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MANUFACTURE OF COMPOUND LUMBER

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Fig. 1.

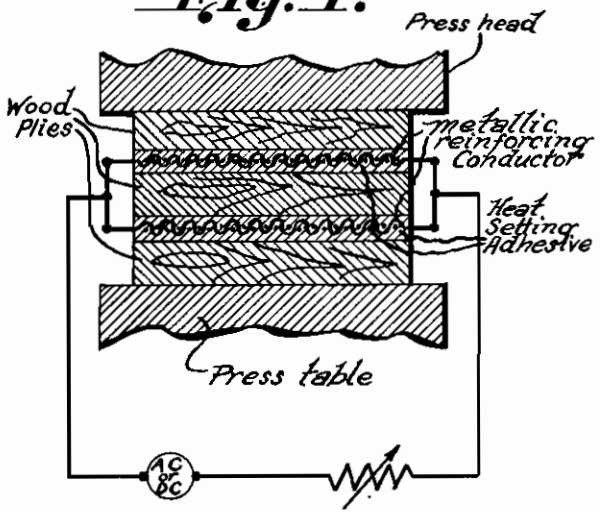


Fig. 3.

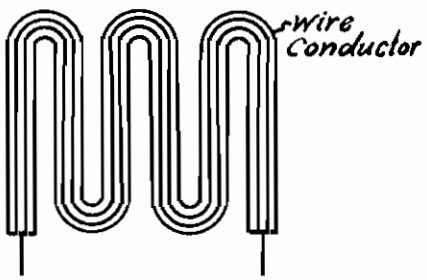


Fig. 2.

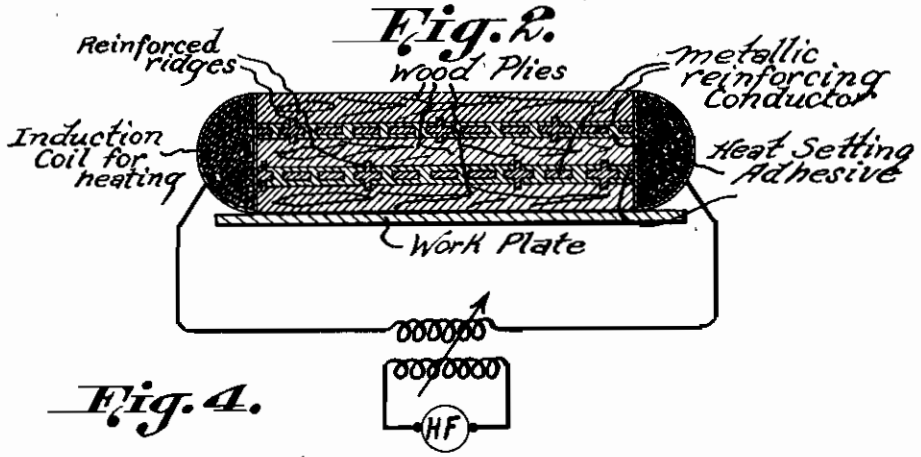
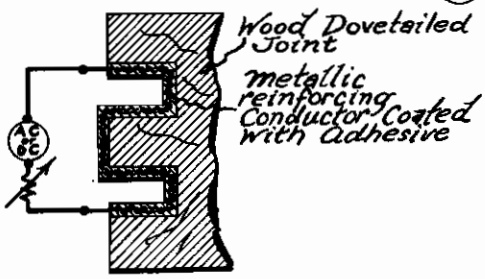


Fig. 4.



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ALIEN PROPERTY CUSTODIAN

MANUFACTURE OF COMPOUND LUMBER

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Application filed September 13, 1938

This invention relates to manufacture of compound lumber; and it comprises a method of making compound lumber from plies of wood or other fibrous material which may have considerable thickness, said method comprising assembling layers of fibrous material with alternate layers of a thin electric conductor, usually in the form of a network of resistance wires, a wire screen or a foraminous metal plate, a heat-setting adhesive also being introduced into the resulting joints, then subjecting the resulting assembly to pressure and simultaneously heating said conductor internally by an electrical method, which may involve the passage of an electric current through said conductor or the use of induction heating, thereby producing heat-setting of said adhesive in situ and the formation of permanent bonds at said joints; all as more fully hereinafter set forth and as claimed.

Ply-wood and other laminated products have found many new uses in the industrial arts within the past few years. This is due largely to improved methods of manufacture and the use of heat-setting adhesives, such as the phenol-formaldehyde resins. One method of using phenol-formaldehyde adhesives in the manufacture of plywood, for example, is described in the U. S. patents to Weber et al, Nos. 1,960,176 and 1,960,177. In the method there described the adhesive is used in the form of sheets or films which are made by impregnating thin tissue paper with a phenol-formaldehyde resin in its initial stage of condensation, followed by drying said adhesive to a non-tacky state. These adhesive sheets are inserted between plies to be united and the assembly is subjected to heat and pressure in a press provided with heated platens, the heat being passed through the plies to the joints. The heat produces setting of the adhesive and the articles can be quickly removed from the press in a finished state. A more recent improvement involves the production of reinforced compound lumber by the use of adhesive sheets comprising foraminous metal sheets coated with a phenol-formaldehyde resin, for example. These reinforced adhesive sheets are inserted between plies to be united, followed by the application of heat and pressure, as described in the copending application, filed of even date herewith, by Dr. Willy Lüty. This new method has likewise greatly extended the range of usefulness of compound lumber. But up until the time of the present invention no wholly satisfactory method has been known, whereby heavy or thick layers of wood and other materials could be combined to form compound lumber, this term, including combined paper board and other fibrous materials as well as laminated wooden products.

In attempting to combine thick layers of wood, for example, with the use of a heat-setting adhesive, it has been found that the heat of the platens of the usual press takes too long to pass through the thick layers in order to reach the joints. It is necessary to employ high platen temperatures in order that the joint may eventually reach the relatively high temperatures required to produce setting of the adhesives. This produces a considerable amount of steam, from the moisture present, and this steam is driven into the joint. It may be sufficient in quantity to retard or entirely prevent the setting of the adhesive. For these reasons it has been considered necessary in the past to resort to cold-setting adhesives in the production of compound lumber from thick parts. These low temperature methods, however, are cumbersome and expensive. In the gluing together of large pieces, for example, hours or days are required for the adhesive to set satisfactorily. And during this long period it is necessary to keep the pieces under high pressure. The clamping devices required for this purpose are cumbersome and expensive, since they must be made of heavy material in order to withstand the high stresses which are developed. Machine presses have been employed in order to produce the initial pressing. But when such presses are used it is necessary to remove the pieces from the press and to apply some type of screw clamp to maintain the pressure, owing to the rather obvious fact that it would not be economically feasible to leave the pieces in an expensive machine press for the length of time required to produce final setting. Needless to say this method has likewise not proved to be economical. For these reasons compound lumber made from heavy pieces has not been widely employed in the arts.

The difficulties involved in making compound lumber from heavy parts, as outlined above, are eliminated by the present invention. In our new process any of the usual heat-setting adhesives are employed and these are quickly set in situ by means of heat and pressure. But in the present method the heat required to produce setting is generated in situ rather than being passed through the plies which are being united. This result is accomplished by the use of metallic conductors in the joints which are heated electrically to produce setting of the adhesive. Electrical heating may be accomplished by inducing eddy

currents in the metal or merely by passing an electric current of high amperage through the metal to produce resistance heating. The temperatures produced in the joint can be closely controlled with both of these methods.

The metal conductors employed in this invention may be of various types and shapes. If desired resistance wires of nichrome or other resistance alloy may be used. These wires may be formed in the shape of a band of sinuous shape, for example, which is spread out to form a network substantially covering the surface of the joint. It is not necessary that such conductors cover the entire surface of the joint since the heat conductivity of the molten adhesive is rather high and since the adhesive tends to flow in the joint before setting takes place. It is also possible to employ wire screening, wire gauze or perforated sheet metal, as described in the acknowledged application of Dr. Lüty. And, if desired, the metal conductors may be pre-coated with the heat-setting adhesive before being employed, as also described by Dr. Lüty. If resistance wires are used, with some distance between the wires, the pre-coating method is of special advantage since the coated wires tend to hold the plies apart until the adhesive has softened and at this point the excess adhesive on the wire flows readily to penetrate the spaces between the wires.

If the electric conductor is not pre-coated there are various ways in which the adhesive may be applied. For example, it is possible to coat both faces of the articles to be united, to lay the conductor on one of the coated faces and then to apply adhesive over the conductor. When the conductor is made of resistance wire which is spaced apart some distance or when made from a wire screen it is possible to place the conductor over one of the surfaces to be united which is uncoated and to apply the adhesive over the conductor. In this case the adhesive will usually pass through the conductor and spread satisfactorily on the surface beneath. But it is generally more satisfactory to pre-coat the conductor with the adhesive and to dry the adhesive to a non-tacky state before it is used without impairment of its heat-setting properties. The sheeted adhesive thus produced is convenient to handle and produces excellent results.

As stated previously, any of the usual heat-setting adhesives may be employed in our new method. These include, solutions of heat-setting gums and the like, but best results are obtained with the heat-setting artificial resins, such as the phenol-formaldehyde resins. We prefer to employ the alkaline condensation product of phenol-formaldehyde in its initial stage of condensation. This can be produced, for example, in the manner described in the acknowledged patents to Weber et al. It is also possible to employ the solutions of phenol-formaldehyde resins in various organic solvents which are sold on the market as Bakelite varnishes, for example. The conductors of our invention can be pre-coated with these adhesives by spraying or dipping operations, for example. It is possible to pass the conductors continuously through a bath of an adhesive, followed by heating to dry and harden the adhesive without impairment of its heat-setting properties as described in more detail in the acknowledged application of Dr. Willy Lüty.

If foraminous sheet metal is employed as the conductor in this invention, inductive heating is advantageous. These sheet metal conductors may be made of various shapes. For example, it has been found advantageous to provide them with reinforcing ridges or projecting knobs or spikes and the like which become embedded in the plies and produce interlocking engagement between the plies and the metal. Reinforcing ridges may be provided to oppose shearing forces, for example, the ridges being placed perpendicular to the shearing forces.

It is possible to vary the heat generated at various portions of the joint by varying the cross section of the metal conductors slightly or by varying the spacing of the resistance wires. The smaller the cross section of the metal, the more the heat generated. And when resistance wires are used, the closer the spacing, the more the heat generated. It is also possible to bend the metallic conductors to fit joints of different shape. For example the joints may be roughened, notched or dovetailed and the conductors can be bent in a corresponding manner.

Our new method has several important advantages. The thickness of the parts which are united has no effect whatever upon the time required to produce setting of the adhesive. It is thus possible to unite thick planks for the production of I-beams, for example, as readily and quickly as it was formerly possible to unite thin veneers in the production of ply-wood. We have also found that the parts to be united may contain a substantial quantity of moisture without affecting the set produced. Any steam generated by the heating is driven out of the joint or is absorbed by the cooler adjoining fibrous material without damaging the adhesive. The heat generated by the electrical heating is highly localized and therefore only a small quantity of heat is required. The consumption of electricity is small. It is also possible to unite any number of plies simultaneously into a single unit; a result which was impossible under former practice. Our method is extremely flexible and can be suited to almost any type or shape of joint which is desired in the production of compound lumber of any desired thickness.

Our invention can be described in somewhat more detail by reference to the accompanying drawing which illustrates, more or less diagrammatically, several different ways of conducting the process of the present invention, as well as showing several different forms of metallic conductors which can be employed in this process. In this showing

Fig. 1 is a partial vertical section through a piece of compound lumber assembled in a press ready to be united by heat and pressure, the heat to be supplied by the passage of an electric current through the conductor,

Fig. 2 is a vertical section through a work plate on which there is mounted a pressed assembly of wooden plies with alternate layers of foraminous metal conductors this assembly being surrounded by an induction coil adapted to supply internal heating to produce setting of the adhesive in the joints,

Fig. 3 shows an assembly of resistance wires which may serve as a metallic conductor within this invention, while

Fig. 4 is a side elevation of one section of a dovetailed joint with a foraminous sheet metal conductor in position, in said joint.

The drawing is supplied with appropriate legends which are believed to make the various fig-

ures self-explanatory. In Fig. 1 there is shown an assembly of three wooden plies alternating with two layers of a metal screen which serves as a metallic conductor and also, incidentally as a reinforcement. The assembly is shown mounted in a press, of which the press head and press table are partially shown. The metal screen is attached on both sides to a source of current which, of course, may be either alternating or direct. A variable resistance is included in the circuit by means of which it is possible to vary the current through the reinforcement and therefore the temperature attained in the joint. The temperature required to produce setting of a phenol-formaldehyde adhesive, for example, is about 130° C.

In Fig. 2 a work plate is shown on which there is mounted a similar assembly of wooden plies alternating with metallic conductors, after having been combined by means of heat and pressure. The conductors shown in this figure are in the form of perforated plates. They are provided with reinforcing ridges which, as shown, become imbedded in the plies and serve to strengthen the resulting compound lumber. The assembly is surrounded with an induction coil which serves to produce internal heating by induction, that is, by inducing eddy currents in the metallic conductors. The induction coil is shown attached to a variable transformer which in turn is connected to a source of high frequency current. The temperature produced within the joint can be easily regulated to that which is required to produce proper setting of the adhesive.

In Fig. 3 there is shown an assembly of resistance wires which is in the form of a sinuous belt. This belt can be inserted between plies of fibrous material to be united and can be adjusted readily to provide the proper shape and spacing of conductors to produce the desired internal heating of the joint. If desired this belt can be coated with adhesive and dried before it is inserted in the joint

In Fig. 4 there is shown a side view of one section of a dove-tailed joint with a metallic sheet conductor in position in the joint. The metallic conductor shown is in the form of a wire screen which is filled or coated with a heat-setting adhesive. This screen is shown attached to a source of current for resistance heating. The cooperating dove-tailed section, not shown, is inserted into the section shown from the left side of the figure as is believed to be evident from the drawing.

While we have described what we consider to be the best embodiments of our method, it is evident that many details can be varied widely without departing from the purview of this invention. In its broad scope our invention involves the manufacture of compound lumber with the use of heat-setting adhesives, said adhesives being set in situ in the joints by heat supplied from electrical conductors which are present in the joints, the said conductors being heated electrically. While it is evident that the advantages of this method extend to the production of plywood and thin veneers, it is especially applicable to the manufacture of compound lumber from thick parts which cannot be economically united by methods employed previously in the art. Our new method is capable of uniting thick pieces as cheaply and satisfactorily and with substantially the same rapidity of production as this could be accomplished in the case of thin veneers by methods used previously in the art. It is therefore evident that our method has greatly extended the range of utility of compound lumber. Modifications of our method which would be evident to those skilled in the art and which fall within the scope of the following claims we consider to be within our invention.

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JAKOB DIETRICH.
WILLY LÜTY.