleviate the above disadvantages.

[0013] The objects of the invention are achieved by a method for maintenance of an exhaust air ductwork whilst said exhaust air ductwork is in use, which method has the steps of:

- measuring the initial air pressure of an exhaust air duct,
- fitting a suction chamber airtight around an outlet valve of the exhaust air duct,
- manually removing the outlet valve of an exhaust air duct with help of a pair of airtight arranged work gloves,
- measuring the air pressure of the exhaust air duct with an air pressure measurement device and regulating the suction air pressure of the exhaust air duct with an adjustable valve or with an adjustable suction fan,
- accessing said exhaust air duct through at least one airtight lead-in.

[0014] Preferably, said suction air pressure of the exhaust air duct is precisely regulated by a pressure monitoring device equipped with said adjustable suction fan. Preferably, said exhaust air duct is accessed with a camera unit and/or with a measurement unit. Preferably, said exhaust air duct is accessed with a duct cleaning brush for cleaning of said exhaust air duct. Preferably, said exhaust air ductwork is carried out stepwise so that air is prevented from flowing from one room to another.

[0015] Furthermore, the objects of the invention are achieved by an apparatus for accessing an exhaust air ductwork whilst said exhaust air ductwork is in use, which apparatus has a suction chamber suitable for fitting airtight around an outlet valve of an exhaust air duct, which suction chamber has:

- at least one airtight lead-in, through which at least one airtight lead-in the exhaust air ductwork can be accessed,
- a pair of airtight arranged work gloves suited for manual removal of the outlet valve of an exhaust air duct,
- an air pressure measurement device suited for measuring the air pressure of the exhaust air duct, and
- a connection for an adjustable suction fan, which connection has an adjustable valve suited for regulating the suction air pressure of the exhaust air duct when said suction fan is not in use.

[0016] Preferably, said suction chamber is equipped with sealing devices and fastening devices for airtight fitting of said suction chamber around an outlet valve of an exhaust air duct. Preferably, said suction chamber is equipped with a fitting device for airtight fitting of said suction chamber around an outlet valve of an exhaust air duct. Preferably, said apparatus has a camera unit or a

measurement unit or a duct maintenance unit or a duct cleaning brush suited for entering the exhaust air duct through the at least one airtight lead-in. Preferably, one lead-in of the said at least one airtight lead-in of the said suction chamber is arranged through said connection.

[0017] Preferably, said apparatus has an adjustable suction fan suited for regulating the suction air pressure of the exhaust air duct connected to said connection. More preferably, said adjustable suction fan is equipped with a pressure monitoring device for precise regulation of the suction air pressure of the exhaust air duct connected to said connection. Preferably, at least part of the casing of said suction chamber is arranged to be transparent. More preferably, said suction chamber is equipped with a lighting fixture.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018]

Figure 1 shows one embodiment of an apparatus for accessing an exhaust air ductwork according to the present invention;

Figure 2 shows another embodiment of an apparatus for accessing an exhaust air ductwork according to the present invention.

[0019] In the following the invention will be described in greater detail by means of preferred embodiments with reference to the accompanying drawings of Figures 1-2.

DETAILED DESCRIPTION OF THE INVENTION

[0020] Figure 1 shows one embodiment of an apparatus for accessing an exhaust air ductwork according to the present invention. In the figure the lower part shows a side view and the upper part shows a top view of the apparatus when fitted airtight around an exhaust air duct outlet valve located on wall.

[0021] The apparatus for accessing an exhaust air ductwork whilst said exhaust air ductwork is in use according to the present invention has a suction chamber suitable for fitting airtight around an outlet valve of an exhaust air duct. The suction chamber of the apparatus for accessing an exhaust air ductwork according to the present invention has at least one airtight lead-in 5, 9, through which at least one airtight lead-in 5, 9 the exhaust air ductwork can be accessed and a connection 6 for an adjustable suction fan.

[0022] The suction chamber according to the present invention has also a pair of airtight arranged work gloves 10 suited for manual removal of the outlet valve of an exhaust air duct and an air pressure measurement device 11 suited for measuring the air pressure of the exhaust air duct. Furthermore the suction chamber according to the present invention also has a connection 6 for an adjustable suction fan, which connection 6 has an adjustable valve 7 suited for regulating the suction air pressure

of the exhaust air duct when said suction fan is not in use. In this embodiment one lead-in 9 of the said at least one airtight lead-in 5, 9 of the said suction chamber is arranged through branch 8 of the connection 6.

[0023] The suction chamber of the apparatus for accessing an exhaust air ductwork according to the present invention may also be equipped with sealing devices 12 and fastening devices 1, 2, 3 for airtight fitting of said suction chamber around an outlet valve of an exhaust air duct. At least part of the casing of the suction chamber according to the present invention may be arranged to be transparent. For example the suction chamber may have windows 4 through which one can monitor the actions inside the suction chamber.

[0024] Figure 2 shows another embodiment of an apparatus for accessing an exhaust air ductwork according to the present invention. In the figure the lower part shows a side view and the upper part shows a top view of the apparatus when fitted airtight around an exhaust air duct outlet valve located on wall.

[0025] Another embodiment of an apparatus according to the present invention has a suction chamber suitable for fitting airtight around an outlet valve of an exhaust air duct. The suction chamber of another embodiment of an apparatus has at least one airtight lead-in 5, 9 through which the exhaust air ductwork can be accessed and a connection 6 for an adjustable suction fan. The suction chamber has also a pair of airtight arranged work gloves 10 suited for manual removal of the outlet valve of an exhaust air duct and an air pressure measurement device 11 suited for measuring the air pressure of the exhaust air duct and a connection 6 for an adjustable suction fan with an adjustable valve 7. Also in this embodiment one lead-in 9 of the said at least one airtight lead-in 5, 9 of the said suction chamber is arranged through branch 8 of the connection 6. The suction chamber of another embodiment of an apparatus is equipped with sealing devices 12 and fastening devices 1, 2, 3 for airtight fitting of said suction chamber around an outlet valve of an exhaust air duct. The suction chamber has also windows 4 through which one can monitor the actions inside the suction chamber.

[0026] The suction chamber of another embodiment of an apparatus according to the present invention is also equipped with a lighting fixture 13. Furthermore, another embodiment of an exhaust air ductwork access apparatus has an adjustable suction fan suited for regulating the suction air pressure of the exhaust air duct connected to the connection 6. The adjustable suction fan is equipped with a pressure monitoring device 14 for precise regulation of the suction air pressure of the exhaust air duct connected to the connection 6.

[0027] When the apparatus for accessing an exhaust air ductwork according to the present invention is used for maintenance of an exhaust air ductwork whilst said exhaust air ductwork is in use first the initial air pressure of an exhaust air duct is measured. The air flow volume in the branch exhaust duct is measured to ensure that

the air flow value can be kept at the same level after the maintenance operation. The air pressure of the branch exhaust duct behind the outlet valve is also measured. After the initial air pressure measurement the suction chamber is fitted airtight around an outlet valve of the exhaust air duct.

[0028] The suction chamber according to the present invention may have one side open for positioning the suction chamber around an outlet valve of an exhaust air duct. The open side of the suction chamber is equipped with sealing devices 12 so that when the open side of the suction chamber is pressed against a wall or a ceiling the connection becomes essentially airtight. The fastening devices 1, 2, 3 of the suction chamber may be used such as suction pads 1 for fastening, a rigging screw 2 for tightening and telescopic arms 3 for securing said suction chamber around an outlet valve of an exhaust air duct. In some cases e.g. when the outlet valve of an exhaust air duct is not on wall or on ceiling a separate fitting device may be used for airtight fitting of said suction chamber around an outlet valve of an exhaust air duct. When the suction chamber is being positioned and fastened the adjustable valve 7 is kept open to ensure that the air flow from the outlet valve of the exhaust air duct does not alter substantially. Also the air duct accessing units such as a camera unit, a measurement unit and a duct cleaning brush can already be inside the suction chamber.

[0029] When the suction chamber is in place the outlet valve of an exhaust air duct is removed manually with help of a pair of airtight arranged work gloves 10. As the outlet valve of an exhaust air duct is being removed at the same time the air pressure of the exhaust air duct is measured with an air pressure measurement device 11 and consequently the suction air pressure of the exhaust air duct is regulated with an adjustable valve 7 or with an adjustable suction fan. For example the valve 7 is adjusted so that the pressure drop caused by the suction chamber corresponds to the initial pressure drop caused by the outlet valve of an exhaust air duct. When the outlet valve of an exhaust air duct has been removed typically said exhaust air duct is first accessed with a camera unit. Said camera unit is substantially small in diameter so that the effect the camera unit has the air pressure of the exhaust air duct can typically be compensated with the adjustable valve 7. The camera unit can be accompanied by a measurement unit or a measurement unit can be used separately to access said exhaust air duct. The camera unit and/or the measurement unit can be used for inspection of the exhaust ductwork even beyond the said exhaust air duct. The pair of airtight arranged work gloves 10 can be used to control the moving of said camera unit and/or the measurement unit.

[0030] In the cleaning phase said exhaust air duct is accessed with a duct cleaning brush. Before accessing said exhaust air duct for cleaning a suction fan suited for regulating the suction air pressure of the exhaust air duct is connected to the connection 6. Next said exhaust air

duct is accessed with a duct cleaning brush the at least one airtight lead-in 5, 9. The lead-in 9 of the said at least one airtight lead-in 5, 9 used for a duct cleaning brush may be arranged through connection 6. The cleaning of said exhaust air ductwork is carried out stepwise only one branch at a time so that air is prevented from flowing from one room to another.

[0031] As the cleaning of the exhaust air duct is carried out at the same time adjustable valve 7 is opened and the air pressure of the exhaust air duct is measured with the air pressure measurement device 11 and consequently the suction air pressure of the exhaust air duct is regulated with the adjustable suction fan. The air pressure drop in the exhaust air duct pressure drop caused by the cleaning operation can be compensated with the suction fan. Said suction fan has typically a stepless speed control. This way the pressure in said exhaust air duct can be kept constant and the impurities from said exhaust air duct can be removed with the help of said suction fan. The pressure is being regulated with the help of said air pressure measurement device 11. The pressure may be regulated throughout the entire cleaning operation so that only said exhaust air duct is affected. The pair of airtight arranged work gloves 10 can be used to control the moving of said duct cleaning brush. For circumstances where special precision is required said adjustable suction fan may be equipped with a pressure monitoring device 14 for precise regulation of the suction air pressure of the exhaust air duct connected to the connection 6.

[0032] With the help of the solution according to the present invention the exhaust air ductwork can easily be cleaned and maintained properly whilst said exhaust air ductwork is in use. The solution according to the present invention is especially well suited for critical ventilation and air conditioning applications.

Claims

1. A method for maintenance of an exhaust air ductwork whilst said exhaust air ductwork is in use, **characterized by** the steps of:

- measuring the initial air pressure of an exhaust air duct,
- fitting a suction chamber airtight around an outlet valve of the exhaust air duct,
- manually removing the outlet valve of an exhaust air duct with help of a pair of airtight arranged work gloves,
- measuring the air pressure of the exhaust air duct with an air pressure measurement device (11) and regulating the suction air pressure of the exhaust air duct with an adjustable valve (7) or with an adjustable suction fan,
- accessing said exhaust air duct through at least one airtight lead-in (5), (9).

2. A method according to claim 1, **characterized in that** said suction air pressure of the exhaust air duct is precisely regulated by a pressure monitoring device (14) equipped with said adjustable suction fan.

3. A method according to claim 1 or claim 2, **characterized in that** said exhaust air duct is accessed with a camera unit and/or with a measurement unit.

4. A method according to any one of claims 1 to 3, **characterized in that** said exhaust air duct is accessed with a duct cleaning brush for cleaning of said exhaust air duct.

5. A method according to claim 4, **characterized in that** the cleaning of said exhaust air ductwork is carried out stepwise so that air is prevented from flowing from one room to another.

6. An apparatus for accessing an exhaust air ductwork whilst said exhaust air ductwork is in use, **characterized in that** said apparatus has a suction chamber suitable for fitting airtight around an outlet valve of an exhaust air duct, which suction chamber has:

- at least one airtight lead-in (5), (9), through which at least one airtight lead-in (5), (9) the exhaust air ductwork can be accessed,
- a pair of airtight arranged work gloves (10) suited for manual removal of the outlet valve of an exhaust air duct,
- an air pressure measurement device (11) suited for measuring the air pressure of the exhaust air duct, and
- a connection (6) for an adjustable suction fan, which connection (6) has an adjustable valve (7) suited for regulating the suction air pressure of the exhaust air duct when said suction fan is not in use.

7. An exhaust air ductwork access apparatus according to claim 6, **characterized in that** said suction chamber is equipped with sealing devices (12) and fastening devices (1), (2), (3) for airtight fitting of said suction chamber around an outlet valve of an exhaust air duct.

8. An exhaust air ductwork access apparatus according to claim 6 or claim 7, **characterized in that** said suction chamber is equipped with a fitting device for airtight fitting of said suction chamber around an outlet valve of an exhaust air duct.

9. An exhaust air ductwork access apparatus according to any one of claims 6 to 8, **characterized in that** said apparatus has a camera unit or a measurement unit or a duct maintenance unit or a duct cleaning brush suited for entering the exhaust air

duct through the at least one airtight lead-in (5), (9).

10. An exhaust air ductwork access apparatus according to any one of claims 6 to 9, **characterized in that** one lead-in (9) of the said at least one airtight lead-in (5), (9) of the said suction chamber is arranged through said connection (6). 5
11. An exhaust air ductwork access apparatus according to any one of claims 6 to 10, **characterized in that** said apparatus has an adjustable suction fan suited for regulating the suction air pressure of the exhaust air duct connected to said connection (6). 10
12. An exhaust air ductwork access apparatus according to claim 11, **characterized in that** said adjustable suction fan is equipped with a pressure monitoring device (14) for precise regulation of the suction air pressure of the exhaust air duct connected to said connection (6). 15 20
13. An exhaust air ductwork access apparatus according to any one of claims 6 to 12, **characterized in that** at least part of the casing of said suction chamber is arranged to be transparent. 25
14. An exhaust air ductwork access apparatus according to claim 13, **characterized in that** said suction chamber is equipped with a lighting fixture (13). 30

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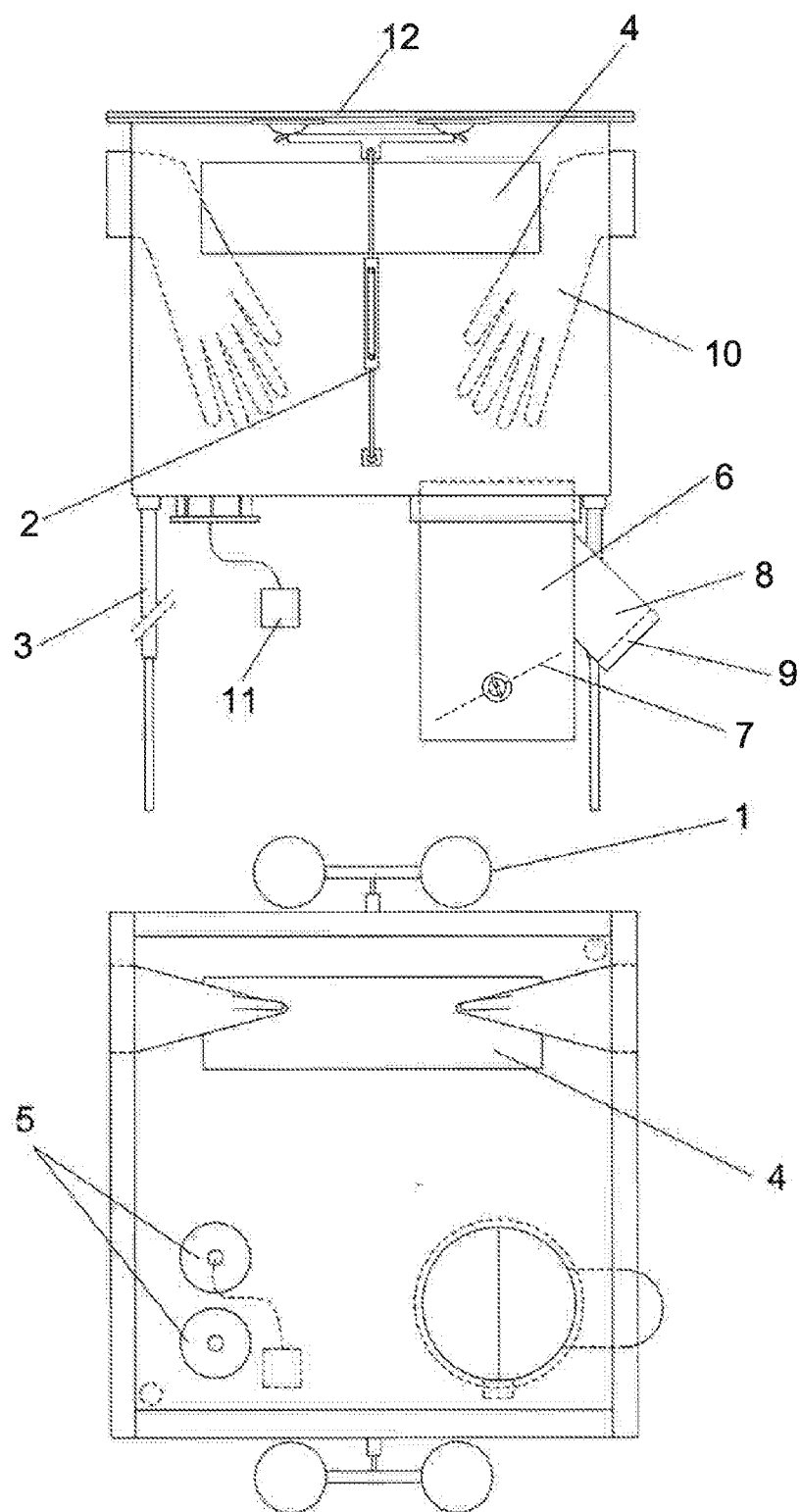


Fig. 1

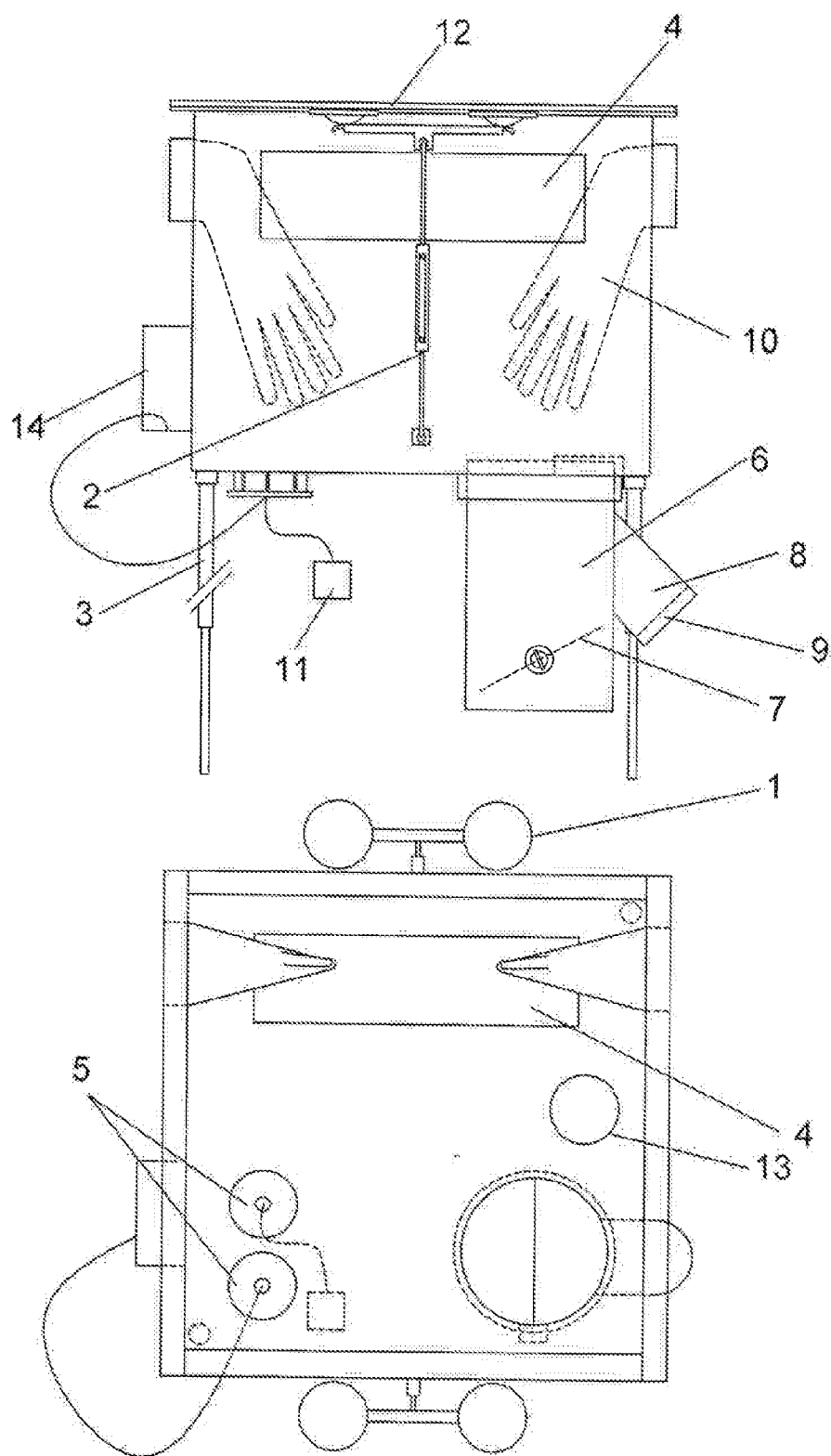


Fig. 2