A heat exchanger (30) for a dryer includes a core in which a plurality of tube units (32) and a plurality of fin units (34) are alternately stacked. Front and rear covers (40, 42) are attached at front and rear sides of the core. A front plate (50) is positioned between the core and the front cover and a rear plate (50) is positioned between the core and the rear cover. The plates (50) have openings (52) at locations corresponding to the opened ends of the tube units (32). The plates (50) are physically coupled with the front and rear covers (40, 42). The plates (50) are also attached to the core with a cladding material by a brazing operation.
The present invention relates to a heat exchanger for a dryer and, more particularly, to a heat exchanger with a new structure capable of improving heat transfer efficiency.

In general, a dryer performs a drying operation on clothing by blowing hot air generated by a heater into a drum. Dryers can be divided into exhaust type dryers and condensing type dryers, depending on a method for processing the humid air generated by the drying operation.

In case of the exhaust type dryer, humid air exhausted from a drum is discharged to outside of the dryer. In the condensing type dryer, humid air discharged from the drum is condensed to remove moisture, and the moisture-removed dried air is transferred back into the drum so as to be re-circulated.

The condensing type dryer includes a drum for drying laundry, a filter for filtering out foreign materials, a heat exchanger (or condenser) for removing moisture of the laundry through a heat exchange operation, a fan for facilitating drying by generating air flow, a heater for heating the air flow to shorten the drying time, and piping for connecting the components.

FIGS. 1a and 1b show an example of a condensing type dryer. As shown in FIGs. 1a and 1b, an arrow I indicates a flow of external air and an arrow II indicates a flow of air that is re-circulated through the drum of the dryer. As shown, a drum 11 in which laundry is to be received is rotatably installed inside a main body 10, and a door 12 is installed at a front side of the main body 10. The drum 11 is rotated by a belt 19 connected to a motor 17 installed at a lower portion of the main body 10.

A heat exchanger (or condenser) 13 is installed at the lower portion of the main body 10 and condenses hot and humid air circulated through the drum 11 to remove moisture from the air. Front and rear sides of the heat exchanger 13 are connected with a circulation duct 14. The circulation duct 14 is connected with both front and rear sides of the drum 11, so that when air is discharged through the drum 11, it can be re-introduced into the drum 11 after passing through the heat exchanger 13.

A heater 15 for heating air which has passed through the heat exchanger 13 and a circulation fan 16 for forcibly circulating air through a circulation duct 14 are installed at the circulation duct 14. The circulation fan 16 is connected with a different shaft of the motor 17 for driving the drum 11.

In order to condense air circulated through the circulation duct 14, external cold air must be supplied to the heat exchanger 13. For this purpose, an external air supply duct 18 connected with an outer side of the main body 10 is connected with one side of the heat exchanger 13. A cooling fan 20 for forcibly sucking external air through the external air supply duct 18 and discharging it into the main body 10 and a cooling fan driving motor 21 are installed at the opposite side of the heat exchanger 13 to which the external air supply duct 18 is connected.

Reference numeral 22 is a filter for filtering out foreign materials such as waste thread or the like from the air exhausted to the circulation duct 14 through the front side of the drum 11. A water receiver (not shown) for collecting condensed water generated during a condensing process is installed at a lower side of the heat exchanger 13. A pump 23 for sending the condensed water collected in the water receiver to a storage tank 2 is also installed at the lower side of the heat exchanger 13.

The purpose of the dryer is to dry laundry quickly with as little power consumption as possible. In order to reduce power consumption and shorten the drying time, a method for increasing a capacity of the heater or the fan has been considered. However, doing so adds additional cost to the dryer and electrical charges in increase due to an increase in the power consumption. In addition, noise can also increase.

FIG. 2 shows an example of a heat exchanger that can be used in a condensing type clothes dryer. As shown, the heat exchange includes an external air inflow unit 13a and a humid air inflow unit 13b. Dry ambient air is introduced into the external air inflow unit 13a and humid air that is circulated through the dryer is introduced through the humid air inflow unit 13b. The heat exchanger allows heat from the humid air to be transferred to the flow of external air. As a result, water droplets condense on the inner surface of the heat exchanger. In the condensing type dryer, the heat exchanger is a core component playing an important role in the overall drying efficiency.

One object of the present invention is to provide a heat exchanger structure capable of increasing heat exchange efficiency.

Another object of the present invention is to obtain economical efficiency in the mass production of such devices and in the materials used.

Still another object of the present invention is to enhance drying efficiency by using a heat exchanger with better performance in a dryer or a washing machine that includes a drying function.

To achieve at least the above objects in whole or in part, the present invention provides a heat exchanger for a dryer which includes humid air flowing units having a duct form with both ends opened. The heat exchanger also includes external air flowing units, which are alternately stacked with the humid air flowing units to form a core. Front and rear covers are attached at front and rear sides of the core. Plates are positioned between the core of the heat exchange unit and the front cover and between the core and the rear cover. The plates have a plurality of openings corresponding to the opened ends of the humid air flowing units.

Preferably, the plates are bonded to the core of the heat exchange unit by a cladding material. Also, preferably, serrated extending tabs formed along peripheral edges of the plates are bent around extending protru-
The plates with their respective covers.

[0017] The core of the heat exchange unit and the plates may be made of a metal material with excellent heat conductivity, and the cladding material may include a metal component having a melting point lower than that of the plates and the core of the heat exchange unit.

[0018] A condensing type dryer or a washing machine that includes a drying function that embodies the invention includes: a drum rotatably installed inside a cabinet; a heat exchanger for condensing moisture from a flow of humid air; a fan for generating a flow of air; and a heat source for applying heat to the re-circulated air. In this dryer, the heat exchanger includes a plurality of tube units which conduct a flow of humid air through the heat exchanger, and a plurality of fin units that conduct a flow of exterior air through the heat exchanger. The tube units and fin units are alternately stacked to form a core of the heat exchanger. Front and rear covers are attached at front and rear sides of the heat exchange unit, the center thereof being opened. Plates are positioned between the core of the heat exchange unit and the front and rear covers. The plates have a plurality of openings corresponding to opened ends of the tube units.

[0019] The heat exchanger according to the present invention has advantages in that the bonding between the heat exchange unit and the front and rear covers is strong, heat exchange performance is excellent. Also, the technique used to bond the plates and attached front and rear covers to the heat exchanger core takes considerably less time than traditional methods that rely upon an epoxy, resulting in more efficient mass production. As a result, a fabrication cost of a dryer or a washing machine employing the heat exchanger can be reduced.

[0020] 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 objects and advantages of the invention may be realized and attained as particularly pointed out in the appended claims.

[0021] The invention will be described in detail with reference to the following drawings in which like reference numerals refer to like elements, and wherein:

- FIG. 1a is a sectional view showing an example of a clothes dryer;
- FIG. 1b is a plan view of the clothes dryer in FIG. 1;
- FIG. 2 is a perspective view showing an example of a heat exchanger;
- FIG. 3 is an exploded view showing components of a heat exchanger according to the present invention;
- FIG. 4 is a front view of a plate of the heat exchanger according to the present invention;
- FIG. 5a is a perspective view of a front cover of the heat exchanger according to the present invention;
- FIG. 5b is a side view of the front cover of the heat exchanger according to the present invention;
- FIG. 5c is a front view of a sealing member formed at a rear side of the front cover of the heat exchanger according to the present invention;
- FIG. 6 is a front view of a different plate of the heat exchanger according to the present invention;
- FIG. 7 is a side view of the heat exchanger with a plate coupled therewith;
- FIG. 8 is a side view of a different sealing member of the heat exchanger according to the present invention; and
- FIG. 9 is a side view of the heat exchanger including the sealing member in FIG. 8.

[0022] The present invention will be described in detail with reference to the accompanying drawings.

[0023] FIG. 3 shows components of a heat exchanger according to the present invention. A heat exchange unit 30, in which heat is exchanged between external air and internal air, includes a plurality of tube units 32 and a plurality of fin units 34 that are alternately stacked. Both ends of the tube units 32 are opened and the tube units 32 have a duct structure which may have a rectangular cross-sectional shape. Of course, other cross-sectional shapes could also be used. A pipe (not shown) which recirculates air through the dryer is connected with both ends of the tube units 32. The fin units 34 include a plurality of air passages with heat exchanging fins in the air passages. The fin units 34 can be formed by repeatedly bending a thin metal plate in a zigzag fashion. The tube units 32 and the fin units 34 are repeatedly stacked on one another in an alternating fashion to form the core of the heat exchanger. The tube units 32 and the fin units 34 can be made of a metal material with excellent heat transfer characteristics, and preferably are made of aluminum or an aluminum alloy.

[0024] Front and rear covers 40 and 42 are coupled with the front and rear surfaces of the heat exchange unit 30. The front and rear covers 40 and 42 perform a coupling medium function to allow the heat exchange unit 30 to be easily coupled with the recirculation pipe or other components. The front and rear covers 40 and 42 are made of a plastic group such as ABS-GF and are formed typically according to an injection molding method. A sealing member can be additionally formed at the portion where the front and rear covers 40 and 42 are coupled at the sides of the heat exchange unit 30 in order to prevent a leakage of air.

[0025] The front and rear covers 40 and 42 can be attached to the heat exchange unit 30 through a mechanical method, but are usually attached using an adhesive (bonding agent) as a coupling medium to prevent a leakage of air or heat. For example, the front and rear covers 40 and 42 can be attached using epoxy bonding. Where an epoxy bonding agent is used, usually an organic bonding agent which has weak heat transfer characteristics is used. In addition, the organic bonding agents require a significant amount of time to bond. As a result, the as-
In the present invention, a thin metal coupling plate, instead of a bonding agent, is used to attach the front and rear covers 40 and 42 to the core of the heat exchange unit 30. FIG. 4 shows the structure of one embodiment of a coupling plate according to the present invention. As shown, the plate 50 is a thin metal plate including a plurality of openings 52 therein. The openings 52 have a size and location that corresponds to the open ends of the tube units 32 of the heat exchange unit 30. As such, the openings serve as a flow passage for humid air circulated through the tube units 32. In addition, bars 51 located between the openings 52 of the plate have a size and location corresponding to the fin units 34 of the heat exchange unit 30. Thus, the bars 51 serve as one side of an air passage through the fin units to prevent external air passing through the fin units 34 from flowing out the sides of the fin units 34.

The plate 50 is formed to have a size and shape that matches the front and rear end portions of the heat exchange unit 30. Preferably, the plate 50 is thin and made of light metal or a metal alloy with excellent heat conductivity. If possible, the plate 50 is made of the same material as the core of the heat exchange unit 30.

Preferably, the plate 50 is attached to the core of the heat exchange unit 30 without using an epoxy type bonding agent that might degrade heat transfer. Instead, in the present invention, the plated 50 and the core of the heat exchange unit 30 are attached to each other through a brazing method. The brazing allows the two metals to be firmly bonded within a very short time. In the present invention, a metal cladding material is preferably used as a brazing medium. The cladding material has a melting point lower than the melting points of the materials of the core of the heat exchange unit 30 and the plate 50. Also, the cladding material layer is preferably very thin.

For example, when the material of the plate 50 and the core of the heat exchange unit 30 is aluminum, a cladding material having a melting point lower than the melting point of aluminum, which is approximately 550°C, is selectively used. But the present invention is not limited thereto.

During the brazing process, a cladding material may be coated onto the plate 50, to which the core of the heat exchange unit 30 is attached. Preferably, the cladding material layer has a thickness of about 100 micrometers or less. Then, the attached plate 50 and heat exchange unit 30 are heated to a temperature higher than the melting point of the cladding material, but lower than 550°C (the melting point of aluminum). The cladding material becomes molten, and when the assembly is cooled, the plate 50 and the heat exchange unit 30 are firmly bonded together. Typically, there is little cladding material remaining after the brazing process. Even if a very small amount of cladding material remains at the bonding portion between the plate 50 and the heat exchange unit 30, the metal component of the cladding material does not interfere with heat transfer, so the heat exchanger is not affected negatively.

FIGs. 5a and 5b show the structure of the front cover 40 (or the rear cover 42) according to the present invention. As shown, the front cover 40 has a cross-sectional similar to a rectangular shape and includes an opening therein. The opening has almost the same shape as the cross-sectional shape of the core of the heat exchange unit and serves as a passage to allow internal circulated humid air of the dryer to flow to other parts of the dryer after passing through the tube units 32.

Preferably, the opening formed at the front portion 44a of the front cover 40 does not have a channel corresponding to the regions of the tube units 32. It is preferable to form the channel regions using the plate, which also serves as a means of connecting the front cover 40 and the heat exchange unit 30. As shown in FIG. 5a, a central support wall 45 may formed at the central opening of the front cover 40, but it is not an essential element. That is, the central support wall 45 can be omitted according to circumstances.

Because the front cover 40 (or the rear cover) is coupled to the heat exchange unit 30 via the plate 50, it is preferred that the front cover (or the rear cover) has a coupling structure that facilitates its coupling with the plate 50. In the present invention, a rear protrusion 44b is integrally formed to extend with a certain length at a rear side of the front cover 40. The rear protrusion 44b is used to physically couple the cover 40 to the plate 50. As shown in FIG. 5a, in order to facilitate physical coupling, a rim 44c can be formed to be thicker at an edge of the rear protrusion 44b. In addition, the rim 44c can be formed of a sealing member. The sealing member 44c can be made of a material with elasticity, and can be additionally (or integrally) attached at an outer circumferential surface of the coupling part of the front cover 40 (or the rear cover) to make its coupling with the plate 50 firm as well as to prevent a leakage space that may be generated at the coupling part with the plate 50.

FIG. 5c is a plan view showing a form of the sealing member 44c and it is noted that the shape of the sealing member 44c is similar to the shape of the front cover. Preferably, the sealing member 44c is made of a material with elasticity for exerting tight coupling. The sealing member 44c should also be heat resistant for enduring a high temperature of, for example, above 80°C, such as heat resistant rubber or urethane, etc.

The rear protrusion 44b is formed such that it has a form and area similar to those of the heat exchange unit 30. Preferably, the rear protrusion 44b is also formed so that it has overall dimensions smaller than the dimensions of the plate (to be described in detail).

The structure of the plate 50 needs to be designed to allow the front cover 40 (or the rear cover) and the plate to be physically combined. The front cover 40 and/or the rear cover 42 are made of a material such as plastic formed through a general injection molding, so a
chemical bonding method through heating is not recommended.

Thus, in one embodiment of the present invention, for the physical coupling, the plate 50 has the structure as shown in FIG. 6. As shown in FIG. 6, a plurality of protrusions 54 are formed in a serrated form around an outer circumference of the plate 50. Because the protrusions 54 can be easily bent, the protrusions 54 are bent and coupled with an edge of the end of the front cover 40 so that the plate 50 can be firmly attached with the front cover 40. The rear cover 42 can also be attached in the same manner. The bent portions of the plate can be bent around the protrusion that extends from the cover.

Because the plate 50 is coupled with the heat exchange unit 30 by brazing or soldering, and is coupled to the front cover 40 (or the rear cover 42) in the above-described mechanical coupling manner, the firmness of the coupling can be maintained without degrading heat transfer characteristics. In addition, since the plate 50 and the core of the heat exchange unit 30 can be very quickly coupled through the brazing process, assembly time is fast, which helps productivity. Also, because the plate 50 and the front cover 40 (or the rear cover 42) are coupled through the physical or mechanical method, the fabrication of the overall heat exchanger is inexpensive.

Next, the heat exchanger according to another feature of the present invention will now be described with reference to FIG. 8. As shown in FIG. 8, the sealing member 45 is coupled at an outer surface of the front cover 40 additionally or integrally. The sealing member 45 plays an important role with respect to the overall heat exchange system. Condensed water generated in the tube units 32 of the heat exchange unit 30 can leak into the fin units 34. When condensed water flows into the fin units 34, external air flow is restricted and the heat exchange operation is impaired. As a result, the condensing efficiency of the heat exchanger is degraded, which leads to degradation of drying efficiency of a dryer employing the heat exchanger.

The sealing member 45 is designated to prevent condensed water from leaking/flowing into the fin units 34. Thus, preferably, the sealing member 45 is designated such that hot humid air inside the dryer that flows to the tube units 32 is prevented from flowing to the fin units 34. With reference to FIG. 9, a sealing member 45b attached on the front cover 40, has an exterior peripheral edge that flares outward as it approaches the heat exchanger. Likewise, a sealing member 45b is attached on the rear cover 42 such that the rear peripheral edges flare outward.

The two sealing members 45a and 45b are made of a material that can endure high temperature and have excellent durability, and preferably are made of a material such as heat resistant rubber or urethane. The sealing members can be additionally coupled or integrally formed on the outer circumferential surface of the front cover 40 or the rear cover 42.

Accordingly, in a heat exchanger for a dryer embodying the invention, the core of the heat exchange unit 30 and the front and rear covers 40 and 42 are coupled by the plates 50. A heat exchanger embodying the invention also prevents leakage of condensed water, which prevents an introduction of leaked condensed water to other components.

As so far described, the heat exchanger for a dryer according to the present invention has many advantages as follows.

The new coupling structure for coupling the front and rear covers to the core can reduce the material costs be as much as 20 percent, and the manufacturing time can be considerably reduced. This translates into economical efficiency in terms of mass productivity and materials.

Because the front and rear covers are attached to the core by brazing, in a very short period of time, the fabrication process can be simplified.

In addition, because the plates and the core of the heat exchange unit can be completely coupled and sealed, the heat exchange performance of the heat exchanger can be improved.

When the heat exchanger is used in a dryer or a washing machine that includes a drying function, the unit cost of the overall system can be lowered and the drying efficiency can be enhanced.

The foregoing embodiments and advantages are merely exemplary and are not to be construed as limiting the present invention. The present teaching can be readily applied to other types of apparatuses. The description of the present invention is intended to be illustrative, and not to limit the scope of the claims. Many alternatives, modifications, and variations will be apparent to those skilled in the art. In the claims, means-plus-function clauses are intended to cover the structure described herein as performing the recited function and not only structural equivalents but also equivalent structures.

Claims

1. A heat exchanger, comprising:

   a core comprising a plurality of tube units configured to conduct a flow of moist heated air and a plurality of fin units configured to conduct a flow of ambient air, wherein the plurality of tube units and plurality of fin units are stacked in an alternating fashion to form the core; a front cover coupled to a front of the core and configured to conduct a flow of air into the plurality of tube units; a rear cover coupled to a rear of the core and configured to conduct a flow of air out of the plurality of tube units; and at least one plate positioned between the core and one of the front cover and the rear cover,
wherein a plurality of openings are formed in the plate at locations that correspond to open ends of the plurality of tube units.

2. The heat exchanger of claim 1, wherein the at least one plate is bonded to the core by a cladding material.

3. The heat exchanger of claim 2, wherein the cladding material melts at a temperature that is lower than melting points of the tube units, the fin units and the at least one plate.

4. The heat exchanger of claim 2 or 3, wherein the cladding material comprises a metal having good heat conductivity.

5. The heat exchanger of any of claims 1 to 4, wherein the at least one plate includes serrated tabs on its exterior periphery which are configured to be bent to attach the at least one plate to one of the front cover and the rear cover.

6. The heat exchanger of claim 1, wherein the at least one plate comprises:
   a front plate coupled to the front of the core and to the front cover; and
   a rear plate coupled to the rear of the core and to the rear cover.

7. The heat exchanger of claim 6, wherein the front and rear plates are coupled to the core by a cladding material, and wherein the front and rear plates are coupled to the front and rear covers, respectively, by mechanical attachment means.

8. A heat exchanger, comprising:
   a core comprising a plurality of tube units configured to conduct a flow of moist heated air and a plurality of fin units configured to conduct a flow of ambient air, wherein the plurality of tube units and plurality of fin units are stacked together in an alternating fashion to form the core;
   a front cover coupled to a front of the core and configured to conduct a flow of air into the plurality of tube units, wherein a protrusion is formed on a side of the front cover adjacent the core;
   a front cover plate positioned between the core and the front cover and mechanically attached to the protrusion on the front cover;
   a rear cover coupled to a rear of the core and configured to conduct a flow of air out of the plurality of tube units, wherein a protrusion is formed on a side of the rear cover adjacent the core; and
   a rear cover plate positioned between the core and the rear cover and mechanically attached to the protrusion on the rear cover.

9. The heat exchanger of claim 8, wherein the front cover plate and the rear cover plate are both attached to the core by a cladding material.

10. The heat exchanger of claim 9, wherein the cladding material has a melting point that is lower than melting points of the core, the front cover plate and the rear cover plate.

11. The heat exchanger of claim 9 or 10, wherein the cladding material comprises a metal and has excellent heat conducting properties.

12. The heat exchanger of any of claims 8 to 11, wherein a plurality serrated tabs are formed on an exterior periphery of the front cover plate and the rear cover plate, and wherein the serrated tabs are bent around the protrusions on the front cover and rear cover to attach the front cover plate to the front cover and to attach the rear cover plate to the rear cover.

13. The heat exchanger of claim 12, wherein the protrusions on the front cover and rear cover extend substantially around the periphery of the front cover and rear cover.

14. The heat exchanger of any of claims 8 to 13, wherein the core, the front cover plate and the rear cover plate are all made of metal having excellent heat conducting properties.

15. The heat exchanger of any of claims 8 to 14, wherein the front cover plate and the rear cover plate both have a plurality of openings that correspond to opened ends of the plurality of tube units.

16. A heat exchanger, comprising:
   a core comprising a plurality of tube units configured to conduct a flow of moist heated air and a plurality of fin units configured to conduct a flow of ambient air, wherein the plurality of tube units and plurality of fin units are stacked together in an alternating fashion to form the core;
   a front cover coupled to a front of the core and configured to conduct a flow of air into the plurality of tube units, wherein a protrusion is formed on a side of the front cover adjacent the core;
   a front cover plate positioned between the core and the front cover and mechanically attached to the protrusion on the front cover;
   a rear cover coupled to a rear of the core and configured to conduct a flow of air out of the plurality of tube units, wherein a protrusion is formed on a side of the rear cover adjacent the core; and
   a front sealing member positioned between the front cover and the front cover plate, wherein the front sealing member is configured to prevent condensate from the tube units from entering the fin units;
a rear cover coupled to the rear of the core and configured to conduct a flow of air out of the plurality of tube units; a rear cover plate positioned between the core and the rear cover; and a rear sealing member positioned between the rear cover and the rear cover plate, wherein the rear sealing member is configured to prevent condensate from the tube units from entering the fin units.

17. The heat exchanger of claim 16, wherein at least one of the front cover plate and the rear cover plate have a plurality of apertures at locations that correspond to opened ends of the plurality of tube units.

18. The heat exchanger of claim 16 or 17, wherein the front cover plate and the rear cover plate are coupled to the core by a cladding material.

19. The heat exchanger of claim 18, wherein the front cover plate and the rear cover plate are mechanically attached, respectively, to the front and rear covers.

20. The heat exchanger of claim 19, wherein tabs are formed on the exterior periphery of the front and rear cover plates, and wherein the tabs are bent to attach the front and rear cover plates to the front and rear covers, respectively.

21. The heat exchanger of any of claims 16 to 20, wherein the front and rear sealing members are formed of polyurethane.

22. The heat exchanger of any of claims 16 to 21, wherein the front and rear sealing members are formed of a material that is capable of withstanding temperatures above 80°C.

23. A dryer comprising the heat exchanger of any of claims 1 to 22.
FIG. 2
FIG. 9