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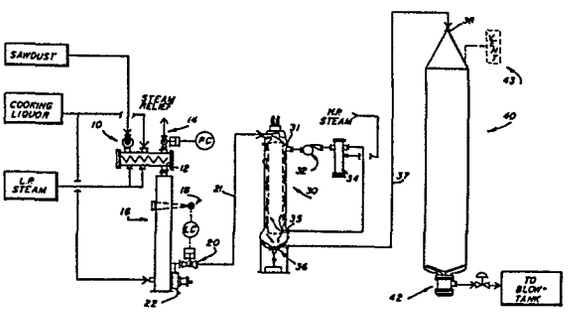
## (54) Sawdust pumping, and processing.

(57) A method and apparatus are provided for effecting treatment of sawdust to produce paper pulp in a simplified and efficient manner. The sawdust is entrained with liquid so that it forms a slurry having a consistency of between about 10-25%, and preferably between about 15-22% solids. The slurry consistency is maintained generally constant throughout the treatment process. The slurry at that consistency is pumped by a fluidizing, high speed, degassing, centrifugal pump (22). The pumping action alone provides for transport of the slurry to a digester vessel (40, 46). The digester vessel may be an upflow vessel, a hydraulically filled downflow vessel (40), or a superatmospheric vapor phase downflow vessel (40). Kraft pulping may be practiced in the digester, or a sulfite process may be practiced in the digester (46) and the slurry then passed to a refiner to produce a mechanical pulp. Between the pump and the digester the slurry passes through a heating device (30), which may comprise a fluidizing mixer for directly introducing high pressure steam into the slurry, or a pressure diffuser (30) for effecting indirect heating of the slurry.

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# SAWDUST PUMPING AND PROCESSING

## BACKGROUND AND SUMMARY OF THE INVENTION

There are many areas throughout the world where a substantial volume of sawdust and like cellulosic residues are available for the production of paper pulp. While such raw material can effectively be utilized to produce paper pulp employing existing technology, the existing technology is expensive, troublesome, and has very little flexibility. For instance, a typical treatment system utilizable for producing chemical pulp from sawdust is illustrated in U.S. Patent 3,475,271, and a commercial version thereof is shown in a brochure entitled "Kamyr Sawdust Systems Pass the 500,000 Tons Per Year Mark". Such systems include an expensive vapor phase feeder, and maintain a substantially atmospheric vapor phase at the top of the digester vessel.

According to the present invention, a method and apparatus are provided that eliminate the vapor phase feeder utilized in conventional sawdust treatment systems, thereby lowering maintenance problems, and providing a number of treatment options. According to the present invention, sawdust may be treated in an upflow digester, or may be treated in a hydraulically filled downflow digester, or may be treated in a downflow digester having a superatmospheric vapor phase. This provides for greater thermal stability, which may be very desirable in many situations.

The term "sawdust" as used in the present specification and claims means sawdust and like cellulosic materials, including wood residues, which

are fine enough to react like small particles during handling. This may be contrasted with the way that large comminuted cellulosic particles - such as wood chips - react during handling.

A key to the sawdust treatment process according to the present invention is the unexpected discovery that it is possible to pump sawdust slurries having a consistency high enough to effect practical chemical treatment thereof. That is, according to the present invention it has been found that it is possible to pump sawdust slurries having a solids consistency of between about 10-25%, and more desirably between about 15-22%. Pumping can be accomplished utilizing commercially available fluidizing, high speed, degassing, centrifugal pumps and related systems such as shown in U.S. Patents 4,435,193 and 4,410,337, and sold commercially by Kamyr, Inc. of Glens Falls, New York, and Kamyr AB of Karlstad, Sweden, under the trademark "MC" pump. The discovery that it is possible to pump medium consistency (e.g. 10-25%) sawdust slurries is surprising since the fine particles tend to act as a solid, as opposed to the situation with pulp or the like wherein the material is more flexible. Further sawdust slurries do not filter well, and a sawdust slurry with a consistency of as little as 10% solids is virtually a semi-solid.

According to the method of the present invention, sawdust is treated by: mixing the sawdust with a liquid to produce a slurry having a solids consistency of between about 10-25% (preferably about 15-22%); and pumping the slurry, without dilution, to a treatment stage to ultimately produce pulp. At the treatment stage, the slurry is heated (either indirectly, or by direct mixing of high

pressure steam with the slurry - as by utilizing a fluidizing mixer), the slurry is introduced into the vertical vessel, chemical treatment of the slurry within the vessel is practiced, and the slurry is discharged from the vessel. Preferably the vessel is an upflow vessel and the slurry is pumped, without dilution, and under the influence of the fluidizing, high speed, centrifugal pump, up through the vessel. Alternatively, the vessel may be a downflow vessel, either a hydraulically filled vessel or one having a superatmospheric vapor phase.

The chemical treatment in the vessel facilitates breaking down, or effects breaking down, of the lignin in the sawdust. For instance, a sulfite treatment can be provided in the vessel, with the slurry discharged from the vessel then being passed to a refiner to produce a mechanical pulp. Alternatively, the slurry may be subjected to Kraft processing in the vessel, resulting in the production of Kraft pulp. Irrespective of the treatment process, the mixing of the sawdust with liquid is preferably practiced by mixing the sawdust with low pressure steam and a treatment liquid, and then feeding it into a vertical chute, and pumping the slurry from the bottom of the chute. The slurry maintains substantially the same consistency (i.e. a consistency between about 10-25%) without phase separation (solid/liquid) throughout all the treatment procedures.

The apparatus according to the invention comprises: a means for entraining the sawdust in a liquid; a fluidizing, high speed, centrifugal pump such as disclosed in said patents 4,435,193 and 4,410,337; a vertical digester; a conduit between the pump and the digester; and a direct or indirect

heating means for heating the slurry before introduction into the digester. The interconnection between the pump and the digester consists of the conduit, a valve means in the conduit, and the heating means, the force provided by the pump ultimately effecting passage of the slurry through the digester.

It is the primary object of the present invention to provide for the effective, simple, and versatile treatment of sawdust to produce pulp. This and other objects of the invention will become clear from an inspection of the detailed description of the invention, and from the appended claims.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIGURE 1 is a diagrammatic view of exemplary apparatus according to the present invention, for practicing an exemplary method according to the invention;

FIGURE 2 is a diagrammatic view of a second embodiment of apparatus according to the present invention; and

FIGURE 3 is a partial, diagrammatic view, showing a third embodiment of exemplary apparatus according to the present invention.

## DETAILED DESCRIPTION OF THE DRAWINGS

FIGURE 1 illustrates a component for a preferred embodiment of an apparatus according to the present invention, for effecting the production of Kraft pulp. The apparatus in this embodiment

comprises a conventional low pressure feeder 10 mounted atop a conventional horizontal steaming vessel 12 (also known as a steam mixer, having a horizontal axis mixing screw therein), having a steam relief pressure controlled vent 14. Sawdust is fed from a source to the feeder 10, and is introduced into the vessel 12 wherein it is entrained in liquid to produce a slurry. The liquid may comprise white liquor from a Kraft process, and additionally low pressure steam is introduced into the vessel 12. The slurry discharged from the vessel 12 is preferably discharged into a vertical chute 16, although it may instead be fed to a conduit connected directly to the pump to be hereinafter described. In the chute 16, a liquid level is maintained utilizing a conventional gamma level indicator 18, which controls a valve means 20 in a conduit 21 leading from the bottom of the chute 16. A liquid, such as white liquor, is preferably introduced into the chute 16.

The structures 10, 12, 14 and 16 comprise means for entraining the sawdust in liquid, to produce a slurry having a solids consistency of between about 10-25% (and preferably between about 15-22%). The slurry has that consistency at the bottom of the chute 16, where the pump 22 is located.

The pump 22 is shown only schematically in FIGURE 1, but in addition to pumping components thereof it will have degassing components, as shown in U.S. Patents 4,435,193 and 4,410,337, the disclosures of which are hereby incorporated by reference herein. The pump 22 comprises a fluidizing, high speed, degassing, centrifugal pump. Typically, the impeller thereof is rotated at

2000-3400 rpm in order to effect fluidization of the slurry. Such a pump 22 is commercially available from Kamyr, Inc. of Glens Falls, New York and Kamyr AB of Karlstad, Sweden, under the trademark "MC" pump.

Operatively connected to the conduit 21 is a heating means 24 and a vertical vessel 26. The heating means 24 in the embodiment illustrated in FIGURE 1 comprises a mixer for directly mixing high pressure steam into the slurry. Various forms such a mixer may take are shown in Canadian Patent 1,102,604, such a mixer comprising a fluidizing mixer. A typical mixer that may be utilized for the heating means 24 is sold by Kamyr, Inc. and Kamyr AB under the trademark "MC" mixer.

The vessel 26 comprises a continuous digester, and in the embodiment illustrated in FIGURE 1 is an upflow vessel having a conventional discharge mechanism 28 at the top thereof. In the vessel 26 chemical treatment of the slurry may be practiced. A Kraft delignification process is practiced in the vessel 26, white liquid - introduced during slurrying of the sawdust - providing an active alkali charge which conventionally will be in the range of 9-24% Na20 on bone dry raw material. The heating means 24 brings the slurry up to optimum cooking temperature normally in the range of 140-175°C. The pump 22 brings the slurry up to normal treatment pressure, which is typically 600-1200 kPa, and the slurry is maintained at that pressure, and is maintained in the digester 26 for a time period of about 30-130 minutes. These values are merely exemplary values, and they may vary somewhat depending upon the nature of the sawdust and the particular subsequent

treatment steps to be applied to the pulp, and the ultimate pulp to be produced.

The embodiment illustrated in FIGURE 2 is substantially identical to that illustrated in FIGURE 1 except that heating of the slurry to optimum cooking temperature is accomplished utilizing an indirect heating means 30, and the digester 40 comprises a downflow digester.

The vertical vessel 30 connected to the pump 22 by the conduit 21 preferably comprises an indirect heating vessel with a movable screen, such as shown in U.S. Patent 4,368,628. In such an indirect heating vessel with a movable screen, the slurry is maintained, without dilution, at substantially the same pressure as it had when discharged from the pump 22. Liquid is withdrawn from the vessel 30 by the pump 32, passes through steam heater 34, and is recirculated back to the vessel to be introduced at inlet 35. Thus, the slurry is indirectly heated as it passes through the vessel 30 and the amount of liquid withdrawn at 31 is substantially the same as the amount of liquid introduced at 35, so that the consistency of the slurry is not significantly changed during heating utilizing vessel 30. The slurry is discharged from conventional discharge mechanism 36 and passes through conduit 37 to be introduced at the top 38 of the downflow digester 40. Pulp as it is produced is discharged from the bottom of the vessel 40 utilizing a conventional discharge mechanism 42.

According to the present invention, there is a good deal of versatility in the operation of the downflow digester 40. Preferably the downflow digester 40 will be hydraulically filled. Alternatively, it may have a superatmospheric vapor

phase at the top thereof, and noncondensable gases may be vented - in this instance - utilizing vent 43. In either case, the thermal stability of the process is greatly enhanced compared to the substantially atmospheric digester utilized in commercial prior art practices.

The apparatus utilized in FIGURES 1 and 2 is primarily useful for the production of chemical pulp. The apparatus of FIGURE 3 is utilized for the production of mechanical pulp, particularly chemi-mechanical pulp (CMP), or chemithermomechanical (CTMP) pulp. In this embodiment, the chemical treatment vessel 46 is much smaller than the vessels 26, 40, since complete delignification does not take place in the vessel. Typically, sulfite is added to the slurry in the vessel 46 (for example by entraining the sawdust with sulfite in the mixing means), and the slurry when discharged from the vessel 46 in discharge line 47 passes to a conventional refiner 48. The mechanical pulp produced is discharged into line 49.

Typically, sodium sulfite at pH 9-10 is the mild pretreatment liquid in the vessel 46, and the temperature therein is at about 130-170°C. However, in some situations, no chemical need be added at all, but rather merely by heating of the slurry with high pressure steam (as in fluidizing mixer 24) to about 110-150°C, fibrilization in refiner 48 will be facilitated, producing thermomechanical pulp (TMP).

According to the method of the present invention, sawdust is treated by mixing the sawdust with a liquid (in steam mixer 12 and chute 16) to produce a slurry having a solids consistency of between about 10-25%, and preferably between about 15-22%; and pumping the slurry, utilizing

fluidizing, high speed, centrifugal pump 22, without dilution, to a treatment stage to ultimately produce pulp. At the treatment stage, the slurry is heated to optimum temperature, and introduced into a treatment vessel. Heating may be accomplished directly - as by mixing high pressure steam directly into the slurry utilizing steam mixer 24 - or indirectly, as by utilizing pressure diffuser 30.

In the treatment vessel, some chemical treatment of the slurry is practiced. The chemical treatment merely facilitates breaking down of the lignin in the sawdust where a mechanical pulp is ultimately to be produced. If a Kraft pulp is ultimately to be produced, in the vessel the chemical treatment breaks down the lignin in the sawdust. The pulp is ultimately discharged from the vessel, whether it be vessel 26, 40 or 46. The chemical treatment takes place during upflow, or hydraulically filled downflow.

Treatment in the vessel 46 may be a sulfite treatment, with the discharge pulp ultimately be refined in refiner 48. Treatment in the vessels 26, 40 is a Kraft treatment, with the Kraft pulp ultimately being produced.

It will thus be seen that according to the present invention a simple, effective, and versatile method and apparatus have been provided for the treatment of sawdust to produce pulp. According to the invention, the vapor phase feeder, and maintenance and cost disadvantages associated therewith, has been eliminated at the same time that versatility of the system has been enhanced.

While the invention has been herein shown and described in what is presently conceived to be

the most practical and preferred embodiment thereof, it will be apparent to those of ordinary skill in the art that many modifications may be made thereof within the scope of the invention, which scope is to be accorded the broadest interpretation of the appended claims so as to encompass all equivalent methods and devices.

**WHAT IS CLAIMED IS:**

1. Apparatus for producing pulp from sawdust comprising: means for entraining sawdust in liquid to produce a slurry; a pump; a digester for effecting chemical treatment of slurry therewithin to facilitate breakdown of, or to effect breakdown of, the lignin in the sawdust; a conduit interconnecting said pump and said said digester, said conduit having valve means disposed therein; and means disposed in said conduit for effecting heating of the slurry pumped from the pump to the digester, for optimum treatment of the slurry in the digester; characterized in that: said pump comprises a fluidizing, high speed, degassing, centrifugal pump operatively connected to said means for entraining sawdust in liquid to effect pumping of the sawdust slurry; and

said pump is connected through said conduit and said heating means to said digester so that said pump provides the motive force for moving the slurry through the digester, and the interconnection between said pump and said digester consists of only said conduit, said valve means, and said heating means.

2. Apparatus as recited in claim 1 further characterized in that said digester comprises an upflow digester having an inlet at the bottom thereof, and a discharge at the top thereof, and wherein said conduit and said pump are interconnected to said inlet at the bottom of said digester.

3. Apparatus as recited in claim 1 further characterized in that said digester comprises a downflow, hydraulically filled vessel, having an inlet at the top thereof and a discharge at the bottom thereof, and wherein said conduit and said pump are connected to said inlet at the top of said digester.

4. Apparatus as recited in claim 1 further characterized in that said digester comprises a sulfite digester, and wherein said apparatus further comprises a refiner operatively connected to the discharge from said digester.

5. Apparatus as recited in claim 1 further characterized in that said means for entraining the sawdust in liquid consists of: a horizontal steam mixer; a low pressure feeder through which sawdust is fed to said horizontal steam mixer; means for introducing liquid and low pressure steam into said horizontal steam mixer; a vertically extending chute extending downwardly from the discharge from said steam mixer; and means for introducing liquid into said vertical chute; and further characterized in that said fluidizing, high speed, degassing, centrifugal pump is operatively connected to a bottom portion of said chute.

6. A method of treating sawdust by mixing the sawdust with a liquid to produce a slurry having a solids consistency of between about 10-25%; and characterized by:

pumping the slurry, without dilution, to a treatment stage to ultimately effect production of pulp.

7. A method as recited in claim 6 further characterized in that at said treatment stage the following steps are practiced: (i) heating the slurry to an optimum processing temperature; (ii) introducing the heated slurry into a continuous treatment vessel as a result of said pumping; (iii) effecting chemical treatment of the slurry in the vessel to facilitate the breaking down, or to effect the breaking down, of the lignin in the sawdust; and(iv) discharging the treated slurry from the vessel.

8. A method as recited in claim 7 further characterized in that step (ii) is practiced by introducing the slurry into the bottom of an upflow vessel, the slurry flowing upwardly in the vessel under the influence of said pumping; and step (iv) is practiced by discharging treated slurry from the top of the vessel; and step (i) is practiced by passing the slurry to an indirect heating vessel, introducing heated liquid under pressure into the indirect heating vessel, removing a volume of liquid generally commensurate with the volume of heated liquid introduced, from the vessel, and heating the removed liquid and circulating it to provide heated introduction liquid; and step (ii) is practiced by passing the heated slurry from the discharge of the indirect heating vessel to the inlet to the treatment vessel.

9. A method as recited in claim 7 further characterized in that the vessel is a vertical downflow vessel, having a vapor pressure maintained at the top which is significantly greater than atmosphere pressure; and further characterized in

that step (ii) is practiced by feeding the slurry directly to the top of the vessel under the influence of said pumping, and step (iv) is practiced by discharging from the bottom of the vessel.

10. A method as recited in claim 9 further characterized in that step (iii) is practiced by effecting a sulfite treatment thereof, and the method is further characterized by the step (v) of passing the slurry discharged from the vessel to a refining stage, and effecting refining of the sawdust slurry to produce mechanical pulp.

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Fig. 1

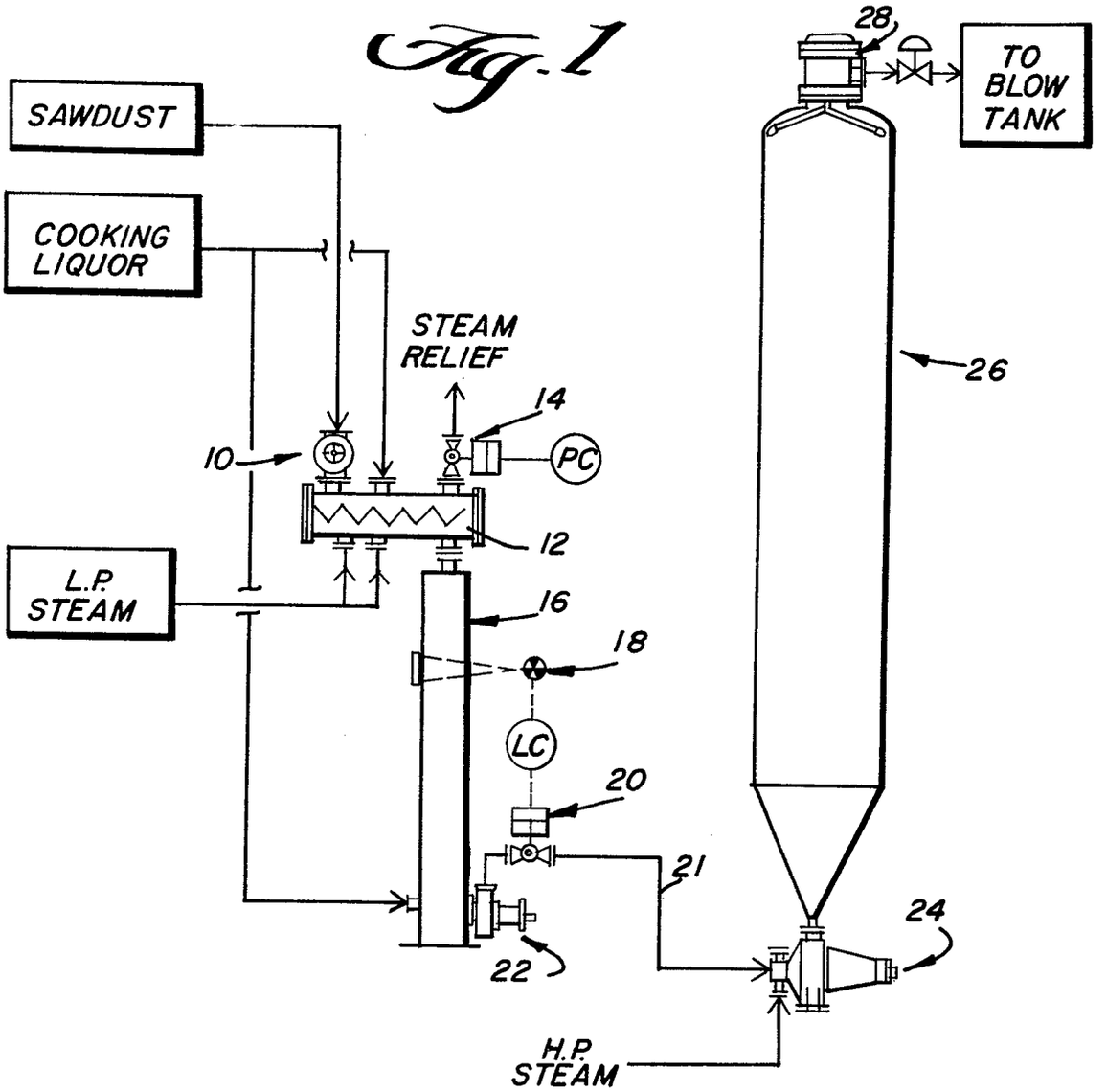
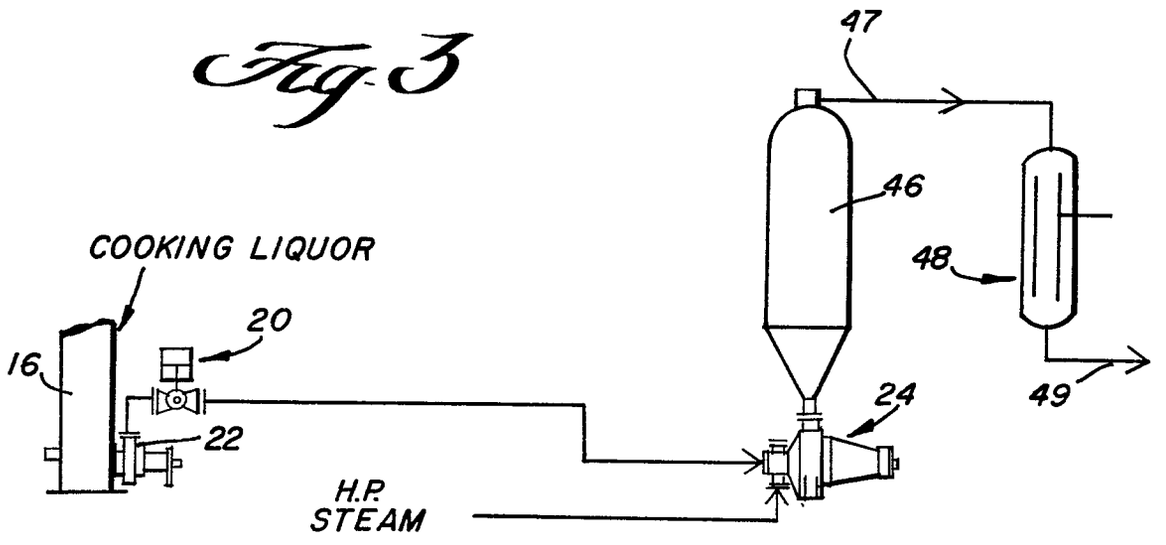



Fig. 3



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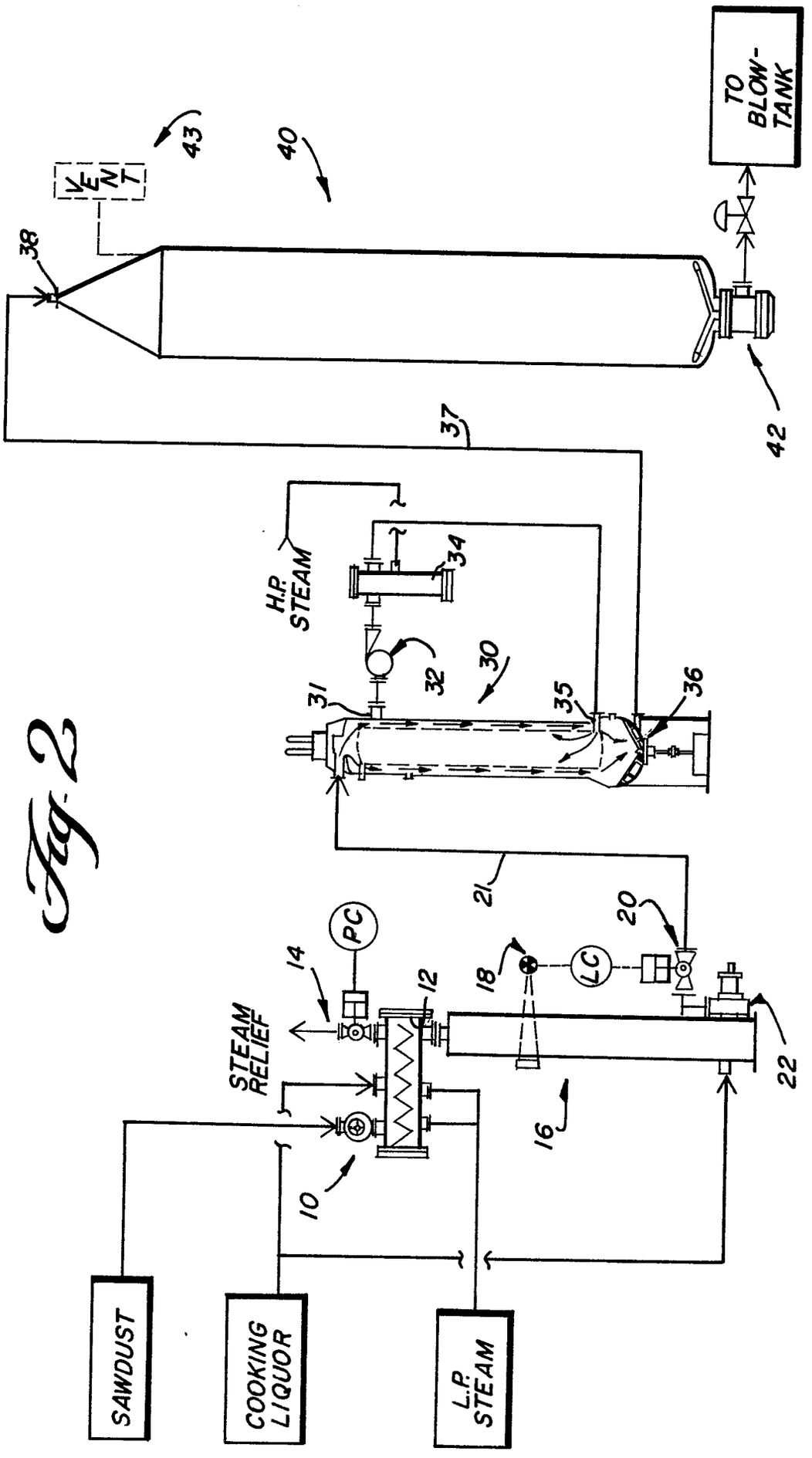


Fig-2

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# EUROPEAN SEARCH REPORT

0157279
Application number

EP 85 10 3154

## 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.4) |
|---|---|---|---|
| X,Y | US-A-3 586 600 (J.P.RICH et al.)<br>* Figures 1,2; column 1, line 1 - column 3, line 13; column 4, lines 37-74 * | 1,3,5-7,9 | D 21 C 7/06<br>D 21 C 3/22 |
| X,Y | FR-A- 569 326 (P.-R.FOURNIER)<br>* Page 1, lines 26-58; page 2, lines 15-50 * | 1,6,7 | |
| Y | FR-A-1 226 093 (BUSS)<br>* The whole document, in particular drawing and page 1, right-hand column, lines 16-20 * | 1,3,6,7,9 | |
| A | US-A-4 370 172 (C.GUIESSAZ)<br>* Figure 1; column 3, line 38 - column 4, line 68; column 6, lines 37-60 * | 1,6,7 | TECHNICAL FIELDS SEARCHED (Int. Cl.4)<br>D 21 C |
| D,A | US-A-3 475 271 (O.A.LAAKSO) | | |
| D,A | US-A-4 410 337 (J.GULLICHSEN et al.) | | |

The present search report has been drawn up for all claims

| Place of search | Date of completion of the search | Examiner |
|---|---|---|
| THE HAGUE | 28-05-1985 | NESTBY K. |

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
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