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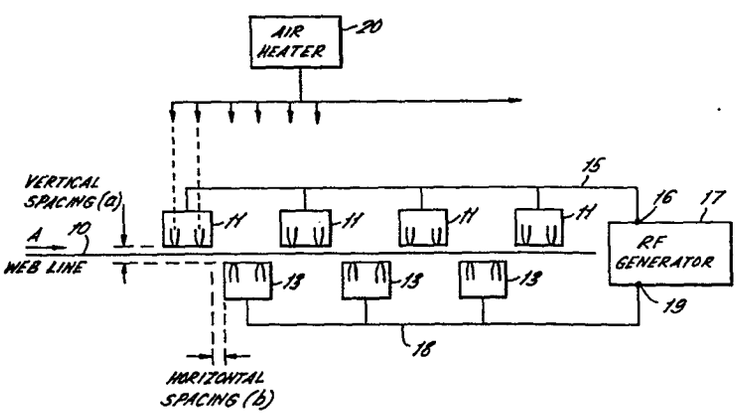
(54) Convective drying.

(57) A convective dryer has nozzle 11 and 13 for directing hot air from a heater 20 at a material 10 to be heated. The nozzles 11 and 13 are electrically conductive and also constitute electrodes energised by an R.F. generator 17 to generate an R.F. field in the region of the material 10 to augment drying.



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"CONVECTIVE DRYING"

The invention relates to methods of and apparatus for convective drying of materials in which heated air or other gas is directed onto the material to be dried.

Such a dryer may comprise a plurality of nozzles or jets for the heated air or gas and the material is passed between or below these jets or nozzles. The material may be a web, e.g. of fabric, which is passed between the jets or nozzles or it may be material, e.g. sheet material or pieces, which is carried on a belt or other carrier between or below the jets or nozzles.

According to the present invention, in a convective dryer having a plurality of jets or nozzles for directing a heated gas onto material passed over the jets or nozzles, these jets or nozzles are formed of electrically conductive material and are arranged to constitute the electrodes or at least

some of the electrodes of radio frequency heating means providing a radio frequency field in the region through which the material to be dried is passed.

By this arrangement, the radio frequency heating means heats the material internally so that heat transfer to the material occurs within the body of the material as well as on the surface thereof where the convective heating is effected.

The internal heating of the material causes moisture from the interior to move to the surface of the material, keeping this surface wet and so allowing higher air (or other gas) temperatures to be used than would be the case in the absence of radio frequency heating. Thus the overall drying efficiency is increased, resulting in increased drying speeds and reduced dryer length and may give improved material quality.

The invention furthermore includes within its scope a method of drying a material comprising the steps of passing the material through a heated gas stream and simultaneously subjecting the material to a radio frequency field.

The material to be dried would usually be electrically non-conductive and thus the radio frequency field would give dielectric heating. The frequency of operation may be chosen in accordance with known practice for dielectric heating.

The radio frequency heating may be "stray field" heating in which the electrodes are all arranged beneath the material to be dried. Preferably however "through field" heating is effected using electrodes above the material co-operating with electrodes below the material. The electrodes in such an arrangement preferably are staggered, that is to say upper electrodes are arranged above spaces between lower electrodes.

Preferably the major part of the heat input is applied to heating the air or other gas for the convective drying. Typically the amount of power input to the radio frequency heating is between 1/5th and 1/10th of the total energy input to the dryer.

The jets or nozzles for the heated gas may be arranged, in the known way, to form an air flotation device to support the material to be dried. Such an arrangement may conveniently be used for the drying of webs of material.

For materials which have to be carried through the dryer on a belt, it is convenient to provide jets or nozzles both above and below the belt, these jets or nozzles being arranged to form electrodes of a "through field" radio frequency heating system. Such

an arrangement may conveniently be applied to the drying of sheet materials such as insulation board and plaster board and to other products such as pulp or fibre mouldings. The technique may also be applied to the baking or processing of a wide range of foodstuffs.

In the following description of one embodiment of the invention, reference will be made to the accompanying drawing which illustrates diagrammatically in side elevation a dryer for web material.

Referring to the drawing, the material to be dried is shown diagrammatically as a web 10 of electrically non-conductive material which is moved through the dryer in the direction of the arrow A. Above the web is a plurality of spaced nozzle boxes 11 each constituting an electrode and each having one or more nozzles 12 for directing heated air onto the web. Similarly, below the web, there are nozzle boxes 13, these nozzle boxes constituting electrodes and having nozzles 14 to direct heated air onto the web.

Electrically the nozzle boxes 11 are connected as shown at 15 in parallel to one output terminal 16 of a radio frequency generator 17. The nozzle boxes 13 are connected electrically in parallel as shown at 18 to the second terminal 19 of the radio frequency generator. The various nozzles are fed from an air

heater 20 in which the heat may be generated from any convenient fuel source for example, gas, oil, steam banks or electrical resistance heaters.

The resonant frequency of the output circuit of the radio frequency heater may be made controllable, as is well known in radio frequency heating, e.g. by the use of adjustable capacitors or inductors in the radio frequency circuit.

The positional arrangement of the electrodes in which the upper electrodes 11 are staggered with respect to the lower electrodes 13, provides a "through field" radio frequency heating system which permits relatively thick materials to be processed without substantial differential heating occurring. The ratio of the vertical spacing between the upper and lower electrodes (as shown at a in the figure) to the horizontal spacing (as shown at b in the figure) is chosen to suit the particular material being dried, this ratio being chosen in accordance with the thickness of the material, the loss factor and the vapour diffusion characteristics through the material, as well as to give optimum web stability and convective heat transfer. The radio frequency heating heats the material internally and so tends to drive moisture towards the surface of the material thereby keeping

the surface of the material wet. This allows the drying to take place at a much higher air temperature than would be possible if there was no radio frequency heating and hence gives an improved drying efficiency and increased drying speeds.

The major part of the energy input to the system is into the air heaters. The amount of energy provided by the radio frequency heating is typically between 1/5th and 1/10th of the total energy input to the dryer.

Although in the embodiment illustrated, the electrodes and nozzles are spaced along the length of the web to be dried, they may additionally or alternatively be spaced across the width of the web.

CLAIMS:

1. A convective dryer having a plurality of jets or nozzles for directing a heated gas onto material passed over the jets or nozzles wherein the jets or nozzles are formed of electrically conductive material and are arranged to constitute the electrodes or at least some of the electrodes of radio frequency heating means providing a radio frequency field in the region through which the material to be dried is passed.

2. A convective dryer as claimed in claim 1 wherein the electrodes are all arranged beneath the material to be dried.

3. A convective dryer as claimed in claim 1 wherein electrodes are provided above the material co-operating with electrodes below the material.

4. A convective dryer as claimed in claim 3 wherein the electrodes are staggered, with upper electrodes arranged above spaces between lower electrodes.

5. A convective dryer as claimed in any of the preceding claims and wherein the major part of the heat input is applied to heating the gas for the convective drying.

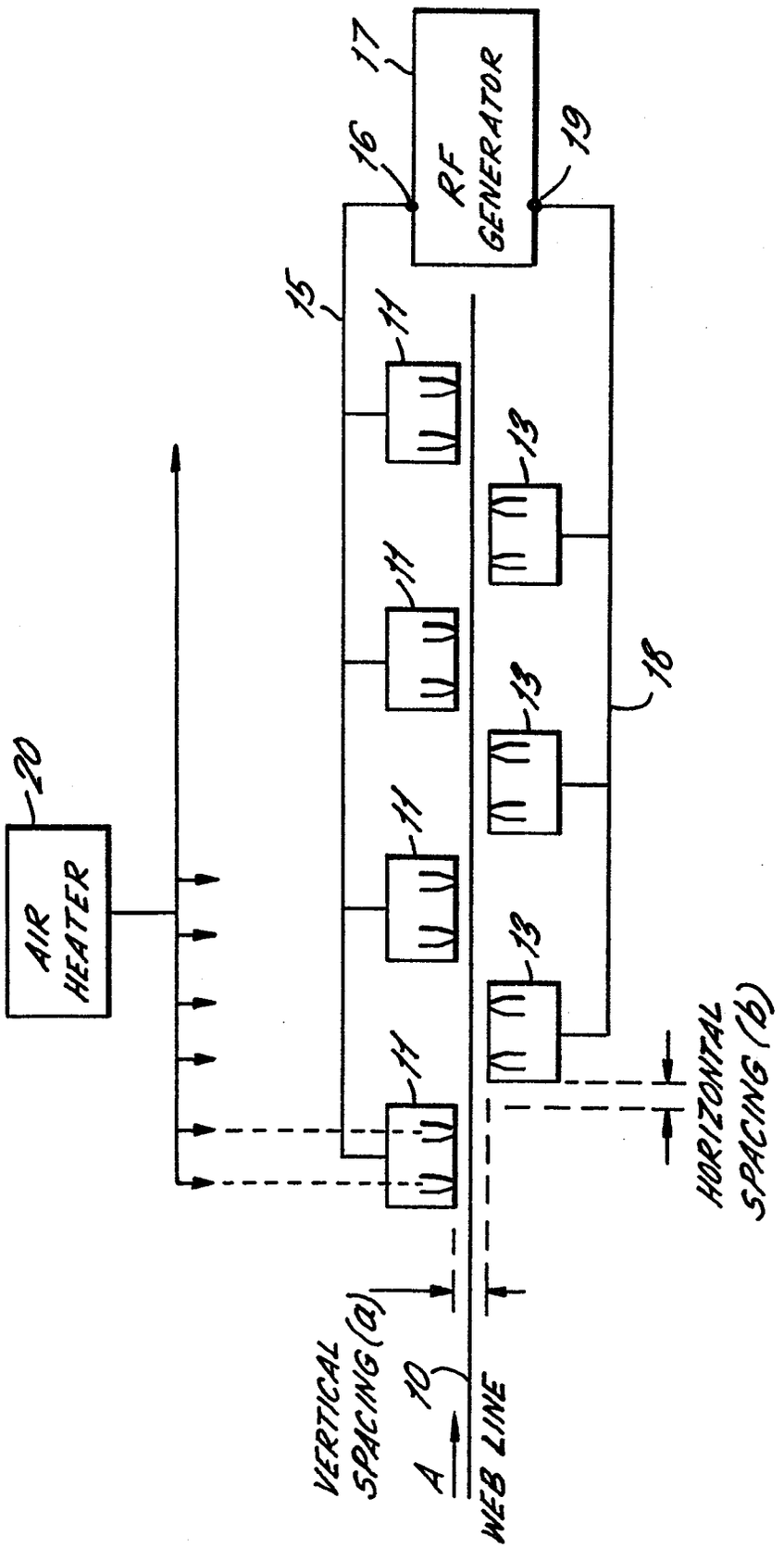
6. A convective dryer as claimed in any of the preceding claims wherein the amount of power input to the radio frequency heating is between 1/5th and 1/10th of the total energy input to the dryer.

7. A convective dryer as claimed in any of the preceding claims wherein the jets or nozzles for the heated gas are arranged to form an air flotation device to support the material to be dried.

8. A method of drying a material comprising the steps of passing the material through a heated gas stream and simultaneously subjecting the material to a radio frequency field.

9. A method as claimed in claim 8 wherein the major part of the heat input is applied to heating the gas.

10. A method as claimed in claim 8 wherein the power input to the radio frequency heating is between 1/5th and 1/10th of the total energy input to the dryer.


AIR HEATER
20
RF GENERATOR
17
16
19
15
11
13
14
18
VERTICAL SPACING (a)
A
10
WEB LINE
HORIZONTAL SPACING (b)