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PATENT SPECIFICATION

DRAWINGS ATTACHED

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Int. Cl.:—B 27 j 1/00, B 29 j 5/00

COMPLETE SPECIFICATION

Sugarcane Processing

I ROBERT BOOTHE MILLER a citizen of
of the Dominion of Canada, of 12540 126
Avenue, Edmonton, Alberta, Canada, do
hereby declare the invention for which I pray
that a Patent may be granted to me, and the
method by which it is to be performed to be
particularly described in and by the following
statement:—

This invention relates to a process for
making board products including boards and
veneers) from sugar cane and a board pro-
duct comprising fibre from sugar cane. More
particularly the invention concerns such a
process using the rind from sugar cane ob-
tained by the process described in the co-
pending Application No. 30498/65 (Serial
No. 1126492) of even date (on which the
present Application is divided).

Sugar from sugar cane is produced by a
conventional process which initially requires
the violent destruction of the whole cane stalk
by the use of massive machinery that cuts
crushes shreds and breaks the whole cane
stalk and then under enormous pressure force-
fully squeezes out the natural juices. This is
referred to as milling and while it has been
used successfully in the extraction of the juices
from the whole cane it destroys many desir-
able structural characteristics of the rind por-
tion of the stalk. The primary commodity
sought from the usual methods of processing
sugarcane and in the fact the only commodity
normally derived from sugarcane is the actual
sugar itself with little or no regard to the
recovery of other products. A by-product
of conventional sugarcane processing is bagasse
which is the fibrous or woody portion of sugarcane
used as fuel at most mills.

It has been discovered that the fibrous struc-

ture of the rind of sugarcane has special
desirable physical and structural character-
istics when the fibres are used in the form
of fibre bundles. In the milling required
by conventional processes for handling sugarcane
these desirable fibre characteristics are
totally destroyed and it is not possible under
any circumstances in conventional sugarcane
processes to preserve these characteristics. The
problem concerns more than processing the
rind alone since it is necessary at the same
time to consider the recovering of the juice
from the stalk as well as the recovering of
the rind fibres in such a condition as to
preserve these characteristics. With conven-
tional processes and apparatus it is virtually
impossible to extract the juice from the sugarcane
and at the same time maintain the rind
fibres in a substantially discrete, continuous
or undisturbed rind form so that the rind fibres
can be utilized in the manner contemplated
by this invention.

The rind portion of sugarcane stalk, as it
is referred to hereinafter, contains numerous
fibre bundles, sometimes called fibrovascular
bundles, which are groups of elemental fibres
in discrete elongated units. The elemental
fibres of sugarcane rind resemble somewhat
the elemental fibres of ratan and hackberry,
but differ materially from the bast fibres as
found in certain dicotyledonous plants as flax,
hemp, ramie and jute. The fibre bundles
in the rind of the sugarcane differ materially
from the fibrovascular bundles of certain mono-
cotyledons as sisal, hemp, raffia, pineapple and
ristra, manila hemp and other such plants.
Although there are similarities between the
elemental fibres of these plants and elemental
sugarcane fibres, sugarcane rind contains fibre

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Price 25p

bundles which have been found to make the sugarcane rind particularly useful in the manufacture of products as will be explained.

The rind produced by the process of the aforesaid Patent Application is a highly useful product not heretofore obtainable by conventional processes and apparatus for handling sugarcane. The fibre bundles can be manipulated and processed into a variety of different forms; for example, building boards, planks, mats, flexible sheets, and the like, having a variety of uses. The rind product of this invention has fibre bundles which, in effect, are unbroken and undisturbed. When the rind strips are laid side-by-side and subjected to suitable pressure, an action takes place termed fibre flow, which will be explained in detail. While normally the fibre bundles make up discrete strips, when subjected to heat and pressure, the fibre bundles flow or more transversely with respect to their length and can be pressed into a continuous homogeneous mass of aligned long fibre bundles wherein each strip loses its identity as such.

The present invention comprises a process for making board products from sugarcane comprising longitudinally opening the sugarcane stalk without damaging the rind, removing the pith from the rind and subjecting the rind thus freed of pith to heat and pressure.

The invention also provides a board product made by this process comprising rind from sugarcane wherein the rind has been manipulated into a composite material of interlocked rind held together by the natural binder material of the sugarcane.

In order that the invention may be better understood reference will now be made to the accompanying drawings in which:

Figure 1 is a perspective view of the details of a portion of a stalk of sugarcane;

Figure 2 is a schematic diagram illustrating the novel process of this invention;

Figure 3 is a side elevation view showing diagrammatically the apparatus employed in this invention;

Figure 4 is a plan view, corresponding generally with Figure 3;

Figure 5 is a perspective view of a typical portion of a stalk of sugarcane illustrating, among other things, various types of internodes;

Figures 6 and 7 are perspective views of typical rind strips of this invention, showing respectively the exterior and interior surfaces;

Figures 8, 9, and 10 are detailed view of the surfaces of products made from the strips shown in Figures 6 and 7 and

Figure 11 is a perspective view illustrating diagrammatically the manufacturing of board products of the fibres from rind strips.

Sugarcane is a member of the grass family grown in many tropical and subtropical areas of the world. Figure 1 shows a typical section of sugarcane stalk. This portion of the

stalk 10 has two nodes 12, the part there-between being an internode. The outer region or rind 14 of the internode is hard and contains numerous fibrovascular bundles that strengthen the stalk. The interior 15 of the stalk is mainly soft pith that contains most of the sweet natural sugar juice. The exterior of the mature internode is usually covered with a thin film of waxy bloom or cuticle wax, as it is frequently called. Wax is also found throughout the rind portion as well as on the surface. A ring 16 beneath the node 12 contains a high concentration of wax. A band 17 above the wax ring 16 is called the leaf scar. A root band 18 is a small section of the node just above the leaf scar 17 that usually differs in colour from the internode and has many small dots. Under favorable moisture conditions, a root may develop at each dot, should the section of stalk 10 be placed in the ground. Just above the root band 18, and not usually clearly distinct from it, is a transition area known as the growth ring 19. Elongation and growth of the internode takes place in this area. A bud 20, when exposed to favorable moisture and temperature conditions and with proper stimulus, can develop into a new shoot. Expansion of the diameter of the stalk 10 may result in growth cracks 21 which may extend inwardly through the rind. Smaller, barely distinct, cork filled cracks may develop along the internode and separate the fibrous materials of the rind for short distances. Sugarcane ordinarily averages about 9 per cent by weight of rind and about 91 per cent by weight of water and soluble solids found in the pith.

FIGURE 2 shows schematically the novel process for the production of a fibrous article from the rind of sugarcane. The stalks, represented at 30, are harvested, the leaves are removed, and the cane may be washed at conventional cleaning plants or cane laundries, if desired, as represented at 31. In this invention, the stalks are processed separately, as represented at 32, compared with the present processes wherein the stalks are processed in bulk.

Cleaning of the rind to produce fibre bundles free of foreign matter, loose fibres and other parts of the stalk is begun by removing the cuticle wax from the exterior of each separate stalk as represented at 33. This wax naturally adheres to the rind and is removed as a wax or powder. No attempt is made to remove that wax which extends through the rind, but only the cuticle wax adhering to the exterior of the rind portion of the stalk along the internodes and at the wax band (see FIGURE 1). Since cane wax has commercial value, it may be collected and refined into commercially usable wax products.

The thin epidermis layer of fine, loose fibres is removed from the exterior of the rind, as represented at 35, in order to expose

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the relatively hard, strong fibre bundles. The epidermis has no structural value, and if left could materially lessen some of the physical as well as chemical properties of the rind strips ultimately produced. Since the epidermis of some varieties of sugarcane is quite colorful, for special uses, as will be explained, the epidermis may be left on. The important thing is to remove from the outside of the whole cane stalk all of the trash, wax, and loose matter, including the epidermis, although in some cases as just stated, the epidermis only may be left on. This cleaning of the stalk is effected without penetrating or damaging the fibre bundles of the rind.

The whole stalk 36 with the exterior wax and epidermis removed is further processed by cutting it longitudinally throughout its length into two parts to expose the interior pith and by spreading the rind, as represented at 37. The cutting and spreading serves the purpose of ultimately preserving the rind of the stalk in as large pieces as conveniently possible and at the same time opening up the stalk for access and removal of the juice laden pith. While this process has been carried out successfully by severing the stalk into two parts it is possible to split each stalk longitudinally into more than two parts or to make a single longitudinal cut into one side of the rind only.

After the pith is exposed by splitting the stalk longitudinally, the pith is carefully removed from the stalk strips 38 without squeezing the pith to express the juice therefrom, as represented at 39. The stalk, at this station, is separated into two major components; namely, the soft pith containing most of the juice still held in the pith cells and the cleaned fibrous rind portions. At no point is the stalk subjected to pressure so as to express a substantial amount of juice; and, furthermore, the rind has not been subject to milling or any substantial physical force other than the single cutting action. After this separation step, the pith is ready for further processing to remove the juice. The rind is in the form of strips the length of the stalk pieces. Extremely crooked pieces of stalk can be cut crosswise into shorter pieces for easy handling prior to the start of process, if necessary.

Next, the rind strips are conditioned for utilization of the elongate, individual fibres. This may be performed as part of the pith removal operation. For making veneer and other board products, for example, wherein it is desirable to position individual rind fibres into compact and continuous special shapes, it is beneficial to loosen or break mechanically the natural bond between separate fibres without significantly lessening the longitudinal tensile strength of the fibres. This may be accomplished in a number of ways, for example, by passing the rind strips through a pair of rollers which serve to press and flatten the strips and spread apart the individual fibres due to the compression action of the rollers. Another way to accomplish this is to pull the rind strips longitudinally over and firmly against a substantial part of a curved surface, preferably with the exterior of the rind engaging the surface, so that the strips leave the surface at an angle with respect to the direction that the strips engaged the surface. This forces the strips from their normal curved shape to a flat shape. A rotatable wheel or roller may be used instead of a fixed curved surface; and for good results, the rind should engage 180 degrees of the circumference of the wheel, leaving the wheel in the direction opposite to the direction of engagement with the wheel.

In a continuous sugarcane stalk handling operation, the rind will contain a considerable amount of moisture after the pith is removed. The conditioning of the rind to loosen the fibres should occur soon after the pith is removed and before the rind is dry; otherwise, if the rind is allowed to dry to ambient moisture or is dried artificially, it will curl and twist into distorted shapes and become extremely difficult to handle, particularly for purposes of placing the several fibres into presses or molds.

The rind strips 40 may be washed by spraying or by dipping prior to conditioning the strips to loosen the fibres, as represented at 41. It has been found that the strips dry readily in air, but if the strips are to be baled, it may be desirable first to pass the strips through a mechanical dryer. The rind strips 42 thus obtained are relatively clean, undisturbed elongated groups of long fibre bundles. They may be handled and processed further in the particular manner to be described.

FIGURES 3 and 4 illustrate diagrammatically apparatus for processing sugarcane to provide the rind for use according to this invention. Whole cane stalks, such as the stalk 50, are introduced into the front of the apparatus after being de-leaved and preferably after being washed. The cane stalk 50 immediately is gripped between a pair of power-driven rollers 52 and 54 which serve to hold the stalk 50 in properly aligned position and to advance the stalk through the apparatus. The whole stalk 50 is propelled to the first of a series of treating stations comprising a rotating brush 55 in the shape of an iris with the stalk 50 passing therethrough. The rotating brush has wire bristles 56 or bristles formed of another suitably stiff material, for example nylon, or the like. The bristles 56 extend radially from the longitudinal axis of the cane and rotate in a plane normal to the path of the stalk. As the bristles 56 rotate around and scrape over the outside surface of the stalk 50, they remove the cuticle wax as the

moving stalk passes. As the bristles 56 pickup the wax dust, suction in a line 57 withdraws the wax from the bristle area and carries the wax off for recovery and processing. The bristles 56 may also remove extraneous matter such as field dirt which may not have been washed off. Preferably, the bristles 56 are of such length and of a pliable nature so that the wax portion only will be removed and the rind will not be penetrated. Bristles with a considerable amount of flexibility and rotating at a rapid speed are suitable for removing the wax. This invention also contemplates that other means such as scrapers may be employed for the removal of wax, as well as the bristles 56.

A second rotating brush 59 similar in construction to the brush 55 is spaced therefrom and receives the stalk 50 after passing through a pair of idler guide rollers 60 and 61. The brush 59 may have bristles 62 which are similar to the bristles 56, but which have characteristics suitable for removing the thin epidermis layer on the exterior of the stalk. The epidermis and other foreign matter is carried away by a conduit 63.

The whole stalk 50 then is engaged by another pair of rollers 52 and 54 which force the stalk 50 into a stalk severing station in the form of a stationary knife or blade 64 positioned in the path of the stalk. Other stalk severing devices may be used instead of the particular stationary blade 64, for example a moving saw may be used as well. Whatever form of stalk severing member is used, the pith within the stalk should not be subjected to sufficient pressure to express a material amount of the juice. It is desirable that as much of the juice remain in the pith at this point of the operation for extraction at a subsequent station.

After the stalk, which now is in two pieces, leaves the stalk severing station, it is propelled to the next station where it is spread apart and advanced by a pair of power-driven spreader wheels 65 and 66. The two halves of the stalk 50 are spread apart by back-to-back frusto-conical shaped surfaces of the wheels 65 and 66, and held in proper position by discs 67 and 68. The two halves of the stalk 50 are designated 50a and 50b. The frusto-conical shaped surfaces on corresponding sides of the spreader wheels 65 and 66 serve to engage the rind portion of one-half of the stalk rather than the inner soft pith portion. Since the rind is hard and rigid compared with the pith, little pressure if any is applied to the pith; and, consequently, juice is not extracted.

The stalk halves 50a and 50b leave the spreader wheels 65 and 66 partially spread and are forced to the next station comprising a stalk turning or aligned member 70 which serves to twist the two stalk halves 50a and 50b about one-quarter turn so that the pith

or inner portion faces downward and the outer curved rind portions face upwardly. The aligning member 70 has a vertically extending thin plate portion 71 curving at the midsection 72 into a horizontally extending plate portion 73. The stalk halves engage and slide along the vertical portion 71 and by the time they reach the horizontal portion 73, they are properly positioned.

The next station comprises a pair of flattening wheels 75 and 76 which guide the stalk halves and prepare them for the succeeding station. Wheel 75 may have a flat, cylindrical surface for engaging the rind while wheel 76 may be a soft, surfaced air-inflated wheel, which together serve to flatten the rind somewhat to spread the stalk halves open farther in order to more completely expose the pith, yet which do not exert sufficient pressure to express a material amount of juice from the pith. These two wheels 75 and 76 additionally serve to propel the stalk halves 50a and 50b into the succeeding station, at which time the stalk halves must be advanced relatively forcefully.

The next station, the stalk halves engage an assembly 80 for separating the pith from the rind. This assembly 80 comprises a top roller 81 which is a control or backup roller having a flat, cylindrical surface for engaging the top of the rind and a lower brush type roller 82. The bristles 83 of the brush roller 82 rotate into the path of the moving stalk halves. The bristles 83 may be of wire or of other suitable material and of suitable length to gently scrape the pith from the inside of the rind. The bristles contact the oncoming pith in tangential relationship with respect to the rind. Little or no compressing action is applied by the bristles to the pith in a direction normal to path of the rind. This prevents or substantially limits the amount of juice that will be forced out of the pith. This invention contemplates that devices other than the specific assembly 80 may be employed to remove the pith from the rind.

As second assembly 84 is spaced from the first assembly 80 for separating the pith from the rind and includes a control roller 85 and a lower brush type roller 86 similar to the brush roller 82, but which may have bristles 87 slightly stiffer and slightly shorter than the bristles 83 to assure that substantially all of the pith is separated from the rind. The speed of the rotating brushes also may be set differently so that forces of a different nature are applied to remove the pith. Additional assemblies such as the assemblies 80 and 84 may be employed as necessary to remove adhering pith. A pair of idler rollers 88 and 89 are positioned between the assemblies 80 and 84 for guiding the stalk halves.

The pith removed from the inside face of the rind contains most of the sugar content of the cane stalk. To assist in the removal of

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the pith from the brushes 82 and 86, a fluid
such as air may be forced through conduits
90 and 91 and adjusted to blow the pith off
of the brushes and off the rind onto suitable
conveyors for transfer of the pith for further
processing to remove the juice. While apparatus
for handling only one stalk is illustrated, the
apparatus may be duplicated and aligned trans-
versely side-by-side so that the same power
supply may drive the various parts and several
stalks may be handled simultaneously.

FIGURE 5 illustrates a typical section of
whole rind stalk prior to processing.
FIGURES 6 and 7 illustrate typical strips of
rind produced by this process and apparatus
wherein the exterior wax, as well as the thin
epidermis layer, and the pith have been re-
moved. The separate fibre bundles are gener-
ally unbroken and undisturbed, although the
rind has been flattened out somewhat. The
strips possess considerable tensile strength
longitudinally.

The stalk portion 100 shown in FIGURE
5 has an outer rind 101 surrounding the inner
pith 102. The stalk nodes are shown at 103
defining the internode portions 104 and 105.
The internodes of sugarcane are not always
cylindrical, that is the diameter at different
points lengthwise tends to vary rather than
be constant. Internode portions of sugarcane
stalk take various forms and have been termed,
for example, tumescent, bobbin-shape,
conoidal, obconoidal and concave-convex. The
internode portion 104 of the stalk 100 may be
termed bobbin-shape since the middle of the
internode is of a diameter smaller than the
ends of the internode adjacent the nodes 103.
The internode 105 of the stalk 100 may be
termed concave-convex. This invention accom-
modates all types of internode shapes.

FIGURE 6 shows the exterior 108 of one-
half of that portion of strip 107 which may be
obtained from the stalk portion 100 of
FIGURE 5. If there are growth cracks in the
rind originally, such growth cracks may appear
in the strip 107; for example, as at 109. Such
growth cracks may extend all the way through
the thickness of the rind strip. Because of
the generally flattening of the strips, due to
the action of the rollers of the apparatus, the
nodes tend to disappear. There may be a dis-
continuance of the identity of the individual
fibre bundles but not necessarily a reduction
in the longitudinal tensile strength of the strip
at each node. The outer surface of the strip
107 has the same general appearance as the
outside surface of the stalk 100; however,
the corky cracks tend to disappear upon
flattening of the strip whereas they might be
predominant in the whole stalk 100. The
inside surface 110 of the rind strip 107 is
shown in FIGURE 7 and has an appearance
considerably different from that of the exterior.
Various individual fibre bundles are not as
pronounced and the surface is not as hard

as the outer surface. The nodes are less
noticeable on the inside; although, upon care-
ful observance, they can be detected.

A desirable action or phenomenon may be
obtained between the long fibre bundles of the
rind making the strips highly suitable for the
manufacture of a variety of articles. Move-
ment of the individual fibre bundles laterally
can be induced, which for the sake of con-
venience, hereinafter is called fibre flow. This
has advantages considering both structure and
appearance. When fibre flow is induced, there
is a tendency of the fibre bundles to separate
and to move laterally of the longitudinal axis
of the rind strip.

It has been discovered that the fibre flow
phenomenon is due to or affected by a rela-
tionship of heat, pressure, time and moisture
content of the rind. If the rind strips are
subjected to sufficient heat; and if sufficient
pressure is applied for a sufficient time; and
if the moisture content of the rind is sufficiently
high, fibre flow will occur. The fibre bundles
apparently are held together by lignin and
perhaps other naturally occurring binder sub-
stances. It appears that the natural binder
substances are melted or that a chemical reac-
tion occurs under conditions of heat, pressure,
time and moisture, and when so affected, the
adhesive properties of the binder substances
decrease sufficiently to allow the fiber bundles
to be moved relatively easily with respect
to one another without disturbing or lessening
the tensile strength or other physical charac-
teristics of the individual fibre bundles. After
the fibre flow conditions are relieved, that
is after the temperature is dropped and the
pressure is lessened, the adhesive properties
of the natural binder substances return to hold
the fibre bundles together in their new rela-
tive positions.

When several rind strips are laid side-by-
side and overlapped, then subjected to fibre
flow conditions, the fibre bundles are forced
to interlock and to intermingle thereby com-
bining the strips into a uniform, homogeneous
mass of fibre bundles aligned generally in the
same direction. The fibre flow, in addition to
combining adjacent strips into a homogeneous
mass, closes up the growth cracks and corky
cracks so that they are no longer readily visible
and, in some cases, actually nonexistent and
the different shapes of the original internodes
or the crooked configuration of the stalk tend
to disappear.

Various items, such as boards, panels,
vener, planks, and the like, can be made out
of rind strips utilizing the fibre flow pheno-
menon. The ranges of temperature, pressure,
time periods and moisture content of the rind,
in varying relative proportions are important.
Heat in conjunction with a high moisture con-
tent of the rind causes a release of a syrupy,
brown liquid which may migrate through the
rind fibres from low to high density areas and

collect. An excessive release of this brown material may discolor the fibres. Upon cooling, the brown material appears to harden or set and its presence has an effect on the resultant desirable adhesive characteristics between the reoriented fibre bundles. The amount of brown material released appears to be proportional to the amount of moisture in the rind, and washing and squeezing of the rind prior to heating lessens the amount of brown material released. In order to control fibre flow and to enhance the desirable characteristic of items made from rind fibre, the release of the brown material must be controlled. When pressure is applied to layers of rind as by a press, an extremely smooth surface on the resulting item can be obtained should sufficient fibre flow be induced and controlled.

Different adhesive or binder materials, either low temperature setting or high temperature setting, may be added to the rind to hold the fibres together upon the application of heat and pressure. It has been found that especially desirable results can be obtained by using a high temperature setting melamine adhesive. Since melamine produces formaldehyde, it appears that the formaldehyde reacts with or causes a reaction of certain substances naturally present in the rind such that extremely strong bonds between the fibre bundles are obtained which are not obtained by use of other adhesives or resins.

By way of example, a variety of board and panel-like articles have been made under the following conditions and ranges: 300—600 p.s.i., applied by a press or mold to layers of rind strips; temperatures between 280° F to 320° F; moisture contents of the rind times between 3 minutes to 2-1/2 hours. Numerous observations have been made. For example, increasing pressures increase the density of the article and improve the fibre flow phenomenon. Increasing temperature above 280° F has a direct effect on increasing the release and flow of the brown material. A moisture content of the rind of at least about 10% appears to be necessary at about 600 p.s.i. and temperature at about 280° F in order to obtain fibre flow, but an increase of moisture requires less pressure. Satisfactory articles have been made with rind having considerably less than 10% moisture content but with little fibre flow. A moisture content of the rind in excess of 25% causes water to be expressed on the application of pressure and heat which tends to wash away any added adhesive or resin material and to otherwise reduce control over fibre flow. The fibre flow phenomenon is not instantaneous but occurs over a period of time; and under fixed conditions of heat and pressure, a corresponding degree of fibre flow will result.

An important technique in utilizing the fibre

of sugarcane rind to make articles by subjecting the rind to fibre flow conditions when a press or mold is used, is to cool the press or mold while pressure is maintained on the rind fibres. The press should be cooled to near or below 212° F before the pressure is released and the article is removed therefrom. The application of heat to the moist rind, in effect, creates steam and other gases which are confined within the rind by the mold or by the platens of the press. This internal pressure must be released before the articles are released. If the press is not cooled before the pressure is relieved, the article tends to warp or swell when removed from the press or mold, the bond between fibres is adversely effected, and dimensions of the article are likely to change.

In general, highly satisfactory board and panel articles, and a variety of different shaped articles, can be manufactured from the rind of sugarcane using the following conditions: (1) a press or mold pressure of about 300 p.s.i., (2) a temperature of about 280° F, (3) time of heating of about 9 minutes for an article about 1/4 inch thick or less, (4) a moisture content of the rind of about 15%, (5) cooling of the press or mold below about 212° F before releasing the pressure. When these conditions are applied to rind strips, the fibres can be manipulated into a variety of shapes having a remarkably smooth surface. The articles thus formed exceed hardwoods in strength.

FIGURES 8, 9 and 10 illustrate the surface of typical board articles that can be made from the rind strips produced by the foregoing process and apparatus. FIGURE 8 shows the surface of a board 120 wherein the exterior surface 108 of the rind strips 107, for example, are placed so as to form the exterior of the board. A node can be detected at 103. Certain individual fibre bundles are easily recognized. FIGURE 9 shows the exterior face of a board 120 made from rind strips such as the strips 107 wherein the inner surface 110 is used as the exterior face of the board. A very close arrangement of fibre bundles is quite evident in the texture of this surface. FIGURE 10 illustrates a type of chipboard 123 that can be made from strips such as the strips 107. The strips first may be cut crosswise into short lengths 3/4 inch to 1-1/2 inches long, for example. Layers of the chips 124 are then placed in a press or mold with a binder and subjected to heat and pressure so as to utilize the fibre flow phenomenon to bind and interlock the short fibre lengths into a structurally strong, composite, rigid article. The appearance of the board on both sides is essentially the same. This type of board represents the versatility of the rind strips. In addition, the rind strips can be broken up to make a board resembling conventional hardboard.

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by ejection when a roll the press is used on the be cooled to 70 5 pressure is applied therefrom. rind, in gases which 75 10 mold or by normal pressure articles are cooled before the press tends to is adversely article are board and shaped on the rind conditions: 300 p.s.i., F, (3) time an article 90 25 a moisture (5) cooling 212° F When these 95 30 the fibres of shapes face. The woods in the sur- 100 35 be made the fore- FIGURE 8 20 wherein rind strips as to form de can be adual fibre FIGURE 9 120 made 127 wherein be exterior arrangement in the tex- illustrates made from The strips not lengths example. placed in a subjected the fibre block the strong, balance of the same. versatility rind strips assembling 130 65

Boards, panels, veneers and like articles of considerable strength, can be made out of the long fibre bundles of sugarcane rind strips in the following manner. A number of strips are placed side-by-side on the lower plate of a press. The desired thickness of the resulting article can be selected by the depth to which the strips are piled in the press. When making the board or veneer, the nodes of the stalk can be aligned alternately so that adjacent strips do not have nodes located side-by-side. While there is no noticeable decrease in strength of the strips at the nodes, since a number of fibre bundles on the inside of the rind continue through the nodes, the overlapping of the nodes adds considerably to the appearance of the resulting board, particularly if the exterior of the stalk is to become the exterior of the board.

Preferably some adhesive or binder substance is added to bond the strips, although there is considerable natural bonding of the fibres due to naturally occurring substances in the rind and due to a mechanical interlocking of the fibres. The binder can be applied to each strip before it is placed in the press or it can be applied to the strips as necessary for consistency after the strips have been positioned in the press. The binder can be in wet or dry form and can be applied to the strips by dipping, spraying, dusting, painting, etc. Pressure and heat is then applied to the group of strips, as explained previously. The dimensions of the resulting board or veneer depend on the size of the press and arrangement of the strips. A board structure can be formed by aligning all of the strips in one direction, by aligning strips crosswise in alternate layers, or by placing the strips in random fashion. Several thin veneer sections can be bonded together in a separated pressing operation with the fibres of adjacent veneers aligned at a right angle, similar to plywood. Boards with an endless variety of surface textures and patterns can be created. Different designs can be made by varying the alignment of the strips. The strips can be cut into different shapes to produce different designs or textures.

Rind strips can be made with the epidermis left on, and since the epidermis of certain varieties of sugarcane have considerable color this can be used to advantage. Boards having colorful surfaces can be manufactured by using rind strips with the epidermis left on as the exterior surface of the resulting board product. By using whole strips with long undisturbed fibre bundles as the interior of the board, the strength of the board can be maintained even though the fibres on the surface add little or no strength to the board.

The strips can be made up in rolls 130, illustrated in FIGURE 11. Such rolls consist of continuous fibre bundles aligned adjacent one another in uninterrupted fashion through-

out the length of each roll. The fibres may extend lengthwise or transversely when the strips are manufactured into the rolls, and the rolls can be made into practically any length or width desired. The long fibre bundles in the form of the rolls 130 can be manufactured further into boards of considerable strength by aligning the bundles of several different rolls alternately in opposite directions, as illustrated in FIGURE 11, and then bonding the overlapping portions 131 of the several rolls in a composite board structure 132 having the bundles of alternate laminates extending in opposite directions as represented by arrows 133 and 134. The number of such laminates employed may vary depending on the desired thickness of the finished board and the thickness of roll material used.

The rind strips, because of their unique and distinctive appearance, can be used effectively as an exterior laminate over ordinary plywood or other base or core material. This has been done by taking an ordinary sheet of plywood, laying strips of rind thereon and applying a pressure after coating the strips with a binder material. This adds an extremely unique and ornamental surface to ordinary plywood. It has been found that plywood can be strengthened if the plywood is used as a base and a veneer of fibre bundles is applied thereto.

In the manufacture of articles, it is necessary only to place the rind strips loosely in position in a press and no special care or careful alignment other than generally even distribution of the strips is necessarily required. This is because of the fibre flow action which allows the individual fibre bundles to move into close proximity to one another and fill the spaces therebetween. Curved and specially shaped articles may be manufactured as well as board-like articles. The pressure applying apparatus may comprise a conventional stationary press of the type having cooperating flat platens. Alternatively, the pressure applying apparatus may comprise cooperating rotating roller elements. Hydraulic press type apparatus known to the plywood industry may be used to form curved articles. Any number of adhesive or binder substances and proportionate amounts thereof can be used to make board and similar products from the rind strips, and different heat and pressures, as explained previously, can be applied, depending upon the characteristics desired of the resulting product.

Co-pending Patent Application No. 30498/65 (Serial No. 1126492) claims a process for obtaining cleaned sugarcane rind from sugarcane comprising removing substantially all of the stalk and non-stalk material from the exterior of the stalk of sugarcane to expose the exterior fibre of the rind, and removing from the interior of the stalk substantially all of the pith of the stalk.

Co-pending Patent Application No.

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- 30497/65 (Serial No. 1126491) claims a process for treating sugarcane stalks having as components a pith core, rind encircling the pith, an outer epidermis, and wax on the exterior of said stalks, which process comprises the steps of opening each stalk longitudinally into a plurality of longitudinal portions, while the stalk is moving in a longitudinal direction along a travel path, exposing a pith-bearing side of each opened stalk portion, separating from said opened portions at least one of said stalk components from others of said stalk components, collecting said separated component from each of a plurality of stalks, and treating said collection separately from said other stalk components.

WHAT WE CLAIM IS:—

1. A process for making board products from sugarcane comprising longitudinally opening the sugarcane stalk without damaging the rind, removing the pith from the rind and subjecting the rind thus freed of pith to heat and pressure.
2. A process according to claim 1 comprising cleaning the rind of the sugarcane to remove foreign matter from the exterior of the rind without materially disturbing the rind, arranging the cleaned rind in a press, and then pressing the rind with a binder to form a board.
3. A process according to claim 2 wherein the moisture content of the rind is between 10 and 25% by weight before subjecting the rind to heat and pressure.
4. A process according to claim 2 wherein the temperature applied is above about 212° F.
5. A process according to claim 4 comprising the further step of maintaining the pressure on the rind while reducing the temperature below about 212° F.

6. A process according to claim 5, comprising forming the rind to the desired shape under controlled conditions of heat, pressure, time and moisture content of the rind sufficient to relieve the natural bond between fibres of the rind to allow the fibres to flow with respect to one another, and thereafter restoring the natural bond.

7. A process according to claim 6 further comprising cutting the rind into short lengths and then subjecting said short lengths to heat and pressure.

8. A process according to claim 6 comprising pressing the rind with a binder to form a veneer.

9. A process according to claim 8 further comprising stacking a plurality of said veneers with the rind in different veneers aligned crosswise, and pressing the plurality of stacked veneers with a binder to form a laminate.

10. A board product made by a process according to claim 1, comprising rind from sugarcane wherein the rind has been manipulated into a composite material of interlocked rind held together by the natural binder material of the sugarcane.

11. A board product according to claim 10 including an additional binder material extending throughout.

12. A board product according to claim 11 being a veneer.

13. A board product comprising a laminate of veneers according to claim 12, with the rind in different veneers aligned crosswise.

14. A process for making board products, substantially as described herein.

15. A board product, substantially as described herein.

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