

EMPTY FRUIT BUNCH (EFB) PROCESSING EQUIPMENT FOR THE PALM OIL INDUSTRY

The present invention relates to improvements in fibre processing equipment for producing useable fibre from empty fruit bunches (EFB's) in the
5 palm oil industry.

In the palm oil industry the oil is extracted from the fruit of the palm oil tree. These fruit are on bunches and are called full fruit bunches (FFB). After the fruit has been removed (for processing into palm oil and associated products) the remainder of the bunch is made up of fibre held together via
10 vegetative material and thorns at the extremities. These empty fruit bunches are called EFB. Traditionally the EFB's have been dispersed around the trunks of younger trees to decompose and fertilise the growing trees. Also EFB's can be used in production of fibre products such as car seats, mattress filling and building products.

15 The method traditionally used for breaking up EFB's into its component fibres utilized a hammermill. This has not been particularly successful as it damaged and broke the long fibre strands and required very substantial energy input.

Figure 1 of the annexed drawings shows a section along the centre axis
20 of an EFB showing construction of a centre core 1 and spikelets 2 radiating out and up from this central core. The spikelets are also made up of fibre and the fibres culminate at the ends in the form of hard spikes.

Previous attempts to reduce EFB's to fibre have in the main relied on hammer milling, flails or blades to reduce the mass of damp fibre to separate
25 fibres. The approach generally being to contain the EFB's until reduced to fibre, being contained by an external encasement screen until the fibres are reduced to a size to pass through apertures. This has required extremely high energy inputs and causes much damage to the fibre, reducing much of the fibre to short lengths and dust prior to escaping from the mill or the like. In the case of sharp
30 flails or rotating knives the groups of fibre contained in the spikelets and EFB are immediately cut into unseparated chunks and damaged and substantially reduced in length. A further major problem with reducing EFB's to fibre has

been the numerous thorns located in clusters at the ends of the spikelets giving rise to very numerous spikes protruding around the outer surface of the EFB.

It is the purpose of this invention to process EFB's and produce separated individual long fibre strands and separate thorns into fibres which will be
5 suitable for the above identified industries and any other industry that might usefully use such separated fibres.

It is the object of this invention to use minimal energy to remove successive layers of separated fibre from the EFB regardless of EFB orientation and to remove the layers of fibre in such a way as to separate the fibres and
10 reduce thorns to fibre without cutting or damaging the fibre which would reduce the natural fibre length below a desired level or reduce the normal fibre strength. A preferred objective is to ensure separation of fibres in an energy efficient manner.

According to one aspect of the present invention, there is provided a
15 shredding mechanism for fibrous material such as oil palm empty fruit bunches (EFB's) or coconut husks, said shredding mechanism having at least one first disc adapted for rotation within a space between at least two second discs whereby said first disc and said second discs rotate in opposite direction about spaced parallel axes, said second discs each having radially extending and
20 circumferentially spaced fibrous material engaging formations located around their peripheries, said first disc also including radially extending and circumferentially spaced fibrous material engaging formations located around its periphery, and means for sequentially delivering fibrous material to said space between said second discs.

25 Conveniently, a plurality of said first and second discs are provided with said first discs each being located at least partially between a pair of said second discs. Preferably, the two or more second discs are integrally formed with a common hub region or are interconnected whereby they are arranged to rotate together. Preferably, the first discs are integrally formed with a common
30 hub region or are interconnected whereby they are arranged to rotate together. Conveniently, the first and second discs have independent rotation means whereby the speed of rotation of the first and second discs is independently

variable. Preferably the number of the radially extending formations on each of said second discs is greater than on the or each of said first discs. Preferably the axis of rotation of said second discs is located at a level higher than the axis of rotation of the first discs. Conveniently, the radially extending formations on the second discs are round pegs and preferably also taper towards their outer extremities.

According to another aspect of the present invention, there are provided novel forms of macerators as described in the following. -

More specifically, the present invention provides macerator apparatus for fibrous material comprising a pair of counter rotating members defining a region therebetween through which fibrous material is passed. Still further, the present invention provides macerator apparatus for fibrous material comprising a pair of counter rotating drums defining a region therebetween through which fibrous material is passed, each said drum having a plurality of pintle formations extending therefrom whereby the pintle formations on said drums intermesh in said region to provide a combing effect on said fibrous material.

In accordance with other aspects, the present invention provides apparatus for forming fibre material from fibre containing members such as oil palm empty fruit bunches (EFB's) or coconut husks, said apparatus comprising delivery means for delivering sequentially single fibre containing members from a holding means for such fibre containing members; primary shredding means for receiving fibre containing members from said delivery means and for shredding said members to form fibrous material therefrom; secondary macerator means for receiving the fibrous material formed by said primary shredding means and for forming individual strands of fibre therefrom; washing means adapted to receive the fibres from said secondary macerator means and to wash said fibres; and drying means adapted to dry the washed fibres from said washing means. Conveniently, the washing apparatus for washing fibrous material comprises rotatable drum means for receiving fibrous material therein, said drum means including means for moving the fibrous material longitudinally along the drum means, and means for introducing a washing or cleaning medium into the drum means.

The processing stages are as follows :-

Stage 1

In a primary shredder, whole EFB's are mechanically separated into smaller fibrous components. The primary shredder may utilize a shredder of
5 mechanism as described in the preceding paragraphs. This shredder may be fed by a singulator feed hopper. The EFB's are thereby conveyed singularly into the primary shredder to provide uniform spacing and quantity loaded into the shredder for optimum operation. Capacity up to 40 tonnes/hour.

Stage 2

10 Secondary Macerator - The smaller fibrous sections previously shredded are here separated down into individual strands of fibre. The invention allows for a series of different processes to fully singulate the fibres. A number of different processes are covered in the body of this patent application each successive process being applied until the standard of commercial grade fibre is
15 achieved. In the preferred embodiment a series of pintles radiating outwardly from the surface of two opposing drums intermesh to provide a reactive combining process, with interceding rollers set at a precise distance apart to crush thorns separating them into coarse fibre without damage to normal thickness fibre.

20 Stage 3

Wash and Rinse - The individual strands of fibre are washed and rinsed, removing any oil and other residue. This residue and oil are processed and recycled until it is useable, then it is taken off into a holding tank. This process is explained further in the body of this patent and is based on a continuous
25 process with an internal structure that causes the tumbling washing process that moves the fibre mass lineal through the machine.

Stage 4

Spin Dry - The washed and rinsed fibres are spun using centrifugal force to remove the residual water. The invention provides for an internal rotating
30 helix which rotates at a slight variation of speed to outer spin dry drum, thus processing the fibre through the machine.

Stage 5

Tumble Dry - The spin dried fibre is totally dried using hot air forced through a tumble drier which is fitted with an internal mechanism to progress the fibre through the machine.

5 Stage 6

Baling - The dried clean fibre is baled ready for transport.

Several preferred aspects of the present invention will now be described with reference to the accompanying drawings, in which:

Figure 1 is a schematic longitudinal cross-sectional view of an empty fruit
10 bunch (EFB);

Figure 2 is a perspective view of a hopper and singulating conveyor for delivering EFB's to a primary shredding mechanism;

Figure 3 is a schematic cross-sectional view of one preferred form of primary shredding mechanism according to the present invention;

15 Figure 4 is a schematic side elevation view (housing removed) of the primary shredding mechanism shown in Figure 3;

Figure 5 is a detailed partial perspective view of the peripheral regions of the discs shown in Figures 3 and 4;

Figures 6 to 9 are partial views of (similar to Figure 3) showing other
20 preferred features of the co-pending discs of the primary shredding mechanism;

Figure 10 is end elevation view of a secondary macerator device capable of use in association with the primary shredding mechanism shown in Figures 3 to 9;

Figure 11 is a partial perspective view of the drum members shown in
25 Figure 10;

Figures 12 and 13 are respectively longitudinal and transverse cross-sectional views of a self cleaning drum capable of use as a secondary macerator as shown in Figures 10 and 11;

Figures 14, 15 and 16 are detailed perspective views showing operation
30 of a secondary macerator as illustrated in Figures 10 to 13;

Figure 17 illustrates that the secondary macerator drums may be arranged in towers such that the discharge from one drum pair feeds a second drum pair and so on;

Figures 18 to 27 illustrate still further possible preferred forms of
5 secondary macerators;

Figures 28 and 28a show schematically washing and rinsing mechanisms for the fibre;

Figure 29 illustrates schematically one possible form of spin drying mechanism; and

10 Figure 30 illustrates a tumble linear transfer drying mechanism.

Figure 2 of the drawings shows schematically a singulating conveyor in which a quantity of EFB (3) can be loaded into the storage hopper (4), the floor of which is convoluted with a series of inverted "V's" (5) which guide the EFB into alignment with a series of chains (6) moving between the central "V" ribs, 15 the chains are of very durable construction and are fitted with a series of rollers on both sides of each chain to give lateral stability and resist forces generated when "V" shaped side spikes (7) attached to the chain engages into an EFB. The width of the hopper is such (in one preferred embodiment for parallel chains) that the bridge or arch normally formed by removing EFB's supported 20 between a narrow sloping sided bin is avoided. The distance across the hopper being greater than that which can be sustained by an arch formed by the EFB. The forked prongs (7) attached securely to the chain engage in an EFB and drag in the main a singular EFB (8) from the pile of EFB's (3). Any other EFB loosely engaged against the impaled EFB fall away and return to the hopper 25 due to the effect of gravity as the chain ascends the steeply sloping floor with the impaled EFB at the water level of the top of the hopper the inverted "V's" cease further ensuring the return of loose EFB's and largely supplying a singular EFB on each of the impaling members. The position of the EFB impaling members along the chain and relative to each other and the timed relationship of each 30 chain to the other is such that one EFB at a time is submitted to the primary shredder for ongoing processing.

The invention discloses a unique method of storing energy, restraining the EFB to a controlled feed rate and removing and carrying away layers of fibres as shown in Figures 3 and 4 (Figure 3 being side elevation and Figure 4 being front elevation).

5 The primary shredding machine is comprised of a series of large diameter discs (9) of high quality steel mounted with spacers (10) between each successive disc along a shaft (11) giving a precise predetermined distance between each disc giving a multiple of discs along the shaft. In this disclosure a 1 metre wide feed chute (12) allows the engagement of two large EFB (13) in
10 distinct separate locations (14) across the face of the discs fed from the singular feed hopper. Said discs are attached to a substantial shaft and bearing assembly and in turn mounted on a heavy duty frame and driven with a power source. A second like series of discs (15) mounted on a second separate shaft (16) and bearing assembly is mounted on the frame to cause the second disc
15 assembly to engage centrally between the discs of the first assembly to form a plurality of even spacings between each successive disc.

The second disc assembly (15) is powered by a separate variable speed power supply enabling the precise control of the rotational speed of the exterior of the discs downwardly and semi vertically between the first disc assembly (9).
20 Said first disc assembly (9) (or feed disc assembly) has radially disposed about its circumference a series of evenly spaced round pegs (17) with tapered pointed ends. The spiked round pegs (17) are fitted into the outer disc centre line. The outer edge of the first disc assembly (9) is a complete radius so that the outer diameter of the circular edge of the disc is equal to the disc thickness.
25 The combination of the round spiked pegs (17) inserted into the round outer edge of the discs means that completely smooth and rounded edges are presented to the EFB so as not to cut the fibre. The purpose of the first or feed disc assembly (9) is that the rotational forces generated by the second disc assembly (15) horizontally conveys the EFB (13) against the first disc assembly
30 (9) impaling the EFB on its spiked pegs (17) preventing the EFB being prematurely ingested in whole and having very large pieces fed through the machine. This enables a variable speed control of the feed rates of the EFB

which is on the feed discs (9). Two timed streams of EFB's (14 & 13) are presented to the Primary Shredder in alternate fashion and located so as not to impinge on each other during the processing phase. There is substantial kinetic energy stored in the spinning discs and the feed rate of the disc assembly is set to take advantage of the alternative feed of the EFB allowing for full engagement of one EFB and as the EFB is processed and past mid point extremities of the EFB a second EFB is engaged.

The second disc assembly (15) is comprised of a series of discs with relatively flat outer surfaces at 90° to the sides of the discs the outer corners only are radiused. Inserted in the outer surface and radially disposed with gaps between each member there is attached a round peg (18) with a flat top with radiused edges, this peg diameter is equal to the disc width and is at a height above the disc to best engage in a controlled depth of the fibre which as the round peg (18) (see Figure 5) passes through the EFB removes a layer of fibres equal to the height of the tooth and with the loose fibres (19) trailing either side of the tooth, by this means the controlled group of fibres are separated and removed without cutting by being engaged against the face of the tooth which is equal to the thickness of the disc.

As seen in Figure 5, the discs rotate with the group of fibres (19) looped around the leading edge of the round tooth (18) and the EFB engaged on the spikes of the leading discs (9), the fibre is separated and pulled away from the EFB with the trailing ends pulling around the rounded surfaces of the restraining feed discs, thereby separating and maintaining the natural fibre length without cutting.

As shown in Figure 6, the remaining portions of the EFB (20) that are impaled on the lead disc spiked pins (17) are conveyed down between the rotating discs (Figure 7) with peripheral pegs or teeth (18) being engaged with like rounded flat topped pegs or teeth (21) located at 90° to the side faces of the rotating discs (15). They in turn, engage groups of fibres from the sides of the remaining EFB (20) pulling it around the curved leading edge and/or pulling the remaining segments of fibre from around the spiked pins on the lead discs as it progresses further downward (Figure 8) between the opposing spinning discs,

subsequent fibre engages round teeth of additional length to take a further layer of fibre away from the remaining segment of EFB (20) (Figure 9) impaled on feed teeth (21) until such time as controlled by clearance of the engaging teeth and the radiused edge of the disc and the feed spiked pin, until the fibre is removed.

The centrifugal force of the disc (15) containing the round fibre engaging pintles (17) or the outer circumference and sides of disc is sufficient to clear all fibre.

After the EFB has been through the primary shredder it then passes into secondary macerating drums (22 & 23) (Figure 10) via inclined conveyors (c) shown in Figure 3. The drums counter rotate and the high speed drum (macerating) (22) rotating faster than the self cleaning slow speed drum (fibre feed drum) (23). Both these drums have rows of round flat headed pintles (24) across the width of the drum and around the circumference of the drum. These pintles intermesh across the drums at mid point (25) (Figure 11 - plan view of two drums) and cause a "combing" effect on the shredded EFB further individualising the fibre which is the purpose of this fibre processing plant. Due to the high speed of the macerating drum (22), the centrifugal force generated causes the high speed drum (22) to remain clean, throwing off any fibre stuck to the drum.

Figures 12 and 13 illustrate the mechanism principle of the self cleaning drum (23) (fibre feed drum). A central shaft (26) supported at each end by bearings (27) supports an external drum (28) via plates (29 & 30) attached both to the central shaft (26) and the external drum (28). This drum has rows of holes (31) across the face of the drum and around the circumference and inside the drum are cross bars (32) in which the round headed pins which comb the fibre are secured. These bars have bearings (34) mounted on each end of the bar (32) which run in an offset cam (35) causing the bars to extend out through the drum at the combing position and retract into the drum at the cleaning position. This offset distance is the same as the pindle length. Due to the neat tolerance fit of the pins and the holes in the drums this causes any fibre caught on the pins to be pushed off as the pin retracts, see Figure 14. There is also a secondary flat

scraper which extend the full width of the drum that scrapes off any residue or fibre stuck to the drum. Also, an optional rotating cylindrical stiff bristled brush running across the width of the drum and counter rotating to the drum can be employed to further keep the drums clean.

- 5 The function of the flat headed round pins on the macerating drums is as follows :-

In Figure 15, the pins (35) on the slow moving fibre feed drum (23) feed the fibre clockwise toward the fast moving macerating drum which is rotating anti-clockwise as the pins engage and pass between each other. The pins on
10 the fast moving macerating drum (37) engage in the presented fibre (39) and pull the fibre (39) around the pins (35) on the slow moving feed drum. As the pins are round this stops any ripping or cutting of fibre ensuring that fibre is separated and fibre length is maintained. As the pins on the macerating drum are moving much faster than the feed drum a pulling / separating action is
15 achieved allowing for a clean separation of fibres (Figure 16).

These drums can be mounted in macerator towers (Figure 17) (fed by inclined conveyors) consisting of, in one convenient form, three sets of macerating drums vertically mounted. This causes the fibre to be "combed" three times at ever increasing speeds ensuring a fine separation and break up
20 of resultant fibre.

Due to the spike in the shredded EFB (which must be removed) there is need to crush the spikes / thorns to flatten the spikes / thorns and therefore break up the spikes / thorns into its individual fibres (the spikes / thorns being composed of fibres joined together in a hard portion).

- 25 Therefore, a second and even third macerator tower may be necessary consisting of a macerator drum with round headed pins then directly under that, compression rollers, then another macerator drum directly under the compression drum. Importantly some clearance between crushing drums so as to reduce the thorn to fibre is required to avoid crushing or damaging other fibre.

30 In Figure 17, the compression rollers (40) consists of two counter-rotating drums running at a very close proximity to each other. These drums are spinning fast and take the fibres, crush them and eject them into the lower

macerating drum (41). The same applies to the third tower if necessary.

A further embodiment of the macerating drum is that at each tower the round flat headed pin diameters decrease and the pitch of the pins both across the drum and around the circumference also decreases accordingly, ensuring a
5 finer "combing" action, thereafter ensuring a finer individual action of the fibre.

There are a number of possible alternatives to the secondary macerating procedures. Figure 18 shows one possible alternative. In this embodiment, two counter rotating drums 42 are used, one drum rotates faster than the other causing a differential surface speed, both drums are metallised (43) with
10 tungsten carbide to create a rough surface to separate and hold fibres. High pressure water (44) at the underside separates the bonding, softer tissue from the fibrous material while the fibres remain captive and restrained on their passage down between the surface of the rollers. The axial movement of the rollers in a reciprocating manner 45 causes forces to separate the fibres at 90°
15 to the direction of travel and direction of separating forces applied to the fibres by the rollers differential surface speeds.

Figure 19 shows a second possible alternative for secondary maceration of the fibres. In this arrangement, a series of close spaced counter rotating discs (46) are provided. These discs are metallised with tungsten carbide (47). The
20 shredded EFB fibre is forced with high pressure water 48 into these counter rotating discs. The discs (46) are tapered (49) on the circumference to allow easy entry of shredded EFB. Fibres are then entrapped and forced between the counter rotating discs (Figure 20) towards the centre point between the discs pivotal point (51) at the horizontal centre point (51) the action is vertical
25 downwards, slight differential speeds would give a vertical downward separating force (51). At (52) the separating forces are horizontally inward and at (53) the separating forces are horizontally outwards. This variation of separating forces should ensure an effective means of separating the fibres.

Figure 21 shows a still further embodiment for a macerator of shredded
30 EFB fibre using three discs, the two outside discs (54) have overlapping holes (55) to allow high pressure water jets to assist in the fibre separation. These outside discs also have axial movement to vary fibre processing clearance. The

aim is to have a wide area of surface contact between overlapping discs to separate fibre regardless of orientation. The fibre separating forces would be the same as in Figure 19, hence again ensuring an effective means of separating fibres.

5 A further means of macerating the shredded fibre is by two counter rotating plates (Figures 22 & 23). Plate (56) (Figure 21) has two tapered edges running to a radiused point around circumference and discs (57) are machined to surround plate (56) with even clearance (58) (Figure 22) around external profile of disc (57). This clearance (58) between disc faces will be adjustable by
10 means of moving discs (57) axially closer or apart from the external faces of disc (56) disc shafts (59) can have the shaft centre distance increased or decreased. The EFB shredded fibre may be discharged into a fibre entry control chute (60) (Figure 24). By varying the position of this control chute the forces to separate the fibres change in a combination of actions and directions by the variation of
15 radiuses and relative surface speeds of the opposing factors. Figure 25 shows the resultant direction of separating forces on the EFB fibres. Two streams of fibre are simultaneously processed between the inside faces of discs (61) and outside surfaces of disc (62).

Figures 26 and 27 show a further embodiment for macerating fibre again
20 using counter rotating discs. Disc (63) has two straight tapered sides and plates (64) have matching tapers and fully enclose tapers on plates (63) forming a minimal clearance at (65) (Figure 26). The internal faces of discs (64) and the external faces of disc (63) are again metallised with tungsten carbide to ensure a good grits and maceration of shredded fibre. Fibre thickness is determined by
25 the clearance at (65). This clearance is adjusted by axially moving discs (64) closed or apart and/or moving disc shafts (66) closed or further apart.

Washing and rinsing of the shredded and macerated fibre is shown in Figure 28. After the EFB has been shredded and macerated down to individual fibres it must be washed and rinsed to remove any oil and residue. Washing
30 and rinsing are undertaken in two stages. The first stage is a wash using a biodegradable detergent. The washing cycle is accomplished by means of a large horizontal revolving stainless steel cylinder (67). On the inside of this

cylinder is an external auger (68). Shredded and macerated EFB is deposited through the end of the cylinder via an inclined conveyor. After being deposited into the revolving cylinder, the revolving motor tumbles the EFB fibres via horizontal paddles (69) running full length of barrel and the auger motion moves
 5 the EFB along towards the rinse stage. The bottom of the barrel is immersed in a detergent solution ensuring that fibre is immersed and thoroughly washed. Running up the centre of the cylinder is a spray bar (70) (Figure 28A) consisting of a high pressure steam line (71) and a water detergent line (72) mounted in relationship with the flow of the tumbling fibre, so that the fibre continually
 10 passes through jets of super heated water or water detergent mix. Following the washing stage, the fibre is carried via the auger into the rinsing stage. This consists of the same structure as the washing stage where the fibre is thoroughly rinsed and cleaned.

A spin drying mechanism is shown in Figure 29. Rinsed EFB fibre is
 15 deposited into the spin dryer at the top of the entry chute (73) where it is transported slowly via a moving auger (74) into the actual spin drying machine (75). The drying mechanism consists of an internal revolving cylinder (76) and an external fixed cylinder (77) enclosing an auger (78) with a fine pitch fixed to the spinning internal cylinder (76) which is supported each end by bearings.
 20 The external cylinder (77) has small holes to allow water to escape caused by the centrifugal force. An outer cylinder collects this water and it is pumped away. After passing through the spin dryer the fibres are transported via an inclined conveyor to the tumble dryer shown in Figure 30. The tumble dryer consists of a slowly revolving horizontal cylinder (79) with an internal auger (80).
 25 The fibre is fed through infeed chute (81) into the dryer barrel and is carried around and up via the revolving auger and falls back down through hot air forced through the cylinder through ducts (82) from a heat exchanger.

Waste water recycling is achieved by running discharge drainage from rinsing / washing process through a number of separating processes where the
 30 drainage water passes over a curved wire screen where the majority of the liquid is removed leaving the solids of the tail of the screen to drain further before being discharged as relatively dry solids. These solids are then passed

into a holding tank. The drainage liquid is then passed into a settlement tank where any oil in the mixture can come to the top and any heavier particles can settle as sludge at the bottom. The water is then put through an oil separator to remove any oily residue left and then is held in a tank to be used again. There
5 are two tanks for holding water, so when the solution becomes unusable the other tank is used while the unusable solution is replaced.



THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A shredding mechanism for forming fibrous material from a fibrous material containing member such as oil palm empty fruit bunches or coconut husks, said shredding mechanism having at least one first disc adapted for rotation within a space between at least two second discs whereby said first disc and said second discs rotate in opposite directions about spaced parallel axes, said second discs each having radially extending and circumferentially spaced fibrous material engaging formations located around their peripheries, said first disc also including radially extending and circumferentially spaced fibrous material engaging formations located around its periphery, and means for sequentially delivering fibrous material to said space between said second discs.
2. A shredding mechanism according to claim 1 wherein a plurality of said first and said second discs are provided with said first discs each being located at least partially between a pair of said second discs.
3. A shredding mechanism according to claim 1 or claim 2 wherein said two or more second discs are integrally formed with a common hub region or are interconnected whereby they are arranged to rotate together.
4. A shredding mechanism according to claim 2 or claim 3 when appended to claim 2 wherein said first discs are integrally formed with a common hub region or are interconnected whereby they are arranged to rotate together.
5. A shredding mechanism according to any one of claims 1 to 4 wherein the first and second discs have independent rotation means whereby speed of rotation of the first and second discs is independently variable.



6. A shredding mechanism according to any one of claims 1 to 5 wherein the numbers of the radially extending formations on each of said second discs is greater than on the or each of said first discs.
7. A shredding mechanism according to any one of claims 1 to 6 wherein an axis of rotation of said second discs is located at a level higher than an axis of rotation of the or each of said first discs.
8. A shredding mechanism according to any one of claims 1 to 7 wherein the radially extending formations on the second discs are round pegs.
9. A shredding mechanism according to claim 8 wherein said round pegs taper towards their outer extremities.
10. A shredding mechanism according to claim 8 or claim 9 wherein the radially outer end of each said round peg is a curved surface.
11. A shredding mechanism according to any one of claims 1 to 10 wherein a peripheral edge surface of each said second disc is curved when viewed in diametrical cross-section.
12. A shredding mechanism according to any one of claims 1 to 11 wherein first individual spaced formations extend from side faces of the or each of said first discs.
13. A shredding mechanism according to any one of claims 1 to 12 wherein second individual spaced formations extend from side faces of each of said second discs.



14. A shredding mechanism according to any one of claims 1 to 13 wherein said fibrous material engaging formations on the or each said first disc are round pegs of substantially uniform cross-section with a substantially flat radially outer surface.
15. A shredding mechanism according to claim 14 wherein the diameter of said round pegs on the or each said first disc is substantially equal to the thickness of the first disc on which they are mounted.
16. A shredding mechanism according to claim 14 or claim 15 wherein a peripheral edge of the substantially flat outer surface of each said round peg is chamfered or radiused.
17. A shredding mechanism according to any one of claims 1 to 16, further including delivery means for delivering single said fibrous material members to the shredding mechanism.
18. A shredding mechanism according to claim 17 wherein said delivery means comprises a storage hopper adapted to receive and hold a plurality of said fibrous material members, a conveyor mechanism comprising at least one elongated endless conveying means carrying a plurality of evenly spaced fibrous material member engaging formations, each said fibrous material member engaging formation being adapted to engage only one said fibrous material member.
19. A shredding mechanism according to claim 18 wherein each said elongated endless conveying means comprises a chain.
20. A shredding mechanism according to claim 18 or claim 19 wherein each said fibrous material member engaging formation comprises a spike.



21. A shredding mechanism according to any one of claims 18 to 20 including inclined support surfaces on either side of the or each said elongated endless conveying means forming a trough configuration thereabout at least adjacent said storage hopper.

22. A shredding mechanism according to claim 21 wherein the or each said elongate endless conveying means is inclined upwardly from said storage hopper.

23. A shredding mechanism according to claim 21 or claim 22 wherein the depth of said trough configuration decreases progressively away from the storage hopper.

24. Apparatus for forming fibre material from fibre containing members such as oil palm empty fruit bunches (EFB's) or coconut husks, said apparatus comprising delivery means for delivering sequentially single fibre containing members from a holding means for such fibre containing members; primary shredding means for receiving fibre containing members from said delivery means and for shredding said members to form fibrous material therefrom; secondary macerator means for receiving the fibrous material formed by said primary shredding means and for forming individual strands of fibre therefrom; washing means adapted to receive the fibres from said secondary macerator means and to wash said fibres; and drying means adapted to dry the washed fibres from said washing means.

25. Macerator apparatus for fibrous material comprising a pair of counter rotating members defining a region therebetween through which fibrous material is passed.



26. Macerator apparatus for fibrous material comprising a pair of counter rotating drums defining a region therebetween through which fibrous material is passed, each said drum having a plurality of pintle formations extending therefrom whereby the pintle formations on said drums intermesh in said region to provide a combing effect on said fibrous material.

27. Macerator apparatus for fibrous material comprising at least two pairs of counter rotating drums arranged one above the other, each said pair defining a region therebetween through which fibrous material is passed, the drums of at least one of said pair of drums having a plurality of pintle formations extending therefrom whereby the pintle formations on said drums intermesh in said region to provide a combing effect on said fibrous material, and the drums of at least another pair of said drums comprising compression means to compress and crush the fibrous material passing therethrough.

28. Macerator apparatus according to claim 26 or claim 27 wherein the pintle formations on each said drum are arranged in circumferential rows with the rows on said drums intermeshing in said region.

29. Macerator apparatus according to any one of claims 26 to 28 wherein at least some of said pintle formations are movably arranged to substantially withdraw inwardly of the drum at at least one rotational position of the drum.

30. Macerator apparatus according to claim 27 or any one of claims 26 to 29 when appended from claim 27 wherein the diameter of the pintle formations on the relatively upper pair of drums being greater than the diameter of the pintle formations on the relatively lower pair of drums.

31. Macerator apparatus according to claim 27 or any one of claims 26 to 29 when appended from claim 27 wherein the speed of rotation of the relatively upper pair of drums is less than the speed of rotation of the relatively lower pair of drums.



32. Macerator apparatus according to any one of claims 26 to 31 wherein the drums of any said pair of drums with pintle formations are relatively rotated at different speeds.

33. Washing apparatus for washing fibrous material comprising rotatable drum means for receiving fibrous material therein, said drum means including means for moving the fibrous material longitudinally along the drum means, and means for introducing a washing or cleaning medium into the drum means.

34. Washing apparatus according to claim 33 further including drying means for drying the fibrous material from said drum means.

35. A delivery means for a primary shredder apparatus comprising a plurality of elongated endless conveying means each carrying a plurality of evenly spaced fibrous material engaging formations, each of said fibrous material member engaging formation being adapted to engage only one said fibrous material member, a first end of each said elongated endless conveyor being arranged within a storage means for said fibrous material members and there being a sufficient number of said elongated endless conveying means to prevent bridging of said fibrous material members within said storage means above said first ends of the elongated conveyors.

36. A delivery means for a primary shredder according to claim 35 wherein at least three and preferably four said elongated endless conveying means is provided.