Aug. 11, 1964 L. SIMON 3,144,381

CONTINUOUSLY OPERABLE VERTICAL DIGESTER FOR COOKING PRE-IMPREGNATED FIBROUS RAW MATERIALS

Filed July 11, 1961 2 Sheets-Sheet 1

FIG. 1

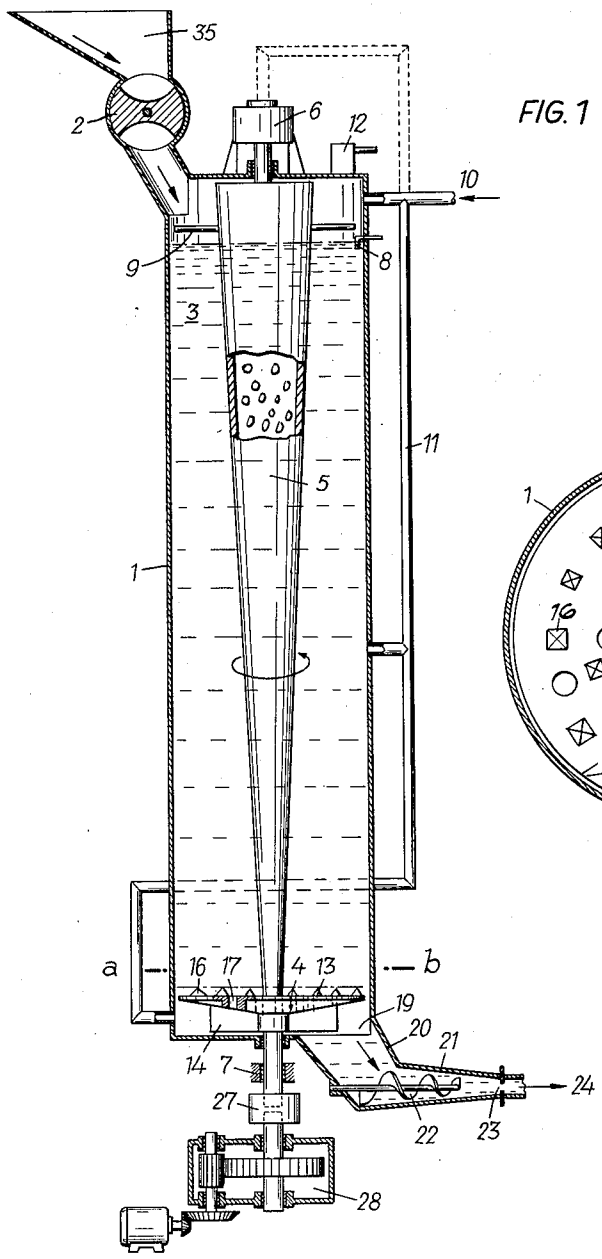
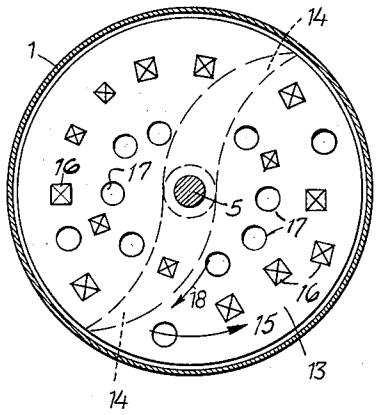


FIG. 2



INVENTOR
LUDWIG SIMON

By Wenderoth, Lind & Ponack

ATTORNEYS

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FIG. 3

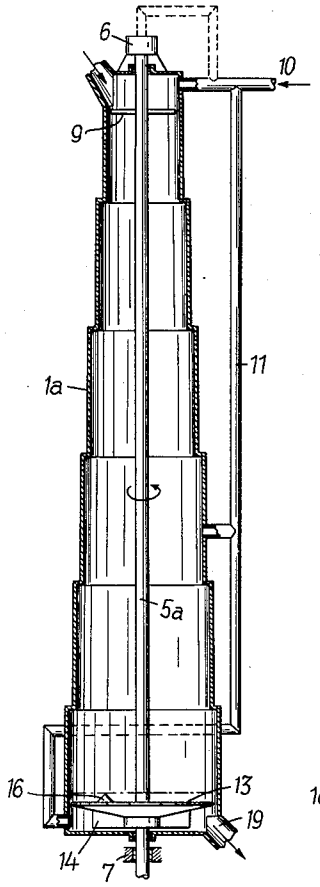


FIG. 4

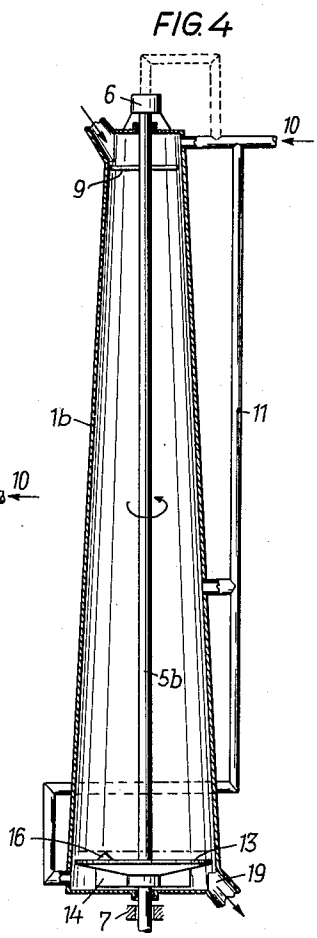
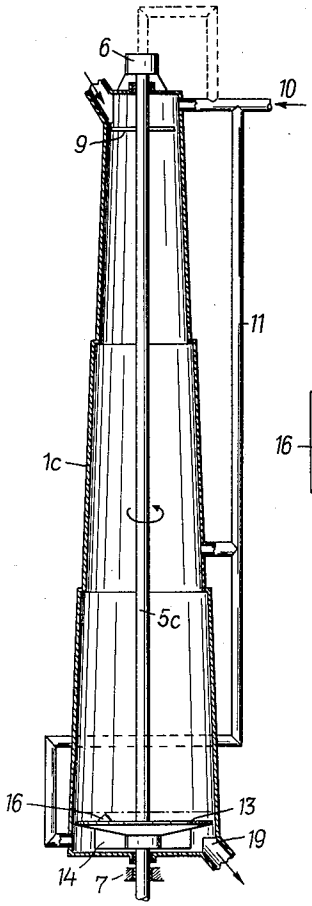


FIG. 5



INVENTOR
LUDWIG SIMON
By Henderoth, Find & Forrack
ATTORNEYS

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CONTINUOUSLY OPERABLE VERTICAL DIGESTER FOR COOKING PRE-IMPREGNATED FIBROUS RAW MATERIALS

Ludwig Simon, St. Polten, Austria, assignor to J. M. Voith Aktiengesellschaft, St. Polten, Austria, a corporation of Austria

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5 Claims. (Cl. 162—237)

This invention relates to a continuously operable vertical digester for cooking pre-impregnated fibrous raw materials for the manufacture of chemical or semi-chemical pulp at temperatures over 100° C. and under pressure.

It is an object of the invention to provide a digester which is suitable for a continuous cooking operation in the vapor phase.

It is desired in industry to increase the productivity of labor and to save raw materials. In long years of research, the semi-chemical process has been developed in the pulp industry in order to reduce the raw materials required in the manufacture of pulp and to reduce also the price of the various products. The next step was the continuous digestion by cooking in the vapor phase, using pre-impregnated raw material. This resulted in a considerable reduction in steam consumption compared to cooking in a liquid phase and in a reduction of labor costs compared to the discontinuous operation. In addition, the cooking temperature was increased above the usual temperature to enable a better utilization of a given digester volume by a reduction of the cooking time. For the same reason, the surplus of digester chemicals has been used with good results.

There is an additional measure which can be adopted to reduce the costs of the manufacture of pulp from pre-impregnated raw materials. This consists in the use of digesters having a large volume.

Several proposals have already been made to achieve this aim. Most digesters of the type mentioned initially hereinbefore are provided adjacent to the bottom with stirrer arms, scrapers, spiral scraper blades or the like for loosening the material and subsequently to effect or facilitate its discharge. A considerable portion of the pulp column rests on these means so that they are under a high pressure load as they rotate together with parts of the pulp column. Some of the digesters designed according to known proposals are hardly suitable for this function. The relatively short shafts used to rotate said means are under compressive stress and it is not possible owing to the high temperature to provide bearings within the digester or the discharge region thereof in order to reduce the buckling stress acting on the shaft.

Vertical digesters have been disclosed which comprise a shaft extending throughout the height of the digester. In addition to other disadvantages inherent in part of these digesters, their main disadvantage resides in the provision of shaft bearings inside the digester. The function and life of these bearings are adversely affected by the existing temperature conditions.

All these difficulties have been eliminated by the invention. As has been mentioned initially hereinbefore, the invention relates to a continuously operable vertical digester for cooking pre-impregnated fibrous raw materials for the manufacture of chemical or semi-chemical woodpulp at temperatures above 100° C. and under pressure, which digester comprises a centrically mounted, driven vertical shaft, a digester bottom having one or more discharge openings which are suitably connected to one or more cylindrical or conical screw-type extruders or the like and/or a disintegrator, which digester is characterized in that the shaft extends throughout the digester vessel

from top to bottom and is mounted in known manner in an axial bearing on the cover of the vessel and guided in a radial bearing below the bottom of the vessel, and that a discharge device carrying the entire pulp column is supported by the shaft next to the digester bottom. In a preferred embodiment, the diameter of the shaft may be larger at the top end than at the bottom end of the digester. The shaft may be hollow and formed with holes, through which the steam introduced into the shaft enters the interior of the digester.

Further advantages and details of the invention will be explained with reference to the accompanying drawings, in which

FIG. 1 is a longitudinal sectional view showing one embodiment of a digester according to the invention.

FIG. 2 is a sectional view taken on line *a*—*b* of FIG. 1.

FIGS. 3, 4 and 5 are diagrammatic views showing modifications.

The drawings and the following specification disclose also features that are not a part of the invention but are required to understand the same and in any case suitable.

The vertical cylindrical digester **1** operates continuously in the vapor phase and serves for cooking pre-impregnated fibrous raw materials for manufacturing chemical or semi-chemical pulp at temperatures over 100° C. and under pressure. The digester may also be used for pre-treating any fibrous raw material.

The material to be cooked is introduced into the digester **1** from a hopper **35**. The weight of the material **3** to be cooked in the digester loads the rotating outlet device **4**, which is secured to a continuous, vertical shaft **5** having a controllable speed. The shaft **5** is supported by an axial bearing (step bearing) **6** carried on the cover of the digester **1**. A lower bearing **7** also disposed outside the digester serves as a guide bearing for the shaft. Owing to this arrangement the continuous vertical shaft **5** is stressed only in tension and torsion rather than in flexion because the load of the discharge device **4** is uniformly divided by the material **3** to be boiled. For this reason the volume of the digester may be large without involving structural difficulties because the digester having a given height may be given an appropriate diameter.

As is known per se, the material **3** to be boiled must slowly descend in the digester **1**. This descent must be uniform in order to ensure a uniform cooking. The discharge device **4** must continuously and uniformly remove the cooked material from the digester. The chips of raw material descend in the digest **1** under the action of the force of gravity, which can act on the material **3** being cooked without hindrance in all cross-sections unless the chips form "bridges." To fulfil this requirement, the available cross-section of the digest **1** must be downwardly enlarged in known manner to provide for a progressive relief of the chips of raw material.

In the embodiment shown in FIGURE 1 this results from the shape of the continuous vertical shaft **5**, the the diameter of which at the top end of the digester **1** is larger than at the lower end of the digester at the outlet device **4**.

The digester is provided with a device **8** of any known type for indicating the level of the material to be cooked. It is also suitable to provide the continuous vertical shaft **5** at its top end with stirring arms **9** for leveling the material **3** to be cooked.

Steam at more than 100–200° C. is introduced through the steam supply conduit **10** into the digester **1** to heat the material to be cooked. A steam pipe **11** is connected to the digester approximately in the middle and also below the outlet device **4**, e.g. by means of a ring conduit provided with a plurality of supply connections, in order to equalize the steam pressure in the digester. An

automatic device **12** is provided to eliminate air and gasses from the digester **1**.

If, in accordance with the invention, the shaft **5** is hollow and provided with holes, steam can be supplied also from the top by means of the conduit indicated with dash-and-dot lines.

The rotating outlet device **4** driven by the shaft **5** at, e.g. 20–30 revolutions per minute, consists of a disc **13** having approximately the same diameter as the bottom of the digester, and two or more stirring arms **14** which are disposed below the disc **13** and curved opposite to the direction of rotation **15**. The stirring arms **14** are rigidly secured to the underside of the disc **13**. Pegs or pins **16** in the form of pyramids, cones, prisms, cylinders or the like are secured to the top face of the disc **13**. The disc **13** is also formed with through holes **17**. During the rotation of the outlet device **4**, the pins **16** mix the cooked chips of the raw material.

At the same time, these chips are comminuted to some extent at the cooking temperature because the weight of the material **3** being cooked presses the cooked material onto the disc **13**. Owing to the friction between the chips and between the chips and the digester wall the material being cooked cannot rotate in synchronism with the disc **13**. Owing to the pressure exerted by the material **3** being cooked on the top face of the disc **13** and owing to the force of gravity, the cooked and comminuted raw material falls through the holes **17** into the space between the disc and the digester bottom, in which space the stirrer arms **14** rotate in the direction **15**. They are preferably curved opposite to the direction of rotation. Owing to the shape of the stirrer arms **14**, the material is urged outwardly towards the discharge opening **19** in the direction of the arrow **18** and flows through a discharge conduit **20** into a conical or cylindrical screw-type extruder **21**, which is radially or tangentially disposed.

The rotating screw **22**, which is driven, e.g. by an electric motor having a controllable speed, compresses the material and feeds it to the adjustable discharge opening **23**, through which it is extruded from the extruder **21**. The material is blown out in the direction of the arrow **24** by means of steam.

The shaft **5** is connected by a clutch **27** to a stub shaft of the transmission **28**, which is driven by an additional electric motor.

FIG. 3 shows another design of the digester providing for a relief of the chips of the raw material in the digester. To this end, the digester **1***a* is assembled from a plurality of relatively short cylindrical parts. The diameter of each part is larger than that of the part preceding in the direction of flow. This digester provides for a stepwise enlargement of the free cross-section of the digester.

FIG. 4 shows another form of the digester **1***b*, which has the shape of an upright cone providing for a continuous increase of the free cross-section of the digester from top to bottom to afford a progressive relief of the chips of the raw material.

FIG. 5 shows a digester in which features of the digesters of FIGS. 3 and 4 are combined. This digester **1***c* consists of a plurality of conical parts and the top diameter of each part is larger than the bottom diameter of the part preceding in the direction of flow. This provides for an increase of the free cross-section of the digester in the downward direction and for a stepwise and continuous relief of the raw material.

According to the invention the digester may have a conical shaft **5** (FIG. 1) or a cylindrical shaft **5***a* (FIG. 3), **5***b* (FIG. 4) or **5***c* (FIG. 5). This conical or cylindrical shaft is desirably provided with a plurality of projections, pins or the like, which extend substantially at right angles to the shaft and prevent a formation of bridges by the material being cooked.

The invention provides an arrangement of the shaft and of the discharge device carried thereby in which the shaft is stressed only in tension and possibly in torsion

and the bearings disposed outside the digester are exposed only to the environmental temperature and are easily accessible for maintenance. As contrasted with known designs, the features of the invention enable the construction of reliable digesters having a large volume without involving design difficulties.

What is claimed is:

1. A vertical digester for the continuous cooking of preimpregnated fibrous raw materials in the manufacture of pulp at temperatures above 100° C. and under pressure, comprising a digester vessel adapted to contain a pulp column and having a top and a bottom, said bottom having at least one outlet, a vertical shaft coaxially disposed in and extending throughout said digester vessel and through the top and bottom thereof, an axial thrust bearing for said shaft located above said top, a radial bearing for said shaft disposed below said bottom, drive means for rotating said shaft in said axial and radial bearings, a discharge device fixed to and carried by said shaft above and adjacent to said bottom, said discharge device comprising a disc secured to said shaft having perforations as well as projections provided on its top face and having approximately the same diameter as the digester bottom, and at least two stirrer arms rigidly secured to said disc on the underside thereof and serving for pushing the digested chips collected at the bottom of the vessel radially outwards.

2. A digester as set forth in claim 1 wherein the diameter of said shaft is larger at the top than at the bottom of said digester vessel.

3. A digester as set forth in claim 1 wherein said shaft is hollow and provided with holes so that steam can pass through said holes into the interior of said digester vessel.

4. A vertical digester for the continuous cooking of preimpregnated fibrous raw materials in the manufacture of pulp at temperatures above 100° C. and under pressure, comprising a digester vessel adapted to contain a pulp column and having a top and a bottom, said bottom having at least one outlet, a vertical shaft coaxially disposed in and extending throughout said digester vessel and through the top and bottom thereof, an axial thrust bearing for said shaft located above said top, a radial bearing for said shaft disposed below said bottom, drive means for rotating said shaft in said axial and radial bearings, a discharge device fixed to and carried by said shaft above and adjacent to said bottom and the diameter of said shaft being larger at the top than at the bottom of said digester vessel.

5. A vertical digester for the continuous cooking of preimpregnated fibrous raw materials in the manufacture of pulp at temperatures above 100° C. and under pressure, comprising a digester vessel adapted to contain a pulp column and having a top and a bottom, said bottom having at least one outlet, a vertical shaft coaxially disposed in and extending throughout said digester vessel and through the top and bottom thereof, an axial thrust bearing for said shaft located above said top, a radial bearing for said shaft disposed below said bottom, drive means for rotating said shaft in said axial and radial bearings, a discharge device fixed to and carried by said shaft above and adjacent to said bottom, said shaft being hollow and provided with holes so that steam can pass through said holes into the interior of said digester vessel.

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