

[54] MICROWAVE DRYING APPARATUS

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[51] Int. Cl. B01k 5/00

[58] Field of Search 34/1, 156

[56] References Cited

UNITED STATES PATENTS

- 3,491,457 1/1970 Schreiber et al. 34/1
- 3,449,836 6/1969 Schreiber et al. 34/1

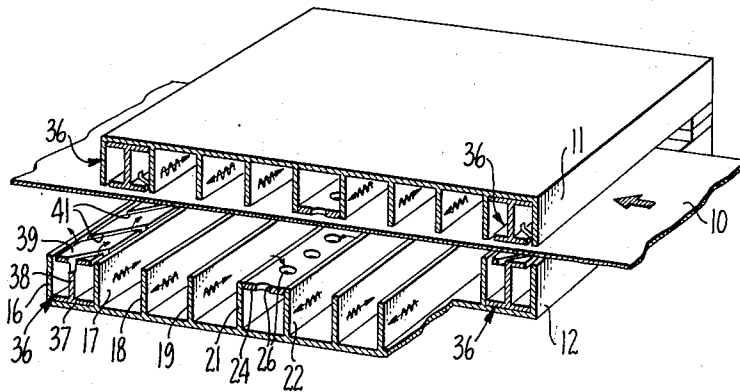
- 3,324,570 6/1967 Flaith et al. 34/156
- 3,181,250 5/1965 Vits 34/156 X

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[57] ABSTRACT

A device is provided for drying a continuous web or sheet of material passing through a drying zone. The device includes two air cushions which face each other and force the sheet of material passing through the drying zone to stay midway between opposite microwave drying units. Further, to prevent wrinkling of the sheet material, the air cushions are provided by spaced slots extending at an angle to the path of travel of the sheet to ensure that streaking of a coating on the sheet is obviated.

6 Claims, 4 Drawing Figures



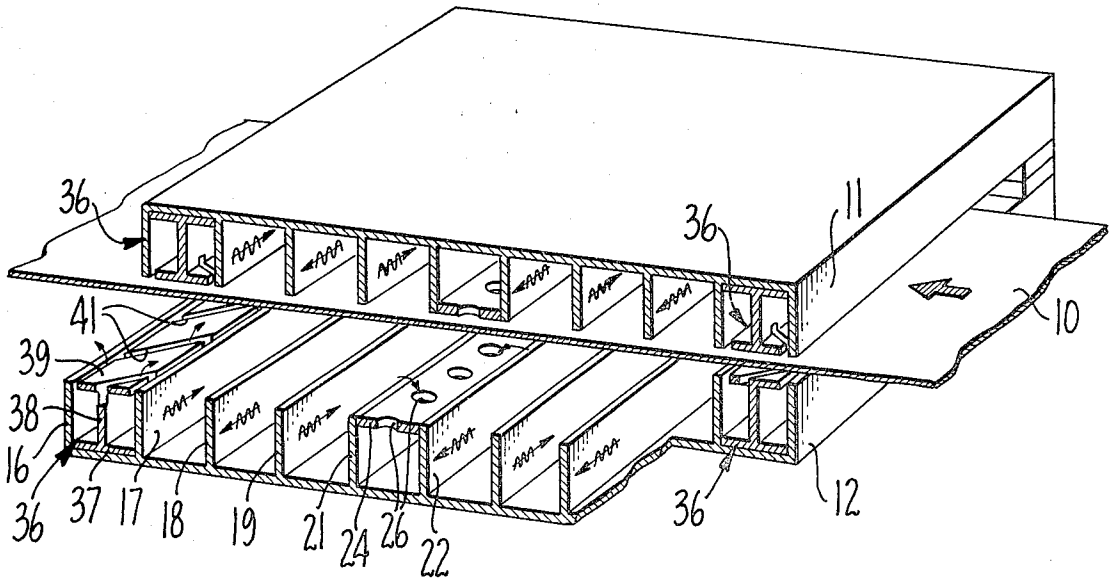


FIG. 1.

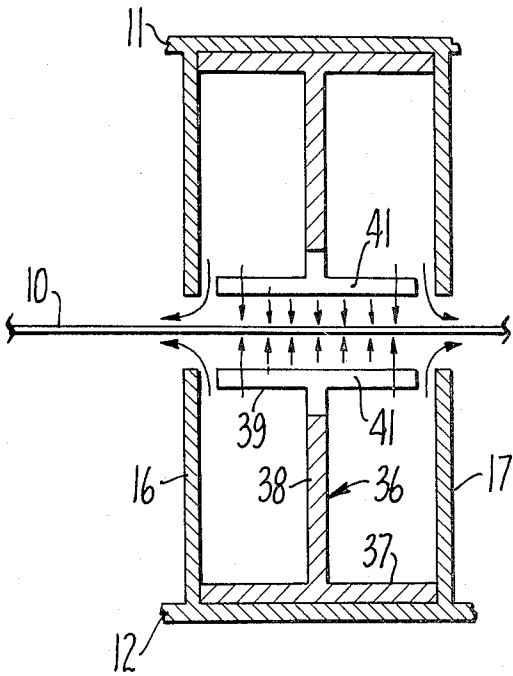


FIG. 2.

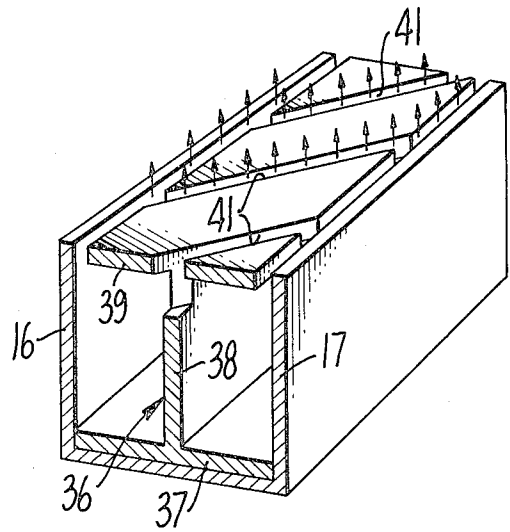


FIG. 3.

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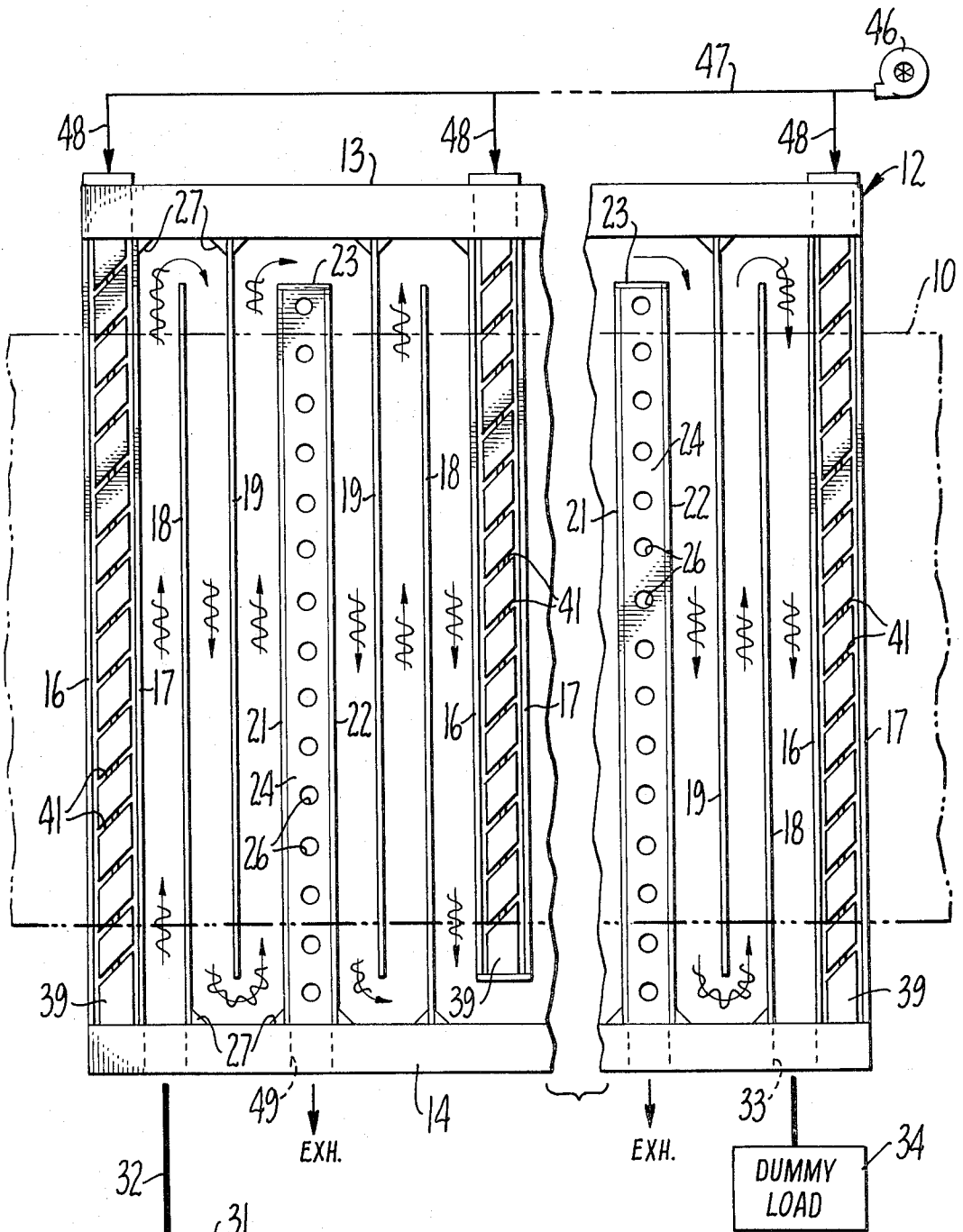


FIG. 4.

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MICROWAVE DRYING APPARATUS

BACKGROUND OF THE INVENTION

The simultaneous application of a gas to a sheet of material undergoing drying by microwave energy is known and one can refer to prior U.S. Pat. Nos. 3,449,836, 3,475,827 and 3,491,457. In these and other prior art devices, however, the gas impingement was such that gas was not effective to maintain the web spaced equally between the opposite waveguides providing the microwave energy application.

SUMMARY OF THE INVENTION

It is in general the broad object of the present invention to provide an improved drier for a continuous web of material by microwave energy in which opposite and equal air cushions are provided on opposite sides of the web to hold the web in a centralized position as it passes through the opposite waveguides of the microwave drier.

A further object of the present invention is to provide air cushions so spaced and provided that wrinkling of the web or of a coating on the web is obviated.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of an embodiment of the apparatus for practicing the present invention.

FIG. 2 is a section taken transversely through the means providing the opposite air cushions.

FIG. 3 is a perspective view showing the air outlet means provided at an angle to the run of the web.

FIG. 4 is a top plan view of one-half of the microwave drier assembly.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In the description which follows, it is assumed that a coated or a partially dry web is being dried by the combined action of microwave energy and jets of a drying gas such as air, nitrogen or superheated steam applied to a web of the sheet material indicated at 10. The web 10 is drawn through the drier by means well known to those skilled in the art and therefore is not illustrated. The movement of the web can be in the direction indicated by the arrow or in the opposite direction.

The drier comprises upper and lower sections indicated at 11 and 12. These sections are alike so a description of one will suffice. The drier sections 11 and 12 are spaced apart about a quarter of an inch to minimize the tendency for dust or lint which may accumulate between the two halves to cause arcing. Each drier section includes a plurality of waveguides and a plurality of gas distribution means and gas collection means. Basically, each drier section includes opposite parallel end walls 13 and 14 joined together by walls 16 and 17 which provide a first duct through which the drying gas is passed for release against the web. A wall 18 also extends from end wall 14 toward the opposite end wall 13 but is spaced therefrom. A wall 19 extends from the end wall 13 toward the end wall 14 but is also spaced therefrom. Extending from wall 14 are parallel walls 21 and 22 which extend toward end wall 13, the end of these walls being closed as at 23 and by a top plate 24 provided with a plurality of apertures 26 through which the drying gas is exhausted. Angular guide plates 27 are provided at the junction of each of the aforementioned walls with an end wall to direct the flow of the microwaves through the drier.

A source 31 of microwave energy is provided to feed the spaced waveguides through line 32 into the waveguide provided by walls 17 and 18. The generator 31 can be any well-known source of RF energy and in one practical embodiment of the invention the energy source consisted of a Klystron and associated power supply operating at 2,450 MHz. Suitably the RF generator operates at a frequency from about 300 to 30,000 MHz. Thus the ISM allocated frequencies of 915; 2,450; 5,800 and 22,125 MHz are suitable.

The microwave energy is fed into the waveguides provided sequentially, for example, by walls 17 and 18, 18 and 19, 19 and 21, 22 and 19, 19 and 18, and 18 and 16 to pass through the drying section. At the terminal end 33 of the waveguide a dummy load 34 is provided to absorb excess energy and, in case of a web break, to absorb total energy input. The microwave energy is introduced through a split microwave tee, one half being on the upper section 11 and the other half being on the lower section 12. The usual microwave tuning devices are included and since these are well known they are neither described nor shown.

In accordance with the present invention, there is provided in conjunction with and between walls 16 and 17 (FIGS. 2 and 3) an air distribution device, generally indicated at 36, which includes a base 37 having an upstanding flange 38 provided centrally thereof and providing a support for a cover 39 which fits in spaced relation between walls 16 and 17 and in the plane of the upper ends of the walls and fitting close to the edges of the walls so that air can escape between the cover and the walls, as is shown in FIG. 2, and through slots 41 provided in the cover 39.

As appears in FIG. 2, the air release occurs on opposite sides of the sheet and under conditions such that the forces applied by the opposite air streams to the sheet are opposite and equal. Further and in accordance with the preferred embodiment, the slots 41 are at an angle to the run of walls 16 and 17 so that the air is released angularly across the sheet. This prevents streaking of any coating which may have been applied to the sheet. If the web is not coated or if streaking is not objectionable, the slots can extend parallel to the run of the sheet. The air is supplied by a fan 46 through a manifold 47 connected by line 48 to each of the air inlets. If desired, the air may be heated and filtered. The air is exhausted through outlets 49.

I claim:

1. In an apparatus for drying a moving web of a sheet material moving in one direction through the apparatus, the apparatus including at opposite edges of the moving web and in spaced relation thereto opposite first and second end walls extending parallel to said direction, a top wall and a bottom wall extending between said end walls generally parallel to the plane of the web of sheet material and on opposite sides thereof, a third and a fourth wall extending from each said top and bottom wall toward said web of sheet material and between said end walls to provide a gas duct, means for supplying gas to said duct for discharging gas against said web, a fifth wall extending from said first end wall toward the second end wall and spaced therefrom to provide a waveguide, a sixth and a seventh wall extending from the first end wall toward the second end wall to provide a gas exhaust duct and an extension of the waveguide, and means for feeding microwave energy into said wave guide.

2. In an apparatus for drying a moving web of sheet material as in claim 1, an eighth wall extending from the second end wall toward and spaced from the first end wall between the fifth and sixth walls to continue the waveguide with the fifth wall.

3. In an apparatus for drying a moving web of sheet material as in claim 2, wherein said sixth and seventh walls are spaced from the second end wall and are closed at their ends adjacent the second end wall, a top plate covering the sixth and seventh walls and having a plurality of apertures therein through which the gas is exhausted, said sixth wall defining a continuation of the waveguide with the eighth wall.

4. In an apparatus for drying a moving web of sheet material as in claim 3, wherein gas distribution means comprising slot means is in said gas discharge duct between said third and fourth walls to evenly distribute gas against said web.

5. In an apparatus for drying a moving web of sheet material as in claim 4, wherein said gas distribution means comprises an upstanding flange extending longitudinally in equally spaced relationship between said third and fourth walls, a cover supported on said flange in spaced relation between the

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third and fourth walls and in the plane of the upper ends of the third and fourth walls to define longitudinally extending slots between the opposite edges of the cover and the adjacent edges of the upper ends of the third and fourth walls, a plurality of slots in said cover disposed at an angle to the direction of movement of said web and at an angle to the third and fourth walls so that gas is released angularly across the web of sheet

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material to prevent streaking or wrinkling of said web of sheet material as it is moved through said drying apparatus.

6. In an apparatus for drying a moving web of sheet material as in claim 5, wherein a plurality of gas discharge ducts, waveguides and exhaust ducts are alternately arranged in said drying apparatus.

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