

May 1, 1951

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2,550,730

DIE STOCK AND PROCESS OF MAKING SAME

Filed Jan. 20, 1947

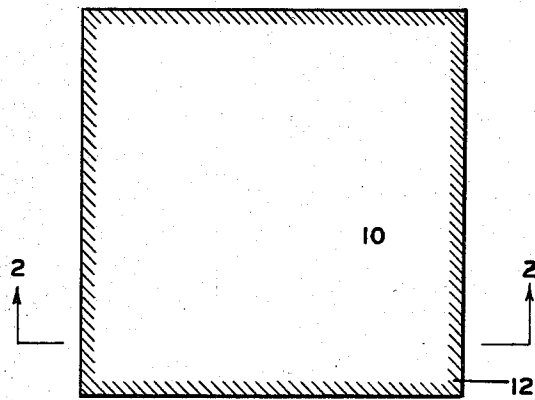


FIG. 1

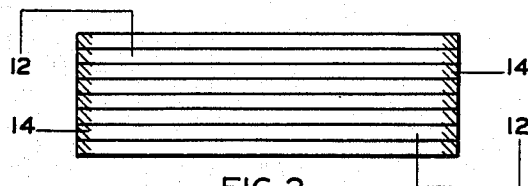


FIG. 2

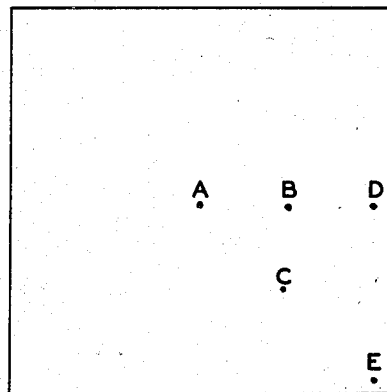


FIG. 3

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2,550,730

DIESTOCK AND PROCESS OF MAKING SAME

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Application January 20, 1947, Serial No. 723,100

6 Claims. (Cl. 154—132)

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The present invention relates to improve-
ments in thick, dense, laminated slabs, such as
die stock, electrical panels and the like slabs,
and to the process of making such slabs from
a multiplicity of relatively thin sheets made from
fibrous ligno-cellulose material such as wood,
preferably hardwood, and from woody parts of
annual vegetable growths.

One of the objects of the invention consists in
the provision of slab-like bodies having edge
portions which are of especially high resistance to
absorption of moisture.

A principal object of the invention is the pro-
vision of a process for the manufacture of
densely consolidated die stock and like slabs
which have high bond strength and are sub-
stantially free from internal strains and from
splitting, checking and the like defects, and
have such properties substantially uniformly
throughout, that is, not only in the central por-
tions but also up to and at the edges of the slab.
All these properties, and especially high bond
strength, are highly important in die stock for
from it are made dies to replace steel dies in
the pressing and flanging of sheet metal, metal
spinning chucks, templates, and other devices
subject to severe duty in use. Defects when
present cause the loss not only of the material
itself, but also of the cost of die etc. fabrica-
tion, of production line time, etc.

In previously known die stock slabs, areas at
and near the edge portions of the slab generally
had a lower bond strength than portions nearer
the mid-portion of the slab area. Due to the
non-uniformity and low bond strength near the
edge portions of the slabs, it has generally been
necessary to trim off considerable areas of the
relatively weak edge portions, and such exces-
sive trimming resulted in the loss of a consid-
erable proportion of the product.

With the process of the present invention,
losses of such large proportions of the slab area
are avoided by sealing the edges, thereby pre-
venting substantial loss of moisture at and near
the edges in the hot pressing of the slabs, and
this in turn serving to insure high bond strength
and other valuable properties uniformly through-
out the slab and particularly at and close to the
slab edges.

In carrying out the invention, ligno-cellulose
fiber is first prepared from wood chips or
equivalent by subjecting same to hydrolysis and
fibration treatment, preferably by subjecting
wood chips to the hydrolyzing action of high-
pressure steam and explosion in a gun as

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described in U. S. Patent No. 1,824,221. Other
conventional modes of hydrolyzing ligno-cellulose
material may be used, and reduction to fiber can
also be accomplished mechanically, as by grind-
ing, etc.

The fiber is felted into sheets and passed
through a drier such as a "Coe" drier, for
example, and when an especially smooth surface
is desired, the sheets are then passed between
heated rolls under light pressure. These sheets
are quite porous and relatively light in weight,
having a specific gravity of less than 1, prefer-
ably about .5 and are preferably fairly thin,
as about .4 inch thick for example. The sheets
preferably contain sizing material, such as
petrolatum for example, to impart improved
resistance to absorption of moisture.

According to the present invention the porous
edges of the sheets are treated with a sealing
material in order to prevent escape of moisture
from the edge portions during the subsequent
heating and pressing operation. The edge seal-
ing step is very important in order to produce
a slab having high bond strength and high
modulus of rupture at and near the edge por-
tions thereof. These narrow sealed edges may
be trimmed off when products of high uniformity
throughout are desirable, as for making dies.
When they are retained in the final products,
as when the sealed-edge slabs are manufactured
in sizes adapted for making table and bench tops,
counters and the like, the permanently sealed
edges are of high utility because of their great
resistance to moisture absorption.

The edge-sealing material may be resinous
and resin-like products such as obtained from
residues remaining after extraction of rosin,
etc., from pine wood with a solvent (sold under
the trade name of "Vinsol"), phenol-formalde-
hyde resins, furan resins, gilsonite, asphalts, tars,
rosins, polymerized oils, waxes, sulphur, sugars,
lignin and similar thermoplastic or thermoset-
ting materials. The "Vinsol" or other resinous
material may be prepared for treatment of the
sheet edges in the form of a solution, as for
example, dissolved in alcohol or other volatile
vehicles. Such a solution may advantageously
contain about 30% of "Vinsol." In cases where
the sealing material is soluble or readily dis-
persible in water, water may be used as the
vehicle to carry the sealing material into the
edge portions of the sheet. Alternatively, the
sealing materials may be in the form of soaps
prepared, for example, by saponifying the resin-

ous or resin-like materials with an alkali to form a soap.

The sealing material thus prepared may be applied at the edges of the blank sheets by rolls, or by spraying, brushes, or any other mechanical applying means. In order to obtain satisfactory results, sufficient material is applied so that the solution containing the sealing material will tend to penetrate uniformly about 1" from the edge portion of the sheet. The volatile vehicles used in connection with the preparation of the sealing material are then permitted to evaporate from the sheet and the material remains in the edges of the sheet.

Before pressing, the moisture content of the sheet should be adjusted to about 3 to 8% by weight of the sheet, although satisfactory slab products may be obtained with use of sheets having a somewhat lower moisture content and also with use of sheets having moisture content up to about 10 to 12% by weight of the sheet. A moisture content of about 4 to 7% is most preferable for securing slabs which will be quite free from strains and blisters. It is desirable to have the moisture content of the sheets used for making the slabs as uniform as possible.

If such thick slabs could be made from dry or practically dry sheets, humidification thereof after pressing would not be practicable. By the present invention, the slabs are made from sheets having their moisture content in substantial equilibrium with atmosphere, and this moisture is substantially retained in the product slab during and after the hot pressing of the slab. In this way material shrinking and swelling of the slab through absorption of moisture from the atmosphere are avoided.

In preparing the slabs from the edge-sealed and properly humidified thin sheets, several of such sheets are placed in a stack or pile. The number of sheets placed in the stack or pile is dependent upon the thickness desired in the slab product. If the final thickness of the die stock slab is intended to be, for example, about 1", then 8 sheets are ordinarily placed in the pile. Reduction in thickness of the porous sheets or blanks in being pressed into slabs is quite considerable, as from about 0.4" to 0.125" in this case, which is considerably less than half the original thickness.

While all the component sheets may be of the relatively light porous type above described, if desired the top and bottom sheets of the pile may be more highly compressed sheets having a specific gravity greater than 1, such as used in making the product prepared in accordance with my copending application Ser. No. 425,034, filed December 31, 1941, now Patent No. 2,459,851. These preliminarily consolidated sheets are quite dense and strong, and highly water resistant, and when they are used to form the surfaces of the slab, its surface hardness will be very high. The thickness of such surface sheet portions will not be greatly reduced in pressing the pile into a slab.

The stack or pile is now subjected to a hot-pressing operation in a platen press to compress the arranged sheets into a dense and integral slab. The moisture-containing ligno-cellulose fiber material will bond together, when subjected to heat and pressure in the press. The bonding of the ligno-cellulose fiber occurs not only within the individual piles in connection with their consolidation and reduction in thickness in the press, but also between the several component

sheets of the slab, without the use of a separate adhesive or bonding agent.

The pressure and temperature to be applied are mainly dependent upon the amount of moisture in the sheets and the specific gravity desired in the final product. For example, if the moisture in the sheets is about 5%, the pressure may be about 1500 pounds per square inch, and the platen temperature about 170° C., and the specific gravity of the resulting slab will be about 1.38. Again, if the moisture in the sheets is about 8%, and the pressing and temperature conditions are about the same as above, the specific gravity of the final product will be higher, as about 1.4-1.42. If the specific gravity of the final product is too high due to unduly high moisture content, objectionable strains and blisters may occur in the finished slab.

During the pressing operation with platens at about 170° C., the temperature at the center of the stack reaches about 160° C. Due to the sealed edges, any material escape of moisture in the form of steam and of other gases, which may form during the pressing operation, is not possible. It is essential, in order to obtain slab products of high uniform strength, to prevent any material escape of steam from the sheets during the pressing operation, for if steam is permitted to escape during the hot pressing (as it will escape from the edges and from some distance adjacent to the edges in the absence of the edge-sealing of the present invention), the edge portions of the finished product will be comparatively weak and defective. Such hot pressure operation is quite prolonged as, for example, about ½ hour is required with press platens at 170° C. to bring the temperature at the center of a 1" slab to about 160° C. The thickness reduction in pressing enables effective sealing to be attained in manner above described, the resin-containing edges being compressed in the case of 1" die stock made from 8 porous sheets, each .4" thick for example from an original 3.2" to 1". Thus an ample quantity of resin material is supplied to thoroughly permeate and fill the voids in the fiber material upon being heated, and serve effectively for sealing the edges and preventing escape of steam in the hot-pressing operation.

In order to secure high strength, especially bond strength, and to be able to remove the product slab from the press after completion of the pressing cycle without blistering or otherwise damaging such product, the pressure on the press platens is maintained until the product has been chilled to a temperature below the boiling point of water.

In a modified form of procedure, thermoactive adhesive materials may be applied between successive sheets of the stack which is to be subjected to the pressing operation. The adhesive so placed appears to prevent migration of the moisture from the sheets near the surfaces toward the center sheets during the subsequent hot-press treatment, and this is desirable in order to secure the best possible slab product. Various adhesive materials having thermoactive, i. e., thermosetting or thermoplastic characteristics may be used, preferably those which tend to fuse and set at temperatures in the approximate range of 110°-160° C. Such adhesive materials are preferably waterproof and thermoactive glues. Thermosetting phenolic glues are especially well adapted for this purpose. The thermosetting phenolic glue material known as "Tego," which

is obtainable in film or sheet form and sets at a temperature of about 135° C. is well adapted for this purpose, and its use will be described below for illustration of embodiments of the invention.

In the accompanying drawing forming a part of this specification,

Figure 1 is a plan view of a die stock slab,

Figure 2 is a sectional view of line 2—2 on Figure 1, and

Figure 3 is a diagrammatic view showing the approximate relative locations of the testing points on edge-trimmed slabs to obtain data for use in making comparison studies of different die stock slabs.

Reference character 10 designates a die stock slab 10 made up of a plurality of laminated sheets 12. The sheets 12 have the areas near the edge portions thereof sealed with a sealing material 14 which serves to prevent escape of moisture from the stack of sheets during the hot-pressing operations.

In making a comparison study for exemplification purposes and not for limitation of the invention, four 20-inch square slabs of 1-inch thickness die stock material containing 8 laminations were prepared as follows:

Slab #1.—The edges of the component sheets were sealed with Vinsol.

Slab #2.—The edges of the component sheets were sealed with Vinsol, and a layer of "Tego" adhesive was placed between successive sheets.

Slab #3.—The edges of the component sheets were not sealed, and no adhesive was placed between the sheets.

Slab #4.—The edges of the component sheets were not sealed, and a layer of "Tego" adhesive was placed between successive sheets.

Substantially the same procedure was followed in preparing the fiber and in forming the sheets for each of the four slabs, and substantially the same temperature and pressure and time was used in the press during the pressing operation. After pressing, the four 20-inch square slabs were trimmed to 18-inch squares, this treatment serving to remove all or practically all of the Vinsol-containing edge portions.

Samples were taken from each of the four 18-inch square slabs at corresponding locations A, B, C, D, and E as per the following location table, and as shown in the diagrammatic view in Figure 3, and the specific gravity, modulus of rupture, and bond strength of these samples were determined.

A—Center of the square slab.

B—Midway between A and D.

C—Midway between A and E.

D—At the edge of the slab and midway between E and an adjacent corner.

E—At a corner (and edge) of the slab.

	Locations on Slabs	Slabs			
		1	2	3	4
Specific Gravity	A	1.42	1.40	1.41	1.38
	B	1.41	1.40	1.40	1.38
	C	1.41	1.39	1.41	1.38
	D	1.40	1.41	1.38	1.38
	E	1.41	1.39	1.37	1.39
Bond Strength, #/per sq. in.	A	742	982	938	1,010
	B	784	982	896	1,080
	C	770	940	1,008	1,010
	D	726	897	224	562
	E	868	955	140	182
Modulus of Rupture, #/per sq. in.	A	15,700	17,650	15,800	14,535
	B	14,200	16,190	14,700	16,200
	C	14,750	15,300	15,050	16,600
	D	14,800	17,000	8,200	15,300
	E	15,100	15,710	7,400	15,670

It will be observed that the specific gravity of the several samples was approximately the same in all cases, but that the bond strength and modulus of rupture differed considerably in the samples taken from the several locations.

The beneficial effect of edge sealing on bond strength can be observed by comparing the bond strength at edge locations D and E with that at inner locations A, B and C. In slabs 1 and 2, made from component sheets having their edges treated with the sealing material, bond strengths were relatively uniform throughout the entire slab area, there being but little variation in the bond strength data for locations A, B, C, D and E. In sample slabs 3 and 4, made from component sheets the edges whereof had not been treated with sealing material, the bond strengths of the slabs at the edge locations D and E were much lower than the bond strength at inner locations A, B and C of these two slabs.

In comparing the modulus of rupture of the various samples in the above table, it will be seen that slabs 2 and 4, which were made with interposed layers of "Tego" adhesive, had a higher modulus of rupture, particularly at the edge portions. In this connection particular attention is directed to the data of slabs 2 and 3 at locations D and E. It will also be observed that slab 1, which had the edges of the laminated sheets sealed, had a modulus of rupture at edge locations D and E equal to approximately twice the modulus of rupture at edge locations D and E of slab 3 (edges unsealed). Although the edge portions of slab 4 were not sealed, the "Tego" adhesive between the sheets apparently acted as a seal between the layers, thus preventing substantial migration of moisture between layers throughout the slab area and as a result thereof the modulus of rupture was not substantially affected near the edge portions D and E.

From the above table it will be apparent that edge-sealing of the sheets, and also the combination of edge-sealing the sheets and using an adhesive between the layers, serve to materially increase the bond strength of the final product, particularly at areas adjacent to the edge portions of the sheets.

This application is a continuation-in-part of my copending application Ser. No. 473,574, filed January 25, 1943, now abandoned.

While I have herein described a preferred embodiment of my invention, it is understood that I do not confine myself to all the precise details set forth by way of illustration, as modification and variation may be made without departing from the spirit of the invention or exceeding the scope of the attached claims. I am not to be strictly held to matters of theory as hereinabove expressed and included in order to convey a better understanding of the invention.

I claim:

1. Process of making dense slabs of ligno-cellulose fibrous material containing moisture, which comprises forming hydrolyzed ligno-cellulose fibers into sheets having a specific gravity of less than 1 and containing from 3 to 8% of moisture by weight, applying a sealing material to the edges of the sheets, then arranging a plurality of the sheets into a stack with water-proof thermally active adhesive between successive sheets, subjecting the stack to heat and pressure and simultaneously utilizing the sealed edges to prevent moisture escape, and cooling the compressed stack while under pressure to a temperature below the boiling point of water, to unite the stack.

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into a substantially integral moisture-containing dense product having a specific gravity greater than 1.

2. Process as defined in claim 1, and in which the sealing material applied to the edges of the sheets is a thermoplastic material in a volatile vehicle.

3. Process as defined in claim 1, and in which the sealing material applied to the edges of the sheets is a thermosetting material in a volatile vehicle.

4. Process as defined in claim 1, and in which the sealing material applied to the edges of the sheets is a soap in a volatile vehicle.

5. Process as defined in claim 1, and in which the stack is compressed to less than half the original thickness.

6. Process of making dense slabs of hydrolyzed ligno-cellulose fibrous material, which comprises forming a stack including top and bottom ligno-cellulose sheets having specific gravity greater than 1 and intermediate layers of edge-sealed ligno-cellulose sheets having a specific gravity of less than 1, and said sheets containing 3 to 8% of moisture by weight, subjecting the stack to heat and pressure and simultaneously utilizing

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the sealed edges to prevent moisture escape, and cooling the compressed stack before releasing the pressure, to unite the stack of sheets into a dense product having specific gravity greater than 1 and containing moisture that was present in the original sheets.

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