



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
26.01.2011 Bulletin 2011/04

(51) Int Cl.:
D06F 58/20 (2006.01)

(21) Application number: **09425282.2**

(22) Date of filing: **14.07.2009**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO SE SI SK SM TR
Designated Extension States:
AL BA RS

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(54) **Air recirculation device for use with a dryer**

(57) The invention relates to an air recirculation device for use with a dryer, comprising an inlet of hot and humid air (14) which can be connected to the expulsion pipe of air from the dryer, an outlet of mixed air (16) which can be connected to the inlet air pipe of the dryer, an escape vent (18) of the hot air coming from the dryer, an intake (19) of fresh air from the outside environment and a humidity dosage valve (20) joined to said escape vent (18) and movable from a position of complete closure of said escape vent (18), wherein all the air coming from the inlet (14) is directed towards the outlet (16), and a position of total aperture, wherein all the air coming from the inlet is discharged outside and the outlet (16) is in communication with the fresh air intake (19) to emit air from the outside environment into the dryer, passing through a number of intermediate positions in which the air coming from the inlet is mixed with air coming from the outside environment. The device comprises, in addition, detection and control means able to perform measurements at least on the outgoing air correlated to the humidity of the air in the dryer and to correspondingly control the position of the humidity dosage valve.

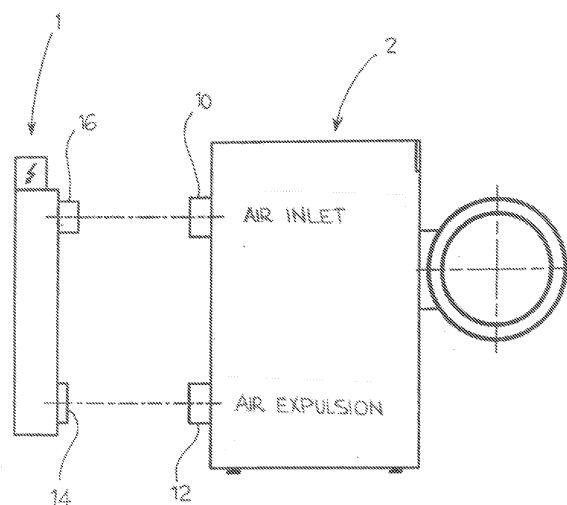


Fig. 3

Description

[0001] The present invention relates to an air recirculation device suitable for joining to a dryer, or drum dryer, for example for the laundry machine sector, and a method of re-utilising the hot air expelled from said dryer.

[0002] As is known, one type of these dryers uses an electric resistor to heat the incoming air used to dry the clothes in the machine drum. The energy consumption of these machines is high. In addition, the hot air expelled from the dryer is dispersed into the environment, for example through an outlet chimney.

[0003] The need is therefore deeply felt to recover this outgoing hot air so as to achieve an energy saving.

[0004] Some solutions for recovery of the hot air have already been proposed. However, none of these has proved particularly efficient, and in any case the known solutions are complicated and expensive to produce. In fact, they have met with little success and their use is extremely limited.

[0005] For example, a recovery device has been proposed which uses a refrigerator unit to condense the humidity and recover the air. However this solution entails higher energy consumption, management of drainage of a considerable amount of water, costly maintenance, the need to periodically clean the condensation group and check the coolant as well as very high initial costs for a modest yield.

[0006] The purpose of the present invention is to propose a recirculation device and a method of recovering the air which make it possible to recover most of the hot air leaving the dryer so as to achieve a significant energy saving.

[0007] Another purpose of the invention is to make available a recirculation device which combines high efficiency and yield in terms of energy saving with structural simplicity, making it extremely reliable and advantageous to manufacture, install and maintain.

[0008] Such purpose is achieved by a device according to claim 1 and with a method according to claim 6. The dependent claims describe preferred or advantageous embodiments of the recirculation device and of the recovery method.

[0009] The characteristics and advantages of the recirculation device according to the invention will in any case be more evident from the description below of its preferred, but non limiting, embodiments, with reference to the attached drawings, wherein:

[0010] - Figure 1 schematically illustrates an air recirculation device according to the invention;

[0011] - Figure 2 is an elevated view of the recirculation device;

[0012] - Figure 3 is a view of the recirculation device and of a drying machine, separately; and

[0013] - Figure 4 shows an example of a humidity dosage valve.

[0014] In said figures, reference numeral 1 globally denotes an air recirculation device suitable for being joined

to a dryer or drum dryer 2.

[0015] The dryer 2 has an inlet pipe 10 of air from the outside, heating devices of the air (not shown), and an expulsion pipe 12 of the hot air to the outside.

[0016] According to a general embodiment, the air circulation device 1 comprises an inlet 14 of hot and humid air which can be connected to the expulsion pipe 12 of the dryer, an outlet 16 of mixed air which can be connected to the inlet pipe 10 of the dryer, a hot air escape vent 18, that is of humid air, communicating with the outside environment, and a fresh air intake 19, that is of air with little humidity, from the outside environment.

[0017] A humidity dosage valve 20 is associated to the escape vent 18, said valve being movable between a position of total closure of the escape vent 18, wherein all the air coming from the inlet 14 is directed towards the outlet 16, and a position of total opening, wherein all the air coming from the inlet 14 is discharged outside through the vent 18 and wherein the outlet 16 communicates only with the intake 19 to emit air from the outside environment into the dryer. The valve 20 can be blocked in a number of intermediate positions, in which the air coming from the inlet 14 is mixed with the air coming from the outside environment through the intake 19 before being re-emitted into the dryer.

[0018] According to one embodiment, inside the recirculation device 1 there is a bulkhead 3 which defines a first air passage 4 from the inlet 14 to the outlet 16 and a second air passage 5 from the fresh air intake 19 to the outlet 16.

[0019] Advantageously, the dosage valve 20 is positioned along the first air passage 4 so that, when it is in the position of total opening of the escape vent 18, it fully closes such first passage 4 downstream both of the inlet 14 and of the escape vent 18. In this condition therefore, the outlet 16 communicates only with the outside environment through the intake 19 and the second air passage 5.

[0020] The recirculation device 1 also comprises detection and control means able to perform, at least on the outgoing air, measurement of a parameter correlated to the humidity of the air in the dryer and to control the position of the dosage valve 20 so as to emit into the dryer a flow of air such as to keep the humidity inside it below a pre-set threshold.

[0021] For example, such pre-set threshold is 70%.

[0022] According to one embodiment, said detection and control means comprise a humidity probe placed along the passage of air towards the outlet 16.

[0023] According to a preferred embodiment, in place of, or in combination with the humidity probe, said detection and control means comprise a first temperature probe 22 of the incoming air from the dryer and a second temperature probe 24 of the outgoing air.

[0024] According to one embodiment, the humidity dosage valve 20 is a blade valve driven to rotate by an electric motor 26.

[0025] Advantageously, such blade valve comprises a

fixed plate 30 joined to the rotation shaft 27 of the electric motor and, facing each side of said fixed plate, a closure plate 32 elastically coupled to the fixed plate. For example, the closure plates 32 are coupled to the fixed plate 30 by springs 34.

[0026] Advantageously, in addition, the recirculation device 1 is heat-insulated from the outside, for example by a rock wool coating, to maintain the heat accumulated by the passage of hot air.

[0027] The recovery method of the hot air expelled from the dryer using the recirculation device described above is as follows.

[0028] The device is placed beside the dryer so that the inlet 14 is connected to the expulsion pipe of the dryer and the outlet 16 is connected to the inlet pipe of the dryer.

[0029] Then, a measurement of a parameter correlated to the humidity of the air in the dryer is performed on the air coming out of the device at least. Depending on such measurement, the position of the dosage valve is adjusted so as to emit into the dryer a flow of air such as to keep the humidity inside it below a pre-set threshold.

[0030] In the preferred case of using temperature probes, the humidity of the air in the dryer is estimated by the measurement and comparison of the air temperature coming into the recirculation device from the dryer through the inlet 14 and the outgoing temperature from the recirculation device towards the dryer.

[0031] Without being bound to any specific theory, it was found that if the temperature T_{in} of the incoming air flow from the dryer is below a value T_{min} between 40-50 °C, for example 45°C, such air flow has too much humidity and must be completely discharged through the escape vent 18, for example, through an exit chimney. As a result the dosage valve is driven to open completely.

[0032] On the contrary, it was found that if the T_{in} temperature of the incoming air flow to the recirculation device from the dryer is above a value T_{max} between 60-70 °C, for example 65°C, such air flow is dry enough to be completely re-emitted into the dryer. As a result the dosage valve is driven to completely close the escape vent 18.

[0033] Within the $T_{min} - T_{max}$ range, the air flow from the dryer has a humidity content such as to require mixing with air from the outside environment.

[0034] Specifically, it was found that, to achieve the desired relative humidity inside the dryer, the difference between the T_{in} temperature of the incoming air flow and the temperature of the outgoing air flow from the recirculation device must be essentially equal to a predefined T_{diff} value, for example between 20°C and 30°C, preferably 27°C.

[0035] In other words, one aspect of the present invention consists of having discovered a rapport between the humidity inside the dryer and the temperatures of the incoming and outgoing air flows of the recirculation device.

[0036] Consequently, within the $T_{min} - T_{max}$ range the position of the humidity dosage valve is controlled in feed-

back to maintain the aforesaid temperature ratio. For example, the more the valve opens the escape vent 18, contemporaneously closing the first air passage 4, the more fresh air with a reduced humidity content is aspirated by the dryer from the outside environment through the intake 19. The more the valve closes the escape vent 18, opening the first passage 4, the more hot air with a certain humidity, coming out of the dryer is re-utilised and re-emitted into the dryer.

[0037] The relation between the temperatures of the air flows thus makes it possible to maintain the right balance between the temperature of the air to be emitted into the dryer, influenced more by the flow of outgoing hot air from the dryer itself, and its humidity, adjustable by aspiration of drier air from the outside environment.

[0038] According to one embodiment, the dosage valve is controlled in a discontinuous manner, at intervals of time, for example with a distance of time of two minutes between one command and the next so as to allow the air flow circulating in the dryer to steady after adjustment of the valve position. Among other things, some drying machines actually work at intermittence, during which the drum inverts the direction of rotation and the air aspiration stops.

[0039] The recirculation device according to the invention makes it possible to achieve an effective and significant saving of energy, up to 60% of the electricity normally used in an electric dryer.

[0040] It is worth noting that the recirculation device is simply and immediately installed. Among other things it prevents the need for an evacuation pipe of air from the dryer, thereby making it possible to position the dryer in places where there is no room for an outlet air pipe.

[0041] Device maintenance is practically null. In fact there are no filters and it does not require any special cleaning.

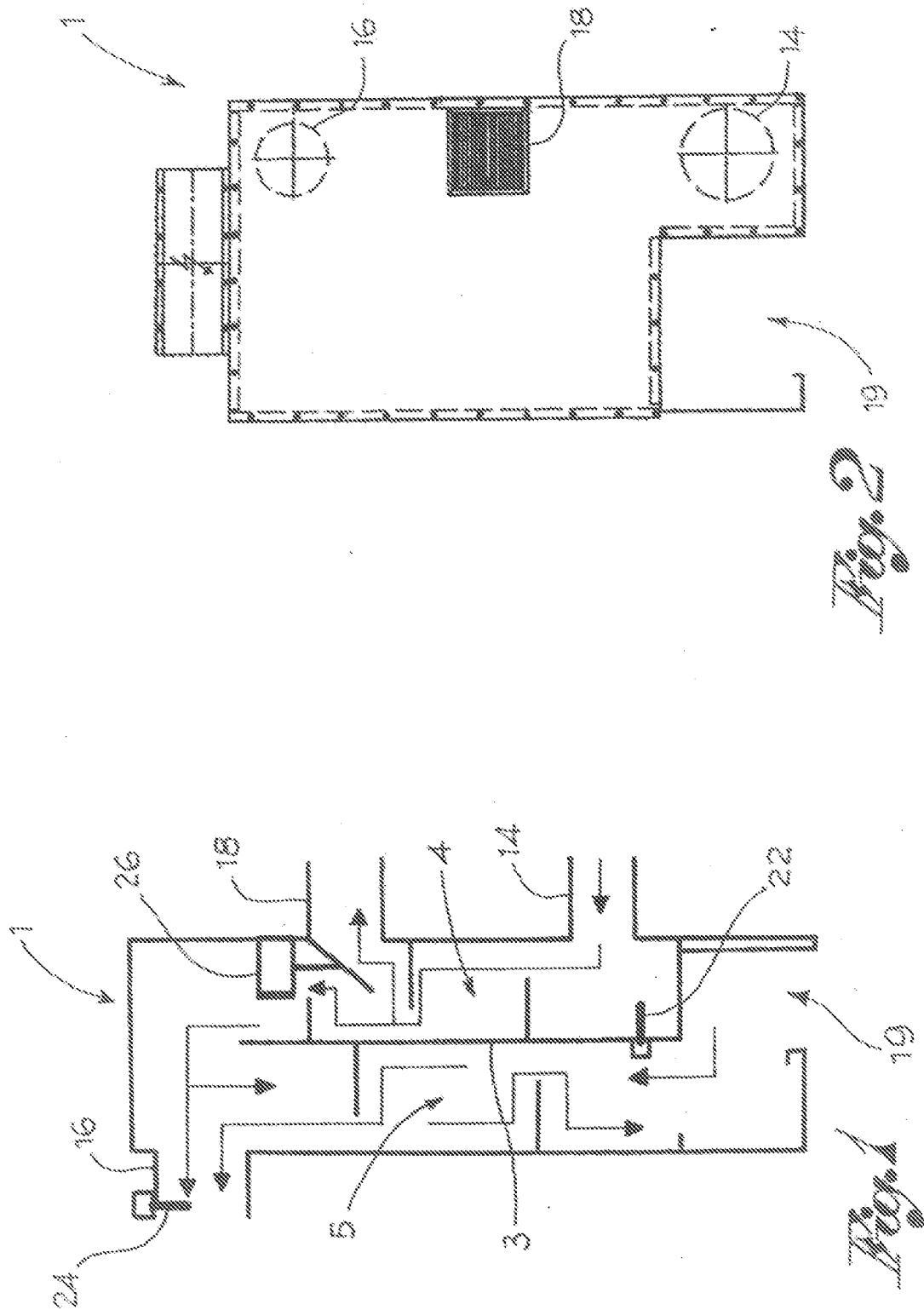
[0042] A person skilled in the sector may make modifications, adaptations and replacements of elements with others functionally equivalent, to the embodiments of the recirculation device and the hot air recovery method according to the invention while remaining within the scope of the following claims. Each of the characteristics described as belonging to a possible embodiment may be realised independently of the other embodiments described.

Claims

1. Air circulation device associable to a dryer, comprising:

- an inlet of hot and humid air (14) suitable to be connected to the expulsion pipe of air from the dryer;
- an outlet of mixed air (16) suitable to be connected to the air inlet pipe of the dryer;
- an escape vent (18) for the hot air coming from

- the dryer;
- an intake (19) of fresh air coming from the outside environment;
 - a humidity dosage valve (20) associated to said escape vent (18) and movable between a position of complete closure of said escape vent (18), wherein all the air coming from the inlet (14) is directed towards the outlet (16), and a position of complete aperture, wherein all the air coming from the inlet is discharged to the outside and the outlet (16) is in communication with the air intake (19) for emission into the dryer of fresh air from outside, passing through a number of intermediate positions in which the air coming from the inlet is mixed with the fresh air coming from outside; and
 - detection and control means able to perform, on the outgoing air at least, measurement of a parameter correlated to the humidity of the air in the dryer and to control the position of the dosage valve so as to emit into the dryer a flow of air such as to keep the humidity inside it below a predefined threshold.
2. Device according to claim 1, wherein said detection and control means comprise a humidity probe positioned along the passage of the air towards the outlet.
 3. Device according to claim 1 or 2, wherein said detection and control means comprise a temperature probe (22) of the incoming air coming from the dryer and a temperature probe (24) of the outgoing air.
 4. Device according to any of the previous claims, comprising internally a bulkhead (3) which defines a first air passage (4) from the inlet (14) to the outlet (16) and a second air passage (5) from the fresh air intake (19) to the outlet (16).
 5. Device according to claim 4, wherein the dosage valve (20) is positioned along the first air passage (4) so that when the escape vent (18) is completely open, it fully closes such first passage (4) downstream of both the inlet (14) and the escape vent (18).
 6. Device according to any of the previous claims, wherein the humidity dosage valve (20) is a blade valve driven to rotate by an electric motor.
 7. Device according to claim 6, wherein said blade valve (20) comprises a fixed plate joined to the rotation shaft of the electric motor and, facing each side of said fixed plate, a closure plate elastically coupled to the fixed plate.
 8. Method for re-utilising the air coming out from a dryer, comprising the phases of:
 - making available an air recirculation device according to any of the previous claims;
 - connecting the inlet of the device to the air expulsion pipe of the dryer;
 - connecting the outlet of the device to the air inlet pipe of the dryer;
 - performing, at least on the outgoing air, measurements of a parameter correlated to the humidity of the air in the dryer; and
 - checking the position of the dosage valve so as to emit into the dryer a flow of air such as to keep the humidity inside it below a pre-set threshold.
 9. Method according to claim 8, wherein the humidity of the air in the dryer is estimated by measuring and comparing the temperature of the air entering the recirculation device from the dryer and leaving the recirculation device towards the dryer.
 10. Method according to claim 9, wherein the humidity dosage valve is controlled so as to ensure a flow of air entering the dryer having a temperature of 20-30 °C below the temperature of the air flow leaving the dryer.
 11. Method according to any of the claims 8-10, wherein, if the temperature of the outgoing air from the dryer is less than about 40-50 °C, the dosage valve is activated so as to completely close the first passage of air so that only air from the outside environment flows into the dryer.
 12. Method according to any of the claims 8-11, wherein if the temperature of the outgoing air from the dryer is over about 60-70 °C, the dosage valve is activated so as to completely close the escape vent so as to re-emit in the dryer all the outgoing air from the dryer.



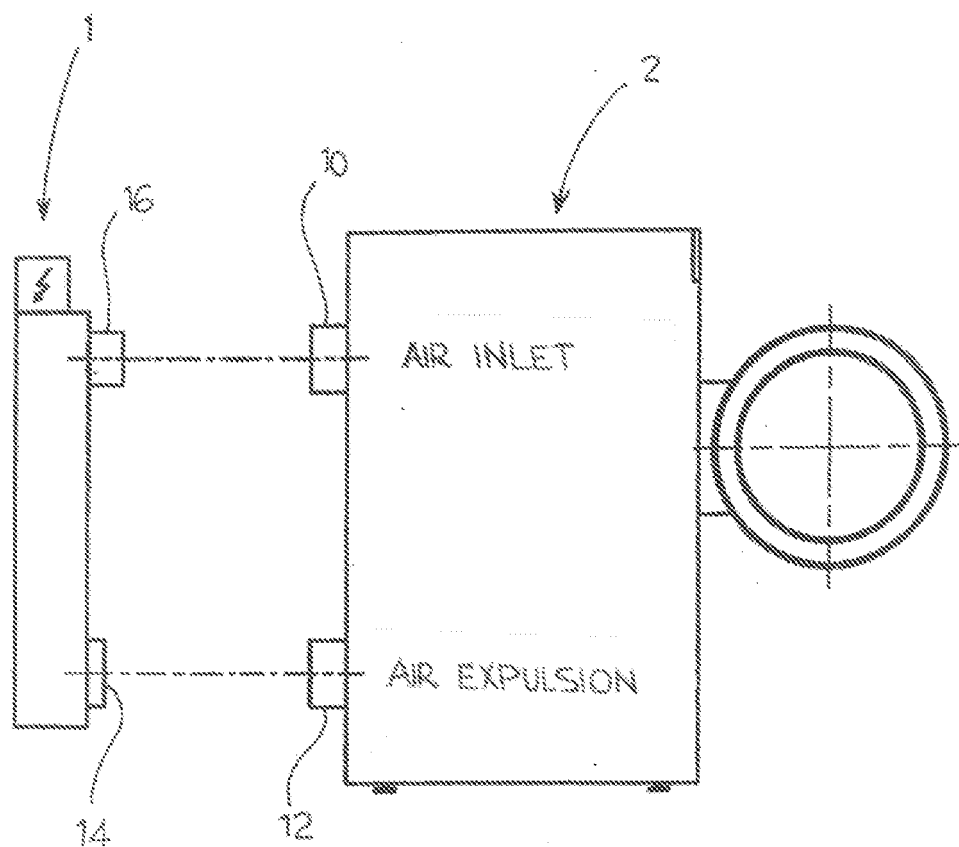


Fig. 3

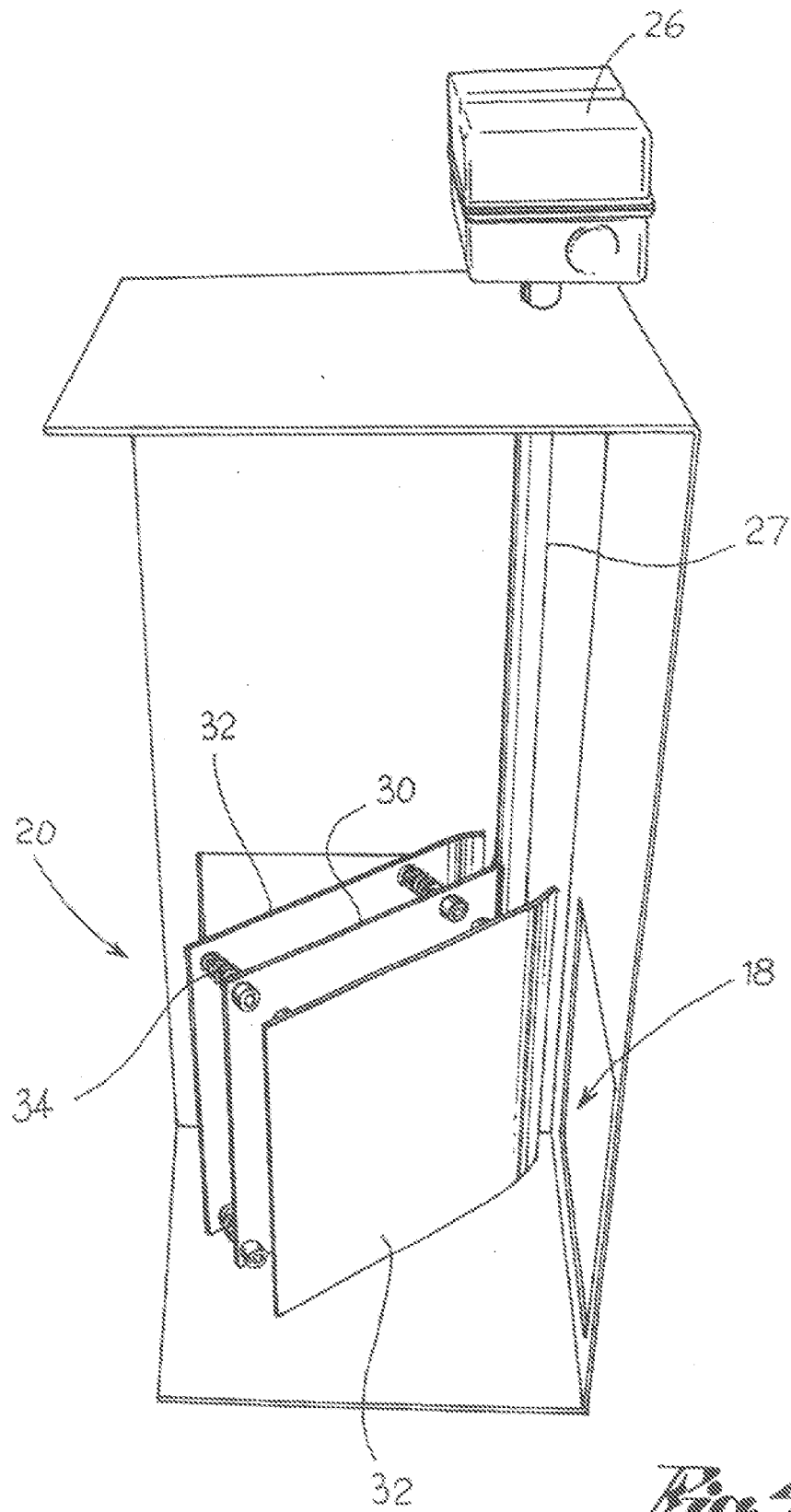


Fig. 4



EUROPEAN SEARCH REPORT

Application Number
EP 09 42 5282

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 2 November 2009	Examiner Westermayer, Wilhelm
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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EPO FORM 1503 03/82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
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