

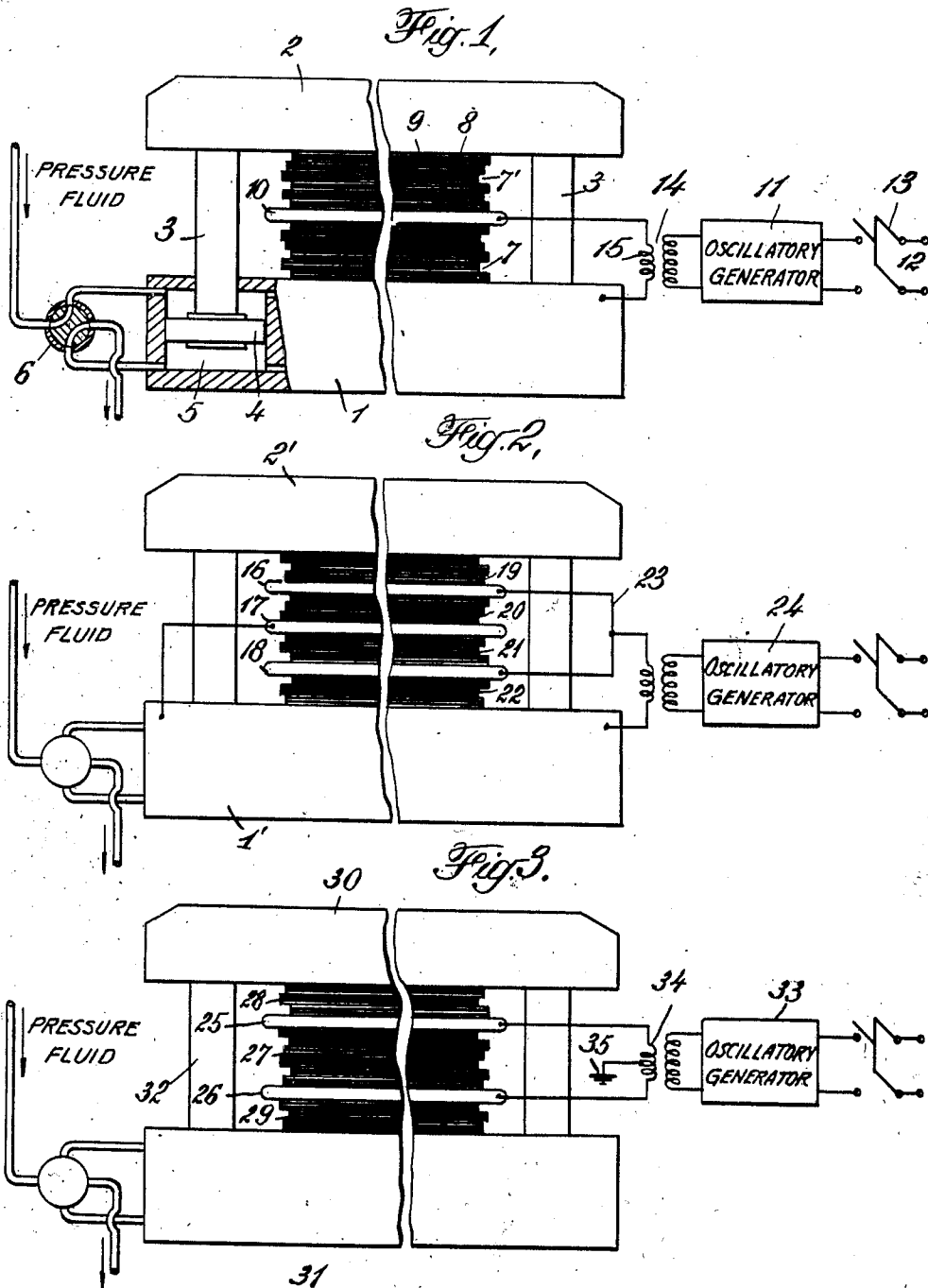
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ELECTRICAL HEATING

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ELECTRICAL HEATING

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This invention relates to heating or treating objects or materials by electric energy, and more particularly concerns a method of and apparatus for electrically generating heat in or otherwise electrically activating materials while applying mechanical pressure thereto.

It is frequently desired to heat, dry or otherwise treat objects or materials while subjecting them to pressure or clamping or supporting them against undesired movement or disarrangement. Examples include the bonding of veneers or other parts of wood or other material into laminated panels or other composite structures. In such operations, the several laminae or parts must be clamped together in a press or like structure with a suitable adhesive between the parts to be bonded, and the stack or bundle held under pressure until the adhesive is activated, cured or dried by heat, after which the pressure is released to permit removal and replacement of the load. Further, in drying or heating materials it is frequently desirable that pressure be applied thereto, and in some cases that such pressure be increased or decreased as the drying or heating progresses. In many instances, the heating, drying or activation of the material can best be accomplished by dissipating electrical energy within the material itself. This may be done by placing the material in an alternating electrostatic field of relatively high voltage and frequency, set up between conductive members engaging opposite surfaces thereof.

The material to be treated is preferably pressed, clamped or squeezed between conductive surfaces maintained at different electrical potentials so as to create an alternating electrostatic field in the material. In treating materials that are relatively non-conductive, such as wood, glass, cellulosic materials and the like, extremely high voltages and frequencies are required to produce an effective electrostatic field.

Presses or equivalent apparatus capable of applying substantial pressure to materials or objects of the type described comprise generally two opposed beds or platens connected by columns or equivalent mechanism and employing screws, hydraulic pressure pistons or like means capable of producing relative movement between the platens to alternately clamp and release the work under treatment. Due to the magnitude of the mechanical loads encountered, the press beds and columns must be made of strong metal, usually steel, and for this reason the opposed beds are necessarily electrically connected. It is therefore impossible to impress a difference of

electrical potential between the two beds or platens of a standard press. Insulation of the opposed press beds from each other is impractical because known insulating materials are not strong enough to be used as or form load-carrying parts of press columns or beds. The use of insulating supports between electrodes and the press beds undesirably increases the size of press opening required for a given size of load, and also limits the pressure that the press can apply.

With the above considerations in mind, it is the object of the present invention to provide a method and apparatus for electrically heating, drying or activating and simultaneously pressing or clamping materials or objects in which electrically connected beds or platens of a press or equivalent structure are employed to apply electrical energy to the material and in which no insulation other than the material under treatment is employed. Other objects and advantages of the invention will be apparent from the ensuing description of a typical embodiment thereof.

In general, the above and other objects of the invention are accomplished by dividing the material to be treated into at least two parts, interposing one or more conductive electrodes between such parts and impressing a difference of electrical potential either between two or more of the interposed conductive electrodes, or between one or more of such electrodes and the electrically connected press platens to set up an alternating electrostatic field in the material. With this arrangement, the only insulation used comprises the material under treatment, and the above noted disadvantages inherent in the use of insulation in the press structure or between the press beds and the load are eliminated.

The invention will be described in connection with the application thereof to the operation of bonding sheet material, specifically wood veneers, into laminated plywood panels, and such an application has been illustrated in the drawing. The invention is not limited to the embodiments illustrated and described, but is generally applicable to all operations that involve simultaneously pressing or clamping and dissipating electric energy in materials susceptible to such treatment. In the drawing:

Fig. 1 is a diagrammatic and simplified elevation of a hydraulic plywood press arranged and equipped to operate in accordance with the invention; and

Figs. 2 and 3 are elevations similar to Fig. 1

showing modified arrangements employing a plurality of conductive plates distributed through the load.

Referring to Fig. 1, the press there illustrated comprises a lower bed or platen 1 and an opposed upper bed or platen 2 connected in the usual manner by a plurality of columns 3, two of which are shown. Any suitable known means may be employed to cause relative movement between the press platens 1 and 2 so that the platens may be separated to admit a load and then drawn together to impose pressure thereon. In the illustrated embodiment, each of the columns 3 is fixed to the upper platen 2 and hydraulic pressure apparatus is employed to move each column relative to the lower platen 1. As shown in the drawing, a piston 4, vertically slidable in a hydraulic cylinder 5 formed in or fixed to the platen 1, is connected to the lower end of each column 3. Hydraulic fluid such as oil is admitted from a high pressure source to the upper or lower end of the cylinder 5 through the ducts shown under control of a valve 6. The valve 6 operates in a known manner to bleed the fluid from the side of the piston 4 opposite that to which pressure fluid is applied by the valve. It will be understood that the press illustrated preferably includes at least four columns 3 and that suitable connections are provided for simultaneously moving all of the columns in the manner described.

The material under treatment shown for the purpose of illustrating the invention is a stack 7, 7' of wood veneer sheets 8 to be bonded into plywood panels. The sheets are superimposed with a suitable adhesive 9 between each adjacent pair of sheets that are to be bonded. Plywood panels usually comprise an odd number of from three to five veneer sheets bonded together, and the stack 7, 7' comprising the load shown in the press may consist of a plurality of such panels, the adhesive being omitted where the outer surfaces of the panels meet. The stack 7, 7' is tightly compressed between the platens 1 and 2 of the press.

In accordance with the invention, a conductive plate or electrode 10 may be interposed at an intermediate point between two parts of the material under treatment and arranged to divide the load along a plane substantially parallel to the surfaces of the platens 1 and 2. In the illustrated embodiment, the stack of veneer sheets is divided by the plate 10 into two parts, 7 and 7' of approximately the same thickness. The plate 10 may be placed between two veneer sheets 8 comprising the outer faces of adjacent plywood panels. With a load other than plywood veneers, the plate may be disposed between similar or identical masses of material or objects.

A suitable source of electrical energy is so connected as to impress a potential difference between the plate 10 and the press structure including the platens 1 and 2. In bonding plywood and generally in heating, drying or treating relatively non-conductive materials, it is generally preferred to create a high frequency high voltage alternating electrostatic field through the load, and accordingly the source of energy illustrated is an oscillatory generator 11, energized from a suitable source 12 through a switch illustrated at 13. The generator 11 shown delivers high frequency high voltage alternating energy through a coupling transformer 14, the output coil 15 of which is connected in series between the plate 10 and the lower platen 1 of the press by suitable con-

ductors as shown. Means other than the coupling transformer 14 for connecting the generator 11 between the plate 10 and the press might be employed. Since the columns 3 of the press electrically connect the lower platen 1 with the upper platen 2, both platens are maintained at the same instantaneous polarity. The generator 11 may comprise any suitable source of high frequency, high voltage energy such as a vacuum tube oscillator, and the output circuit of the generator may be tuned to the generated frequency in any known manner. With the arrangement described, two electrostatic fields are produced, one between the plate 10 and the lower press platen 1, embracing the lower part 7 of the load, and the other between the plate 10 and the upper press platen 2, embracing the upper part 7' of the load.

Upon the application of energy in the manner described, the adhesive 9 between the veneer sheets 8 is heated, dried or cured by the dissipation therein or in the adjacent sheets of electrical energy from the impressed alternating electrostatic field, and the plywood panels are thus bonded. When the bond is completed, the generator 11 is de-energized, the upper press platen 2 is lifted, the stack 7, 7' is removed from the press and the plate 10 is removed from the stack for use with another load.

The plate 10 shown is of somewhat greater area than the cross-sectional area of the load comprising the stack 7, 7'. This may be desirable in bonding plywood and in other applications where substantially uniform dissipation of electrical energy across the section of the load is desired, since it results in the production of an electrostatic field of substantially uniform density throughout the load section. Where uniform density of the electrostatic field is obtained by other means or is unimportant, and where concentration of the field density is desired, the area of the interposed electrode may be equal to or smaller than the load section.

In most cases it is preferred to so place the conductive plate 10 that it divides the load in half and lies midway between the platens 1 and 2 of the press, so that the load is symmetrically disposed on either side of the plate. This insures that the two parts of the load are respectively disposed in electrostatic fields of equal dimensions and, if the dielectric constants of the parts of the load are the same, these parts will absorb or dissipate energy at the same rate. Central disposition of the plate 10 is not essential to the invention in its broader aspects and an unsymmetrical arrangement of the load parts may be employed to produce more rapid dissipation of energy in one part of the load than in the other.

In some cases it may be desirable to subdivide the load into more than two parts so as to either reduce the length of the active electrostatic fields or accommodate loads of increased total thickness. This may be accomplished according to the invention by employing a plurality of conductive plates or electrodes interposed at predetermined intervals through the load, as shown in Figs. 2 and 3. In the arrangement of Fig. 2, the electrode plates are symmetrically disposed and the difference of potential is impressed on the load between adjacent plates or between the uppermost or lowermost plate and the adjacent press platen. Thus the three plates 16, 17 and 18 of Fig. 2 divide the load into four substantially equal parts 19, 20, 21 and 22. The central plate 17 is grounded to the press structure and so electrically connected to the press platens 1' and 2', while the

other plates 16 and 18 are connected together by a conductor 23. The opposite output terminals of the source of energy 24 are respectively connected to the press platen 1' and the conductor 23 leading to the interconnected plates 16 and 18. Thus the source 24, when energized, impresses a potential difference across each load part 19, 20, 21 and 22 between one of the plates 16 or 18 and either one of the press platens 1' or 2' or the central grounded plate 17.

In the arrangement of Fig. 3, two electrode plates 25 and 26 are employed, and for symmetrical arrangement, are so disposed that the thickness of the part of the load 27 between them is twice the thickness of the load parts 28 and 29 disposed respectively between each plate 25 or 26 and the adjacent press platen 30 or 31. Here the potential difference from the source 33 is impressed between the two plates 25 and 26, and the press structure comprising the platens 30 and 31 and the connecting columns 32 serves to keep the upper surface of the load part 28 and the lower surface of the load part 29 at the same potential, which is ground potential, since it is midway between the terminals of the source. With this arrangement, an electrostatic field is impressed on the load part 27 between the electrode plates 25 and 26, and a second electrostatic field is impressed across the two outer load parts 28 and 29 in series, this field extending from the plate 25, through the load part 28, the upper platen 30, the columns 32 and the lower platen 31, thence through the lower load part 29 to the electrode plate 26. The press structure is grounded and the midpoint of the output coil 34 of the source 33 may also be grounded as indicated at 35, although this ground connection is not essential since with the disclosed arrangement both the midpoint of the output coil 34 and the press structure will be at neutral or ground potential.

With the arrangements described, a very high electric potential may be impressed across the load carried in a press without the use of any insulating structure in the press mechanism, while at the same time the opposed press platens may be employed as electrodes of common instantaneous polarity. In all arrangements, the press may be grounded, either by connecting it to a grounded terminal of the potential source in the arrangements of Figs. 1 and 2, or by grounding it directly and using a source with ungrounded terminals, as in Fig. 3. Grounding the press structure simplifies the installation and avoids hazards to operators.

I claim:

1. In apparatus of the character described, in combination, a press including opposed electrically connected electrically conductive platens and means for moving said platens relative to each other, a mass of relatively non-conductive material disposed between said platens and engaged thereby, a conductive plate interposed in and dividing said mass at a point intermediate said platens, a source of high frequency high voltage electrical energy having output terminals of opposite instantaneous polarity, means for connecting one of said terminals to said electrically connected press platens and means for connecting the other of said terminals to said conductive plate whereby said press platens serve as electrodes of the same instantaneous polarity and said plate serves as an electrode of opposite instantaneous polarity, and electrostatic fields are set up in said mass between such electrodes.

2. In combination with a press including spaced opposed electrically connected platens of electrically conductive material and means for moving said platens relative to each other, a load in said press comprising a mass of relatively non-conductive material clamped between and in contact with said platens, a conductive plate interposed transversely through said load at a point intermediate said platens and lying substantially parallel to said platens, and means for impressing a high voltage high frequency difference of electrical potential between said plate and said electrically connected platens whereby said plate is insulated from said platens by said load.

3. In combination with a press including spaced relatively movable opposed platens of electrically conductive material, electrically conductive means connecting said platens and means for moving said platens relative to each other, a load in said press comprising a mass of relatively non-conductive material clamped between said platens, a conductive plate interposed transversely through the load substantially parallel to said platens and dividing the load into substantially equal parts substantially symmetrically disposed with respect to said plate, and means for impressing a high voltage high frequency difference of electrical potential between said plate and said electrically connected platens, whereby said platens form electrodes of one instantaneous polarity and said plate forms an electrode of opposite instantaneous polarity for impressing electrical energy on the parts of said load.

4. In combination with a press including spaced relatively movable electrically connected opposed platens of electrically conductive material and pressure means for relatively moving said platens, a load in said press comprising a mass of relatively non-conductive material clamped between said platens, at least one conductive electrode interposed in and dividing said load at a point between and spaced from said platens, and a source of high frequency high voltage electrical energy having terminals of opposite instantaneous polarity connected respectively to said plate and to said electrically connected platens, said plate being insulated from said platens solely by said load.

5. In combination with an electrically grounded press including spaced electrically connected opposed platens of electrically conductive material and pressure exerting means for moving said platens relative to each other, a load in said press comprising a mass of relatively non-conductive material clamped between said platens, at least one conductive electrode interposed in and dividing said load at a point between and spaced from said platens, and a source of high frequency high voltage electrical energy having output terminals of opposite instantaneous polarity connected respectively to said electrode and said electrically connected press platens, whereby said press, said platens and the ends of the load adjacent said platens are maintained at ground potential.

6. In combination with a press including spaced electrically connected opposed platens of electrically conductive material and pressure exerting means for moving said platens relative to each other, a load in said press comprising a stack of sheets of relatively non-conductive material clamped between said platens with adhesive between at least some of said sheets, a conductive plate interposed in said stack at a

point intermediate said platens, a source of high frequency high potential electrical energy having output terminals of opposite instantaneous polarity, means for connecting one of said terminals to said electrically connected press platens and means for connecting the other of said terminals to said conductive plate whereby said connected platens and said plate respectively form electrodes of opposite instantaneous polarity with said load as the sole insulation between such electrodes.

7. In combination with a press including spaced electrically connected opposed platens of electrically conductive material and pressure exerting means for moving said platens relative to each other, a load in said press comprising a plurality of superimposed masses of relatively non-conductive material clamped between said platens, a plurality of electrodes each comprising a conductive plate interposed between adjacent pairs of said superimposed masses, a source of high frequency high voltage electric energy having output terminals of opposite instantaneous polarity, means electrically connecting one of said terminals to every second one of said electrodes, and means connecting the other of said terminals both to the intervening electrodes and to said connected press platens.

8. In combination with a press including spaced electrically connected opposed platens of electrically conductive material and pressure exerting means for moving said platens relative to each other, a load in said press comprising three superimposed masses of relatively non-conductive material engaged by and clamped between said platens, a conductive plate disposed between each adjacent pair of said superimposed masses, and a source of high voltage high frequency alternating electrical energy connected between said plates, whereby said conductive plates form electrodes of opposite instantaneous polarity insulated from each other by the central mass of said load and said electrically connected platens maintain the outer surfaces of the outer masses of said load at the same potential.

9. The method of impressing electrical energy on a mass of relatively non-conductive material which comprises interposing a conductive plate in the mass at an intermediate point therein, clamping the mass between electrically connected conductive platens of a press with the opposite surfaces of the mass in contact with the conductive platens, and impressing a high frequency high voltage difference of electrical potential between the connected press platens and the plate.

10. The method of laminating relatively non-conductive sheet materials which comprises laying up a stack of laminae with adhesive between at least some of the laminae in the stack and interposing an electrically conductive plate in such stack at an intermediate point therein, clamping said stack between electrically connected conductive platens of a press with the ends of the stack in contact with the platens and applying high frequency high voltage alternating electrical potential between said connected press platens and said conductive plate.

11. The method of laminating relatively non-conductive sheet materials which comprises laying up a stack of laminae with an adhesive between at least some of the laminae in the stack and interposing an electrically conductive plate

transversely through such stack substantially at its midpoint, clamping said stack between electrically connected platens of a press with the ends of the stack in contact with the platens and connecting a source of high voltage high frequency alternating electrical energy between said electrically connected press platens and said conductive plate.

12. The method of laminating relatively non-conductive sheet materials which comprises laying up a stack of laminae with an adhesive between at least some of the laminae in the stack and interposing an electrically conductive plate in such stack at each of two intermediate points which are spaced from each other and from the ends of the stack, clamping the stack between electrically connected conductive platens of a press with the ends of the stack in contact with the platens and connecting a source of high voltage high frequency alternating electrical energy between said conductive plates.

13. In an apparatus for heating and applying pressure to a mass of relatively non-conductive material, in combination, a press structure including electrically conductive, electrically interconnected, relatively movable platens disposed in spaced opposed relationship, a mass of relatively non-conductive material interposed between said platens, power means for clamping said mass between the platens, means providing a plurality of electrodes disposed in generally parallel spaced relationship so as to form an electric condenser assembly with portions of said mass respectively forming the dielectric between adjacent electrodes, at least one of said electrodes comprising a plate-like conductive member interposed in said mass in insulated spaced relation to said platens, two other of said electrodes being located respectively at the opposite ends of said mass which are adjacent said platens and being connected and arranged to operate at the same instantaneous electric potential, and a source of high frequency high voltage electrical energy having terminals of opposite instantaneous polarity, one of which said terminals is electrically connected with said one electrode and the other of which said terminals is connected electrically with said two other electrodes.

14. In apparatus of the character described, in combination, a press structure including electrically conductive, electrically interconnected, movable platens disposed in spaced opposed relation, a mass of relatively non-conductive material interposed between said platens with the opposite ends of the mass adjacent said respective platens, power means for clamping said mass between said platens, a conductive plate interposed in said mass at a point intermediate its ends in insulated spaced relation to said platens, a source of high frequency, high voltage, electrical energy having terminals of opposite instantaneous polarity, means for connecting one of said terminals to said plate, and means for connecting the other of said terminals to both ends of said mass and to the adjacent press platens, whereby electrical energy may be impressed on said mass while the ends of the mass adjacent said electrically connected platens are maintained at the same instantaneous polarity.

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