June 27, 1933. T. W. DIKE ET AL 1,916,134

PROCESS OF RAPID EDGE GLUING WOOD SHEETS AND THE PRODUCT THEREOF

Filed Sept. 19, 1929 2 Sheets-Sheet 1

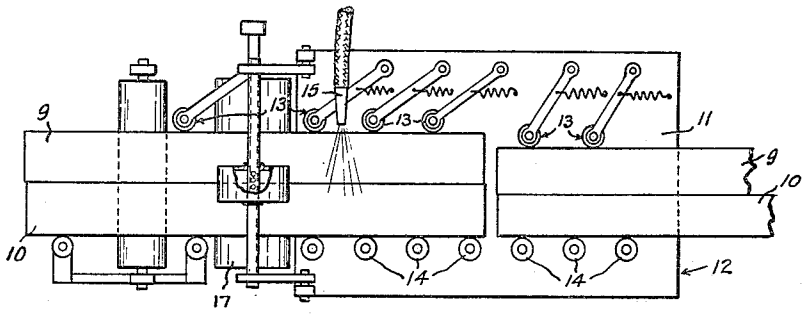


Fig. 1

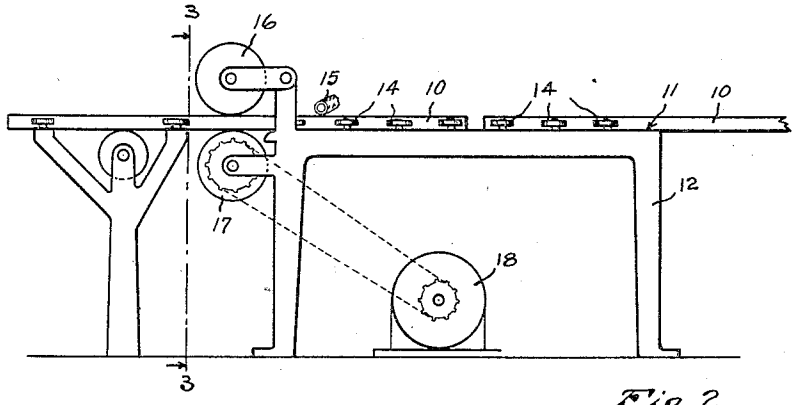


Fig. 2

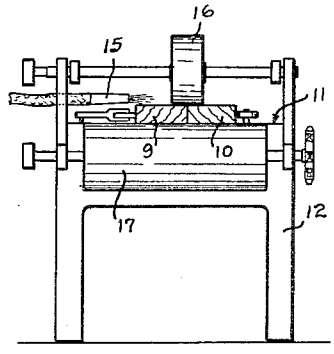


Fig. 3

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PROCESS OF RAPID EDGE GLUING WOOD SHEETS AND THE PRODUCT THEREOF

Filed Sept. 19, 1929 2 Sheets-Sheet 2

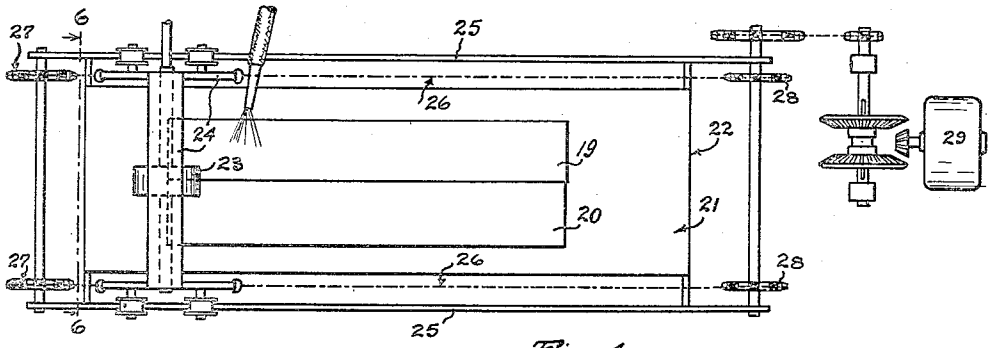


Fig. 4

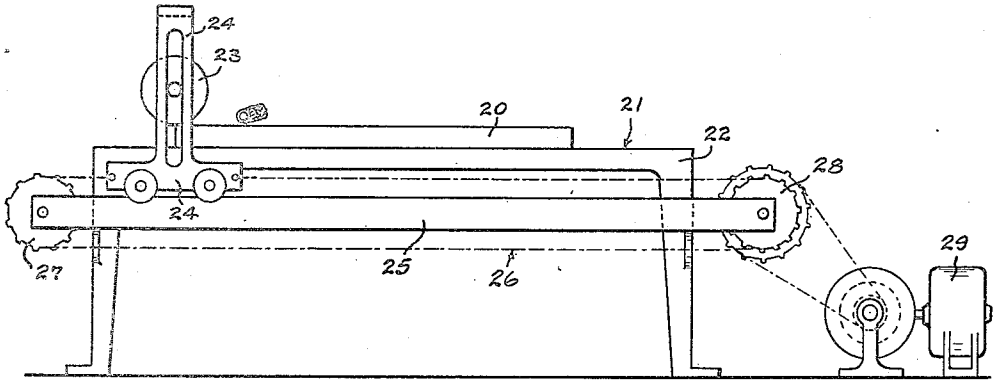


Fig. 5

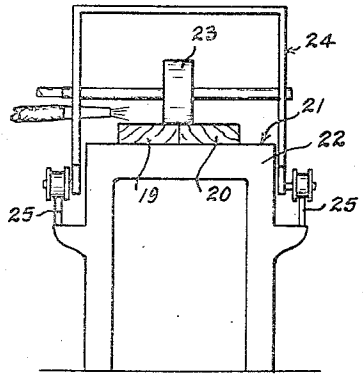


Fig. 6

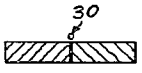


Fig. 9



Fig. 7



Fig. 8

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Patented June 27, 1933 1,916,134

UNITED STATES PATENT OFFICE

THEODORE WILLIAMS DIKE, OF NEW WESTMINSTER, BRITISH COLUMBIA, CANADA, AND CHARLES N. CONE, OF SEATTLE, WASHINGTON, ASSIGNORS, BY MESNE ASSIGNMENTS, TO LAMINATING PATENTS CORPORATION, OF SEATTLE, WASHINGTON, A CORPORATION OF DELAWARE

PROCESS OF RAPID EDGE GLUING WOOD SHEETS AND THE PRODUCT THEREOF

Application filed September 19, 1929. Serial No. 393,684.

Our invention relates to a process of rapidly edge gluing one sheet of wood to another sheet of wood, to the product thereof and to the device for carrying out the same. Our principal object is to greatly speed up this operation so as to make it possible to do edge gluing continuously by machine. The said invention reduces the time for performing a single edge gluing operation from a period of minutes to seconds, for instance from two to fifteen seconds instead of fifteen minutes or more as formerly. Other objects of our invention are to eliminate the use of adhesive tape, make it possible to edge glue green veneer as well as dry veneer and produce edge glue-joints so economically that the field for edge gluing is greatly extended and it is thereby made possible to salvage much material that was formerly wasted for lack of a sufficiently practical means of uniting narrow pieces into wide sheets.

In the manufacture of plywood, the veneer sheets which form the plies are flat glued face to face. These sheets may be very thin, even five-one-thousandths (5/1000) of an inch. Particularly is this true in the case of expensive woods. To form a panel of a given width, for example, thirty six inches as is common, sheets of that width are frequently selected. However, it is necessary, both to utilize narrow width and to produce special figured effects, to edge glue narrow strips of veneer to build out the desired width. These narrow strips would otherwise be wasted. Also, in the manufacture of plywood, it is common practice to use as the core, an assembly of strips of a cheaper kind of wood, or of pieces discarded as face stock on account of defects. Thus the core also is a built up structure of edge glued strips. The same is frequently true of the backs of panels. Thus edge gluing is vitally important to the art of manufacturing veneer products.

Heretofore, sheets of dry veneer have not usually been edge glued to each other directly, i. e., wood to wood union, but have ordinarily been joined by means of narrow strips of adhesive tape glued to their flat surface along the joint after the two edges have been brought in contact. Frequently no further means of joining the edges has been used and the costly troublesome and unsatisfactory taping method has been substituted for the desired end of actually uniting the edges but if an actual union between the edges was especially desired, the tape has been used as a hinge and the edges bent back upon themselves, wet glue applied to them, then the edges brought into contact in the original flat position and held in contact for the fifteen minutes or more required for the wet glue to set. Attempts have been made to eliminate the tape and glue the edges directly by running them through a scarfing machine so as to increase the area of contact to which the adhesive is applied but in this case also wet glues have been used and the time of setting before the joint became strong enough to handle has been fifteen minutes or more. Also the wet glues squeeze out of the joint and cause serious trouble. A method of very quickly and directly uniting sheets of veneer with edges of the ordinary right angle form without the use of tape has been greatly desired but has not heretofore been available neither has it heretofore been possible to edge glue sheets of green veneer.

But serious objections obtain to "taping" as follows: When the core is made up of taped veneer sheets and then expensive wood is applied thereto for facing, there is an unevenness in the surface over the taped portion, it being understood that the tape is left in place on the joint. This unevenness is very noticeable when the face stock is highly polished—often the tape pattern shows through, even a very slight unevenness being detectable since the polished surface is light reflecting and with light as a detector, the revealing of slight differences in the surfaces is facilitated; also, the weakness of a taped product is objectionable. This weakness is due to poor adhesion between the face of the veneer and the paper of the tape, which elsewhere is wood to wood. There is much difficulty, and to date it is impossible to get as strong a bond on the face in a taped product as is desired. The tape is often perforated to minimize by so much, this objection. Apart from any strains in use, mere moisture and temperature changes in laminæ themselves are apt to rupture a taped product; also such strains often result in the face veneer humping up, which, of course, shows up most conspicuously on a polished surface. When gummed tape is applied, the strips are wet and expanded, therefore when the unit dries out, greater contraction occurs along the taped portion than elsewhere and so move-

ment occurs there which is not present elsewhere. This results in the distortion in the veneer facing which appears as unevenness in highly polished surface where light effects are prominent, and the smallest flaws are rendered conspicuous.

In the field of green veneer, so far as we are aware, there is no prior art in practice of edge gluing.

The problems which are special to edge gluing are as follows:

While in ordinary plywood manufacture the time period of setting of the glue is relatively of considerable duration, varying from five to thirty minutes, in edge gluing the time period must be reduced to the minimum, i. e., to the order of seconds. Among other reasons quantity production after the manner of plywood making, is impossible, each glue joint must be individually formed and of course this means practically in one step because repeated handling equally interferes with quantity production. This involves careful consideration of gluing itself under the definite conditions and environment incident to plywood manufacture.

In edge gluing time is the most important consideration. The glue must attain its strength very quickly. A glue line becomes strong or "sets" immediately when its moisture content falls to a certain amount. This amount varies with different kinds of glue but each glue will have some amount of moisture below which it is strong enough to stand handling and above which it is not. When several sheets of wet veneer containing dry glue on the glue lines are put into a hot press the moisture in the wood in general tends to move in a direction perpendicular to the source of heat, that is, the hot plates.

This is true for all of the moisture except for a certain amount which is located in the territory adjacent to the edges of the panel. The result of this is that a good portion of the glue line, or lines, is a gathering point as it were for a considerable amount of the total moisture and consequently the moisture content of the glue line remains at a figure above the figure at which the glue line obtains its strength or "sets". The portion adjacent to the edges of the panel does not become such a gathering ground for the excess moisture because most of the moisture in this territory escapes in a lateral direction. This is proven by the fact that when a panel is taken out of the hot press too soon the center portion always blisters while the edges remain stuck. In consequence of this tendency of the moisture to run away from the source of heat, the glue line in a panel is relatively slow in getting its set, especially in the center portion.

All such latitude of operations in ordinary plywood manufacture is not possible in edge gluing. In edge gluing, having in mind the fact that time is of great importance, it will be seen that it is very important that the glue line is not so situated with reference to the source of heat that it, the glue line, becomes the gathering ground of the excess moisture, as it does in hot pressing a panel. This must be obviated positively. The moisture of the wood must either escape away from the glue line or at least not in any direction which would throw it into the line. It is a primary purpose of our invention to provide a process of edge gluing which satisfies these conditions and requirements.

Summarily, in all cases the action of the heat in our process is to drive the moisture away from the glue line. When edge gluing by our process, it is not necessary to continue the application of the heat sufficiently long to drive the moisture entirely out of the wood, it only being essential to dry out the glue line itself and a small portion of the immediately adjacent wood. This behavior of the moisture under the influence of the heat in our process is functionally different from the behavior of the moisture under the influence of heat in hot plate methods of making plywood with either wet glues or dry powdered adhesives by flat gluing, where a layer of face veneer is interposed between the source of heat and the glue, and the moisture in the veneer, is driven by the heat towards the glue line, and the glue line is the last portion of the wood to be dried out and the drying out process is retarded by the indirect application of the heat and the necessity of drying out the whole mass. Also in our process of edge gluing, the glue line lies in a plane perpendicular to the flat surface of the veneer and to the source of heat and if the heat is applied by contact the source of heat contacts directly with the outer edge of the glue line. These features we believe disclose important functional differences between our art of edge gluing with dry powdered adhesives and methods of flat gluing with similar material in the manufacture of plywood. They also explain the marked advance of our method over the prior art in the matter of time which is the most vital advantage of our process.

Consequently, it will be seen that the conditions provided for by our invention are just the reverse in edge gluing in that the glue line is the first region to dry out thus getting its set quickly, whereas in panel gluing with the hot press, the glue line is the last region to dry out.

When it is considered that glue gets its set only by reason of having the moisture reduced to a certain figure, it will be seen that the difference in direction in the escape of the moisture becomes a very practical consideration. If it were purely a drying problem it would not matter which way the moisture escaped perhaps as long as it was finally eliminated, but this is not purely a drying

problem inasmuch as adhesion begins only when drying has reached a certain stage. Therefore, to get quick adhesion, one must get very rapid drying and must so position the heat and the glue line to be able to effect this.

In plywood manufacture, the press members are kept clean of glue by reason of the intervening sheet of veneer, that is, for example, in a hot press process the hot press plate does not directly contact the glue—its heat is transmitted through a sheet of veneer. In edge gluing, the glue is exposed and provision must be taken that such glue as is employed is caused to set without permitting it to smear up the heating means, and the machinery employed. We have discovered that by following the invention herein disclosed, that this smearing up problem is overcome.

Combined with this problem of keeping the heating members clean is the requirement of preventing an excess of glue being applied and remaining at the glue line. The "squeeze out" problem is non-existent in ordinary panel manufacture by the cold process, but is a real difficulty in edge gluing. While an ample amount of glue must be present to fill the irregular spaces between the adjoining edges of the veneer sheets, yet all excess must be removed to avoid smearing, and our invention provides for removing such excess so that these various conflicting conditions are harmonized.

Even though the hot means contacts directly the glue exposed along the glue line, we provide for keeping the source of heat clean and for driving the moisture in a lateral direction, that is, perpendicular to and away from the glue line.

Pressure sufficient to make contact must be applied and yet in edge gluing, where single thin sheets are involved, buckling of the sheets must be avoided, so the pressure must be relatively small as compared to that employed in plywood manufacture.

Again, the time during which pressure must be applied must be reduced to the order of seconds, i. e., the period of setting of the glue must be very short in order to make production in the necessary quantity possible since single sheets are dealt with in edge gluing, i. e., the operation in edge gluing is individual. In plywood manufacture, the problem is the control of penetration of the glue, while in edge gluing, the problem is the control of the time period. A quick bond is a vital factor in edge gluing because pressure can only be applied to one unit at a time—a rack of sixty edge glued joints is impossible.

Also, in edge gluing, the quantity of glue applied and left in place must be just enough to form a film and substantially fill the space between the adjoining faces—all surplus glue must be removed so that the glue line is rendered unnoticeable or as inconspicious as possible. In plywood manufacture, the "squeeze out" of the glue is immaterial—it simply runs out on the edges which are trimmed off in shaping and sizing the panel, but in edge gluing there is no shaping and sizing operation. A surplus of glue in edge gluing operates to "gum up" the machine.

A very essential feature of our invention is that it enables us to provide a joint with clean faces entirely free from the smearing of the flat surfaces and squeezing out of liquid glue from the joint that has been the characteristic of previous methods. It is well known in the art that the smearing tendency of wet glues has been a serious obstacle to the development of machinery for edge gluing. Since in our method the presence of the glue substance is entirely confined to the contacting edges and it is only rendered plastic and not liquid, we avoid these troubles completely and this enables us to develop mechanism for performing a repetition of an indefinite number of rapidly performed and repeated edge gluing operations without encountering the difficulties of the glue smearing the machine or product.

In plywood manufacture with the hot press, the entire moisture of both sheets is involved in the glue problem, while in edge gluing only the portion of the sheets immediately adjacent the glue line is involved, the heat driving the moisture towards the glue line in plywood manufacture, while in edge gluing the moisture is driven from the glue line. Here again then, we have a different problem to meet in providing for the plasticizing of the glue, which means sufficient moisture must be present. Too much moisture delays the setting period.

It is to be noted that in any gluing operation it has been heretofore necessary to apply pressure upon the bodies being joined so as to obtain good contact between the surfaces being glued, and to maintain this pressure until the bond is sufficiently set so that the body formed can be handled without disrupting the bond. It is desirable to shorten as much as possible the period of time during which it is necessary to maintain this pressure. This is especially true in edge gluing, i. e., in forming bodies of which the plane of the largest surface is substantially perpendicular to the plane of the joints, for the pressure must be applied in a direction substantially perpendicular to the plane of the joints, and since this is the direction of the largest dimension of the bodies it is obviously not practical to apply the pressure upon an assembly of bodies of this nature, the pressure being transmitted from one body to another as is common practice in making plywood. For this reason pressure must be applied and maintained separately upon each

body to be formed and the shorter the time during which pressure must be maintained the less equipment and space will be required for this purpose. It is often very desirable to accomplish the whole gluing operation in one machine. In order to make this possible it is necessary that the time be very short during which the body being formed must be kept under pressure and the shorter is this time the greater will be the capacity of the machine and the more simply it can be constructed.

The length of time during which it is necessary to maintain pressure depends upon the rapidity with which the glue sets.

In gluing, in general, the formation of a glue bond depends upon bringing the glue into a plastic condition in place between the surfaces to be joined so that good contact is obtained between the glue substance and the surfaces to be joined, and setting the glue in place while the contact is maintained by the application of pressure. In the common methods of gluing, water, or some other liquid of a solvent nature, is used to bring the glue into a plastic condition and the glue is set in place by the removal of the water or other liquid from the glue. The rapidity with which the glue sets depends upon the rapidity with which the liquid can be removed from it. The less liquid the glue contains, the more quickly can the liquid be removed from it so that it will be set and the bond will be formed.

In the methods of gluing in common use, the glue is applied in the form of a colloidal dispersion of the glue in a liquid. In order that such a glue may be applied it must have a certain degree of fluidity, and since its fluidity depends upon the proportion of liquid to glue, a certain minimum amount of liquid must be used in order to impart to the dispersion sufficient fluidity so that it can be applied.

We have provided a process for overcoming these difficulties and for carrying out these objects which consists of a combination of a particular condition of glue, a method of supplying the necessary plasticizing liquid, together with a step of removing from the portion of the faces adjacent to the joint any accidental glue in contact therewith, together with a method of freeing the adhesive on the edge joint of the excess of water so that it acquires sufficient strength to permit handling very quickly.

The above mentioned general objects of our invention, together with others inherent in the same, are attained by the device, illustrated in the following drawings, the same being preferred exemplary forms of embodiment of our invention, throughout which drawings like reference numerals indicate like parts:

Figure 1 is a plan view of a machine in which our invention may be applied;

Fig. 2 is a view in side elevation of the same;

Fig. 3 is a view in end elevation of the same;

Fig. 4 is a plan view of a modified form of the same wherein the heating means is moved over the panel;

Fig. 5 is a view in side elevation of the machine shown in Fig. 4;

Fig. 6 is a view on line 6, 6 of Fig. 4;

Figs. 7 and 8 are views in plan and section of a modified form of the heating means, i. e., an electrically heated shoes; and

Fig. 9 is a fragmentary view of still another modified form of the heating means comprising an electrically heated wire operating as a radiator.

Two sheets 9 and 10, of wood or veneer, one of which has been contacted with adhesive in discrete particle form in the presence of a plasticizing liquid as by dampening with a plasticizing liquid and dipped into the adhesive material in the form of dry or discrete particles, are brought together on a supporting surface 11 of the assembling table 12. These sheets may be pressed together by resiliently mounted rollers 13 operating against guide rollers 14. Any excess adhesive material accidentally lodged upon the faces of the sheets of wood, being dry, is readily removed by any suitable means as an air blast from nozzle 15, so that all smearing of the machine and face of the panel is avoided.

The sheets 9 and 10 then pass between heated rollers 16 and 17, the latter being driven by motor 18. These rollers may be steam, gas or electrically heated. Upon passing the rollers 16 and 17 the two sheets 9 and 10 are edge glued together into a single panel, the glue having been set in the time required for it to pass through the rollers, i. e., substantially within a few seconds, so that the process is continuous, one set of sheets following the other progressively through the heating rollers 16 and 17.

In the modified form shown in Figs. 4, 5 and 6, the sheets of wood 19 and 20, prepared as specified for sheets 9 and 10 as respects adhesive material and plasticizing liquid, are brought together on supporting surface 21 of heated table 22 and heated roller 23, mounted in carriage 24 on rail 25 is rolled over the adjoining edge portions of the sheets. The carriage 24 may be reciprocally moved by chain 26 operating over sprockets 27 and 28, said chain being actuated by motor 29. Even without having the sheets subjected to laterally directed pressure during the heating operation, we have found it possible to edge glue the sheets.

Instead of heating rollers, the heating means may be in the form of an electrically heated shoe, disposed for relative movement

as respects the sheets. Or the heating means may be an electric conductor 30 in which heat may be developed as a radiator and may be disposed above the edges to be joined.

The above apparatus constitutes at least two forms of devices whereby our invention may be carried out.

In carrying out the process part of our invention, we use the adhesive in the dry powdered or discrete particle form when spread. Water for plasticizing the glue may be either in the wood by reason of the wood being in its green state (that is, the water never having been dried out) or else if the wood is dry to start with it is previously moistened in sufficient amount for plasticizing the glue. This veneer sheet may then be dipped in the dry adhesive to pick up such quantity of dry glue material as may be caused to adhere thereto, the rest falling off by gravity. This is one way by which the adhesive in a predetermined amount may be applied. Moreover, because of the fact that the glue is thus applied in the dry state any accidental particles which lodge on the faces can be readily removed either by brushing or blowing off or by other appropriate means so that the faces are left in a clean condition as far as any glue is concerned, at the same time leaving all of the glue desired in the joint. "Accidental" is used to include idea of adding a surplus in the first instance to insure substantially filling the space between the edges to be joined.

In order for glue to "set" or attain strength enough to bear handling, the water, as more fully explained above, in the glue must be reduced to a certain percentage (which percentage varies with different glues). If the water is above this per cent the glue will not have strength. That is, there must first be sufficient water present to plasticize the glue and then this water must quickly be removed in order to get a quick set. Therefore, in order to make a glue set quickly it is necessary to remove the water quickly. In order to accomplish this we position the source of heat so that the water is driven out of the glue in the shortest possible time, that is, so that the water is not driven toward the glue line but is driven away from the glue line. The use of the dry glue and the fact that the faces adjacent to the glue line are clean enables the source of heat to be applied directly to the edges of the glue line. While in edge gluing as heretofore practiced, the glue in solid form is caused to become plastic, then fluid, then plastic and then a solid, in our process of edge gluing, the glue is caused to pass directly from the solid form to the plastic for a period of time of the order of seconds and then caused to become a solid.

It will be understood that in this process we are unable to use the amount of pressure that is commonly applied in wood gluing in general. Such pressure, as is explained elsewhere would cause the sheets to buckle and become unmanageable. Our process therefore has to reckon with the slight amount of pressure that we are able conveniently to use.

In carrying out our invention we may start with either green veneer or sheets of wood or dry sheets or veneer. In practicing our invention with dry veneer we first moisten at least one of the edges which are to be joined by any convenient means as for instance contacting the edge with the surface of a cloth covered roller which is kept saturated with water. We then contact at least one of the moistened edges with a suitable dry adhesive in powdered form as for instance powdered casein. This may be done by various means for instance by blowing the powdered adhesive against the moistened edge or by contacting the moistened edge with a mass of powdered adhesive in a container or with a thin film of the same spread out upon a flat surface. In any case the moisture on the surface of the wood causes a sufficient and fairly definite amount of adhesive to adhere and as the edge is the only portion that is wet we easily remove accidental glue from the flat surfaces by a jet of air or by brushing or other convenient means. We then bring the edges to be joined into contact and while maintaining sufficient pressure to secure intimate contact between the edges, apply heat preferably by contact with a heated metal surface along the joint to be formed, in a direction parallel to the glue line and the heat flowing in a direction perpendicular to the flat surface of the veneer. The pressure to secure contact between the edges while the heat is being applied may be secured by any convenient means. We have found in practice that the joint can be formed and set almost instantaneously, a matter of two to fifteen seconds sufficing for the performance of the steps mentioned and the formation of a secure joint.

In order to edge glue dry veneer at maximum speed by this method it is essential that a very small amount of moisture be applied to the edges and that the subsequent operations of applying the powdered glue and setting the joint be performed immediately afterwards as the moisture which is available in contact with the particles of glue is most efficient in influencing the formation of the joint, while moisture which has been absorbed away from the edge into the structure of the wood has but little influence. If the operation of pressing is delayed the moisture is allowed to absorb away from the edge into the wood and there may not be enough remaining in contact with the glue to form a joint. In respect to the amount of glue substance required we have found

that the amount of adhesive particles ground to a fineness of 40 mesh or finer which will adhere to a moist wood surface is sufficient to produce a satisfactory joint. In regard to the heat it is necessary that the heating element be heated considerably above the boiling point of water and we have found in practice that if it is heated to a temperature of 250° F. a satisfactory joint is produced in a few seconds. It is necessary also that the heating element remain well above 212° during the contact in order to dry out the glue joint rapidly.

In performing our invention on green veneer the operations are similar but owing to the green veneer being already moist it is not always necessary to apply additional moisture by contacting it with the wet surface of the roller. In many cases however, the extreme edge of the veneer will have dried out somewhat and the contact with the wet roller or other moistening means is desirable to insure that the edge be sufficiently moist. The only other difference when using green veneer is in the duration of the application of heat, it being essential that sufficient heat be stored in the heating medium to dry out locally the narrow portion of the two sheets of veneer immediately adjacent to the glue joint. In any case the glue joint is formed by the same mechanism as in the previous instance, but the application of heat must be continued for a few seconds longer because of the greater amount of moisture to be removed.

Also, in edge gluing green veneer we prefer in practice to use an adhesive substance like powdered casein which becomes relatively insoluble after being set by heat as this avoids danger of the glue joint being destroyed by contact with moisture derived from the wet veneer. As in edge gluing wet veneer by our method only a very narrow strip close to the glue joint is dried out by the heat, it frequently becomes moistened again in a short time but if glues of the character described are used the joint is not injured. Thus in edge gluing with water resisting adhesive in accordance with our invention, it is not necessary to dry out any large mass but merely the glue line itself and the immediately adjacent wood. Furthermore, the moisture need only be driven from the glue line. As the surface united and consequent consumption of glue is relatively small in the art of edge gluing the cost of the adhesive is of little account and hence the more expensive and highly water-resistant adhesives may be used as desired.

With dry fir veneer one-sixteenth (1/16) of an inch thick we find that the application of heat requires about two seconds and with green veneer about five seconds so that in either case the operation is performed with great rapidity and the quick edge gluing of green veneer offers no substantial difficulties over dry veneer. With conveniently arranged means for moistening the edges, applying the powdered adhesive, removing accidental excess and applying the pressure and heat, the entire operation either with wet or dry veneer of considerable thickness is easily performed in fifteen seconds and in many instances with the ordinary thin sorts of veneer can be performed in two or three seconds. The matter of speed in our process is of first importance both because the time element in processes of this nature is a measure of the cost, and because we are able to reduce the time element to such a low value that if desired the setting of the joint may take place progressively along its length and not simultaneously throughout, as for instance, by the action of a heated roller previously mentioned, slowly travelling along the joint and leaving the joint dried out and set behind it. The operation may also be performed progressively in the reverse manner with the veneer in motion and the source of heat stationary. This feature facilitates the performance of edge gluing with high efficiency machinery.

The great saving in time by the use of our process is due not only to the fact that we do not have as much water to dry out of the glue joint but is further due to the fact that because of the methods that we employ we are enabled to do the gluing operation mechanically or in a continuous manner, thus effecting a further great saving of time.

Our invention is the reduction of time in two ways, (1) we reduce the time by reason of not having so much moisture to dry out and (2) we reduce the time by providing means by which this gluing can be done in a continuous or mechanical manner.

The reason why we can do edge gluing mechanically and continuously, thus effecting a great saving in time, is because we eliminate this squeeze-out of excess glue. This squeeze-out has heretofore been a bar to continuous and mechanical methods of edge gluing because of the smearing both of the faces of the stock being glued and of the machine.

In the above we have described and set forth our invention with the pressure reduced to an amount that is sufficient to bring the edges of the sheets of veneer into contact. However, our invention goes further and we have discovered that we may edge glue without employing any pressure whatever and particularly without maintaining pressure at the time the joint is being formed.

The significance of the elimination of pressure appears in that it is evident that there is a sufficient plasticity or flowing of the adhesive by the heat in edge gluing, according to our invention, so that even though the edges are not actually contacting, nevertheless they may be bound.

Our experience leads us to the conclusion and we suggest that the explanation is that the mass of the adhesive which will become plastic swells or expands, thereby establishing the bond in contact with the edge even when they are not in contacting relation.

As prior art edge gluing has commonly required upwards of fifteen minutes for the formation of the joint, the gain in time by our method is very great. We believe we are the first to edge glue green veneer and also the first to edge glue dry veneer in a period of time measured by seconds rather than minutes.

When the glue is applied in the dry powdered form and heat is used, it can be brought into a state sufficiently plastic to form a bond, with a very small amount of liquid. Because a very small amount of liquid is used it can be quickly removed, and therefore by our invention a bond can be obtained in a very short period of time. It is understood that the glue does not need to be absolutely dry, but so long as it can be handled in powdered form it is dry enough.

It is possible to use less liquid in our process of gluing because it is necessary to use only enough to make the glue sufficiently plastic to form a bond under the influence of heat, while in the method of gluing in common use in which the glue is dispersed in the liquid before being applied, it is necessary to use enough liquid to bring it into a state sufficiently plastic or fluid so that it can be applied. It requires more liquid to bring glue into a state sufficiently fluid to be applied than is required to bring it into a state sufficiently plastic to form a bond. For instance, less than one part of water to one part of casein is required to bring it, under the influence of heat, into a condition sufficiently plastic to form a bond, but if one part of casein is dispersed in one part of water by the use of caustic soda or some other method of dispersion, it will form a tough dough or jelly which is impractical to spread uniformly upon the surface to be glued.

The benefits of our process of gluing can also be obtained by applying the glue in the form of a powder suspended in a liquid and using heat. By suspension we mean a state or condition in which the particles do not dissolve or form a colloidal dispersion in the liquid. A mixture of a proportionally small amount of water and a powdered glue material in the suspended condition does not become cohesive or doughy and remains in a condition in which it can be applied. It is not necessary to spread the dry adhesive and plasticizing liquid separately. It is also possible for enough of the plasticizing liquid to be absorbed or imbibed in the particles of adhesive, and for both of them to be spread at the same time, as discrete particles.

In regard to the character of the adhesives which can be employed we have found that a wide range of materials may be used and that any of the common adhesives which are rendered plastic by a small amount of moisture, equal to approximately one-quarter or one-half the dry weight of the adhesive in the presence of heat, and are readily dried out to a strong horny condition by the removal of the moisture by the further application of heat, may be used, this included practically all common adhesive material such as animal glue, various raw and modified starches, dried blood albumen, wheat gluten, casein, soya bean flour and other vegetable protein containing substances as well as natural substances containing mixtures of protein and starches such as wheat flour, corn meal, and similar products. Silicate of soda in powdered form may also be used but is not reliable through tendency to recrystallize and lose its adhesive qualities and through its high degree of alkalinity causing staining of the veneer.

Raw starch flour is an example of an adhesive material suitable for this process with which a suspension can be formed with a proportionally small amount of water. Dry powdered casein is an example of an adhesive material which will absorb an amount of water sufficient to make it plastic (under the influence of heat) and still remain in a condition in which it can be spread as discrete particles.

However, we are not confined to the use of the above mentioned materials but can use any adhesive material that under the influence of heat and a liquid, or heat, a liquid and the action of chemicals, will become sufficiently plastic to make good contact with the surfaces to be joined, and will adhere to these surfaces and when the liquid is removed will form a strong transversely continuous film bonding together the two surfaces to be joined. That is, our new method of applying heat and pressure to the forming of joints enables any kind of matter to be joined with appropriate adhesives, and joined very quickly, so that it makes possible continuous methods for joining.

Our method of gluing can be used to join together pieces of which the surfaces to be joined are not substantially plane surfaces. All that is necessary is that the surfaces to be joined be of such a nature that good contact can be obtained between them by moderate pressure. This is useful in joining split or torn veneer. The source of heat should be at least wide enough to cover the glue line throughout the greater part of its length.

It is possible and sometimes desirable to use with the dry adhesive material chemicals in a dry powdered form. For example, if the adhesive used is casein and it is desired to have it become plastic by the use of less heat, this can be accomplished by compound-

ing with the dry powdered casein, sodium fluoride and lime. When this mixture becomes wet the sodium fluoride and lime react to form caustic soda, which helps to bring the casein into a plastic condition. Waterproofing agents like paraformaldehyde in powder form or formaldehyde in solution may be used either mixed with the adhesive or in solution in the moistening water for the purpose of rendering the joint more insoluble, as for instance paraformaldehyde with animal glue. Also, chemicals can be used in solution in the liquids used, for instance caustic soda in water. Also, if the powdered adhesive is applied in suspension in a liquid, chemicals can be added in solution in the liquid, as for instance formalin can be used in a suspension of casein in water, to improve the water resistance of the bond formed.

We have found also that by adding dispersing agents such as caustic soda or a mixture of lime and sodium fluoride to the moistening water or as a dry powder reagent to the adhesive powder the amount of moisture and heat required to plasticize the adhesive and produce a satisfactory bond may be materially reduced and the time of forming the bond shortened.

In practicing our invention, sufficient liquid must be present at the joint so that under the influence of heat, or heat and the action of chemicals, the glue will become sufficiently plastic to form a bond. The liquid need not necessarily be water. For example, alcohol and acetone both have similar plasticizing effects. These liquids are volatilized more rapidly than water and hence speed up operation. The liquid can be applied by sponging or sprinkling it on to one or both of the surfaces to be joined either before or after the dry powdered glue is applied. However, when it is applied before the dry powdered glue, it helps to hold the glue powder in place. When water is the liquid used the pieces to be joined can be glued in the green or undried state if sufficient heat is used to dry out that part of the pieces immediately adjacent to the glued surfaces so that the liquid will be removed from the glue.

The dry powder can be applied by dusting it on to one or both of the surfaces to be joined, or by bringing the moistened surface into contact with the powder so that some of the powder will adhere to it,—gravity automatically pulling off all excess. Sufficient heat must be applied to bring the glue, under the influence of the liquid or the liquid and chemicals, into a sufficiently plastic condition. The heat may be applied by directly contacting a source of heat such as a steam heated metal plate with the surface of the body being joined, the plane of which intersects the plane of the joints. The heat may also be applied by radiation from a source of heat upon the body being joined.

The radiator may be substantially a plane surface, as for example the radiating surface of an electric hot plate, a grid of hot wires, a collection of gas burners, or it may even be substantially a line, for example a single hot wire, or a hot pipe.

In any case the radiator, if radiant heat is to be used, will be located as close as is practicable to the glue line, or may be applied directly in contact with the edge of the glue line. If a plane, it will be substantially at a right angle to the plane of the glue line. If the source of heat itself is linear in nature, as a hot wire, it will be roughly in the plane of the glue line.

In any case, the direction of transmission of heat to the glue line will in general be in the plane of the glue line, or substantially so; as contrasted with the use of a hot press where the direction of transmission of heat to the glue line is perpendicular to the glue line.

The limitation to these methods of applying heat is that there must not be so great a thickness of any portion of the body being joined interposed between the source of heat and any part of the surfaces being joined that the heat cannot penetrate sufficiently to make the glue plastic. This is to be borne in mind when choosing the direction of heat transmission and the surface of a composite body to which the heat is to be applied. By "glue line" we mean the joint or plane of uniting of the bodies or pieces joined.

With less expensive woods, the advantages of the present invention are greater because the cheapness of the reclamation enables salvaging much which could not be thought of in the taping process. As the edge gluing of veneer is the principal means for producing wide surfaces of thin wood in the manufacture of plywood and also in veneering furniture it is a fundamental factor in the economy of utilizing such products. A large proportion of the sheets produced when the veneer is cut are either narrow in themselves or else made narrow by the chopping out of defects and without edge gluing most of this narrow material would be wasted, hence the usefulness of means of performing edge gluing with rapidity and consequent economy is self evident. As our method of edge gluing is highly successful with green as well as dry veneer further important industrial savings are derived from this feature. Up to the present time most veneer has been dried before using and hence the art of edge gluing has heretofore been applied only to dry veneer but since methods of manufacturing plywood by simultaneously drying and flat gluing together sheets of green veneer have now come into common use, it is obvious that further economies are effected by our discovery

of a practical method of edge gluing green veneer. As illustrative of this, suppose, for example, we have a two foot wide piece all clear except two large knots, one and one-half inches in diameter and six inches from each edge. Such a piece of veneer would be first condemned to the grade of core stock. However, experience shows that in putting this strip through the dryers, the knots fall out and hence the whole piece is discarded on account of three inches total of knots. With our invention, the two strips in which the knots occur may be chipped out, and the three remaining pieces edge glued to form a veneer sheet, twenty-one inches wide, and raise the piece to face stock grade. This is possible because strips only three inches wide may be profitably edge glued by our invention, while the present practice is to waste such a piece described above. Thus, we reduce the waste to a mere cutting out of defective strips as opposed to wasting large pieces. At the present time, the potential width of the clear stock is the measure of use of the sheet but with our invention, actual width of the defective portions becomes the measure of wastage.

Obviously, changes may be made in the forms, dimensions and arrangement of the parts of my invention, without departing from the principle thereof, the above setting forth only preferred forms of embodiment.

We claim:

1. The process of rapidly edge gluing one sheet of wood to another sheet comprising contacting one of the edges to be joined with undispersed discrete particles of adhesive in the presence of sufficient liquid to plasticize the adhesive material; bringing together the edges to be joined on a supporting surface; and applying heat directly to the glue line, whereby the moisture is driven away from the glue line.

2. The process of rapidly edge gluing one sheet of wood to another sheet comprising contacting one of the edges to be joined with undispersed discrete particles of adhesive in the presence of sufficient liquid to plasticize the adhesive material; bringing together the edges to be joined on a supporting surface; and simultaneously applying heat and pressure directly to the glue line, said pressure being applied to a degree whereby contact is established between the adhesive and the surface being joined, and said adhesive is rendered plastic and caused to set quickly, whereby the moisture is driven away from the glue line.

3. The process of rapidly edge gluing one sheet of wood to another sheet comprising contacting one of the edges to be joined with undispersed discrete particles of dry adhesive in the presence of sufficient water to plasticize the adhesive material; bringing together the edges to be joined on a supporting surface; and applying heat directly to the glue line, whereby the moisture is driven away from the glue line.

4. The process of rapidly edge gluing one sheet of wood to another sheet comprising contacting one of the edges to be joined with undispersed discrete particles of dry adhesive in the presence of sufficient water to plasticize the adhesive material; bringing together the edges to be joined on a supporting surface; and simultaneously applying heat and pressure directly to the glue line, said pressure being applied to a degree whereby contact is established between the adhesive and the surface being joined, and said adhesive is rendered plastic and caused to set quickly, whereby the moisture is driven away from the glue line.

5. The process of rapidly edge gluing one sheet of wood to another sheet comprising contacting one of the edges to be joined with undispersed discrete particles of dry adhesive in the presence of sufficient water to plasticize the adhesive material; removing accidental glue; bringing together the edges to be joined on a supporting surface; and applying heat directly to the glue line, whereby the moisture is driven away from the glue line.

6. The process of rapidly edge gluing one sheet of wood to another sheet comprising contacting one of the edges to be joined with undispersed discrete particles of dry adhesive in the presence of sufficient water to plasticize the adhesive material; removing accidental glue; bringing together the edges to be joined on a supporting surface; and simultaneously applying heat and pressure directly to the glue line, said pressure being applied to a degree whereby contact is established between the adhesive and the surface being joined, and said adhesive is rendered plastic and caused to set quickly, whereby the moisture is driven away from the glue line.

7. The process of rapidly edge gluing one sheet of wood to another comprising providing one of the edges to be joined with undispersed discrete particles of adhesive in the presence of sufficient water to plasticize the adhesive material; bringing together the edges to be joined; and applying heat to the edge portions being joined during relative movement between the sheets and the heating means, whereby the edge gluing operation is rendered continuous.

8. The process of rapidly edge gluing one sheet of wood to another comprising contacting one of the edges to be joined with undispersed discrete particles of adhesive in the presence of a plasticizing liquid more volatile than water; and applying heat directly to the glue line thereby driving the plasticizing liquid away from the glue line,

whereby a very rapid setting of the glue results.

9. In the process of rapidly edge gluing one sheet of wood to another, the step of adding as a plasticizing liquid, a liquid more volatile than water whereby the setting period of the glue is shortened.

10. As an article of manufacture, a sheet comprising a plurality of sheets of wood veneer in a substantially wet, saturated, green condition, and joined along their marginal edges.

11. In a device of the character described the combination of a supporting surface on which may be brought together two pieces of wood; means for removing accidental adhesive base powder deposited on the face of the pieces; and a heating means relatively movable as respects said pieces of wood and said supporting surface.

12. As an article of manufacture, a wood fabrication composed of two or more wood pieces united along their marginal edges by a bond resulting from the rapid application of heat directly to the glue line after the forming of said glue line by undispersed discrete particles of adhesive in the presence of sufficient liquid to plasticize the adhesive material sufficiently for the formation of the bond, identifiable discrete particles of adhesive remaining between said marginal edges.

13. As an article of manufacture, a continuous sheet of green veneer composed of two or more pieces of green veneer united along their marginal edges by a bond resulting from the rapid application of heat directly to the glue line after the forming of said glue line by undispersed discrete particles of adhesive in the presence of sufficient liquid to plasticize the adhesive material.

14. As an article of manufacture, a wood fabrication composed of two or more wood pieces united along their marginal edges by a bond resulting from the rapid application of heat directly to the glue line after the forming of said glue line by undispersed discrete particles of adhesive in the presence of sufficient water to plasticize the adhesive material sufficiently for the formation of the bond, identifiable discrete particles of adhesive remaining between said marginal edges.

15. As an article of manufacture, a continuous sheet of green veneer composed of two or more pieces of green veneer united along their marginal edges by a bond resulting from the rapid application of heat directly to the glue line after the forming of said glue line by undispersed discrete particles of adhesive in the presence of sufficient water to plasticize the adhesive material sufficiently for the formation of the bond, identifiable discrete particles of adhesive remaining between said marginal edges.

16. As an article of manufacture, a wood fabrication composed of two or more wood pieces united along their marginal edges by a bond resulting from the rapid application of heat directly to the glue line after the forming of said glue line by undispersed discrete particles of adhesive in the presence of sufficient plasticizing liquid more volatile than water to plasticize the adhesive material sufficiently for the formation of the bond, identifiable discrete particles of adhesive remaining between said marginal edges.

17. As an article of manufacture, a continuous sheet of green veneer composed of two or more pieces of green veneer united along their marginal edges by a bond resulting from the rapid application of heat directly to the glue line after the forming of said glue line by undispersed discrete particles of adhesive in the presence of sufficient plasticizing liquid more volatile than water to plasticize the adhesive material sufficiently for the formation of the bond, identifiable discrete particles of adhesive remaining between said marginal edges.

18. The process of rapidly edge gluing one piece of wood to another comprising a contact of one of the edges to be joined with undispersed discrete particles of adhesive in the presence of a plasticizing medium; bringing together the edges to be joined, applying pressure and heat to the glue line.

19. The process of rapidly edge gluing one piece of wood to another which comprises applying to one of the edges to be glued, an adhesive material in dry powdered form, causing the plasticization of the material and subjecting the material to bonding conditions in the presence of heat.

20. The process of rapidly edge gluing one piece of wood to another piece comprising contacting one of the edges to be joined with undispersed discrete particles of adhesive in the presence of sufficient liquid to plasticize the adhesive material; bringing together the edges to be joined; and applying heat directly to the glue line, whereby the moisture is driven away from the glue line.

21. The process of rapidly edge gluing one piece of wood to another which comprises providing at a glue line between the edges to be glued an adhesive material in discrete particle form and a plasticizing liquid and applying heat directly to the glue line.

22. The process of rapidly edge gluing one piece of wood to another which comprises providing at a glue line between the edges to be glued an adhesive material in dry powdered form and a plasticizing liquid and applying heat directly to the glue line.

23. The process of rapidly edge gluing one piece of wood to another which comprises providing at a glue line between the edges to be glued an adhesive material in discrete particle form and a plasticizing liquid and plas-

ticizing chemicals and applying heat directly to the glue line.

24. The process of rapidly edge gluing one piece of wood to another which comprises providing at a glue line between the edges to be glued an adhesive material in dry powdered form and a plasticizing liquid and plasticizing chemicals and applying heat directly to the glue line.

25. The process of rapidly edge gluing one piece of wood to another one comprising applying heat directly to the glue line on which the adhesive particles are present in discrete form.

26. The process of rapidly edge gluing one piece of wood to another one comprising applying heat directly to the glue line on which the adhesive particles are present in discrete form in the presence of a plasticizing liquid.

27. The process of rapidly edge gluing one piece of wood to another one comprising applying heat to the glue line on which the adhesive particles are present in discrete form in the presence of a plasticizing liquid in such manner that the action of the heat drives the plasticizing liquid away from the glue line.

28. A process of rapidly edge gluing one piece of wood to another piece comprising the steps of providing discrete particles of adhesive together with a plasticizing agent upon at least one of the edges to be joined and bringing the members into contact in a heating zone whereby a bond is formed.

29. The process of rapidly edge gluing which comprises contacting one of the edges to be glued with discrete particles of an adhesive characterized by being plasticized by a liquid and rendered insoluble by heating, and contacting the edges to be glued in the presence of the plasticizing liquid and subjecting to bonding conditions whereby a water resistant bond is produced.

30. The process of rapidly edge gluing which comprises contacting one of the edges to be glued with casein in discrete particle form and bringing the edges to be glued together in the presence of a plasticizing liquid and subjecting to bonding conditions whereby a water resistant bond is produced.

31. The process of rapidly edge gluing which comprises contacting one of the edges to the glue with discrete particles of adhesive characterized by being plasticized by a liquid and a chemical, and rendered insoluble by heating and bringing together the edges to be glued in the presence of the plasticizing liquid and chemical and subjecting the whole to bonding conditions whereby a water resistant bond is produced.

32. The process of rapidly edge gluing two pieces of wood comprising the steps of applying an adhesive in discrete particle form to at least one of the edges to be joined in the presence of a plasticizing liquid, and contacting the edges of the pieces of wood, removing adhesive in the dry particle form accidentally deposited on the surfaces of the pieces of wood adjacent to the edges and applying heat directly to the glue line whereby a bond is formed with the adjacent face portions of the pieces of wood clean.

33. The process of uniting members, which comprises associating wood sections edge to edge with interposed adhesive material in discrete-particle form, and subjecting to bonding conditions.

34. The process of uniting members, which comprises associating wood sections edge to edge with interposed adhesive material in discrete-particle form, and holding the edges together while applying heat directly to the glue line.

35. The process of uniting members, which comprises associating wood sections edge to edge with interposed adhesive material in discrete-particle form, and holding the edges together while applying heat directly to both sides of the glue line.

36. The process of uniting members, which comprises associating wood sections edge to edge with interposed adhesive material in discrete-particle form, and holding the edges together while applying heat directly to the glue line in a continuous manner commencing at one end of the glue line and ending at the other end.

37. The process of uniting members, which comprises associating wet wood sections edge to edge with interposed adhesive material in discrete-particle form, and subjecting to bonding conditions.

38. The process of uniting members, which comprises associating wet wood sections edge to edge with interposed adhesive material in discrete-particle form, and holding the edges together while applying heat directly to the glue line.

39. The process of uniting members, which comprises applying adhesive material in powdered form to the edge of a wet wood section, associating the edge of another section, and subjecting to heat and pressure.

40. The process of rapidly edge gluing one sheet of wood to another sheet of wood, comprising contacting one of the edges to be joined with undispersed discrete particles of adhesive, bringing together on a heated supporting surface the edges to be joined, and applying heat to the opposite side of the glue line while holding the edges together.

41. The process of uniting members, which comprises associating wood sections edge to edge with interposed adhesive material in powder form, and subjecting to bonding conditions.

In witness whereof, we hereunto subscribe our names August, 1929.

THEODORE WILLIAMS DIKE.
CHARLES N. CONE.