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Shore et al.

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[54] **HEAT TREATMENT OF FLOWABLE SOLIDS**

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[73] Assignee: **The A.P.V. Company Limited,** Crawley, Sussex, England

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Related U.S. Application Data

[62] Division of Ser. No. 40,806, May 27, 1970, Pat. No. 3,700,468.

[52] **U.S. Cl.** **99/468,** 21/56, 21/94, 34/182, 99/474, 99/479, 259/85

[51] **Int. Cl.** **A23l 3/22**

[58] **Field of Search** 99/211, 216, 477–479, 99/468, 474; 21/56, 94; 34/122, 181, 182; 259/85; 426/511

[56] **References Cited**

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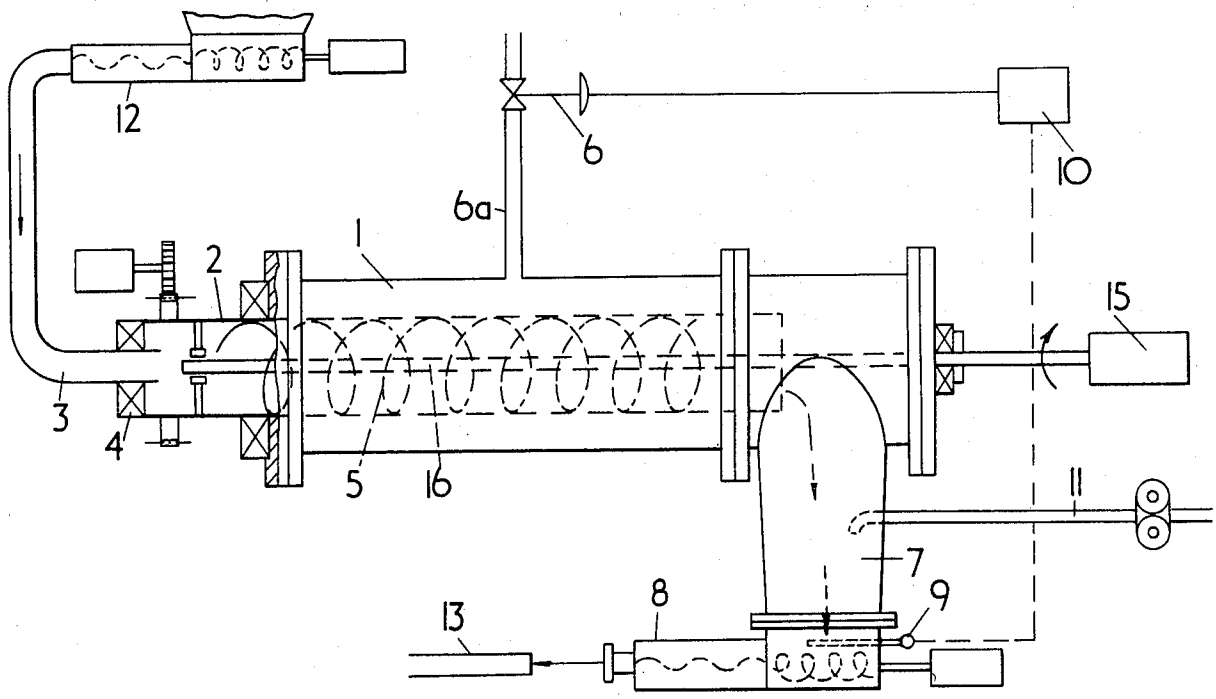
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[57] **ABSTRACT**

The specification discloses a method and apparatus for heat treatment, particularly sterilizing particulate solid material such as meat cubes or beans. The particles of solid material are positively fed by a conveyor, such as a screw conveyor, through a chamber with an atmosphere of steam or other heating gas, and the residence time determined by the positive feeding is such as to ensure that the required treatment in the chamber is completed.

6 Claims, 4 Drawing Figures



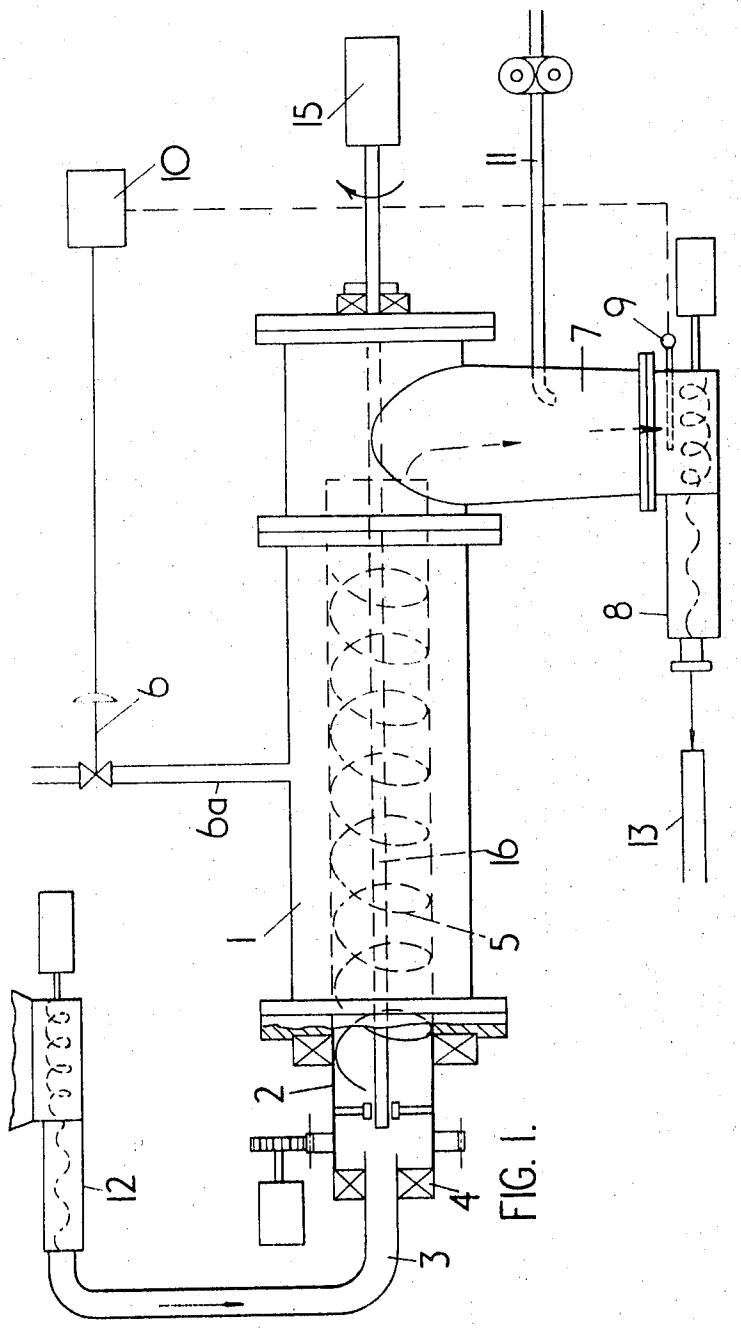


FIG. 1.

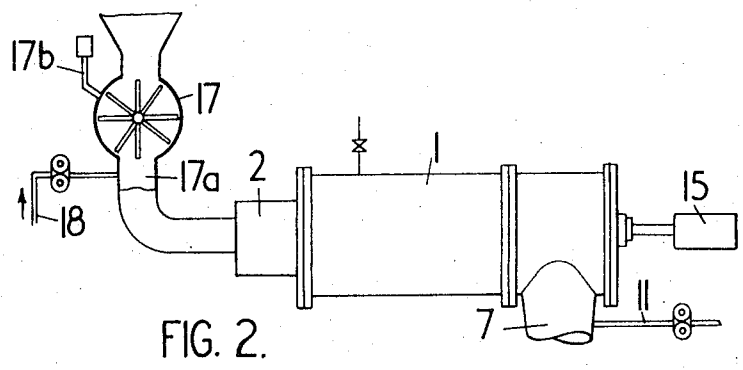


FIG. 2.

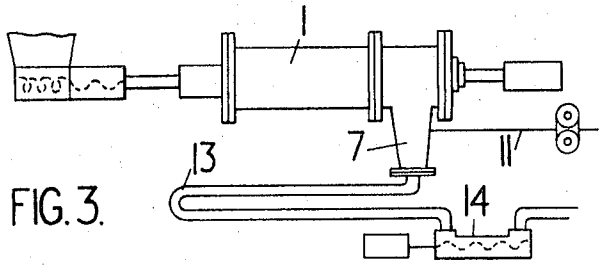


FIG. 3.

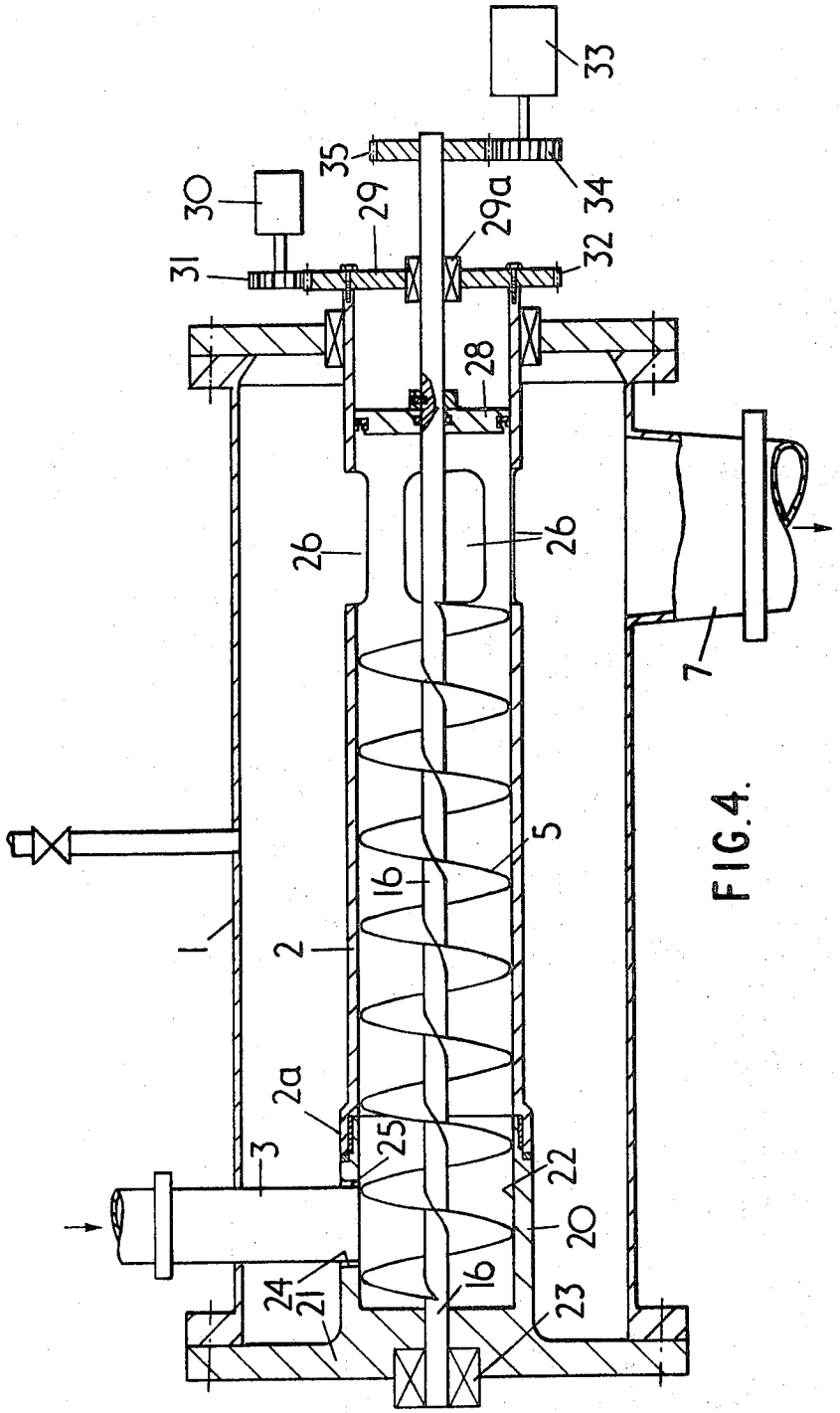


FIG.4.

HEAT TREATMENT OF FLOWABLE SOLIDS

CROSS REFERENCE TO A RELATED APPLICATION

This application is a division of application Ser. No. 40,806 filed May 27, 1970, now U.S. Pat. No. 3,700,468.

This invention relates to the heat treatment of flowable solid materials, with or without a liquid phase, and in particular, but not solely, to the sterilization of particulate food-stuffs.

A primary problem with heat sterilization of solid materials is to ensure that the residence time for all particles is sufficient to ensure that the centres of the largest particles reach sterilization temperature. This must be done with a minimum exposure of the whole mass of particles to the sterilizing medium, usually steam, in order to make the use of heat as economical as possible. High holding efficiency is thus the aim.

One prior proposal for continuous cooking of particulate solids is the use of a stationary outer drum and a rotary conical inner drum, which is internally free from baffles or the like. The inner drum is provided with means for introducing steam or other heating gases. The control of residence time of the particles is apparently by controlling the rotational speed of the inner drum so that the particles do not cascade down the coned surface but progress in an orderly manner. The apparatus is thus not wholly satisfactory for sterilization processes where the residence time needs to be very strictly controlled to ensure that each particle has a substantial residence time so that it could not go through the process unsterilized and therefore act as a focus of subsequent infection of a batch, e.g., a can of meat or beans.

It has also been proposed previously to use screw conveyors to convey meat particles through cooking tanks, but no special precautions apparently were taken to ensure the residence of the particles was standardised. The conveyors apparently operated with large clearances in their tanks, so that there was no question of each particle being positively driven.

The present invention consists in a method of heat treating particulate solid materials, with or without a liquid phase, by mechanically conveying the particles of solid material through an atmosphere, usually of steam, at a sufficient temperature for the heat treatment to be carried out, the particles being conveyed in such manner that their movement is positive and accurately controllable.

The method is preferably used for sterilizing, and a preferred form of conveyor is a generally horizontal screw conveyor which is filled with solid particles only to a level below the axis of the screw.

The rate of flow to the conveyor may be controlled by a pump or, if the particles are liable to be damaged by a pump, a rotary or other metering valve in a gravity feed line.

The invention further consists in apparatus for heat treating particulate solid materials comprising a conveyor arranged to pass the solid material positively through a chamber and means for maintaining an atmosphere of hot gas in the chamber.

The invention will be further described with reference to the accompanying diagrammatic drawings which show preferred embodiments of apparatus according to the invention.

In the drawings:

FIG. **1** is a layout diagram of one form of sterilizing plant constituting a preferred embodiment of the invention;

FIG. **2** illustrates a modification of the plant shown in FIG. **1**;

FIG. **3** shows a further modification of the plant of FIG. **1**, and

FIG. **4** is a more detailed view of a preferred form of a sterilizing plant according to the invention.

FIG. **1** shows a sterilizing plant for sterilizing the solid particles separately from the liquid phase or in conjunction therewith.

A typical arrangement of the system is shown in FIG. **1**. A pressure vessel **1** is suitably equipped to carry an inner rotary perforated cylinder **2**. The solid particles are positively fed into the cylinder **2** by a pump **12** through an entry pipe **3** entering the inner perforated cylinder **2** via a rotary seal **4**. Inside the perforated cylinder **2** is a helical screw **5** which is rotated by a motor unit **15**. The speeds of rotation of the perforated cylinder **2** and the screw **5** are independently adjustable. The screw **5** operates in the cylinder with the minimum practicable clearance.

The screw **5** takes up the particles and transports them along the perforated cylinder **2** during which time they pick up heat from steam entering via an entry pipe **6a** and controlled by a control valve **6**. The particles fall off the end of the perforated cylinder into a discharge hopper **7** and are pumped away into a holding device **13** by a positive pump **8**. A temperature probe **9** in the pump feed hopper measures the outlet temperature of the particles and controls the steam valve **6** by means of temperature controller **10**. The liquid phase can enter with the solids at **3**, in which case some of it filters through the perforated cylinder **2** and runs along the bottom of the vessel **1** to the outlet hopper **7**, becoming heated to sterilizing temperature en route. Alternatively, some or all of the liquid can be pumped in under pressure at **11** in which case it should be preheated beforehand in a heat exchanger or by steam injection to sterilizing temperature. Various devices are in existence to do such a heating duty on liquid media, and need not be considered further here as they form no part of the present invention.

In order to ensure a constant holding time in such a device, the working level must be maintained below the central axial shaft **16** and provided this is the case, the holding time is governed solely by the pitch of the screw **5** and its speed of rotation. It is thus important that the relative speeds of the feed pump **12** and the screw **5** are controlled to maintain a suitable level. The feed pump **12** and the outlet pump **8** serve as pressure seals on the device.

If the solid particles are such that they cannot be pumped without damaging them, (e.g., fruits) then the use of the arrangement shown in FIG. **2** may be a more suitable means of feeding the device. In this case, a rotary metering valve **17** in a gravity feed line **17a** replaces the feed pump **12**, the rate of feeding being governed by the speed of rotation of the valve. The valve acts as a seal to maintain the pressure within the heater. In this arrangement the liquid phase can be either pumped in at a low temperature to mix with the solids below the metering valve at **18** or preheated to steriliz-

ing temperature and pumped in at **11** to mix with the solid before entering the holding tube. The rotary valve **17** is vented at **17***b*. In addition a valve similar to the valve **17** may be used at the outlet in place of the pump **8** in FIG. **1.**

An alternative outlet arrangement shown in FIG. **3** eliminates the pump **8,** the hopper **7** discharging directly into a holding tube **13.** In this case, the pressure in the system is maintained at the outlet by a pressure reducing device, e.g., a positive pump **14** or a valve similar to the valve **17.**

Various means of controlling the process are incorporate. Thus the speed of the rotating devices within pressure vessel **1** can be varied to adjust the holding time to that most suitable for heating various products to sterilization temperature. The temperature controller **10** controls the admission of steam to maintain a constant temperature at the entry of the holding device **13.**

It may be necessary to add viscoelastic agents to promote plug flow in the holding tube. Such materials can be added with the liquid at point **11** or into the hopper before sterilizing.

The device is totally enclosed and can be presterilized by recirculation of pressurized hot water at a suitable temperature, e.g., 20 minutes at 280° F (138° C). Alternatively, steam sterilization can be employed.

Referring now to FIG. **4,** it will be seen that instead of introducing the particles at one end of the cylinder **2,** where immediate take up by the screw **5** might be problematical, an alternative arrangement is provided. The inlet end **2***a* of the cylinder **2** is journalled and thrust supported on a static extension **20** of an end member **21** of the outer pressure vessel **1.** The extension **20** has an internal cavity **22** with the interior of the cylinder **2,** and the screw **5** is extended through the cavity **22,** its shaft being supported in a bearing **23** in the end member **21.** The inlet tube **3** opens into an aperture **24** on the extension **20,** and a clearance **25** around the tube **3** provides some connection between the cavity **22** and the interior of the pressure vessel **1.**

The cylinder **2** is not perforated over most of its length but it provided with large slots **26** adjacent the outlet end of the screw **5,** to act as discharge outlets from which the particles fall by gravity into an outlet **7,** and also to allow ingress of steam from the pressure vessel. A sealing plate **28** is mounted on the shaft **16** to prevent or limit loss of pressure through a bearing **29***a* by which the shaft is supported in an end drive plate **29** of the cylinder **2.**

The cylinder **2** is driven from variable speed motor **30** via a pinion **31** meshing with an external ring gear **32** on the plate **29.** The shaft **16** is driven by a variable speed motor **33** via meshing gears **34** and **35.**

Various modifications may be made within the scope of the invention. Thus the cylinder **2** of FIGS. **1** to **3** need not be perforated over all of its surface, but only sufficiently to allow steam to enter and liquid to leave freely.

Also, the contra-rotation of the inner cylinder **2** and the screw **5** is not always necessary to prevent carrying over of the particles by the screw.

Further, the operation may be controlled without a temperature probe, e.g., solely by maintaining a predetermined steam pressure.

We claim:

1. In apparatus for heat treating particulate solid materials including a pressure vessel and means for maintaining an atmosphere of hot gas in the pressure vessel, means for conveying the solid particles through the pressure vessel comprising a generally horizontally disposed cylinder and a screw conveyor within said cylinder, means for rotating said screw conveyor so as to establish a residence time of the particles passing through the pressure vessel as determined by the speed of rotation of said screw conveyor, means for rotating said cylinder in a direction opposite to the direction of rotation of said screw conveyor whereby both the movement of the particles through the cylinder by the screw conveyor is positively controlled and the residence time of the particles passing through the pressure vessel is accurately controllable by the speed of rotation of said cylinder and said screw conveyor.

2. Apparatus as set forth in claim **1,** in which said conveyor operates with minimal clearance in said cylinder.

3. Apparatus as set forth in claim **1,** wherein said cylinder has a feed end, said apparatus comprising a static chamber forming an extension at the feed end of the cylinder, the screw conveyor extending into the said static chamber, and an inlet line extending through a wall in the static chamber for feeding solid particles into the said static chamber.

4. Apparatus as set forth in claim **1,** including an inlet for emitting heating gas to the pressure vessel to provide the said atmosphere of hot gas, and wherein the cylinder is provided with apertures to allow ingress of the said hot gas to the interior of the cylinder.

5. Apparatus as set forth in claim **4,** having an outlet adjacent one end of the cylinder, in which at least some of the apertures are provided adjacent the outlet end of the screw conveyor and are large enough to allow the particles to pass out of the cylinder to the outlet.

6. Apparatus as set forth in claim **1,** wherein said cylinder is provided with apertures to allow ingress of hot gas to the interior of said cylinder and to allow egress of liquid from the interior of said cylinder.

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