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## DRUM TYPE WASHING AND DRYING MACHINE

### Field of the Invention

5           The present invention relates to a drum type washing and drying machine controlling washing, rinsing, dewatering and drying processes in a rotary drum having a substantially horizontal or slanted rotational axis.

### 10   Background of the Invention

          There is shown in Fig. 7 a prior art drum type washing and drying machine. Hereinafter, the configuration thereof will be described in detail.

15           As illustrated in Fig. 7, housing 1 accommodates therein water tub 4 supported by a plurality of suspensions 2 and dampers 3. An opening of water tub 4 is opened and closed by door 5 and rotary drum 6 is rotatably mounted in water tub 4. Rotary drum 6 is operated by laundry motor 7  
20   and a number of water passing holes 8 and baffles 9 are prepared therein. Wash water supply valve 10 for supplying water into water tub 4 and cooling water supply valve 11 for supplying cooling water are installed in housing 1. Prepared at water tub 4 is drain outlet 12 which  
25   communicates with drain pipe 14 via drain valve 13.



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Blower 15 functioning to blow air into water tub 4 through air injection opening 16, heater 17 in communication with blower 15, and heat exchanger 18 in communication with water tub 4 and blower 15, and cooling water hose 19  
5 directly connected to cooling water supply valve 11 and opened toward heat exchanger 18 constitute a drying air circulation path (for example, see Japanese Laid-open Publication No. 1997-215893).

The drum type washing and drying machine configured as  
10 described above is operated as follows. Upon initiating a washing process by loading laundry articles into rotary drum 6, wash water supply valve 10 is opened to fill fresh water in water tub 4 up to a predetermined level. Next, rotary drum 6 is driven to rotate at about 50 r/min, and the loaded  
15 laundry articles are subject to repeated lift-up and drop motions by baffles 9 and are washed by washing fluid with the aid of impact of dropping on a surface of the water. Upon termination of the washing process, the washing fluid is drained through drain pipe 14 by operating drain valve 13.  
20 After finishing the water draining process, the laundry articles are dewatered by rotating rotary drum 6 at a high rotation speed of about 1000 r/min. The dewatering process is followed by a drying process.

In the drying process, rotary drum 6 is driven to  
25 rotate to move up and down the laundry articles therein as

in the washing process and, at the same time, hot air heated by blower 15 and heater 17 is supplied to the laundry articles in rotary drum 6 through air injection opening 15, so that moisture in the laundry article is heated and evaporated therefrom. The hot air containing therein vapor is directed to heat exchanger 18 to be cooled down and dehumidified by a heat exchange process induced by a mixing with cooling water provided from cooling water supply valve 11 to heat exchanger 18 via cooling water hose 19. The dehumidified air is then re-heated by heater 17 and re-directed into rotary drum 6. In this way, a series of drying process cycles are executed.

However, such prior art drum type washing and drying machine having the above described configuration suffers from certain drawbacks as follows. That is, it is difficult to secure a space required for separately installing duct-shaped heat exchanger 18 in housing 1 having restricted dimensions. Further, in order to dry uniformly the laundry articles in the drying process, it may be necessary to increase the amount of circulating air. However, such heat exchanger 18, which performs dehumidification by way of mixing humidified air with the cooling water, produces a problem of flying back of the cooling water, resulting in introducing the cooling water into heater 17 or dampening the dried laundry articles, if the amount of the circulating

air is increased.

Summary of the Invention

5           It is, therefore, an object of the present invention to provide a drum type washing and drying machine capable of executing heat exchange within the space of a compact housing and, at the same time, preventing the flying back of cooling water even when an increased amount of circulating  
10   air is employed, to thereby achieve an uniform drying of laundry articles.

          To attain the object, there is provided a drum type washing and drying machine configured as follows: a rotary drum having a substantially horizontal or slanted rotational  
15   axis is incorporated in a water tub having an opening for loading and unloading laundry articles into and from the rotary drum, the opening of the water tub being opened and closed by a lid; a warm air is blown into the rotary drum by a blower while heated by a heater; the heated air is  
20   directed into the rotary drum by an air flow passage which is integrated with the water tub; a heat exchanger is fixedly installed in the air flow passage, which is fed with the cooling water by a cooling unit, wherein the heat exchanger has an uneven cooling surface.

25           In accordance with the present invention, there is provided a drum type washing and drying machine including: a

rotary drum having a substantially horizontal or slanted rotational axis; a water tub incorporating the rotary drum therein and having an opening for loading and unloading laundry articles into and from the rotary drum; a lid for opening and closing the opening of the water tub; a heater for making warm air; a blower for blowing the warm air into the rotary drum; an air flow passage, integrated with the water tub, for directing the warm air blown by the blower into the rotary drum; a heat exchanger fixedly installed in the air flow passage; and a cooling unit for supplying cooling water to the heat exchanger, wherein the heat exchanger has an uneven cooling surface.

#### Brief Description of the Drawings

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The above and other objects and features of the present invention will become apparent from the following description of preferred embodiments given in conjunction with the accompanying drawings, in which:

20 Fig. 1 shows a vertical cross sectional view of a drum type washing and drying machine in accordance with a first preferred embodiment of the present invention;

Fig. 2 offers a perspective view of a heat exchanger of a drum type washing and drying machine in accordance with a second preferred embodiment of the present invention;

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Fig. 3 gives a perspective view of a heat exchanger of

a drum type washing and drying machine in accordance with a third preferred embodiment of the present invention;

Fig. 4 presents a perspective view of a heat exchanger of a drum type washing and drying machine in accordance with a fourth preferred embodiment of the present invention;

Fig. 5 illustrates a perspective view of a heat exchanger of a drum type washing and drying machine in accordance with a fifth preferred embodiment of the present invention;

Fig. 6 depicts a perspective view of a heat exchanger of a drum type washing and drying machine in accordance with a sixth preferred embodiment of the present invention; and

Fig. 7 provides a vertical cross sectional view of a prior art drum type washing and drying machine.

#### Detailed Description of the Preferred Embodiments

Hereinafter, the preferred embodiments of the present invention will be described with reference to the accompanying drawings, wherein like parts to those of the prior art washing and drying machine are designated with like reference numerals, and descriptions thereof will be not repeated. Further, the present invention is not limited to the preferred embodiments to be described hereinafter.

(Preferred embodiment 1)

As illustrated in Fig. 1, suction duct 20 and water tub 21 are formed in one body and suction air inlet 22 is incorporated in water tub 21. Heat exchanger 23, e.g., of a plate shape, is fixedly installed in suction duct 20. Provided at a rear side of water tub 21 is fan case 24 including therein blower 25 for blowing a warm air into rotary drum 6 and heater 26 for heating warm air blown by blower 25. Duct 27 connects suction duct 20 and fan case 24. Suction duct 20, fan case 24 and duct 27 constitute air flow passage 28, a part of air flow passage 28, e.g., suction duct 20 being incorporated in water tub 21. Air flow passage 28 is configured to guide the warm air blown by blower 25 into rotary drum 6.

Cooling water supply valve 29 for introducing cooling water to heat exchanger 23 through cooling water hose 30 constitutes a cooling unit with cooling water hose 30. Heat exchanger 23 has an uneven cooling surface. Various heat exchangers in accordance with the present invention will be described in the following embodiments.

An operation of the above configuration will now be described hereinafter. Operations of washing, rinsing and dewatering process thereof are identical to those of the prior art configuration and descriptions thereof will be omitted.

In the drying process, the warm air blown by blower 25 is heated by heater 26 and directed into rotary drum 6 through air injection opening 31. The heated air undergoes heat exchange with the damp laundry articles in rotary drum 6, thus containing moisture therein. Then, the moist air is forwarded into suction duct 20 through suction air inlet 22, at which time the cooling water flows along a surface of slanted heat exchanger 23, e.g., of a plate shape, to thereby cool down heat exchanger 23.

The moist warm air forwarded into suction duct 20 comes into contact with the surface of heat exchanger 23 while losing heat and being dehumidified. The dehumidified warm air is directed into fan case 24 through connection duct 27 to be re-heated by heater 26 and then is re-directed into rotary drum 6 through air injection opening 31. The cooling water flowing down along the surface of heat exchanger 23 is drained through drain outlet 12 of water tub 21, drain valve 13 and drain pipe 14.

As described above, in the present embodiment of the present invention, suction duct 20 for directing the warm air blown by blower 25 into rotary drum 6 is integrated with water tub 21; heat exchanger 23, e.g., of a plate shape, is fixed in suction duct 20, i.e., in air flow passage 28; the cooling water is introduced to heat exchanger 23 by the cooling unit; and heat exchanger 23 has an uneven cooling surface. Such configuration of the present embodiment

enables the heat exchange to be performed in the space of compact housing 1. Further, the heat exchange executed at the surface of heat exchanger 23 prevents the dispersing of the cooling water as experienced in the prior art washing and drying machine and, at the same time, suppresses the flying back of the cooling water even though the amount of air is increased, which in turn facilitates a uniform drying of the laundry articles after termination of the drying process without introducing the cooling water to heater 26.

(Preferred embodiment 2)

As shown in Fig. 2, heat exchanger 32, e.g., of a plate shape is configured to have an uneven cooling surface 320 and is mounted in a suction duct (not shown) constituting an air flow passage. Cooling surface 320 of heat exchanger 32 is formed by using at least one horizontal cooling surface 320a and at least one vertical cooling surface 320b, arranged alternately and slanted substantially parallel to the direction of air flow 41, which constitutes a stepped shape as a whole. The rest of the configuration is substantially the same as in the first preferred embodiment.

An operation of the above configuration will now be described. The basic operations of the drying process are

substantially identical to those of the first preferred embodiment and descriptions thereof will be omitted.

In the drying process, while the cooling water flows and drops down along the surfaces of slanted heat exchanger 32, it takes longer time for the cooling water to flow from top to bottom of heat changer 32 and, at the same time, a heat exchange area is increased, thereby improving the drying efficiency.

In the present embodiment described above, since the cooling surface of heat exchanger 32 is formed in a stepped shape slanted substantially parallel to the direction of air flow, the cooling water flows and drops down therealong at a lower speed and easily spreads over heat exchanger 32 to thereby secure enough time and area for coming into contact with a humid circulating air, enabling an efficient heat exchange.

(Preferred embodiment 3)

As illustrated in Fig. 3, heat exchanger 33, e.g., of a plate shape is configured to have an uneven cooling surface 330 and is mounted in a suction duct (not shown) constituting an air flow passage such that cooling surface 330 thereof is formed by using at least one horizontal cooling surface 330a and at least one vertical cooling surface 330b. One or more grooves 34 are formed on at least

one of the cooling surfaces of heat exchanger 33 in a manner to be at a predetermined degree, preferably about 90 degree, to a flowing direction of the cooling water. Even though, in Fig. 3, the grooves 34 have been described to have a shape of a straight line, the grooves 34 may have a waveform shape, a zigzag shape or the like. The rest of the configuration is substantially the same as in the second preferred embodiment.

An operation of the above configuration will now be described hereinafter. The basic operations of the drying process are substantially identical to those of the first preferred embodiment and descriptions thereof will be omitted.

In the drying process, while the cooling water flows and drops down along the surfaces of slanted heat exchanger 33, the cooling water is guided by the grooves 34 to thereby be spread over the entire surface of heat exchanger 33, which in turn increases the heat exchange area. As a result, the drying efficiency is enhanced.

As described above, since heat exchanger 33 is configured to have one or more grooves 34 on at least one of the cooling surfaces thereof at a predetermined degree, preferably about 90 degrees, to the flowing direction of the cooling water in the present embodiment, the cooling water is guided by grooves 34 and thus is spread over the entire surface of heat exchanger 33 to thereby increase the heat

exchange area, thereby improving the drying efficiency.

(Preferred embodiment 4)

5       As illustrated in Fig. 4, heat exchanger 35, e.g., of  
a plate shape is configured to have uneven cooling surfaces  
and is mounted in a suction duct (not shown) constituting an  
air flow passage. Heat radiation fins 36 are provided at a  
rear side of at least one of the cooling surfaces of heat  
10   exchanger 35. The rest of the configuration is  
substantially the same as in the second preferred embodiment.

An operation of the above configuration will now be  
described hereinafter. The basic operations of the drying  
process are substantially identical to those of the first  
15   preferred embodiment and descriptions thereof will be  
omitted.

In the drying process, when the cooling water flows  
and drops down along the surfaces of slanted heat exchanger  
35, the heat exchange area may be increased owing to heat  
20   radiation fins 36 prepared at the rear side thereof, thereby  
improving the drying efficiency.

As described above, since heat radiation fins 36 are  
provided at the rear side of at least one of the cooling  
surfaces of heat exchanger 35 in the present embodiment, the  
25   contact area with the moist circulating air can be secured  
sufficiently, which enables an efficient heat exchange.

(Preferred embodiment 5)

As shown in Fig. 5, heat exchanger 37, e.g., of a  
5 plate shape is configured to have uneven cooling surfaces 38  
and is mounted in a suction duct (not shown) constituting an  
air flow passage. Cooling surfaces 38 of heat exchanger 37  
are hydrophilically treated. The rest of the configuration  
is substantially the same as in the second preferred  
10 embodiment.

An operation of the above configuration will now be  
described. The basic operations of the drying process are  
substantially identical to those of the first preferred  
embodiment and descriptions thereof will be omitted.

15 In the drying process, while the cooling water flows  
and drops down along the surfaces of slanted heat exchanger  
37, the cooling water is rarely formed into drops due to the  
hydrophilically treated cooling surfaces 38 of heat  
exchanger 37, so that the cooling water is easily spread  
20 over the surfaces of heat exchanger 37 to thereby improve  
the drying efficiency.

As described above, since cooling surfaces 38 of heat  
exchanger 37 are subject to a hydrophilic treatment in the  
present embodiment, the cooling water rarely exists in the  
25 form of drops on the surfaces of heat exchanger 37 and thus  
uniformly spreads along the steps of heat exchanger 37,

which enhances the capacity of heat exchanger 37.

(Preferred embodiment 6)

5           As shown in Fig. 6, heat exchanger 39, e.g., of a plate shape is configured to have an uneven cooling surface 390 and is mounted in a suction duct (not shown) constituting an air flow. One ore more slits or water channels 40 are formed at heat exchanger 39 in the slanted  
10           direction thereof. The rest of the configuration is substantially the same as in the second preferred embodiment.

          An operation of the above configuration will be described. The basic operations of the drying process are substantially identical to those of the first preferred  
15           embodiment and descriptions thereof will be omitted.

          In the drying process, the cooling water flows and drops down along the surfaces of slanted heat exchanger 39 having slits 40 in the slanted direction thereof. After completion of the drying process, the water remaining on the  
20           heat exchange surfaces flows down along slits 40 formed at heat exchanger 39, so that generation of rust and mold at the heat exchange surfaces due to the remaining water can be prevented, thereby maintaining the drying efficiency of heat exchanger 39.

25           As described above, since there are formed one or more slits 40 at heat exchanger 39 in the inclined direction

thereof in the present embodiment, the cooling water is prevented from remaining on the surfaces of heat exchanger 39, which in turn prevents the growth of mold due to the remaining water and deterioration of the capacity for the heat exchange accompanied thereby.

In the preferred embodiments of the present invention, the heat exchanger has been described to have an uneven cooling surface of a stepped shape. However, the uneven cooling surface of the heat exchanger is not limited to a stepped shape, but a waveform shape, a zigzag shape or one or more protrusions and/or depressions.

As explained hitherto, the drum type washing and drying machine in accordance with the present invention can perform the heat exchange process within the limited space of the compact housing and, at the same time, prevent the flying back of the cooling water, even when an increased amount of circulating air is employed, to thereby achieve a uniform drying of the laundry articles. Accordingly, the drum type washing and drying machine in accordance with the present invention is useful for controlling the washing, rinsing, dewatering and drying processes in the rotary drum having a substantially horizontal or slanted rotational axis.

While the invention has been shown and described with respect to the preferred embodiments, it will be understood by those skilled in the art that various changes and modifications may be made without departing from the spirit

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and scope of the invention as defined in the following claims.

## CLAIMS

1. A drum type washing and drying machine comprising:
  - a rotary drum having a substantially horizontal or slanted rotational axis;
  - a water tub enclosing the rotary drum and having an opening for loading and unloading laundry articles into and from the rotary drum;
  - a lid for opening and closing the opening of the water tub;
  - a heater for making warm air;
  - a blower for blowing the warm air into the rotary drum;
  - an air flow passage, integrated with the water tub, for directing the warm air blown by the blower into the rotary drum;
  - a heat exchanger fixedly installed in the air flow passage; and
  - a cooling unit for supplying cooling water to the heat exchanger,wherein the heat exchanger has an uneven cooling surface, wherein the cooling surface of the heat exchanger includes alternately disposed at least one horizontal cooling surface and at least one vertical cooling surface, which constitute a shape of a set of stairs as a whole slanted substantially parallel to the flow direction of the warm air passing around the heat exchanger.
2. A drum type washing and drying machine comprising:
  - a rotary drum having a substantially horizontal or slanted rotational axis;
  - a water tub enclosing the rotary drum and having an opening for loading and unloading laundry articles into and from the rotary drum;
  - a lid for opening and closing the opening of the water tub;

- a heater for making warm air;
- a blower for blowing the warm air into the rotary drum;
- an air flow passage, integrated with the water tub, for directing the warm air blown by the blower into the rotary drum;
- a heat exchanger fixedly installed in the air flow passage; and
- a cooling unit for supplying cooling water to the heat exchanger,

wherein the heat exchanger has an uneven cooling surface, and the cooling surface is provided with at least one groove for guiding a part of the cooling water therethrough.

3. A drum type washing and drying machine comprising:

- a rotary drum having a substantially horizontal or slanted rotational axis;
- a water tub enclosing the rotary drum and having an opening for loading and unloading laundry articles into and from the rotary drum;
- a lid for opening and closing the opening of the water tub;
- a heater for making warm air;
- a blower for blowing the warm air into the rotary drum;
- an air flow passage, integrated with the water tub, for directing the warm air blown by the blower into the rotary drum;
- a heat exchanger fixedly installed in the air flow passage; and
- a cooling unit for supplying cooling water to the heat exchanger,

wherein the heat exchanger has an uneven cooling surface, and heat radiation fins are prepared at a rear side of the cooling surface.

4. The drum type washing and drying machine of any one of claims 1 to 3, wherein the cooling surface is hydrophilically treated.

5. The drum type washing and drying machine of claim 1 or 3, wherein one or more slits are formed at the heat exchanger in a slanted direction thereof to guide at least a part of the cooling water therethrough.

6. A drum type washing and drying machine comprising:  
a rotary drum having a substantially horizontal or slanted rotational axis;  
a water tub enclosing the rotary drum and having an opening for loading and unloading laundry articles into and from the rotary drum;  
a lid for opening and closing the opening of the water tub;  
a heater for making warm air;  
a blower for blowing the warm air into the rotary drum;  
an air flow passage, integrated with the water tub, for directing the warm air blown by the blower into the rotary drum;  
a heat exchanger fixedly installed in the air flow passage; and  
a cooling unit for supplying cooling water to the heat exchanger,  
wherein the heat exchanger has an uneven cooling surface, and the cooling surface of the heat exchanger is formed in a stepped shape, slanted substantially parallel to the flow direction of the warm air passing around the heat exchanger, and  
wherein the cooling surface is hydrophilically treated.

7. A drum type washing and drying machine comprising:
- a rotary drum having a substantially horizontal or slanted rotational axis;
  - a water tub enclosing the rotary drum and having an opening for loading and unloading laundry articles into and from the rotary drum;
  - a lid for opening and closing the opening of the water tub;
  - a heater for making warm air;
  - a blower for blowing the warm air into the rotary drum;
  - an air flow passage, integrated with the water tub, for directing the warm air blown by the blower into the rotary drum;
  - a heat exchanger fixedly installed in the air flow passage; and
  - a cooling unit for supplying cooling water to the heat exchanger,
- wherein the heat exchanger has an uneven cooling surface, and the cooling surface of the heat exchanger is formed in a stepped shape, slanted substantially parallel to the flow direction of the warm air passing around the heat exchanger, and
- wherein one or more slits are formed at the heat exchanger in a slanted direction thereof to guide at least a part of the cooling water therethrough.