(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 921 199 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
14.05.2008 Bulletin 2008/20

(51) Int Cl.:
D06F 58/00 *(2006.01)*

(21) Application number: **07021664.3**

(22) Date of filing: **07.11.2007**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IS IT LI LT LU LV MC MT NL PL PT RO SE SI SK TR
Designated Extension States:
AL BA HR MK RS

(30) Priority: **08.11.2006 KR 20060110194**
08.11.2006 KR 20060110151

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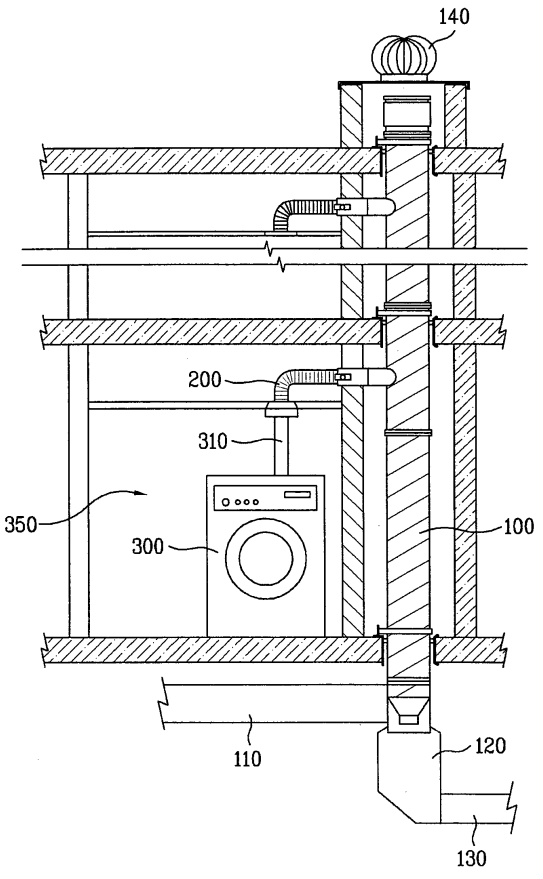
(54) Exhaust structure from dryer in apartment building

(57) The present invention relates to an exhaust structure from dryers in an apartment building including at least one riser tube running vertically crossing stories of the apartment building, a plurality of branch tubes branched from the riser tube to apartments on each of the stories for guiding exhaust gas from the apartments to the riser tube, and a fan mounted to a top of the riser tube and to be driven for making a pressure distribution in the riser tube to be the same with a pressure distribution on an outside of the building, substantially.

Fig. 1



EP 1 921 199 A2

Description

[0001] This application claims the benefit of Korean Patent Applications No. 10-2006-0110194, filed on November 8, 2006 and No. 10-2006-0110151, filed on November 8, 2006, which are hereby incorporated by reference in their entireties as if fully set forth herein.

BACKGROUND OF THE INVENTION

Field of the Invention

[0002] The present invention relates to a structure for discharging gas from laundry dryers in many apartments to an outside of a apartment building, and a laundry dryer manufactured suitable for such a structure, and more particularly, to an exhaust structure suitable for discharging gas from laundry dryers, taking characteristics of the gas from the laundry dryers into account.

Discussion of the Related Art

[0003] Starting to make an appearance in large cities, the apartments are becoming a general residential type, currently. Though the apartment buildings have had below 15 stories mostly, apartment buildings even over 20 stories are constructed, and apartment buildings 30 to 40 stories or higher are constructed in extreme cases, recently.

[0004] In cases of comparatively low story apartment buildings, related art gas discharge structures cause no problems. Even if there are problems, the problems can be solved by opening windows in each apartment to vent the apartment.

[0005] However, a high apartment building has different situation. Though a wind speed is low in a case of a low rise apartment building owing to various obstacles, such as friction with ground surface, buildings, and the like, the wind speed becomes the higher as a height of a high rise apartment building becomes the higher owing to less obstacles, such as the friction, the buildings, and the like.

[0006] Moreover, vortex becomes the more intensive as the height of the high rise apartment building becomes the higher. That is, because there is less obstacles around the high rise apartment building, wind that hits the high rise apartment building follows a side wall or over a top of the building. If the wind follows a side wall or over a top of the building thus, the wind speed of the wind becomes faster, and forms even the vortex. In the case of the high rise apartment building, it is difficult to open the windows for venting the apartment due to such wind.

[0007] Accordingly, as a structure for discharging gas from each of apartments in such a high rise apartment building, a riser tube running in a vertical direction crossing each story, and one or more than one branch connected between each apartment and the riser tube are provided. That is, smell from food and so on is discharged from a kitchen to the riser tube through a vent hole in the kitchen and the branch, and gas is discharged from a bathroom to the riser tube through a vent hole in a ceiling of the bathroom and the branch. In the meantime, at a top of the riser tube, there is a non-power fan running by the wind. The non-power fan assists the discharge of the gas from the riser tube to the outside of the building.

[0008] However, the strong wind rushing to a discharge opening at the top of the riser tube in the high rise apartment building interferes smooth discharge of the gas through the riser tube by using the non-power fan.

[0009] Moreover, because opening the window for venting the apartment is difficult, in general, a dryer is provided. Of the dryers, a dryer which burns fuel for generating hot air produces harmful exhaust gas including carbon monoxide gas in addition to general exhaust gas. Therefore, the related art high rise apartment building has a problem in that such exhaust gas can not be discharged.

[0010] Moreover, the related art exhaust structure is not suitable for the exhaust gas from the dryer, having characteristics that much moisture, much foreign matters, such as lint, and harmful substances, such as carbon monoxide, in a case the hot air is generated by burning fuel, are contained, and amount is large because the laundry dryer is used for a long time.

SUMMARY OF THE INVENTION

[0011] Accordingly, the present invention is directed to an exhaust structure in an apartment building.

[0012] An object of the present invention is to provide an exhaust structure in an apartment building for discharging gas from laundry dryers in a high rise apartment building, exclusively.

[0013] Additional advantages, objects, and features of the invention will be set forth in part in the description which follows and in part will become apparent to those having ordinary skill in the art upon examination of the following or may be learned from practice of the invention. The objectives and other advantages of the invention may be realized and attained by the structure particularly pointed out in the written description and claims hereof as well as the appended drawings.

[0014] To achieve these objects and other advantages and in accordance with the purpose of the invention, as embodied and broadly described herein, an exhaust structure from dryers in an apartment building includes at least one riser tube running vertically crossing stories of the apartment building, a plurality of branch tubes branched from the riser tube to apartments on each of the stories for guiding exhaust gas from the apartments to the riser tube, and a fan mounted to a top of the riser tube and to be driven for making a pressure distribution in the riser tube to be the same with a pressure distribution on an outside of the building, substantially.

[0015] The exhaust structure further includes a motor

for providing driving force to the fan, a first pressure sensor for sensing a pressure of an inside of the riser tube, and a motor controller for driving the fan with reference to a pressure sensed at the first pressure sensor such that the pressure distribution in the riser tube is the same with the pressure distribution on the outside of the building, substantially.

[0016] In this instance, preferably, the motor controller detects a flow rate of the exhaust gas in the riser tube with reference to the pressure sensed at the first pressure sensor for controlling operation of the motor.

[0017] Moreover, each of the plurality of branch tubes has at least one of a backflow preventive damper for preventing the exhaust gas from flowing backward, and a fire damper mounted thereto, or a carbon monoxide filter mounted thereto for filtering carbon monoxide.

[0018] In the meantime, the exhaust structure may further include a drain structure provided to an underside of the riser tube for draining condensed water from the exhaust gas. In this case, preferably, the exhaust structure further includes an outdoor air tube provided to an underside of the riser tube, the outdoor air tube being in communication with an outside of the building.

[0019] In the meantime, preferably each of the plurality of branch tubes is connected to the riser tube with a downward slope.

[0020] In the meantime, at least one of the plurality of branch tubes is a dryer branch tube for guiding the exhaust gas from the laundry dryer in each of the apartments to the riser tube, and at least one of the plurality of branch tubes is a kitchen branch tube or bathroom branch tubes connected to a dryer branch tube.

In this case, the dryer branch tube has a constant flow rate damper mounted thereto.

[0021] It is to be understood that both the foregoing general description and the following detailed description of the present invention are exemplary and explanatory and are intended to provide further explanation of the invention as claimed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0022] The accompanying drawings, which are included to provide a further understanding of the invention and are incorporated in and constitute a part of this application, illustrate embodiment(s) of the invention and together with the description serve to explain the principle of the invention. In the drawings:

[0023] FIG. 1 is a partial section of an apartment building illustrating an exhaust structure therein in accordance with a preferred embodiment of the present invention.

[0024] FIG. 2 is a sectional view illustrating the connection structure between the branch tube and the riser tube in FIG. 1.

[0025] FIG. 3 is a sectional view illustrating the connection structure between the branch tube and the riser tube in FIG. 2 in accordance with another preferred embodiment of the present invention, schematically.

[0026] FIG. 4 illustrates an exhaust structure in accordance with another preferred embodiment of the present invention, schematically.

DETAILED DESCRIPTION OF THE INVENTION

[0027] Reference will now be made in detail to the preferred embodiments of the present invention, examples of which are illustrated in the accompanying drawings. Wherever possible, the same reference numbers will be used throughout the drawings to refer to the same or like parts.

[0028] FIG. 1 is a partial section of an apartment building illustrating an exhaust structure therein in accordance with a preferred embodiment of the present invention.

[0029] Referring to FIG. 1, the apartment building includes a riser tube 100 running in a vertical direction crossing each story of the building and a plurality of branch tubes 200 branched from the riser tube 100 to each of the apartments.

[0030] The riser tube 100 is for exclusive discharge of exhaust gas from the laundry dryers 300 to an outside of the building. That is, in the apartment building, there can be a plurality of riser tubes for discharging gas from bath rooms and kitchens, and, of the plurality of riser tubes, the riser tube 100 in FIG. 1 may be a riser tube for discharging gas from the laundry dryers 300.

[0031] In the meantime, the branch tube 200 is branched from the riser tube 100 and extended to a laundry room 400 having the laundry dryer 300 and so on installed therein, and a gas exhaust tube 310 is connected between the discharge hole in the dryer 300 and an inlet to the branch tube 200.

[0032] There is a fan 140 on a top of the riser tube 100, and it is preferable that the fan 140 of the present invention is connected to a power unit, such as a motor. Though a non-power fan can be used in a case the gas from the laundry dryer 300 is discharged through the riser tube 100, discharging a high flow rate of gas from the laundry dryer with the non-power fan is likely to be inadequate. Moreover, it is preferable that, because the gas discharged through the riser tube has a high flow rate due to comparatively long time use of the laundry dryers, and similar living patterns of each apartment, the fan 140 is connected to a power unit.

[0033] Though not shown, the riser tube 100 has a second pressure sensor (not shown) mounted therein for transmission of a sensing result to a motor controller (not shown) which controls the motor. A mounting location of the motor controller is not limited, i.e., the motor controller can be mounted in the vicinity of the motor or in the laundry room 400.

[0034] In the meantime, mounted to an underside of the riser tube 100, there is an outdoor air tube 110 so that the riser tube 100 is in communication with an outside of the riser tube 100. Mounted to an underside of the outdoor air tube 110, there is a drain structure 120 connected to a drain line 130 for draining condensed water

from the gas in the riser tube 100.

[0035] Referring to FIG. 2, mounted to an inside of the branch tube 200, there are a backflow preventive damper 210 for preventing the gas from flowing backward, a carbon monoxide filter 220 for filtering carbon monoxide from the gas, and a lint filter 230 for filtering lint from the gas.

[0036] In the laundry dryers, depending on kinds of heat source for hot air, though there can be an electric type, there can also be a type that burns coal fuel, such as fuel gas. In a case of burning fuel thus, it is required to filter the carbon monoxide and discharge the carbon monoxide through the riser tube 100. Otherwise, a problem can happen, in which the gas containing the carbon monoxide is introduced into the apartment. Taking a residential environment of a high rise building, in which opening of the window is difficult for venting, into account, a requirement for preventing the carbon monoxide from introducing into the apartment is larger.

[0037] Moreover, it is preferable that a fire damper 240 is mounted to the branch tube 200, for preventing fire from spreading to other apartments through the riser tube 100 and the branch tube 200.

[0038] In the branch tube 200, there is a first pressure sensor 232 mounted in front of the lint filter 230. The first pressure sensor 232 may be arranged to transmit a sensed signal to a filter controller (not shown) provided to the laundry room 400 separately, or to a filter controller provided to the dryer 300. For an example, a signal line from the first pressure sensor 232 can be connected to the controller at the dryer 300, for which the dryer 300 is provided with a connector for receiving a signal from an outside of the dryer 300.

[0039] A gas flow from the dryer 300 in the exhaust structure will be described.

[0040] The gas from the laundry dryer 300 is discharged to the riser tube 100 through the gas exhaust tube 310 and the branch tube 200. If the laundry dryer 300 is a type which produces hot air by burning fuel, the carbon monoxide contained in the gas discharged from the laundry dryer 300 is removed at the carbon monoxide filter 220 in the branch tube 200.

[0041] The lint in the gas is removed at the lint filter 230 in the branch tube 200.

[0042] The gas discharged to the riser tube 100 through the branch tube 230 is discharged to an outside of the apartment through the top of the riser tube 100.

[0043] In the meantime, the fan 140 at the top of the riser tube 100 is rotated by the motor. the operation of the fan 140 will be described in more detail.

[0044] The inventor discovers that a flow rate of the gas being discharged from the dryer can be obtained experimentally, or theoretically by using a pressure in the riser tube 100. That is, the flow rate of gas being discharged can be detected by using the pressure sensed at the second pressure sensor in the riser tube 100. Moreover, correlation between a rotation speed of the fan 140 and the flow rate of the gas being discharged can be obtained experimentally, or theoretically, and the power unit can be controlled to control the rotation speed of the fan 140 taking the correlation into account. The flow rate of gas being discharged is detected by the pressure sensed at the second pressure sensor, and the rotation speed of the fan 140 is controlled according to the flow rate.

[0045] In this case, it is preferable that the motor (not shown) which is the power unit is controlled such that the fan 140 generates power according to the flow rate of the gas to be discharged.

[0046] That is, if the pressure in the riser tube 100 is sensed at the second pressure sensor in the riser tube 100, the flow rate of the gas in the riser tube 100 being discharged is detected, and driving power of the motor is determined according to the flow rate detected thus. Accordingly, if the flow rate of the gas is high, the motor increases the rotation speed of the fan 140 to increase a discharge speed of the gas being discharged.

[0047] In the meantime, if the fan 140 is driven with the power unit the same as in the case of the present invention, a pressure distribution in the riser tube 100 will vary with the flow rate of the gas to be discharged, and the rotation speed of the fan 140. it is preferable that the rotation speed of the fan is controlled according to the flow rate of the gas to be discharged taking the pressure distribution into account so that the discharge of the gas is the smoothest.

[0048] The inventor carries out simulation on a pressure distribution of an inside of the riser tube versus a rotation speed of the fan 14 for cases the speed of gas being discharged to an outside of the riser tube 100 is 2m/s, 12m/s, or 22m/s, respectively.

[0049] As a result of the simulation, it is known that the discharge of gas to the outside of the building is smooth in a case the pressure distribution in the riser tube 100 and the pressure distribution of the outside of the building is the same with each other. The pressure distribution in the riser tube 100 and the pressure distribution of the outside of the building are the most similar when the speed of the gas being discharged is 12m/s, taking a pressure drop of the outside of the building following increase of a height is 4Pa/3m (3m is equivalent to a height of one story) into account.

[0050] Accordingly, the motor can provide power at a rotation speed of the fan 140 that makes the pressure distribution in the riser tube 100 which depends on the flow rate of the gas being discharged and the pressure distribution of the outside of the building similar by means of the motor controller.

[0051] In the meantime, the gas from the laundry dryer 300 contains a large amount of moisture, the moisture is liable to condense on an inside wall of the riser tube 100, to turn into liquid. The liquid condensed thus flows down along the inside wall of the riser tube 100, and drained to an outside of the riser tube 100 through the drain structure 120. Though not shown, the drain structure may include a water collecting portion, a drain pump, valve and

float switch.

[0052] Operation of the pump may be controlled, manually, or automatically. In a case the operation of the pump controlled automatically, a float switch is provided to the water collecting portion for switching as a float floats to a certain height. The float switch may be mechanical, or electrical. That is, when the float switch is switched as the float floats to a certain height, a valve opens, and the drain pump comes into operation.

[0053] The outdoor air tube 110 connected to the underside of the riser tube 100 enables smoother discharge of the gas from the top of the riser tube 100.

[0054] In the meantime, even if the riser tube 100 is filled with the gas fully, to elevate a pressure therein, the gas flowing backward to the branch tube 200 is blocked by the backflow preventive damper 210 in the branch tube 200, failing to be introduced into the apartment.

[0055] Currently, since each apartment uses the laundry dryer for a comparatively long time period, the time periods of the use of the dryers can be overlapped among the apartments. In such a case, the flow rate of the gas being discharged through the riser tube 100 becomes high, to elevate the pressure in the riser tube 100, which makes the gas being discharged through the riser tube 100 vulnerable to be introduced into the apartments. The backflow preventive damper 210 serves to prevent this.

[0056] In the meantime, in a case the lint filter 230 in the branch tube 200 is blocked with the lint, the pressure at the first pressure sensor 232 in front of the lint filter 230 rises. According to this, the filter controller at the laundry room 400 or the dryer 300 compares the pressure to a reference, and sounds an alarm or turns on a lamp for informing to the user that the lint filter 230 is blocked, to replace the lint filter 230 with a new one.

[0057] It is preferable that the branch tube 200 is connected to the riser tube 100 with a downward slope, for preventing the liquid from the moisture contained in the gas from backward flowing to the dryer 300 following the branch tube 200, but directing the liquid to the riser tube 100.

[0058] In the meantime, when the dryer 300 is installed in the laundry room 400, the user in each of the apartments connect the outlet of the dryer 300 to the branch tube 200 with the gas exhaust tube 310. Therefore, it is preferable that the gas exhaust tube 310 is flexible so as to be bent softly.

[0059] Depending on embodiments, the lint filter 230, the carbon monoxide filter 220, and the backflow preventive damper 210 may be mounted to the branch tube 200 or to the gas exhaust tube 310. For an example, different from the embodiment, at least one of the lint filter 230, the carbon monoxide filter 220, and the backflow preventive damper 210 may be mounted to the gas exhaust tube 310. If one of the lint filter 230, the carbon monoxide filter 220, and the backflow preventive damper 210 is mounted to the gas exhaust tube 310, though it is not necessary to mount the same element to the branch tube 200, the mounting of the same element does not matter.

[0060] In the meantime, if a seller of the dryer 300 provides the gas exhaust tube 310 together with the dryer 300, the gas exhaust tube 310 may have the lint filter 230, the carbon monoxide filter 220, and the backflow preventive damper 210 mounted thereto. In this case, a building having the fire damper 240 mounted thereto can be provided by a constructor. In this instance, it does not mean necessarily that the fire damper 240 is mounted to the branch tube 200 without fail, but not to the gas exhaust tube 310.

[0061] Moreover, the gas exhaust tube 310 may not be required depending on a shape of the branch tube 200. Because such a gas exhaust tube 310 may be connected to the branch tube 200 as one body, and provided by the constructor, or a structure of a related art kitchen or a bathroom may be utilized for the gas exhaust tube 310. For an example, the fan is mounted to an inlet of the branch tube 200, and the dryer 300 may be installed such that the outlet of the dryer is close to the inlet. In this case, the gas exhaust tube 310 may be provided to the inlet of the branch tube 200 in a shape similar to a hood used in the related art kitchen.

[0062] In the meantime, different from the foregoing description, the first pressure sensor for determining the lint filter 230 of being blocked may be provided to a discharge flow passage of the gas in the dryer 300.

[0063] In a case of the dryer 300 of a type in which the hot air is produced by burning fuel, the carbon monoxide filter 220 may be mounted to the discharge flow passage of the gas.

[0064] Moreover, the backflow preventive damper 210 may also be provided to the discharge flow passage of the gas in the dryer 300. In a case the outlet of the dryer 300 is connected to the gas exhaust tube 310, and the gas exhaust tube 310 is connected to the branch tube 200, the gas that can flow backward from the riser tube 100 is blocked at the backflow preventive damper 210 in the dryer 300, such that the gas can not be introduced into the apartments any more.

[0065] FIG. 3 is a sectional view illustrating the connection structure between the branch tube 200 and the riser tube 100 in FIG. 2 in accordance with another preferred embodiment of the present invention, schematically. The branch tube of the embodiment is applicable to one provided for the laundry dryer exclusively, or one provided for the dryer, the kitchen, and the bathroom.

[0066] Referring to FIG. 3, the branch tube 200 at each apartment guides the gas from the laundry dryer to the riser tube 100. As described before, it is preferable that the branch tube 200 is connected to the riser tube 100 with a downward slope.

[0067] In the meantime, referring to FIG. 3, a connection portion between the branch tube 200 and the riser tube 100 is bent upward moderately, to have a bent portion 252, 254. Since the gas flowed through the branch tube 200 moves upward following the riser tube 100, a bent at an upper portion of the connection portion between the branch tube 200 and the riser tube 100 to form

an upper bent portion 252 can make a gas flow smoother.

[0068] Moreover, a bent at a lower portion of the branch tube 200 to form a lower bent portion 254 can prevent the gas being discharged upward following the riser tube 100 from flowing backward, effectively.

[0069] FIG. 4 illustrates an exhaust structure in accordance with another preferred embodiment of the present invention, schematically. Different from the foregoing embodiment, the embodiment suggests a structure for discharging the gas from the dryer of each apartment to an outside of the apartment building independently. That is, FIG. 4 illustrates a structure for discharging the gas from a dryer of a particular apartment to the outside of the apartment building.

[0070] Accordingly, the exhaust structure of the embodiment includes an exhaust pipe line 500 I communication with an outside of the building for discharging gas from the laundry dryer to the outside of the building, an exhaust fan 520 for making the gas to flow, and a damper 510 for preventing the gas from flowing backward through the exhaust pipe line 500. The exhaust pipe line 500 may correspond to the gas exhaust pipe 310 or the branch tube 200 of the dryer in the foregoing embodiment.

[0071] In the meantime, since an object of the embodiment lies on smooth discharge of the gas from dryer in an extra high rise building to an outside of the building, it is preferable that the exhaust fan 520 is a capacity variable type of which capacity varies with an environment of use. That is, it is preferable that the higher a location of the apartment, the higher the power rate of the exhaust fan 520. Therefore, it is preferable that the variable capacity fan has a wide range of capacity and is linearly controllable. The exhaust fan 520 can be an exhaust fan in the dryer, or the exhaust fan in the exhaust pipe line 500. In this case, the exhaust fans may be two in total.

[0072] Though it is preferable that the damper 510 is provided to an outside wall 550 of the building, the location of the damper 510 is not limited to this. For an example, the damper 510 may be provided to an inside of the laundry dryer.

[0073] Along with this, it is preferable that the damper 510 and the exhaust fan 520 are operated interlocked with operation of the dryer. That is, it is preferable that, for discharging the gas from the dryer, the damper 510 is opened, and the exhaust fan 520 is operated while the dryer is operated, and when operation of the dryer is stopped, the damper 510 is closed for preventing the backflow, and operation of the exhaust fan 520 is stopped.

[0074] In this case, both the exhaust fan 520 and the damper 510 can be mounted to the inside of the dryer. That is, the dryer itself can make smooth discharge of the gas adequately according to an environment of use with flexibility. Of course, the backflow can also be prevented by using the damper.

[0075] In the meantime, as described before, it is preferable that the exhaust pipe line 500 is sloped downwardly for smooth discharge of the water from an inside of the building to the outside of the building. The description of the filter in the foregoing embodiment is also applicable to the embodiment.

[0076] As has been described, the exhaust structure of the present invention has the following advantages.

[0077] The present invention can provide an exhaust structure exclusively for exhaust gas from laundry dryers suitable for discharging exhaust gas from laundry dryers in an apartment building or a high rise building, and a laundry dryer suitable for such an exhaust structure.

[0078] The present invention solves the laundry dryer exhaust gas discharge problems the high rise apartment building has. Particularly, the exhaust structure of the present invention solves the problem that can not be solved by using the related art kitchen or bathroom exhaust structure due to characteristics of the discharge gas from the laundry dryer.

[0079] It will be apparent to those skilled in the art that various modifications and variations can be made in the present invention without departing from the spirit or scope of the inventions. Thus, it is intended that the present invention covers the modifications and variations of this invention provided they come within the scope of the appended claims and their equivalents.

Claims

1. An exhaust structure from dryers in an apartment building comprising:

at least one riser tube running vertically crossing stories of the apartment building;
a plurality of branch tubes branched from the riser tube to apartments on each of the stories for guiding exhaust gas from the apartments to the riser tube; and
a fan mounted to a top of the riser tube and to be driven for making a pressure distribution in the riser tube to be the same with a pressure distribution on an outside of the building, substantially.

2. The exhaust structure of claim 1, further comprising:

a motor for providing driving force to the fan;
a first pressure sensor for sensing a pressure of an inside of the riser tube; and
a motor controller for driving the fan with reference to a pressure sensed at the first pressure sensor such that the pressure distribution in the riser tube is the same with the pressure distribution on the outside of the building, substantially.

3. The exhaust structure of claim 2, wherein the motor controller detects a flow rate of the exhaust gas in

the riser tube with reference to the pressure sensed at the first pressure sensor for controlling operation of the motor.

4. The exhaust structure of claim 1, wherein each of the plurality of branch tubes has at least one of a backflow preventive damper for preventing the exhaust gas from flowing backward, and a fire damper mounted thereto.

5. The exhaust structure of claim 4, wherein each of the plurality of branch tubes has a carbon monoxide filter mounted thereto for filtering carbon monoxide.

6. The exhaust structure of claim 1, further comprising a drain structure provided to an underside of the riser tube for draining condensed water from the exhaust gas.

7. The exhaust structure of claim 6, further comprising an outdoor air tube provided to an underside of the riser tube, the outdoor air tube being in communication with an outside of the building.

8. The exhaust structure of claim 1, wherein each of the plurality of branch tubes is connected to the riser tube with a downward slope.

9. The exhaust structure of claim 1, wherein at least one of the plurality of branch tubes is a dryer branch tube for guiding the exhaust gas from the laundry dryer in each of the apartments to the riser tube.

10. The exhaust structure of claim 9, wherein at least one of the plurality of branch tubes is a kitchen branch tube or bathroom branch tubes connected to a dryer branch tube.

11. The exhaust structure of claim 10, wherein the dryer branch tube has a constant flow rate damper mounted thereto.

Fig. 1

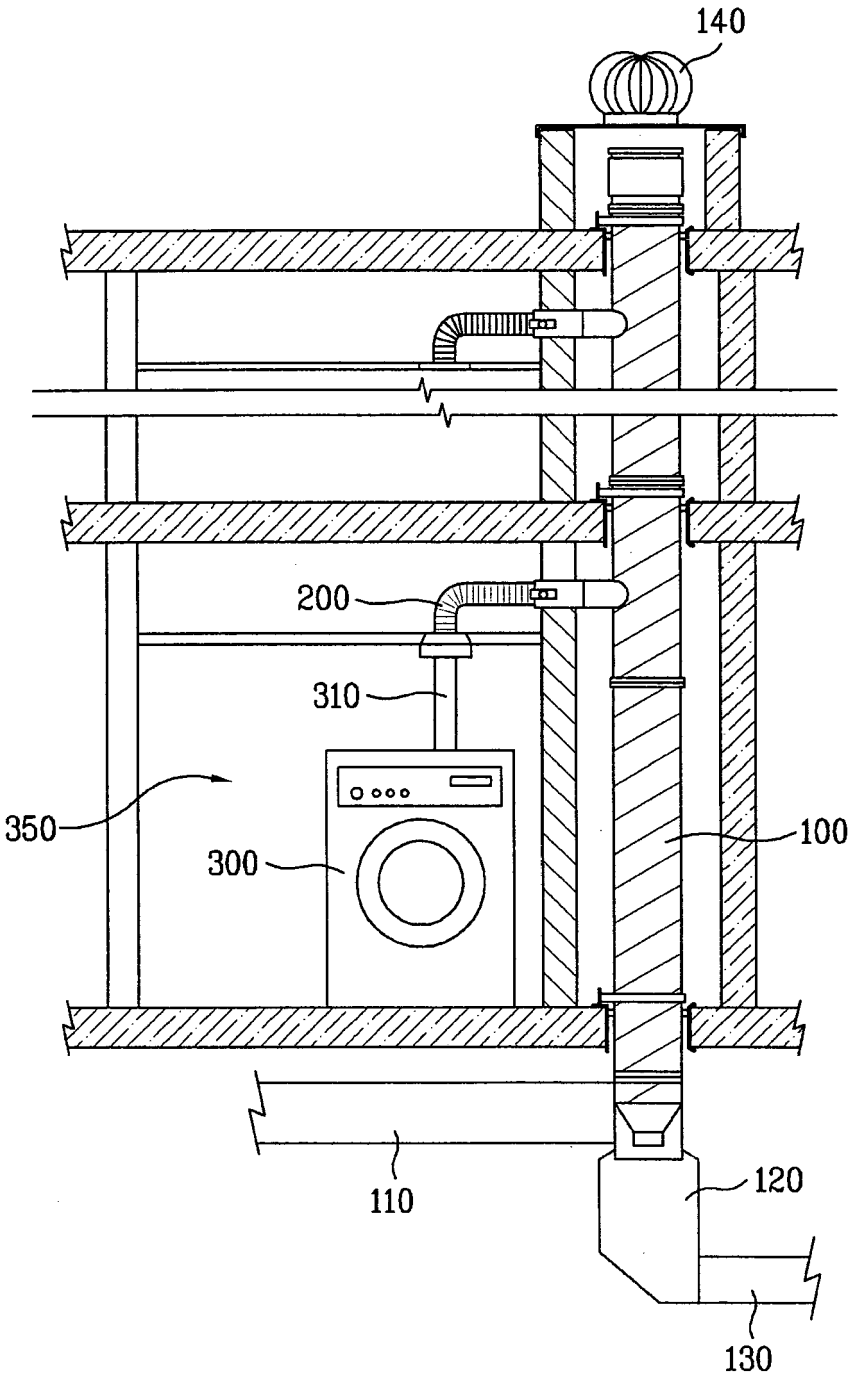


Fig. 2

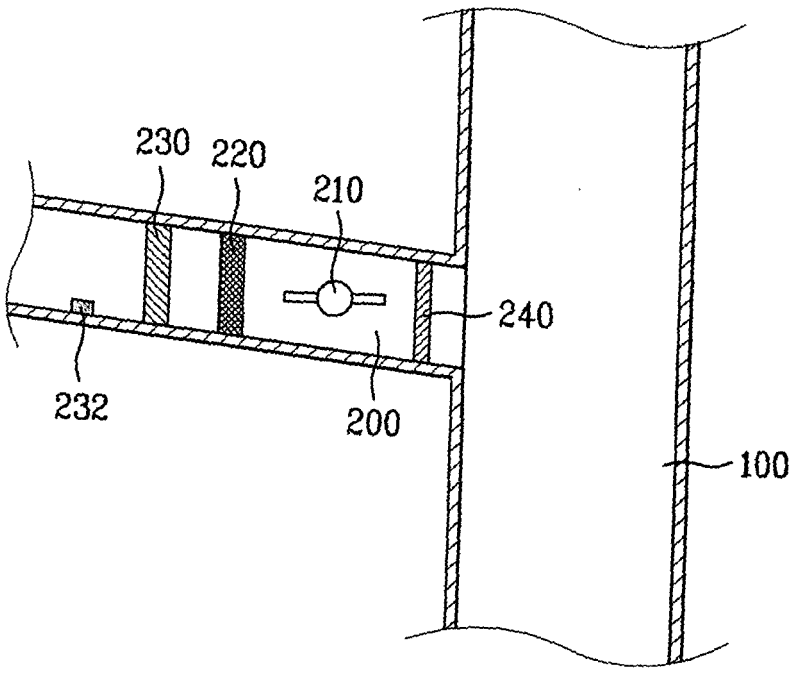


Fig. 3

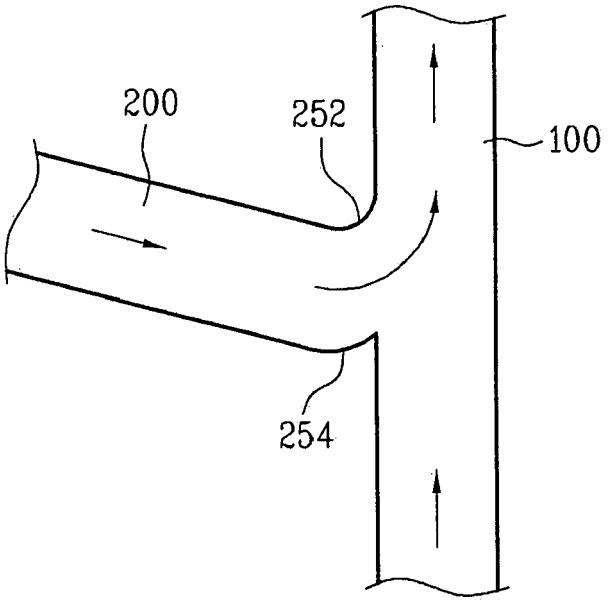
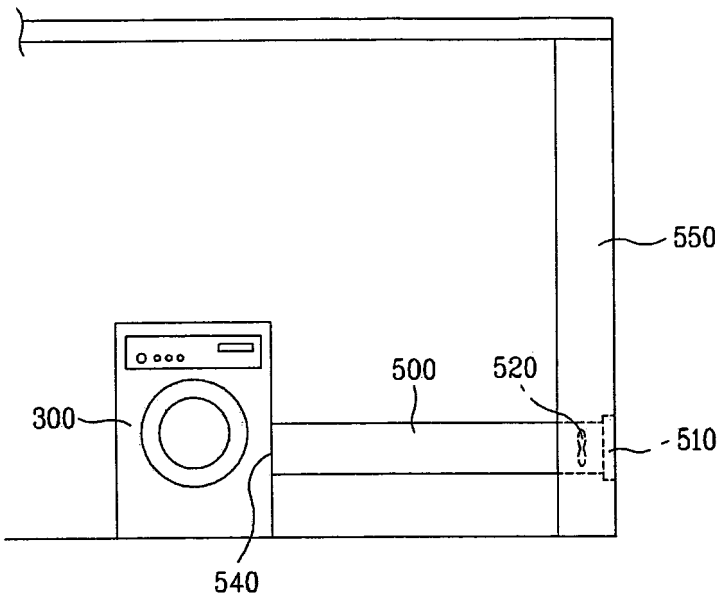


Fig. 4



REFERENCES CITED IN THE DESCRIPTION

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