

UNITED STATES PATENT OFFICE.

EMIL PASSBURG, OF BERLIN, GERMANY.

PROCESS OF DRYING SUGAR-LOAVES IN VACUUM.

SPECIFICATION forming part of Letters Patent No. 717,265, dated December 30, 1902.

Application filed January 27, 1902. Serial No. 91,488. (No specimens.)

To all whom it may concern:

Be it known that I, EMIL PASSBURG, a subject of the Emperor of Germany, residing at No. 33 Brückenallee, in the city of Berlin and Empire of Germany, have invented certain new and useful Improvements in Processes of Drying and Cooling Sugar-Loaves in Vacuum to Obviate Cracks in the Same, of which the following is a specification.

The drying of sugar-loaves under vacuum has become known by German Patents Nos. 15,840 and 20,197. Notwithstanding the great advantages which the drying under vacuum possesses with reference to economy of time, space, and cost of labor the above-mentioned methods of drying fine-grained or finely-crystallized sugar-loaves from which the sugar solution used for liquoring has been drawn off by suction or centrifugal power have hitherto found no employment, for the reason that such loaves when quickly dried under vacuum are found to crack, and thereby become unsalable or deteriorated in value. The former methods of drying in vacuum can therefore only be employed to a limited extent—as, for instance, in Russia—for drying coarse crystalline sugar-loaves which are subjected to special treatment by the influence of great heat and in which the sugar solution not being removed by suction or by centrifugal power becomes melted to a compact mass. Sugar-loaves prepared in this especial manner, more especially when the same are dried in their iron molds, can bear or resist the continual action of high temperatures, as also rapid heating and rapid drying under vacuum, without breaking or cracking, while fine-grain sugar-loaves, which for manufacturing reasons are not only, as a rule, dried without their iron molds, but also for the purpose of drawing off the clear or fine liquor (sugar solution) are subjected to suction or centrifugal power, in consequence of which the crystalline structure of the loaves becomes a loose one and very liable to crack. I have made extensive experiments as to the reason of this cracking or splitting of such loaves during the drying and have invented a process by means of which this difficulty may be overcome. I have observed during

the aforesaid experiments that when the loaves are rapidly heated their outer layer or mantle expands to a considerably greater extent, as it becomes heated so much more rapidly than their inner core, that by the different expansion of the various layers of the loaves a separation of such layers takes place already when the loaves are heated in the atmosphere, and the loaves consequently crack. The liability of this cracking is greater in the atmosphere if the loaves after being previously heated are thereupon subjected to a vacuum in a drying apparatus the walls or heating-bodies of which are considerably hotter than the sugar, which by the evaporation or drying under vacuum cools quickly, the outer layer of the sugar-loaf naturally drying more rapidly than the core of the loaf. The heat conducted to the mantle of the loaf from the heated apparatus after the drying of the outer layer of the loaf can no longer be here used for the evaporation of the moisture, on account of which the outer layer of the loaves thus becomes still warmer, while the moist core of the loaf, further cooling through the evaporation, consequently contracts and separates itself from the mantle or outer layer, thereby causing cracks in the same.

For the purpose of overcoming the defects referred to my invention consists of the process hereinafter described of drying sugar-loaves, which comprises the steps of heating the loaves to be dried, permitting the same to cool, and simultaneously with the fall of temperature gradually increasing the rarity of the surrounding medium in proportion to the fall of temperature of the loaf until the latter is cooled throughout.

In the accompanying drawings, Figure 1 is a side elevation of an apparatus for use in carrying on the improved process. Fig. 2 is a vertical section through a sugar-loaf, the core being differently shaded from the mantle or exterior portion for illustration. Fig. 3 is a vertical section, on a smaller scale, through one of the vacuum-chambers shown in Fig. 1. Fig. 4 is a vertical longitudinal section, on a smaller scale, through one of the heating-chambers shown in Fig. 6. Fig. 5 is a top view of the air-pump shown in Fig. 1, and

Fig. 6 is an elevation showing one heating-chamber in front view and an adjacent similar heating-chamber in vertical section.

Similar letters of reference indicate corresponding parts.

The sugar-loaves are heated by hot air in a closed chamber B or in a vacuum drying apparatus A, fitted with steam-pipes or other heating-bodies, similar to the process described in German Patent No. 15,840.

C C are condensers connected each at one side by suitable pipes H, having valves V V, with the cylinder E of one side of the air-pump K for low-vacuum evaporation and at the other side by suitable pipes I, having valves V' V', with the cylinder D of the other side of the air-pump for high-vacuum evaporation. As the cylinder E is connected by pipe S with the valve-chest R of the cylinder D so as to suck behind the same and there produce a partial vacuum, there is produced high vacuum in D upon the working of the air-pump.

The heating-chamber shown in Fig. 6 and also in Fig. 4, possesses only one heating-body, which is located adjacent the bottom of the chamber and formed of parallel tubes Q. This chamber B is only heated, not cooled. The serpentine tubes N of the drying apparatus A shown at the right in Fig. 1 on the contrary, serve interchangeably for either heating or cooling. For heating steam is admitted by turning the valve G from the boiler through the pipe O, the valve Z being closed. The condensed water runs off through pipe X, the valve W being closed, and through the open valve P to the condensed-water waste-pipes. When it is desired to cool by means of the pipes N, the valves P and G are closed, and through the now-opened valve W water is permitted to flow into the tubes N, the water flowing through the opened valve Z into the water-reservoir. T represents the tubes leading from the drying apparatus to the condensers. For the purpose of preventing any current or motion of air in these chambers or apparatus, which would cause the cracking of the sugar, the said chambers must be closed. The duration of the heating depends upon the size of the loaves and occupies from eight to twelve hours if the temperature is from 60° to 75° centigrade. The temperature of the sugar-loaves by that time averages from 50° to 60° centigrade, whereupon the loaves are subjected to a vacuum. For this purpose the vacuum apparatus A, which is fitted with heating and cooling appliances, is heated to about the same temperature as the sugar, although in cases where sugar with a very small percentage of water has to be dried the heating of the vacuum-chamber is scarcely required. After the vacuum apparatus has been heated the steam or other heating medium is shut off before or during the period the valve connecting the apparatus with the air-pump is being opened.

The vacuum is not rapidly created, as heretofore, but in proportion to the gradual cooling of the sugar-loaves caused by the evaporation of the water contained therein. Beginning with a low gradually-increasing vacuum by opening the air-pump valve the highest vacuum is only reached by a corresponding further cooling of the sugar-loaves. As the mantle or outer layer of the loaf dries first and transmits no more heat through evaporation, but still continues cooling, it is necessary also to regulate the cooling of the vacuum drying apparatus in such manner that with the increasing dryness of the sugar-loaves the temperature of the heated drying apparatus is reduced in about the same proportion. If these precautions are not taken, as heretofore—i. e., if the vacuum is quickly reached by fully opening the air-pump valve without regard to the cooling of the drying apparatus having sufficiently progressed—the mantle of the sugar-loaves will naturally remain hot, as it continually receives heat from the drying apparatus, the core cooling through evaporation, and thus causing differences in temperature and thereby cracks in the loaves. The process is therefore regulated by adjusting the degree of the vacuum according to the temperature which the apparatus, and consequently the mantle of the sugar-loaves, attain during their continuous cooling. If, for instance, the apparatus and the loaves are heated at the beginning of the evaporation up to 55° centigrade, the air-pump valve is sufficiently heated to create a vacuum of about six hundred and sixty millimeters column of mercury, at which point the water contained in the sugar boils at about the same temperature. The air-pump valve is subsequently throttled to such extent as to maintain the evaporation at this temperature of about 55° to 50° centigrade, and consequently no greater difference of temperature than 5° can occur. If, for instance, the apparatus and also the mantle of the sugar-loaves cool during the continuation of the process to a temperature of about 50° centigrade, the throttled air-pump valve is opened to a slightly-increased degree to obtain a higher vacuum of about six hundred and ninety to seven hundred millimeters column of mercury, under which water turns into steam at 50° to 45° centigrade. The creation of a gradually-increasing vacuum is consequently obtained by a corresponding regulation of the air-pump valve or any other mechanical appliance in a manner that the boiling-point in such vacuum drops in proportion with the temperature of the mantle of the sugar-loaves until the highest possible vacuum of about seven hundred to seven hundred and fifty millimeters column of mercury is reached, at which point the temperature of the cooling apparatus and the sugar will also have reached 40° to 25° centigrade. According to the finer grain or the smaller or greater hardness or firmness of the sugar-loaves, more

latitude may be allowed to avoid a difference in temperature between drying apparatus and sugar—*i. e.*, in the case of firm and coarse crystalline sugar slightly-larger differences between the temperature of the sides of the apparatus and the sugar-loaves may occur than would be permissible with sugar of finer grain, thus showing a gain by shortening the drying time. In all cases where loaves which have been subjected to suction or centrifugal power are to be dried it is necessary that with the increasing vacuum also the drying apparatus cools in a certain proportion, if this cooling should not previously have taken place to a temperature of the air surrounding the drying plant. Only in the rarest cases the loaves are completely dried after being only once heated and once acted upon by the vacuum, as the preliminary heating may only take place at a medium temperature in consequence of the risk of cracking. Thus in most cases a second drying or finishing or after-drying of the loaves must be resorted to. The loaves, which after the preliminary drying have become entirely cool, must therefore be again warmed and thereupon subjected to the influence of the vacuum to remove the small amount of moisture still remaining in the core of the loaf. These preliminary-dried loaves, which have lost about seventy to ninety per cent. of the water they contain, are peculiarly sensitive to cracking, as a partially-dried loaf cracks more readily upon being heated than a wet one. The subsequent drying must, therefore, be carried out with still greater care than even the preliminary drying. To effect this, the loaves are first, in a similar manner as described with reference to the preliminary drying, heated in the closed heating-chamber B or in the vacuum apparatus A, but at a temperature of only about 50° to 60° centigrade. Hereupon the heating medium to the vacuum apparatus is shut off. The apparatus, as well as the outer layer of the loaves, consequently become cool, either through the outer cooler air or through cooling-water, while the moist core remains warm before the vacuum is produced.

It may appear at the first glance contradictory that the preliminary-dried and cooled loaves be first again warmed and once more cooled to obtain the necessary equalization of the temperature before being subjected to the vacuum. This proceeding is, however, absolutely necessary to avoid cracks and to at once obtain a practical advantage, in view of the fact that if an equalization of the temperature were attempted by the loaves being first heated—for instance, at 35° to 65° centigrade—until the outer and inner layer of the same were uniformly warmed to this temperature so protracted a period would be necessary for this purpose that the improved process would lose the advantage of the accelerated drying over that of the hitherto-em-

ployed drying process in the drying-room and would also become too expensive as regards plant, owing to the larger dimensions of the drying apparatus then required. It is thus requisite to reheat the loaves at a greater heat than that which the moist core of the loaf shall take—*i. e.*, at an air-temperature of 50° to 60° centigrade—that in consequence of the difference in temperature between the heat-carrier—*viz.*, the air—and the object to be heated—that is, the sugar—a certain energy of the heat-carrier is generated by means of which the heat is sufficiently rapidly conveyed to the sugar. In order, therefore, to warm the cooled and still moist core of the preliminary-dried loaf throughout to 35° to 50° centigrade, (at which temperature the same would contain the necessary quantity of heat stored up sufficient for the evaporation of the remaining water,) the mantle or outer layer of the loaf must first be heated to about 50° to 60° centigrade and hereupon the further introduction of heat into the interior of the loaf and at the same time the cooling of the apparatus continued until the heat accumulated in the mantle of the loaf has been to such extent transmitted to the core of the loaf that both the mantle and core become heated to about 35° to 50° centigrade, or in the case of especially sensitive loaves until the cooling of the mantle has so increased that the same is cooler than the core of the loaf before the production of the vacuum. If this transmission of heat from the mantle to the core and the sides of the apparatus does not take place before the vacuum is produced, the mantle of the preliminary-dried loaf will remain warm on account of being dry, while the apparatus is cooling under vacuum that the differences in temperature caused by the cooling of the core caused by evaporation will create cracks. It is therefore necessary that the cooling of the apparatus and also of the mantle of the secondary-heated loaves shall take place some considerable time—say about one to four hours—before the creation of the vacuum. Fig. 2 represents a previously-dried sugar-loaf, of which the portion L indicates the core, which has remained moist, while the part M indicates the dry mantle. On account of the inferior heat-conducting properties of the layers of sugar in the loaf the core is not heated to more than 35° centigrade after the mantle has been heated for about six to nine hours and has reached a temperature of about 45° to 50° centigrade. After the heating-steam has been shut off from the drying apparatus or cooling-water turned on the outer layer of the mantle of the sugar-loaf radiates its heat against the cooled sides of the apparatus, while those parts of the dry and warm mantle nearest the moist core transmit their heat to the latter. Simultaneously with the cooling of the mantle of the sugar-loaf its core receives heat, thus effecting an equalization of temperature within the loaf. Notwithstanding this equalization

of temperature a cracking of the sugar-loaves can still occur if the vacuum be too-quickly created. If it be assumed that in accordance with the hereinbefore-described secondary heating and cooling the moist core of the loaf as well as the mantle possess a comparatively uniform degree of heat of 40° to 45° centigrade and that a vacuum of, for instance, seven hundred and forty millimeters be created in the drying apparatus within a short time, at which the evaporation takes place at 25° centigrade, the core of the loaf will quickly cool to this low temperature, while the mantle of the loaf or the walls of the apparatus cannot give off the heat to the outside so rapidly, in consequence of which differences of temperature are produced which cause a cracking of the loaves. It is therefore also in the case of the further drying of the secondary-heated and cooled sugar-loaves necessary to create the vacuum so slowly by the means before described that the mantle of the loaf is given sufficient time to cool to about a temperature corresponding to that of the core, becoming cooler in consequence of the evaporation in order to retain the equalization of temperature also during the period of evaporation.

The preparation of the previously dried and cooled sugar-loaves for their final drying under vacuum may be regarded as consisting of two operations—first, the secondary heating of the loaves, which requires six to nine hours, and, second, the cooling of the mantle of the secondary-heated loaves for the purpose of an equalization of temperature within the latter, which requires about one to four hours. After the termination of these operations of secondary heating and cooling the vacuum is created by gradually opening the air-pump valve until, together with the required cooling of the apparatus and the loaves, the highest vacuum has been reached. The evacuation is continued until the water from the sugar, which is seen in a jet through the observation-glass of the condenser, ceases to run, after which the drying is finished and the loaves having approximately assumed the tempera-

ture of the air surrounding the apparatus may be at once removed from the latter and papered.

What I claim, and desire to secure by Letters Patent of the United States, is—

1. The process herein described of drying sugar-loaves, which consists in heating the loaf to be dried, permitting the same to cool, and simultaneously with the fall of temperature gradually increasing the rarity of the surrounding medium in proportion to the fall of temperature of the loaf, until the latter is cooled throughout, substantially as set forth.

2. The process herein described of drying sugar-loaves, which consists in heating the loaf to be dried, permitting the same to cool and simultaneously with the fall of temperature gradually increasing the rarity of the surrounding medium in such proportion to the fall of temperature as to maintain an equilibrium of temperature between the drier-mantle and the moist core, until the loaf is entirely cooled, substantially as set forth.

3. The process herein described of drying sugar-loaves, which consists in heating the loaf to be dried, permitting the same to cool, and simultaneously with the fall of temperature gradually increasing the rarity of the surrounding medium in such proportion to the fall of temperature as to maintain an equilibrium of temperature between the drier-mantle and the moist core, reheating the loaf, permitting the same to partially cool, and then gradually increasing the rarity of the surrounding medium in such proportion to the fall of temperature as to maintain an equilibrium of temperature between the dry mantle and the moist core, until the loaf is entirely cooled, substantially as set forth.

In testimony that I claim the foregoing as my invention I have signed my name in presence of two subscribing witnesses.

EMIL PASSBURG.

Witnesses:

ERNST VON NIESSEN,
HENRY HASPER.