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MEANS FOR PROGRESSIVE DIELECTRIC HEATING

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Fig. 1.

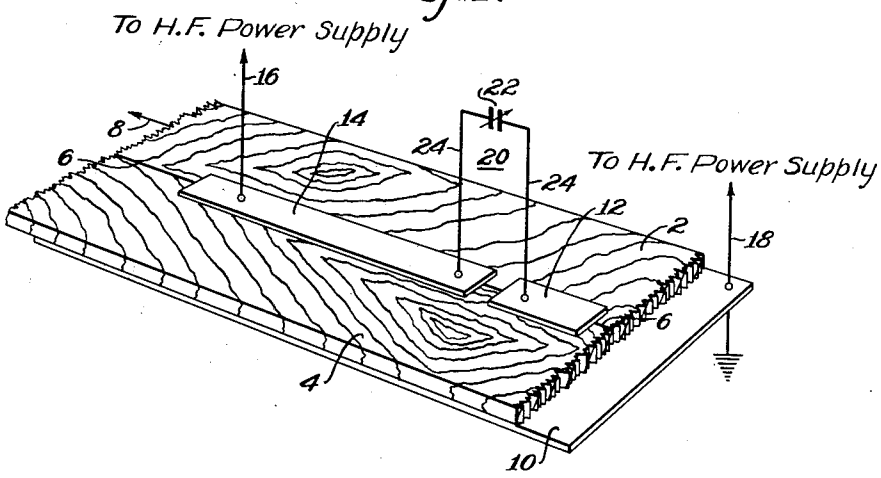
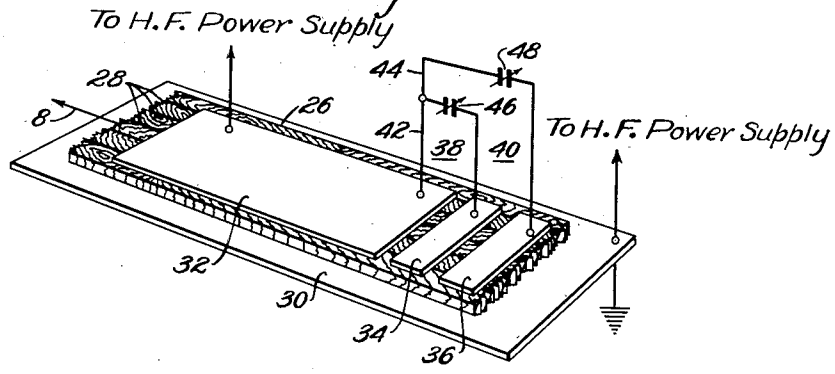


Fig. 2.



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MEANS FOR PROGRESSIVE DIELECTRIC HEATING

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My invention relates to means for utilizing high-frequency dielectric heating for obtaining high-speed production of edge-glued wood veneering. More generally, my invention is directed to means in which glue bonds two or more pieces of dielectric material together, and can be speedily and properly cured by means of dielectric heating.

In edge-gluing wood veneers or strips, it is necessary to cure or set the glue used to bond the several pieces of wood together in order to impart strength to the glue lines or joints. In accordance with my invention, the glue lines are set by passing them through a high-frequency electric field having lines of force that generally parallel the glue lines. It is desirable, in such practice, to use as high a voltage as possible across the glue line in order to secure a high rate of production. Initially, the glue is wet and cannot withstand a high voltage gradient. However, as the glue in the joints begins to set or cure, it becomes drier and its dielectric loss factor changes in a manner which lowers the rate at which heat is generated in the joint at a given voltage. On the other hand, as the glue sets, the maximum voltage gradient that it can withstand without arcing or breakdown, increases.

A broad object of my invention is to provide a dielectric heating system in which a board made from edge-glued pieces can be produced while the pieces making up the board continuously move through the heating-electrodes of the system.

An object of my invention is to provide a dielectric heating system of a type described for the progressive production of boards of edge-glued pieces of wood, the system being characterized by being able to set the glue line bonding the pieces in a minimum of time and with a minimum length of heating-electrodes.

A more general object of my invention is to provide a dielectric heating system of a type described for making a veneer-board of a type described, which system comprises, in effect, a plurality of pairs of heating-electrodes arranged along the path of travel of the board, but connected to a common or single source of high-frequency power through voltage - controlling means which permits different and controllable voltages to be applied to the several pairs of heating-electrodes.

Objects, features and innovations of my invention, in addition to the foregoing, will be discernible from the following description of its

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essential features. The description is to be taken in conjunction with the accompanying schematic drawing of the parts necessary to an understanding of my invention.

In the drawing:

Figure 1 is a perspective view of one form of apparatus embodying my invention, and

Figure 2 is a perspective view of a second form of apparatus embodying my invention.

In the embodiment shown in Fig. 1, the work to be dielectrically heated is indicated as comprising two flat pieces of wood veneer 2 and 4, which are to be edgewise secured together at a joint or glue line 6 comprising a suitable glue, such as, for example, a resin, that will set or cure under heat or under heat and pressure. The glue in the joint is cured as the wood pieces 2 and 4 are continuously moved by any suitable means in the direction of the arrow 8, between a lower relatively large grounded flat metal plate or heating-electrode 10 and two much narrower flat metal plates or heating-electrodes 12 and 14 arranged successively in the direction of travel of the glue line 6. The heating-electrodes 12 and 14 lie in a plane, and are spaced so as to be relatively insulated. They are also insulated from the heating-electrode 10.

A source of high-frequency power is connected in any suitable manner across the relatively insulated heating-electrodes 10 and 14. This is shown schematically by means of conductors 16 and 18 representative of connections from a suitable power supply. A further circuit-branch 20, including a variable capacitor 22, is connected to the electrodes 12 and 14 by means of connecting conductors 24. Hence, the voltage between the heating-electrodes 10 and 14 is applied to a circuit including, in series, the circuit-branch 20 and the spaced heating-electrodes 10 and 12. The result is that the voltage across the heating-electrodes 10 and 12 will be less than that across the heating-electrodes 10 and 14 because of the voltage drop introduced by the capacitor 22. Preferably, but not necessarily, the conductor 16 is connected to the heating-electrode 14 at a point near where the glue line emerges from beneath the heating-electrode 14; whereas the circuit 20 is connected at the opposite end of the heating-electrode 14. However, broadly, my invention is not restricted to such precise connections.

Although the heating-electrode 10 has been shown as a single metallic plate for convenience, it can be otherwise formed for electrical cooperation with the heating-electrodes 12 and 14

to provide, in effect, a first pair of heating-electrodes 10 and 12, and a second pair of heating-electrodes 10 and 14, each pair providing a distinct dielectric field. When the glue line 6 enters the first dielectric field between th first pair of heating-electrodes 10 and 12, it is preheated and partially dried and partially cured. After such treatment, the glue can be heated faster and can withstand a higher voltage-gradient. Hence, the higher voltage provided between the second pair of heating-electrodes 10 and 14 will set the glue line more rapidly. Consequently, the heating-electrodes are arranged to provide a substantially straight path in which the wood pieces 2 and 4 move substantially rectilinearly; the heating electrode 12 being in a first portion of the path and the heating electrode 14 being in a second or different portion of the path.

Since only one glue line is being treated, the upper heating-electrodes 12 and 14 need not be wide. Their lengths, however, are dependent on such considerations as the voltage and frequency of the power supply, the power demand, the kind of glue used, the speed of travel of the wood, and similar factors known to the art. In the embodiment shown, the final heating-electrode, such as 14, is longer than the first heating-electrode, such as 12, in instances where the later treatment requires a longer time, even with higher voltage gradients.

As an example of an application of apparatus in accordance with the described embodiment, ¼ inch thick boards can be edge-bonded with a urea formaldehyde adhesive by using frequencies in the neighborhood of 5 megacycles, and an insulated heating-electrode of about 3 to 4 feet long following an insulated heating-electrode about 1 foot long, both being from ½ inch to ¾ inch wide. The voltage across the first pair of heating-electrodes, such as 10 and 12, may be in the order of two-thirds of the voltage across the second pair of heating-electrodes, such as 10 and 14. To obtain such a division of voltage, the capacitance of the capacitor 22 should be about twice as much as that between the heating-electrodes 10 and 12, bearing in mind the board between the pairs of heating-electrodes is a factor in the capacitance. The area of the heating-electrodes 12 and 14 can be made small if a small capacitance between each pair of heating-electrodes is desired. By making the capacitor 22 variable, finer adjustments in the voltage can be obtained. It is to be observed that the reactance of the branch circuit from the high-frequency power supply across the heating-electrodes 10 and 14 is capacitive, and that the reactance of the branch circuit 24 is of the same sort, namely, also capacitive.

Fig. 2 shows an arrangement, in accordance with my invention, in which, in effect, three different pairs of heating-electrodes provide three different voltages for dielectrically heating traveling work, the voltages becoming higher as the work becomes better able to withstand the higher voltage. Fig. 2 also differs from Fig. 1 in that the upper heating-electrodes are wider so that wider work can be heat-treated, as for example, a board 26 having a plurality of parallel edgewise joints or glue lines 28.

With reference to Fig. 2, a source of high-frequency power is connected across a lower table heating-electrode 30 and an upper heating-electrode 32 at the exit end of the heating system. For preliminary heating of the work, two other heating-electrodes 34 and 36 are provided successively toward the feeding end of the heating equipment. The pair of heating-electrodes 30 and 34, and the pair of heating-electrodes 30 and 36 are supplied with power through circuits 38 and 40, respectively, connected by wire-connection conductors 42 and 44, respectively, to the upper heating-electrode 32. The circuits 38 and 40 include variable capacitors 46 and 48, respectively, for controlling the voltage that is absorbed in each. For example, if it is desired to have the voltage cross the pair of heating-electrodes 30 and 34 higher than that across 36 and 30, the capacitance of the capacitor 46 in the circuit 38, should be higher than the capacitance of the capacitor 48 in the circuit 40.

While I have described my invention in forms which are now preferred, it is obvious that the forms are subject to wide modification in accordance with the teachings and principles of the invention herein disclosed. Thus by reversing the connections or the direction in which the work travels, it will first be subjected to a higher voltage-gradient and then to a lower voltage-gradient. It is also apparent that each pair of heating-electrodes can provide a distinct electric field having a voltage-gradient which is sharply different from any next adjacent dielectric field. My invention is in the nature of an improvement over that more broadly disclosed and claimed in the co-pending application of Theodore P. Kinn, Serial No. 760,348, now Patent No. 2,546,004, filed concurrently herewith.

I claim as my invention:

1. Dielectric heating equipment comprising a plurality of pairs of spaced heating-electrodes between each of which a high-frequency electric field can be established, each pair comprising an insulated heating-electrode, said plurality of pairs of heating-eletcrodes being so arranged that a dielectric material to be heat-treated can pass successively therebetween, connection means for connecting a source of high-frequency power having a first voltage between a first pair of said plurality of pairs of spaced heating-electrodes, and circuit means, comprising a voltage controlling connection, for deriving a second voltage from said first pair of heating-electrodes and applying said second voltage to a second pair of said plurality of pairs of spaced heating-electrodes.

2. Dielectric heating equipment providing an elongated narrow path for heating particular portions of a dielectric material successively along different portions of the path, comprising a first pair of spaced relatively insulated heating-electrodes, one of said heating-electrodes being along one side of a first portion of said path and the other of said heating-electrodes being on the other side of said first portion of said path, a second pair of spaced relatively insulated heating-electrodes, one of said second pair of heating-electrodes being on one side of a second portion of said path and the other of said second pair of heating-electrodes being on the other side of said second portion of said path, said first portion of said path being spaced from said second portion of said path, said heating-electrodes which lie on the same side of said path being relatively insulated, a work-receiving conveyor movable successively between said pairs of heating-electrodes, a first circuit means comprising said first pair of said electrodes, said first circuit means being connected to a high-frequency power supply for providing a high-

frequency voltage across said first pair of heating-electrodes, a second circuit means comprising said second pair of said heating-electrodes for applying a high-frequency voltage to said second pair of heating-electrodes, said second circuit means being connected through a voltage controlling connection across said first pair of heating-electrodes, said first and second circuit means being non-resonant at the frequency of the high-frequency power supply.

3. Dielectric heating equipment comprising a plurality of pairs of spaced heating-electrodes between each of which a high-frequency electric field can be established, each pair comprising an insulated heating-electrode, said plurality of pairs of heating-electrodes being so arranged that a dielectric material to be heat-treated can pass successively therebetween, a conveyor for passing such material between said pairs of heating-electrodes, a supply of high-frequency power, a first circuit means including a first pair of said heating-electrodes, said first circuit means being connected across said high-frequency power supply, said first circuit means, as a whole, having a substantially capacitive reactance with respect to the frequency of said high-frequency power supply, and a second circuit means connecting a second pair of said plurality of pairs of heating-electrodes to and across said first pair of heating-electrodes with said second circuit means, as a whole, also having the same sort of reactance as the first circuit means with respect to the frequency of said high-frequency power supply, said second circuit means including a voltage regulating connection that extends to and between the insulated heating-electrodes of said first and second pairs of heating-electrodes.

4. Dielectric heating equipment as defined in claim 3, but further characterized by a high voltage point of connection from said high-frequency power supply to said first circuit means being made to the insulated heating-electrode of said first pair of heating electrodes, such point of connection being removed from the point of connection of said second circuit means to the latter insulated heating electrode.

5. Dielectric heating equipment comprising a plurality of pairs of spaced heating-electrodes between each of which a high-frequency electric field can be established, each pair comprising an insulated heating-electrode, said plurality of pairs of heating-electrodes being so arranged that a dielectric material to be heat-treated can pass successively therebetween, a conveyor for passing such material between said pairs of heating-electrodes, a supply of high-frequency power, a first circuit means including a first pair of said heating-electrodes, said first circuit means being connected across said high-frequency power supply, said first circuit means, as a whole, having capacitive reactance with respect to the frequency of said high-frequency power supply, and a second circuit means connecting a second pair of said plurality of pairs of heating-electrodes to and across said first pair of heating-electrodes with said second circuit means, as a whole, also having capacitive reactance with respect to the frequency of said high-frequency power supply, said second circuit means including a voltage controlling connection that extends to and between the insulated heating-electrodes of said first and second pairs of heating-electrodes.

6. Dielectric heating equipment as defined in claim 5, but further characterized by the high voltage point of connection of said high-frequency power supply to said first circuit means being made to the insulated heating-electrode of said first pair of heating electrodes, such point of connection being removed from the point of connection of said second circuit means to the latter insulated heating electrode.

7. Dielectric heating equipment as defined in claim 6, but further characterized by said circuit means including a variable capacitor in said connection.

8. Dielectric heating equipment comprising a plurality of pairs of spaced heating-electrodes between each of which a high-frequency electric field can be established, each pair comprising an insulated heating-electrode, said plurality of pairs of heating-electrodes being so arranged that a dielectric material to be heat-treated can pass successively therebetween, a conveyor for passing such material between said pairs of heating-electrodes, a supply of high-frequency power, a first circuit means including a first pair of said heating-electrodes, said first circuit means being connected across said high-frequency power supply, said first circuit means, as a whole, having a predominantly capacitive reactance with respect to the frequency of said high-frequency power supply, a second circuit means connecting a second pair of said plurality of pairs of heating-electrodes to and across said first pair of heating-electrodes with said second circuit means, as a whole, also having the same sort of reactance as the first circuit means with respect to the frequency of said high-frequency power supply, said second circuit means including a voltage determining connection that extends to and between the insulated heating-electrodes of said first and second pairs of heating-electrodes, and a third circuit means connecting a third pair of said plurality of pairs of heating-electrodes to and across said first pair of heating-electrodes, with said third circuit means including a voltage determining connection extending to and between the insulated heating-electrodes of said first and third pairs of heating-electrodes.

9. Dielectric heating equipment as defined in claim 8, but further characterized by said third circuit means, as a whole, having a predominantly capacitive reactance with respect to the frequency of said high-frequency power supply.

10. Dielectric heating equipment as defined in claim 9, but further characterized by said connections of said second and third circuit means including a variable capacitor.

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