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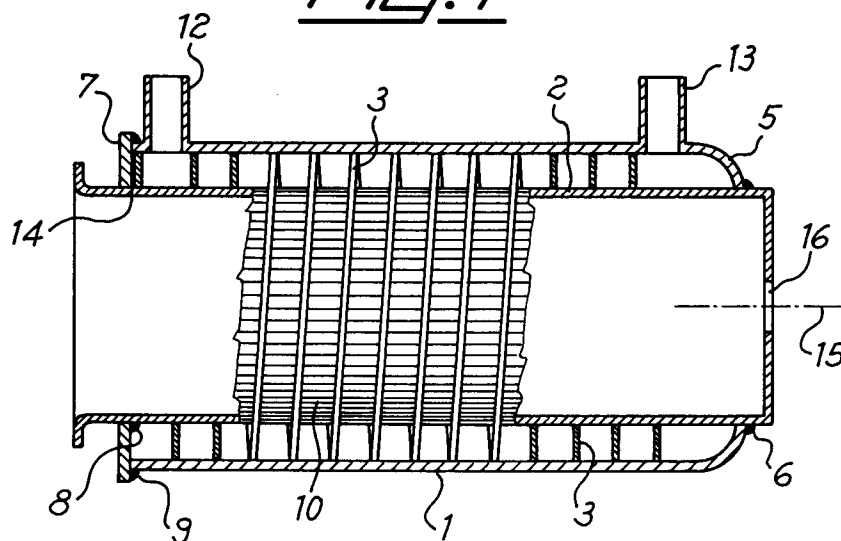
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I-20122 Milano (IT)(54) **Freezing drum with built-in evaporator and method for the manufacture thereof.**

(57) A freezing drum, of the type with built-in evaporator, comprises a substantially cylindrical external jacket (1) made of metal, a cylindrical freezing chamber (2), made of metal as well, coaxially positioned inside said jacket and at least a spiral-shaped

path provided in the hollow space between the jacket and the chamber. The freezing chamber (2) has a rough external surface preferably obtained by plastic machining of the metal, for instance by knurling.

Fig. 1**EP 0 670 461 A1**

The present invention concerns a freezing drum with built-in evaporator and a method for the manufacture thereof.

In particular, the invention concerns a high performance freezing drum that is suitable to be used in machines for foodstuff processing, for instance in machine for ice-cream production.

An example of freezing drum with built-in evaporator is described in the previous patent application N. MI93A000926 in the name of the same Applicant. In this application a freezing drum with built-in evaporator is described that includes a couple of tubular metal elements, coaxially positioned one inside the other, and a spiral-shaped metal strip with an edge inserted into a corresponding helical groove provided on the internal surface of the outer tubular element, whereas the opposite edge of the strip is put in tight contact with the external surface of the inner tubular element.

In respect of other embodiments of the known technique, the freezing drum described in said previous patent application allowed to reduce the thickness of the freezing chamber and consequently improved the quickness of thermal exchange between the substance contained in the freezing chamber and the thermal exchange fluid circulating in the evaporator. This indisputable advantage involves however a considerable manufacturing precision with very limited tolerances that, if not properly complied with, may jeopardize the efficiency of thermal exchange.

As particularly refers to the machines designed for the production of food mixtures, the continuous requirement of achieving a more effective thermal exchange as well as a better global performance of the freezing drums clashes with the need of realizing structures of such a sturdiness as to be able of bearing without inconveniences the considerable stresses transmitted by the stirrer which turns inside the freezing chamber itself. As a matter of fact, it is necessary to have a freezing chamber with walls of considerable thickness due to said of mechanical stresses, but this involves unavoidable losses in efficiency of the thermal exchange between the product within the chamber and the fluid circulating on the outside thereof.

An object of the present invention is to provide a freezing drum with built-in evaporator allowing to obtain a better efficiency of thermal exchange versus those of the known type.

A further object of the present invention is to provide a freezing drum with built-in evaporator having a particularly sturdy structure even with reduced thicknesses of the wall of the freezing chamber.

These objects are achieved by means of the present invention that concerns a freezing drum of the type with built-in evaporator, comprising a sub-

stantially cylindrical external jacket made of metal, a cylindrical freezing chamber, made of metal as well, having a diameter lower than that of said jacket and placed in coaxial position within said jacket, as well as at least a spiral-shaped path provided in the hollow space between said jacket and said chamber, characterized in that said freezing chamber has a rough external surface.

The rough surface outside of the freezing chamber has the double advantage of creating turbulence in the fluid thermal exchange fluid lapsing thereof, and of providing a larger superficial extent involved in the thermal exchange itself.

This is clearly in contrast with the solutions adopted by the known technique that involve an accurate turning of the external surface of the freezing chamber in order to allow the helically running metal strip to perfectly adhere to the external surface of the freezing chamber. If the strip is not fixed by a continuous welding line to the external surface of the chamber, possible blow-by between contiguous sections of the helical path of the evaporator are therefore limited or avoided, and this was considered to prevent a consequent decrease in performance of the evaporator itself. It has however been noticed that performance decrease due to said blow-by may be negligible if compared to the increase in performance obtained thanks to the roughness of the external surface of the chamber.

The invention also concerns a method to obtain such a freezing drum, that involves a machining of the external surface of the freezing chamber so as to allow the achievement of a rough surface.

The machining of the external surface of the freezing chamber may be carried out by chip removal or preferably may be carried out by plastic deformation of the material. In the latter case a knurling of the external surface of the freezing chamber is performed.

This kind of machining, besides allowing the achievement of a rough surface, provides the considerable advantage of causing a so-called "surface hardening" of the material, namely an increase in superficial hardness that may result even double in respect of the hardness of the original material.

Moreover an increase in the external diameter of the freezing chamber versus the original diameter is also obtained as a function of the characteristics of machining and knurling tools used to perform it. This type of machining, therefore, provides the freezing chamber with a considerable resistance to the mechanical stresses to which it is submitted, which resistance is higher than that of the freezing chambers of known type with walls equally thick.

These and other advantages will become evident from the following description, given by way of illustration and with no limiting purposes, with reference to the accompanying drawings, wherein:

- figure 1 is a side view, partially in section, of a possible embodiment of a freezing drum according to the present invention;
- figure 2 is a side view, partially in section, of another possible embodiment of a freezing drum according to the present invention;
- figure 3 is a schematic view of the profile of a knurling tool;
- figure 4 is a magnified view of a superficial portion of the freezing chamber in the drum of figure 2;
- figure 4A is a sectional view, out of proportions of a portion of the wall of the freezing chamber in figure 4;
- figure 5 is a magnified view of a surface portion of the freezing chamber in the drum of figure 1; and
- figure 5A is a sectional view, out of proportions, of a portion of the wall of the freezing chamber in figure 5.

Figures 1 and 2 show a freezing drum with built-in evaporator comprising an external jacket 1, a freezing chamber 2 housed inside the jacket 1 in coaxial position thereto and a helical path obtained by means of a spiral-shaped strip 3 positioned in the hollow space between the jacket 1 and chamber 2. On the bottom of the latter, a through hole 16 may be provided for the drive shaft of the stirring means (not shown).

The evaporator built-in in the freezing drum is therefore constituted by at least a helical path defined by the internal surface of the jacket 1, by the external surface of the chamber 2 and by the strip 3 kept in tight contact between said surfaces.

It is of course possible to provide a helical groove on the internal surface of the jacket 1 capable of accommodating one of the edges of the strip 3 as in the previous patent application N. MI93A000926 of the same Applicant, but it is possible to provide also two or more helical paths by winding up other strips on the chamber 2.

Preferably, the chamber 2 is made of stainless steel, whereas the jacket 1 and the strip 3 are made of soft iron.

The end portion 5 of the jacket 1 has an axial section having a diameter decreasing down to a value equal or slightly higher than the external diameter of the chamber 2. This allows to seal the hollow space between the jacket 1 and the chamber 2 at its bottom end by means of a continuous welding line 6 between the edge of the portion 5 and the external surface of the chamber 2.

The front end of the hollow space is sealed by an annular flange 7, previously welded on the

chamber 2 along the continuous welding line 8, and by the subsequent welding along the line 9 between the flange 7 and the jacket 1. The strip 3 is fixed, at least at its front end, by means of a welding spot 14 on the annular flange 7.

As an alternative to the represented embodiments, it is also possible to design the front portion of the jacket 1 like the back portion 5 in order to limit the weldings necessary for the realization of the freezing drum.

In any case, on the jacket 1 at least a couple of manifolds 12 and 13 is provided for the inlet and outlet of the thermal exchange fluid, for instance freon, that circulates within the hollow space.

According to an advantageous feature of the invention, the freezing chamber 2 has a rough external surface that can be obtained both by chip removal or by a plastic type machining of the material.

The superficial roughness allows to increase the turbulence of the thermal exchange fluid in the evaporator and increases the surface involved in the thermal exchange between the product contained in the chamber and the fluid circulating in the evaporator.

In figure 1 the superficial roughness of the external surface 10 of the chamber 2 is obtained by a parallel knurling, whose grooves are laid substantially parallel to the axis 15 of chamber 2.

In the embodiment shown in figure 2, the roughness of the external surface 11 of chamber 2 is obtained by a "herringbone" knurling, namely by a double series of grooves slanting between each other.

Knurling, be it parallel or "herringbone", consists in a plastic machining of the material that causes a "superficial hardening" of the treated surface. This provides the surface with a higher hardness, even more than double, in respect to that of the original material and allows to obtain a high resistance to mechanical stresses, to which the freezing chamber 2 is usually submitted, even for limited thicknesses of the wall of the chamber itself.

Furthermore, the improvement in the thermal exchange efficiency through the wall of the freezing chamber 2 compensates the performance loss, though negligible, due to possible blow-by of the fluid of thermal exchange between contiguous sections of the evaporator. In fact, in case a welding line between the strip 3 and the external surface of the freezing chamber 2 is not provided, the roughness of the surface itself jeopardizes the perfect sealing between the contiguous sections of the evaporator. Nevertheless, the amount of fluid not following the helical path, but flowing from a section to the subsequent one through the gaps present between the strip 3 and the external sur-

face of the chamber 2, causes a definitely negligible performance loss if compared to the considerable performance increase due to the superficial roughness.

Figure 3 schematically shows the profile of a knurling tool with the characteristic factors that cause the configuration obtainable on the treated surface. Said factors are in particular the pitch "p" equal to the distance between two consecutive grooves (see also figures 4 and 5) that generally varies as a function of the diameter of the piece to be machined; the notching angle "alpha" ranging between 50 and 90 degrees as a function of the hardness of the material to be treated, more precisely increasing as the material hardness decreases; finally the height "h" depending both on the angle "alpha" and the pitch "p". For example, ratios established by the standardization rules (Tab. UNI 149) foresee that for $\alpha = 90$ degrees h should be $0.5p$, while for $\alpha = 60$ h should be $0.9p$.

Figure 4 shows an enlargement of a portion of the external surface 11 of the freezing chamber 2. This is obtained by means of knurling tools consisting of a couple of washers having helical grooves slanting at respectively opposite directions to an angle beta. The grooves will therefore result to be slanting by an angle beta in respect of the axis of the chamber 2, while they will be slanting between each other by an angle equivalent to 2β . In the example of figure 4 the angle beta is about 30 degrees.

Figure 4A shows a section of the wall of the freezing chamber where, following the knurling machining, the thickness "S" of the original wall (represented by the profile with dashed line) is increased by a certain value "ds" corresponding to the maximum points of the external profile. In particular, there is a ratio between the pitch "p" and the maximum increase of thickness "ds": for herringbone knurling of the hollow type $ds = 0.15p$ approximately, while for herringbone knurling of the raised type $ds = 0.35p$ approximately.

Figures 5 and 5A show examples of parallel knurling such as the one used for the freezing chamber in figure 1. In this embodiment the direction of grooves is substantially parallel to the axis of the chamber 2. The relations existing between "p" and "ds" are the same as those already mentioned for the treatment with herringbone knurling.

Besides the already mentioned advantages, the increase in the external diameter of the chamber 2 contributes to increasing the mechanical resistance of the chamber itself even for relatively limited thicknesses of the original material. The efficiency of the thermal exchange is also enhanced thanks to the increasing extent of the surface lapped by the

fluid of thermal exchange.

The assembling of the freezing drum, after the surface treatment of chamber 2, first of all foresees the arrangement of the metal strip 3 on the external surface of the freezing chamber itself and the fastening of an end of the strip 3 to the external surface of the chamber 2 or, preferably, to the flange 7 by means of a welding spot 14. The strip 3 is then wound up helicoidally onto the surface of chamber 2 as far as its opposite end where it is cut and possibly fixed by means of another welding spot.

The jacket 1 is then thermally enlarged and inserted externally onto the chamber-strip assembly. The subsequent cooling of the jacket 1 allows the free edge of the strip 3 to come in tight contact with the external surface of the chamber 2 and with the internal surface of jacket 1.

The sealing between jacket 1 and chamber 2 in correspondence to their ends is obtained by means of a continuous welding line 9 between the jacket 1 and the flange 7, and a continuous welding line 6 between the end portion 5 of the jacket 1 and the external surface of the chamber 2.

Claims

1. A freezing drum, of the type with built-in evaporator, comprising a substantially cylindrical external jacket made of metal, a cylindrical freezing chamber, of metal as well, having a diameter lower than that of said external jacket and housed inside said jacket in a coaxial position, as well as at least a spiral-shaped path provided in the hollow space between said jacket and said chamber, characterized in that said freezing chamber has a rough external surface.
2. A freezing drum according to claim 1, characterized in that the external surface of said freezing chamber is knurled.
3. A freezing drum according to claim 2, characterized in that said knurling is a parallel knurling.
4. A freezing drum according to claim 2, characterized in that said knurling is a herringbone knurling.
5. A method for the manufacture of a freezing drum with built-in evaporator according to one of claims 1 to 4, characterized in that a machining with chip removal from the external surface of said freezing chamber is carried-out to obtain a rough surface.

6. A method for the manufacture of a freezing drum with built-in evaporator according to one of claims 1 to 4, characterized in that a plastic machining of the external surface of said second tubulal element is carried-out to obtain a rough surface. 5

7. A method according to claim 6, characterized in that said plastic machnining consists of a parallel knurling. 10

8. A method according to claim 6, characterized in that said plastic machining consists of a herringbone knurling. 15

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Fig. 1

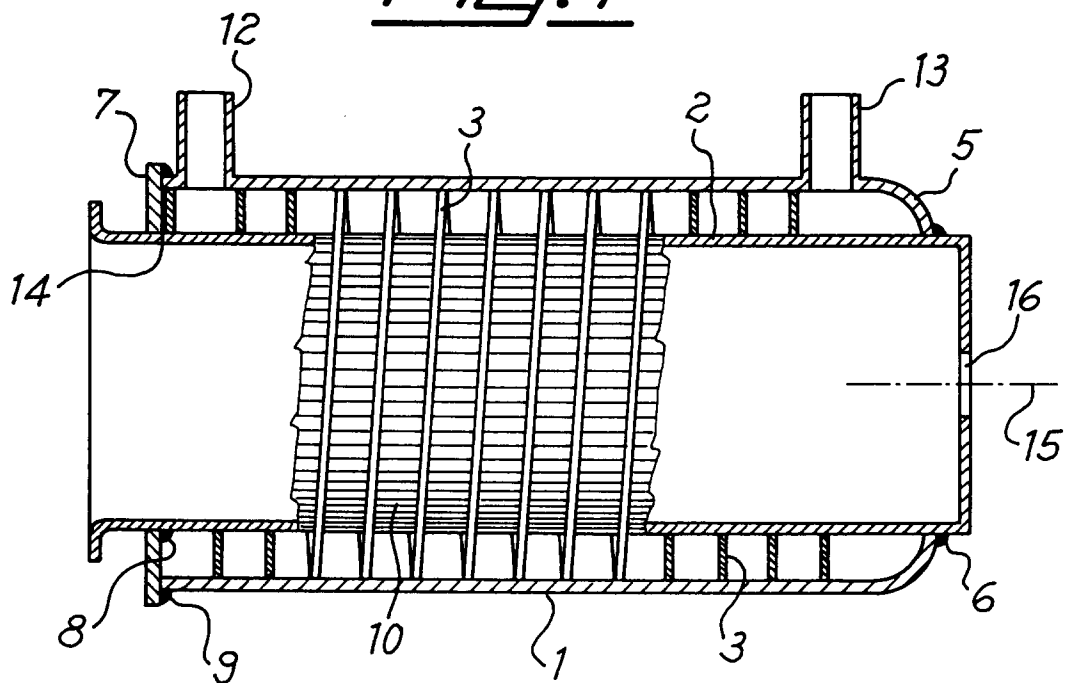


Fig. 2

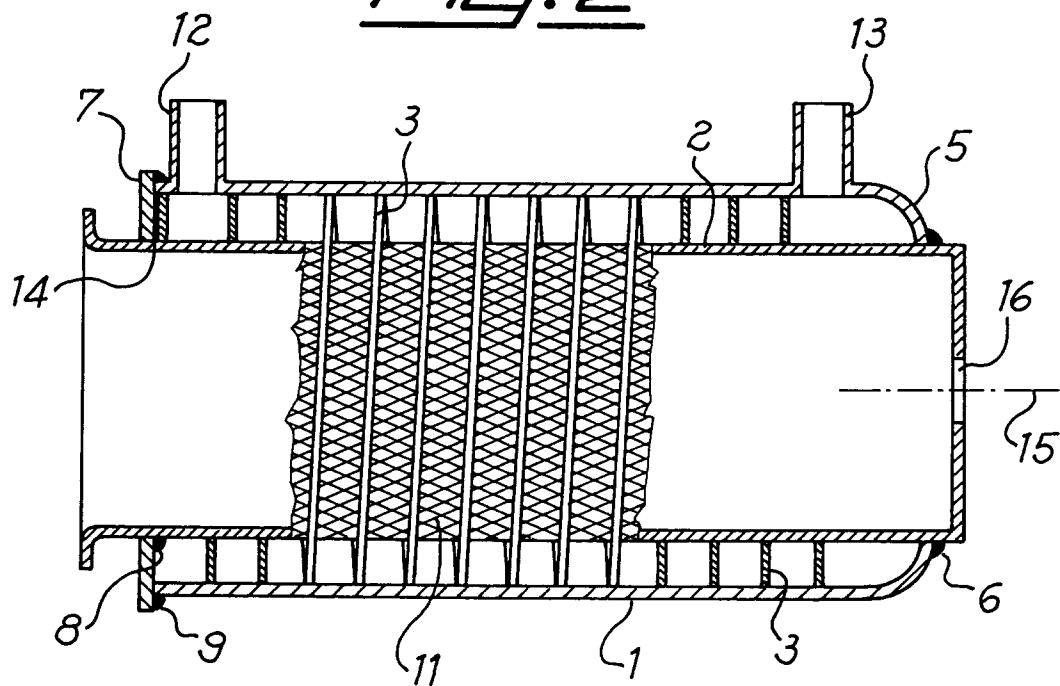


Fig. 3

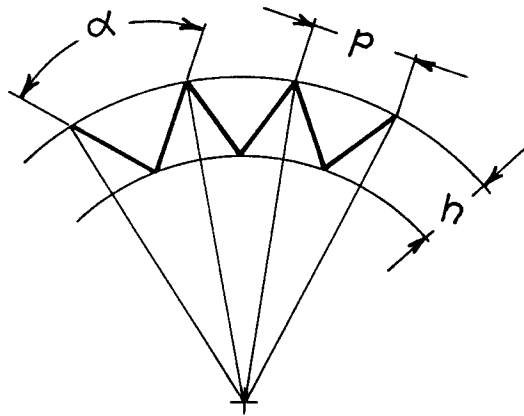


Fig. 4A

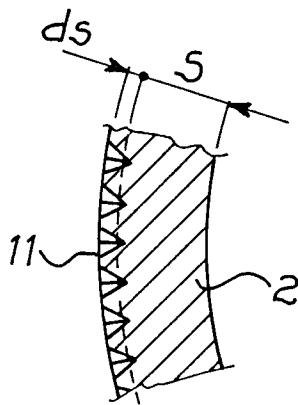


Fig. 4

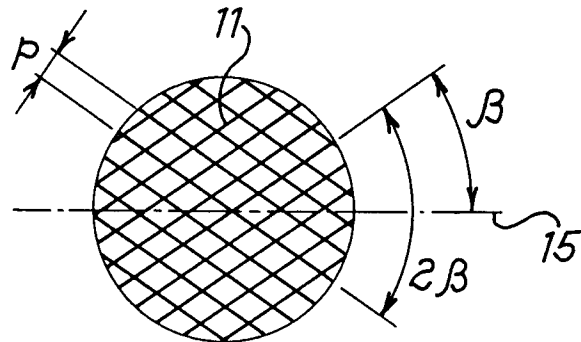


Fig. 5A

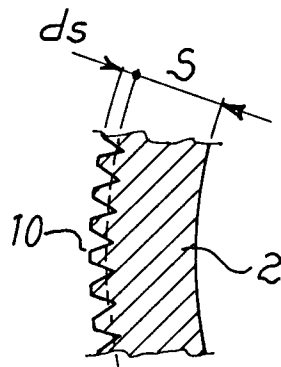
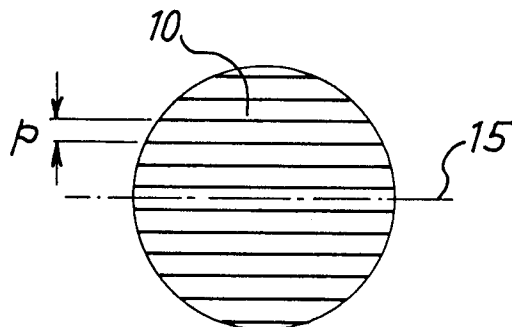


Fig. 5





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EUROPEAN SEARCH REPORT

Application Number
EP 95 10 2633

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	US-A-4 991 407 (ALVAREZ ET AL.) 12 February 1991 * column 4, line 5 - column 6, line 14; figures *	1,2,4	F25C1/14 F25B39/02
Y	---	3,6-8	
Y	US-A-3 893 322 (CAMPBELL ET AL.) 8 July 1975 * column 1, line 60 - column 3, line 28; figures *	3,6-8	
A	---		
A	EP-A-0 108 364 (HITACHI LTD. ET AL.) 16 May 1984 * page 6, line 1 - line 25; figures 1,2 *	5	
A	---		
A	US-A-4 514 900 (BENARD) 7 May 1985 * abstract; figure 11 *	1,2	
A	---		
A	CH-A-303 791 (DOEBELI OSCAR) 16 February 1955 * the whole document *	1,2,4	

The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 20 June 1995	Examiner Eccetto, M
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	