

July 21, 1942.

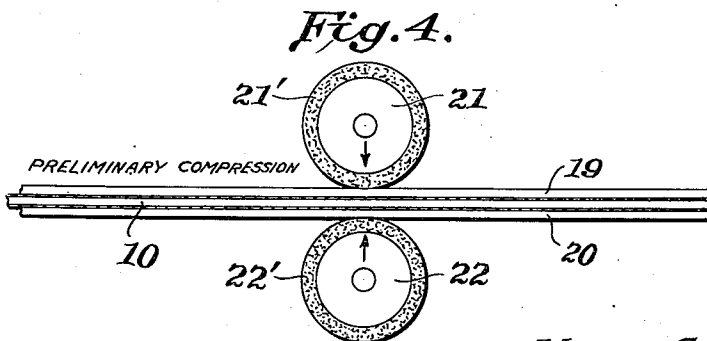
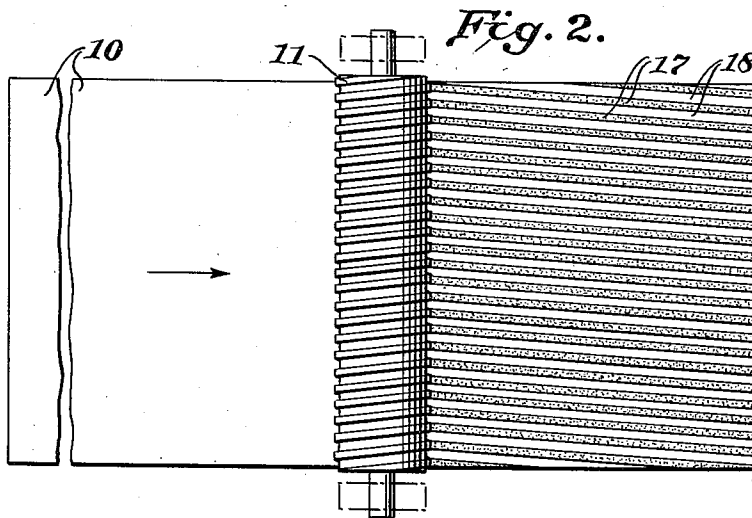
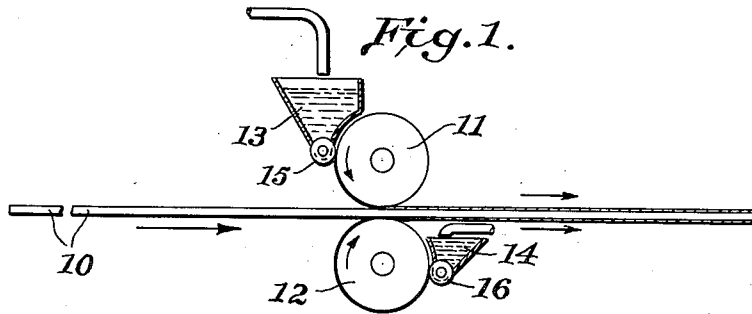
H. GALBER

2,290,548

GLUING METHOD

Filed June 27, 1939

2 Sheets-Sheet 1



Inventor:

Harry Galber,
By *Cushman, Darby & Cushman.*

Attorneys

July 21, 1942.

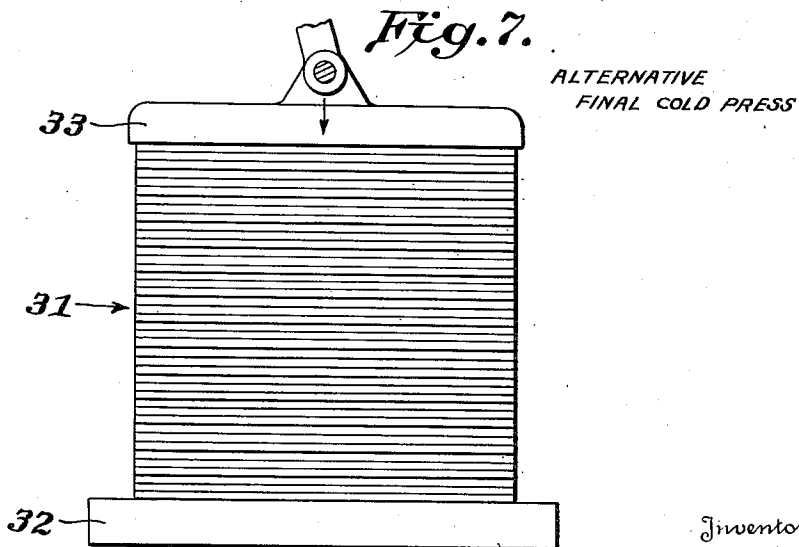
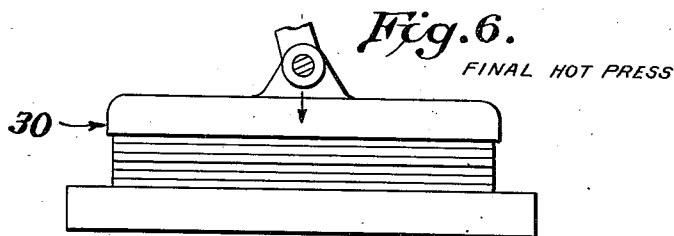
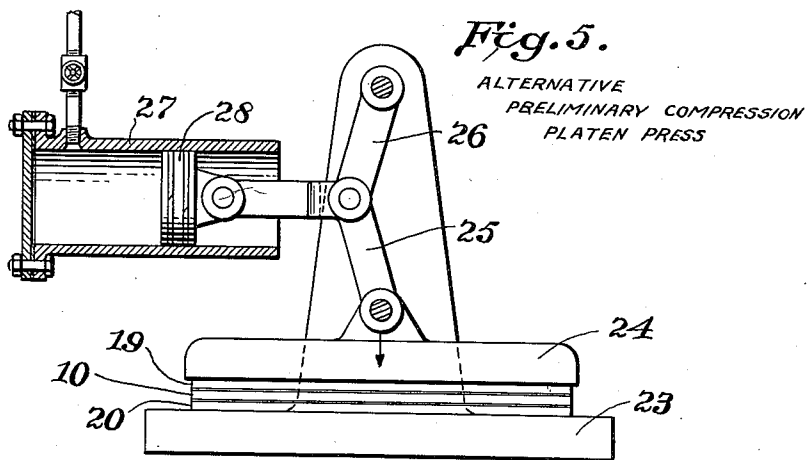
H. GALBER

2,290,548

GLUING METHOD

Filed June 27, 1939

2 Sheets-Sheet 2



Inventor:

Harry Galber,
By *Cushman, Dabney, Cushman*
Attorneys

UNITED STATES PATENT OFFICE

2,290,548

GLUING METHOD

Harry Galber, Seattle, Wash., assignor to I. F. Laucks, Inc., Seattle, Wash., a corporation of Washington

Application June 27, 1939, Serial No. 281,473

2 Claims. (Cl. 144—309)

The present invention relates to an improvement in gluing practice. While my new method is particularly valuable in facilitating volume production of hot pressed plywood, it is also applicable in general gluing practice with fluid or semi-fluid glues by either cold or hot press methods wherever a glue is spread on at least one of the surfaces to be joined and subsequently solidified while the assembly is maintained under pressure. For the purposes of this description and the appended claims, these glues may be called dispersed glues and by that term I intend to include not only true solutions, but suspensions and adhesive mixtures in general of a spreadable fluid or semi-fluid character.

One of the principal objects of the invention in certain important applications is to improve transfer of the adhesive from the spread surface to a contacting unspread surface with an improved uniformity of distribution and to simultaneously obtain more uniform and better controlled penetration. Another and very important object is to greatly widen assembly time tolerance. By this term, I mean the permissible interval which may elapse between the spreading of the adhesive and the application of bonding pressure to the assembled parts. Other objects are to improve the character of glue bonds, to reduce glue consumption, and to facilitate handling of the spread assemblies.

To the accomplishment of the foregoing and related ends, the invention, then, comprises the features hereinafter fully described, and particularly pointed out in the claims, the following description setting forth in detail certain illustrative embodiments of the invention, these being indicative, however, of but few of the various ways, in which the principle of the invention may be employed.

While, as indicated, the present invention is, by no means, confined to the plywood art, one of its most advantageous uses is in that field and consequently the subsequent description will exemplify such use. It will become apparent, however, that the method may readily be applied in other ways.

In plywood manufacture, for example, it is the usual practice to spread the glue in a fluid or at least semi-fluid condition on both sides of the core ply, and, then in making the ordinary three ply panels, assemble the spread core between two face plies to which no glue has been directly applied. After a varying assembly time interval, the assembly is subjected to bonding pressure which in the cold process is maintained for a

number of hours, but is reduced to a few minutes in the hot press process. In either case, for best results, it is necessary to obtain a final re-distribution of the spread adhesive as a thin uniform film over both contacting surfaces. Obtaining an effective glue transfer from the spread to the unspread surface is a vital consideration.

Other features are also essential to obtaining an effective bond with the least adhesive. In particular, it is necessary to have the glue penetrate adequately, but not excessively, into the porous wood of both contacting surfaces and between them there must be retained a sufficient residue or film to strongly unite the parts. Another consideration necessary for volume production, is that the gluing conditions allow a sufficient time interval to permit successive assembly of a number of panels and allow pressing of the group either successively or "en masse" without subjecting any units to conditions which would form a non-commercial bond. It may be explained that in the cold process it is customary to glue the panels up in rather large batches and then press the batches "en masse." This implies that the first panels glued up will not be subjected to bonding pressure until the batch has been completed, and in practice it frequently requires 15 or 20 minutes to assemble a batch and get it under pressure. The wood plies are either dry or nearly dry and hence very absorbent and consequently during this interval the glue will progressively thicken due to loss of gluelwater into the dry wood. As the glue consistency increases, its ability both to penetrate and to transfer steadily decreases.

The effect of these tendencies is to make the plywood produced by this cold process batch method quite variable in quality, the last panels laid up in each batch often tending to have an inferior starved bond due to excessive penetration of the adhesive which has not had time to thicken sufficiently before the application of pressure, while the first panels in the batch usually suffer to some degree from the reverse condition and show poor transfer with deficient penetration and a weak superficial bond due to excessive thickening during the long assembly time interval. Generally, the best panels and the only ones exhibiting the highest order of adhesion are obtained in the middle of the batch where intermediate and ideal assembly time conditions have obtained.

The same condition exists to a lesser degree if the hot press process is used. In that case the panels are not ordinarily pressed "en masse"

in a large batch, but are usually spread in smaller batches and pressed individually or with not over two panels in a press opening. Since the time in a hot press to complete the bond is ordinarily only a very few minutes, generally not over three to five minutes, the assembly time period is shorter and the resulting variations between individual panels are reduced accordingly. However, the same differences exist and in hot press practice also, a wider assembly time tolerance is much to be desired.

More recently an improved method of hot press gluing has been developed employing what is called mastic or semi-fluid glue. This method operates on the principle of initially applying the glue in approximately the thick viscous state which is ideal for best bond formation and then pressing the plies before any appreciable change from that consistency can occur. This process is described in the copending application of Theodore Williams Dike and myself, Serial No. 95,460, now Patent 2,178,566. In this process, tolerance of assembly time is still further limited and, unless it is kept very short, the adhesive, having been applied in an initially thickened condition, will soon become too thick to either transfer or penetrate properly. The present invention, while applicable to any of the processes described, is particularly beneficial as an improvement on the mastic gluing process because it greatly widens the restricted tolerance of assembly time and provides the process with a very desirable increase in flexibility.

As an example of the operation of my invention, I will first describe the ordinary procedure of manufacturing fir plywood by the mastic process and then describe such manufacture by the improved mastic process which results from applying the principles of the present invention. In the manufacture of fir wallboard, for instance, a dry glue base for a mastic soybean glue is made by mixing 95 lbs. of fine ground soybean flour with 4 lbs. of fine ground soda ash and 1 lb. of pine oil. 100 parts by weight of this dry powder are mixed with 200 parts of water. Then 10 parts of hydrated lime separately mixed with 50 parts of water are added, followed by 4 parts of caustic soda separately dissolved in 10 parts of water, followed by 30 parts of "N" brand sodium silicate and finally by a mixture of 1.8 parts carbon bisulfide and 1.2 parts of carbon tetrachloride. The viscosity one-half hour after making up will then be about 30 MacMichael with #18 wire, the ratio of water to dry glue base being 2.6 to 1. This is a very heavy bodied semi-fluid glue.

Dry $\frac{1}{8}$ " cores at about 3% moisture are spread at the very low rate of 50 lbs. of this wet glue per thousand square feet of three-ply panels employing rubber covered reticulated or pattern spreading glue rolls with sufficient pressure on the rolls to cause the core pieces to positively move forward and the semi-fluid glue to be spread at the same speed and the adhesive to be printed on the wood in a corresponding pattern. In this instance, the glue rolls are grooved spirally with eleven grooves per inch so as to produce an adhesive pattern consisting of a corresponding series of raised adhesive areas or glue ridges with spaces between merely wetted with the adhesive, but free from any excess.

The spread cores are laid on backs which have been placed on a conveyor and a face ply is laid on the cores forming the complete assembly which is then moved into a hot press. Two assemblies are pressed in each opening. The

press is immediately closed and a pressure of about 200 lbs. per square inch of panel surface is applied. The assembly time between the spreading of the cores and the application of the pressure may vary from about 30 seconds to five minutes. The press plates are heated to a uniform temperature of 225° F. and, after 140 seconds, the press is opened and the panels removed.

This method produces extremely well glued plywood with both a very small consumption of glue and low injection of glue water into the plies, provided the time of assembly is kept within these narrow limits. It is highly efficient because of these features as well as the very short time in the press and the panels are more uniform and better glued than those produced by the cold process. However, there is still some variation in the product. For example, upon examination a panel thus made with an assembly time of only one-half minute was found to show complete transfer with entire obliteration of the original spread-pattern indicating that the glue was redistributed by the pressure into a very uniform film, but there was an excessive penetration and the panel, while fully commercial, showed indications of a starved joint with an insufficient residue between the contacting surfaces to produce a bond of maximum strength. In this case, it was evident that the panel had been pressed a little too soon after spreading for ideal results. In this instance, a more ideal panel could have been produced with this very short assembly time of one-half minute by running the glue at a still higher initial viscosity, but that expedient would have objectionably narrowed the tolerance of longer assembly time, causing deficient penetration to become prohibitive after about two and a half minutes instead of five minutes. A similar panel made at the same time with an assembly time of one and one-half minutes was found to have a very strong and practically ideal bond, while another made with the time extended to the permissible maximum of five minutes, although fully commercial, was not found to be ideal. The transfer was seen to be poor with the original pattern of spread lines still visible and the glue penetration into the unspread ply was insufficient. Beyond an assembly time of five minutes the results were found to fall off rapidly.

With other forms of mastic or semi-fluid glue somewhat wider tolerance of assembly time may be attained, particularly by compounding with a certain proportion of more thermoplastic adhesive components. However, thus far a maximum tolerance of twenty minutes has been found to be the approximate upper limit when using the semi-fluid glues of the mastic process and even this extension adds considerably to the gluing cost by necessitating the use of more expensive materials.

It is thus seen that the assembly time tolerance problem is a general characteristic of gluing with dispersed glues regardless of whether cold press or hot press methods are used. With the cold process a wide tolerance is required and there are correspondingly wide variations in the quality of the panels produced between the permissible extremes. With the ordinary hot process the same condition obtains, but under narrower limits, and, with the mastic process just described, the same restriction is also encountered and the changes are more abrupt due to the shorter interval of tolerance.

After observing, for instance, that the mastic

panel made with a 30 second assembly time had a starved joint with excessive penetration, it would be logical to expect that any very early pressing of a panel would inevitably produce a starved joint. Up to the present, as far as I am aware, this has been the general opinion. I have now discovered that if the proper procedure is followed, not only is this untrue, but such early application of pressure, instead of being detrimental, may be very beneficial and produce the unexpected result of greatly widening the tolerance. For instance, in the improved mastic gluing procedure subsequently described, I am able to extend the tolerance from five minutes up to twenty minutes and with a specially compounded mastic glue having a normal tolerance of twenty minutes, by my procedure I can extend that period to two hours.

In practicing my invention in the manufacture of fir plywood with mastic glue, I may take the assembly and within thirty seconds, instead of hot pressing it, apply a momentary cold pressure nearly up to the crushing limit of the wood. In this case with Douglas fir the momentary pressure applied was 250 lbs. per square inch. I then at once released the pressure and subsequently pressed it in the usual manner in the hot press after an additional interval of ten minutes. The resulting panel was found to have an ideal bond even better in general quality than the panel produced with one and one-half minutes assembly time without any preliminary compression. A duplicate precompressed panel finally pressed after a total assembly time of twenty minutes, while not showing as good a bond as the ten minute panel, was entirely commercial and actually superior to that produced after five minutes without precompression. These panels were made with the soybean mastic glue previously described. I have obtained similar results with mastic panels made with a very high grade glue normally capable of permitting twenty minutes assembly time. By precompressing them excellent panels were produced with a total assembly time of two hours. A similar beneficial result was obtained by applying my precompressing method when using the cold process. In this case excellent panels were produced after a total assembly time of forty minutes which were better than panels produced without precompression with an assembly time of twenty minutes.

I have found that this improvement is generally applicable to the gluing of porous materials with glues which are spread on at least one surface and subsequently solidified under pressure. If both contacting surfaces are spread, similar advantageous results are obtained, the principal difference being that, since the glue is already present on both surfaces, the necessity of obtaining transfer is eliminated. However, the same benefits are obtained in regard to control of penetration and obtaining the proper residual film between the surfaces.

In general, in plywood gluing, I find that the precompression should take place early while the glue still remains quite soft and is either at least somewhat fluid or is flowable under pressure. In other words, the precompression should always take place before very marked change has taken place in glue consistency such as would interfere with transfer and penetration. In the hot process, with glues of ordinary consistency the precompression should usually take place not later than ten minutes after spreading and in the cold process not later than about fifteen

minutes after spreading and in both cases, of course, it is ordinarily preferable to precompress much sooner. With mastic glues, precompression should not be postponed more than about three minutes after spreading and preferably should take place within about one minute.

In regard to pressure, in most cases, I find that although even low pressure is beneficial, the best results are obtained when using fairly heavy pressure, in some cases nearly up to the crushing limit of the wood. High pressures are particularly desirable in treating dense woods having small pores or in dealing with originally less fluid glues, such as mastic even with the soft porous woods. The extent of penetration can be controlled by varying the pressure in accordance with the consistency of the glue existing at the time of applying the pressure and the character of the wood or other porous surface to be penetrated. If the glue is very thick or the wood dense and difficult to penetrate, a proportionately higher pressure will be required to obtain a given degree of penetration and conversely with very fluid glue or very porous wood less pressure will produce the best results. Penetration can also be regulated by precompressing early while the glue is still most fluid to induce greater penetrating or by delaying the precompression until the glue becomes thicker to avoid too much penetration. Heat may also be used to induce flow and penetration, but is usually unnecessary. By following these rules, the correct procedure for any given set of conditions can be found easily.

The principles of my invention can also be applied readily to gluing insulating board, paper and other porous materials. In the case of paper, for the most part, it will be found much more absorbent than wood and, for this reason, comparatively light pressures usually can be employed and short intervals between spreading, precompression and final pressing. Some varieties of paper are much less porous than others, so that the adjustment of the different factors should be modified according to the conditions.

It has been shown that if the precompressing is applied before the glue has substantially changed in its consistency, its effect is to redistribute the adhesive from the area of original deposit in a substantially uniform penetrating film over both of the contacting surfaces, thus securing complete transfer from the spread to the unspread surface and simultaneously a desirable immediate and uniform penetration into both of the contacting surfaces or plies. If the precompressing pressure is only momentary or of short duration, even though the glue has not previously had time to thicken appreciably, nevertheless, starving of the joint does not occur as would be the case if this early pressing was long continued. Instead of that, the desirable condition of a uniform moderate penetration into both surfaces results, leaving an adequate residual film between the plies along with the essential transfer. A further advantage is that these results occur in a short time interval so there is no need for more than a momentary application of pressure.

I then find that having thus obtained in advance the essential transfer, penetration and adequate residual film of glue on the surfaces, a comparatively long period can then elapse before the final bonding pressure is applied. Immediately after releasing the precompression, the residual film which is now much shallower than

the original deposit, changes to a tacky form having much higher viscosity due to squeezing of glue water into the wood and hence after the release of the precompression, since the adjacent wood has already been saturated, the consistency changes but slowly and the glue remains at least tacky for a long time. Owing to this feature, the final bonding pressure may be applied either fairly promptly after this initial thickening has taken place or only after a comparatively long interval and yet very little difference in the quality of the bond will result. This is, of course, due to the ease with which such tacky surfaces unite with each other. Good commercial bonds result because the transfer and penetration essentials have already been supplied and all that remains is merely to unite the tacky glue films on both contacting surfaces and hold the surfaces in good contact during the setting or hardening of the glue. In ordinary gluing without precompression both transfer and penetration must for the most part be obtained during the final pressing step, very often after the glue has become too much dried up to have the necessary ability to flow. This difference is characteristic of my process. It is thus seen that in my process the two films on the adjacent ply surfaces will remain tacky and hence soft enough to unite quite readily, long after they would be unable to meet the requirements of the old process which demands considerable ability to flow at the time of pressing. By the term "tacky," therefore, I imply a condition which permits contacting films to unite by flow. In the cold process the condition must permit a sufficient amount of flow to be induced by pressure alone, but in the hot process the heat is a valuable aid to inducing flow since all adhesives of this character are thermoplastic when moist.

When the precompression step is omitted, the final bonding pressure has to secure simultaneously adequate, but not excessive, penetration into both surfaces, complete transfer, and a proper residual film. If the pressing is done early, the transfer requirement is met, but the residual film is lost and a starved joint results due to the continuing pressure forcing the residual glue deep into the wood. The tendency where only one of the contacting surfaces has been spread with glue and the assembly time is considerable, is towards the other extreme so as to create an unfavorable difference between the situation on the two adjacent surfaces. A deficiency of penetration and transfer results with respect to the unglued ply which becomes worse and worse as assembly time is extended. It is thus seen that in my process the step of preliminary pressing avoids both the starved joint and poor transfer difficulties with the additional advantage that not only is assembly time tolerance greatly extended, but also the resulting bonds are more uniform and the action of the adhesive becomes more effective. Due to this, I find there is a saving in glue consumption of about fifteen per cent. There is a further advantage also in the handling of pre-compressed panels when they are finally loaded into the press for final pressing. The precompression tends to stick the plies together somewhat so that it is not only very difficult to displace them from their proper location, but also the assembly as a whole can be handled as a unit more quickly and easily. Without precompression, the plies lie loosely one upon the other and have to be handled with care to avoid displacement.

Besides useful applications in gluing porous sheet materials including both wood and paper, the principles of my invention may also be applied in gluing together materials of irregular shape, for example, in consolidating with an adhesive porous materials of a granular character, such as sawdust or ground cork. After thoroughly mixing the granules with the adhesive, so that a fair proportion of the surfaces carry a film of glue, a preliminary pressure may be applied to cause a proper transfer over the mutually contacting surfaces along with penetration and the creation of a residual film and then the pressure may be released so that the glue remaining on the surfaces becomes merely tacky rather than fluid and then the final consolidating pressure may be applied and a strong bond secured as long as the final pressure is applied before the film of glue has dried up so much as to be no longer tacky. In such cases, it is often not necessary to supply enough adhesive to make a completely continuous film over all the contacting surfaces, since an adhesive union of less than the full area of contact may be adequate. In such case, by my precompressing method, the adhesive will produce a strong bond wherever its presence permits the desired transfer, penetration and residual tacky film to be formed. By this method, composite articles may be produced with exceptional strength and economy of glue.

The method of carrying out the present invention is not limited to any particular form of apparatus and it must be understood that the accompanying drawings are simply diagrammatic representations of suitable machines for performing the various method steps.

In the drawings:

Figure 1 is a diagrammatic side elevation of a suitable core ply coating apparatus.

Figure 2 is a diagrammatic plan view of the same.

Figure 3 is a diagrammatic side view of the preliminarily assembled plies, the plies being shown spaced apart and the thickness of the adhesive being considerably exaggerated.

Figure 4 is a similar diagrammatic view representing one manner of performing the preliminary compression step.

Figure 5 is a similar view representing an alternative method of performing the preliminary compression step.

Figure 6 is a diagrammatic representation of a final compression step, and

Figure 7 is a similar view of an alternative final compression step.

As shown in Figure 1, a core ply 10 may be passed between grooved rubber applicator rolls 11, 12, of substantially the character disclosed in my copending application Serial No. 191,096, now Patent 2,188,456, where semi-fluid, relatively thick adhesive is applied. The adhesive is preferably transferred to the rolls from receptacles 13, 14, by doctor rolls 15, 16.

Figure 2 is an exaggerated representation of an adhesive pattern, consisting of ribs 17 of excess glue, alternating with spaces 18 which are merely wetted with the adhesive. In practice, the adhesive ribs and the intervening spaces will be relatively smaller than as represented in the accompanying drawing, and any other desired adhesive pattern may be substituted for that shown.

In Figure 3, upper and lower uncoated plies 19, 20 have been applied, and the preliminary compression step may be performed by pressure

rolls 21, 22, as represented in Figure 4, or by a platen press, as shown in Figure 5, comprising a base 23, a head 24, toggle links 25, 26 and means, such as an air cylinder and piston 27, 28 for applying force to the toggle. The representation of the press and of the means for actuating the same is purely diagrammatic, as any suitable press may be employed.

After a sufficient number of preliminarily compressed plywood panels have been collected, two or three or more may be subjected to final compression in a hot press 30, or, alternatively, a greater number may be subjected to a final cold pressing operation in a stack 31 in a cold press comprising base 32 and head 33.

In carrying out the present method, when porous sheet materials, such as wood plies, are used, either a press, such as is shown at 23, 24, or a pair of pressure rolls, such as 21, 22 may be used with desirable results. With paper, roll pressure is preferred in most cases. Under some conditions, it is desirable to cover the pressure rolls 21, 22 with rubber, as indicated at 21', 22', and, in such cases, the panels may be assembled on a conveyor and automatically carried through the bite of the rolls on their way to the final press. In other cases, the panels may be accumulated in small batches adjacent the glue spreader and then pre-compressed in a platen press in small batches, instead of singly, as indicated in Figure 5. In some cases, the platen press is preferable because the application and release of pressure is somewhat more gradual and there is less tendency to displace or fracture the plies. The use of rubber rolls for the same reason produces somewhat better results than metal surfaced rolls, due to the yielding action of the rubber.

Other modes of applying the principles of the invention may be employed, changes being made as regards the details described, providing the features stated in any of the following claims or the equivalent of such, be employed.

I claim:

1. The method of manufacturing plywood which comprises coating the upper and lower surfaces of core ply material with coatings of flowable adhesive, assembling with said core ply, upper and lower uncoated plies with their surfaces in con-

tact with the coated surfaces of the core ply, preliminarily compressing the assembled plies while the adhesive remains soft and flowable under pressure, for only a momentary period of time, and substantially immediately releasing the compression, said preliminary compression being at a pressure sufficiently high to be effective to cause transfer of the adhesive from the coated ply to the adjacent uncoated ply surfaces, to obtain appreciable and substantially uniform penetration of the plies by the adhesive, to squeeze a portion of the glue water into the wood and thereby leave on the surfaces a residue of tacky adhesive sufficient to avoid a starved joint, and subsequently subjecting the assemblies thus produced to a final bonding compression for a sufficient period of time to permanently set the adhesive and to permanently bond the plies together.

2. The method of manufacturing plywood which comprises coating the upper and lower surfaces of core ply material with coatings of relatively thick, semi-fluid adhesive in a pattern consisting of areas having an excess of adhesive and substantially uncoated areas, assembling with the coated core ply material, upper and lower uncoated plies with their surfaces in contact with the adhesive on the core ply material, preliminarily compressing the assembled plies while the adhesive remains soft and flowable under pressure, for only a momentary period of time, and substantially immediately releasing said preliminary compression, said preliminary compression being at a pressure sufficiently high to be effective to spread the adhesive from the excess areas to the substantially uncoated areas, to cause transfer of the adhesive from the coated ply to the adjacent uncoated ply surfaces, to obtain appreciable and substantially uniform penetration of the plies by the adhesive, to squeeze a portion of the glue water into the wood and to leave on the surfaces, a residue of tacky adhesive sufficient to avoid a starved joint, and subjecting the assemblies thus produced to a final compression for a sufficient period of time to permanently set the adhesive and to permanently bond the plies together.

HARRY GALBER