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"A HEATING PROCESS AND APPARATUS"

This invention relates to a heating process and apparatus.

When heating a chamber for drying wet articles disposed
5 therein, conventionally hot air has been fed to the chamber by means
of a pump or a heat source, such as oil, gas or a larger heating
apparatus has been needed in order to that the chamber interior.

Namely, for the purpose of drying the wet articles, energy
for heating the chamber interior is forced to be used in combination
10 with a heat energy for feeding the hot air. A great quantity of
energy, such as electric power, oil or gas have been wastefully
consumed in order to operate the pump and the heating apparatus.

An object of this invention is to remove the afore-
mentioned disadvantages of the conventional art.

15 Accordingly, this invention provides a heating process and
its apparatus in which air pressure within a chamber is reduced to
a balanced level, whereby any wet articles disposed in the chamber
are heated and dried effectively without consuming energy wastefully.

According to one aspect of the present invention, there is
20 provided a heating process in which a reduced air process is
produced within a chamber by forcibly educting air from the sealed
chamber and discharging it to the outside by rotating rotary means
installed in operative relationship to the chamber, and in which
equilibrium conditions with the reduced air pressure in the chamber
25 are maintained by the continuous rotation of said rotary means and
such continuous rotation of the rotary means under equilibrium
conditions generates heat of air friction by means of which the
chamber interior is heated.

According to another aspect of the present invention, a heating apparatus comprises a sealable chamber having an air eduction opening and rotary means mounted at a zone of rotation in the air eduction opening, by means of which rotation of the air within the chamber is forcibly educted and discharged thereoutside, and an air friction heat-generating area formed in the zone of rotation of the rotary means to produce a reduced pressure in the sealed chamber, the arrangement being such that continuous rotation of the rotary means when equilibrium conditions have been established generates heat of air friction to heat the chamber interior.

Therefore, various kinds of wet articles, such as agricultural or marine products, clothes or the like that are placed in the chamber may be dried efficiently and speedily due to the reduced air pressure effect as well as the effect of the heat of air friction.

According to one embodiment of this invention, outer air is supplied to the chamber by way of rotary outer air feed means installed in the chamber, so that the temperature within the chamber can be set uniformly to achieve an effective drying.

According to another feature of this invention, the outer air is additionally heated by heating means installed in the chamber in order to prevent a fall in the chamber temperature, and the heating means is controlled manually or automatically responsively to the temperature within the chamber.

This invention will be further described, by way of example, with reference to the accompanying drawings, in which:-

Fig. 1 is a partially cut away front view of one embodiment of heating apparatus according to this invention;

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Fig. 2 is a partially cut away perspective view of another embodiment of heating apparatus according to this invention;

Fig. 3 is a partially cut away perspective view of outer air feed means of the heating apparatus of Fig. 2;

5 Fig. 4 is a partially cut away section of an embodiment of the outer air feeding means;

Fig. 5 is a partially cut away front view of another embodiment of the heating apparatus according to this invention;

10 Fig. 6 is a partially cut away sectional view showing the lower structure of the heating apparatus of Fig. 5;

Fig. 7 is a partially cut away plan view of rotary air feed means of the above structure of Fig. 5;

Fig. 8 is a side view of the rotary air feed means in Fig. 7;

15 Fig. 9 is a sectional view taken on line IX - IX of Fig. 8;

Fig. 10 is a plan view of air flow regulating means in its use condition;

20 Fig. 11 is a sectional view taken on line XI - XI of Fig. 10;

Fig. 12 is a partially cut away perspective view of another embodiment of heating apparatus according to this invention;

Fig. 13 is a partially cut away perspective view of outer air feed means mounted in the heating apparatus of Fig.

25 12; and

Fig. 14 is a perspective view of rotary air feed means

mounted in the heating apparatus of Fig. 12.

A preferred example of a heating process and its apparatus according to this invention will now be described with reference to Fig. 1.

5 A square type chamber 1 is closed by a pair of doors 2,2. The chamber 1 is shielded by two external walls 3a, between which is incorporated a heat insulating material 3. A suction opening 4 is provided centrally in the chamber ceiling. In the suction opening 4 there is mounted rotary means a directly connected to
10 a motor 5. The rotary means a is provided with a propeller fan or a sirocco fan or the like, which has a plurality of vanes 6 rotatable by the motor 5. Each vane 6 has a certain pitch or inclination so that air can be educted from the chamber 1 and discharged smoothly.

15 Symbol A denotes a friction heat generating zone whereat the rotary means a is rotated.

Outer air feed means 7 comprises an outer air feed pipe 7a whose end 7b is directed to the bottom of the chamber 1. In
20 Fig. 1, the chamber 1 is shown supported by legs 8 and the feed pipe 7a is supported below a bottom wall of the chamber 1.

The outer air feed pipe 7a has an adjusting valve 10 provided with a handle, by which the flow of the outer air passing through the feed pipe 7a can be adjusted. The adjusting valve 10 may be used as an automatic control valve which can control
25 variably the reduced working air pressure in the chamber 1, taking into consideration the temperature within the chamber 1 and the

air pressure difference between the inside of and the outside of the chamber 1. Therefore, the outer air is supplied to the chamber 1 in dependence from the temperature of the chamber 1 or the reduced air pressure therein.

5 The chamber interior can be inspected through a window 11 and an indication panel 12 indicates the temperature, air pressure, etc., in the chamber 1. The motor 5 is shielded by a cylindrical casing 13 in which is formed a passage for discharging the air. A silencer 15 is provided for eliminating noise. Further, to dry
10 wet articles placed in the chamber 1, a number of shelves (not illustrated) on which they may be disposed may be mounted in the chamber. Needless to say, the shelves are perforated so as to obtain a ventilation effect.

 Now, the heating process of this invention will be
15 described.

 When the motor 5 is energized, the vanes 6 are rotated and the air pressure within the chamber 1 is gradually reduced, since the air therewithin is educted forcibly and discharged
outside the chamber 1 by rotation of the vanes 6. The difference
20 between the reduced air pressure within the chamber 1 and a normal air pressure thereoutside gradually becomes larger but after a short lapse of time the pressure difference therebetween is maintained at a balanced level. The air pressure difference is defined by a suction force of the rotary means a and the clearance
25 gap between the suction opening 4 and the rotary vanes 6, but the difference between the reduced air pressure within the chamber 1

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and the normal air pressure thereoutside is maintained at a balanced level so long as the vanes 6 are rotated continuously.

While this balanced air pressure difference is maintained, an air retaining phenomenon occurs in the friction heat generating zone A where the vanes 6 are rotated. Since the vanes 6 are rotated continuously in that zone A, heat of air friction is generated and the air temperature is gradually raised. The air heated by this heat of friction is circulated throughout the chamber 1 and it is possible to heat the chamber 1 to a desired temperature.

Accordingly, when any wet articles to be dried are disposed within the chamber 1, the aqueous content of each article is evaporated rapidly by the reduced air pressure effect within the chamber 1. In addition to this, owing to the air friction heating effect, the chamber temperature is raised and all articles disposed in the chamber are heated and the wet articles are dried uniformly and speedily.

Further, during the heating process of the chamber 1, when feeding outside air thereinto by opening the valve 10 of the outer air feed pipe 7, the temperature within the chamber is decreased, but, due to the outer air supply some of the vapour within the chamber 1 is discharged by rotation of the vanes 6, so that the drying effect is expedited.

As described above, because neither a pump for feeding hot air nor a heater for heating the chamber inside is required, this invention can contribute to a great saving of energy.

An embodiment as shown in Figs. 2 and 3 will now be

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described. A difference between the above embodiment of Fig. 1 and this embodiment resides in the technical structure of the outer air feed means. The other structure is the same as in the embodiment of Fig. 1. A description of the same components as shown in Fig. 1 will be omitted. In Fig. 2, outer air feed means 16 is incorporated in the bottom of the chamber 1. The outer air is sucked into a suction opening 16a and is fed into an air passage 17 and a suction pipe 18. At a front end of the suction pipe 18 is a nozzle 19 which is controlled by a handle 18a projecting from a front panel of the chamber 1.

Fig. 4 shows another embodiment of the outer air feed means. A passage 20c of the outer air feed means 20 is filled with a filtering material 21, which is replaceable to filter out dust in the outer air. An outer air feed pipe 20b leads from the passage 20c to an inner opening 20a directed into the chamber 1. The outer air is fed into the chamber 1 by opening a valve 22 by means of a handle 22a.

Another embodiment of this invention will now be described with reference to Figs. 5 to 11.

The construction of this embodiment is basically the same as that of the embodiment of Fig. 1. The embodiment shown in Figs. 5 to 11 comprises outer air feed means, air flow regulating means, etc. Since the same features of construction as shown in Fig. 1 have the same numerals, their description will be omitted.

Outer air feed means 25 are mounted in the lower part of the chamber 1. An outer end 25a of the feed means 25 is formed at one side of the outer walls 3a, while an inner end 25b thereof

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is formed at a sirocco fan wheel 27 which is positioned at a centre of rotary air feed means 26. As shown in Fig. 6, the sirocco fan wheel 27 is mounted within and around a cylinder 28. Further a preferred number of heaters 30, each having a plurality of fins 29, is incorporated in the outer air feed means 25. The heaters 30 perform the function of an additional heating device. The outer air supply is adjusted by manual operation of a handle 31a interconnected with an adjusting valve 31. The heaters 30 may be controlled automatically by means of a thermostat (not illustrated) so that the chamber 1 can be maintained at a constantly set temperature.

The adjusting valve 31 may be replaced by an automatic control valve which is opened or closed while detecting the chamber temperature or the air pressure difference between the inside of and the outside of the chamber.

A number of agitating cylinders 32 are provided and are disposed in radial directions. A slit-type opening 33 is formed on each agitating cylinder 32. The outer air by which the sirocco fan wheel 27 has been rotated is fed into a number of agitating cylinders 32 by way of a perforated disc 34 and discharged upwardly from the slit-type openings 33. A bearing 35 is provided between the cylinder 28 and the sirocco fan wheel 27. Air flow regulating means 36 are mounted on the rotary air feed means 26. The air flow regulating means 36 comprise a plurality of sloping plates 37, and a gap g is formed between adjacent sloping plates 37.

As shown in Fig. 11, heated air is supplied to the chamber 1 along the inclination of each sloping plate 37 so as to obtain a

uniform temperature throughout the chamber 1. Further, by adjusting the inclination of the sloping plates 37, it is possible to adjust the quantity of air fed to the chamber 1.

5 A perforated plate 39 (Fig. 5) is supported at the upper part of the chamber 1 in order that the air in the chamber 1 may be educted uniformly from the whole area by rotation of the rotary means a. At the same time, in view of safety of operation, the perforated plate 39 is mounted to cover the rotary means a which would otherwise be exposed. Thus, it is impossible for any
10 operator to touch the rotary means a directly.

Further, it is optional to mount a number of shelves (partially illustrated) for supporting the articles to be dried, but it is of course inevitable to provide the shelves with a ventilation effect.

15 A heating process using the above embodiment will now be described.

As described previously, the air in the chamber is heated by the effect of the reduced air pressure due to the rotary means as well as by the heat of air friction thereof. In the
20 embodiment as shown in Figs. 5 to 11, the desired temperature of the air in the chamber 1 is first of all set, and then the outer air feed means 25 is operated. The outer air is supplied to the chamber 1 by adjusting the handle 31a of the adjusting valve 31 and is then additionally heated by the heaters 30. The temperature of
25 the heated outer air is identical to or similar to that of the air within the chamber 1. The heated air sucked in by way of the air flow regulating means 31 is rotated by the rotary air feed means

26 and uniformly fed into the chamber 1.

Accordingly, any wet articles that are disposed in the chamber are heated and dried uniformly with the minimum energy consumption.

5 A further embodiment of this invention will now be described with reference to Figs. 12 to 14.

The principle, function and operation of this embodiment are identical to those in the previously described embodiments. Outer air feed means 40 comprise an air passage 41, into which the
10 outer air is introduced from an opening 41a. In the air passage 41 there are incorporated a number of heaters 43 which are partitioned by a number of baffle boards 42. The outer air sucked into the passage 41 is liable to be retained in the passage 41 due to the baffle boards 42, so that the retained air is heated by the
15 heaters 43. The air passage 41 is connected to a conduit 44 which leads by way of an adjusting cock 45 to a cylinder 48 having a trunnion 47. The opening or closing of the cock 45 is effected by operating a handle 45a. A by-pass pipe 46 by-passes the
-adjusting cock 45. Rotary air feed means 50 has a cylindrical
20 casing 54 and is rotatably mounted in the cylinder 48. The rotary air feed means 50 comprises a number of vanes 51, each of which is inclined obliquely. Each of the vanes 51 is provided at its top edge with a slit 52, from which the heated air is fed into the chamber 1. Due to repulsion by the rotating vanes 51, the rotation
25 of the cylinder 54 is expedited, thereby rotary air feed means 50 is rotated smoothly. As a result, the heated air can be maintained at a constant temperature throughout the chamber 1.

As shown in Fig. 12, in the chamber 1 there are supported a plurality of perforated shelves 60 as well as a plurality of air flow regulating means 36 as shown in Figs. 10 and 11. The opening or closing of the adjusting cock 45 may be effected automatically by
5 a timer (not illustrated). Further, the by-pass pipe 46 may function as means for rotating the cylinder casing 54.

As described previously, the air within a sealed chamber is first of all educted forcibly and is discharged thereoutside by rotation of rotary means mounted on the chamber. Then, the air
10 pressure therewithin is reduced to a balanced level. Meanwhile, heat of air friction is generated by continuous rotation of the rotary means and the chamber inside is heated by the heat of air friction. After the air heated by the heat of air friction has reached a desirable temperature, preferably heated, outer air may be
15 supplied into the chamber by way of outer air feed means having a heater in order to enhance furthermore the drying effect of the chamber. At the same time, a certain proportion of vapours caused by the wet articles in the chamber may be discharged outside the
chamber.

20 Further, since the outer air feed means is provided with the rotary air feed means, the sucked in outer air is distributed uniformly throughout the chamber by rotation of the rotary air feed means. Accordingly, the air in the chamber is maintained everywhere at a constant temperature and any wet articles therein are dried
25 uniformly.

The heating process and apparatus of this invention

avoids the need to install a conventional large-scale heater and saves consumption of a great quantity of energy. Only a small-sized heater may be installed additionally. Thus, the energy consumption can be saved greatly. Various kinds of wet articles, such as agricultural or marine products, clothes or the like disposed in the chamber, can be dried effectively and speedily.

As described previously, the rotary means for educting and discharging the air within the chamber is mounted on the top of the chamber, while the outer air feed means and its related devices are mounted at the bottom thereof. However, the position of the former may be replaced with that of the latter.

Further, since the heated air at high temperature is generated continuously and fully fills the chamber, the chamber itself becomes a heat source. Accordingly, such highly heated air can be used for various kinds of heaters, such as a room heater, a hot water making device, a heater for a greenhouse, etc. Thus, the heating process and its apparatus according to this invention may be applied to various industrial fields.

As many widely different embodiments of this invention may be made without departing from the scope thereof, it is to be understood that the invention is not limited to the specific embodiments thereof except as defined in the claims.

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C L A I M S

1. A heating process in which a reduced air pressure is produced within a chamber by forcibly educting air from the sealed chamber and discharging it to the outside by rotating rotary means
5 installed in operative relationship to the chamber, and in which equilibrium conditions with the reduced air pressure in the chamber are maintained by the continuous rotation of said rotation means and such continuous rotation of the rotary means under equilibrium conditions generates heat of air friction by means of which the
10 chamber interior is heated.
2. A heating process according to claim 1, wherein heated or unheated outer air is sucked into the chamber and its amount is controlled manually or automatically.
3. A heating process according to claim 2, in which the
15 amount of outer air sucked into the chamber is controlled to maintain the temperature at reduced pressure therein substantially at a desired value.
4. A heating process according to claim 1, 2 or 3, wherein
20 wet articles are disposed in the chamber and are dried uniformly therein.
5. A heating process substantially as herein described with reference to the accompanying drawings.
6. A heating apparatus comprising a sealable chamber having
25 an air eduction opening and rotary means mounted at a zone of rotation in the air eduction opening, by means of which rotation of the air within the chamber is forcibly educted and discharged



thereoutside, and an air friction heat-generating area formed in the zone of rotation of the rotary means to produce a reduced pressure in the sealed chamber, the arrangement being such that continuous rotation of the rotary means when equilibrium

5 conditions have been established generates heat of air friction to heat the chamber interior.

7. A heating apparatus according to claim 6, wherein the chamber is provided with outer air feed means to feed the outer air into the chamber, the outer air feed means including additional
10 heating means to heat the sucked in air to a preferred temperature.

8. A heating apparatus according to claim 6 or 7, wherein the outer air feed means includes a manually or automatically adjustable valve by which the outer air passing through the feed means is adjustable in accordance with the temperature of or reduced
15 pressure in the chamber.

9. A heating apparatus according to claim 7 or 8, wherein the outer air feed means is provided with rotary air feed means which is rotated by the outer air.

~~10.~~ A heating apparatus according to any of claims 6 to 9,
20 wherein the chamber is provided with means for receiving therein wet articles, whereby their moisture content is vaporised and they are dried uniformly and speedily.

11. A heating apparatus according to any of claims 6 to 10, wherein the chamber is provided with means for opening and closing
25 a chamber access opening and is shielded by an outer wall in which is incorporated a heat insulating material.



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12. A heating apparatus according to any of claims 6 to 11, wherein the rotary means comprises a plurality of angled rotary vanes.

13. A heating apparatus constructed and adapted to operate substantially as herein described with reference to and as
5 illustrated in the accompanying drawings.

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