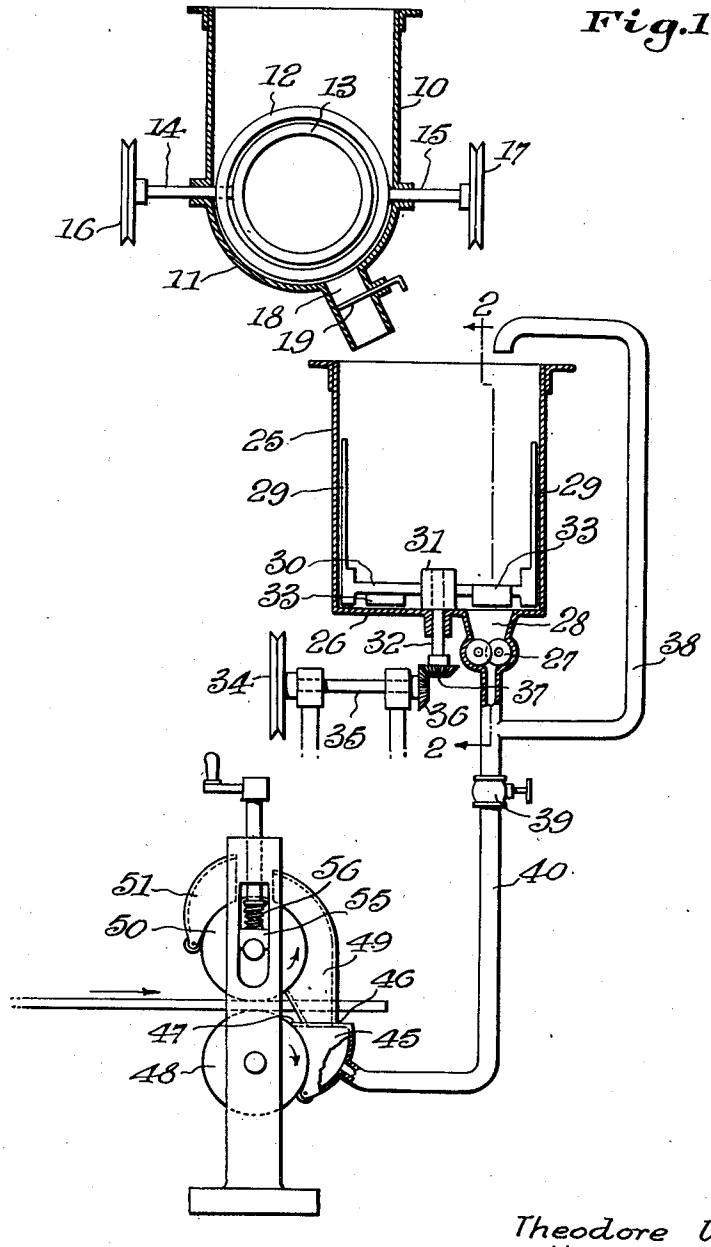
Sept. 12, 1944. T. W. DIKE ET AL 2,357,880

APPARATUS FOR MAKING PLYWOOD AND THE LIKE

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Fig. 1.



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APPARATUS FOR MAKING PLYWOOD AND THE LIKE

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Fig. 2.

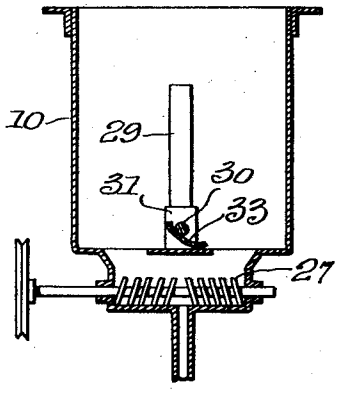
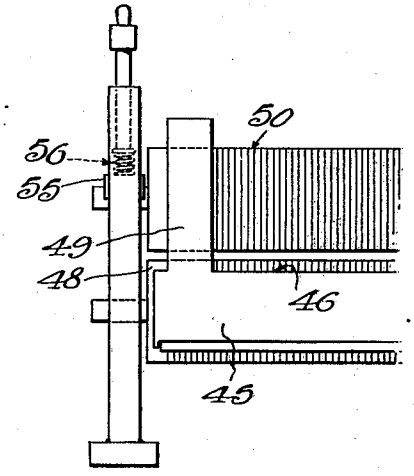


Fig. 3.



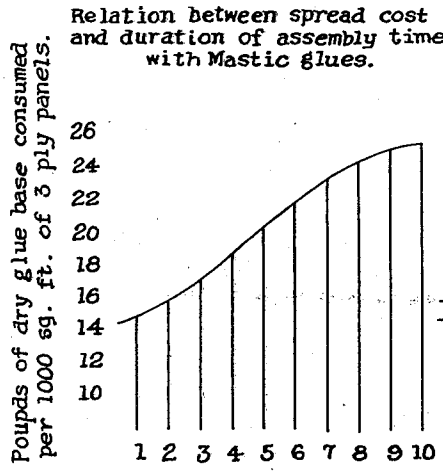


Fig. 5.

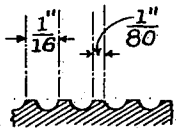


Fig. 4.

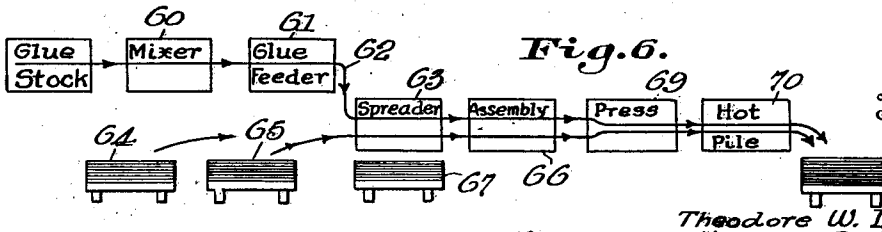


Fig. 6.

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UNITED STATES PATENT OFFICE

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APPARATUS FOR MAKING PLYWOOD AND THE LIKE

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Application November 2, 1939, Serial No. 302,583

2 Claims. (Cl. 144—280)

The present application is a continuation-in-part of our copending application Serial No. 95,460, filed August 11, 1936, now Patent 2,178,566, dated November 7, 1939.

Recently, as described in that application (Ser. No. 95,460), we have developed a new type of dispersed glues very useful for hot pressed plywood manufacture and characterized by a very heavy consistency. These adhesives are aqueous dispersions preferably of proteinous character which are non-self-flowing and normally occupy a viscosity range between about 10 and 90 No. 18 wire MacMichael, in which range small masses have no flow whatever and large masses flow only slowly under the influence of gravity. As fully described in our copending application, these glues have demonstrated many advantages in hot pressed plywood manufacture including remarkable uniformity of adhesion with extremely low spread cost and great reduction in water injected into the plies as well as in spoilage difficulties such as stain and checking which have formerly resulted from the tendency of normal fluid glues to migrate deeply into the wood. These non-self-flowing adhesives, owing to their peculiar character, have come to be designated in the industry as "mastic" glues, and, therefore, for the sake of brevity this descriptive term will be used in the subsequent specification. The above mentioned improved results in the manufacture of plywood have only been obtained after extensive research and much experiment to develop a practical sequence of steps for handling material of this peculiar consistency and these methods and the required apparatus form the subject of the present invention.

The heavy consistency of mastic glues has presented a difficult problem at every stage of the handling beginning with the mixing, continuing through the step of transferring the mixed glue to the spreading apparatus, continuing also in the movement of the glue through the spreader until the material is deposited by the applicator rolls upon the plies which are being spread. Our method of handling solves these difficulties, so that, at the moment of spreading and from then on, special advantages are obtained which facilitate the operations of pressing and completing the formation of the glue bond. The present invention, therefore, deals with and has for its object the development of a complete and satisfactory sequence of steps and arrangement of apparatus covering the handling of the glue throughout the entire process from the original mixing until the glue bond is completed.

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 a few of the various ways in which the principle of the invention may be applied.

We have developed the following sequence of steps in obtaining a commercially practical process of gluing plywood with mastic glues. Preferably, these steps are:

1. Mixing in batches in a powerful mixer which must be of heavy construction and adapted to quickly discharge the glue.

2. Discharge from the mixer into a special positive displacement glue feeder capable of supplying the glue to the spreading apparatus under pressure at a controlled rate.

3. Spreading in a modified type of spreading apparatus supplied with specially reticulated applicator rolls capable of depositing the glue thinly and with extreme uniformity as a distinct pattern upon the surfaces of the plies.

4. Assembly of the spread plies with the required unglued plies including the valuable feature that the uniformity of the glue distribution is not destroyed or objectionably altered by the handling involved in the assembly operation.

5. Hot pressing with heavy pressure and moderate heat after a carefully controlled assembly interval to first transform the pattern deposit obtained from the spreading rolls to a thin, uniform all over film between the associated plies and then form a correspondingly uniform initial glue bond of adequate but limited penetration and at the same time store in the plies sufficient heat to insure the completion of the bond.

6. Discharge of the plywood from the press as soon as both the initial bond is formed and sufficient heat has been stored in the assembly and then transforming the initial bond without pressure to final durable form by the action of the heat stored in the assembly under conditions which guard against too rapid cooling of the panels.

Describing now in detail the steps in our process and the apparatus required, our experience has taught the fundamental fact that the inherent character of mastic glue is such that gravity can only be used in moving large masses, and that, since the problem of spreading glue upon veneer plies is for the most part a problem of accurately controlling the distribution of small

masses, other means than gravity are necessary for effective operation. This is quite different from the conditions which obtain in the handling of ordinary fluid glues which due to their mobility can readily be handled by gravity means, since they will flow satisfactorily through pipes and also are able to wet moving surfaces and pick up fairly uniformly on such surfaces and often require only the action of gravity to remove any undesired excess. With mastic glues these advantages are not available and wherever the masses to be moved are small, we find it essential to employ pressure greater than gravity and, in some places, we find it is necessary that the displacement of the material to its new location be effected by positive means, such as a positive displacement pump. While these restrictions have presented a difficult problem which has only been solved by the development of new methods and a new sequence of steps in handling the glue, the final result is to obtain important advantages and a new efficiency in plywood manufacture. These advantages will be apparent in the light of the following description, when considered in connection with the accompanying drawings, showing, somewhat diagrammatically, preferred mechanism for carrying out the method.

In the drawings:

Figure 1 is a diagrammatic view, partly in side elevation and partly in vertical section, showing an apparatus, in accordance with the present invention.

Figure 2 is a vertical section taken substantially on line 2—2 of Figure 1.

Figure 3 is a fragmentary rear elevation of the glue applicator rolls, looking from the right in Figure 1.

Figure 4 is a fragmentary, enlarged, radial section of one of the applicator rolls.

Figure 5 is a graph showing the relation between the amount of glue applied and the average assembly time, and

Figure 6 is a diagrammatic plan view of a preferred plant layout.

1. *Glue mixing*

As described in our copending application, Serial No. 95,460, mastic glues may be made in a wide range of composition, and by using a variety of constituents, but the essential correct consistency results from a substantial restriction of the amount of water used during the mixing. When mixing ordinary fluid glues, it is common practice to restrict the water during the early stages so as to stir the ingredients initially at a heavy consistency to assure great intimacy of admixture, but as soon as this condition has been obtained, the remaining water is added and the glue is thinned down to its normal fluid consistency and the mixing is completed in that condition. For this reason, glue mixers for fluid glues do not have to be of heavy construction, for, while there is some heavy mixing to be done at the start, it is applied to much less than the volume of the full batch and all manipulation of the full batch is done under quite fluid conditions. With mastic glue the consistency of the batch is very heavy at all times, so that satisfactory and efficient mixing involves the use of a heavily constructed machine and the expenditure of a substantial amount of power. These are the conditions which obtain in mixing bread dough in bakeries and we find that in practice commercial dough mixers give fairly satisfactory results. However, for this purpose, dough mixers are generally unnecessarily expensive and we prefer to use a simple, but sturdy mixer of the well-known spherical type, such as is shown in the accompanying drawings. This mixer may comprise a cylindrical container 10 provided with a hemispherical bottom 11 of the same diameter as the cylinder and with two power operated ring stirrers 12, 13 revolved in opposite directions, the outer ring 12 closely fitting the hemispherical bottom and the inner ring 13 loosely fitting the interior of the outer one, the rings being driven by horizontal shafts 14, 15, respectively, having pulleys or gears 16, 17 projecting from opposite sides of the mixer. Owing also to the heavy consistency of the glue, we provide a discharge opening 18 of large diameter, usually about seven and one-quarter inches in diameter for a spherical mixer having a thirty inch diameter. With such a discharge opening located near the bottom of the mixer and provided with an equally large valve 19, we find the contents of a batch can be quickly discharged by gravity into the apparatus required for the next step in our process. It is noted that this is one of only two instances where we have found it practical to rely, at least partially, on gravity as a factor in moving mastic glue. Even in this case, however, we find it necessary to have the mixer running when the batch is being discharged, since the action of the stirring rings is necessary to bring the glue to the discharge opening in sufficiently heavy masses, so that they are able to drop through by gravity. With the apparatus described, however, using a thirty inch mixer with a seven and one-quarter inch discharge opening, we are able to discharge a glue batch of five hundred and fifty pounds in one minute. If the above mentioned provision for rapid discharge of the batch is not available, difficulty in discharging the completed glue is so great that the emptying of the mixer takes longer than the mixing of the batch.

2. *Storing the glue and supplying the spreader*

In large commercial plywood plants, it is usually necessary to have some kind of a receiving tank for the mixed glue to provide a reservoir from which to supply the spreader. By this means, the glue mixing is made independent of the glue spreading. With fluid glues this requirement does not involve any difficulty, since any simple overhead tank will act as a reservoir and the glue can pass by gravity through a pipe to meet the requirements of the spreader. With mastic glue, such gravity handling is impossible and it has been an extremely difficult problem to make the glue mixing independent of the spreading and at the same time find some means for feeding the heavy non-fluid glue to the spreader at the varying rate necessitated by normal fluctuations in the speed of the spreading operation.

At first sight, it would seem that this problem could be readily solved by providing as the spreader feeder a positive displacement pump of some sort in the bottom of a simple receiving tank. This method was, in fact, tried a number of times, but always proved unsatisfactory and the failure was invariably due to the same cause; namely, inability to feed the heavy glue at a uniform rate through the intake opening of the pump. In practice, this problem of "feeding the feeder" proved so baffling that an attempt was made to evade it by building a positive displacement pump having an enormous pump chamber capacity, so that the cylinder, which was built in two halves, could be opened up with the piston

retracted and an entire batch of glue placed in front of the piston which it was expected could then be discharged to the spreader under pressure with satisfactory uniformity when the pump was closed up and the piston slowly driven ahead by power means. However, this solution gave a great deal of trouble because a large amount of air was entrapped in front of the feeder piston which caused a seriously variable discharge and also entailed the inconvenience and expense of having a large enough piston chamber to provide a sufficient reservoir between the mixing and spreading operations.

The problem of providing a combined receiving tank and glue feeder was finally solved after much costly experiment by providing a cylindrical or cone-shaped open top receiving tank, such as is shown at **25** in the accompanying drawings. Into this tank, glue is discharged by gravity from the mixer. The capacity of this tank is preferably large enough to hold at least two batches of mixed glue. Just below the bottom **26** of the tank **25**, a powerful but small positive displacement pump **27** is provided with intake openings **28** penetrating the tank bottom, the pump being located so that the glue moving through these openings is immediately taken up by the impeller of the pump which is preferably of the double spiral type or, alternatively, of the gear type. Power means are then provided in the receiving tank for both scraping down the sides and also for continually pressing or squeezing the glue down into the intake openings **28**. This scraping and feeding may be accomplished by securing a pair of upwardly extending scraper blades **29** to the ends of arms **30** secured to or integral with a hub **31** mounted on a vertically disposed rotatable shaft **32**, and by securing to those arms, a pair of downwardly and rearwardly inclined blades **33**, positioned to pass over the openings **28** in close proximity to the floor of the tank and the upper ends of the openings **28**. Hence, when rotational movement is imparted to the shaft **32**, the upwardly extending scraper blades **29** assist in circulating the main body of glue in the tank **25**, while the inclined, compression blades or hoes **33** engage the glue adjacent the bottom of the tank and push the same along a circular path toward the pump intake openings **28**. During this movement of the glue by the blades, a strong downward component of force is imparted to the glue, so that when the blades pass over the openings **28**, the glue is positively forced or squeezed downwardly therethrough, into the pump chamber.

Rotational force may be imparted to the shaft by any convenient means, for instance, by a gear or pulley **34** secured to the outer end of a shaft **35** having, on its inner end, a pinion **36** in mesh with a similar pinion **37** on the shaft **32**.

With this positive method of feeding into the intake of a positive displacement pump, pumping action with the heavy non-self-flowing adhesive becomes effectively controllable. It is then possible to regulate the supply to the glue spreader either by by-passing back to the tank any excess beyond the requirements of the spreader, for instance, through a conduit **38**, or by varying the speed and corresponding output of the positive displacement pump. Since the by-pass method eliminates the expense of a variable speed drive, it is preferred, the supply then being readily controlled by suitable valving, such as valve **39**.

Obviously, the foregoing solution of the problem can be effected with various types of apparatus, provided provision is made for the essential features of mechanically hoeing, pressing or squeezing the glue into the pump intake with positive displacement pumping, through a conduit such as that shown at **40**, to the spreader at controllable rate.

3. *Spreading mastic glue*

Modification of the customary double roll glue spreader has also proved necessary for successful handling of mastic glues. In the ordinary double roll glue spreader, the fluidity characteristic of normal glues furnishes the means for moving the adhesive through the machine and onto the plies which are being spread. The plies are passed through the bite of the applicator rolls which have previously been supplied with a roughly regulated amount of adhesive which is transferred from the rolls to the upper and lower surfaces of the plies as they pass through the bite. Both upper and lower rolls form one wall of respective upper and lower glue tanks, the tanks in turn being supplied by gravity through pipes from a receiving tank or directly from the glue mixer. The fluid glue in each tank wets the surface of the adjacent downward revolving roll and an amount clings to it which can be roughly adjusted by the setting of a doctor or wiping roll which usually is placed in the bottom of the tank, so that any excess of glue not desired upon the surface of the roll is doctored off back into the tank.

With mastic glue, the non-self-flowing characteristic makes it impossible for this method to function effectively. The usual glue tanks can, of course, be supplied through pipes with glue under pressure from the positive displacement feeder, but, owing to the lack of self-flow, the revolving glue roll pushes the heavy glue away from its surface, and, unless the parts are considerably modified, influence of gravity is ineffective to maintain a sufficient arc of the roll in contact with the glue to properly smear its surface. In the case of the lower spreader roll in all double roll glue spreaders, the glue reservoir has to be kept well down on the periphery of the roll, since the reservoir top must be below the bite of the rolls to leave the bite clear and permit the plies to be fed through the machine. We have found that this difficulty can be solved as far as the lower glue tank **45** is concerned without changing the location of the glue tank, by enclosing its upper surface with a cover **46** adjusted to close off the whole top except for a narrow gap **47** which may be from one-eighth to one-quarter inch wide adjacent to the surface of the downward moving roll **48**. Unless an excess of glue is fed into the lower tank, we then find that no overflow takes place through this gap and that the combined effect of a continuous supply of glue under pressure from the positive displacement pump **27** plus the pumping effect of the downward revolving roll **48**, as it passes through the gap **47** down into the tank is adequate to generate sufficient pressure in the mass of glue to force it against the roll surface with a large arc of contact effective to keep the roll surface supplied with glue. In practice, however, we have found it difficult to so regulate the feed into the tank as to avoid an excess which, of necessity, escapes through the gap between the tank cover and the spreading roll. A convenient solution of this overflow difficulty is to supply one or more overflow outlet conduits or chimneys

49, through which excess glue can escape. If these chimneys are placed close to the ends of the spreader roll 48 clear of the stock passing through the spreader, they may be run up past the upper roll 50 so as to provide a supply of glue for the upper glue tank 51. As will be explained subsequently, the latter does not need to be enclosed. A further improvement has been to leave the chimney 49 open on the side next to the upward revolving surface of the upper spreading roll 50, which permits the friction between the heavy glue and the upward revolving upper spreading roll to assist in lifting the glue up, carrying it over and transferring it into the upper glue hopper 51.

Since the upper glue tank or hopper is above the bite of the spreading rolls, there is no restriction as to its location on the periphery of the roll or as to its capacity. We find that if it is located up high on the periphery and arranged to allow the roll surface itself to form the greater portion of the floor or bottom of the tank instead of merely forming one side-wall as in the prior practice, then a sufficient weight of glue may be carried in the tank to insure adequate, uniform smearing or coating of the upper roll surface. This also provides capacity to accommodate a variable supply and thus eliminates the overflow trouble. This is the only other instance in which we utilize gravity in handling mastic glue.

By this method, it becomes possible to adequately supply the surfaces of the spreading rolls, notwithstanding the non-self-flowing character of the glue. However, as explained in detail in our copending application Serial No. 95,460, it has been highly desirable in order to fully utilize the advantages of mastic glue to provide the spreading rolls with a special form of reticulated surface adapted to print on the veneer plies a pattern of glue in a series of parallel lines of heaped up ridges of glue separated by narrow areas merely wetted by the adhesive, but freed from any excess.

It has been customary for a long time in plywood plants to apply the ordinary fluid glues by using metal or sometimes rubber surfaced spreading rolls provided with reticulated surfaces. The simplest and commonest form of surface with metal rolls has been a series of spiral grooves having a pitch or frequency of about 10 to the inch and separated from each other by a flat-topped land or ungrooved portion of roll surface having a width usually about one-quarter the width of the groove. Thus, if the pitch is ten to the inch, the groove will be about eighty thousandths of an inch wide and the land or ungrooved portion will be about twenty thousandths wide. The depth and volume of the groove is then selected to deposit the proper quantity of glue or "spread" upon the plies. Owing to the fluid character of the glue, the linear spread pattern is almost entirely destroyed by self-flow at the moment when the core stock emerges from the bite of the rolls, but this method gives a rough control of spread which, while objectionably lacking in precision, proves adequate due to the large volume of fluid glue which is ordinarily applied. With the mastic glue, it has been found that if extreme accuracy of deposit can be obtained, the volume applied can be reduced about 50% as compared to the equivalent fluid glue. As described in our copending application, Serial No. 95,460, this accuracy of distribution is obtained by pattern spreading the glue in definite ridges separated by areas merely wetted with the adhesive, but free from any excess. To accomplish this result, with a material having the heavy consistency of mastic glue, we find that two essential modifications of the spreader roll functions are necessary. In the first place, the roll bearings, such as are shown at 55, must be heavily loaded by springs 56, so that the spreading can be done under comparatively heavy pressure. We find that the pressure necessary for proper spreading is about 100 lbs. per linear inch of core stock width in the bite of the rolls. This pressure may vary, in some instances, from as low as fifty to as high as one hundred and fifty pounds, but, in all cases, it is several times greater than the corresponding pressure used to spread fluid glues which is normally only about ten pounds per linear inch. Moreover, we find that greatly improved results are obtained if steel rolls, instead of rubber or rubber covered rolls, are used, since it is necessary to squeeze the lands of the spreading rolls down through the heavy glue under this high pressure, so that the glue in the grooved portion may contact the wood and be transferred to the wood in the desired form of a ridge of glue. If these high pressures were used with rubber rolls, the lands and grooves might be deformed to a sufficient degree to prevent proper pattern deposition of the glue.

It is also necessary to subdivide the distribution of glue on the surface more than with fluid glues. The latter are able to flow out sideways from the areas of excess glue application, so that a pitch of ten grooves per inch produces a fairly uniform distribution of the glue over the surface of the ply, this distribution mostly occurring by actual sideways flow as the core leaves the bite of the rolls, but is further spread out mechanically when the plies are squeezed together. With the mastic glue which has no self-flow in small masses, the deposit is left in definite ridges which, in order to produce the ultimate desired "all over" film deposit, must be caused to spread out sideways over the intervening land or unspread surface wholly by the bonding pressure which is subsequently applied to the plies. For this reason, in order to produce the desired exceptional uniformity of deposit which is essential, since the volume applied is to be reduced about 50%, we find the frequency of pitch of the grooves in the applicator rolls must be increased as much as is practical. This distribution by frequency of pitch has been found quite critical with mastic glues in gluing plywood. A pitch of about sixteen grooves per inch is desirable, as indicated in Figure 4, but, in some instances, may be as low as fourteen or as hight as twenty per inch. Above twenty, it has not proved possible to deposit enough glue, and below fourteen the space between the ridges is too great for satisfactory final distribution and it is also difficult to hold the spread down to the proper amount. Of course, it is understood that the volume deposited by the groove is controlled by its cross section which is adjusted as desired to produce the right spread. We have thus found in practice that neither the pressure nor the grooving of the ordinary spreader rolls used for fluid glues can be employed successfully in spreading mastic glues and that it is essential to provide a great increase in available spreading pressure and a substantial increase in the frequency of the pitch of the grooving.

By making these modifications with proper equipment and suitable handling, mastic glue can be spread at very low rates with a degree of

uniformity which is impossible with fluid glues. Without this exceptional uniformity of distribution, the large excess spread customary with fluid glues would have to be used. Thus, our method of glue distribution makes it possible to realize one of the principal economies of the mastic type of glue.

4. *Assembling the plies*

The next step is the assembly of the spread plies with the required unglued plies. It is at this point that another important advantage of mastic glue is realized. In the assembly process, the spread cores are handled by the gloved hands of the operator who lays them down transversely in proper position on an unspread face ply in edge abutment with the adjacent core stock. A serious difficulty with all fluid glues has been that this handling causes wipes, both due to the pressure of the operator's fingers on the surface of the core and to wiping action as the core piece is slid into proper position on the unspread ply. The fluid glue, of course, offers very little resistance to mechanical displacement and the effect has been to produce wiped areas which are almost entirely freed from glue and which consequently produce corresponding areas of no adhesion or very weak adhesion. The mastic glue has the important advantage that due to its heavy consistency such handling does not seriously displace it. At most, the ridges of the pattern deposit are simply flattened locally, but the local quantity of glue remains undisturbed and the handling does not cause any areas of no adhesion or of defective adhesion. This feature for the first time removes one of the serious defects which have existed hitherto in practically all plywood.

During assembly, the mastic glue provides another advantage. Owing to its thick heavy character, it does not act as a lubricant; in fact, the rough ridged surface of the deposit has a valuable "non-skid" quality which completely prevents the plies sliding around on each other during the handling of assembly and loading into the press. This removes another of the common causes of defective plywood, for with fluid glues, displacement of the relationship between the individual plies is common and consequent open joints between core stock, overlapped cores and failure of the panel to trim out to the full size are a frequent occurrence. With the mastic glue, once the parts are assembled in proper relation to each other, they maintain that relationship so that the non-skid character of the mastic glue has proved a very valuable feature in practice.

In all gluing practice with aqueous dispersed glues, it is necessary to control the assembly time or interval which elapses between assembly of the spread plies and the application of the bonding pressure. If the assembly time is too long, the glue is apt to dry up and produce a weak bond due to insufficient penetration, while with fluid glues, the reverse trouble may occur if the assembly time is too short, in which case the glue may not have thickened sufficiently from contact with the porous wood and hence excessive penetration occurs with the formation of a starved joint. In fir plywood manufacture the usual assembly time tolerance is between about ten and about thirty minutes, but these limits are largely fixed by the specific character of the glue and the wood. It is not, therefore, possible to any marked extent with fluid glues to vary the assembly time tolerance by putting on more glue to permit a desired long assembly time, or to take advantage of ability to maintain a short assembly time to reduce spread and make a saving of adhesive. The full spread of fluid glue large as it is, is required to insure commercial adhesion, and, if more were applied, it would simply flow out and be lost at the edges of the assembly. With mastic glue, due to absence of self-flow, this restriction does not exist, and, while maximum assembly time tolerance is normally very much less than with fluid glues, there is nevertheless a very distinct relationship between the amount of spread and the amount of assembly time which is permissible, so that it is possible to economize by adjusting the spread to the assembly time. Attention is called to the chart, Figure 6, which represents actual experience with this relationship with a typical low cost soybean mastic glue which has been used extensively. It is noted that the practical limits of assembly time tolerance have been found to lie between about one-half minute and ten minutes and that to produce equivalent bond strength it only requires about fourteen and one-third pounds of dry glue base per thousand square feet of three ply panels when the assembly time is held down to one-half minute, while, when the average assembly time is extended to ten minutes, almost twenty-six pounds of dry glue base are required. In view of this relationship, it is seen that marked economies can be obtained by providing facilities and apparatus adapted to reduce the average assembly time and that the quantity of glue spread should be controlled with relation to the average assembly time which will be used in any specific instance. Control of this relationship is, therefore, a useful feature of our process.

5. *Hot pressing*

Having controlled both the spread and the assembly time in proper mutual relation, the panels are loaded into the hot press and we preferably apply the maximum mechanical pressure which the wood will stand without crushing. With Douglas fir this runs from 200–225 lbs. per square inch. This amount of pressure immediately squeezes out the ridges of glue laterally across the intervening bare spaces producing the desired thin uniform all over film between the associated plies and simultaneously causes the glue to penetrate the associated plies uniformly, but only to the comparatively shallow depth necessary to obtain adhesion. There is no waste of glue by excessive penetration nor deep migration of glue water with consequent staining of the face plies. Under the influence of the pressure and the heat which should be moderate so as to avoid forming steam blisters, the glue so distributed quickly thickens to form the initial glue bond. With a press plate temperature of about 230° F. and two three-ply three-tenths inch fir assemblies in each press opening, after two and one-half minutes, a large amount of heat has been stored in the plies and the bond has reached sufficient strength so that no injury to the bond or separation of the plies can occur upon release of pressure.

6. *Completing the glue bond*

When this condition is reached, the press is opened and the panels are discharged to a close pile, so that the maximum amount of heat is retained within the wood structure. If, in this

manner, the panel is guarded against too rapid cooling and remains closely piled for at least three or four hours, it will be found that during the interval the glue has dried out almost completely and full normal bond strength has been attained.

It is thus seen that with suitable apparatus available and by following this sequence of steps, the mastic glues have great commercial advantages, which include reduction of glue spread of up to 50% as compared to equivalent fluid glues, reduction of objectionable water injected into the plies of over 60% with consequent desirable low moisture content in the plywood, almost entire elimination of stains due to migration of glue water away from the surface actually contacted by the adhesive, reduction in tendency to check due to low water content and the elimination of defects and troublesome features which have characterized the use of fluid glues, such as wipes, skidding of the plies, etc.

In Figure 6, we have illustrated, diagrammatically, the preferred steps in the method of manufacturing plywood in accordance with the present invention, and have shown the manner in which the glue and the wood plies are processed, handled or manipulated separately until they reach an assembly station or stations, together with the manner in which the assemblies, comprising plies and glue, are jointly processed, manipulated and handled until the complete plywood panels are formed. The dry glue ingredients and water are mixed at **60**, whereupon the glue flows by the combined actions of gravity and the mixing blades to a receiving vessel **61**. The glue is then forced by the circulating blades in the receiving vessel to the pump **62**, from which it is forced to the glue spreading device **63**. Face plies from stacks **64**, **65** are assembled at **66** with core plies which have been fed from a stack **67** through the spreader **63**. The assemblies are subjected to heat and pressure in a hot press **69**, and the pressed assemblies are piled in a stack **70** and stored for a sufficient time to enable the heat in the panels to complete the setting of the glue to make a final bond.

Although the invention has been described in considerable particularity, it must be understood that the foregoing description and the accompanying drawings are illustrative only and that the invention must be considered to cover all modifications coming within the scope of the appended claims and their equivalents.

We claim:

1. Apparatus for use in the manufacture of plywood of the type wherein wood plies are adhesively united by a heavy, semi-fluid glue of such viscosity as to be incapable of self-flow except in large volumes, said apparatus comprising a storage vessel having a discharge opening in its floor, a force pump having its inlet connected to said opening, power means for circulating a supply of such glue in said vessel and including means for forcing glue under pressure through said discharge opening into the inlet of the pump, upper and lower glue applicator rolls having grooved surfaces, conduit means for delivering glue from the outlet of the pump directly to the lower of said rolls only and for maintaining a body of glue in contact with the surface of that roll under pressure, and additional conduit means for conducting glue from said body of glue upwardly into contact with the surface of the upper roll.

2. An apparatus for adhesively coating core plies with a semi-fluid glue of such a viscosity as to be incapable of self-flow when applied to the plies in a pattern spread comprising excess glue areas and intermediate areas merely wetted with adhesive, said apparatus comprising a pair of oppositely rotating, horizontally disposed upper and lower glue applicator rolls having grooved surfaces, means on the downwardly moving, discharge side of the lower roll defining a chamber having a substantially closed top and an open side facing said roll, means for delivering such heavy glue under pressure from a source of supply to said chamber, conduit means extending upwardly from said chamber and having an open side adjacent the upwardly moving, discharge side of the upper roll, whereby glue under pressure flows upwardly into contact with the upwardly moving face of the upper roll and is carried upwardly therewith, and means defining a glue trough on the downwardly moving, inlet side of the upper roll, said means having an open side or bottom facing said upper roll.

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