Dec. 7, 1937. C. S. JENNINGS ET AL 2,101,335

ART OF DRYING MATERIALS

Filed Sept. 17, 1934 4 Sheets-Sheet 1

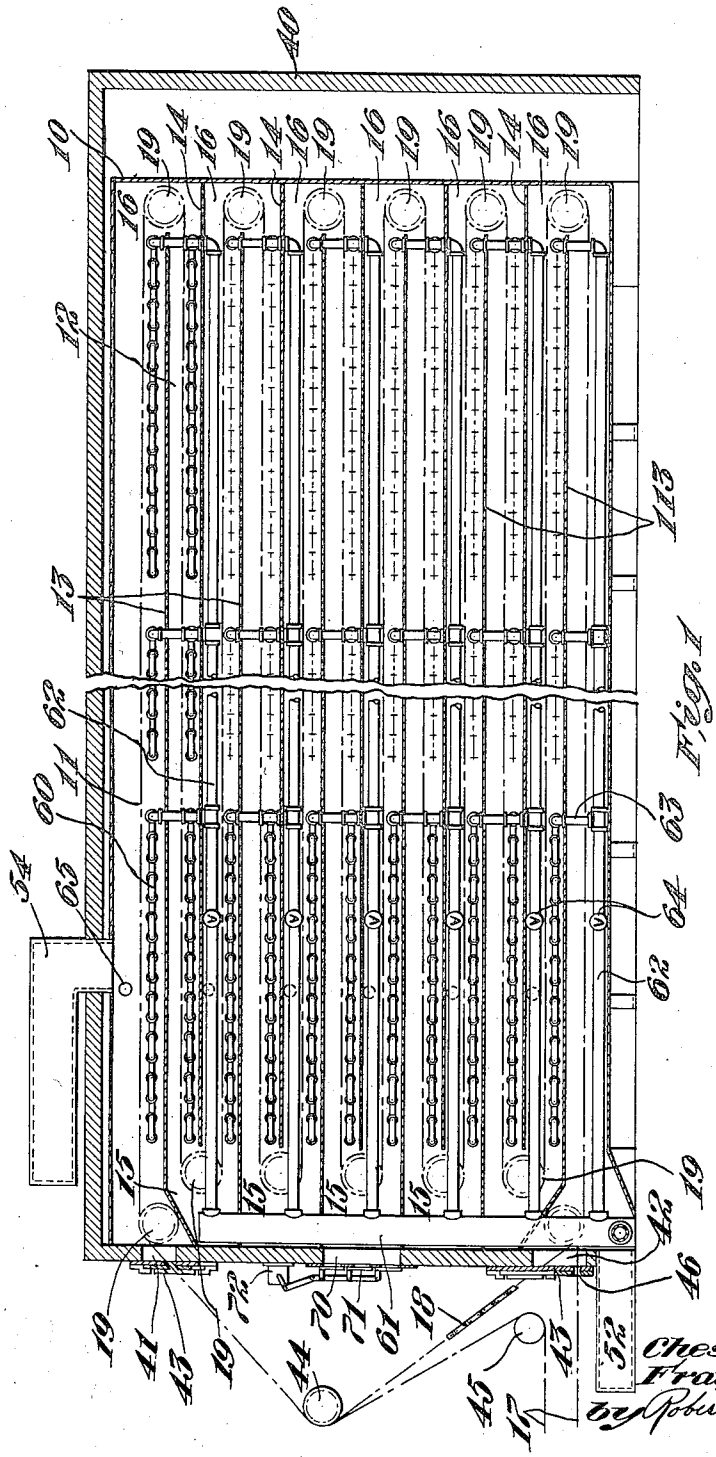


Fig. 1

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ART OF DRYING MATERIALS

Filed Sept. 17, 1934 4 Sheets-Sheet 2

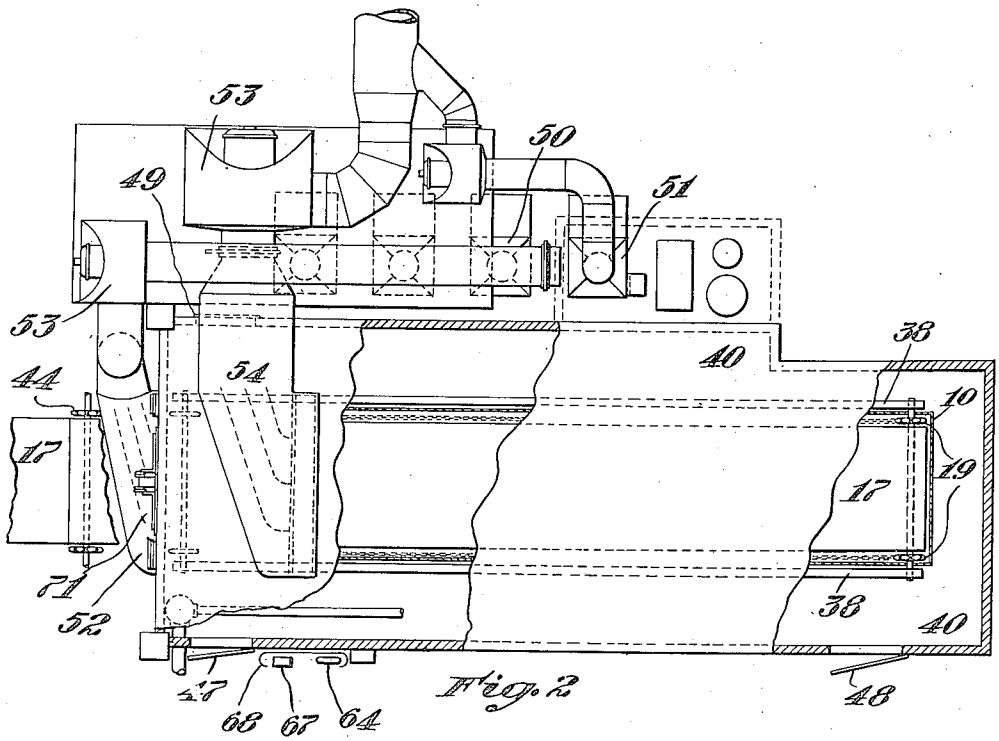


Fig. 2

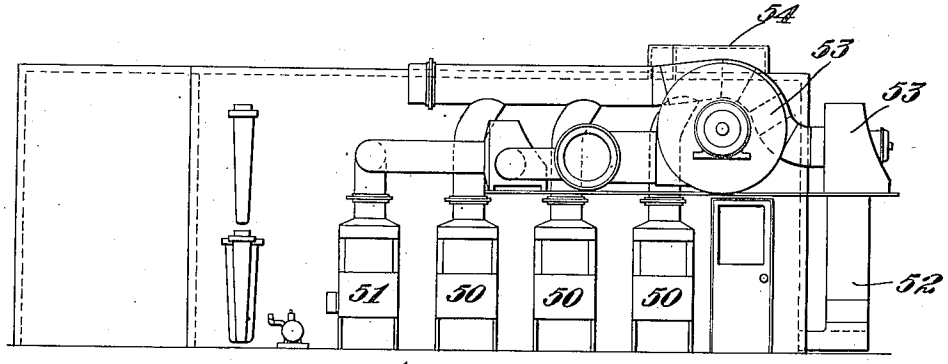


Fig. 3

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ART OF DRYING MATERIALS

Filed Sept. 17, 1934 4 Sheets-Sheet 3

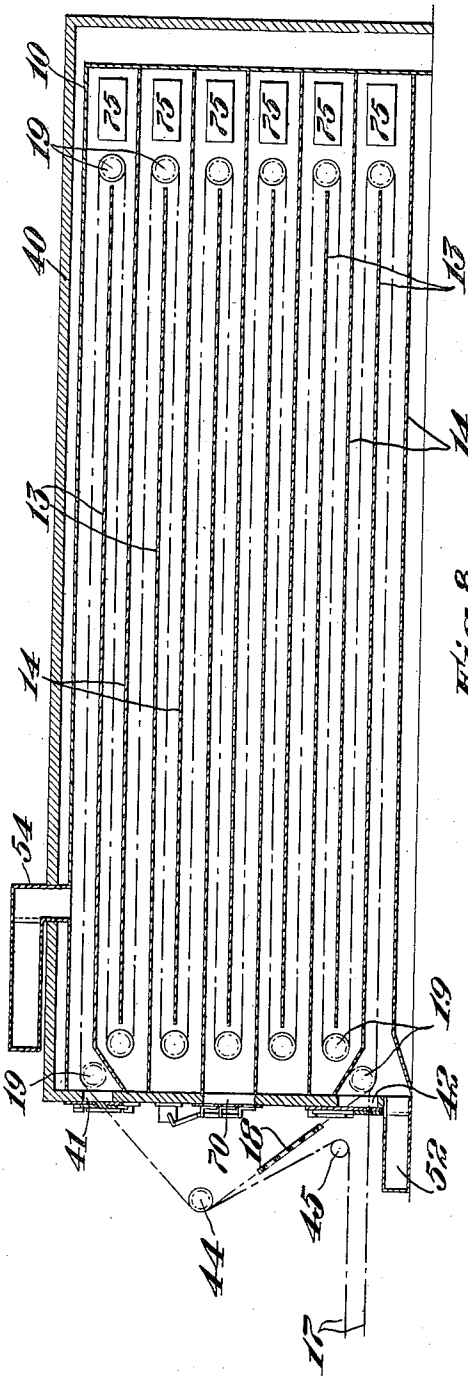


Fig. 6

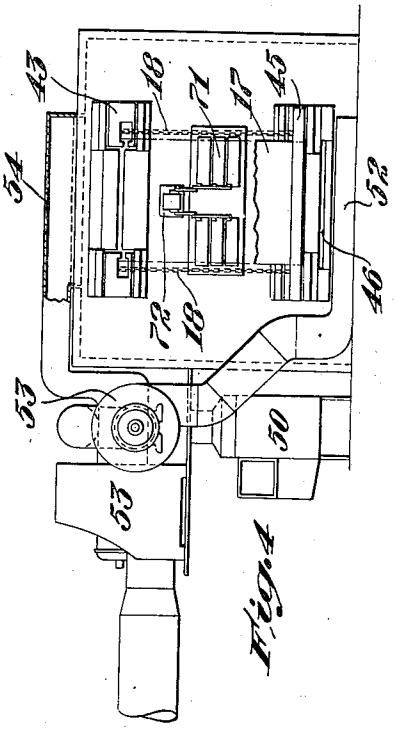


Fig. 4

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ART OF DRYING MATERIALS

Filed Sept. 17, 1934 4 Sheets-Sheet 4

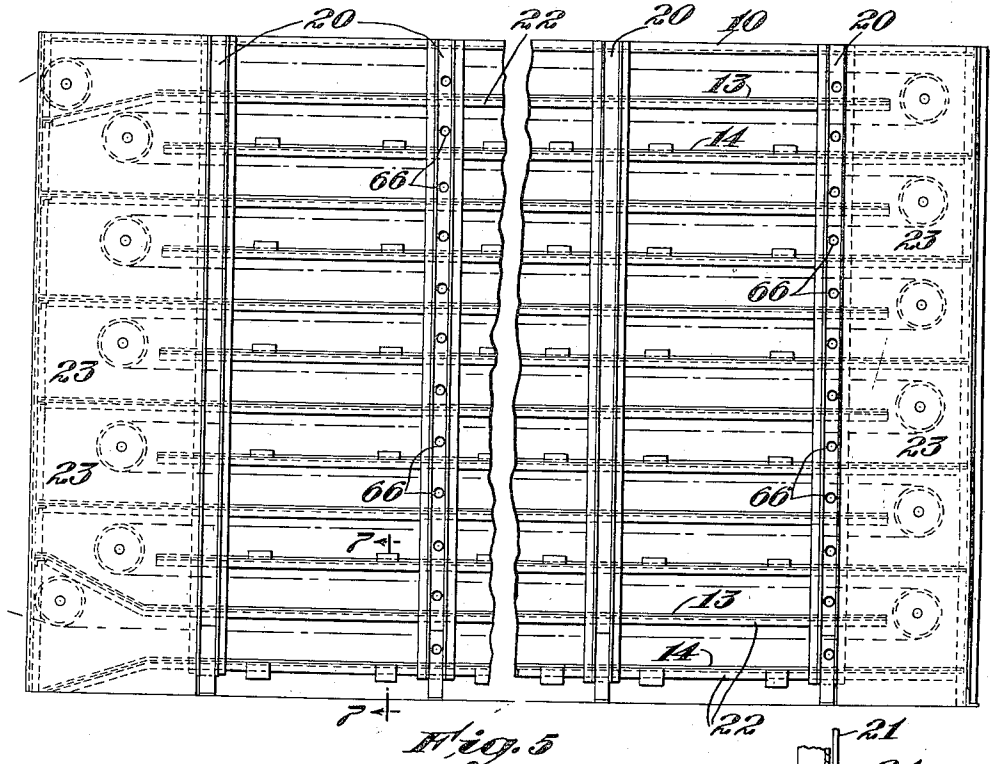


Fig. 5

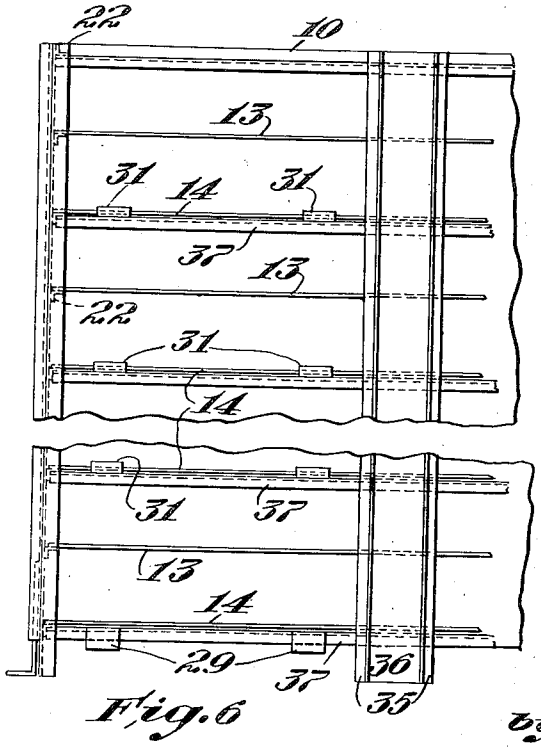


Fig. 6

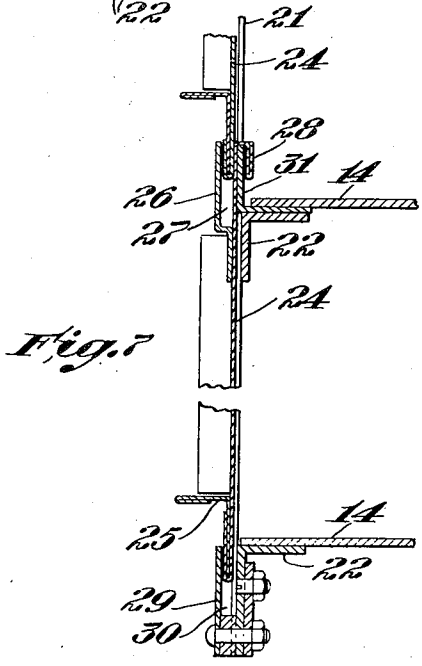


Fig. 7

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Patented Dec. 7, 1937 2,101,335

UNITED STATES PATENT OFFICE

2,101,335

ART OF DRYING MATERIALS

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Application September 17, 1934, Serial No. 744,332

1 Claim. (Cl. 34—24)

This invention relates to an improvement in the art of drying materials and more particularly to drying methods and apparatus wherein the material to be dried is conveyed through a plurality of compartments in a housing and has for its primary object the removal of moisture from the material during its passage through the housing by the action of a stream of conditioned air which flows through the compartments in a direction opposite to that in which the material travels whereby the stream has its initial contact with the material as the latter is leaving the housing and its final contact with the material as it is entering the housing.

A further object of the invention resides in the employment of radiant heat for the removal of the moisture in conjunction with the action of the stream of conditioned air.

Another object of the invention resides in the supply to the stream of conditioned air as it flows through the housing of additional air when required to render the operation of the air stream more efficient.

These and other objects of the invention will appear from a consideration of the following description and of the accompanying drawings in which is illustrated one form of apparatus by which the invention may be carried out and in which:

Fig. 1 is a side view partially in section illustrating one form of apparatus embodying this invention;

Fig. 2 is a plan view of such apparatus;

Fig. 3 is a view in elevation of the side opposite that shown in Fig. 1;

Fig. 4 is an end view of such apparatus;

Fig. 5 is a side view of the housing structure the doors being omitted;

Fig. 6 is an enlarged elevation of one end thereof;

Fig. 7 is an enlarged detail sectional view of the housing taken along the lines 7—7 of Fig. 5 and showing the manner in which the doors are mounted; and

Fig. 8 is a view similar to Fig. 1 of another form of apparatus embodying this invention.

The material to be dried is conveyed through a housing 10 in any suitable manner, as by the conveyor 11, through a plurality of compartments 12 defined by horizontally arranged baffle plates or partitions 13 and 14 which provide passages 15 and 16 respectively connecting the compartments at alternate ends. The compartments 12 are considered as grouped in pairs defined by the baffle plates 14. The conveyor 11 may be of any desired type capable of transporting the material. As shown in the drawings the material to be dried is a web of textile fabric 17 and the conveyor comprises a pair of chains 18 provided with tenter pins which, in accordance with the well known practice in the textile art, engage the edges of the web. The chains 18 pass around pairs of sprockets 19 suitably arranged in the housing, one pair being located in each of the passages 15 and 16.

The housing 10 as shown particularly in Figs. 5, 6 and 7 comprises a plurality of vertical upright U-beams 20 to the inner faces of which are secured plates 21. The edges of the plates 21 extend beyond the beams and fixed thereto are angle beams 22 on which rest the baffle plates or partitions 13 and 14. Overlapping plates 23 close the sides of the housing at each end and are provided with notches through which the shafts of the sprockets 19 pass. Between the vertical beams 20 are mounted removable doors 24 through which access may be had to pairs of compartments 12 between the baffle plates 14.

Each door 24 is flanged at each end and provided at the bottom with angle strips 25 and at the top with an offset strip 26 spaced from the face of the door to form a pocket 27. The upper edge of each door is bent inwardly and down to form a hook 28. Suitably secured to the lowest angle beam 22 at each side are strips 29 spaced from the face of the beam to define a pocket 30. Vertically disposed above each strip 29 and secured to the angle beams which support the baffle plates 14 are provided angle clips 31. As shown the top angle beam 22 is reversed so that the vertical flange extends upwardly instead of downwardly as in the other beams. The doors in the lowest row are mounted by inserting the vertical flanges of the angle strips 25 in the pockets 30 and engaging the hooks 28 with the clips 31. The vertical flanges of the angle strips 25 on the doors in the other rows are received in the pockets 27 of the doors just below and the hooks 28 engage the clips 31 with the exception of course that the hooks 28 of those doors in the top rows engage the vertical flanges of the top angle beams 22.

The wall at the right end of the housing as shown in Fig. 5 is similarly constructed having at the center vertical angle beams 35 and a plate 36 to which horizontal angle beams 37 are secured. The ends of the baffle plates 14 rest upon and are secured to the beams 37. The spaces at right and left of the plate 36 are closed by doors in the manner above described, strips 29 and clips 31 being provided as shown in Fig. 6.

The left end of the housing is open; suitably located cross beams, shown in dotted lines in Fig. 5, being fixed to the corner uprights and supporting the ends of the baffle plates 13. The top and bottom of the housing are closed. Frames 38 at either side of the housing support the ends of the shafts for the sprockets 19 (see Fig. 2).

The housing 10 is completely enclosed within a casing 40 the open end resting against one wall of the casing. Formed in this wall of the casing are adit and exit openings 41 and 42 respectively, by which the conveyor and material enter and leave the housing. It will be noted that the adit opening leads to the top compartment 12 and the exit opening leads from the bottom compartment. The baffle plates at the bottom of the top compartment and at the top of the bottom compartment are inclined and pairs of sprockets 19 are mounted in the housing adjacent these openings. The openings are provided with gates 43 having apertures just the proper dimensions to permit the passage of the chains and fabric. Air seals such as curtains (not shown) may also be installed to prevent air from entering or escaping from the housing.

The conveyor chains pass around sprockets 44 in their journey outside the casing from the opening 42 to the opening 41. The fabric web 17 fed over a roller 45 is engaged with the chains as they pass around the sprockets 44 and is disengaged from the chains as they pass around the sprockets 19 near the opening 42 and leaves the housing through an aperture 46 in the gate 43 of that opening. It will be understood that this disengagement of the web from the chains is due to the action either of gravity or of knockers (not shown) of any well known type. Doors 47, 48 and 49 are provided in the walls of the casing through which entry to the housing may be had.

As the material is conveyed through the housing the moisture therein is removed by the action of a stream of conditioned air flowing through the housing in a direction opposite to that in which the material travels. It will be understood that the term "moisture" includes not only water but other liquids or sizing depending upon the treatment to which the material has been previously subjected and that the term "conditioned air" is used herein to designate air at a selected temperature and/or dew point, which air is of controlled temperature and humidity and with particular reference to air whose moisture content has been reduced below that of the prevailing atmosphere.

The conditioned air is here shown to be supplied by a dehumidifier system of suitable type. Such system comprises a plurality of dehumidifier units 50 where the moisture content of the air is reduced by the action of a lithium chloride solution and a regenerator unit 51 in which such solution is from time to time treated to restore its moisture absorbing properties. The air, having its temperature fixed at the desired level either before or after it has been treated in a dehumidifier unit 50 is supplied to the housing 12 through a pipe 52. This pipe enters the bottom compartment 12 below the exit opening 42, the end of the baffle plate 14 being bent downwardly as shown in Fig. 1. The stream of air under the impulse of one or more blowers 53 flows upwardly through the housing compartment and escapes through a pipe 54 leading from the top compartment near the adit opening 41.

Thus the initial contact of the air stream with the material takes place as the latter is leaving the housing and the final contact with the material takes place as the latter is entering the housing. Hence the stream of air, being driest when it initially contacts the material which is at that time nearly dry, will quickly extract from the material at a relatively low temperature any excess of moisture therein above the amount considered desirable. As the contact of the stream with the material continues, the amount of moisture in the stream increases but since the evaporative tendency of the moisture in the contacted material also increases as the opening 41 is approached, the differential between the absorptive property of the air stream and the evaporative tendency of the moisture in the material contacted may consequently be kept at an effective level during the entire flow of the stream of air through the housing so that moisture is continuously and efficiently removed from the material.

For the purpose of assisting the extraction of moisture from the material supplementary heating means are provided in the housing. As shown in Fig. 1 this means comprises coils 60 supplied with steam from a header 61 and feed pipes 62 and 63. The coils like the compartments are grouped in pairs the supply of steam to each pair being controlled by valves 64 in accordance with the information supplied by thermostat bulbs 65. The header 61 and feed pipes 62 and 63 are arranged in the casing at the side opposite the dehumidifier system and the pipes 63 enter the housing through openings 66 in the vertical beams 20. The valves 64 together with the indicator 67 controlled by the thermostat bulbs 65 may be located in a cabinet or recess 68 on the outer wall of the casing so that they are readily accessible to the operators.

The radiant heat thus supplied to the compartments by the coils is so regulated that the temperature of the compartment first traversed by the material is the highest and the temperature of the compartment last traversed is the lowest. Thus the greatest heat is supplied to the material as it is entering the housing and carrying the most moisture and the least heat is supplied to the material as it is leaving the housing substantially dry. Preferably the temperature of the first compartment traversed by the material is approximately 150° F. and that of the last compartment so traversed is approximately 80°. The moisture in the material is thus brought to the surface, the heat of vaporization or a portion thereof being supplied by direct radiation to the material, and carried off in the form of vapor by the stream of conditioned air. Moreover, the temperature of the air stream, as it flows through the housing, is raised so that its capability of absorbing moisture will be increased, and its efficiency maintained throughout its flow.

In the casing wall is an inlet 70 controlled by dampers 71 which may be opened or closed by any suitable means (a manually or automatically operated device 72 being indicated). Additional air may thus be admitted directly into the housing, which air mingles with and is carried along by the air stream flowing through the housing. As shown in Fig. 1 the inlet 70 is located about midway between the top and bottom of the housing and leads to the middle passage 15. The air stream has, by the time it reaches this passage, absorbed considerable moisture from the material which it has already contacted and its temperature has been raised appreciably. The air entering through the inlet being of a dew

point lower than that of the stream reduces the dew point of the stream and increases its absorbing properties. This is of considerable advantage because the material beyond the inlet with which the stream contacts carries more moisture than that already contacted.

The inlet **70** is opened preferably when the material being dried is heavy and contains a large amount of moisture while when a light fabric having only a relatively small amount of moisture is being dried the inlet may be closed. The use of the inlet is also determined by the range of temperature to which the material may be subjected. When the allowable temperature is high a supply of additional air is often found not necessary since the air stream by reason of its higher temperature can absorb all the moisture required. On the other hand when the allowable temperature is lower, due for example to local conditions or to the reaction of the particular material to heat, the inlet may be opened since the additional air would increase the absorbing properties of the stream and at the same time hold the temperature down. The automatic control of the damper may be effected through the use of a thermostat (not shown) which will respond to the temperature or humidity within the housing or to both if so desired. The blower **53** at the outlet of the air from the housing is of sufficient strength to prevent the escape of the air stream through the inlet **70** and at the same time to draw the additional air into the housing.

The apparatus shown in Fig. 8 differs from that described above in that no coils for the supply of radiant heat directly to the material to be dried are provided. In that apparatus heating units **75** which may be of suitable type, as for example steam coils or radiators, are mounted in the passages **16** connecting each pair of compartments defined by the baffles **14**. Suitable thermostats and valves (not shown) are provided for the regulation of the units **75**. It will be understood that the temperatures of the pairs of compartments will be varied in substantially the same way as in the apparatus shown in Figs. 1 to 7. The same reference numerals are applied on Fig. 8 to indicate elements common to both apparatus. As the stream of conditioned air supplied through the pipe **52** flows through the passages **16** its temperature is stepped up by the units **75** so that while its moisture content is increased by its passage over the material its capacity is also increased and its effectiveness is maintained until it leaves the housing through the pipe **54**. While only the pipes **52** and **54** are shown in Fig. 8 it will be understood that the apparatus also includes the dehumidifier and regenerator units shown and described as part of the apparatus set forth in Figs. 1 to 7.

While certain embodiments of this invention have been shown and described it will be understood that we are not limited thereto and that other embodiments may be made without departing from the spirit and scope of the invention as set forth in the following claim.

We claim:

The steps in the drying of material which is conveyed into a housing having a plurality of connected compartments therein, through said compartments and out of the housing, which comprise subjecting the material to radiant heat as it passes through the compartments, the heat in the compartment first traversed by the material being greater than that in the compartment last traversed, setting up an air stream in the housing which flows through the compartments thereof in contact with the material and in the direction opposite to that in which the material travels, supplying conditioned air to the housing to constitute the initial portion of the air stream and supplying additional air to the housing at an intermediate compartment, which mingles with the conditioned air to constitute the final portion of the air stream, said additional air increasing the effectiveness of the air stream which at that point had been reduced below the effectiveness of the conditioned air as it was supplied to the housing due to the moisture absorbed by the air stream in drying the material with which it had been in contact in the compartments it had flowed through before reaching the compartment at which the additional air was supplied, whereby drying of the material is performed by the air stream in two stages, first by the mingled air which constitutes the final portion of the air stream and second by the conditioned air which constitutes the initial portion of the air stream.

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