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MEANS FOR INDURATING LUMBER

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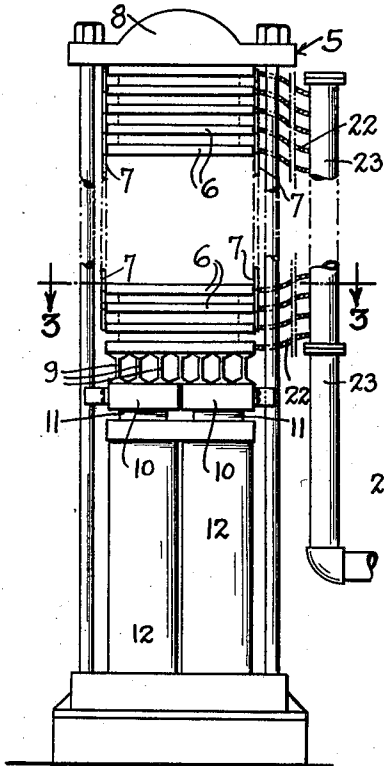


Fig. 1.

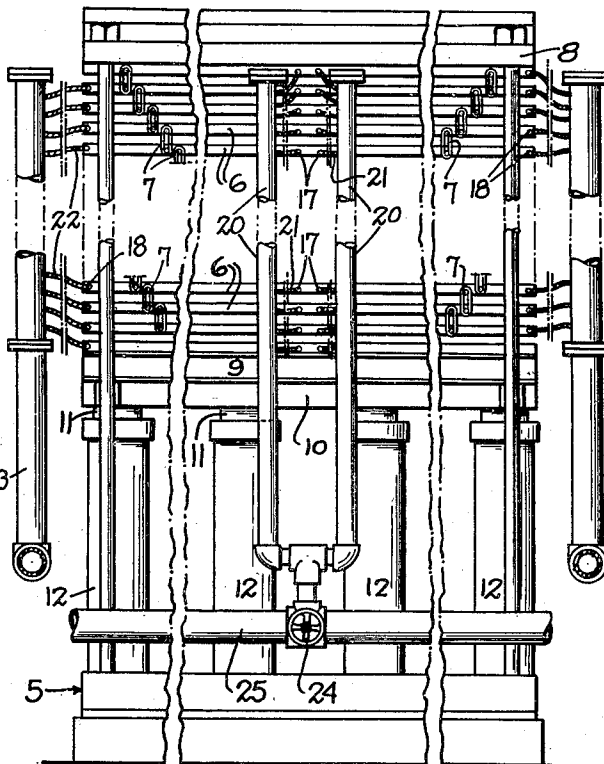


Fig. 2.

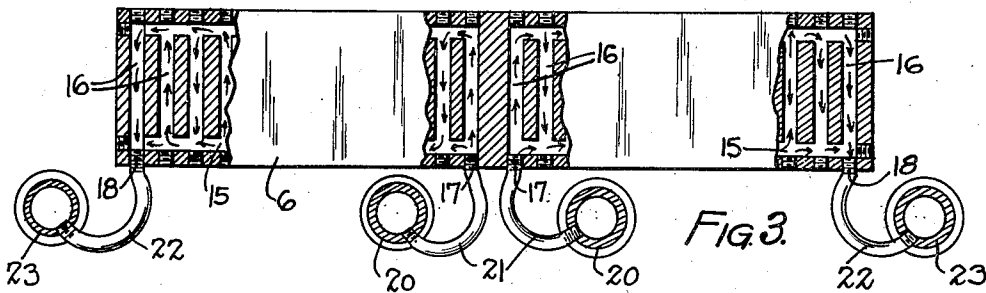


Fig. 3.

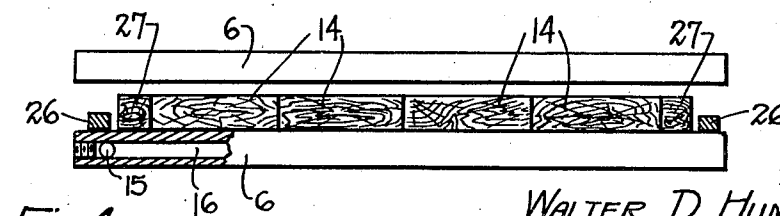


Fig. 4.

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MEANS FOR INDURATING LUMBER

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3 Claims. (Cl. 144—281)

This invention relates to a process of treating natural lumber, and in particular to the practical embodiment of such process, so that the product can be commercially manufactured and sold for general use as a substitute for, an improvement on, and in competition with natural hardwoods.

The process has to do with the induration of lumber, either natural lumber or impregnated lumber and, while the induration of lumber broadly, has been disclosed in prior patents, the practical and economical production of lumber that has been so processed as to render it denser, stronger, harder, tougher and more wear-resistant has not been taught. The laboratory production of indurated lumber has been disclosed in various manners, but such methods and the means for carrying out the processes have been costly and wholly impracticable when applied to the production of indurated lumber on a scale where it would be commercially saleable as a substitute for and in competition with natural hardwoods of comparable grades, quality, appearance and physical characteristics.

An object of my invention, therefore, is to provide a simplified and economical process and practical means for the application of such process whereby the product can be produced on a large scale and profitably sold at or below the going market prices of competitive natural hardwoods.

A further object of my invention is to employ suitable means for compressing natural lumber at temperatures required to bring about the induration of the natural lumber and to cool the processed lumber so that a minimum of time is consumed in getting the processed lumber out of the press in which the process takes place.

The process herein described is applicable to and well adapted for indurating the so-called soft woods of nearly all species and may also be used successfully with any hard woods in general use when, for any reason, it is desired to make such hardwoods harder, stronger, tougher, closer-grained or more wear-resistant. The better grades of the cheapest, least desirable woods, whether soft or hard, may, by this process, be given qualities, characteristics, properties and appearances which make them compare favorably with the better natural hardwoods of comparable grades, qualities, appearance and physical characteristics. Lumber which has been impregnated to make it rot-, fire-, or water-resistant, or immune from attacks of termites or beetles, may likewise be processed as readily and as successfully as unimpregnated natural lumber.

When it is desired to make lumber harder, heavier, denser, tougher, stronger and more wear-resistant than it is in its natural state, I have found that the following methods yield the best and most economical results in the shortest possible time. By elevating the temperature of the lumber to well above the boiling point of water, the moisture contained therein in the form of water, sap and other aqueous solutions, is turned into steam, most of which, after having thoroughly softened the wood fibers and cell walls, is driven off, or out of the lumber as the temperature of the wood is further elevated. The natural gums, waxes and resins contained in and rather uniformly distributed throughout the lumber, are liquefied at such elevated temperatures, and under adequate pressure, all excess thereof is forced into the cell voids of the lumber. Continued increase of pressure on the lumber results in collapsing the cell voids and bringing the cell walls into such close proximity or contact that when subsequently cooled, said gums, waxes, resins and other binders not only act as adhesives or binders, cementing the cell walls together, but also act as fillers in any voids which might otherwise be present. The compressed lumber then being cooled, while still under heavy pressure, to or below the temperature at which said gums, waxes, resins and other binders harden or solidify, is firmly and permanently held in its finally reduced sectional area and volume.

It is to be understood that natural lumber may, by the process herein described, be made as much heavier as desired, up to a maximum dry weight of about ninety pounds per cubic foot.

Increase in strength, hardness, toughness, wear-resistance and weight per cubic foot of the final indurated product is approximately proportional to the reduction of the sectional area of the natural lumber used, due allowance being made for the moisture content of the natural lumber and the reduced moisture content of the final product, said moisture content in both cases being based on the oven-dry weight of test pieces used for the purpose and expressed as a percentage of such oven-dry weight per cubic foot.

Compressing natural lumber at temperatures considerably above the boiling point of water results in not only forcing much of the water, sap and other aqueous solutions out of the lumber, but also converts these liquids into steam, most of which passes out of the lumber into the atmosphere. This results in making the final indurated product substantially dryer than the natural lumber used in making it was, and also

frequently results in a product having a moisture content substantially as low as natural hardwood lumber which has been kiln dried. Hence, my process minimizes warping and effects a substantial saving by practically eliminating the necessity for kiln drying and in many instances greatly reduces the time and expense necessary to reduce the moisture content of the final indurated product to the eight or ten percent required for the most exacting uses of lumber.

In carrying out my process, in order to render it more commercially profitable and practicable, use is made of a hydraulic press, which together with the process, is illustrated in the accompanying drawing, in which;

Figure 1 is an end elevation of a hydraulic press built to accommodate and process a large quantity of lumber in one operation,

Figure 2 is a side elevation of the press shown in Figure 1, parts being omitted for convenience in illustration,

Figure 3 is a section taken on the line 3—3 of Figure 1 and shows the means of heating and cooling the press plates, and

Figure 4 is a cross section through two plates showing the relative arrangement of the lumber, anti-spreader strips and spacer bars.

Referring to the drawing in detail, 5 indicates generally a hydraulic press comprising a number of spaced plates 6, which are suspended through the medium of the links 7 from the top 8 of the press, the lowermost plate being supported or arranged to be lifted by, the beams 9 which extend longitudinally of the press. The beams rest on the upper ends of the piston heads 10, the pistons 11 of which operate in the cylinders 12 under the influence of hydraulic pressure.

The plates are suspended by the links 7, so that, as the pistons move upwardly, the plates so close the spaces as to compress between them the lumber 14, positioned in the press. The press is designed to accommodate a maximum of thirty-six hundred board feet of lumber at one time and the hydraulic pistons will apply the necessary pressures, as will be hereinafter set forth, in order to compress, for instance, natural Douglas Fir lumber or equivalent to one third of its original thickness, resulting in an output of twelve hundred board feet of indurated lumber.

In order that the steel plates may be quickly heated and subsequently rapidly cooled to expedite my process, they are bored longitudinally, as at 15 and laterally as at 16, the ends being plugged, except at the inlets 17 and outlets 18. The plates are thus provided with ducts through which may be forced steam and cold water alternately to heat and cool the plates. The plates are twenty-six in number, are one hundred and forty-six inches long and sixty inches wide, thus giving twenty-five, three inch spaces for the accommodation of thirty-six hundred board feet of natural lumber, the anti-spreader strips and the spacer bars hereinafter described. The inlets 17 are supplied by the feeder heads 20 to which they are connected by the flexible pipes 21. In like manner, the outlets 18 are connected by the flexible pipes 22 to the outlet headers 23. The pipes 21 and 22 are long enough to permit any operating movement or accumulation of the plates 6. The inlet of water and steam is controlled by the three-way valve 24 in the inlet line 25. The ducts in the steel plates 6 extend laterally so that the material between them acts as ribs in strengthening the plates. In order to prevent the lateral

spreading of the lumber when being compressed between the plates, I employ anti-spreader strips 27 which may be of relatively harder wood than the lumber being processed, with the result that when the plates exert pressure there can be little or no spreading or unevenness of the outside edges of the outer planks and this also minimizes the amount of planing necessary to secure clean true edges. In order to positively and accurately regulate the final thickness of the indurated lumber when fully compressed between the plates, I employ steel spacer bars 26 of the thickness which it is desired that the final product is to be. The following process or method of operation is carried out in the press:

Assume that three thousand board feet of rough Douglas Fir lumber is to be indurated by the process herein referred to. There are one hundred pieces of such lumber, each piece being two and one half inches thick, twelve inches wide and twelve feet long. Each piece contains thirty board feet, or two and one half cubic feet, and the average moisture content of the entire lot is twenty percent of the net oven-dry weight of the lumber. The moisture is in the form of water, sap and other aqueous solutions. Each piece or plank weighs ninety pounds, or thirty-six pounds per cubic foot when put into the press. It is desired to so process this lumber that the final product will have dimensions of one inch in thickness, twelve inches in width and twelve feet in length; will have a moisture content of about eight per cent of its oven-dry weight; will weigh eighty-one pounds per cubic foot, which is substantially the weight of dry lignum vitae and the final compressed and indurated lumber will measure twelve hundred board feet since it will have been compressed to forty per cent of its original thickness, without change of width or length. It will likewise have been reduced from the original volume of 250 cubic feet to 100 cubic feet. The detailed description of my preferred method or process for carrying through the operation is as follows, although various other methods may be used:

First.—Four natural Douglas Fir planks, as above described, are inserted side-by-side and as close together as possible in each space between the plates of the hydraulic press. In a press of the suggested dimensions and capacity the entire lot of 100 planks referred to above will be accommodated at one time.

Second.—An anti-spreader strip 27, of the same thickness and length and as hard as, or preferably harder, than the lumber being processed, is placed outside of, and in close contact with the outside edges of the outer planks of each set of four planks in each space between the plates of the press. For a press of the dimensions and capacity referred to, 50 such anti-spreader strips are required for each full charge of the press. If preferred for any reason, and if a small amount of waste, caused by a little breaking down of the outside edges of the outer planks, is not objectionable, an economy may be effected in the processing of some species of lumber by dispensing with the use of the anti-spreader strips referred to.

Third.—Steam is then admitted to all the plates simultaneously and only enough hydraulic pressure is applied to the planks to keep them from warping—say 25 to 50 pounds per square inch. The planks remain under such hydraulic pressure and subject to the heat of the plates until they attain a temperature of about 105 degrees

to 110 degrees centigrade, which, under ordinary working conditions, takes from ten to fifteen minutes.

Fourth.—Then increased hydraulic pressure is so applied to the plates that the plates slowly compress the planks at as uniform a speed as is consistent with operating conditions. During this step in the operation maximum steam pressure varying from 25 to 125 pounds per square inch to effect a corresponding elevation of temperature, depending on the condition and species of the natural lumber used and the qualities and characteristics to be imparted to the final product, is turned into and maintained in the plates. This part of the operation usually takes from 10 to 15 minutes.

Fifth.—At any convenient time in the operation, steel spacer bars 26 of the proper thickness and length (in this case one inch thick and twelve feet long) are placed outside of, and half an inch or so away from the outer edges of the anti-spreader strips referred to above. Two spacer bars (one being on each side) are required for each space between the plates of the press. For a press of the dimensions and capacity referred to, 50 such spacer bars are required for each full charge of the press. The spacer bars limit the closing of the plates and accurately determine the thickness of the final product. This feature eliminates time consuming calipering, which is necessary but utterly unreliable in other indurating processes and is entirely out of the question if economical commercial production of high quality is to be attained.

Sixth.—The steam is then turned off and, while still maintaining heavy pressure on the press plates and on the compressed lumber, the plates are rapidly cooled by the circulation of cold water or any suitable refrigerating medium through the plates and the lumber is thus reduced in temperature to the point at which the natural waxes, gums, resins and other binders therein solidify or harden, thereby firmly and permanently holding the compressed lumber in its final reduced sectional area and volume.

If the pressure on the indurated lumber is released before said lumber has been sufficiently cooled, throughout to set and thoroughly harden the gums, resins, waxes and other binding substances which act as binders to hold the finished product in its desired thickness, the lumber will expand irregularly in thickness, or "pincushion", and will be ruined for any use except fuel. The sufficient cooling of the plates and lumber in my press takes about 10 to 15 minutes. The following is a summary of the press time required for producing the finished product:

Heating lumber to 105-110 deg. cent.	10 to 15 min.
Further raising temp. and compressing	10 to 15 min.
Cooling plates and lumber	10 to 15 min.

Average press time required for entire operation to produce 1200 feet of indurated Douglas Fir lumber weighing 81 lbs. per cubic foot----- 30 to 45 min.

The pressure required for reducing Douglas Fir lumber or its equivalent from two and one half inches to one inch thick is from 1,000 lbs. to 1,100 lbs., per square inch. If it is desired to make Douglas Fir lumber or its equivalent weigh only 45 pounds per cubic foot, the time required

for the entire press operation will be reduced to 20 or 25 minutes and the pressure required will be from 700 to 800 pounds per square inch.

Referring further to the above detailed example of the process involved in producing indurated lumber of about the weight of *lignum vitae*, the following additional data are given:

	Per cubic foot
Oven-dry weight of natural lumber used	75.0 lbs.
Moisture content of 20% of oven-dry weight	15.0 lbs.
Actual weight of natural lumber put in press	90.0 lbs.
Moisture removed as steam and by compression (12% of 75 lbs.)	9.0 lbs.
Final weight of indurated product, with 8% moisture content	81.0 lbs.

The final product will have been compressed to 40% of its original thickness without change of width or length; each board will measure one inch thick, twelve inches wide and twelve feet long and contain twelve board feet or one cubic foot and will weight 6,750 pounds per thousand board feet, or, as indicated above, 81 pounds per cubic foot.

When the natural lumber is so green or wet that it will take too long and be too expensive to eliminate excess moisture by pressure between the heated plates, as herein set forth, I may subject the lumber to the influence of dry steam for a short time before placing it in the press for the processing thereof, the steam to be applied in a closed retort.

When the natural lumber is too dry for the successful operation of the indurating process, it may be quickly and economically put into suitable condition by steaming in a closed retort before compression. When considerable moisture must be introduced into the lumber before the processing operation, I have found that applying wet steam in a closed retort gives satisfactory results, or the lumber may be immersed in boiling water or hot or cold water until the moisture penetrates the lumber to a depth of from one quarter to one third the thickness of the lumber. It is not necessary to dampen the lumber uniformly for the reason that the high temperature of the compressing plates converts the moisture in the lumber into steam which uniformly permeates all the fibers of the wood.

I have found that all knots in natural lumber compress to the same thickness as the rest of the board being processed, without causing any annoyance or added expense and also that loose knots in natural lumber invariably become perfectly tight and permanently and securely set when the lumber is processed as herein described.

Lumber which has been indurated by my process is very much more fire-resistant than the natural lumber from which it is made and than hardwood of comparable density for the reason that, by reducing the volume of, or entirely closing the cell voids present in the natural lumber, the volume of air originally contained in the wood is greatly reduced, or, in the case of maximum possible compression, is practically eliminated. Hence, by the reduction or practical elimination of the oxygen in the indurated lumber, the conditions essential to rapid combustion are greatly minimized, more especially since most or all of the oxygen necessary to support combustion is

absent from that side of the flame next to the lumber.

The process is equally well adapted to processing either lumber in its natural state or lumber which has been impregnated with oils, waxes, emulsions or chemical solutions. The plates of the press may be removed as necessary or a number of plates may be accumulated in a compact pile at the bottom of the press and thus make it possible to process lumber of any thickness greater than three inches if so desired. Also the cooling of the plates may be accomplished by the use of any refrigerant such as ammonia, if desired.

My invention is not to be restricted to the precise details of construction or procedure used as an example since various changes and modifications may be made therein without departing from the scope of the invention or sacrificing its chief advantages.

What I claim is:

1. In a machine for indurating lumber, in combination a plurality of movable plates between which layers of lumber planks are compressed to a predetermined thickness, and compressible anti-spreader strips having a density greater than

the density of the wood to be compressed between the plates and in contact with the outer edges of the outer planks of each layer for preventing the spreading of the lumber.

2. In a machine for indurating lumber, in combination a plurality of movable plates between which lumber is compressed to a predetermined thickness, compressible anti-spreader strips having a density greater than the density of the wood to be compressed between the plates and in contact with the outer edges of the planks for preventing the spreading of the lumber, and spacer bars between the plates for limiting the compressing movement thereof.

3. In a machine for indurating lumber, in combination, a plurality of movable platens arranged to be alternately heated and cooled and between which layers of lumber planks are compressed to a predetermined thickness and compressible anti-spreader strips attaining a greater density under compression than the density of the wood to be compressed disposed between the plates and in contact with the outer edges of the outer planks of each layer for preventing the spreading of the lumber.

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