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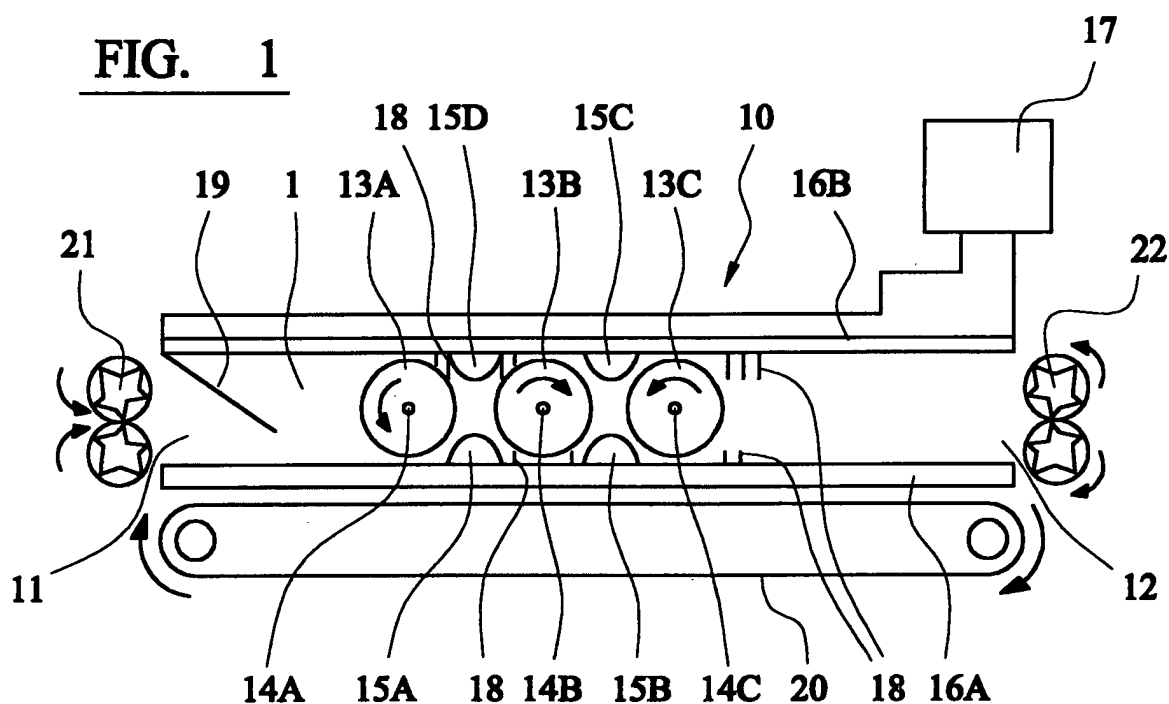
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(54) **Fibre separation**

(57) A device (10) for the separation of fibres from waste material in fibre bearing plants, comprising a plurality of processing members (13A, 13B, 13C) mounted for rotation within an enclosure (1), the enclosure (1) comprising an inlet (11) for material to be processed, an outlet (12) for fibres and a plurality of apertures (24) to allow the egress of waste material. The device is ar-

ranged, in use, to receive material at the inlet (11) to undergo a first processing operation by a first plurality of the processing members (13A). The first plurality of processing members (13A) is arranged along a first axis of rotation (14A), and is arranged to perform a first stage of separation of fibre from waste, and to transfer fibres in a process direction for processing by at least a second plurality of the processing members (13B).



Description

[0001] The invention relates to a device and method for the separation of the fibres from the waste material in bast fibre bearing plants.

[0002] Natural fibre products have a number of advantages over those manufactured from synthetic materials. These include the renewability of the raw material and the biodegradability of products at the end of their useful life. In addition, some fibre crops improve the condition of soil in which they are grown by virtue of their long roots that break up the soil and by the choking out of weeds due to their dense coverage of leaves.

[0003] The processing of the plant material to obtain useable fibres comprises many steps, which are broadly similar for a number of different fibre bearing plants. Examples of plants grown as fibre crops include flax, hemp, jute, manila and ramie etc.

[0004] After the plant has been harvested, the stems are retted to break down the adhesion of the fibres to the waste material. The separation of the fibres from the woody core of the plant stems is known as decortication or scutching. The fibres are subsequently hackled and combed and are then ready for spinning or other uses.

[0005] Historically, the scutching process was carried out by hand and is labour intensive. The cost of hand breaking the plant fibres from the woody core makes the growth of such fibre crops not economically viable in some countries.

[0006] In order to reduce the cost of the decortication process machines have been developed to break up the woody portion and to separate the broken pieces of woody material (which are usually called hurds or shives) from the fibre. These machines have been designed to obtain a high proportion of long fibres (or sliver) which are as long as the raw plant stems and a low proportion of very short fibres (tow).

[0007] With the advent of synthetic fibres and the large amount of cotton (a seed fibre) in use today, most textile producers can only make use of relatively short fibres. Natural short fibres can be used in insulation, paper, composite materials and other applications. In addition the high cellulose content of the hurds makes them a useful raw material for certain products and they have other uses such as animal bedding.

[0008] It is therefore desirable to effectively and cheaply decorticate the retted straw of bast fibre bearing plants without damaging the fibre beyond commercial use or excessively shortening the length of the fibres. Furthermore, given the low volume density of the straw it is desirable to make the decortication means cheap and portable to allow the process to occur near the location where the plants are grown. This reduces the transportation costs associated with the fibre crop and, since the fibre is more valuable than the straw makes the crop more attractive to potential growers.

[0009] It is therefore an object of embodiments of the present invention to provide a device and method for the

separation of the fibres from the waste material in bast fibre bearing plants, in particular for the decortication of retted fibre straw, the device being readily transportable and able to meet relevant standards for the quality of the fibre material produced.

[0010] According to an aspect of the present invention there is provided a device for the separation of fibres from waste material in fibre bearing plants, comprising a plurality of processing members mounted for rotation within an enclosure, the enclosure comprising an inlet for material to be processed, an outlet for fibres and a plurality of apertures to allow the egress of waste material, the device being arranged, in use, to receive material at the inlet to undergo a first processing operation by a first plurality of said processing members, said first plurality of processing members being arranged along a first axis of rotation and being arranged to perform a first stage of separation of fibre from waste and to transfer fibres in a process direction for processing by at least a second plurality of said processing members.

[0011] Preferably, the material to be processed comprises pre-prepared material from plants such as flax, hemp, jute, sisal, manila, ramie, nettles or other fibre bearing plants.

[0012] Preferably, the pre-preparation comprises harvesting, cutting to suitable lengths, retting and drying to a suitable moisture content.

[0013] Preferably, there are provided first through third pluralities of said processing members, said first through third pluralities being rotationally mounted along respective first through third rotational axes. The first through third plurality of processing members are preferably arranged such that the first through third axes are transverse to the process direction and are preferably arranged in sequence such that the first plurality of processing members propel material having undergone the first stage of separation toward the second plurality, and the second plurality propel material having undergone a second stage of separation toward the third plurality. The third plurality of processing members are preferably arranged to propel the material having undergone a third stage of separation toward the outlet for fibres.

[0014] The first plurality of processing members preferably counter-rotate with respect to the second plurality and the second plurality preferably counter-rotate with respect to the third plurality.

[0015] Preferably, each plurality of processing members comprises fibre separation elements which are mounted to a shaft. The first plurality of processing members preferably comprises a plurality of fibre separation elements extending from a common shaft defining the first axis of rotation, the second plurality of processing members preferably comprises a plurality of fibre separation elements extending from a common shaft defining the second axis of rotation and the third plurality of processing members preferably comprises a plurality of fibre separation elements extending from a common

shaft defining the third axis of rotation. Preferably, the fibre separation elements extending from the respective shafts are disposed along the length of their respective shaft and around its circumference.

[0016] Preferably, the fibre separation elements extending from the respective shafts are disposed in such a way as to balance the shafts during rotation.

[0017] Preferably, the fibre separation elements extending from the shaft defining the first axis of rotation each comprise a breaking member and a support member.

[0018] Preferably, a first end of each support element is attached to a shaft and a second end of each support element is attached to a first end of a breaking member.

[0019] Preferably, each breaking member is arranged substantially parallel to the shaft from which the support member extends and is adapted to break the material to be processed and scutch the woody material from the fibres.

[0020] Preferably, each breaking member comprises a cutting edge. The cutting edge may be a substantially linear edge, arranged so that the line of the edge runs parallel to the shaft from which the associated support member extends. The cutting edge may also be arranged to comprise the leading edge of the breaking member as the first shaft rotates.

[0021] Preferably, the fibre separation elements are similar to the L-shaped blades of a rotary cultivator.

[0022] Preferably, the fibre separation elements extending from the shaft defining the second axis of rotation comprise a beating member. Preferably, each beating member is substantially rectangular in plan, end and side elevations and extends normal to the shaft defining the second axis of rotation.

[0023] Preferably, the fibre separation elements extending from the shaft defining the third axis of rotation comprise rods. Preferably, the rods extend normal to the shaft defining the third axis of rotation and are substantially cylindrical.

[0024] Preferably, at least the fibre separation elements extending from the shaft defining the first axis of rotation are adapted to produce and promote air movement in the enclosure to aid the separation of the hurds and the fibre once the woody material has been broken away from the fibres. The air movement is preferably arranged to promote the progress of the fibres through the machine to move the fibres and discourage wrapping of the fibres around the shafts.

[0025] Preferably, the apertures are formed in a lower boundary member mounted below the processing members. The apertures may be formed in both a lower boundary member mounted below the processing members and an upper boundary member mounted above the processing members.

[0026] Preferably, the apertures are adapted to allow the passage therethrough of the waste material, and to substantially prevent the passage of the fibres.

[0027] Preferably the apertures are circular and ar-

ranged in a regular fashion. Preferably, the apertures are arranged in rows, the rows offset to one another so that the centre of the apertures comprising even numbered rows are aligned between the apertures of odd numbered rows. The apertures may make up a high proportion of the area of the boundary members, suitably 70% of the area of the boundary members may comprise. The apertures may suitably have a diameter of 10mm for processing certain plant varieties, and be arranged with 15mm centre distances. The size and arrangement of the apertures may vary for processing other plant varieties.

[0028] Preferably, waste material passes through apertures formed in the lower boundary member under gravity. Waste material may pass through apertures formed in the upper boundary member by means of induced air currents. Such induced air currents may be promoted by suction means, such as cyclone generator. Induced air currents may be provided by the rotating action of the processing members.

[0029] The enclosure may contain means to prevent fibres from moving away from the outlet back toward the inlet. These may comprise spikes extending from the upper and lower boundaries of the enclosure. The spikes may further assist the separation of the fibres from the waste material by holding back partially separated bundles of fibres while the breaking members act on them.

[0030] The enclosure may further contain aerodynamic means to promote a favourable flow of air within the enclosure to aid in the separation process. The aerodynamic means may comprise fins disposed between the envelope defined by the rotating processing members and extending from the upper and lower boundaries of the enclosure.

[0031] The fins may be adapted to produce pockets of slow moving air to aid the removal of waste. The fins may be adapted to generate vortices.

[0032] Preferably, the device may be adapted for easy transportation. The device may be mounted on a wheeled trailer. The device may have wheels attached to it. The trailer or device may comprise retractable legs used to support the device when stationary.

[0033] The device may further comprise feeding means for providing material to the inlet. Such feeding means may comprise conventionally available unbailing mechanisms, conveyor feed systems or, for instance, mechanisms for picking up material directly from the field.

[0034] According to another aspect of the present invention there is provided a method for the separation of fibres from waste material in fibre bearing plants, the method comprising the steps of:

- (a) the reception of material at an inlet of an enclosure;
- (b) the processing of the material to perform a first

stage of separation of fibre from waste;

(c) processing of the material in a second processing operation to undergo a second stage of separation of fibre from waste;

(d) the transfer of fibres after said processing operations to an outlet of said enclosure; and

(e) the removal of waste material from said enclosure through a plurality of apertures during any of steps (b) to (d).

[0035] Preferably, during step (b) material is automatically transferred from the inlet to a first plurality of processing members which are mounted for rotation within the enclosure and which perform the first processing operation and, preferably, following performance of the first stage of separation of fibre from waste, the fibres are automatically transferred to a second plurality of processing members which perform the second processing operation.

[0036] Preferably, automatic transfer of the material from the first plurality of processing members to the second plurality of processing members is achieved by virtue of air currents flowing within the enclosure.

[0037] Preferably, automatic transfer of the material from the first plurality of processing members to the second plurality of processing members is achieved by virtue of the inertia of the material.

[0038] Preferably, said air currents are caused by rotation of the first and second pluralities of processing members.

[0039] The method may comprise third or further subsequent processing operations between the second processing operation and the transfer of fibres to the outlet. The third or further subsequent processing operations and the transfer of material between them may be similar to those described for the first and second processing operations.

[0040] Preferably, removal of the waste material from the enclosure in step (e) occurs in an automatic fashion.

[0041] Removal of waste material may be under gravity and/or assisted by air movement.

[0042] The waste material may be transported away from the enclosure by transportation means. Preferably, the transportation means comprise a conveyor system.

[0043] Preferably, the processing members may rotate at speeds in the range of 300-1000 revolutions per minute. More preferably, the processing members may rotate at speeds in the range 500-750 revolutions per minute. Each plurality of processing members may rotate at its own speed. The speed of rotation of the third plurality of processing members may be greater than that of the first and second pluralities of processing members.

[0044] The method of the second aspect may incorporate any one or more of the device features described

in relation to the first aspect in any logical combination.

[0045] For a better understanding of the invention, and to show how embodiments of the same may be carried into effect, reference will now be made, by way of example, to the accompanying diagrammatic drawings in which:

Figure 1 is a diagrammatic drawing showing a sectional side view of an embodiment of the present invention;

Figure 2 is a diagrammatic drawing showing a plan view of an upper or lower boundary member of the enclosure used in embodiments of the present invention;

Figure 3 is a diagrammatic drawing showing a sectional end view of an embodiment of the present invention; and

Figure 4 is a diagrammatic drawing showing views of the processing members used in embodiments of the present invention.

[0046] Referring now to Figure 1, there is shown an example of a device embodying the present invention. The device 10 comprises an enclosure 1, an inlet 11 for the material to be processed, an outlet 12 for the fibres, first through third pluralities of rotationally mounted processing members 13A-13C, shafts 14A-14C for the first through third pluralities of processing members 13A-13C, fins 15A-15D, a lower boundary 16A, an upper boundary 16B, a cyclone dust extractor 17, spikes 18, an inlet safety plate 19, a conveyor system 20, an inlet feed mechanism 21 and an outlet feed mechanism 22.

[0047] An example of the configuration of the lower and upper boundary members 16A, 16B is shown in Figure 2 which details an example of the arrangement of the apertures 24 in even rows 25 and odd rows 26.

[0048] Figures 3 and 4 show details of the fibre separation elements used in embodiments of the present invention.

[0049] When the device shown in Figure 1 is operating, the first through third pluralities of processing members 13A-13C are caused to rotate under the action of an external power source (not shown). In preferred embodiments of the invention the external power source is a tractor power take off. Power may be transferred from the tractor power take off to the processing members by any suitable transmission means, for example gearing, chain drives, belt drives etc. The central plurality of processing members 13B rotates in the opposite direction to the other pluralities of processing members 13A and 13C. This change in sense may be suitably achieved by the use of gearing, however each plurality of processing members 13A-13C may be driven independently.

[0050] The material to be processed is fed into the enclosure 1 through inlet 11 by the inlet feed mechanism 21. The material to be processed may comprise loose plant straw, straw bales or any other suitable plant material. The inlet feed mechanism is adapted to ensure a constant amount of plant material is fed into the device and may be of a type generally known in the art. This helps to prevent an inlet feed rate of material to be processed that is not balanced by the extraction rate of fibres at the outlet 12. An excess of material fed to the inlet 11 would cause a build up of material within the enclosure 1 and lead to the device 10 becoming blocked.

[0051] The inlet safety plate 19 ensures the first plurality of processing members 13A is not easily accessible by material other than the material to be processed and helps to prevent the rejection of the material to be processed.

[0052] Each plurality of processing members comprises a plurality of fibre separation elements which are mounted on a common shaft which defines the axis of rotation of the plurality of processing members. Each fibre separation element 30 of the first plurality of fibre processing members 13A comprises a support member 32 and a breaking member 31, a first end of each support member 32 is attached to the shaft 14A, and the second end of each support member 32 is attached to a first end of a breaking member 31. Each breaking member 31 is arranged substantially parallel to the shaft 14A and comprises a cutting edge 34. The cutting edge 34 is substantially linear and also runs parallel to the shaft 14A. As the shaft 14A rotates the cutting edge 34 comprises the leading edge of the breaking member 31. The fibre separation elements 30 are similar to the L-shaped blades of a rotary cultivator.

[0053] Once the material to be processed has entered the enclosure 1, the action of the first plurality of processing members 13A is to cause the cutting edge 34 of the breaking members 31 to impact upon the material. This has the effect of damaging the bonding between the fibres and the woody material in the plant stems and may chop the material to be processed into shortened lengths. The air flow created by the movement of the breaking members 31 and the fins 15 and the impact of the breaking members 31 on the stems causes the material to be drawn onto the second plurality of processing members 13B.

[0054] Each fibre separation element 36 of the second plurality of processing members 13B comprises a beating member. Each beating member comprises a prismatic bar of rectangular cross-section that extends normal to the shaft 14B. The action of the second plurality of processing members 13B is to beat the material being processed to further break the bonding between fibres and the woody material in the plant stems. The airflow created by the movement of the beating members and fins 15, the inertia of the material being processed and the impact of the beating members on the stems causes the material to be drawn on to the third

plurality of processing members 13C. Each fibre separation element 38 of the third plurality of fibre processing members 13C comprises a cylindrical rod that extends from the shaft 14C and normal to it. The action of the third plurality of processing members 13C is to cause the rods to open up and separate the fibres from one another once the majority of the woody material has been separated from them. The air flow created by each of the first through third pluralities of processing members 13A-13C and inertia of the material also aids its passage through the enclosure towards the outlet 12.

[0055] As the stems pass through the machine, the hurds that are broken from the stems are forced along the lower boundary member 16A of the enclosure 1 by the motion of the remaining stems and fibres and the airflow created by the pluralities of processing members 13A-13C. The constant sweeping of the lower boundary member 16A by the remaining stems and fibres as they move through the enclosure 1 helps to prevent blockages in the device 10. The hurds then fall under gravity through the apertures 24. The apertures 24 are arranged to allow the easy egress of the hurds, while preventing any loss of fibre. The hurds fall onto the conveyor system 20 and subsequently are collected.

[0056] It may be desirable for each of the pluralities of processing members 13A-13C to rotate at its own speed.

[0057] For example, the speed of rotation of the third plurality of processing members 13C may be greater than that of the first and second pluralities of processing members 13A, 13B to enhance the separation of the fibres and ensure that any hurds that are trapped between the separated fibres are able to fall through the apertures 24.

[0058] The cyclone dust extractor 17 removes any dust and small particles from the enclosure 1 through the apertures 24 in the upper boundary 16B.

[0059] The fibres within the enclosure 1 are prevented from returning towards the inlet 11 by spikes 18, which project through the apertures 24 in upper boundary member 16B and the lower boundary member 16A and by the shaping of the fins 15 and are urged toward the outlet 12 by the action of the outlet feed mechanism 22. The spikes may also help the separation of fibres from the waste by holding back partially separated bundles of fibres while the breaking members 31 act on them.

[0060] Further, the fins 15 produce vortices or pockets of slow moving air beyond a peak or crest line. This turbulent area can help to retain the waste material or slow it down to aid extraction through the apertures 24.

[0061] The outlet feed mechanism 22 comprises a pair of intermeshing fluted rollers of the type generally known in the fibre processing and textile industries that trap the fibres between them and rotate drawing the fibres from the device 10. The speed of the outlet feed mechanism 22 may be controllable relative to the amount of plant material entering the device 1 to ensure the amount of material entering the device 10 is bal-

anced by the amount of material leaving it. Once the fibre has left the machine it can be passed to further machinery or left for later bailing etc.

[0062] In some embodiments, the air flow may be regulated so as to propel the separated fibres from the outlet without the requirement for a specific outlet feed mechanism 22.

[0063] The operation of the device 10 as described above is generally applicable to any of the previously mentioned plant varieties. By way of example, details of the specific construction and operation of the machine for the decortication of hemp will be described. Hemp has been chosen in this instance since it is regarded as the toughest fibre bearing plant to process.

[0064] The hemp plants are harvested, cut to lengths of around 300mm and then retted. The retted material is dried to a moisture content of 15%-20% before being fed into the machine.

[0065] The pluralities of processing members 13A-13C may rotate at 500-750 revolutions per minute. The power needed to operate the pluralities of processing members 13A-13C and the other moving parts may come from a tractor power take off and may be approximately 60 kW.

[0066] The fibre separation elements 30 may extend 200-300mm from the shaft 14A, with a clearance of 70-100mm to the upper and lower boundary members 16A and 16B. The fibre separation elements 30 may be arranged in groups of two, three or four at 180°, 120° or 90° respectively from one another around the circumference of the shaft 14A. The groups of fibre separation elements 30 may be separated from one another along the shaft 14A by approximately 300mm. The breaking members 31 may be approximately 150mm in length.

[0067] The fibre separation elements 36 and 38 may be of similar dimensions to those given for the fibre separation elements 30, with the rods extending from the shaft 14C approximately 8mm in diameter.

[0068] The device 10 may be 2 metres long overall and approximately 2 metres wide.

[0069] The upper and lower boundary members 16A and 16B may be manufactured from 5mm steel plate. This gives them the resilience needed to withstand the ingress of material such as small stones that could be inadvertently fed into the device 10 with the plant material.

[0070] The apertures 24 may be 10mm in diameter and the apertures 24 may comprise 70% of the area of the upper and lower boundaries 16.

[0071] The spikes 18 may be 10mm in diameter and 100mm long. The spikes 18 are arranged in rows across the width of the enclosure 1, transverse to the process direction. The spikes may be reinforced with support means and project through the apertures 24 of the upper boundary member 16B and the lower boundary member 16A. The rows are arranged at 200-300mm intervals along the process direction, and each spike is of a suitable length to prevent the transfer of fibre material back

toward the inlet 11. The length of the spikes 18 may vary according to their position along the process direction due to their proximity to the pluralities of processing members 13A-13C.

[0072] The fins 15A-15D extend from the boundary members 16A and 16B and are disposed transverse to the process direction. The fins may be 100mm in height and of the same width as the boundary members 16A and 16B.

[0073] It can be seen that the device 10 is of suitable dimensions for easy transportation when mounted on a trailer, or towed on its own wheels.

[0074] The dimensions mentioned are to be regarded as examples only, and are to be scaled to achieve the best decortication of different plant varieties. It would be possible to use the basic device 10 with interchangeable boundary members 16A and 16B and the pluralities of processing members 13A-13C operating at different speeds to process different plant varieties.

[0075] It will be appreciated by the person skilled in the art that although a specific embodiment has been disclosed, equivalent elements may replace those shown. For instance, the apertures 24 may be of alternative geometries without substantially altering their technical effect.

[0076] As described above the device and method shown confer advantages over the state of the art in simplifying the decortication of bast fibre bearing plants and providing an effective and readily transportable apparatus for carrying this out.

[0077] The reader's attention is directed to all papers and documents which are filed concurrently with or previous to this specification in connection with this application and which are open to public inspection with this specification, and the contents of all such papers and documents are incorporated herein by reference.

[0078] All of the features disclosed in this specification (including any accompanying claims, abstract and drawings), and/or all of the steps of any method or process so disclosed, may be combined in any combination, except combinations where at least some of such features and/or steps are mutually exclusive.

[0079] Each feature disclosed in this specification (including any accompanying claims, abstract and drawings), may be replaced by alternative features serving the same, equivalent or similar purpose, unless expressly stated otherwise. Thus, unless expressly stated otherwise, each feature disclosed is one example only of a generic series of equivalent or similar features.

[0080] The invention is not restricted to the details of the foregoing embodiment(s). The invention extend to any novel one, or any novel combination, of the features disclosed in this specification (including any accompanying claims, abstract and drawings), or to any novel one, or any novel combination, of the steps of any method or process so disclosed.

Claims

1. A device (10) for the separation of fibres from waste material in fibre bearing plants, comprising a plurality of processing members (13A, 13B, 13C) mounted for rotation within an enclosure (1), the enclosure (1) comprising an inlet (11) for material to be processed, an outlet (12) for fibres and a plurality of apertures (24) to allow the egress of waste material, the device being arranged, in use, to receive material at the inlet (11) to undergo a first processing operation by a first plurality of said processing members (13A), said first plurality of processing members being arranged along a first axis of rotation (14A) and being arranged to perform a first stage of separation of fibre from waste and to transfer fibres in a process direction for processing by at least a second plurality of said processing members (13B). 5
2. A device as claimed in claim 1, wherein there are provided first through third pluralities of said processing members (13A, 13B, 13C), said first through third pluralities being rotationally mounted along respective first through third rotational axes (14A, 14B, 14C). 10
3. A device as claimed in claim 2, wherein said first plurality of processing members (13A) counter-rotate with respect to the second plurality (13B) and the second plurality (13B) counter-rotate with respect to the third plurality (13C). 15
4. A device as claimed in any one the above claims, wherein each plurality of processing members (13A, 13B, 13C) comprises fibre separation elements (30, 36, 38) which are mounted to a shaft (14A, 14B, 14C). 20
5. A device as claimed in claim 4, wherein said fibre separation elements (30, 36, 38) extending from the shaft defining the first axis of rotation each comprise a breaking member (31) and a support member (32). 25
6. A device as claimed in claim 8, wherein a first end of each support element (32) is attached to a shaft (14A) and a second end of each support element (32) is attached to a first end of a breaking member (31). 30
7. A device as claimed in claim 6, wherein each breaking member (31) comprises a cutting edge. 35
8. A device as claimed in any one of claims 4 to 7, wherein said fibre separation elements (36) extending from the shaft defining the second axis of rotation (14B) comprise a beating member. 40
9. A device as claimed in any one of claims 4 to 8, wherein at least the fibre separation elements (30) extending from the shaft defining the first axis of rotation (14A) are adapted to produce and promote air movement in the enclosure (1) to aid the separation of the hurds and the fibre once the woody material has been broken away from the fibres. 45
10. A device as claimed in any one of the above claims, wherein said waste material passes through apertures (24) formed in the lower boundary member (16A) under gravity. 50
11. A device as claimed in any one of the above claims, wherein the enclosure (1) contains means to prevent fibres from moving away from the outlet back toward the inlet. 55
12. A device as claimed in any one of the above claims, wherein the enclosure (1) contains aerodynamic means to promote a favourable flow of air within the enclosure (1) to aid in the separation process.
13. A device as claimed in any one of the above claims, wherein removal of the waste material from the enclosure (1) occurs in an automatic fashion.
14. A method of operating a device (10) for the separation of fibres from waste material in fibre bearing plants, the device comprising a plurality of processing members (13A, 13B, 13C) mounted for rotation within an enclosure (1), the enclosure (1) comprising an inlet (11) for material to be processed, an outlet (12) for fibres and a plurality of apertures (24) to allow the egress of waste material, the method comprising:

receiving material at the inlet (11), said material subsequently undergoing a first processing operation by a first plurality of said processing members (13A), said material subsequently undergoing a first stage of separation of fibre from waste by a first plurality of said processing members (13A) which are arranged along a first axis of rotation (14A), said first plurality of processing members subsequently transferring the fibres in a process direction for processing by at least a second plurality of said processing members.

FIG. 1

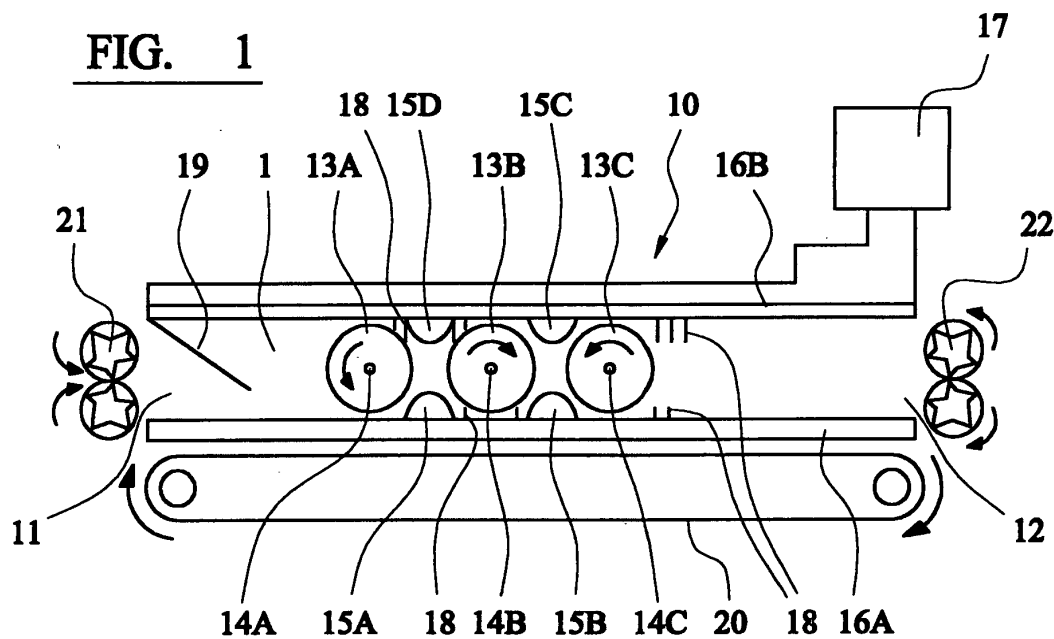


FIG. 2

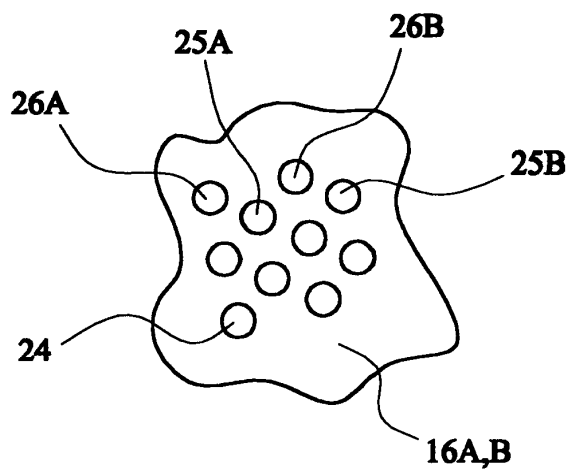
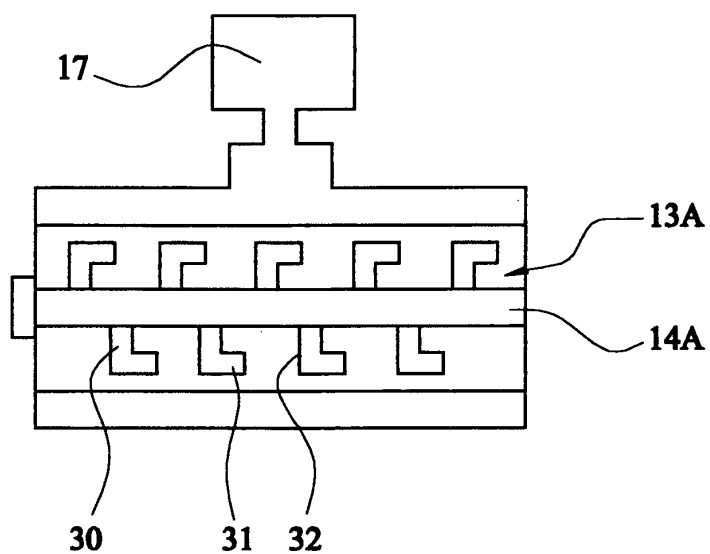


FIG. 3



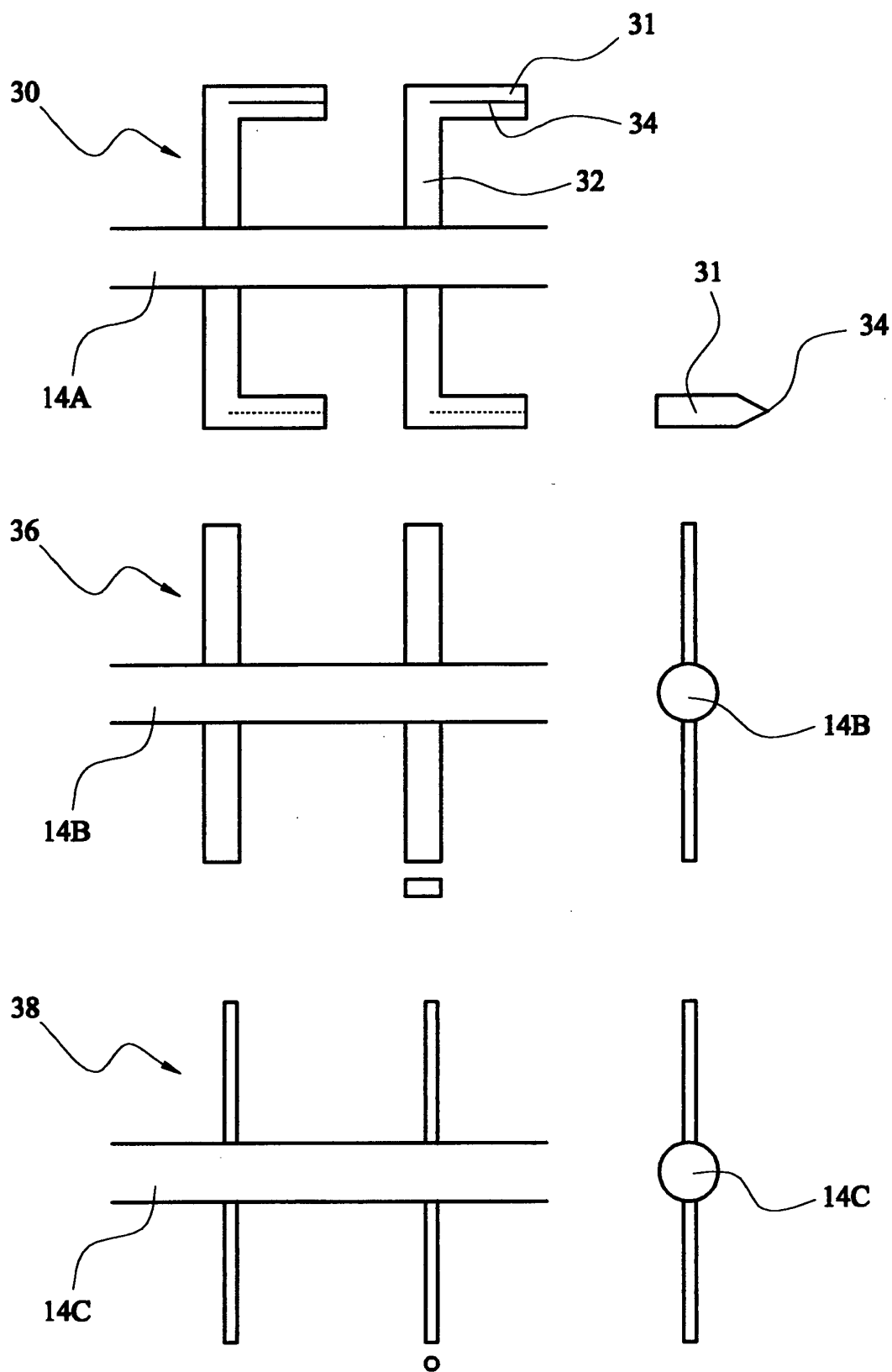


FIG. 4



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 02 25 0617

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.7)
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A	* column 4, line 40 - line 61; claim 1; figure 2 *	1,4,10, 12,14	TECHNICAL FIELDS SEARCHED (Int.Cl.7) D01B
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 6 May 2002	Examiner D'Souza, J
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 L : document cited for other reasons & : member of the same patent family, corresponding document			

EPO FORM 1503 03/82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 02 25 0617

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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