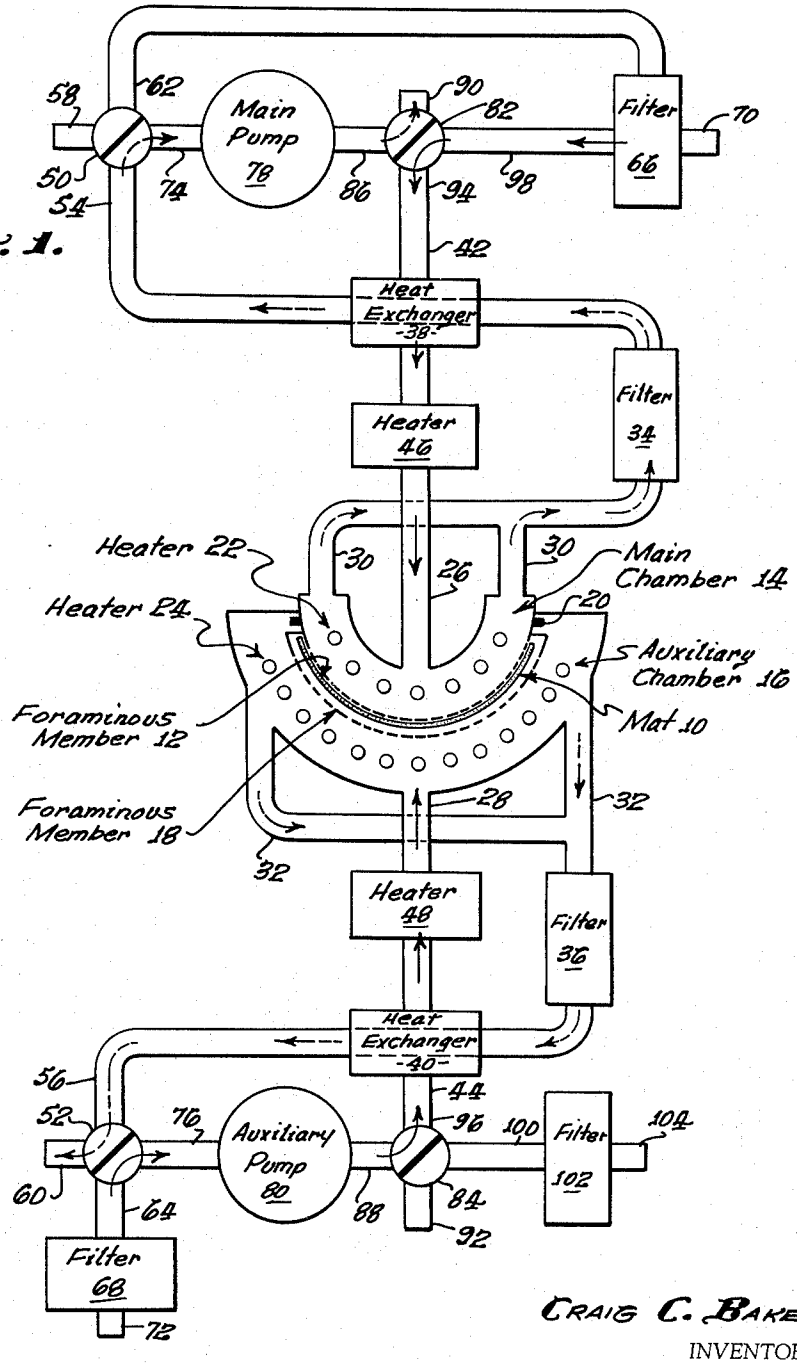
March 22, 1966 C. C. BAKER 3,241,247

METHOD OF AND APPARATUS FOR DRYING STEREOTYPE MATS

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FIG. 1.



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METHOD OF AND APPARATUS FOR DRYING STEREOTYPE MATS

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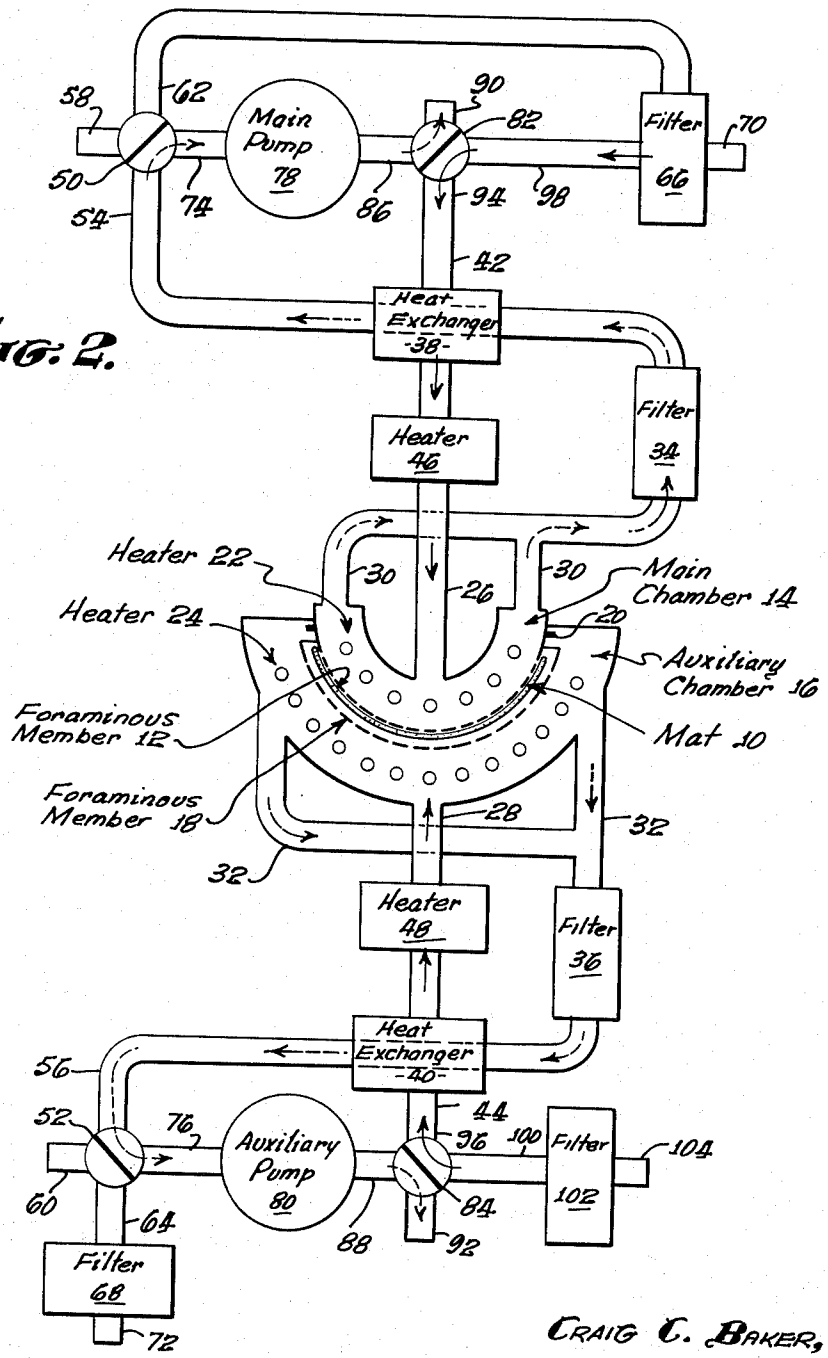


FIG. 2.

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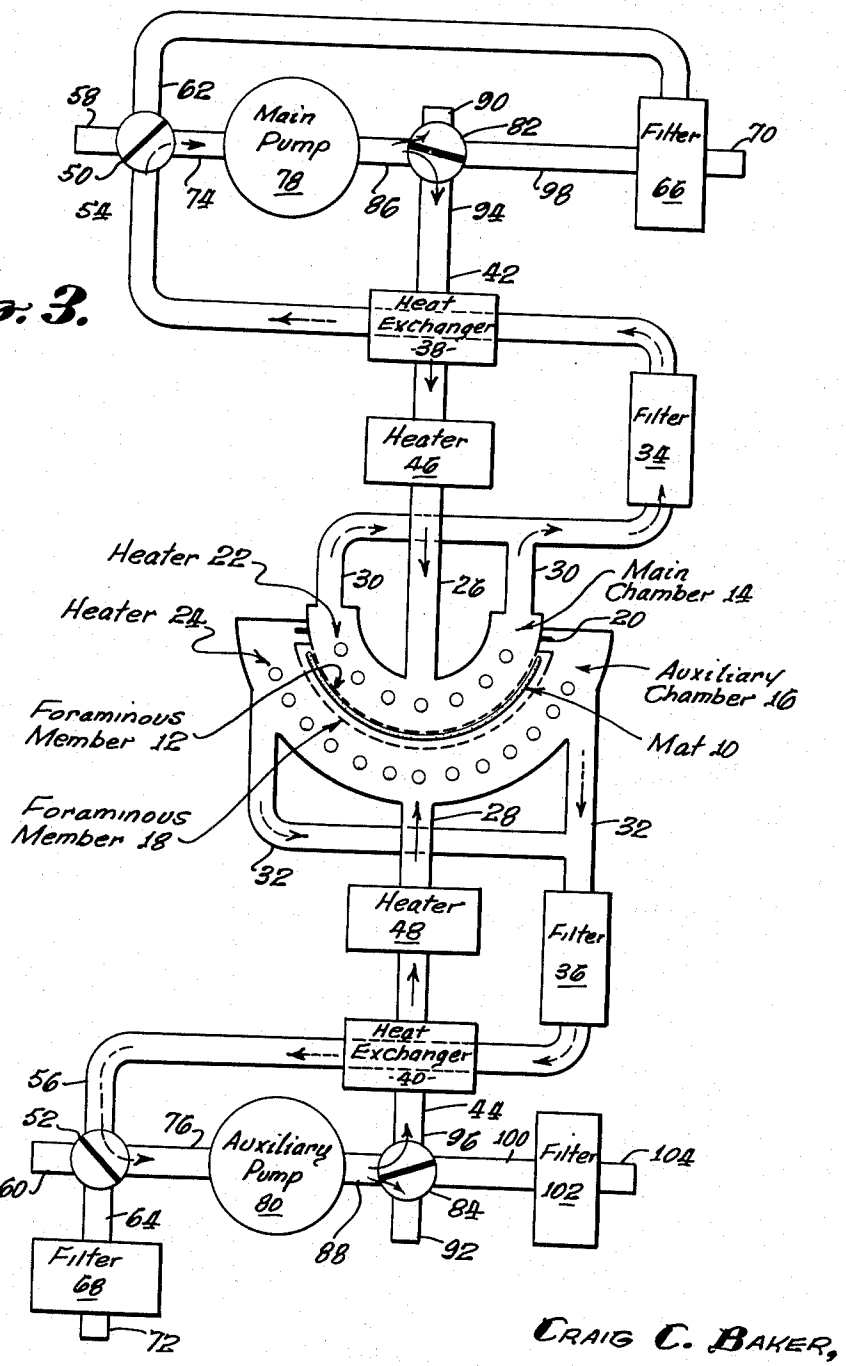
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METHOD OF AND APPARATUS FOR DRYING STEREOTYPE MATS

Filed April 5, 1961 3 Sheets-Sheet 3

FIG. 3.



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United States Patent Office 3,241,247 Patented Mar. 22, 1966

3,241,247

METHOD OF AND APPARATUS FOR DRYING STEREOTYPE MATS

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Filed Apr. 5, 1961, Ser. No. 100,981
10 Claims. (Cl. 34—17)

The present invention relates in general to drying materials in sheet form and since it finds particular utility in the field of drying stereotype mats it will be considered in such connection herein for convenience of disclosure.

In general, it is an object of the present invention to provide an improved method of and apparatus for drying and shrinking stereotype mats, either in so-called predryer, or in a former wherein the final forming, drying and shrinking operations prior to casting are performed on the mats.

It is conventional in pre-drying or forming stereotype mats to support one side of the mat on a foraminous member, such as a screen, a perforated plate, or the like, and to apply a vacuum to the supported side of the mat to hold it against the foraminous member. At the same time, the mat is heated to drive off excess moisture. With this construction, moisture is removed from the mat on one side thereof only, i.e., on the side thereof which is supported by the foraminous member.

An important object of the present invention is to provide a method of and apparatus for pre-drying or forming mats wherein air is circulated, i.e., caused to flow, adjacent both sides of the mat so as to remove moisture from both sides of the mat simultaneously. The air circulated adjacent the supported side of the mat is preferably at subatmospheric pressure, while the air circulated adjacent the other side of the mat may be at atmospheric pressure, subatmospheric pressure, or superatmospheric pressure. In any event, the pressure applied to the supported side of the mat is lower than the pressure applied to the other side thereof so as to produce across the mat a pressure differential holding the mat against the foraminous member.

Controlling the air pressure on and circulating air adjacent both sides of the mat, as opposed to the conventional practice of merely applying a vacuum to the supported side thereof, have a number of important advantages. First, by using subatmospheric pressures on both sides of the mat, it is possible to significantly reduce the temperature at which the moisture in the mat will evaporate, thereby permitting a reduction in the time required to reduce the moisture content to the desired level and/or the heat required to accomplish this. Another advantage of applying subatmospheric pressures to both sides of the mat is that any stresses in the mat are relieved. A further advantage, particularly in a former embodying the invention, is that the differential pressure may be made high enough, e.g., several inches of mercury, irrespective of whether the high pressure component of the differential pressure is subatmospheric or superatmospheric, to form the mat properly without the use of a forming blanket acting on the unsupported side thereof. The elimination of any blanket leaves the unsupported side of the mat exposed for any operations thereon which may be desired, and also leaves the unsupported side of the mat exposed for more efficient heating thereof and for more efficient removal of moisture therefrom. It will be understood that a pulsating differential pressure, achieved by pulsating either the low pressure component of the pressure differential, the high pressure component thereof, or both, may be used to facilitate mat shrinkage during drying while still retaining the mat in engagement with the supporting foraminous member.

A further object of the invention is to provide an apparatus capable of achieving the foregoing which includes a main chamber on and communicating with the supported side of the mat and an auxiliary chamber on and communicating with the opposite side of the mat, main and auxiliary pumps, e.g., blowers, or fans being connected to the main and auxiliary chambers, respectively, to produce the desired low and high pressure components in the main and auxiliary chambers, respectively, and to circulate air through the main and auxiliary chambers, respectively, so as to remove moisture from both sides of the mat simultaneously.

Other and important objects of the invention are to provide valve means for selectively connecting the inlet and the outlet of each pump to the corresponding chamber and the atmosphere in such a manner as to produce any desired pressure, e.g., subatmospheric or superatmospheric, in the chamber, and in such a manner as to discharge all of the air removed from the corresponding chamber to exhaust and introduce only atmospheric air thereinto. Another object is to recirculate part of the air removed from the corresponding chamber back into such chamber while discharging part of the removed air to exhaust and replacing it with atmospheric air. A further object is to continuously recirculate all of the air removed from the corresponding chamber with no removed air being discharged to exhaust and with no removed air being added. Another object is to remove moisture from any such recirculated air. With such constructions, each of the auxiliary and main chambers may be operated on a complete recirculation basis, on a partial recirculation basis, or on a nonrecirculating basis.

Another object of the invention is to provide filter means in series with each pump and chamber for filtering the air introduced into the corresponding chamber, irrespective of whether such air be atmospheric air, or recirculated air.

Another object is to provide in series with each pump and chamber heat exchanger means for transferring heat from the air removed from the chamber to the air introduced into the chamber, whether the introduced air be recirculated air, or atmospheric air. The heat exchanger means in series with each pump and chamber, in addition to pre-heating the air introduced into such chamber, also has the effect of cooling the air removed from such chamber so as to reduce its moisture content, which is an important feature.

Other objects are to provide an apparatus which includes radiant heating means in the main and auxiliary chambers for radiantly heating both sides of the mat and/or to provide heaters in series with the respective pumps and chambers for heating the air introduced into the respective chambers. Preferably, both types of heating are utilized, the radiant heaters directly heating both sides of the mat and the heaters in series with the respective pumps and chambers serving to heat the air introduced into the respective chambers to increase its moisture carrying capacity.

The foregoing objects, advantages, features and results of the present invention, together with various other objects, advantages, features and results thereof which will be evident to those skilled in the art to which the invention relates in the light of this disclosure, may be achieved with the exemplary embodiment of the invention described in detail hereinafter and illustrated in the accompanying drawings, in which:

FIG. 1 is a diagrammatic view of an apparatus which embodies the invention and is capable of performing the method thereof;

FIG. 2 is a view similar to FIG. 1, but illustrating a different set of operating conditions; and

FIG. 3 is a view similar to FIGS. 1 and 2, but illustrating still another set of operating conditions.

In each of FIGS. 1 to 3 of the drawings, the numeral **10** designates a mat which is supported by and one side of which is in engagement with a foraminous member **12** forming one wall of a main air chamber **14**, the foraminous member being a screen, a perforated plate, or the like. As will be apparent, the supported side of the mat **10** is exposed to the pressure in the main chamber **14** through the foraminous member **12**.

On the opposite, or unsupported, side of the mat **10** is an auxiliary air chamber **16**, the unsupported side of the mat being exposed to the pressure in the auxiliary chamber. In the particular construction illustrated, the unsupported side of the mat **10** communicates with the auxiliary chamber **16** through a second foraminous member **18** which forms one wall of the auxiliary chamber. However, the mat **10** normally does not engage the foraminous member **18**.

Any suitable construction may be provided to permit insertion of the mat between and removal thereof from between the main and auxiliary chambers **14** and **16**. For example, the mat **10** may merely be inserted into and withdrawn from the space between the foraminous members **12** and **18**. Alternatively, one of the chambers **14** and **16** may be mounted for movement toward and away from the other, a suitable seal **20** being provided therebetween. Also, while the mat **10** is shown in curved condition, as would be the case in a former, it may be in a flat condition, as would preferably be the case in a predryer. In the latter event, the foraminous members **12** and **18** would be flat and the main and auxiliary chambers **14** and **16** would be complementarily shaped.

The supported and unsupported sides of the mat **10** are respectively heated by radiant heaters **22** and **24** respectively disposed in the main and auxiliary chambers **14** and **16**. Each of the heaters **22** and **24** may comprise a plurality of infrared lamps, preferably of the tube type. It is important to note that the supported and unsupported sides of the mat **10** are respectively directly exposed to the heaters **22** and **24**, through the respective foraminous members **12** and **18**, for maximum heating efficiency.

The main and auxiliary chambers **14** and **16** have air inlet lines **26** and **28** respectively communicating therewith intermediate their ends or edges, and respectively have two outlet lines **30** and **32** communicating therewith at both ends or edges. With this construction, the air flow into each chamber **14** and **16** divides and flows in both directions from the middle of the chamber to insure uniform air circulation over the corresponding side of the mat **10**.

The outlet lines **30** and **32** respectively lead to filters **34** and **36** which filter the air removed from the main and auxiliary chambers **14** and **16** so that it will be clean in the event that it is recirculated back to such chambers, as hereinafter discussed.

From the filters **34** and **36**, the air removed from the main and auxiliary chambers **14** and **16** flows through heat exchanger means or heat exchangers **38** and **40** which extract moisture from the air withdrawn from the chambers **14** and **16** by removing heat therefrom. Thus, the air withdrawn from the main and auxiliary chambers **14** and **16** is dried by the respective heat exchangers **38** and **40** to increase its moisture absorbing capacity in the event of recirculation, or to reduce its humidifying effect in the event it is discharged into the air in a room.

Cool air is supplied to the heat exchangers **38** and **40**, to cool the air withdrawn from the respective chambers **14** and **16**, through lines **42** and **44**, as will be described. The line **42** is connected to the inlet line **26** leading to the main chamber **14** through the heat exchanger **38** and a heater **46**. Similarly, air flows from the line **44** through the heat exchanger **40**, a heater **48**, and the inlet line **28** into the auxiliary chamber **16**.

The filtered and cooled, and thus dried, air removed from the main and auxiliary chambers **14** and **16**, after passing through the heat exchangers **38** and **40**, flows to four-way valves **50** and **52**, respectively. More particularly, the valves **50** have ports **54** and **56** respectively connected to the heat exchangers **38** and **40**, ports **58** and **60** respectively communicating with the atmosphere, ports **62** and **64** respectively communicating with filters **66** and **68** which respectively communicate in turn with the atmosphere at **70** and **72**, and ports **74** and **76** respectively connected to the inlets of main and auxiliary pumps **78** and **80**, which may be centrifugal blowers, for example. As will be discussed in more detail hereinafter, various flow patterns may be produced by selecting different positions for the valves **50** and **52**.

The apparatus of the invention also includes four-way valves **82** and **84** which cooperate with the four-way valves **50** and **52**, respectively, as will be described. The valves **82** and **84** are respectively provided with ports **86** and **88** communicating with the outlets of the main and auxiliary pumps **78** and **80**, ports **90** and **92** communicating with the atmosphere, ports **94** and **96** connected to the lines **42** and **44** leading to the heat exchangers **38** and **40**, and ports **98** and **100** leading to the filter **66** and to a filter **102**, the latter communicating with the atmosphere at **104**.

The foregoing completes a description of the structure of the apparatus of the invention which is shown in the drawings, and its various modes of operation will now be considered.

Operation

As hereinbefore suggested, the mat **10** may be held against the foraminous member **12** by a pressure differential between the main and auxiliary chambers **14** and **16** at least the low pressure component of which, i.e., the pressure in the main chamber **14**, is subatmospheric (although this is not absolutely essential). The high pressure component of the pressure differential, i.e., the pressure in the auxiliary chamber **16**, may be any value, subatmospheric, atmospheric, or superatmospheric, higher than the pressure in the main chamber **14**. Preferably, the pressures in both the main and auxiliary chambers **14** and **16** are subatmospheric to expedite drying of the mat **10** as hereinbefore explained.

The foregoing various pressure component patterns, and corresponding flow patterns through the apparatus, are achieved by means of the four-way valves **50**, **52**, **82** and **84**. Various pressure and flow patterns will now be considered in connection with the respective figures of the drawings.

Considering first the conditions obtaining in FIG. 1 of the drawings, the valves **50** and **82** are in positions such that all of the air withdrawn from the main chamber **14** is discharged to exhaust at **90** through the main pump **78**. The air introduced into the main chamber **14** and flowing over the supported side of the mat **10** is all fresh atmospheric air passing through the filter **66**, the valve **82**, the heat exchanger **38** and the heater **46**, and bypassing the main pump **78**. Consequently, a subatmospheric pressure is produced in the main chamber **14**.

Similarly, the valves **52** and **84** are so positioned that all of the air removed from the auxiliary chamber **16** is discharged to exhaust at **60**, and all of the air entering the auxiliary chamber and flowing over the unsupported side of the mat **10** is fresh atmospheric air flowing through the filter **68**, the valve **52**, the auxiliary pump **80**, the valve **84**, the heat exchanger **40** and the heater **48**. It will be noted that the air withdrawn from the auxiliary chamber **16** bypasses the auxiliary pump **80**, with the result the the pressure in the auxiliary chamber **16** is superatmospheric. The pressure differential acting on the mat **10** is the difference between the subatmospheric pressure in the main chamber **14** and the superatmospheric pressure in the auxiliary chamber **16**. This pressure differential may have any desired magnitude, ranging from

zero to a maximum depending on the sum of the capacities of the main and auxiliary pumps **78** and **80**.

It will be noted that, with the conditions obtaining in FIG. 1, the heat exchangers **38** and **40** pre-heat the air introduced into the main and auxiliary chambers **14** and **16**, extracting heat from the air withdrawn from such chambers. The heat exchangers **38** and **40** also extract moisture from the air withdrawn from the chambers **14** and **16**, which is advantageous in the event that the withdrawn air is discharged into a room, although it may be discharged out of doors, as will be understood.

Referring to FIG. 2 of the drawings, the positions of the valves **50** and **82** are the same as shown in FIG. 1, whereby subatmospheric pressure obtains in the main chamber **14**. However, the positions of the valves **52** and **84** are such that all of the air withdrawn from the auxiliary chamber **16** is discharged to exhaust at **92** through the auxiliary pump **80**, and fresh atmospheric air is introduced into the auxiliary chamber **16** through the filter **102**, the valve **84**, the heat exchanger **40** and the heater **48** so that the auxiliary pump **80** is bypassed. Consequently, subatmospheric pressure exists in the auxiliary chamber **16** also. Under such conditions, the pressure on the mat **10** can be varied from zero to the maximum subatmospheric pressure attainable in either the main chamber **14** or the auxiliary chamber **16**, whereas with the conditions of FIG. 1, the pressure on the mat can be varied between zero and the sum of the maximum subatmospheric and superatmospheric pressures attainable in the chambers **14** and **16**. With the conditions of FIG. 2, a pulsating differential pressure, first biasing the mat **10** toward the foraminous member **12** and then biasing it away from this foraminous member, can be applied to promote shrinkage. This effect may be produced by suitable manual or automatic manipulations of appropriate ones of the valves **50**, **52**, **82** and **84**. As is the case with the conditions of FIG. 1, the exhaust air is cool and dry under the conditions of FIG. 2.

Referring to FIG. 3 of the drawings, the conditions shown therein are the same as those shown in FIG. 2, except that the valves **82** and **84** are so positioned that part of the air withdrawn from the chambers **14** and **16** through the main and auxiliary pumps **78** and **80** is directed back to these chambers by the valves mentioned, the remainder being discharged to exhaust at **90** and **92**. Under these conditions, no air from the atmosphere is being introduced into the main and auxiliary chambers **14** and **16** (except through leakage) so that the maximum subatmospheric pressures of which the main and auxiliary pumps **78** and **80** are capable are produced in these chambers. The capacity of the main pump **78** exceeds that of the auxiliary pump **80** so that when the maximum vacuums of which the main and auxiliary pumps are capable are produced in the main and auxiliary chambers **14** and **16**, the pressure in the main chamber is lower than that in the auxiliary chamber so that a pressure differential exists tending to hold the mat **10** against the foraminous member **12**.

The conditions existing in FIG. 3 of the drawings can be modified, if desired, by so positioning the valves **50** and **52** that some atmospheric air is drawn into the inlets of the main and auxiliary pumps **78** and **80** through the filters **66** and **68**, respectively, by way of the ports **62** and **64**. This limits the vacuums which can be achieved in the main and auxiliary chambers **14** and **16** should this be desired.

Various other relative settings of the valves **50**, **52**, **82** and **84** may be used to obtain pressure relations in the main and auxiliary chambers **14** and **16**, and corresponding flow patterns, which are not shown in the drawings.

It will be understood that various auxiliary control equipment may be used in conjunction with the apparatus hereinbefore disclosed. For example, means may be provided for measuring the moisture content of the air in, or leaving, the main and auxiliary chambers **14** and **16** and for terminating operation of the apparatus when the moisture content has been reduced to a desired level. Alternatively, or in addition, means may be provided for terminating the cycle in response to shrinkage of the mat **10**.

Although an exemplary embodiment of the invention has been disclosed for purposes of illustration, it will be understood that various changes, modifications and substitutions may be incorporated therein without departing from the spirit of the invention as defined by the claims which follow.

I claim:

1. A method of drying a mat, characterized by the use of a foraminous wall engageable by one side of the mat, and including the steps of:

(a) placing said one side of the mat adjacent said foraminous wall;

(b) flowing a first stream of air past said foraminous wall so as to remove moisture exaporated from said one side of the mat;

(c) flowing a second, separate stream of air past the other side of the mat so as to separately remove moisture exaporated from said other side of the mat;

(d) maintaining the pressure in said first stream below the pressure in said second stream so as to create between said streams an air pressure differential acting in a direction to urge said one side of the mat into engagement with said foraminous wall; and

(e) heating both sides of said mat to evaporate moisture therefrom into the respective, separate streams of air so that the moisture evaporated from said one side of said mat is carried away independently of the moisture evaporated from said other side of said mat.

2. In an apparatus for drying a mat, the combination of:

(a) a foraminous member adapted to support a mat on one side thereof;

(b) means providing a main air chamber on the other side of and communicating with said foraminous member;

(c) means providing an auxiliary air chamber on said one side of and communicating with said foraminous member;

(d) means for flowing separate, main and auxiliary streams of air through said main and auxiliary chambers, respectively, so as to separately remove moisture evaporated from opposite sides of a mat supported by said foraminous member, and for simulaneously maintaining the pressure in said main air chamber below the pressure in said auxiliary air chamber so as to create an air pressure differential acting to hold the mat against said one side of said foraminous member; and

(e) means for radiantly heating both sides of a mat held against said one side of said foraminous member by said air pressure differential.

3. In an apparatus for drying a mat, the combination of:

(a) a foraminous member adapted to support a mat on one side thereof;

(b) means providing a main air chamber on the other side of and communicating with said foraminous member;

(c) means providing an auxiliary air chamber on said one side of and communicating with said foraminous member;

(d) pumping means for flowing separate, main and auxiliary streams of air through said main and auxiliary chambers, respectively, so as to separately remove moisture evaporated from opposite sides of a mat supported by said foraminous member, and

for simultaneously maintaining the pressure in said main air chamber below the pressure in said auxiliary air chamber so as to create an air pressure differential acting to hold the mat against said one side of said foraminous member;

(e) said pumping means including a main pump connected to said main chamber and an auxiliary pump connected to said auxiliary chamber; and

(f) means for radiantly heating both sides of a mat held against said one side of said foraminous member by said air pressure differential.

4. In an apparatus for drying a mat, the combination of:

(a) a foraminous member adapted to support a mat on one side thereof;

(b) means providing a main air chamber on the other side of and communicating with said foraminous member and having an inlet communicating with the atmosphere;

(c) means providing an auxiliary air chamber on said one side of and communicating with said foraminous member and having an inlet communicating with the atmosphere;

(d) pumping means for flowing separate, main and auxiliary streams of air through said main and auxiliary chambers, respectively, from their respective inlets so as to separately remove moisture evaporated from opposite sides of a mat supported by said foraminous member, and for simultaneously maintaining the pressure in said main air chamber below the pressure in said auxiliary air chamber so as to create an air pressure differential acting to hold the mat against said one side of said foraminous member;

(e) said pumping means including a main exhaust pump having an inlet connected to said main chamber and an auxiliary exhaust pump having an inlet connected to said auxiliary chamber; and

(f) means for radiantly heating both sides of a mat held against said one side of said foraminous member by said air pressure differential.

5. In an apparatus for drying a mat, the combination of:

(a) a curved foraminous member having concave and convex sides and adapted to support a mat on said convex side thereof;

(b) means providing a main air chamber on the said concave side of and communicating with said foraminous member;

(c) means providing an auxiliary air chamber on said convex side of and communicating with said foraminous member;

(d) means for flowing separate, main and auxiliary streams of air through said main and auxiliary chambers, respectively, so as to separately remove moisture evaporated from opposite sides of a mat supported by said foraminous member, and for simultaneously maintaining the pressure in said main air chamber below the pressure in said auxiliary air chamber so as to create an air pressure differential acting to hold the mat against said convex side of said foraminous member; and

(e) means for radiantly heating both sides of a mat held against said convex side of said foraminous member by said air pressure differential.

6. In an apparatus for drying a mat, the combination of:

(a) a foraminous member adapted to support a mat on one side thereof;

(b) means providing a main chamber on the other side of and communicating with said foraminous member;

(c) means providing an auxiliary chamber on said one side of and communicating with said foraminous member;

(d) pumping means for maintaining a pressure differential, having high and low pressure components, between said auxiliary and main chambers with said high pressure component in said auxiliary chamber and said low pressure component in said main chamber, whereby to hold a mat against said one side of said foraminous member, and for simultaneously flowing separate streams of air through said auxiliary and main chambers;

(e) said pumping means including a main pump connected to said main chamber and an auxiliary pump connected to said auxiliary chamber;

(f) each of said main and auxiliary pumps having an inlet and an outlet;

(g) valve means for selectively connecting said inlet and said outlet of said main pump to said main chamber and the atmosphere;

(h) valve means for selectively connecting said inlet and said outlet of said auxiliary pump to said auxiliary chamber and the atmosphere; and

(i) means for heating both sides of a mat supported by said one side of said foraminous member.

7. An apparatus as defined in claim 6 including:

(a) filter means for filtering air removed from and introduced into said main chamber; and

(b) filter means for filtering air removed from and introduced into said auxiliary chamber.

8. An apparatus according to claim 6 including:

(a) heat exchanger means for exchanging heat between air removed from and air introduced into said main chamber; and

(b) heat exchanger means for exchanging heat between air removed from and air introduced into said auxiliary chamber.

9. An apparatus according to claim 6 wherein said heating means includes:

(a) a heater in series with said main chamber for heating air introduced into said main chamber; and

(b) a heater in series with said auxiliary chamber for heating air introduced into said auxiliary chamber.

10. An apparatus according to claim 6 wherein said heating means includes radiant heaters in said main and auxiliary chambers.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,241,247 March 22, 1966

Craig C. Baker

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 6, lines 20 and 24, for "exaporated", each occurrence, read -- evaporated --; line 53, for "simulaneously read -- simultaneously --.

Signed and sealed this 21st day of June 1966.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

EDWARD J. BRENNER
Commissioner of Patents