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LIGNO-CELLULOSE DIE-STOCK AND PROCESS OF MAKING

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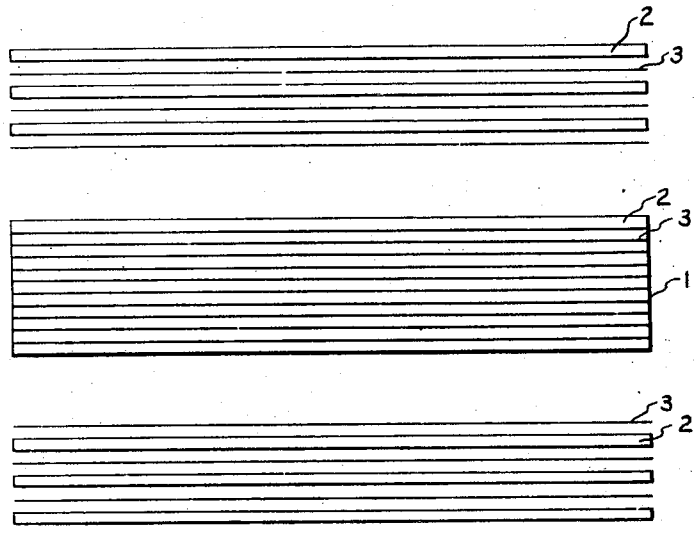

Fig. 1

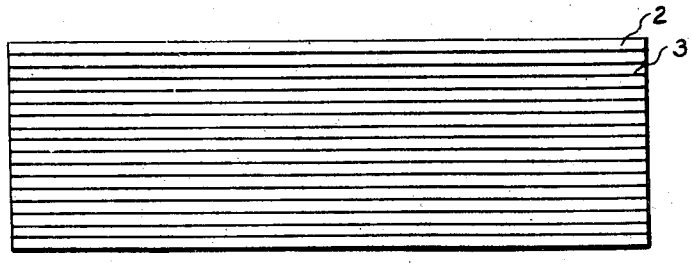

Fig. 2

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LIGNO-CELLULOSE DIE-STOCK AND PROCESS OF MAKING

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2 Claims. (Cl. 154—132)

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The present invention relates to thick dense slabs such as die-stock and the like slabs made from ligno-cellulose fiber material such as wood, preferably hard wood, and from woody parts of annual vegetable growths, and to the process of making same.

Thick ligno-cellulose slabs made in accordance with the present invention are of high utility, being useful for die-stock, that is for making dies to replace steel dies in the pressing of sheet metal, for metal-spinning forms, templates and many other uses.

The principal purpose of the invention consists in the production of die-stock and the like slabs which are of high bond strength, and substantially free from internal strains and from splitting, checking, and like defects, and which are thick enough to be suitable for the various purposes which they are to serve.

For making the slabs relatively thin sheets or boards, as ⅛'' thick for example, are first made from ligno-cellulose fiber, preferably fiber produced by explosion of hard-wood chips in a gun such as described in U. S. Patent #1,824,221 to W. H. Mason. The fiber can be manufactured into such relatively thin boards having two smooth surfaces in accordance with U. S. Patent No. 2,120,137 to W. H. Mason, or in other ways. To make the dense slabs, the thin boards are glued together under heat and pressure, by means of waterproof glue, preferably heat reactive resin glue. The heat reactive phenolic glue material known as "Tego" glue, which is obtainable in thin sheet form, and cures or sets after melting at a temperature of about 135° C., is well adapted for this purpose, and its use will be described for illustration of an embodiment of the invention.

The moisture content of slabs from which dies and like appliances are to be made must be approximately balanced with atmospheric moisture in order to minimize dimensional change after manufacture. About 3–8%, preferably about 5%, of moisture content is desirable.

It is not commercially practicable to humidify such dense thick slabs after manufacture and to get uniform distribution of moisture in this way, but by first bringing the moisture content of the component relatively thin ply-sheets to a state of substantial equilibrium with atmospheric moisture or somewhat above, a completed slab may be made therefrom with a suitable content of moisture distributed substantially uniformly throughout the slab.

When a stack of such ply sheets has been

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introduced into a hot-platen gluing press with intermediate glue films and pressure applied and the heating has progressed inwardly to the center of the stack, with resultant melting and curing of all the glue films, the internal pressure is high by reason of the combined moisture content and temperature conditions. To relieve this internal pressure, the slab, while still under compression, must be cooled through to the center. This can be done by circulating cooling water through the platen passages until the temperature at the slab center has been brought down to about 100° C. or less, whereupon the press can be opened.

In addition to securing the desired moisture content and substantially uniform distribution thereof in the completed slab, a sound product is needed with substantial freedom from strains, checks, cracks and the like, for with lack of such soundness not only is the material itself lost but much added expense as forming and tooling of expensive dies, etc. is wasted.

Good products can be made in a single gluing operation with up to about 11 plies about ⅛'' thick producing a slab up to about 1¼'' thick. When about this limit of thickness is exceeded, however, a single gluing operation will not be productive of desirably good sound slabs having high bond strength and substantial freedom from strains, checks, cracks and the like.

If the ply-stack is much thicker than this, as say about 2 inches thick, or more, difficulties arise by reason of slow heat travel through the ligno-cellulose fiber material and resulting high heat differential. Because of such slow heat travel, either the press platen temperature must be quite high or an excessive time is required to bring the central glue film up to its curing temperature (about 135° C. for "Tego" glue), or both.

Thus in making a 2 inch thick slab in a single gluing operation, even if a high platen temperature as 190° C. is used, over two hours under heat and pressure are required to bring the temperature at the center glue film in the stack up to about 135° C. which is necessary to complete the melting and curing of the "Tego" resin glue throughout the stack. Such high heat applied for such a long time is detrimental to the portions of the slab at and near its surfaces. Under such conditions weakening and embrittlement are encountered in these regions.

Furthermore the excessive heat differential between slab surface and center appears to be pro-

ductive of strains. While the strains are probably somewhat relieved in the cooling operation, they are not relieved to such extent as to get a product free from immediate or later cracking, checking, crazing and the like defects. If lower differentials were resorted to, the time in the press would be excessively prolonged.

The present invention overcomes these difficulties through the use of a plurality of gluing operations. I have found that desirably thick, sound, non-splitting and non-checking products substantially free from strains can be produced by first making use of a single hot press gluing operation to produce a slab which, while moderately thick, is not made too thick to have good soundness properties, and then repeating the hot press gluing operation with use of such slab as a core, together with one or more added glue films and board plies on each side or face of the core so provided, to make a thicker slab. Thus for example, with an 11-ply core about 1¼" thick and say a 6-ply addition, with the plies simultaneously glued to each face of the core and to one another, a 17-ply slab about two inches thick can be produced which is strong and sound and will hold up satisfactorily in use. The same number of plies are preferably added to each face of the core in order to secure uniformity throughout the slab.

The operation above described can be repeated, if desired, using the slab of say 17-plies as a core, and building up at each face with added plies as before. The figures here given are for illustration only, and considerable variation can of course be resorted to, as for example the core can be made considerably thinner, etc.

In the hot press gluing operation in which plies are added to a previously-made core as above described, a somewhat higher temperature is permissible than when making a core, for the addition is made in two parts and the steam for heating the platens can be turned off, and the cooling commenced as soon as the curing heat has struck through to the two innermost new glue films. Thus, material reheating of the core is avoided in carrying out the building-up operations, the core remains sound, and the plies added at each side are well-bonded to the core and to one another, and the whole converted into a thick completed slab which is well and permanently bonded throughout.

In order that dies and the like made from the slabs of ligno-cellulose fiber material will not check and crack and will withstand the severe strains to which they are subjected in use, they should have high bond strength. The bond strength is measured in pounds per square inch required to pull the slab apart, the pull being exerted in a direction normal to the surface plane, and the parting taking place between the glue films. For such purposes as making dies therefrom, the bond strength should be over 300# per square inch, and a bond strength over 400# is better. Such high bond strengths can be secured with the built-up slabs made available by my invention.

In Figure 1 of the attached drawing a laminated core 1 is illustrated made up of board plies 2 and bonded together by means of sheets of glue 3; directly above and below core 1, are additional board plies 2 and sheets of glue 3 (in exploded form for illustration) which are bonded to the core 1 as described. Figure 2 illustrates a finished die-stock product made up of the parts illustrated in Figure 1.

A simple illustrative example showing use of the invention is given below:

11 plies of ligno-cellulose fiber board about 50" by 150" were taken to make a core.

For making these ply sheets, hard-wood chips containing about 2½% of petrolatum size for waterproofing purposes were subjected to steam at 1000# per square inch for about 7 seconds, whereby the self-bonding properties of the fiber encrusting materials were activated, and the chips were converted to fiber by explosive discharge from the region of high steam pressure to atmosphere.

The coarser parts of the fiber were screened out and the fiber was lightly refined, formed from water (which served to remove a large proportion of the water solubles produced by the steam treatment) into a sheet about 100" wide, cut into lengths of about 150", dried and split into two widths of about 50". The dry sheets 50" wide so obtained were subjected to a pressure of about 2000# per square inch between platens heated to about 210° C., and taken out of the press hot, cooled, and their moisture content adjusted to about 5%. The boards so obtained were about ⅛" thick, their specific gravity was about 1.2, and their modulus of rupture was about 14,000 pounds per square inch.

To make a core, a stack of eleven such sheets, containing about 5% of moisture, with intermediate sheets of "Tego" glue, was subjected to a pressure of 1200# per square inch between platens heated to a temperature of 165° C. until the temperature at the center of the stack was raised to 138° C., whereupon the platens were cooled by passing water through the passages therein, and the completed, cooled, core slab removed. The completed core so obtained was about 1¼" thick.

Three plies of the same fiber board as used to form the core were applied to each side of the core with "Tego" glue sheets between these plies and between the added plies and the core, and this stack pressed at a pressure of 1200# per square inch between platens heated to a temperature of 182° C. until the temperature at the region where the innermost new glue films were located was raised to 134° C., the temperature at the core center at this time being only 106° C. The press platens were cooled and the pressure was released and the cooled and completed slab about 2" thick removed and upon being trimmed was ready for use.

Physical properties of the slab so obtained were:

Specific Gravity	Modulus of Rupture (pounds per square inch)	Bond Strength (pounds per square inch)	Rockwell Hardness (M Scale)
1.34	10,725	544	51-70

For the purposes of comparison with the above example embodying the invention, the modulus of rupture values and bond strengths were taken of eight slabs about 2" thick, which were made in substantially the same manner as above described, except that a platen temperature of 190° C. was used and all 17 plies were glued in a single operation. The average modulus of rupture was about 6,900# per square inch, or about ⅓ less than the slab glued in two steps, and the average bond strength was about 265# per square inch, or under half that of the slab glued in two steps.

The slab glued in two steps was a good commercial product, sound and practically free from cracking and checking, while those made by a single gluing operation were not of commercial value and were badly checked and crazed and readily cracked.

It is to be understood that the example given above is for illustration only, and not for limitation of the invention, which is of the scope defined by the claims.

I claim:

1. Process of making thick dense slabs having high bond strength from steam treated and exploded ligno-cellulose fiber material and containing a low percentage of water solubles, which comprises the steps of providing a plurality of dense and relatively thin ligno-cellulose fiber boards from the materials described, adjusting the moisture content of said boards to about 3–8%, subjecting a stack of said boards sufficient to make a core slab not to exceed 1¼ inches thick with intermediate films of heat reactive resin glue to pressure of at least 1000 pounds per square inch while applying to the stack surfaces heat sufficient to melt and set the glue through to the center of the stack but not so great as to cause material detrimental effect at the stack surfaces, cooling the stack while under the stated pressure, then applying a plurality of like boards to each face of the core slab so produced with films of said glue in position for gluing said boards to one another and to the core slab, subjecting the stack so produced to heat and pressure as aforesaid, and cooling the resulting slab when the new glue films have set and while still maintaining the pressure.

2. Process of making thick dense slabs having high bond strength from steam treated and exploded ligno-cellulose fiber material and containing a low percentage of water solubles, which comprises the steps of providing a plurality of relatively thin ligno-cellulose fiber boards from the material described, adjusting the moisture content of said boards to about 3 to 8%, arranging a plurality of said boards in a stack to form a core with a heat reactive adhesive between successive boards of the stack, subjecting the stack to pressure and simultaneously applying heat to melt and set the adhesive between the successive boards of the stack, cooling the stack while under pressure to a temperature below the boiling point of water, then applying a plurality of like boards with a heat reactive adhesive between successive layers to each face of the core so produced, subjecting the arrangement to heat and pressure as aforesaid, and cooling the resulting slab while maintaining the slab under pressure.

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