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(11) Publication number:

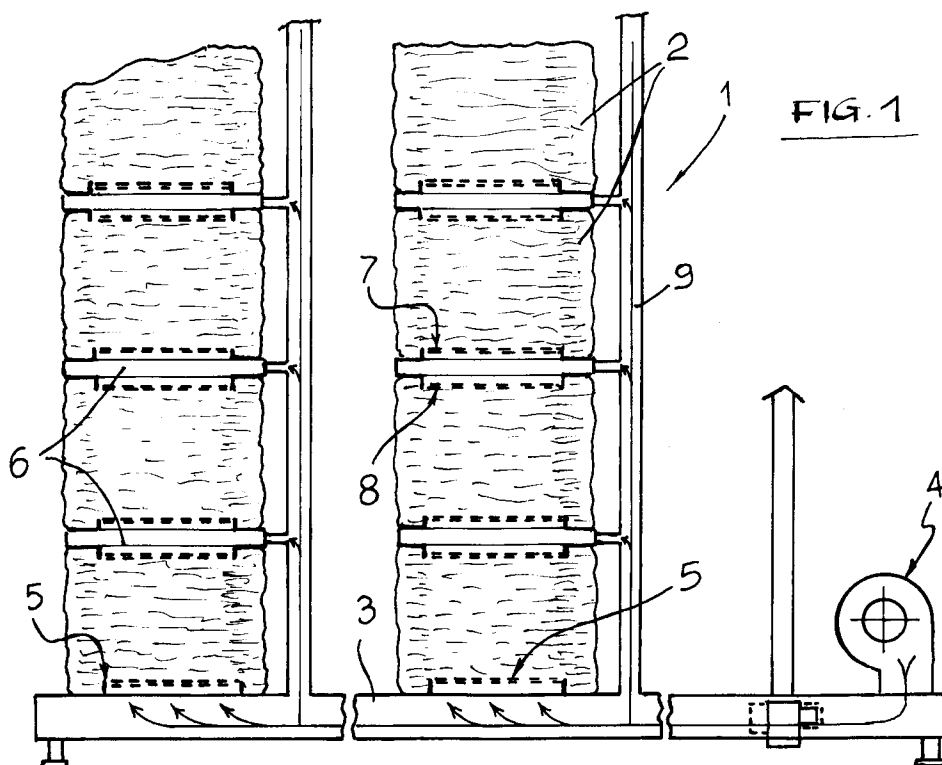
**0 534 382 A1**

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**EUROPEAN PATENT APPLICATION**(21) Application number: **92116245.9**(51) Int. Cl.<sup>5</sup>: **F26B 21/00, F26B 9/10**(22) Date of filing: **23.09.92**(30) Priority: **26.09.91 IT MO910143**(72) Inventor: **Muzzarelli, Gabriele**(43) Date of publication of application:  
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**I-41100 Modena(IT)**(54) **Dry air conveyance device for drying round forage bales.**

(57) The conveyance device (6) comprises a flattened chamber (10) which is suitable to be fed with dry air and has, along the same axis, an upper air outlet (7) and a lower air outlet (8). The chamber (10)

is intended to rest, on opposite sides, against the lower and upper surfaces of respective stacked forage bales (2) which are spaced by a plurality of the conveyance devices (6).

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The present invention relates to a dry air conveyance device for drying round forage bales.

As is known, the use of cylindrical or parallelepipedal forage bales is currently very widespread in the haymaking sector. Said cylindrical bales, also known as round bales, are obtained by means of suitable presses which roll up the green forage when it is picked, allowing a considerable reduction in costs.

Said presses furthermore allow to appropriately differentiate the density of the forage inside the bale. In particular, it is possible to provide higher density in the outer region, in order to have greater strength and waterproofing, and vice versa lower density in the inner core.

However, in this manner the forage is picked and baled with a relatively high degree of humidity which can vary according to the weather conditions, i.e. a degree which exceeds the value required for optimum preservation (approximately 20-25%). High humidity causes the onset of fermentation processes which degrade the quality of the hay, reduce its nutritional value and also cause heavy losses in the amount of hay obtained.

The need therefore arises to dry the round bales of forage in time, generally by blowing dry air through said round bales.

More particularly, known drying units substantially have a bed having modular plates provided with a central hole, at which the bale to be dried is placed. A stream of warm air, produced by a centrifugal fan connected to the bed, is delivered through said hole.

The main problem observed in these drying units resides in an uneven distribution of the dry air within the mass of the bale. This causes a non-uniform drying of the forage, with consequent losses due to fermentation.

This phenomenon is more evident in soft-core bales, since the presence of more compact regions causes the flow-rate of drying air to be greater along the axis of the bale and through the lower lateral surface. A critical zone, located in the upper region of the round bales, in which humidity is maximum at the end of the drying process, is thus formed.

Various solutions have been proposed in order to obviate this problem, such as for example the use of a ring-shaped outlet for the warm air instead of a circular one, or the containment of the escape of the air from the upper part of the bale by means of a cover.

However, the proposed solutions have not yielded fully satisfactory results. In particular, the drying of the bale is significantly non-uniform, and thus entails the risk of fermentation effects, in the case of round bales having a relatively high degree of average humidity (for example more than 40%).

Furthermore, in order to minimize the risk of having fermentable regions, the action for drying the entire bale is often prolonged more than necessary, with a considerable waste of energy.

The fact is furthermore observed that sometimes there are considerable losses of dry air between the delivery hole and the surface of the bale; this obviously entails a further waste of energy.

The aim of the present invention is to solve the above problem by providing a device for the conveyance of dry air which allows to obtain an optimum drying of round forage bales.

Within the scope of this aim, a further object of the present invention is to provide a conveyance device for drying round forage bales which is simple in concept, limited in bulk, safely reliable in operation and versatile in use.

This aim and this object are both achieved, according to the invention, by the present device for the conveyance of dry air for drying round forage bales, characterized in that it comprises a flattened chamber feedable with dry air and having, along the same axis, an upper air outlet and a lower air outlet, said chamber being intended to rest, on its opposite sides, against the lower and upper surfaces of respective stacked forage bales which are spaced by a plurality of said conveyance devices.

The details of the invention will become apparent from the detailed description of a preferred embodiment of the conveyance device for drying round forage bales, illustrated by way of non-limitative example in the accompanying drawing, wherein:

figure 1 is a side view of a drying unit which uses the conveyance device according to the invention;

figure 2 is a perspective view of said conveyance device;

figure 3 is a lateral sectional view of the present invention.

With particular reference to the above figures, the reference numeral 1 generally designates the apparatus for drying round forage bales 2.

The apparatus 1 has a lower ventilation chamber 3 suitable to be fed with the dry warm air produced, in a known manner, by heating elements 4 provided with appropriate blower means. The ventilation chamber 3 has, in a modular manner, a plurality of outlets 5 for the warm air; the outlets 5 have an edge which protrudes with respect to the plane of the chamber 3.

A plurality of conveyance devices 6 for the dry and warm air are arranged at each one of the outlets 5 of the chamber 3 so that said devices are mutually superimposed and parallel. The conveyance devices 6 respectively have an upper outlet 7 and a lower outlet 8 which are coaxial, in the

assembled position, to the underlying outlet 5 of the chamber 3.

The conveyance devices 6 are fed in parallel by means of a duct 9 extending vertically from the lower ventilation chamber 3.

As shown in detail in figure 2, each conveyance device 6 is constituted essentially by a chamber 10 having a flattened shape and has, on one side, a coupling 11 for connection to the duct 9 for the delivery of the warm, dry air. The chamber 10 has, on its opposite faces, along the same axis, the air outlets 7 and 8; said outlets 7 and 8 similarly have a circular edge 12 which protrudes with respect to the respective face of the chamber 10.

It should be noted that the outlets 5 of the ventilation chamber 3 are substantially equivalent, from a functional and constructive point of view, to the upper outlets 7 of the conveyance devices 6.

In practice, each conveyance device 6 is intended to rest, on opposite sides, against the upper surface and the lower surface of respective forage bales 2 which are arranged in a stack and are spaced by a plurality of said conveyance devices. It is thus possible to deliver the dry air from the outlets 7 and 8 of the conveyance devices 6 to both ends of the forage bales 2.

At the same time, the facing surfaces of the chambers 10 of the conveyance devices prevent the escape of the drying air from both of the resting bases of the stacked bales 2. The same result is obviously obtained both with cylindrical forage bales and with parallelepipedal ones.

The conveyance device 6 furthermore allows mutual spacing between the stacked forage bales 2 in order to create a compression chamber whose pressure is constantly equal to that of the lower ventilation chamber 3. The conveyance device is therefore isobaric.

The conveyance devices are sized so that the airflows of drying air substantially follow paths of equal length, so as to provide the uniform distribution of the warm and dry air in the mass of the bale.

In this manner, a stack of soft-core cylindrical bales behaves essentially like a tube whose lateral surface is permeable and through which the drying air escapes uniformly. It is noted that the layer crossed by the air has a limited extent and that the pressure is substantially constant along the axis of the stack of forage bales.

As the forage loses humidity, the pressure along said axis of the stack decreases uniformly, whereas the flow-rate of the air instead increases.

In summary, the described isobaric conveyance device allows to optimally dry round bales of forage picked humid (even with a degree of humidity of over 40-50%), ensuring uniformity in drying (18-20% of relative humidity) or dehydration (10%

of relative humidity). In particular, the difference in uniformity inside the bales is reduced by at least 50% with respect to the conventional method.

The regions subject to the risk of fermentation inside the bales are furthermore completely eliminated.

It should be furthermore noted that the conveyance devices according to the invention allow to dry the bales in multiple superimposed layers, with a drastic reduction in the space required by the apparatus. This reduced bulk furthermore allows the conveyance devices to be employed on mobile structures.

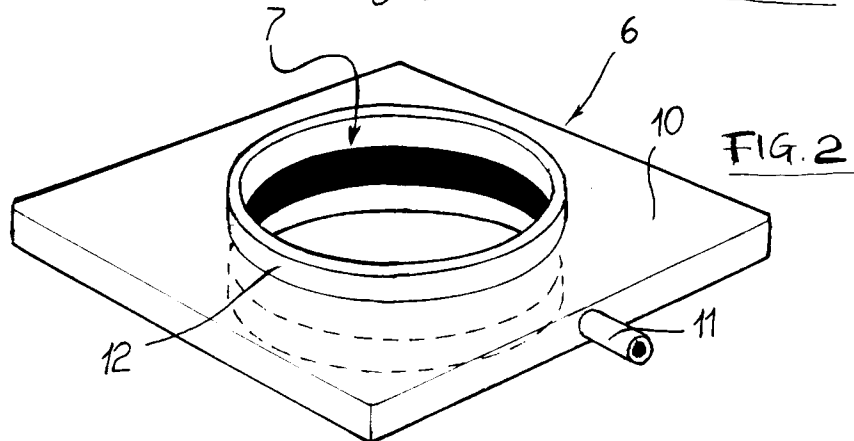
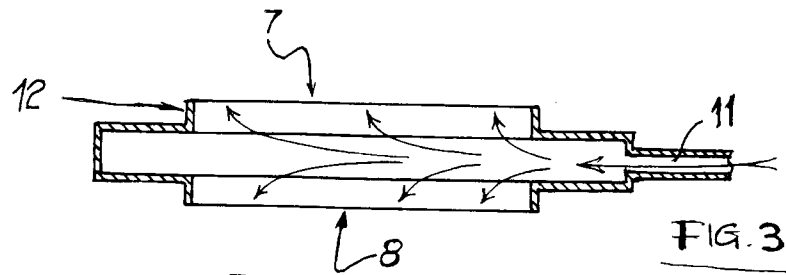
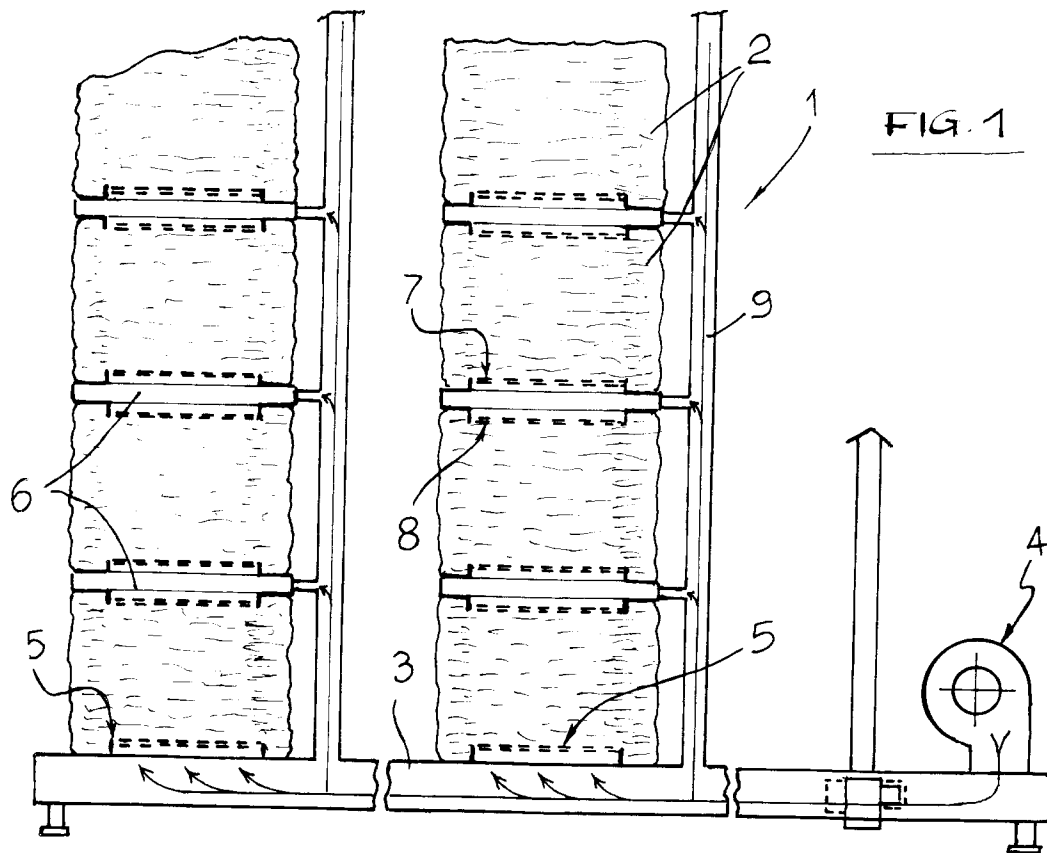
The isobaric conveyance device finally allows to avoid wastes of energy, since the drying action may be performed only for the time actually required and there are no leaks of warm and dry air between the bases of the bales and said conveyance devices.

In the practical embodiment of the invention, the materials employed, as well as the shapes and dimensions, may be any according to the requirements.

Where technical features mentioned in any claim are followed by reference signs, those reference signs have been included for the sole purpose of increasing the intelligibility of the claims and accordingly such reference signs do not have any limiting effect on the scope of each element identified by way of example by such reference signs.

## Claims

1. Conveyance device for dry air for drying round forage bales, characterized in that it comprises a flattened chamber feedable with dry air and having, along a common axis, an upper air outlet and a lower air outlet, said chamber being intended to rest, on opposite sides, against the lower and upper surfaces of respective stacked forage bales which are spaced by a plurality of said conveyance devices.
2. Device according to claim 1, characterized in that said air outlets each have an edge which protrudes with respect to the surface of said flattened chamber.
3. Device according to claim 1, characterized in that said flattened chamber has, on one side, a coupling for connection to a duct for the delivery of the dry air, said coupling extending vertically from a lower ventilation chamber.





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## EUROPEAN SEARCH REPORT

Application Number

EP 92 11 6245

| 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.5) |
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| The present search report has been drawn up for all claims                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                    |                                                      |                                               |
| Place of search<br>THE HAGUE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                    | Date of completion of the search<br>09 DECEMBER 1992 | Examiner<br>SILVIS H.                         |
| <b>CATEGORY OF CITED DOCUMENTS</b><br>X : particularly relevant if taken alone<br>Y : particularly relevant if combined with another document of the same category<br>A : technological background<br>O : non-written disclosure<br>P : intermediate document<br>T : theory or principle underlying the invention<br>E : earlier patent document, but published on, or after the filing date<br>D : document cited in the application<br>L : document cited for other reasons<br>-----<br>& : member of the same patent family, corresponding document |                                                                                    |                                                      |                                               |