(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 894 871 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
03.02.1999 Bulletin 1999/05

(51) Int. Cl.[6]: **C13F 5/00**

(21) Application number: **98201721.2**

(22) Date of filing: **26.05.1998**

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: **03.06.1997 NL 1006216**

(71) Applicant: **Aquarius B.V.**
6006 RV Weert (NL)

(72) Inventors:
- **Derckx, Henricus Antonius Jacobus Maria**
  3680 Maaseik (BE)
- **Torringa, Henderikus Menno**
  6701 AW Wageningen (NL)

(74) Representative:
Seerden, Adrianus Maria
Octrooibureau Vriesendorp & Gaade
P.O. Box 266
2501 AW Den Haag (NL)

(54) Apparatus for drying sugar cubes

(57) Device for drying sugar cubes containing a heating apparatus for heating and dehumidifying the sugar cubes, a conditioning apparatus for cooling off and possibly further dehumidifying the sugar cubes and a conveying apparatus for conveying the sugar cubes through the heating apparatus and the conditioning apparatus, in which the heating apparatus comprises a multimode microwave cavity and a number of microwave heads which are connected to the microwave cavity by their own wave-guide.

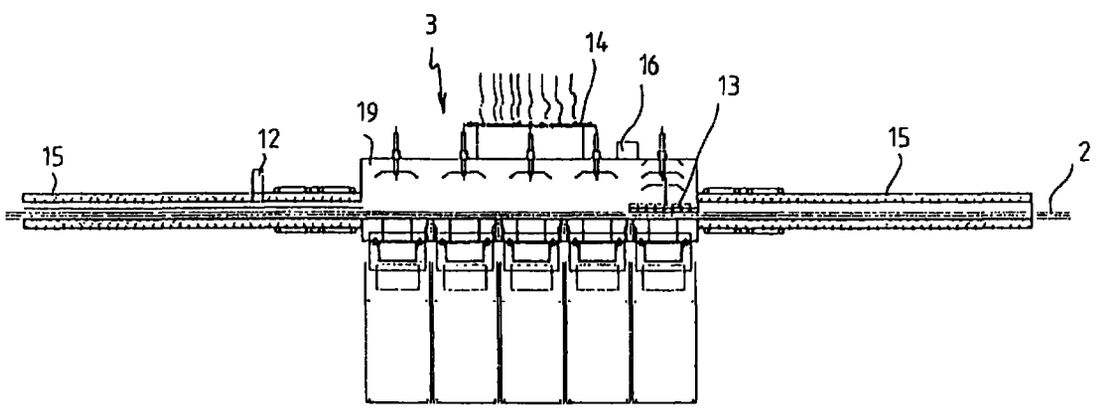

FIG. 2

EP 0 894 871 A1

Description

[0001] The present invention relates to an apparatus for drying sugar cubes.

[0002] When producing sugar cubes, a mixture of sugar and water is pressed to the desired shape, size and weight in a press. Usually, the water content amounts to approximately 1.2% this being reduced to about 0.4% by drying in a drying device. During drying the cubes not only achieve the desired final humidity content but also the required hardness so that they can be packed in boxes. Known drying devices are hot air or infrared drying devices. Suchlike devices frequently have a high energy expenditure and are large in size; drying lines of 40 metres are no exception. If a breakdown occurs in such a known drying device, the latter will only cool down slowly after the drying device has been deactivated. As a result, not only do problems such as caramelization or discolouring of the sugar cubes arise, but in addition to that it takes longer before the failure can be put right.

[0003] It is an object of the invention to provide an apparatus for drying sugar cubes with a lower energy expenditure, in which the apparatus is also more compact and in which furthermore after deactivation, a faster cooling down of the apparatus can be realized.

[0004] For this purpose the present invention provides a device for drying sugar cubes containing a heating apparatus for heating and dehumidifying the sugar cubes, a conditioning apparatus for cooling off and possibly further dehumidifying the sugar cubes and a conveying apparatus for conveying the sugar cubes through the heating apparatus and the conditioning apparatus, in which the heating apparatus comprises a multimode microwave cavity and a number of microwave heads which are connected to the microwave cavity by their own wave-guide. Because drying the sugar cubes takes place by microwave energy generated by the microwave heads, compared to the known drying devices a homogenous heating of the whole sugar cube takes place in which most of the humidity in the sugar cube is released, thus saving between 30% and 50% of the energy. In addition, the length of the drying route can be reduced to approximately 15% compared to hot air and infrared drying. Especially because the microwave cavity is a multimode microwave cavity, that is that a number of microwave heads are provided, for instance up to 30 or more, it is possible to adjust the generated energy in an optimum manner to the sugar cubes in the microwave cavity. A further advantage of the multimode microwave cavity is that the distribution of field intensity over the width and length of the cavity can be very even, so that as a consequence all the cubes are supplied with the same amount of energy, as a result of which all the cubes have a same even temperature and humidity content at the end of the microwave cavity.

[0005] If each wave-guide is provided at the location of the microwave cavity with slots for coupling microwave energy in the microwave cavity, the field intensity can be optimally distributed in the microwave cavity, because of the size, the angle of canting and the mutual positioning of the grooves.

[0006] In an embodiment of the apparatus according to the invention each microwave head has a defined capacity, so that the field intensity in the microwave cavity can be varied accordingly.

[0007] A further embodiment of the invention according to the invention contains a sensor for detecting the number of rows of sugar cubes conveyed by the conveying apparatus into the microwave cavity, a field intensity meter for measuring the field intensity in the microwave cavity and a velocity meter for measuring the conveying velocity of the sugar cubes, as a result of which an exact adjustment and control of the drying process is obtained. A humidity sensor placed in the microwave cavity can further improve this control.

[0008] Some embodiments of a device according to the invention will, by way of example, be described on the basis of the drawing, in which

figure 1 shows a schematic side view of a device for producing and drying sugar cubes,

figure 2 shows a schematic side view of the heating apparatus according to the invention, and

figure 3 shows a schematic top view of the heating apparatus shown in figure 2.

[0009] In figure 1 a device for producing and drying sugar cubes is schematically shown in side view, which device is made in a usual line layout. Sugar and water are supplied in the usual way to a press 1, in which the sugar and the water are mixed and in which the sugar cubes are pressed into the correct shape, size and weight. From the press the sugar cubes are conveyed via a conveying apparatus 2 to the heating apparatus 3.

[0010] The heating apparatus 3 contains a multimode microwave cavity 19 (figure 2) and a number of microwave heads 10 (figure 3). The conveying apparatus 2 conveys the wet sugar cubes 13 through the microwave cavity 19, where the sugar cubes 13 are heated by microwave energy to a temperature of approximately 75°C and most of the humidity in the sugar cubes 13 is released. Because of this the sugar cubes 13 get enough latent energy to arrive at the desired final humidity content in a conditioning apparatus 4 (figure 1). After the sugar cubes have been conveyed through the conditioning apparatus 4, they are conveyed to a usual packaging apparatus 5 by the conveying apparatus 2, where the sugar cubes are packed in boxes or the like. The press 1, the conveying apparatus 2 and the packaging apparatus 5 are electrically driven in the known manner, the drives being adapted to one another.

[0011] In order that as little microwave energy as pos-

sible is lost in the microwave cavity, the conveying apparatus 2 is preferably a conveyor belt made of synthetic material, the dielectric characteristics of which being such, that the conveyor belt takes up as little energy as possible.

[0012] The heating apparatus 3 contains a number of microwave heads 10 which are connected to the microwave cavity by their own wave-guide 17 (figure 3). In the embodiment shown in the figures, the wave-guides are placed horizontally, transverse to the direction of conveyance, with the microwave heads at the ends of the wave-guides. Alternatively, the microwave heads can be placed directly under the stream of sugar cubes, the microwave heads being connected with vertical wave-guides to the microwave cavity. This last alternative embodiment provides a more compact construction form and a good heating of the sugar cubes, which is almost independent of the height of the sugar cubes. In addition, in the exemplary embodiment shown in the figures, the number of microwave heads is five, although in practise up to thirty or more heads can be used. The microwave heads are, for instance, are standard industrial heads with a capacity of 1.2 kW, for example.

[0013] Each wave-guide 17 is provided at the location of the microwave cavity with slots 18 for coupling the microwave energy in the microwave cavity. The size, position and mutual positioning of the slots 18 can be chosen to obtain a desired field intensity distribution in the microwave cavity. Furthermore, each microwave head has a defined capacity, or an independent capacity adjustment in order to further distribute the field intensity as desired.

[0014] Because the microwave heads are independently adjustable, the action of the inventive drying device is improved with regard to the known devices, namely in startup and stop situations. When starting up the inventive device, the microwave cavity will slowly be filled with sugar cubes. In order to obtain a uniform drying process, in accordance with this several microwave heads are switched on upon starting up or more capacity is generated by the microwave heads. An adjustment of this kind can be controlled by the sensor 12 at a known conveying velocity. In a stop situation, for instance when there is a breakdown, the energy supply to the microwave heads can be switched off immediately, as a result of which heating does not take place either. The microwave cavity then cools off immediately. Problems such as caramelization or discolouring do not therefore occur and repairs can be speedily carried out.

[0015] In the microwave cavity 19 there are means, for example one or more ventilators 14, for extracting from the microwave cavity air in which humidity is included which is already leaving the sugar cubes 13. In order to improve air circulation, the conveyor belt is provided with air passages.

[0016] A sensor 12 detects the number of rows of sugar cubes conveyed by the conveyor belt 2 into the microwave cavity, a field intensity meter 16 measures the field intensity in the microwave cavity 19 and, together with the velocity of the conveyor belt 2 measured by the velocity meter, the microwave heads are switched on or off so as to obtain a field intensity distribution desirable under the detected circumstances. The advantage of a multimode microwave cavity having suchlike adjustment, compared to using one large microwave source, is that an exact control of the drying process is obtained. A further improvement of the control of the drying process can be obtained by including a humidity sensor in the microwave cavity.

[0017] A further advantage of a multimode microwave cavity is that there is a uniform distribution of the field intensity over the width and length of the microwave cavity, which results in the supply to all sugar cubes of the same quantity of energy, so that at the end of the microwave cavity all the sugar cubes have an equal temperature and an equal humidity content. As a consequence, all the sugar cubes will eventually have the same residual humidity content and the same hardness, which is important for packaging and further storage of the sugar cubes.

[0018] In order to prevent undesired microwave energy from leaving the heating apparatus 3, the latter is provided with protective devices 15.

[0019] After the sugar cubes have passed through the microwave cavity, they are conveyed by the conveyor belt to and through the conditioning apparatus, where the sugar cubes are cooled by means of cooling means for generating air circulation. In addition, this air ensures the discharge of the humidity which may be leaving the sugar cubes. In that way the sugar cubes obtain the desired final humidity content and the desired hardness.

[0020] Given that the microwave heads are cooled by air, this air is heated. This heated air can be led to the microwave cavity of the heating apparatus by means of tubes. The thermal energy of this air is then used for additional heating of the sugar cubes, this heated air also discharging humidity released in the microwave cavity and preventing condensation in the microwave cavity.

[0021] With the drying device according to the invention a drying process which is 85% faster in comparison to known drying devices is obtained, with an energy saving of 30 to 50%. Moreover, the floor surface required by the device is considerably reduced.

Claims

1. Device for drying sugar cubes containing a heating apparatus for heating and dehumidifying the sugar cubes, a conditioning apparatus for cooling off and possibly further dehumidifying the sugar cubes and a conveying apparatus for conveying the sugar cubes through the heating apparatus and the conditioning apparatus, in which the heating apparatus comprises a multimode microwave cavity and a number of microwave heads which are connected

to the microwave cavity by their own wave-guide.

2. Device for drying sugar cubes according to claim 1, in which each wave-guide is provided at the location of the microwave cavity with slots for coupling microwave energy in the microwave cavity.

3. Device for drying sugar cubes according to claim 1 or 2, in which each microwave head has a defined capacity.

4. Device for drying sugar cubes according to claim 1, 2 or 3, in which the microwave cavity contains means for discharging air and moisture out of there.

5. Device for drying sugar cubes according to any one of the preceding claims, in which the device is provided with a sensor for detecting the number of rows of sugar cubes conveyed by the conveying apparatus into the microwave cavity, a field intensity meter for measuring the field intensity in the microwave cavity and a velocity meter for measuring the conveying velocity of the sugar cubes.

6. Device for drying sugar cubes according to any one of the preceding claims, in which the microwave cavity is provided with a humidity sensor.

7. Device for drying sugar cubes according to any one of the preceding claims, in which the conditioning apparatus is provided with cooling means for cooling the sugar cubes by means of air circulation.

8. Device for drying sugar cubes according to any one of the preceding claims, in which the conveying apparatus is a conveying belt made of synthetic material which absorbs almost no microwave energy.

9. Device for drying sugar cubes according to claim 8, in which the conveyor belt is provided with air passages.

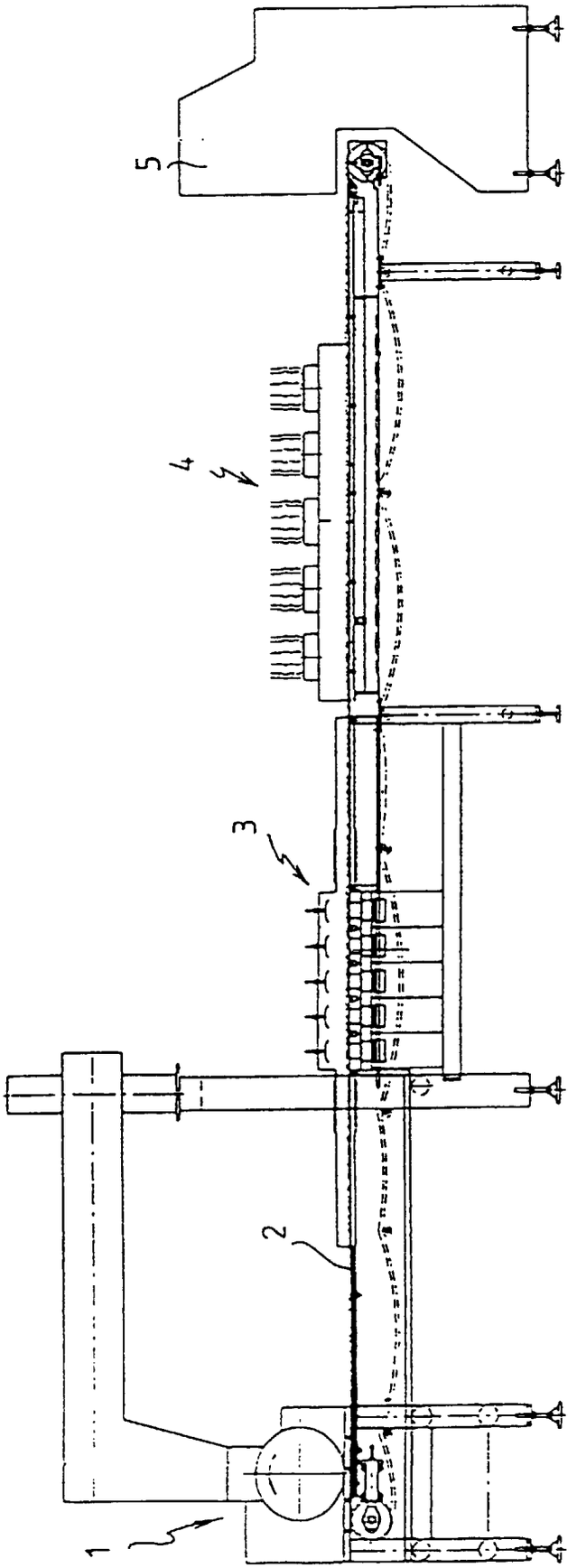

FIG. 1

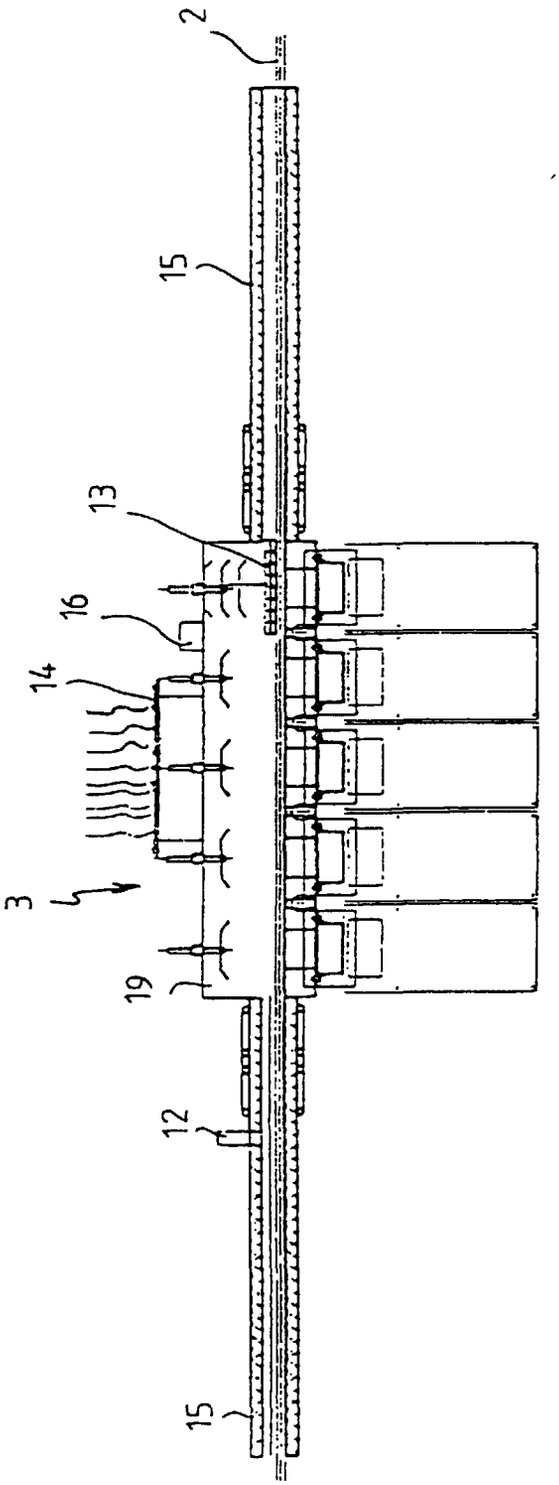

FIG. 2

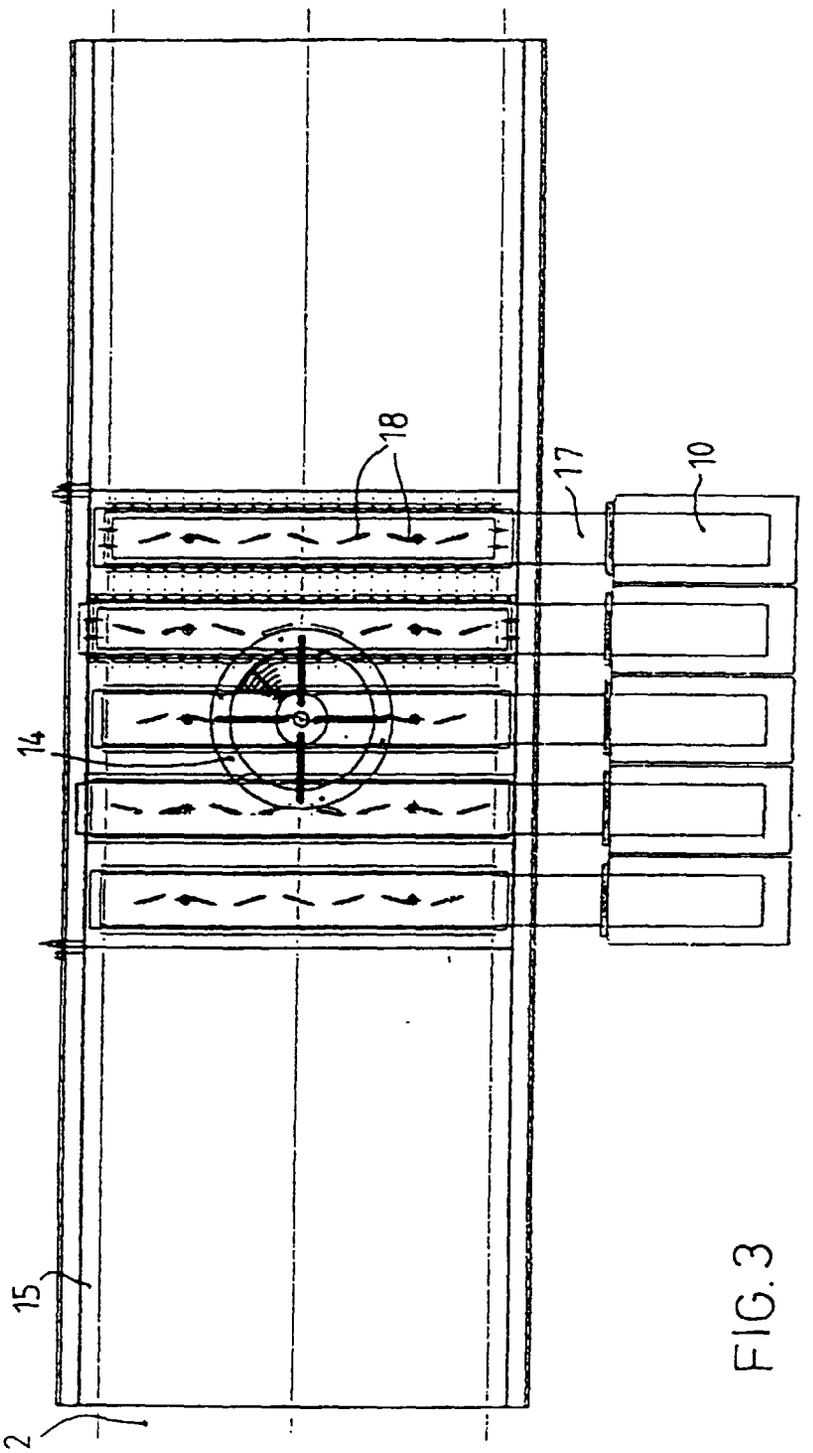

FIG.3

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 98 20 1721

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	EP 0 036 309 A (P.L.VELTMAN) 23 September 1981 * claims; figures *	1	C13F5/00
A		2-9	
A	DE 924 860 C (R.C.BREMER) 3 February 1955 * the whole document *	1-9	
A	EP 0 036 241 A (STORK) 23 September 1981 * the whole document *	1	
A	DATABASE WPI Section Ch, Week 8716 Derwent Publications Ltd., London, GB; Class D17, AN 87-112898 XP002078731 -& JP 62 059000 A (ISHINO SEISAKUJO KK) , 14 March 1987 * abstract *	1	

TECHNICAL FIELDS SEARCHED (Int.Cl.6)

C13F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	25 September 1998	Van Moer, A

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)