



(51) International Patent Classification:
D06F 58/20 (2006.01)

(21) International Application Number:
PCT/EP2011/058277

(22) International Filing Date:
20 May 2011 (20.05.2011)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
A 2010/04514 4 June 2010 (04.06.2010) TR

(71) Applicant (for all designated States except US): **ARCELIK ANONIM SIRKETI** [TR/TR]; E5 Ankara Asfalti Uzeri, Tuzla, 34950 Istanbul (TR).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **SAHIN, Yavuz** [TR/TR]; E5 Ankara Asfalti Uzeri, Tuzla, 34950 Istanbul (TR). **KOCATURK, Serdar** [TR/TR]; E5 Ankara Asfalti Uzeri, Tuzla, 34950 Istanbul (TR). **KAYA, Mehmet** [TR/TR]; E5 Ankara Asfalti Uzeri, Tuzla, 34950 Istanbul (TR).

(TR). **HARTOKA, Onur** [TR/TR]; E5 Ankara Asfalti Uzeri, Tuzla, 34950 Istanbul (TR).

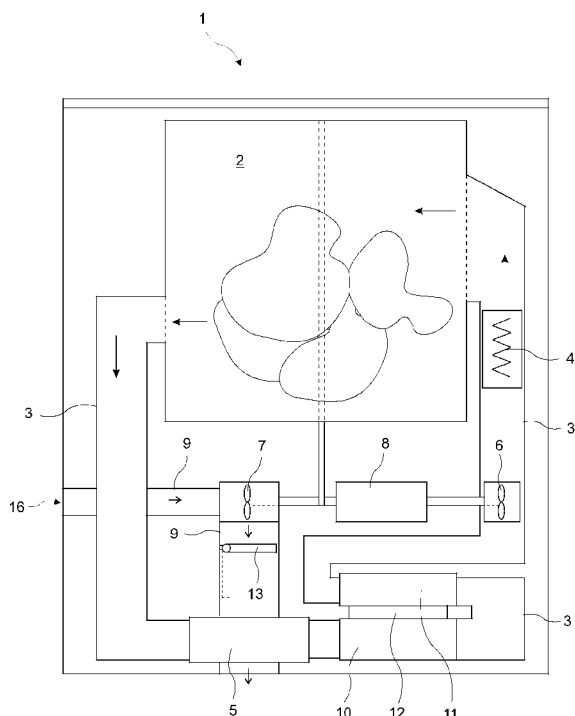
(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, 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, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, 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, ML, MR, NE, SN, TD, TG).

[Continued on next page]

(54) Title: A THERMOELECTRIC HEAT PUMP LAUNDRY DRYER WHEREIN ENERGY IS SAVED

Figure 1



(57) Abstract: The present invention relates to a laundry dryer (1) comprising a drum (2) wherein the laundry is placed, a drying duct (3) wherein the process air is circulated, a heater (4) that heats the process air, a condenser (5) that condenses the process air, a process air fan (6) that circulates the process air in the drying duct (3), a cooling fan (7) that cools the condenser (5), a motor (8) that drives the process air fan (6) and the cooling fan (7) together, a cooling duct (9) that directs the air sucked from the outer environment by the cooling fan (7) onto the condenser (5) and a thermoelectric heat pump (12) disposed in the drying duct (3), having a cold side (10) that condenses the process air passing thereover by cooling and a hot side (11) that heats the process air passing thereover.

Published:

- *without international search report and to be republished
upon receipt of that report (Rule 48.2(g))*

Description**A THERMOELECTRIC HEAT PUMP LAUNDRY DRYER WHEREIN ENERGY IS SAVED**

- [0001] The present invention relates to a laundry dryer which comprises a thermoelectric heat pump and wherein energy is saved by increasing the effectiveness of the thermoelectric heat pump.
- [0002] In laundry dryers wherein the drying air is circulated within a closed cycle, the drying air activated by a fan removes the moisture of the laundry by being passed over the laundry and the water vapor in the air is condensed at the condenser. The drying air dehumidified at the condenser is later heated by being passed over the heater and hot and dry air is delivered unto the laundry. In the state of the art, thermoelectric heat pumps, also called Peltier elements, are also used in laundry dryers in addition to the condenser and the heater. The thermoelectric heat pumps have hot and cold sides, and performs both the functions of condensing by cooling and also of heating the drying air. While the hot side of the thermoelectric heat pumps used in laundry dryers supports the heater, the cold side supports the condenser. In the process of drying the laundry, the drying air is cooled by some amount while being passed over the condenser, afterwards is passed over the thermoelectric heat pump and thereby dehumidification process of the drying air is realized in two steps. Similarly, the heating process is also realized in two steps. The drying air which is almost completely dehumidified of the moisture contained therein by passing through the condenser and the thermoelectric heat pump is heated some amount by being passed over the hot side of the thermoelectric heat pump and afterwards the heating process is completed by the drying air being passed over the heater. The cooling load of the condenser and the thermoelectric heat pump should be balanced for an efficient drying process in laundry dryers wherein the heater, the condenser and the thermoelectric heat pumps are used together. If the cooling load, that is the amount of air that needs to be cooled and condensed, is not evenly distributed to the condenser and the thermoelectric heat pump, the duration of the drying process is prolonged and energy consumption

increases. Particularly in the heating phase at the start of the drying process and the last drying phase at the end of the drying process, the cooling load becomes unbalanced to the disadvantage of the thermoelectric heat pump, a greater amount of the cooling load is compensated by the condenser and the cooling load of the thermoelectric heat pump decreases. Decrease in the cooling load of the thermoelectric heat pump results in the reduction of heating effectiveness and efficiency.

- [0003] In the laundry dryer explained in the European Patent No EP1108812, a process air fan is used for circulation of the process air and a cooling fan is used for cooling the condenser. Both of the fans are rotated by a single motor. In a portion of the drying cycle duration, cooling fan is rotated in the reverse direction to decrease the volumetric flow of air delivered unto the condenser.
- [0004] In the International Patent Application No. WO2008052906, a method is explained that is used for operating a laundry dryer and wherein energy is saved. In the applied method, in the heating phase at the start of the drying process, the process air fan is operated intermittently.
- [0005] The aim of the present invention is the realization of a laundry dryer which comprises a thermoelectric heat pump and wherein energy is saved by increasing the effectiveness of the thermoelectric heat pump.
- [0006] The laundry dryer realized in order to attain the aim of the present invention, explicated in the first claim and the respective claims thereof, comprises a thermoelectric (Peltier) heat pump having a hot side and a cold side, the process air activated by the process air fan continues its path in the drying duct after leaving the drum passing from respectively the condenser, the cold side, the hot side and the heater and is delivered again to the drum in dehumidified and heated state. In the heating phase at the start of the drying process and/or in the last drying phase at the end of the drying process, the air delivered to the condenser by being sucked from the outer environment is prevented or restricted by means of a valve placed in the cooling duct without the need to change the speed and operating direction of the motor rotating the cooling fan. Thus, in the phases of the said drying process, the function of cooling the process air is

predominantly transferred to the thermoelectric heat pump by decreasing the effectiveness of the condenser.

- [0007] In an embodiment of the present invention, the valve stops the cooling air flow to the condenser by completely closing the cooling duct in the heating phase at the start of the drying process and/or in the last drying phase at the end of the drying process.
- [0008] In another embodiment of the present invention, an opening having a narrower surface area than the cooling duct is arranged on the valve. When the valve is changed to the closed position in the heating phase at the start of the drying process and/or in the last drying phase at the end of the drying process, the air flow in the cooling duct is restricted by means of the opening and delivered to the condenser.
- [0009] In another embodiment of the present invention, an adjustment mechanism is disposed in the valve or the cooling duct that provides changing of the area of the opening.
- [0010] In another embodiment of the present invention, the valve is disposed between the cooling fan and the condenser.
- [0011] In another embodiment of the present invention, the valve is disposed at the cooling air inlet through which the cooling duct opens to the outside.
- [0012] In the laundry dryer of the present invention, in the heating phase at the start of the drying process and/or in the last drying phase at the end of the drying process, the cooling air delivered to the condenser is entirely cut off or the volumetric flow of the air is lowered by means of the valve, thereby effectiveness of the condenser is decreased, a large portion of condensation load of the condenser is transferred to the thermoelectric heat pump and energy is saved by increasing the efficiency of the thermoelectric heat pump.
- [0013] The laundry dryer realized in order to attain the aim of the present invention is illustrated in the attached figures, where:
- [0014] Figure 1 – is the schematic view of a laundry dryer.
- [0015] Figure 2 – is the schematic view of the cooling duct, condenser, cooling fan and the valve disposed in the cooling duct situated in a laundry dryer.
- [0016] Figure 3 – is the schematic view of the cooling duct, condenser, cooling

fan and the valve disposed in the cooling duct situated in a laundry dryer in another embodiment of the present invention.

[0017] The elements illustrated in the figures are numbered as follows:

1. Laundry dryer
2. Drum
3. Drying duct
4. Heater
5. Condenser
6. Process air fan
7. Cooling fan
8. Motor
9. Cooling duct
10. Cold side
11. Hot side
12. Thermoelectric heat pump
13. Valve
14. Opening
15. Adjustment mechanism
16. Cooling air inlet

[0018] The laundry dryer (1) comprises a body, a drum (2) wherein the laundry is placed, a drying duct (3) wherein the process air is circulated, a heater (4) that heats the process air, a condenser (5) that condenses the process air, a process air fan (6) that circulates the process air in the drying duct (3), a cooling fan (7) that cools the condenser (5), a motor (8) that drives the drum (2), the process air fan (6) and the cooling fan (7) together, a cooling duct (9) that directs the air sucked from the outer environment by the cooling fan (7) onto the condenser (5) and a thermoelectric heat pump (12) disposed in the drying duct (3), having a cold side (10) that condenses the process air passing thereover by cooling and a hot side (11) that heats the process air passing thereover.

[0019] In the laundry dryer (1) the process air activated by the process air fan (6) continues its path in the drying duct (3) after leaving the drum (2) by passing through the condenser (5), the thermoelectric heat pump (12) and

the heater (4) to be delivered again to the drum (2) in dehumidified and heated state. The condenser (5) is cooled with the air sucked by the cooling fan (7) from the outer environment and delivered by the cooling duct (9) and condenses the process air passing therethrough.

- [0020] The drying process is accomplished in three stages in the laundry dryer (1). The first stage of the drying process is named as the heating phase, in this phase the heater (4) is operated with a high runtime and the foremost aim is to heat the laundry dryer (1). The second stage of the drying process is named as the steady state or the drying phase and the heater (4) is operated in the drying process with a runtime that is predetermined for the steady state. The third stage of the drying process is named as the last drying phase. In this stage, the moisture contained in the process air is decreased substantially since the drying process is nearing the end, the runtime of the heater (4) is slowly decreased and the heater (4) is entirely turned off at the end of the predetermined time.
- [0021] The laundry dryer (1) of the present invention comprises a valve (13) disposed in the cooling duct (9) which prevents or restricts flow of the air delivered to the condenser (5) by closing the cooling duct (9) in the heating phase at the start of the drying process and/or in the last drying phase at the end of the drying process, without changing the speed and operating direction of the motor (8) rotating the cooling fan (7).
- [0022] In the laundry dryer (1), in the heating phase at the start of the drying process, the heater (4) and the thermoelectric heat pump (12) heat the process air by drawing a great amount of energy. Changing the condenser (5) to the passive position or decreasing its effectiveness in the heating phase until the temperature of the process air reaches the drying phase (steady state) value increases the efficiency of the drying process and decreases energy consumption. The valve (13) is closed in the heating phase at the start of the drying process, thereby preventing or restricting delivery of air from the cooling fan (7) to the condenser (5). Since effectiveness of the condenser (5) is decreased, the process air passes through the condenser (5) without being cooled and reaches the cold side (10) of the thermoelectric heat pump (12). The cooling load of the

thermoelectric heat pump (12) is increased by delivering the process air to the thermoelectric heat pump (12) in uncooled state, thereby the effectiveness of the hot side (11) is also increased in accordance with the operating principle of the thermoelectric heat pump (12) and the hot side (11) emits more heat to the process air.

[0023] In the second stage of the drying process, that is in the drying phase, the valve (13) is opened, allowing air flow from the cooling duct (9) to the condenser (5) and thus the condenser (5) is provided to accomplish its condensation function effectively.

[0024] In the last drying phase at the end of the drying process, the valve (13) is closed as in the heating phase at the start, preventing or restricting delivery of air from the cooling duct (9) to the condenser (5). Accordingly, the process air, even though the amount of humidity therein is decreased, passes from the condenser (5) without being condensed and reaches the cold side (10) of the thermoelectric heat pump (12) and the function of condensing the process air is transferred to the cold side (10). Thus, as in the heating phase at the start, more heat is emitted from the hot side (11) to the process air, the operating efficiency of the thermoelectric heat pump (12) increases and energy consumption decreases.

[0025] In an embodiment of the present invention, the valve (13) stops the cooling air flow to the condenser (5) by completely closing the cooling duct (9) in the heating phase at the start of the drying process and/or in the last drying phase at the end of the drying process.

[0026] In another embodiment of the present invention, the laundry dryer (1) comprises an opening (14) disposed on the valve (13), having a surface area narrower than the surface area of the cooling duct (9) in perpendicular direction to the air flow, that delivers cooling air flow to the condenser (5) by restricting but without entirely blocking in the heating phase at the start of the drying process and/or in the last drying phase at the end of the drying process (Figure 2).

[0027] In this embodiment, the condenser (5) is not changed entirely to the passive position in the heating phase and the last drying phase, the volumetric flow of the air flowing from the cooling duct (9) to the condenser

(5) is decreased by means of the opening (14) and the effectiveness of the thermoelectric heat pump (12) is increased by decreasing effectiveness of the condenser (5).

[0028] In an embodiment of the present invention, the laundry dryer (1) comprises an adjustment mechanism (15) disposed in the valve (13) or the cooling duct (9), providing the surface area of the opening (14) perpendicular to the air flow direction to be changed (Figure 3). The adjustment mechanism (15) provides the volumetric flow of the air passing through the opening (14) to be adjusted in the closed position of the valve (13) by increasing, decreasing the surface dimension of the opening (14).

[0029] In an embodiment of the present invention, the valve (13) is disposed inside the cooling duct (9) between the cooling fan (7) and the condenser (5).

[0030] In another embodiment of the present invention, the laundry dryer (1) comprises a cooling air inlet (16) through which the cooling duct (9) opens from the body to the outer environment and the valve (13) is disposed at the cooling air inlet (16).

[0031] In the laundry dryer (1), the air delivered from the cooling duct (9) to the condenser (5) by the cooling fan (7) is entirely cut off or the volumetric flow of the air is lowered by means of the valve (13) in the heating phase at the start of the drying process and in the last drying phase at the end of the drying process. In the mentioned stages of the drying process, the effectiveness of the condenser (5) is decreased, the function of condensing the process air by cooling it is transferred predominantly to the thermoelectric heat pump (12) and energy consumption is decreased by increasing the efficiency of the thermoelectric heat pump (12).

[0032] Furthermore, in the laundry dryer (1) of the present invention, since the drum (2), the process air fan (6) and the cooling fan (7) are rotated together by the motor (8), it is not necessary to stop or slow down the motor (8) for decreasing the effectiveness of the condenser (5).

[0033] It is to be understood that the present invention is not limited by the embodiments disclosed above and a person skilled in the art can easily introduce different embodiments. These should be considered within the

scope of the protection postulated by the claims of the present invention.

Claims

1. A laundry dryer (1) **comprising** a drum (2) wherein the laundry is placed, a drying duct (3) wherein the process air is circulated, a heater (4) that heats the process air, a condenser (5) that condenses the process air, a process air fan (6) that circulates the process air in the drying duct (3), a cooling fan (7) that cools the condenser (5), a motor (8) that drives the drum (2), the process air fan (6) and the cooling fan (7) together, a cooling duct (9) that directs the air sucked from the outer environment by the cooling fan (7) onto the condenser (5) and a thermoelectric heat pump (12) disposed in the drying duct (3), having a cold side (10) that condenses the process air passing thereover by cooling and a hot side (11) that heats the process air passing thereover, **characterized by** a valve (13) disposed in the cooling duct (9) that prevents or restricts the air flow delivered to the condenser (5) by closing the cooling duct (9) in the heating phase at the start of the drying process and/or in the last drying phase at the end of the drying process.
2. A laundry dryer (1) as in Claim 1, **characterized by** the valve (13) that cuts off cooling air flow to the condenser (5) by entirely closing the cooling duct (9).
3. A laundry dryer (1) as in Claim 1, **characterized by** an opening (14) disposed on the valve (13), having a narrower area than the cooling duct (9), which directs the cooling air flow to the condenser (5) by restricting it.
4. A laundry dryer (1) as in any one of the above Claims, **characterized by** an adjustment mechanism (15) disposed in the valve (13) or the cooling duct (9) and providing the area of the opening (14) to be changed.
5. A laundry dryer (1) as in any one of the above Claims, **characterized by** the valve (13) disposed between the cooling fan (7) and the condenser (5).
6. A laundry dryer (1) as in any one of the Claims 1 to 4, **characterized by** a cooling air inlet (16) through which the cooling duct (9) opens from the body to the outer environment and the valve (13) disposed to the cooling air inlet (16).

Figure 1

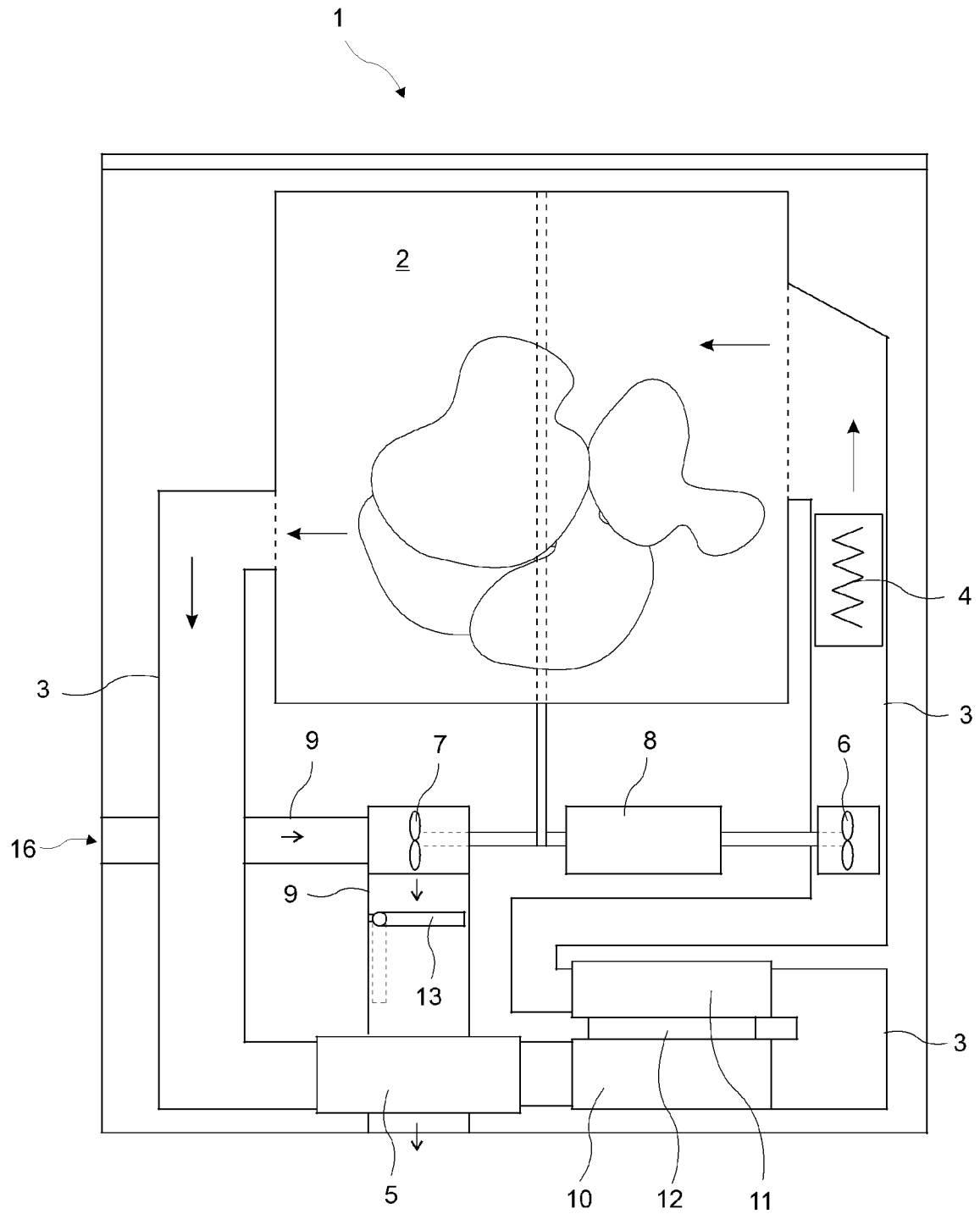


Figure 2

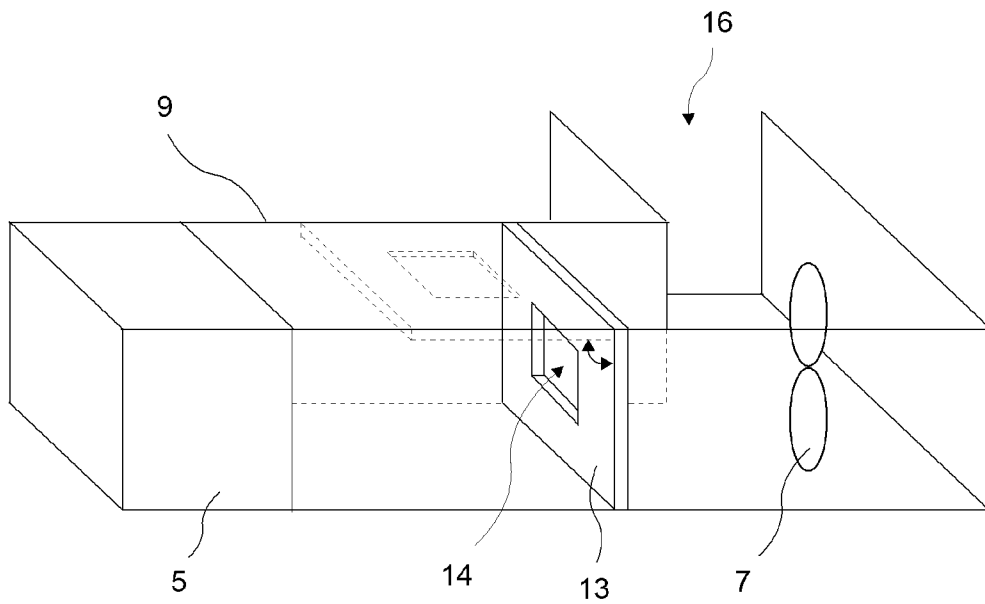


Figure 3

