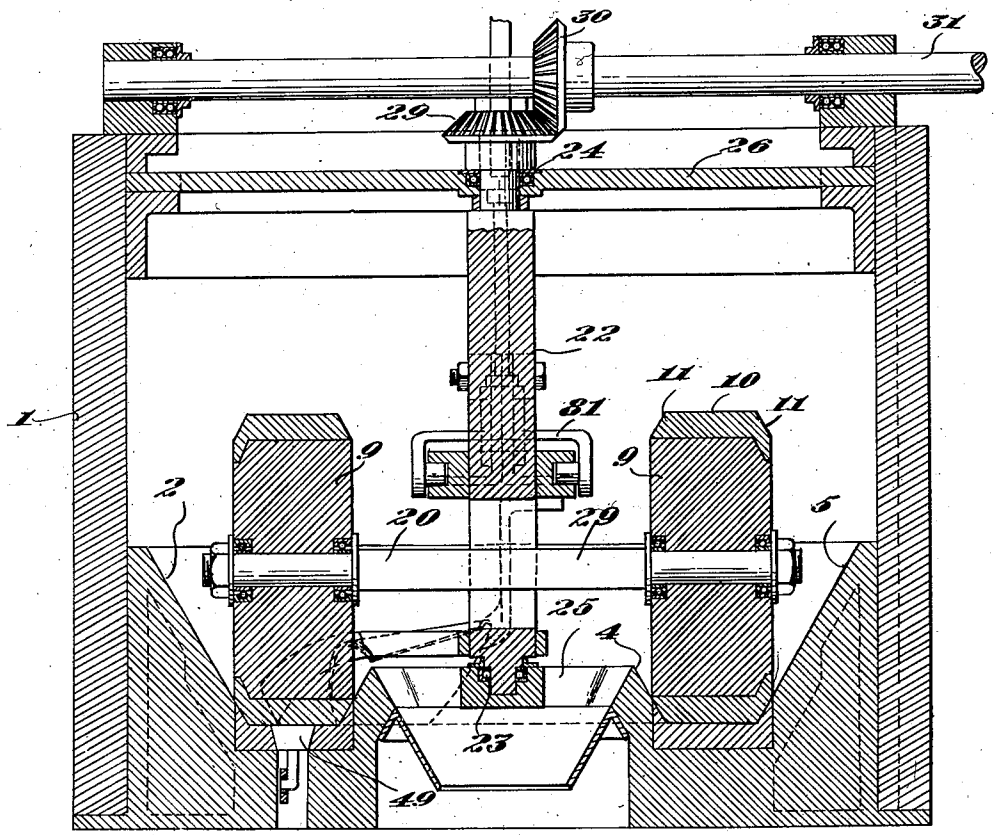
July 15, 1930. R. B. RESPESS 1,770,430

METHOD AND APPARATUS FOR PRODUCING FIBROUS MATERIAL

Filed Aug. 7, 1928 3 Sheets-Sheet 1



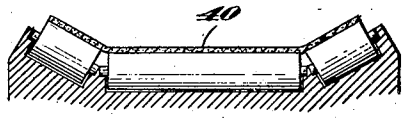


Fig. 1

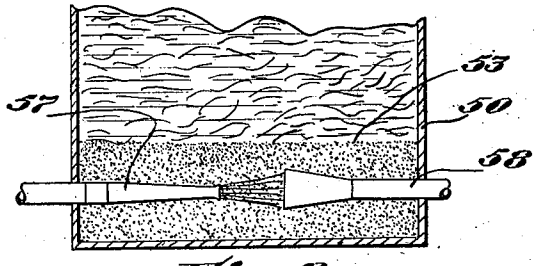


Fig. 2

Inventor
Roland B. Respess
by Roberts, Cushman & Woodberry
Attys.

July 15, 1930. R. B. RESPESS 1,770,430

METHOD AND APPARATUS FOR PRODUCING FIBROUS MATERIAL

Filed Aug. 7, 1928 3 Sheets-Sheet 2

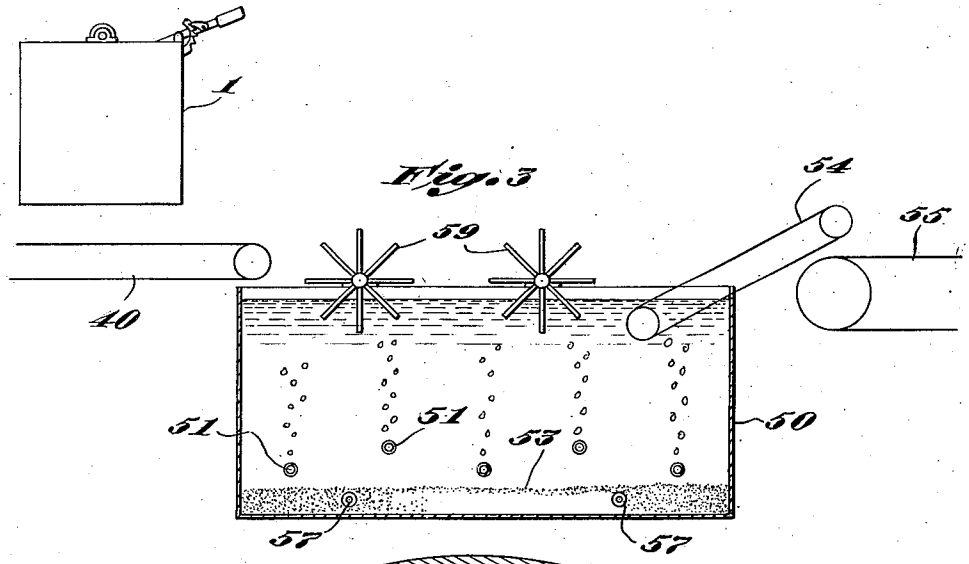


Fig. 3

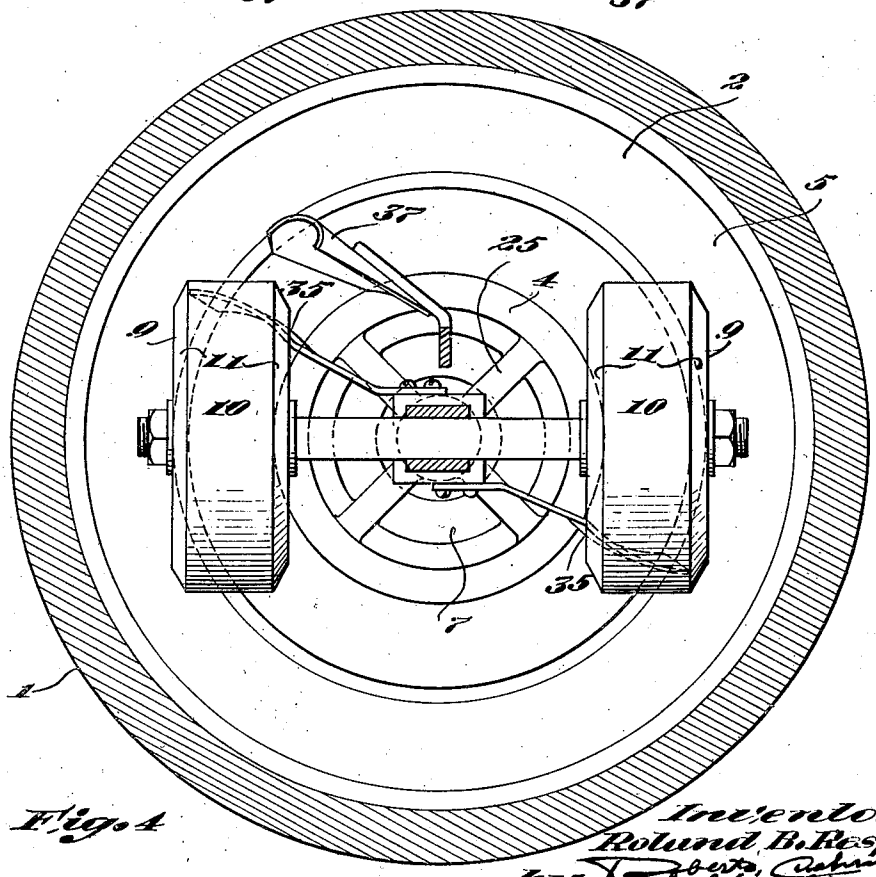


Fig. 4

Inventor
Roland B. Respess
by Roberts, Cahoon & Woodbury
Attys.

July 15, 1930. R. B. RESPESS 1,770,430

METHOD AND APPARATUS FOR PRODUCING FIBROUS MATERIAL

Filed Aug. 7, 1928 3 Sheets-Sheet 3

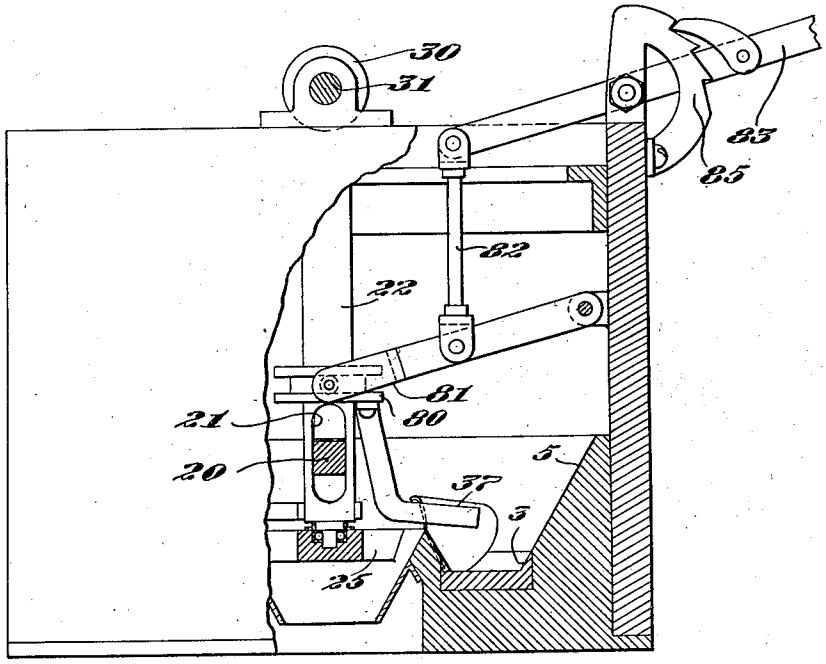


Fig. 5

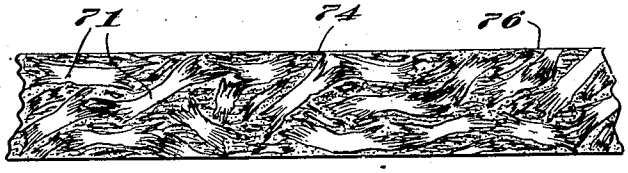


Fig. 6

Inventor
Roland B. Respess
by Roberts Cushman & Woodbridge
Attys.

Patented July 15, 1930 1,770,430

UNITED STATES PATENT OFFICE

ROLAND B. RESPESS, OF WICKFORD, RHODE ISLAND, ASSIGNOR, BY MESNE ASSIGNMENTS, TO RESPATS INC., OF CRANSTON, RHODE ISLAND, A CORPORATION OF RHODE ISLAND

METHOD AND APPARATUS FOR PRODUCING FIBROUS MATERIAL

Application filed August 7, 1928. Serial No. 297,935.

This invention relates to an improved process and appropriate apparatus for manufacturing composition board or articles and for making pulp suitable for the manufacture of board of this character as well as other products that may be made from a fibrous pulp. While the present invention is particularly suited to the reduction of wood, it is also applicable to the treatment of pineapple waste, cocoanut fiber, palmetto fibers, flax straw, saw grass, or other fibrous materials.

Heretofore wood or the like has ben reduced to pulp suitable for the manufacture of fiber board, paper, etc. by cooking the wood chips or the like in the presence of a suitable chemical, whereby the fibrous material is softened so that it substantially disintegrates and the fibers may become more or less isolated. Instead of or in addition to the cooking operation, mechanical reducing means have been commonly used; for example, the wood has been held against a grinding wheel or the like. In any case the process ordinarily is carried on in the presence of a large quantity of water and the material is reduced substantially to the state of separated isolated fibers, from which the natural wood gums or resins may be largely removed.

The present invention particularly provides a most effective method of reducing or separating the fibres, for example, permitting the economical production of pulp from fibrous materials which have not previously been commercially useable for this purpose. For example, woods of a high resinous content, such as southern pine, although having many desirable characteristics, have previously been considered unsuitable for the manufacture of pulp. This high resinous content not only has interfered with the reduction of the wood to pulp by mechanical means but also has rendered the chemical reduction of the same uneconomical and impractical, so that a large amount of this material has been consumed as waste and has had no substantial value. In accordance with this invention, the ultimate product may contain a suitable resinous binder to permit the fibrous particles firmly to be secured to each other, while any excess resin may be removed and utilized for any desired purpose. If desired, the final more or less complete separation of the fibers may be avoided and the product may comprise, at least to a considerable extent, bundles of incompletely separated fibers having frayed brush or bur-like end portions and surfaces which are adapted to be pressed into entangled engagement with similar portions of adjoining fiber bundles, while in addition there is of course a fair proportion of substantially separated fibers of various lengths. The advantageous manner of reducing the pulp provided by the present invention permits the cooking operation to be limited to a comparatively short period or periods, i. e. to a fraction of the time ordinarily employed for this purpose. Thus the disintegration of and injury to the wood fibers by the chemical, which characterizes the ordinary cooking operation, is substantially avoided. Due to the limitation of this cooking operation a sufficient proportion of the natural gums or resinous content of the fibrous material may remain in the partially cooked product to afford a suitable binder for the ultimate board or the like.

After this cooking operation, which may or may not take place in the presence of a chemical such as a soda solution, the fibrous material is mechanically separated. For this purpose I preferably utilize a suitable reducing factor or mill in which a loose abrasive is mixed with the fibrous material. By utilizing means of this character, the cooked chips or fibrous bits are kneaded, ground, severed, split, and in effect masticated so that within a comparatively short time the chips or the like are rapidly reduced to fibrous bundles having frayed portions which are adapted to interlock with similar portions of adjoining fiber bundles. The material may also comprise a considerable percentage of more or less isolated fibers and small wood bits. If desired, suitable long fibers may be added to the pulp just before the end of or at the end of the mechanical reducing operation.

It is to be understood that this reducing operation preferably is carried on when the wood particles are saturated with water. Thus the particles may be taken directly from

the cooker or digester and mixed with sand in the reducing mill. While the step of treating the woody chips by kneading with a comminuted splitting agent or abrasive such as sand can be utilized with dry chips, its effectiveness is greatly increased when the chips are thoroughly soaked. On the other hand, an excess of water is not desirable, since it tends to cause floating of the chips and reduces the effectiveness of the treatment with the abrasive. The abrasive may then be removed from the pulp in any suitable manner, as by a flotation or washing process, and the pulp may be formed into fibrous sheets or products of any desired type in various ways. The ordinary pulp board machines may be utilized for this purpose or the pulp may be simply matted upon a suitable foraminous support, being lightly pressed in place to provide a light insulating board or heavily pressed to form a somewhat denser, stiffer product. In the latter case I have found that a product of excellent qualities may be made by heating the pulp to a fairly high temperature to provide a comparatively dense, rigid material.

The apparatus employed in this process may be comparatively simple and quite compact and requires the attention of few workmen in order to produce a large amount of useable pulp. Furthermore, the percentage of useable pulp recovered from a given amount of raw fibrous material provided is high. The process is advantageous in permitting the manufacture of a large variety of ultimate products therefrom and in being adaptable to the use of a large number of inexpensive raw materials in order to permit the manufacture of these ultimate products.

In the accompanying drawings,

Fig. 1 is a central vertical section through an improved reducing mill which is adapted to perform one step in the process disclosed by the present invention;

Fig. 2 is a sectional view of the means for removing the sand from the pulp;

Fig. 3 is a more or less diagrammatic view of the separating vat;

Fig. 4 is a top view of the assembly shown in Fig. 1;

Fig. 5 is a vertical section through a portion of the mill; and

Fig. 6 is an enlarged sectional detail of one typical finished product manufactured in accordance with the present process.

In accordance with the present invention fibrous materials such as wood, for example saw mill waste, pineapple waste, cocoanut fiber, palmetto fiber, flax straw, saw grass, or other inexpensive fibrous material is utilized. Since there is a large amount of saw mill waste readily available in the presence of steam, water and the like and since this material in many cases has a comparatively high resinous content. I will hereafter refer specifically to the process as the same is applied to the treatment of saw mill waste, but it is to be understood that it is also applicable to various other fibrous material of the character enumerated.

In accordance with this invention it is ordinarily necessary to reduce the raw fibrous materials, such as saw mill waste, wood chips, or the like, to a semi-pulp. For this purpose I preferably partially cook the raw material in order partially to reduce the same. While the extent of the cooking operation may be widely varied, I find that a comparatively short period is preferable for most purposes so that a considerable portion of the natural gums or resinous materials may remain in the partially cooked material when it is removed from the digestor. For example, I have found that hardwood chips may be satisfactorily cooked in approximately one hour in a closed digestor with a caustic soda solution at 10.80 Baumé and steam at 40 lbs. pressure admitted to the digestor. It is evident, however, that higher temperatures can be used and, if an ultimate product of finer texture is desired, the cooking may be continued for a longer period so that a larger percentage of the resinous materials and natural gums are removed. For most purposes, however, it is highly desirable to limit the period of cooking.

After the cooking operation the liquor is drained from the digestor and the chips removed. The chemical constituents of the drained liquor may be recovered and used again. In some cases, sufficient water soluble gums may have passed into the liquid to make it desirable to reclaim the same. Obviously an increase in steam pressure or heat will hasten the chemical action in softening the chips and thus will permit a shorter period of cooking. If desired, the cooking may be done with steam alone without the use of the chemicals.

The partially cooked semi-pulp, preferably while still wet, is introduced into the grinding mill which is shown in Figs. 1 and 4. This mill preferably comprises a cylindrical casing 1 having annular depression or track 2 at its bottom. This track is provided with a central groove lined by a wear-resistant metal shoe 3 and has upwardly inclined inner and outer walls 4 and 5 respectively. An opening 7 may be arranged within the inner wall 4. Suitable grinding wheels 9 are adapted to roll in the track, being provided with wear-resistant shoes 10 having beveled edges 11 which are juxtaposed to the inclined edges of the groove 3. The rollers 9 may be located at opposite ends of an axle 20, the intermediate portion of which is received in a vertically extending slot 21 in the rotatable shaft 22. Preferably the latter is arranged to turn about a vertical axis which is defined by bearings 23 and 24, the latter being sup-

ported upon a spider 25 arranged in the opening 7 at the center of the mill and the latter being supported upon a suitable cross member 26 at the top of casing 1.

The upper end of shaft 22 carries a suitable gear 29 that meshes with a gear 30 upon a drive shaft 31 so that rotation of the latter results in the turning of shaft 22 and axle 20 about the axis of the former, this resulting in the rolling of the members 9 in the annular depression at the bottom of the mill. Secured to the shaft 22 are scrapers 35 which are adapted to follow the rollers and to cast material which has been pressed downwardly to the bottom of the annular depression up against the sides of the same.

In order to permit convenient removal of material from the vat or housing 1, I provide a scoop 37 which is supported upon the shaft 22. The scoop is connected to a collar 80 that is slidably mounted upon a non-circular portion of shaft 22. A swinging yoke 81 is controlled through a link 82 and lever 83 in order vertically to position the collar 80 and the scoop. A suitable ratchet means 85 may be arranged in conjunction with the lever to lock the latter and connected parts in any desired position. The scoop preferably is provided with a concavely curved face which is adapted to receive material from the groove and to cast the same upwardly over the inclined wall 4 and through the opening 7 to any suitable receiving means such as the conveyor belt 40, it being evident that this belt may pass under a plurality of reducing factors to receive material from the same in succession, as desired. A suitable plug 49 is arranged in the bottom of the reducing groove, being removable to permit the ready washing of the mill when the same is necessary.

The partially cooked fibrous material being still saturated when placed within the reducing mill, preferably is mixed with a suitable amount of abrasive, such as sand. The amount of abrasive used may be widely varied from a comparatively small proportion by weight of the weight of the chips to substantially the same or twice as much abrasive by weight as that of the chips. As previously indicated, the fibrous material itself is thoroughly wet at this stage of the process, for example, the included moisture may equal the dry weight of the chips or be twice as much as that weight. The material being located in the mill, the rolls are rotated, cooperating with the loose abrasive in grinding, shredding or masticating the partially cooked fibrous material. The beveled edges of the rolls particularly cooperate with the adjoining inclined surfaces of the groove or track in attaining this effect. Furthermore, the scrapers 35 serve constantly to push a considerable portion of the fibrous material upwardly against the side of the groove so that the material is directed to a position where it will be acted upon between the beveled edges of the rollers and the inclined sides of the annular depression.

While the mill itself, particularly when provided with rollers having beveled edges cooperating with the inclined sides of the depression, is very effective in reducing the fibrous material into pulp, the use of the loose abrasive in conjunction with a reducing mill of this character greatly enhances the efficiency thereof. The axle 20 is not only arranged so that the rollers may move vertically away from the annular depression, but, as the rolls rise, a limited lateral movement thereof may also occur. As a consequence of this arrangement the surfaces of the rolls which tend to contact with the corresponding surfaces of the annular depression have a sliding or rubbing, rolling, grinding and crushing engagement with the fibrous material. Thus a constant grinding and kneading action occurs, the loose abrasive, being thoroughly mixed with the wet fibrous material, is particularly effective in aiding and accelerating the reduction of the semi-pulp, and having a cutting or splitting action upon the softened chips.

It will be noted that this grinding process requires the use of but a small proportion of water compared to the ordinary pulp forming processes. As a matter of fact, the water which impregnates the fibrous material when it is removed from the cooking liquor is sufficient for this purpose. While the mechanical reduction of the pulp may be carried on when the material is dry, it is much more effective when the material is thoroughly wet. Due to the action of this abrasive, it is ordinarily only necessary to continue the action of the mill for a short period of time, the length of this period depending upon the type of pulp which is desired, and the amount of abrasive used.

When utilizing ordinary wood waste including comparatively coarse pieces of wood and particularly wood of a comparatively high resinous content, such for example as southern pine, it is often desirable to provide two cooking operations and two mechanical reducing operations. Thus, for example, materials of this character may be cooked under two hundred and fifty pounds steam pressure, being held at that pressure for from one to ten minutes. During the early stages of the initial cooking operation, turpentine may be removed from the steam by the ordinary separating process. The liquor remaining from the cooking operation contains considerable resin which may be removed for any suitable use, while the chemical, if used, may also be reclaimed. The original cooking is thus effective in removing considerable resin from the chips and permits the same readily to be acted upon by

the reducing mill. The latter serves to split the wood pieces up into smaller chips and partially shredded or split portions which are ready for the second cooking operation. The fibrous material may then be again cooked under conditions similar to those of the first cooking operation and it may thereafter undergo a second similar mechanical reduction. The double cooking and mechanical reduction permits the production of a pulp of comparatively fine texture even out of wood having a high resinous content, while but a single cooking operation may ordinarily be necessary for the manufacture of a pulp of coarser nature, or a pulp made from fibrous materials of a lower resinous content.

I may continue the mechanical reducing operation only until a considerable proportion of the pulp is reduced to the state of fiber bundles, which bundles are characterized by frayed brush or burr-like surfaces which are adapted readily to intertangle with similar portions of adjoining fibrous bundles. Obviously a certain part of the pulp will be further reduced to more or less separated or isolated fibers which may be comparatively long or short, the long fibers serving to bind the fibrous bundles together and the short fibers or particles serving to fill interstices between the same.

If desired, just before the end or at the end of this reducing operation, I may add a small quantity of comparatively elongate fibrous material which is adapted to reinforce and enhance the tensile strength of the ultimate product. Such materials are, for example, jute or cocoanut fibers, flax fibers worked whole, pineapple or palmetto leaves, hemp, coarse vegetable fibers such as sisal, bamboo reed, New Zealand flax, nettle, or ramie stocks. Furthermore, if desired, small uncrushed wood fragments may be added to the pulp at this stage.

From the conveyor belt 40 the pulp may pass to a separating vat 50 where the abrasive is separated from the fibrous material. This vat may be quite tall and is nearly filled with water. Since the fibrous material is thoroughly saturated with water, it tends to have a specific gravity approaching one but the sand obviously is much heavier and accordingly is even more prone to sink than the wet fibrous material or pulp which tends to distribute itself throughout the liquid in vat 50 with the lighter particles thereof rising to the top of this vat. In order to ensure and aid the separation of the abrasive and the fibrous material or pulp I provide a plurality of air jets 51 somewhat above the bottom of the vat. These jets are adapted to inject blasts of air into the liquid, thus agitating the same and driving the lighter fibrous material upwardly toward the top of the vat while the heavier abrasive tends to drop away from the same and to collect at the bottom of the vat as designated by numeral 53. Suitable rotary agitators 59 may be partially or wholly immersed in the liquid in vat 50 and aid in causing the circulation of the same and the consequent tendency of the sand and pulp to separate.

Any suitable means, such as a foraminous belt conveyor 54, may engage the top of the liquid within the vat to pick up fibrous material from the same and to convey it to any suitable receiving belt 55 which, if desired, may be a portion of a machine for manufacturing the final product. This machine, for example, may resemble an ordinary Fourdrinier machine.

The sand falling to the bottom of the vat is impelled out of the same by a suitable water ejector arrangement which is illustrated in Fig. 2. In accordance with this arrangement the water is supplied through a nozzle 57 located at the bottom of the vat and aligned with an open duct 58 of gradually decreasing diameter. The water being impelled at comparatively high speed has considerable kinetic energy, and sand particles are entrained by the same and pass with the water stream into the pipe 58, at the opposite end of which the sand and water are received. The former may then be collected and used again in the reducing mill, or it may be screened and the finer portion thereof utilized for any suitable purpose, while the coarser ingredients alone are utilized in the pulp reducing mill. Obviously any suitable washing apparatus may be used rather than the separating means described above.

A wide variety of products may be made from the pulp which has been finally treated in the manner described above. The ultimate product may be comparatively porous and light, thus providing a strong board having high heat insulating qualities. For this purpose the pulp may be merely rolled out on a suitable supporting felt being leveled and lightly pressed in place.

The pulp which has been lightly pressed in this manner and which is still damp may be separated into slabs or the like and may be subjected to comparatively high pressure at a temperature of the order of ordinary vulcanizing temperatures. This treatment results in the formation of an ultimate product which is comparatively strong and dense and may have a smooth, substantially impervious surface which makes the pressed board suitable for use as paneling or the like. The provision of a product of this character is permitted by the retention of the resinous or natural wood gums in the pulp which, when suitably pressed and heated, provide an impregnating agent which is distributed throughout the pulp and which becomes permanently solidified. While in accordance with the preferred embodiment of this inven-

tion a sufficient resinous or gum content may be retained in the pulp to permit this advantageous result, it is evident that suitable binding material may be added if necessary for this purpose; for example, the resinous constituents reclaimed from the cooking liquor may be again combined with the pulp. If desired, a suitable reagent such as aluminum sulfate may be added before the final baking operation in order to render the soluble resinous constituents insoluble and thus permit the ultimate board to be made substantially waterproof.

Fig. 6 is an enlarged view of a portion of one typical product which may be manufactured by this process, the numeral 71 designating fibrous bundles having frayed brush- or burr-like end portions which are jammed into firm engagement with similar portions of adjoining fibrous bundles. The interstices between the fibrous bundles are filled with more or less separated or isolated fibrous bits, and a plurality of longer fibrous elements 74 may run through the mass of material. The whole is impregnated by a suitable resinous or gummy binding agent 76. Due to the provision of a comparatively large proportion of fibrous bundles rather than isolated fibers, and due to the comparatively large resinous or adhesive content, a product of this character may be comparatively strong and rigid, and may possess substantially smooth, impervious surfaces.

If desired, the surface of board of this character may be suitably embossed in any decorative form when it is being pressed or treated in a mold. The comparatively large chips or splinters lying at the surface of the board give an irregularity to the color tones of the same which is particularly attractive when the board is finished by varnishing, staining or the like. This variegated effect is somewhat analogous to the appearance of a grained wood, but lacks the continuity which is characteristic of wood graining.

For certain purposes I may prefer to utilize the pulp without removing the loose abrasive from the same. For example, the mixed pulp and sand or the like may be mixed with Portland cement to provide a wood concrete wherein the required proportion of sand or other aggregate may be considerably less than in ordinary concrete, and the resulting material may be correspondingly lighter. Furthermore, the presence of the fibrous materials in the concrete causes the same to set in the most satisfactory manner. A wood concrete of this type is particularly advantageous in localities where stone, gravel or similar aggregate is comparatively scarce and must be shipped long distances.

From the foregoing it is evident that I have provided an exceedingly effective means and process for reducing fibrous materials of various sorts to pulp. The characteristics of the resulting pulp may be widely varied to permit the same to be utilized for practically any desired purpose. Thus paper cardboard, fiber board or molded fibrous objects may be manufactured out of pulp of this character and may be provided with varying degrees of porosity or density and with varying gummed or resinous content and with comparatively fine or coarse texture, as desired.

I claim:

1. The process of preparing a wood pulp mixture to be used in making fibrous products, which comprises partially cooking wood waste generally to reduce the same to bundles of fibers which contain a considerable portion of their original resinous content, and kneading the partially cooked fibers in the presence of a comminuted abrasive.

2. The process of preparing a wood pulp mixture to be used in making fibrous products, which comprises partially cooking cellular, fiber-containing material, which is adapted to be split apart and reduced to cells detached at one end from their original matrix, thus generally reducing the same to bundles of fibers which contain a considerable portion of their original agglutinous content, kneading the partially cooked fibers in the presence of a comminuted abrasive, and removing the abrasive from the wood, whereby a product is provided which comprises separate fibers, small fibrous particles and a considerable proportion of bundles of fibers with frayed end portions, this product retaining a considerable amount of the original agglutinous content.

3. The process of preparing a wood pulp mixture to be used in making fibrous products, which comprises partially cooking wood waste generally to reduce the same to bundles of fibers which contain a considerable portion of their original resinous content, kneading the partially cooked fibers in the presence of a comminuted abrasive without addition to the water retained from cooking to form a pulp, separating the abrasive from the pulp, and compacting the latter into a sheet bound by the retained resinous substances.

4. The process of preparing a fibrous pulp, which comprises kneading the fibrous material with a comminuted abrasive, and removing the abrasive from the material by flotation.

5. The process of preparing a fibrous pulp, which comprises cooking fibrous material in a caustic solution, draining the cooking liquor from the wet fibrous material, kneading the fibrous material while still wet with a comminuted abrasive, and removing the abrasive from the material.

6. A reducing mill for making fibrous pulp comprising a casing providing an annular depression, rolls running in said depression, said depression having inclined sides, said

rolls having beveled edges corresponding to the inclination of the sides, and supporting means for said rolls to permit the same to rotate and yet to move vertically away from the bottom of the depression.

7. A reducing mill for making fibrous pulp comprising a casing providing an annular depression with inclined sides, rolls running in said depression and having beveled edges corresponding to the inclination of the sides, supporting means for said rolls to permit the same to rotate and yet to move vertically away from the bottom of the depression, a scraper between said rolls and adapted to engage material packed in the bottom of the depression and cast the same up against an inclined wall thereof.

8. A reducing mill for making fibrous pulp comprising a casing providing an annular depression with inclined sides, rolls running in said depression and having beveled edges corresponding to the inclination of the sides, supporting means for said rolls to permit the same to rotate and yet to move vertically away from the bottom of the depression, an opening at the center of the annular depression, and a scoop to cast material from the depression through the opening, said scoop normally being held above the depression, and controllable means for lowering it into the same.

9. A reducing mill for making fibrous pulp comprising an annular depression with inclined sides, rolls running in said depression and having beveled edges corresponding to the inclination of the sides, supporting means for said rolls to permit the same to rotate and yet to move vertically away from the bottom of the depression, an opening at the center of the annular depression, and a scoop to cast material from the depression through the opening, said scoop normally being held above the depression, controllable means for lowering it into the same, and conveyor means located below the central opening and adapted to receive material therefrom.

10. The process of making a fibrous product, which comprises the cooking of fibrous material partially to soften the same while leaving a comparatively large proportion of the natural gums in the cooked material, reducing the latter mechanically in the presence of a loose abrasive, separating the resulting fibrous pulp and abrasive, forming a sheet or the like of the pulp, and pressing the sheet or the like at a temperature of the order of usual vulcanizing temperatures, whereby a comparatively dense product is formed.

11. A process of manufacturing a fibrous article, comprising the cooking of wood chips to soften and partially separate the same, subjecting the cooked chips to a grinding and kneading action in the presence of a loose abrasive, whereby the separation of fibers is carried further without necessary loss of the wood gums, removing the abrasive, and pressing the material to form a sheet, block or the like.

12. A process of manufacturing a fibrous article, comprising the cooking of saw mill waste of a high resinous content, subjecting the cooked waste to a grinding and kneading action in the presence of a loose abrasive, removing the abrasive and pressing the material to form a sheet, block or the like.

13. A process of manufacturing a fibrous pulp which comprises the cooking of saw mill waste of a highly resinous content, subjecting the cooked waste to a grinding and kneading action in the presence of a loose abrasive, again cooking the material, and then reducing the same in the presence of loose abrasive.

14. A reducing mill for making fibrous pulp comprising a casing providing an annular depression with inclined sides, rolls running in said depression and having beveled edges juxtaposed to the inclined sides thereof, supporting and driving means for said rolls arranged to permit the same to rotate and yet to move vertically away from the bottom of the depression as well as to have a limited horizontal movement in relation to the same.

Signed by me at Boston, Massachusetts, this sixth day of August, 1928.

ROLAND B. RESPESS.