(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number : **0 631 009 A1**

# (12) EUROPEAN PATENT APPLICATION

(21) Application number : **94810361.9**

(51) Int. Cl.[5] : **D21B 1/02**

(22) Date of filing : **20.06.94**

(30) Priority : **28.06.93 CH 1921/93**

(43) Date of publication of application :
**28.12.94 Bulletin 94/52**

(84) Designated Contracting States :
**AT BE CH DE ES FR GB GR IT LI NL PT**

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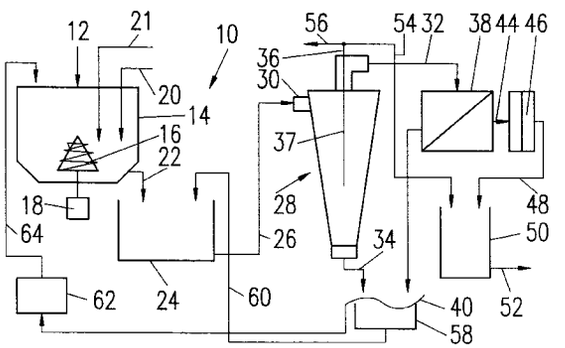
## (54) Method for the recovery and processing of fibers from hollow stalk plants.

(57) Methods are described for the removal of core particles, fiber bundles and fines from a fibrous starting material obtained from hollow stalk plants such as kenaf, by field drying, chopping and coarse comminution of the plant stalks and subsequent summary removal of core particles. The material is pulped in hot water, and fine, lightweight fibers, other fines and residual core particles are separated from this first pulp. A fibrous pulp is recovered wherein the fibers include less than 10%, preferably less than 5 % by weight of non-fibrous materials.

The separation of unwanted constituents may also be achieved by air classifying the plant material pretreated as above, in a special, vertical multistage wind sifter.

The fibers which are obtained in a substantially uncontaminated state are useful as the sole fiber component or as reinforcing fibers in sheet materials such as mulch sheets, paper, cardboard, construction panels and packaging materials, etc.

FIG. 1




EP 0 631 009 A1

The present invention relates to a method for the recovery and processing of fibers from hollow stalk plants and to the use of the fibers obtained by the method. The invention particularly relates to fibers of dicotyledonous plants and more particularly to fibers of kenaf or hemp, their preparation, processing and use.

## Background of the Invention

The expression "hollow stalk plant" is intended to encompass all plants which form a hollow, generally rather long stem which is filled with a kind of woody marrow. Examples of such plants are the dicotyledonous plants such as kenaf and hemp, but also elder and some reed species.

A dicotyledonous plant has two morphologically distinct regions in its stem, namely the outer bark fraction which contains the bast fibers, and the inner, woody core. The ratio between the stalk components varies according to the different species, the nature of the soil and others, and the outer portion comprises 40 to 10 % while the woody core comprises 60 to 90 % of the whole stalk.

In this document, kenaf fibers will be taken as a basis for the following description of the invention. However, it is emphasized that the invention is not limited thereto but can be practiced in using all dicotyledonous plants which have an analogous structure.

Kenaf (hibiscus cannabinus), an annual dicotyledonous plant, originates probably from Eastern Central Africa and is now cultivated all over the world. In Europe, it grows in a height of until 5 meters and produces a dry biomass substance of about 4 to 30 metric tons per hectare, depending on the growth conditions.

During the last decade, plants have been searched for on a worldwide scale which grow rapidly and form cellulose since normal wood plants are growing too slowly for covering the rising demand for paper and paper-like materials. Due to this slow growth, cellulose prices are going up. Furthermore, especially conifers must be intensively chemically treated for providing paper pulp since they contain a considerable amount of resin and hemicelluloses which cannot be tolerated in paper.

It has already become known to prepare paper pulp from kenaf. Thus, US-A-4,106,979 (Ruffini) discloses the preparation of paper pulp from kenaf and other dicotyledonous plants. It appears that for kenaf raw material to be acceptable as an economic papermaking fiber, it will be necessary to first separate the two said stem components which are greatly different in physical, chemical and morphologigal characteristics; only the fibrous components of the outer bark fraction of the stem are suitable for papermaking or generally sheet forming purposes; the core materials consist mostly of fibers too but very special methods are necessary to recover these fibers. In the cited document, the field dried, chopped kenaf stalks are stirred in a pulper at elevated temperature in an alkaline aqueous medium, and the bast fibers are the separated from the pulp on a slit screen fractionator. However, in this known process, the separation efficiency is relatively poor, 82 % according to Example 1, and the separation step uses chemicals which present environmental risks and render the method uneconomic.

It has also been tried to separate the bast fibers from the core material by purely mechanical means. Thus, for example, PCT/AU92/00027, published under WO 92/12808, discloses a method and an apparatus for grading fibrous material, exemplified by the separation of kenaf stalk materials into the bark fibers and the core materials. The apparatus comprises two or more hollow bodies rotating about inclined axes, the bodies having baffles for tumbling the fibrous materials and slits for decharging the fines. However, own tests have shown that the core particles of kenaf are partially opened in the apparatus, forming nest-like dims or tangles which catch longer fibers; the separation efficiency of the method is poor and does not even reach that of the first cited document above, even when using more than three hollow bodies. Furthermore, the starting fibrous material must thoroughly be dried which raises the process costs.

Poor separation efficiencies are also obtained by using the apparatus disclosed in EP-A3-0,122,769.

Therefore, and bearing in mind that hollow stalk plants can only be used as a fiber material, for example in the paper making industry, more generally in the fiber sheet industry, without introducing additional, costly processing steps if the core materials have been separated from the bark fibers with an efficiency of at least 90 %, it is the first and major object of the present invention to provide a new method and apparatus for the separation of fibers from such plants which affords the required separation efficiency.

There is a further object of this invention to provide an effective separation method as pointed out above which does not use hazardous chemical reagents and which produces pure fibers in an economical manner.

## Summary of the Invention

The objects set forth above are attained by the present invention which achieves the required high efficient separation in a wet method using a new and useful separation device, namely a hydrocyclone which will be described later on in more detail. The method of the invention comprises pulping a fiber material previously

obtained by field drying, chopping, and coarse comminution of the plant stalks and subsequent summary removal of core particles, in warm or hot water, preferably water of at least 50 °C, more preferably of 80 to 85 °C, to a solids concentration of from 4 to 20 % by weight during about 5 to 40 minutes, then separating fine, lightweight fibers, other fines and residual core particles from this pulp, and recovering a fibrous pulp wherein the fibers contain less than 10 % by weight of non-fibrous materials. This separation is preferably achieved in passing the pulp into a hydrocyclone having circumferential, central and intermediate collecting volumes, and recovering the fibrous pulp from said intermediate volume of the hydrocyclone situated between said circumferential and central collecting volumes.

This method, using said hydrocyclone, affords a separation efficiency of at least 95 %, i.e. that the fibrous pulp flowing out of the new hydrocyclone of the invention contains solids comprising at least 95 % by weight of fibers.

According to preferred embodiments, the overall yield of fibrous materials can be improved as well as the overall separation efficiency when the fibrous pulp discharged from the intermediate volume of the hydrocyclone is fed into a classifying device where fibre bundles not yet opened in the pulping step, and any residual core particles are separated from the fibers and returned to pulping after a milling treatment.

The material in the circumferential volume of the hydrocyclone, i. e. a layer adjacent to the inner hydrocyclone wall, comprises compact core particles. This material may be collected, separated from the suspending aqueous phase, then milled and returned into the pulper. During milling, the core particles are opened in yielding fine fibers which will, during the procedure described above, accumulate in the central volume of the hydrocyclone. The central volume in the hydrocyclone, comprising fine fibers and other lightweight fines, is discharged therefrom and may be used for papermaking or other purposes, thus improving the overall economics of the method.

The object of the invention is also met by a dry separation technique, comprising feeding a dry fiber material previously obtained by field and/or air drying, chopping, and coarse comminution of the plant stalks and subsequent summary removal of the core particles, into a multistage zigzag wind sifter. The overhead output of this device is an air suspension of fibers which have been separated from the core particles with an efficiency of at least 90 %. The fibers thus separated from the core particles can easily be recovered from the supporting air by screens well known to the one skilled in the art. For a number of uses, this purity of the fibers is already sufficient but if not, the fibers may be subjected to the wet separation procedure already described above.

## Brief Description of the Drawings

The invention will now be described in further detail with reference to the drawing wherein:

Fig. 1 is a process flowsheet showing schematically the overall process of the invention,

Fig. 2 is a vertical cross-sectional view of the hydrocyclone used in the process of the invention, and

Fig. 3 is a horizontal cross-sectional view of the hydrocyclone in the line III-III of Fig. 2.

## Detailed Description of the Invention

Referring now to Fig. 1 which shows in a schematical manner a general flowsheet of an installation 10 for the separation of kenaf fibers from core material, the reference numeral 12 denotes the kenaf feed charged into a pulper vessel 14.

The kenaf feed is obtained in the following way: The kenaf plants are preferably harvested by means of a modified corn chaffcutter machine and pre-dried on the field. The leaves are separated from the stalks and left on the field as a natural fertilizer. The stalks are then coarsely comminuted in a suitable shredder or a corn chaffcutter into lengths of about 10 to 20 mm. The stalk shreds are then dried to a water content of about 13 to 15 %, either naturally on the field or in grass drying facilities.

The dried kenaf shreds are further processed in a central installation, comprising chopping the shreds or opening same on torsion spring drums, and these materials are then separated in a sieving device such as a turbulence classifier. This step results in an about 70 to 80 % separation of the bast fibers from the core materials which are discarded or separately processed.

The fibers which still contain from about 2 to 40 % by weight of core particles constitute the feed 12 (Fig. 1). These fiber materials also contain fiber bundles which were left unopened in the chopping step mentioned above.

The pulper vessel 14 is equipped with a stirrer 16, driven through a shaft by the stirrer motor 18. Steam and, if necessary, water can be introduced into the pulper vessel 14 through the conduit 20 and 21, respectively, so that the liquid level will be kept constant. The pulping water in the vessel 14 is maintained at a temperature of from about 50 to about 90 °C, preferably about 80 to about 85 °C. The amount of charged kenaf

fibers is such that their concentration in the pulper is maintained between 4 and 20 % by weight, preferably at about 14 % by weight. The dwell time of the kenaf fibers in the pulper is about 10 to 20 minutes.

The contents of the vessel 14 is then discharged by line 22 into the storage vessel 24. During pulping, the kenaf fibers are hydrated and softened, most of the fiber bundles are opened, and also a substantial portion of the core particles are opened to yield additional, fine fibers. The pulp in vessel 24 is then pumped into the tangentially ending input pipe 30 of the hydrocyclone 28 for classification; the operation of the hydrocyclone will be explained below. The fiber suspension entering the hydrocyclone 28 is classified into a fiber fraction which leaves the cyclone through line 32, a heavy core fraction consisting principally of unopened core material in the form of dims or tangles discharged through the line 34, and lightweight, fine fibers and other fines, leaving the hydrocyclone by the line 36. The hydrocyclone 28 thus achieves a separation of the charged suspension into three fractions.

The fiber fraction is passed into the vertical separator 38, equipped for example with hole or slot sieves, where remaining fiber bundles are separated from the kenaf fibers. This separator 38 is an optional device since it need not be used if fiber bundles can be tolerated in the final sheet made from the fibers, such as a mulching sheet or low-quality papers. The proportion of fibers in the suspension flowing through line 32 is more than 99 %, about 2 to 3 % thereof being residual fiber bundles. These fiber bundles, separated from the fibers in the separator 38, are fed to a vibration sieve 40 through line 42. The fiber suspension which is free from bundles and any other impurity is passed through line 44 into a deflaker 46, and the deflaked mass is discharged into a reaction vessel 50 through line 48.

If desired, the fines in line 36 from hydrocyclone 28 can be used together with the finally separated kenaf fibers in paper pulp, particularly if mulch sheets are to be produced. Therefore, they can be charged through line 54 into the reaction vessel 50. When this is not desired, the fines are passed through line 56 to other processing facilities or to disposal.

The fiber suspension leaving the separator 38 through line 44 is a suspension of non-classified fibers stemming from the bark portion of the plant. These fibers have a length of about 2 to 13 mm or more. For some special uses of the fibers, it has been found advantageous to further separate these fibers, namely for example into a first, short fiber fraction wherein the fibers have a length of about 2 to 8 mm, which can be used as normal binder fibers in papermaking, and a second, long fiber fraction where the fibers have a length of more than 8 mm; these fibers can be used as so-called armouring fibers. When such a fiber separation is desired, a second hole-and-slit sieve separator (not shown) having a construction similar to separator 38 will be disposed between the first separator 38, shown in Fig. 1, and the deflaker 46. Like separator 38, this second separator has one inlet and two outlets. One outlet is connected to deflaker 46, and the other outlet provides a suspension of either the short fibers or the long fibers, as desired.

As shown in Fig. 1, the core particles separated from the fibers in hydrocyclone 28 are charged through line 34 on the vibration sieve 40 together with the fiber bundles (and, if any, residual core particles) coming through line 42 from separator 38. On the vibration sieve 40, the solids are separated from the aqueous pulping liquor which is collected in vessel 58 and then returned through line 60 into storage vessel 24. The solids remaining on the sieve 40 are fed to a milling device 62, for example an attrition mill sold by Alpine, Austria, wherein the fiber bundles are opened and the core particles are further comminuted; this comminution yields fine fibers since the core particles are mostly tangles of very fine fibers having a length of about 0.1 to 3 mm. The outlet of the attrition mill 62 is returned through line 64 back to the pulper 14.

In the reaction vessel 50, the fibers coming from deflaker 46 and, optionally, the fines from the hydrocyclone 28 (line 54) are further optionally treated to provide bleached fibers. It has surprisingly been found that, probably due to the aforesaid aqueous treatment and separation steps of the fibers, unusual mild conditions are suffficient for this bleaching treatment, and the same bleaching effect is obtained as a bleaching under more severe conditions of fibers which have not undergone the processing method of this invention.

In the reaction vessel 50, the fiber suspension is slightly diluted to a solids content of about 2.5 to 3.5 % by weight. Sodium hydroxide is added until a concentration of about 1.5 % by weight. The mixture is heated, and after about 20 minutes at 80 to 90 °C, about 3 g of hydrogen peroxide having a concentration of about 25 % are added per kg of the suspension. The warm suspension is kept under stirring a further 15 to 25 minutes in the temperature range mentioned above. The suspension is then neutralized by means of a weak acid, particularly acetic acid, to a pH of about 6.5. The fibers are separated by centrifuging and optionally dried. They can be used, as already mentioned, as reinforcing fibers in paper pulps, optionally further containing recycled waste paper, or for replacing cellulose and recycled paper in paper pulps.

It can be seen that the above described method fundamentally differs from separation, pulping and bleaching methods hitherto disclosed for wood and also for dicotyledonous plants. The sole liquid wastes are water and a weak sodium acetate liquor which is fully biodegradable.

The fines leaving the hydrocyclone 28 alternatively through line 56 can easily be separated from the pulp-

ing water and can advantageously be used, as such or together with the compact core particles leaving the hydrocyclone through line 34, as organic, biologically degradable and food allowable filler.

Referring now to Fig. 2 which shows a vertical sectional view of the hydrocyclone 28 used in the method of this invention, reference numerals 30, 32, 34 and 36 denote the same ports or lines, respectively, as in Fig. 1. The pipe 30 ends, in a known manner, tangentially in the upper portion of the cyclone. The upper and lower outlets 32 and 34, respectively, are known from conventional cyclones.

However, the cyclone of Fig. 2 further comprises an inner, central pipe 37 which extends to about the half of the height of the cyclone 28 and serves for evacuating by means of a pump (not shown) the fines fraction of the fibrous material pulp fed into the cyclone through pipe 30.

Fig. 3 shows a horizontal cross-sectional view of the cyclone of Fig. 2 in a plane according to line III-III of Fig. 2. This Figure represents the separating condition of the fiber suspension 66 fed into the cyclone through pipe 30. Due to the centrifugal forces of the helical flow of the suspension, the relatively heavy, unopened core particles 68 accumulate near to the inner wall of the cyclone 28 and are transported by inertial forces downward to the outlet opening 34. The central region of the cyclone 28 is subjected to nearly no turbulence and centrifugal forces; the lightest fibres and other fines 70, stemming from opened core tangles, accumulate in this central space and are evacuated through pipe 37. Finally, the most interesting main fibers having a length of about 2 to 13 mm or more, as described above, will occupy the intermediate region between the inner wall of the cyclone and the central region and are discharged from the hydrocyclone 28 through the pipe 32 together with the main stream of the liquid fed into the cyclone.

The installation described above operates as a continuous process starting from storage vessel 24. The pulping of the kenaf raw material in vessel 14 is discontinuous, but it would be possible to replace the pulping vessel 14 by a continuous pulper.

The object of the invention, namely the separation of the compact core particles from a fiber material previously obtained by field drying, chopping, and coarse comminution of hollow stem plant stalks, is also attained in a dry process by passing the comminuted stalks through a vertical zigzag wind sifter or air classifier, known per se in the art and sold by the Alpine Company, Austria. In a known manner, air is passed from below into the wind sifter, and the fibrous mass to be separated is charged from above into the device. A separation is obtained at all the edges of every angle of the wind sifter tube sections which are disposed according to a zigzag configuration. The fibers are lighter than the core particles and are carried away by and together with the air flow through the separator; they can be collected by suitable screening means known per se from this air flow. The heavier core particles fall down against the air stream and can be collected at the bottom of the air separator. The use of air as a separating medium avoids the still repeating entanglement of core tangles and free fibers which, in the known methods, has impaired the desired separation.

Separation efficiencies around 90 % have been obtained, that is, the fiber fraction is contaminated by less than about 10 % of core particles.

If desired, a complete and total separation from the remaining about 10 % of core particles can be obtained in feeding the fiber fraction, obtained from the wind sifter, into the wet separation installation described above. The overall separation efficiency will be at least 99,5 %.

It follows from the foregoing description that not only the efficiency of separation, as defined above, is dramatically increased, but that the overall yield of usable fibers is increased too since the method of the invention provides an opening of fiber bundles and of core particles which, in the known techniques, are either not separated, thus limiting the uses of the product, or in part separated and discarded.

The fiber materials processed and obtained by the methods of the invention from hollow stem plants, more particulary dicotyledonous plants such as kenaf and hemp, may be used in a multitude of fields. These uses have especially become possible through the method of the invention which guarantees an at least 90 % separation of the compact core particles and, in some cases, of the finest fibers, said separation typically yielding even a nearly 100 % separation efficiency. Examples for such uses which are by far not exhaustive, are the following:

1. Use as a mulching sheet according to EP-A1-0,556,150

   The outflow of deflaker 46 is combined with the outflow in line 54 coming from hydrocyclone 28. The combined suspensions are processed in the conventional pulp processing units and then on a Fourdrinier machine of a paper mill, and a mulch sheet is obtained having a dark brown colour. Additives may be added to the paper pulp from kenaf in the size press and/or the head box which are evenly distributed in the obtained mulch sheet web.

2. Use in filter sheets

   For the manufacture of biologically fully degradable filter sheets, the outflow of the deflaker 46 (line 48) is processed according to point 1. above and passed on a mould machine. Optionally, the outflow of deflaker 46 can be bleached before the other processing steps, as described above.

In an analoguous manner, vleeces may be produced on needle vleece machines or on other non-woven manufacturing facilities where binders such as starch are used.

3. Use in batch papers

Batch papers are papers which contain such a proportion of the fibers obtained in the present invention that their mechanical resistance values are improved or at least held constant in spite of a reduced proportion of cellulose fibers.

A short fiber fraction obtained, as described above, in a vertical slot or hole sieve separator, may be used. If desired, the fibers may be subjected to a hot washing step wherein steam is introduced into the pulper together with the solvent.

The fiber mash thus obtained is brought by means of a deflaker and refiner to a freeness value which corresponds to the product to be manufactured and which is normally pre-established. Then, the mash can be pumped into a storage vessel and further, in a continuous or batch-wise manner, into the machine chest where it is blended with the conventional paper mash.

Alternatively, there is also the possibility to pass the paper mash over the machine and to recover a product as a vleece which can be transported and sold like cellulose. These vleeces can be opened at the end user and worked up like cellulose or rolls of recycled waste paper. The advantage of this application is to make the fiber material available to a circle of users which can now use kenaf without having neither the necessary detail knowledge nor the kenaf plant themselves.

4. Use in art stock and document papers

A mixture is prepared which can be processed on the paper making machine according to points 1 or 3 above, and the mixture is blended with pH neutral fibers to form a mash.

A very high homogeneity is obtained by parallel deflaking and refining and dispersing. In this way, a specific volume is produced which gives the final product most desired special properties as to coating, pigmenting, calendering and especially resistance to ageing.

5. Use in food packaging

Papers filled or reinforced with kenaf fibers may be used as an alternative to known celluloses in the field of food packaging. These raw fibers fulfil the requirements of foodstuff regulations. No environmentally hazardous substances are formed during manufacture, and they are not only economically but also ecologically advantageous.

A possible application comprises for example the production of a sheet on a multiple wire machine whose uppermost layer consists of short kenaf fibers which are prepared and processed as described above, see point 3.

The second and following layers may consist of waste paper or recycled papers, reinforced by kenaf fibers.

This procedure ensures that no toxic or harmful substances will come into contact with foodstuffs.

6. Use in construction materials

A mixture of fibers and fines (combined outflow of lines 48 and 54, Fig. 1) is made up to a mash according to the technique of point 3 above and processed to boards on a paperboard machine. These boards or panels may be used as heat insulation, construction or sound insulation boards in the field of construction.

7. Use in fiber moulding articles

The fibers of the long and short fiber fractions can be used, separately or without separation, for making a fiber pulp by the techniques of points 1 or 3 above which can be processed, for example, into pressed bodies such as egg package boxes, other shaped bodies, or may be used as fillers and insulating materials.

The invention and especially the possibilities of use are not limited to the description given above. The man skilled in the art will be aware of variants, modifications and other changes in the frame of the appended claims without departing from the scope of the present invention.

## Claims

1. A method for the recovery and processing of fibers from hollow stalk plants having bast fibers and core particles, comprising the steps of pulping a fiber material obtained by field drying, chopping and coarse comminution of the plant stalks and subsequent summary removal of core particles, in hot water to a solids concentration of from 4 to 20 % by weight during about 5 to 50 minutes, of separating fine, lightweight fibers, other fines and residual core particles from this first pulp, and of recovering a fibrous pulp wherein the fibers contain less than 10 % by weight of non-fibrous materials.

2. The method of claim 1 wherein said separation is carried out in a hydrocyclone having circumferential, central and intermediate collecting volumes, and recovering the fibrous pulp from said intermediate volume of the hydrocyclone situated between said circumferential and central collecting volumes.

3. The method of claim 1 or 2 wherein residual fiber bundles and core particles are removed from the fibrous pulp obtained in the separation step.

4. The method of claim 3 wherein the materials removed from said fibrous pulp, comprising fiber bundles and unopened core particles, are separated from the pulping water, milled for opening the bundles and the core particles, and the milled material is returned to the pulping step.

5. The method of claim 2 wherein lightweight fibers and other fines are separated as a combined fraction, constituting the central collecting volume of said hydrocyclone, from said first pulp, and the lightweight fraction is combined with said fibrous pulp.

6. The method of claim 2 wherein residual core particles, separating in said circumferential volume, are discharged as an aqueous suspension from said hydrocyclone, separated from the suspending water, and combined with the fiber bundles and unopened core particles removed from said fibrous pulp to be milled and returned to the pulping step.

7. The method of any one of claims 1 to 3 wherein the fibers are separated into a first, short fiber fraction in which the fibers have a length of from about 2 to about 8 mm, and a second, long fiber fraction in which the fibers have a length of more than 8 mm.

8. The method of any one of claims 1 to 7, further comprising bleaching the fibrous pulp separated from fiber bundles and residual core particles.

9. The method of claim 8 wherein the pulp is diluted to a solids content of about 2.5 to 3.5 % by weight, sodium hydroxide is added to a concentration of about 1.5 % by weight, the mixture is heated for about 20 minutes to a temperature of from 80 to 90 °C, aqueous hydrogen peroxide is added, and the mixture is kept under stirring for another 15 to 20 minutes at the said temperature.

10. The method of claim 9 wherein the bleached alkaline solution is subsequently neutralized to about pH 6.5 by acetic acid.

11. A method for the recovery and processing of fibers from hollow stalk plants having bast fibers and core particles, comprising the steps of air classifying a fiber material obtained by field drying, chopping and coarse comminution of the plant stalks and subsequent summary removal of core particles, within a vertical zigzag multiple stage wind sifter and recovering fibers containing less than 10 % by weight of non-fibrous materials from the overhead outflow of the air separator.

12. The method of claim 11 wherein the fibers obtained from the wind sifter are further treated by the method of any one of claims 1 to 10.

13. The use of the fiber materials obtained by the method of any one of claims 1 to 4 and 7 to 12 as reinforcing fibers in fibrous sheet materials.

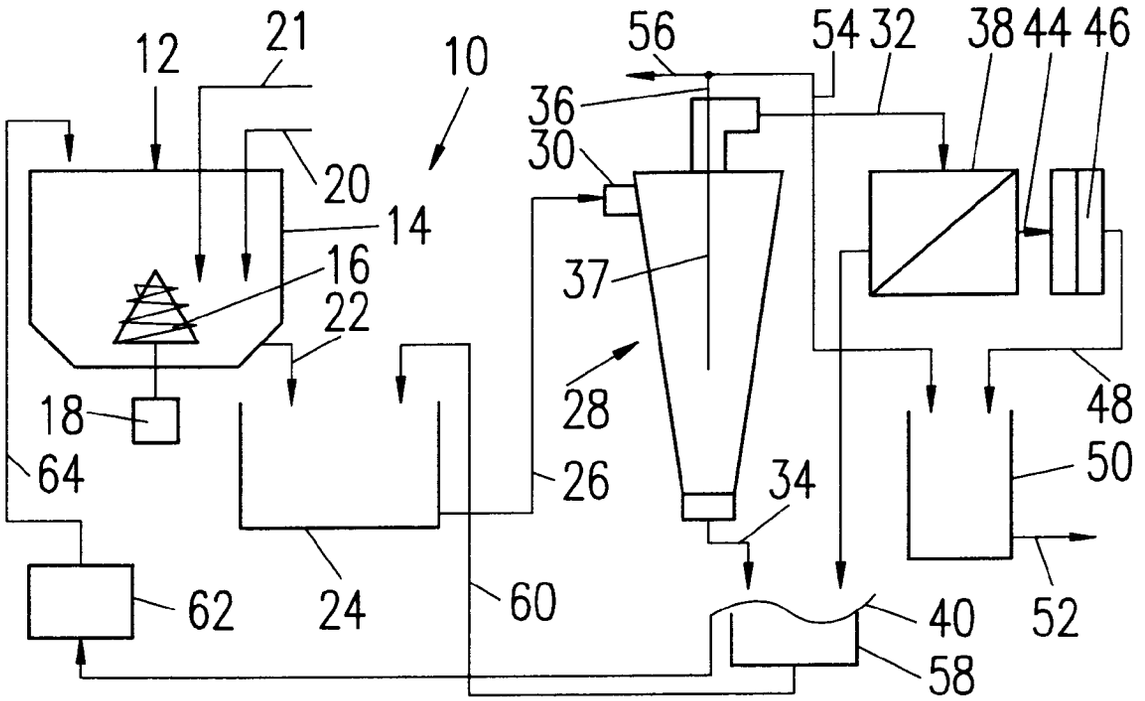
14. A method of making a cellulose containing sheet on a paper making machine, wherein a plant fiber fraction, obtained by the method of any one of claims 1 to 12, is added to the cellulosic paper pulp optionally further containing recycled waste paper, and the combined pulp is then fed to the paper making machine.

15. The method of claim 14 wherein a paper sheet is produced.

16. The method of claim 14 wherein a vleece-like cellulosic product is manufactured.

17. The method of claim 14 or 15 wherein packages are produced which are allowed for foodstuff uses.

FIG. 1



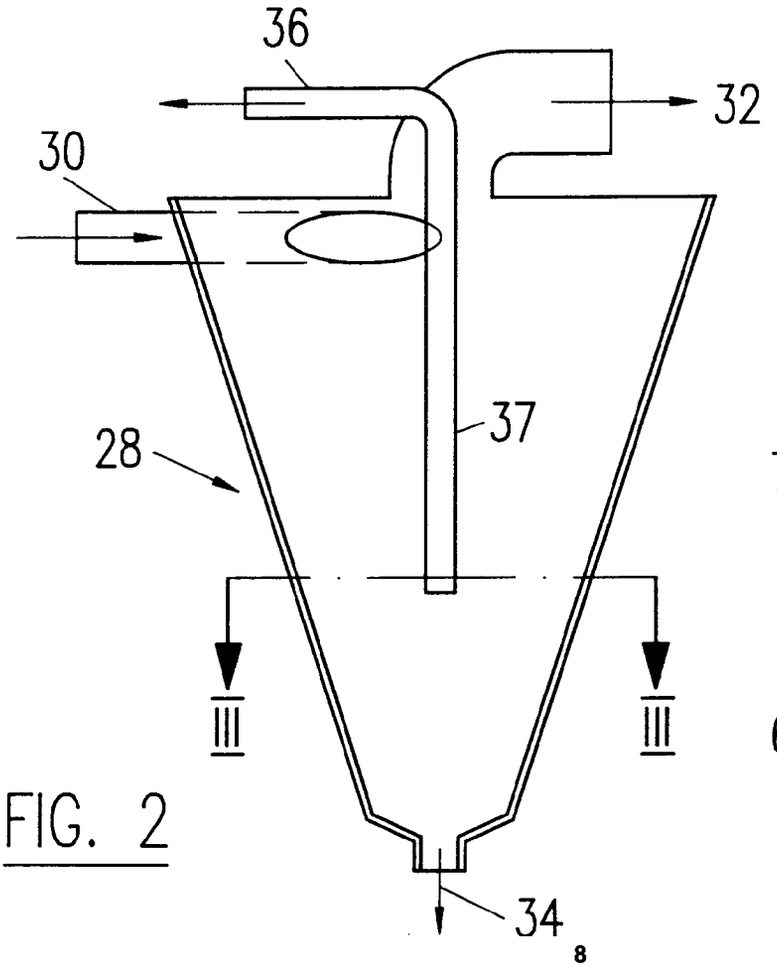
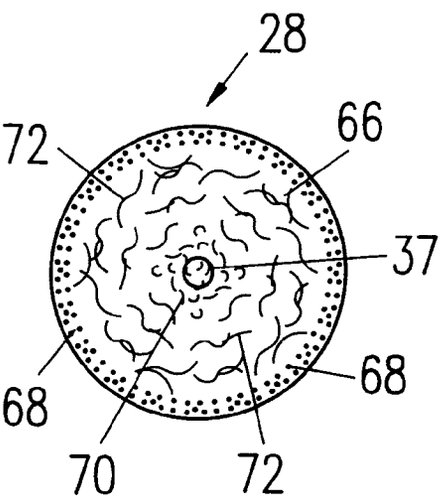




FIG. 2

FIG. 3



European Patent Office

# EUROPEAN SEARCH REPORT

Application Number
EP 94 81 0361

## 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.5) |
|---|---|---|---|
| A | US-A-4 106 979 (RUFFINI ET AL)<br>* the whole document * | 1,7-10 | D21B1/02 |
| A | --- | 4,5 | |
| A | GB-A-846 232 (HAWAIIAN DEVELOPMENT COMPANY)<br>* the whole document *<br>--- | 1,8,9 | |
| A | TAPPI JOURNAL,<br>vol.73, no.11, November 1990, ATLANTA US<br>A.F. KALDOR, C. KARLGREN, AND H. VERWEST<br>'kenaf - a fast growing fiber source for papermaking'<br>* page 205 - page 209 *<br>--- | 1 | |
| A | US-A-4 889 591 (VILLAVICENCIO ET AL)<br>* the whole document *<br>--- | 1,3,4 | |
| A | WO-A-92 12808 (ANKAL PTY LIMITED)<br>--- | | |
| A | EP-A-0 122 769 (WM. R. STEWART & SONS)<br>----- | | TECHNICAL FIELDS SEARCHED (Int.Cl.5)<br>D21B |

The present search report has been drawn up for all claims

| Place of search | Date of completion of the search | Examiner |
|---|---|---|
| THE HAGUE | 5 October 1994 | De Rijck, F |

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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