United States Patent

Jung et al.

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[54] AIR-CIRCULATION APPARATUS FOR SELF-CLEANING OVEN AND THE LIKE

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[51] **Int. Cl.** **A21b 1/00**, F24c 15/32

[58] **Field of Search** ..... 126/21, 21 A, 273

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[57] **ABSTRACT**

An electric motor mounted in a compartment adjacent an oven or other food-treatment chamber carries a pair of centrifugal fans, one in the chamber and one in the compartment. Each fan has on each axial face an array of radially extending vanes or blades. The two central arrays of vanes confronting each other flank the outlet of a conduit open at its inlet to the ambient atmosphere so that air is drawn in through the conduit, then drawn axially in both directions, into the chamber and into the compartment, and then expelled radially to form a gas barrier at this opening. The vanes turned toward the motor draw cooling air in over this motor and the vanes directed into the chamber circulate the gases therein. The fans are rotationally coupled together only by a few angularly spaced bolts, in the cooling-air stream, surrounded by sleeve-like insulating spacers, to prevent heat conduction back to the motor.

12 Claims, 4 Drawing Figures

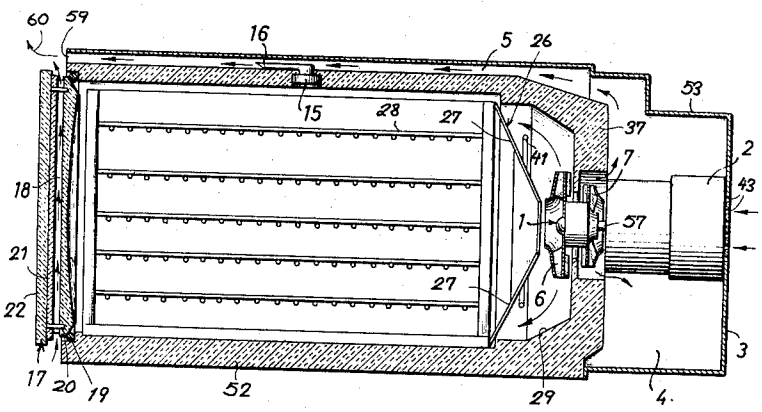


FIG. 1

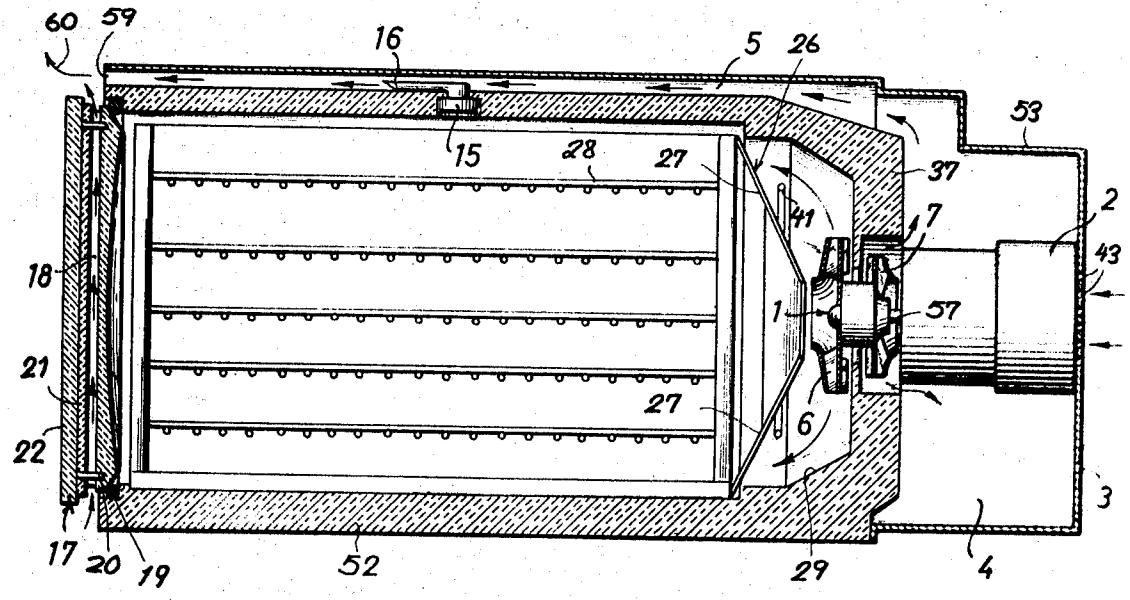
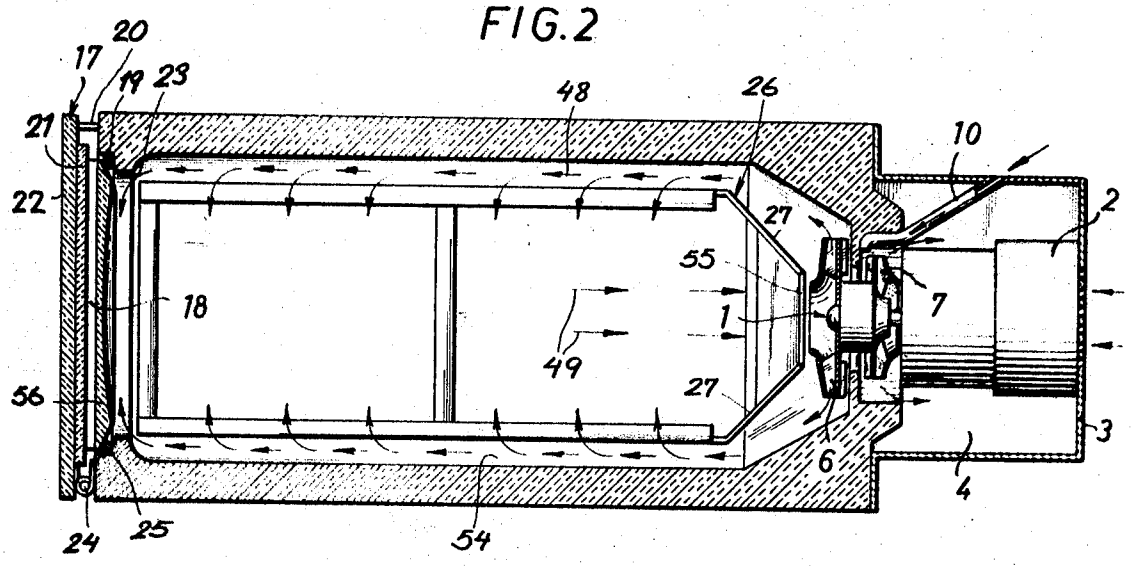


FIG. 2



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FIG. 3

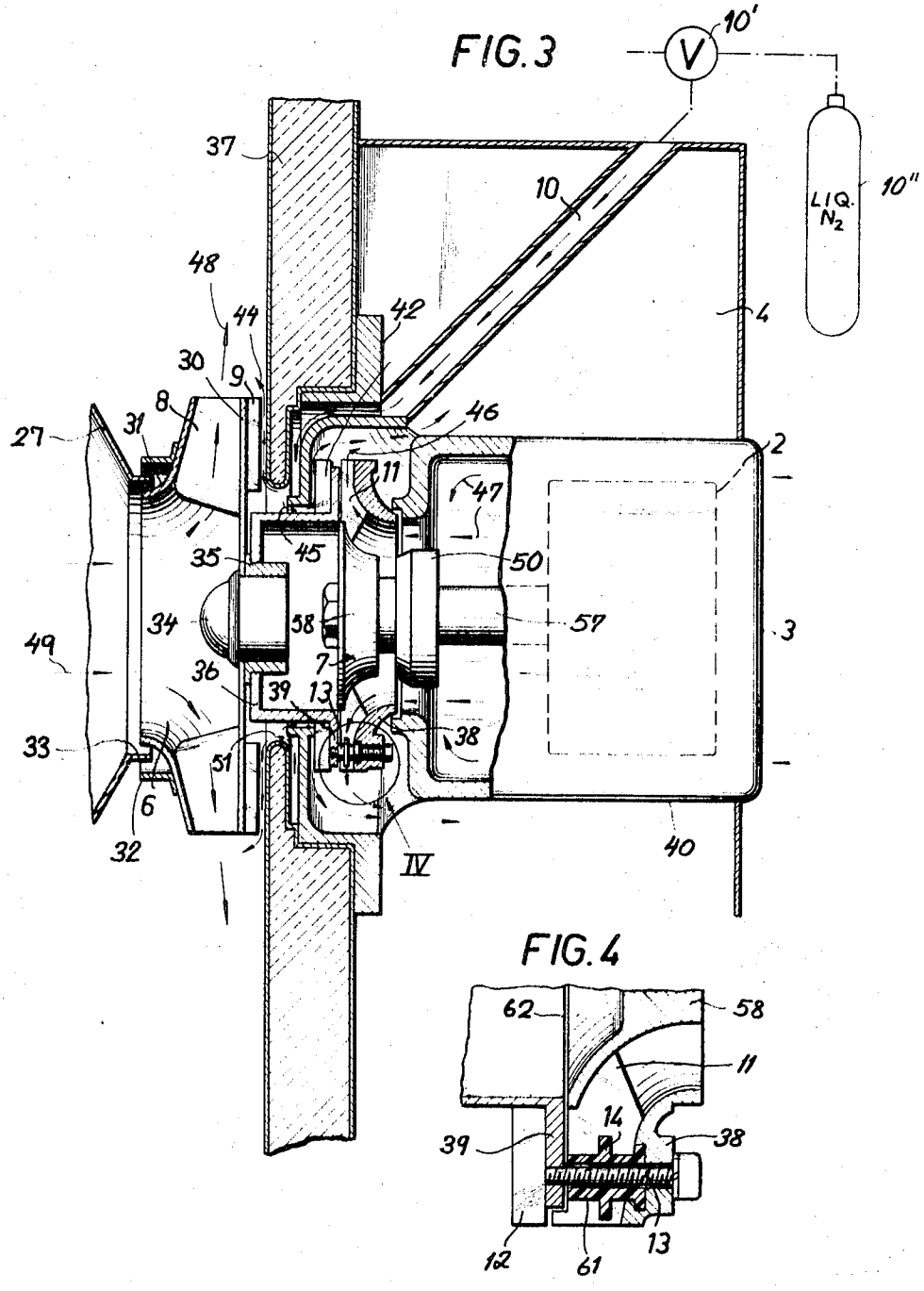


FIG. 4

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AIR-CIRCULATION APPARATUS FOR SELF-CLEANING OVEN AND THE LIKE

FIELD OF THE INVENTION

The present invention relates to an oven. More particularly, this invention concerns a self-cleaning oven having an internal blower for circulating air and distributing heat during cleaning or cooking.

Such an apparatus is described in our commonly assigned patent application Ser. No. 40,128 filed May 25, 1970 and entitled SELF-CLEANING OVEN WITH INTERNAL AIR CIRCULATION.

BACKGROUND OF THE INVENTION

The blower in a self-cleaning oven effects an equal distribution of the heat in the oven during baking or roasting for more regular cooking and during self-cleaning for pyrolytic decomposition and/or oxidation of food residue even in so-called "-dead" corners of the oven.

A persistent problem with conventional ovens of this type is the thermal protection of the blower motor. During self-cleaning, when temperatures in the neighborhood of 400°–500° C are common, this protection is of great importance since such heat can easily destroy most motors. In order to overcome this difficulty the motor can be mounted outside the food-treatment chamber with its drive shaft passing through the oven wall, the fan being mounted on the end of the drive shaft. Such a solution creates a further problem: the prevention of gas leaks around the shaft. The gases developed during a self-cleaning operation are odorous and dangerous and cannot be allowed to return to the kitchen. In addition heat is conducted back along the motor shaft to the motor armature, often damaging it.

OBJECTS OF THE INVENTION

It is, therefore, an object of the present invention to provide an improved apparatus for thermally treating comestibles, particularly in an oven of the self-cleaning type.

Another object is to provide such an apparatus which overcomes the above-mentioned disadvantages.

SUMMARY OF THE INVENTION

These objects are obtained, in accordance with features of the present invention, by an apparatus having a food-treatment chamber in which a food-treatment temperature can be established, and blower means having a drive motor carrying a rotor including centrifugal-fan means arranged to circulate the gases in the oven, to draw gases into the chamber, and to draw a stream of cooling air over the blower drive, i.e. an electric motor.

According to a further feature of the present invention a compartment is provided adjacent the food-treatment chamber, and a pair of fans is provided, one in the chamber and one in the compartment. Each fan is effectively formed as a pair of back-to-back centrifugal fans so that there are altogether four different arrays of vanes, two directed axially in toward each other, and two end ones directed axially outwardly.

In accordance with another feature of this invention the end array of radially extending vanes directed toward the motor serves to draw a current of cooling air into the compartment, over the motor. The other end set of radially extending vanes directed into the chamber circulates the hot oven-cleaning or food-treatment gases in this chamber. The two central, confronting sets of vanes flank a dividing wall between the chamber and the compartment, an opening being improved in this wall which permits the two fans to be connected together and forms an annular gap around the connection. A conduit is provided having one end open to the ambient air and the other end open in the compartment between the one fan and the wall, just adjacent the annular gap. In this manner the two central fans draw the air axially in both directions and expel it outwardly. These two sets of vanes have relative gas-displacing capacities which create a pressure differential across the opening in the wall to draw the air mainly into the oven muffle, with only a minor portion being drawn out into the cooling compartment. In this manner a gas barrier or gas lock is formed at the opening in the wall to prevent the noxious oven gases from escaping. A catalytic afterburner, according to another invention feature, is provided to process the oven gases during self-cleaning and cooking.

According to yet another feature of the oven, the fans are not simply fixed on a common motor shaft, but are rotationally coupled together only by several connector bolts which are radially spaced from the rotation axis and angularly spaced from each other. Insulating spacer sleeves are provided to hold the separate fan elements apart, and thereby to prevent direct heat conduction. These bolts are provided between the two fan elements constituting the fan in the compartment so that the motor is coupled as indirectly as possible to the fan elements or sections in the oven muffle itself. Moreover, the bolts lie in the path of the cooling air.

The present invention is applicable as well for any air circulating system in which hot air or even a cold-preserving or freezing gas stream, e.g. volatilized from liquid nitrogen, is to be brought into contact with goods in a chamber. Thus the invention, in its most general sense, comprises a treatment chamber in a wall of which is mounted the fan arrangement of the instant invention. The fan arrangement comprises a first axial-intake radial-outflow blower disposed within the chamber and drawing the circulating treating gas axially inwardly and circulating it radially outwardly within the chamber. A second axial-intake, radial-outflow fan within the chamber, advantageously provided on the opposite surface of the first fan, draws the treating-gas stream into the chamber and advantageously has a capacity substantially less than the volume rate of flow of the circulating fan so that only a minor proportion of fresh treating gas is induced to flow into the chamber by this second fan in comparison with the quantity of treating gas continuously recirculated within the chamber per unit time. The fresh treating gas may be air or a preserving or deep-freezing fluid, such as liquid nitrogen, which is drawn into the chamber through a duct system independent of the cooling arrangement to be described hereinafter. This duct system communicates with the chamber immediately adjacent the second or intake fan described above.

The fan arrangement, in which all of the blower devices or impellers are driven from a single source and are rotatable about a common axis, also includes a third axial-intake, radial-outflow fan positioned close to the gas intake fan and the duct arrangement mentioned above to divert part only of the fresh gas from the inlet stream away from the chamber and into the motor compartment to form thereby a gas lock as mentioned earlier. This fan creates a cooling stream which flows around the few bolts securing the fans in the chamber to the fans in the cooling compartment. The fourth fan, which may have a volumetric capacity substantially greater than the second and third fans, but generally less than that of the first-mentioned, is also of the aixal-intake radial-outflow type and cooperates with a cooling conduit which opens into the cooling compartment generally axially and surrounds the drive motor of the system to created an influx or primary cooling stream which cools the motor. The radial outflow from this fourth fan can be diverted into the atmosphere without danger and advantageously is combined with the minor cooling stream from the third fan mentioned earlier.

DESCRIPTION OF THE DRAWING

The above and other objects, features, and advantages will become apparent from the following description, reference being made to the accompanying drawing, in which:

FIG. 1 is a longitudinal vertical section through an oven according to the present invention;

FIG. 2 is a longitudinal horizontal section of the oven of FIG. 1;

FIG. 3 shows in enlarged scale a detail of FIG. 2; and

FIG. 4 shown in enlarged scale the detail indicated by arrow and circle IV of FIG. 3.

SPECIFIC DESCRIPTION

The oven shown in FIGS. 1 and 2 basically consists of a body 52 of insulating material defining an elongated chamber or muffle 54. A metal shell 53 fits over the closed end of this body 52 and defines air passages as will be described below. Received in the chamber 54 is a rack 26 which is fitted at its vertical sides with food-tray slides 28 and has end walls 27 which are tapered as a hood and form a port 55.

A motor 2 is mounted in the compartment 5, this motor rotationally drives the blower rotor 1 constituted by a cooling fan 7 in the compartment 4 and a circulating fan 6 in the chamber 54. A hole 51 is formed in a rear wall 37 of the oven compartment, with the fans connected together through this hole. An electric-heating element 41 is provided for heating the chamber 54, although a burner can be used for this purpose.

The oven has a door 17 at its end turned away from the compartment 4. This door is carried on a vertical hinge 24 and comprises three parallel plates 56, 21 and 22 of insulating material, the plates 21 and 22 being cemented flatly together and the plates 56 and 21 being separated by short legs 20 to form a vertically open space 18. The plate 56 has a peripheral heat-resistant seal 19 which fits against an internal rim 25 of the oven opening 23 in a closed position of the door 17 to tightly close the chamber 54. Air blowing across the top of the upwardly open space 18 draws air by the venturi effect through the door to cool it. In the absence of air blown over the top of the door, convection currents of air in the space 18 provide the requisite door cooling.

At the closed end of the oven is a compartment 4 formed by the wall 53 and perforated at 43 in its back wall 3 adjacent a stepped cylindrical sleeve 40 housing the drive motor 2 for the rotor 1.

As best shown in FIGS. 3 and 4, this motor 2 has a shaft 57 passing through a bearing 50 held by a spider (not shown) to the motor housing 40. The shaft 57 carries a hub 58 having a face or side formed with a plurality of angularly spaced and radially extending vanes 11 whose outer edges are all joined by an annular flange element 38 of curved cross section. These vanes 11 serve to draw air in through the perforations as shown by the arrows 47, and expel it outwardly as shown by the arrows 46.

Three angularly spaced bolts 13 (see FIG. 4) pass through the connecting element constituted by the flange 38 and are screwed into bores in another element formed by a flange 39 which is integral with vanes 12. Insulating spacers 61 formed with heat-radiating vanes 14 are provided on the bolts 13 to prevent heat conduction between the flanges 38 and 39. A gap 62, traversed by cooling air which flows over the bolts and their sleeves, is thus formed between the two sections of the fan 7.

The flange 39 is part of a metallic generally cup-shaped body 36 press-fitted to a cylindrical element 35 which is connected to a substantially flat disk 30 by a plug clamp 34. This disk 30 constitutes the base of the centrifugal fan 6 and is formed on its face or side turned toward the oven door 17 with large radially extending vanes 8, and on its opposite face with small radial vanes 9. The outside edges of the vanes 8 are formed with a continuous ring 31 that has an inner periphery axially received within a lip 33 on the hood walls 27. Another annular cylindrical flange 31 is provided spaced radially outwardly from the lip 33 to prevent the passage of air from outside of the rack into the fan 6. In this manner the rims 31 and 32 flank the lip 33.

The oven is further provided with a conduit 10 which passes through the chamber 4 and opens at one end to the ambient air in one position of valve 10′ or to a source 10″ of liquid nitrogen in another position of this valve, and at the other end into an opening formed in a mounting ring 42 which is firmly mounted on the motor housing 40 and surrounds the entire fan arrangement 8, 9, 11, and 12. The opening 51 in the rear wall 37 of the oven defines an annular space around the element 36.

In this manner, when the motor 2 turns, the vanes 11 draw fresh air in through the perforations 43 to cool this motor and its bearing 50, as shown by arrows 47. At the same time air from the tube 10 is deflected outwardly by the vanes 12 through the annular gap between the element 36 and the element 42. The fan 6, which is rotationally coupled to the fan 7 by the connector bolts 13, draws fresh air into the oven interior through the gap 51 as shown by the arrows 44, and circulates gases in the oven interior 54 by sucking them in axially (arrows 49) through the rack 26, and expelling them radially as shown by arrows 48. The fresh air between the vanes 12 and 9, which is fed in directly between these vanes and pulled out in both axial directions, forms a very effective gas barrier or gas lock against the passage of heat or contaminated gases out of the oven interior and into the chamber 4. None of the air used to cool the motor 2, however, can enter the chamber 54 due to the arrangement of the conduit 10 and the relative fan capacities.

Simultaneously the vanes 8 circulate the gases in the oven to effect an excellent distribution of heat during a self-cleaning, cooking or thawing operation.

Atop the oven is a horizontal conduit 5 which opens directly above the door 17 and serves as exhaust for the air displaced by the fan 7, which air serves to form the gas barrier referred to above, and to cool the motor 2. A catalytic afterburner 15 is also mounted in the oven top wall and has a outlet 16 fitted with metal plates pointed in the direction of the air stream of the exhaust conduit 5 so that the hot gases i.e. water vapor carbon dioxide etc. issuing therefrom are thoroughly diluted in the air stream and rendered harmless. The current of gases issuing from the opening 59 of the conduit 5 are further upwardly deflected, as shown by arrow 60, by the air rising by convection in the gap 18 between the hot door plates 56 and 21.

The vanes 9 and 12 are so dimensioned relative to each other that the portion of the air sucked in through the tube 10 and into the oven interior 54 is greater than that sucked in through this tube and thence blown outwardly into the compartment 4. In the embodiment shown the vanes 9 have substantially the same total surface area as the vanes 12, but move at a greater angular speed due to their radial spacing from the axis of rotation which is larger than that of the vanes 12. Thus, the air stream from the conduit 10 is split up, with the larger portion going into the muffle 54 due to the relative fan capacities which made a pressure differential across the opening 51.

This apparatus is equally useful for the quick-freezing and storing of comestibles, since in this case the motor must also be thermally protected from the cold. With such an arrangement, liquid nitrogen fed into the conduit 10 would be vented externally.

We claim:

1. An apparatus for thermally treating comestibles comprising:

means forming a generally closed chamber;

means for establishing a food-treatment temperature in said chamber; and

blower means having a drive motor outside said chamber and a rotor connected to said motor and including centrifugal-fan means for circulating gases in said chamber, for drawing air over said drive motor, and for introducing gases into said chamber, said centrifugal-fan means including a pair ot centrifugal fans, one of said fans being inside said chamber and the other being outside said chamber, said chamber having a wall formed with an opening, said rotor extending through said opening, said fan in said chamber having a first face turned toward said motor and bearing an array of radially extending vanes and a second face turned away from said motor and bearing an array of radially extending vanes, said opening

defining an annular gap around said rotor, said centrifugal-fan means further comprising means cooperating with said vanes on said first face and forming a gas barrier at said gap for preventing issue of gases from said chamber through said opening, the last-mentioned means including a conduit for feeding a gas to a location immediately adjacent said gap, whereby on rotation of said fans said gas is drawn through said gap into said chamber by said array of vanes on said first face.

2. The apparatus defined in claim 1 wherein said fan outside said chamber is formed with a first side turned toward said motor and bearing an array of radially extending vanes and a second side turned away from said motor and bearing an array of radially extending vanes, whereby on rotation of said rotor said gas is drawn axially in two directions from said location by said arrays of vanes on said first face and on said second side to form said gas barrier.

3. The apparatus defined in claim 2 wherein said array on said first face is of higher gas-displacing capacity than said array on said second side to form a pressure differential across said opening constituting said barrier.

4. The apparatus defined in claim 3, further comprising means forming a compartment adjacent said chamber and against said wall for forming an air-circulation path over said motor, said conduit passing through said compartment and having one end open to a supply of said gas and another end opening at said location.

5. The apparatus defined in claim 1, further comprising a pair of mounting elements each connected rotationally to one of said arrays of vanes and connecting means extending between said elements and constituting the sole rotational coupling between said drive motor and said fan outside said chamber, said connecting means including a plurality of elongated connectors radially spaced from said axis and angularly spaced from one another, each connector having one end fixed in one of said elements and another end fixed in the other element.

6. The apparatus defined in claim 5 wherein said one of said elements is rotationally fixed on said array of vanes on said fan outside said chamber turned toward said motor.

7. The apparatus defined in claim 5 wherein said connecting means further includes a plurality of sleeves of insulating material each surrounding one of said connectors and having one end abutting one of said elements and another end abutting the other of said elements. each of said sleevooon-heat-radiating vane.

8. The apparatus defined in claim 7 wherein each of said sleeves is formed with at least one heat-radiating vane.

9. An apparatus for the treatment of goods with a gas, comprising a treatment chamber having a wall provided with an opening, and a fan arrangement mounted in said opening, said fan arrangement including:

a first axial-intake radial-outflow blower in said chamber and rotatable to circulate a treating gas therewithin;

a second axial-intake radial-outflow blower rotatable about a common axis with said first blower and disposed axially rearwardly thereof with respect to said chamber and having a smaller capacity than said first blower for inducing a stream of treatment gas to flow into said chamber;

a third axial-intake radial-outflow blower rotatable coaxially with said first and second blowers and disposed axially rearwardly of said second blower for diverting a portion of said stream away from said chamber and creating therefrom a cooling flow for restricting mixing of the treatment gas with ambient air;

a fourth axial-intake radial-outflow blower rotatable coaxially with said first, second and third blowers and disposed axially rearwardly of said third blower for generating a primary cooling flow of ambient air; and

an electric motor operatively connected to all of said blowers for driving same and disposed in said primary flow.

10. The apparatus defined in claim 9, further comprising duct means opening between said second and third blowers for delivering said stream thereto.

11. The apparatus defined in claim 10, further comprising means for connecting a source of freezing fluid to said duct means.

12. The apparatus defined in claim 10, wherein said duct means opens into the atmosphere.

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