

Nov. 10, 1953

M. D. MACDONALD
METHOD OF MAKING COMPOSITE, CONSOLIDATED
PRODUCTS AND APPARATUS THEREFOR

2,658,847

Filed July 26, 1949

2 Sheets-Sheet 1

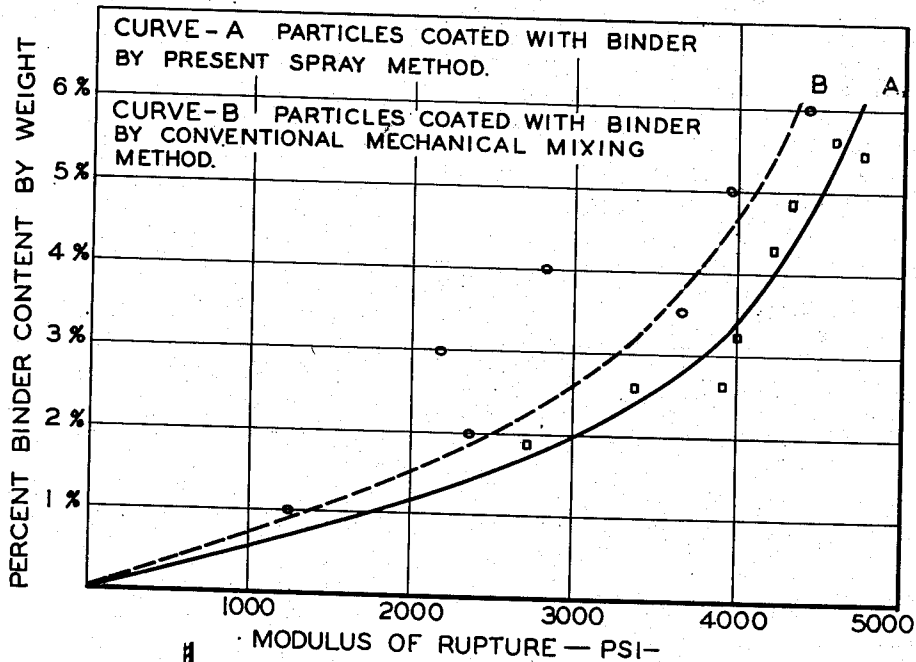


Fig. 1

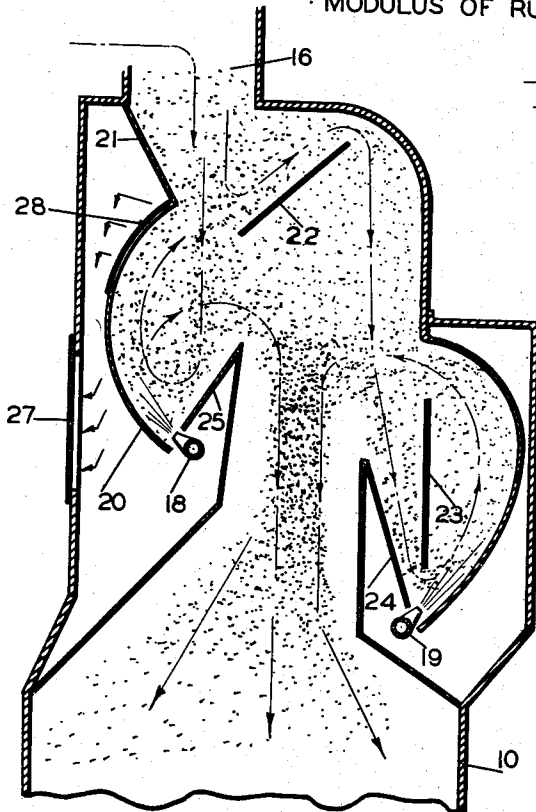


Fig. 3

INVENTOR.
MORTIMER D. MACDONALD

BY
Eugene D. Farley

ATTORNEY

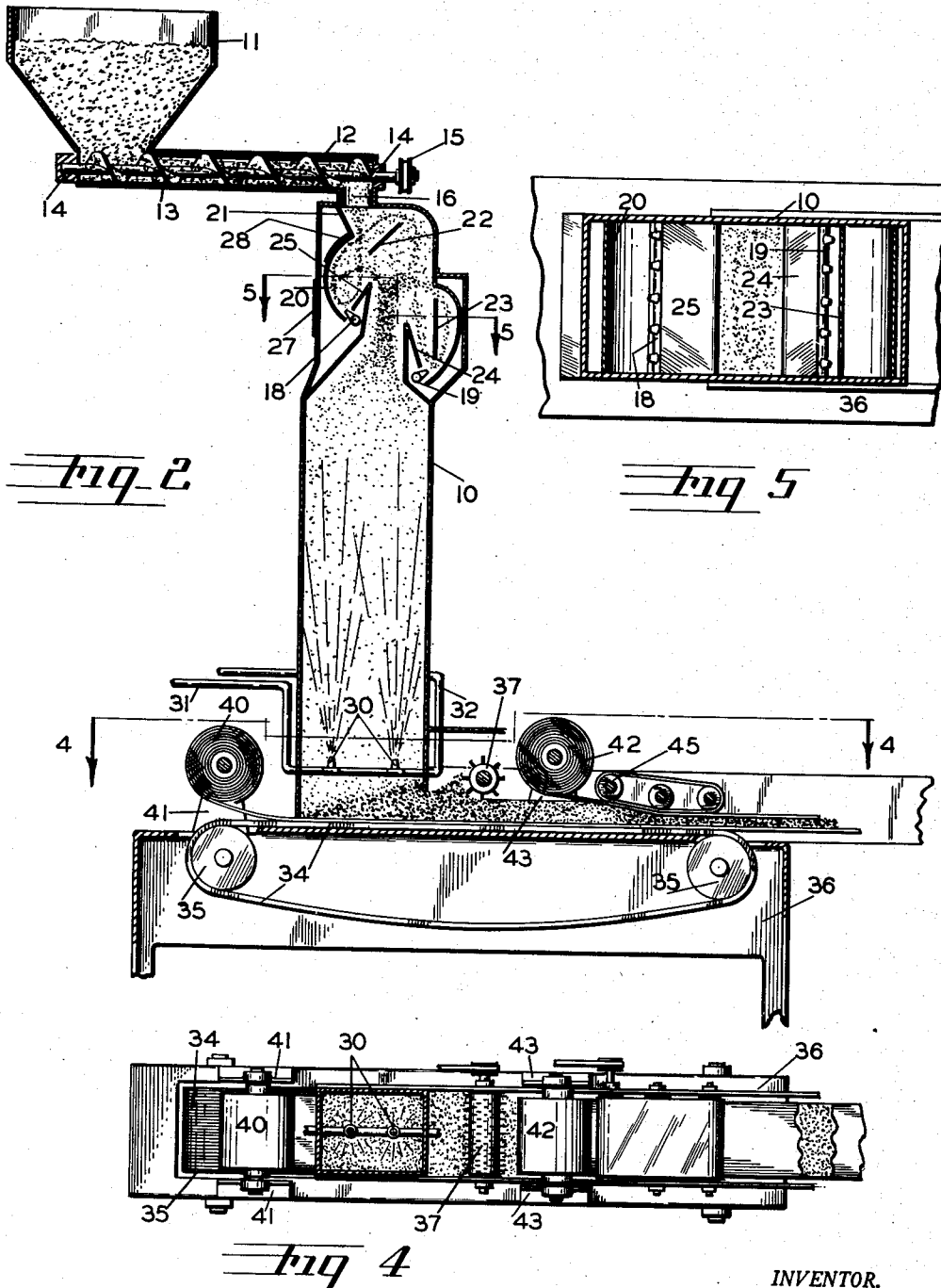
Nov. 10, 1953

M. D. MACDONALD
METHOD OF MAKING COMPOSITE, CONSOLIDATED
PRODUCTS AND APPARATUS THEREFOR

2,658,847

Filed July 26, 1949

2 Sheets-Sheet 2



INVENTOR.
MORTIMER D. MACDONALD
BY *Eugene D. Farley*
ATTORNEY

UNITED STATES PATENT OFFICE

2,658,847

METHOD OF MAKING COMPOSITE, CONSOLIDATED PRODUCTS AND APPARATUS THEREFOR

Mortimer D. Macdonald, Corvallis, Oreg., assignor to State of Oregon, acting by and through the Oregon State Board of Forestry

Application July 26, 1949, Serial No. 106,894

16 Claims. (Cl. 154—101)

1

2

The present invention relates to a method of making composite, consolidated products and to apparatus for use in making the same. It relates particularly to a method of making hardboard from woody materials in particle form, and to apparatus for practicing this method.

In the art of making hardboard and similar composite, consolidated products, it is conventional practice to shape small pieces of woody material into a felt, and then to consolidate the felt by the application of pressure and, often, with the contemporaneous application of substantial heat. This causes the adhesion of the individual particles to each other through the action of the native binders present in the woody material, as well as through the action of extraneous binders, if such have been added. The incorporation of extraneous binders frequently is necessary in order to obtain a consolidated product having the requisite strength. Amounts of extraneous binder of the order of several percent, based on the dry weight of the consolidated product, frequently are used to accomplish this purpose and hence constitute a substantial factor in the cost of the final product.

When extraneous binders are employed, it is the usual practice to add them to the woody particles of which the felt is formed by spraying the felt with the binder in liquid form, immersing it in a liquid binder, mechanically mixing the particles with a suitable binder, or spraying them with a liquid binder as they are being deposited to form a felt. The first three of the above methods often are unsatisfactory and uneconomical in that the coating of the particles is incomplete, which makes the resulting consolidated product correspondingly weak, or a large excess of adhesive material is used to secure thorough coating, which adds substantially to the cost of the product. In the fourth method, namely that in which liquid adhesive is sprayed on the particles as they are formed into a felt, conditions have not heretofore been provided for regulating the flow of particles with respect to the spray of adhesive material in such a manner that maximum coating of the particles is obtained with the use of a minimum amount of adhesive material.

Hence it is the primary object of the present invention to provide method and apparatus for coating particles of material to be formed into

composite, consolidated products with maximum coating efficiency and using a minimum amount of adhesive material, thereby forming consolidated products of maximum strength for a given adhesive content at lowest cost.

A further object of the present invention is the provision of method and apparatus for controlling the flow of particles of material to be formed into composite consolidated products in such a manner that they may be coated effectively with adhesive material while being deposited into a felt or shape suitable for consolidation into a relatively dense, composite product.

Another object of the present invention is the provision of method and apparatus for adjusting the moisture content of particles to be formed into consolidated products to an optimum level at which a mat made up of the particles may be prepressed so as to be self sustaining, and hence easily handled during operations occurring prior to the final consolidation.

Still a further object of the present invention is the provision of method and apparatus particularly adapted for use in forming from wood fiber, planer mill shavings, and other waste wood material a synthetically bound core material that can be utilized directly in the fabrication of flat, or molded board articles.

The manner in which the foregoing and other objects of the present invention are accomplished will be apparent from the following specification and claims considered together with the drawings wherein:

Figure 1 is a graph of board strength values plotted against adhesive content for composite, consolidated boards incorporating varying amounts of adhesive applied (a) by ordinary mechanical mixing methods and (b) by the method described herein;

Figure 2 is a sectional view in elevation of suitable apparatus for coating particles of material with adhesive and for forming the adhesive coated particles into composite consolidated products by the method of the present invention;

Figure 3 is an enlarged view of the mixing chamber of the apparatus of Figure 2;

Figure 4 is a plan view of the apparatus of Figure 2; and

Figure 5 is a sectional view taken along the lines 5—5 of Figure 2.

The method of the present invention for the

production of composite, consolidated products is applicable for use with a variety of raw materials including wood and woody substances such as cane, corn stalks, straw, etc.; mineral products such as asbestos and mineral wool; glass fibers and the like. It is particularly applicable to waste wood products such as sawdust, shavings, and chips. These various materials may be used in the form of particles or pieces of varying size ranging from fibers of relatively small dimensions to the shavings or chips of substantial size formed as waste products resulting from the ordinary wood working operations.

As adhesive materials for use in the execution of the method of the present invention, there may be employed many suitable adhesive substances adapted to cause the adherence to each other of pieces of material to form composite consolidated products in the manner disclosed herein. Suitable adhesives thus comprise the thermosetting resinous materials such as the phenol aldehyde resins, the urea formaldehyde resins, and the like as well as the thermoplastic binders such as asphalt, the bitumens, the various mineral and vegetable waxes, etc. Rubber latex, both natural and synthetic, and animal and vegetable glues also may be employed. Still further, there may be used inorganic cementitious substances such as aqueous suspensions or solutions of sodium silicate, plaster of Paris, magnesium chloride and the like. The commercial thermosetting, phenolic resins in the form of their aqueous solutions having a solids content of about 40% by weight are particularly well adapted for use in the method of the present invention as applied to the production of hardboard of substantial density from waste wood products, and the present invention is described herein with particular reference to such resinous binders as being illustrative of the adhesive materials which may be employed.

Broadly stated, therefore, the presently disclosed method of making composite consolidated products from small pieces of wood or other materials comprises entraining the pieces in a gaseous stream, preferably an air stream, diffusing the particles substantially uniformly throughout the air stream, and passing the diffused pieces through a spray or mist of liquid adhesive material to coat the pieces uniformly with an amount of adhesive which is predetermined with respect to the amount of wood or other material used, shaping the coated pieces into a felt of suitable form, and consolidating the felt to form the final product. In carrying out this method, the composition of the adhesive spray may be adjusted so that not only is the desired amount of adhesive applied to the pieces, but the moisture content of the latter is adjusted to a level at which a felt or mat formed from the pieces may be prepressed cold to form a self sustaining blank, which may be handled with facility without disintegrating prior to its final consolidation.

The particles of wood or other starting materials for the foregoing sequence of operations are usually available in the form of clumps or loose aggregates which tend to remain as such during felting and hence resist uniform coating of the individual particles. They therefore are subjected first to the action of a gaseous stream, e. g. an air stream of substantial velocity. This disintegrates the clumps and separates them into

their component, individual particles which then are entrained in the air stream.

Where particles of wood or other materials of correspondingly low density are employed and entrained in a rapidly moving air stream, the problem is presented of reducing their velocity so that they are proper subjects for subsequent coating and felting operations. If this is not done, they tend to whirl about indefinitely in whatever chamber they may be contained so that they may be coated with adhesive and formed into a felt only with difficulty. In accordance with the present invention, this difficulty is overcome by dividing the particle-entraining air stream into a plurality of such streams which then are directed against each other. This causes the particles carried by the respective streams to impinge against each other and lose their momentum. This, in turn, permits the entrainment of the particles in another air stream of lower velocity, or permits their dropping by force of gravity into a zone in which they are coated with adhesive material.

After the motion of the air-entrained particles has been arrested, they are passed through a spray of liquid adhesive material, the spray preferably being very finely divided, as a mist or fog, and preferably being directly counter-current to the particle stream. This affords an environment in which the individual particles whirl about in the spray so that the entire surface of each particle is exposed to the spray, which therefore coats the particles uniformly. By controlling the relative amounts of adhesive material and particles to be coated, a predetermined and optimum amount of adhesive may be applied, thus avoiding waste of the adhesive, while at the same time applying it uniformly to the particles so that a consolidated product of maximum strength for a given adhesive usage is obtained.

The foregoing advantageous results are readily demonstrable in practice, as is seen from an inspection of Figure 1. Presented therein are the strength values of a number of consolidated board products made by coating wood shavings with resin both in accordance with the method of the present invention and with the conventional method comprising mechanically mixing the resin with the wood particles. These strength values are plotted against the binder content of the various board products. By comparison of the resulting curves, it will be noted that a given resin usage in the presently disclosed method forms a board which is substantially stronger than is one containing the same amount of resin binder but formed by the conventional mechanical mixing method.

Thus a paper faced board containing 6% by weight resin and formed by the conventional mechanical mixing method has a modulus of rupture of 4375 p. s. i. However, a board containing the same amount of resin binder but prepared by the method of the present invention has a modulus of rupture of 4750 p. s. i. This means, of course, that, where a consolidated product having a given strength, for example a strength of 4375 p. s. i., is needed, such a board may be produced by the method of the present invention using only 4.25% resin binder, whereas by the conventional mechanical mixing method, 6% binder would be required to produce a board of equivalent strength. When it is considered that the phenolic resinous binders are expensive, costing at current prices from 12¢ to 15¢ per pound, and that thousands of tons

5

of consolidated composite board products are produced annually, the saving in cost of resin binder by the use of the presently described method is very impressive.

Not only are relatively high strength boards produced by the use of this invention, but, as is clearly apparent from a comparison of the two curves comprising the graph of Figure 1, the boards produced by the present method have much more consistent strength values than do those produced by the conventional method in which the binder is mixed mechanically with the wood particles. In the latter case, the strength properties of the boards tend to be erratic and unpredictable, presumably because of the difficulty of obtaining an even distribution of binder upon the particles prior to consolidation. This is evidenced by the presence of points falling a substantial distance away from the curve. In the case of boards made by the process of the present invention, however, all of the points cluster closely about the curve, indicating that the strength of boards having a given binder content may be predicted with considerable accuracy.

In addition to being able to control accurately the amount of binder applied to pieces of wood and the like by the practice of the present invention, it is possible to control within exact limits the moisture content of the binder coated particles. This may be accomplished, for example, by correlating the moisture content of the spray with the original moisture content of the pieces to a predetermined and desired value. This is of importance, since I have discovered that by adjusting the moisture content of the particles comprising a fibrous felt to a value of between about 10% and about 35% by weight, preferably between about 18% and about 27% by weight, it is possible to prepress the felt in the cold, using relatively simple equipment, until it is consolidated sufficiently to be self-sustaining. When the moisture content is held within the above limits during the prepressing operation, sufficient adhesion is developed between the particles to hold them together in a partially consolidated condition without activating the added binder. The felt then may be handled by ordinary board handling methods and equipment when cutting it into suitable lengths, transporting it from the felter to the press, and introducing it into the latter. This constitutes an important feature of my invention, since it eliminates the necessity of using the cumbersome and expensive equipment necessary in conventional board making operations for cutting and handling the usual bulky and fragile felts.

The effect of adjusting the moisture content of the felt on its ability to be made self-sustaining by prepressing cold is illustrated in the data presented in Table I. These data constitute the results of tests carried out by passing wood shavings individually through a spray of thermosetting liquid phenolic binder containing enough water to impart to the shavings the indicated moisture content, while maintaining the binder content of the shavings uniformly at 2.5% by weight. The shavings were formed into mats, which were prepressed cold over the indicated range of pressures. The self-sustaining qualities of the prepressed mats then were observed, the mat being rated as self-sustaining if it remained hard and board-like, and did not disintegrate upon handling equivalent to that neces-

6

sary to cut it into lengths and introduce it into a press for final consolidation.

TABLE I

Example Number	Total Moisture Content of Unpressed Felt (percent by weight)	Prepressing, Pressure (p. s. i.)					
		50	100	150	200	250	300
1.....	11	-	-	-	-	+	+
2.....	15	-	-	+	+	+	+
3.....	19	-	-	+	+	+	+
4.....	23	-	+	+	+	+	+
5.....	27	+	+	+	+	+	+

+ = Prepressed felt self-sustaining.
- = Prepressed felt not self-sustaining.

It will be apparent from the data of Table I that the moisture content of a mat having a given binder content is of primary significance in determining whether the mat may be prepressed successfully in the cold. As indicated by Example 1, where the moisture content is only 11% by weight, the application of pressures of as much as 200 pounds per square inch does not suffice to make the mat self-sustaining. However, when the moisture content of the mat is at least 27%, the application of a pressure of as little as 50 pounds per square inch is sufficient to form a self-sustaining mat.

It will be apparent further to one skilled in the art that although the data of Table I are illustrative of the results to be obtained using a thermosetting phenolic binder in the usual range of, for example, from about 1% to about 6% by weight, the moisture content necessary to obtain satisfactory prepressing with phenolic binders in different amounts, or with other binders in varying amounts, may readily be determined by experimentation. It is my discovery, however, that by adjusting the moisture content of the particles to a predetermined value, preferably by passing them individually through a spray or mist of adhesive containing a predetermined amount of moisture, the mat formed from the resulting treated particles may be prepressed successfully in the cold to a self-sustaining condition.

Although various types of apparatus may be employed in the practice of the method of the present invention, provided they supply the various mechanical features required to carry out the sequence of steps comprising the method, a typical apparatus is illustrated in Figures 2 to 5, inclusive. It comprises a chamber 10 of suitable dimensions and fabricated from any suitable material. The chamber is provided at its upper end with means for introducing a controlled and measured feed of the particles to be coated with binder and then formed into a felt and consolidated. The introducing means may comprise a hopper 11 into which the particles are placed. The hopper communicates with a tube 12 in which rotates a worm 13 journaled in bearings 14 and driven from any suitable power source through the pulley 15.

Turning of the worm 13 conveys material from the hopper and empties it through the conduit 16 into the upper part of the chamber 10, the feed rate being determined by the size of the worm and the rate at which it is turned. Hence the rate of feed of material into the chamber 10 may be controlled positively so that a predetermined but variable quantity of material may be introduced into the chamber.

As indicated above, particles of wood or similar material introduced into the chamber 10 through the conduit 16 inherently tend to cling together and form aggregates or loose clusters which cannot be coated effectively with a liquid adhesive material. Hence means are provided for disintegrating any such aggregates as they enter the chamber and for reducing them to substantially individual particles. These then are entrained in a gaseous stream and subsequently coated with adhesive. The disintegrating and entraining means comprise a plurality of jets 18, 19 which supply air or other gas at high velocity to the upper portion of the chamber, the stream of gas being directed against the particles of material as they enter the chamber, striking them with sufficient force to disintegrate them into their component particles. These, then, are entrained by the gaseous stream and carried rapidly about in the upper portion of the chamber so that a condition of high turbulence results. This insures the disintegration of the aggregates and the distribution of the particles uniformly throughout the entraining medium.

The condition of turbulence within the chamber 10 is augmented, and the direction of flow of the gaseous stream is controlled by means of baffle plates 20, 21, 22, 23, 24 strategically disposed within the upper portion of the chamber 10 as demanded by the size and character of the particles. The baffles divide the gaseous stream into essentially two separate streams which, as is indicated by the arrows in Figure 3, are directed against each other so that the particles carried thereby impinge against each other and, through the force of the collision, lose their momentum in substantial degree. This has the desirable effect of permitting the particles to settle or to pass through the intermediate and lower portions of the chamber 10 at a reduced velocity while maintaining them substantially individual and separate from each other. When the baffle plates are positioned in the upper portion of the chamber 10 in the pattern illustrated in Figures 2 and 3, in the manner in which the particles carried by the two gaseous streams impinge against each other is quite striking, there being an area of high particle density and low velocity in the channel between and immediately above the baffle plates 24 and 25, in contrast to the scattered mass of rapidly moving particles present in the remaining areas of the upper portion of the chamber.

Analyzing further the action taking place in a tower having a baffle plate arrangement such as is indicated in Figures 2 and 3, it appears that when wood particles are introduced into the top of the tower through conduit 16, a portion of the particles strike against plate 22 and are deflected toward the right-hand side of the tower by the air stream emanating from the jet 18. The plate 22 thus serves a deflecting function, while contemporaneously creating a condition of turbulence in the upper part of the tower.

The remaining portion of the introduced particles falls downwardly against the plate 25 which directs them against the jet 18. They then are entrained in the air stream emanating from the jet and are carried toward the top of the tower, part passing over and part passing under the baffle plate 22. The material passing over plate 22, drops downwardly against the plate 24, which directs the falling particles into the air stream from jet 19. They then are carried upwardly

in a path behind and over plate 23, which serves to prevent a disturbance of the air stream, and pass toward the center of the tower where they come into forceable contact with the particles which have been deflected by the plate 25 and passed under plate 22. The resulting collision occurring between the particle content of the two streams causes the particles to lose their momentum as described above and to fall downwardly through the rest of the tower.

The greater portion of the air or other entraining medium introduced through the jets 18—19 is dissipated through the screens 27—28 which have a mesh size calculated to permit free passage of the air while preventing loss of particles to the exterior. This motion of the air does not disturb the travel of the entrained particles since the air is introduced through jets 18 and 19 at high velocity but at low volume. Hence a very substantial momentum is imparted to the particles which carries them through their respective paths of travel.

A small amount of the entraining medium passes downwardly through the channel between the baffle plates 24—25 carrying the particles with it at greatly reduced velocity, which is little if any greater than that induced by the force of gravity. The particles then enter the intermediate zone of the chamber 10 as individual particles separated from each other and distributed uniformly throughout the entire area of the chamber. As they progress downwardly, they whirl about and pass through a spray or mist of liquid adhesive material emanating from the spray heads 30, 30 preferably directed across the diagonals of the tower and fed with liquid adhesive material through the conduit 31, and with air or other suitable gas under pressure through the conduit 32. As explained above, this fine spray or mist of adhesive material, preferably moving counter-current to the stream of individual particles, coats the latter uniformly with adhesive, the amount applied being controlled accurately by controlling the amount of adhesive introduced through the spray heads 30 relative to the amount of substance to be coated introduced into the chamber via the worm feed 13. It also may be used to adjust the moisture content of the particles by controlling the moisture content of the spray.

After being coated with adhesive, the particles pass to the bottom of the chamber 10, which is open to the atmosphere and which may be stationed above an endless conveyor 34. The conveyor is driven by rolls 35—35 powered by a suitable source and supported on frame 36. It carries the deposited particles beneath smoothing means such as, for example, the picker roll 37. Thus there are provided means for forming the coated particles into a smooth felt of uniform dimensions and suitable for consolidation, although other forming or shaping means may be employed to suit the particular application contemplated.

The felt formed in the manner described above may be consolidated and used as a composite board per se or, if preferred for some applications it may be used as a core layer between facing sheets of wood veneer, paper, pasteboard, synthetic resinous sheets and the like. If the latter application is contemplated, there may be supplied the roll 40 of the sheet material rotatably mounted on the standard 41 placed ahead of the coating chamber 10 with respect to the moving conveyor 34. The roll 40 furnishes a sheet which, lying upon the surface of the belt 34, re-

ceives the coated particles as they are deposited from the coating chamber 10 and thus forms the lower face of the laminated product to be constructed.

There also may be provided the roll 42 rotatably mounted on the standard 43, behind the coating chamber 10 and the picker roll 37. The roll 42 applies a surface sheet to the levelled upper surface of the felt formed of the coated particles. Hence there is formed a blank comprising surface sheets between which is disposed a quantity of adhesive coated particles ready to be formed into a composite consolidated board upon the application of pressure with or without the contemporaneous application of heat, depending upon the type of adhesive employed.

Whether or not facing sheets are applied to the felted material, the latter may be passed beneath pressure means such as the pressure rollers indicated generally at 45. These apply to the felt a pressure of, for example, from 50 to 300 pounds per square inch, and thus cold press the felt to effect its partial consolidation. Where the moisture content of the felt has been regulated in the manner explained above, the prepressing operation makes the felt self-sustaining so that it may readily be cut into lengths and transported to the press where its final consolidation is effected. The latter press (not illustrated) may be of conventional construction and may comprise the customary hardboard press equipped with platens which may be heated to the desired degree.

By way of example, a number of consolidated board products were made by mixing varying percentages of liquid phenolic resin binder having a solids content of about 40% by weight with wood particles in the form of shavings, forming the mixture into a felt, and consolidating the felt by the application of heat and pressure. Both the conventional mechanical method of mixing the binder with the wood pieces and the spray coating method described herein were employed, and the results compared.

In making the board by the mechanical mixing method, the wood pieces were placed in a rotating tumbler or other suitable mixing apparatus, the selected amount of liquid binder added, and the mixing continued until the binder had been dispersed throughout the wood pieces as thoroughly as was permitted by the limitations inherent in this method. The resulting mixture was placed between facing sheets of plastic paper and hot pressed between the heated platens of an hydraulic press at 300 pounds per square inch and 300 degrees F. for 10 minutes. After removal from the press, the boards were tested by subjecting them to the standard test method for measuring the modulus of rupture on flexing.

In making the boards using the spray coating method of the present invention, the particles of wood were introduced at a controlled rate into a coating chamber of the type illustrated in Figures 2 to 5 of the drawings. There they were diffused with and entrained in an air stream, and passed through a controlled amount of liquid resin binder in the form of a mist in the manner described above. The resulting coated particles were placed between facing sheets of plastic paper and consolidated in a heated hydraulic press at a pressure of 300 p. s. i. and a temperature of 300 degrees F. for 10 minutes. The strength values of the resulting board products also were determined by means of the standard test method for measuring the modulus of rup-

ture on flexing. The results of the foregoing tests are given in Table II, each strength value being an average of several test samples. These results are the ones used in plotting the curves of Figure 1, the values being fitted to the curves by the method of least squares.

TABLE II

Example Number	Percent Resin Content (by Weight) of Core Material	Resin Coated by Mechanical Mixing, p. s. i.	Resin Coated by Processing in Spray Tower, p. s. i.
6	1.0	1,320	
7	1.9		2,725
8	2.0	2,475	
9	2.4		3,260
10	2.5	3,895	
11	3.0	2,285	
12	3.1		3,425
13	3.5	3,705	
14	3.5		4,003
15	4.0	2,635	
16	4.2		4,268
17	4.9		4,365
18	5.0	3,985	
19	5.4		4,865
20	5.6		4,662
21	6.0	4,415	

As is apparent from the foregoing experimental data, and particularly from the graph incorporating the same, coating of the particles with binder by the hereindescribed method results in the maximum coating with minimum adhesive usage. This is indicated by the strength values of the boards produced by the two methods, those produced by the present method being uniformly stronger than those produced by the conventional mechanical method and using the same amount of resin binder. This means, as already developed above, that substantially less binder need be employed in the manufacture of board products of a specified strength, this resulting in obvious and substantial savings in cost. Furthermore, by the easily carried out expedient of controlling the moisture content of the binder spray used to coat the particles, the moisture content of the coated particles may be adjusted to a value at which the felt made therefrom is susceptible to prepressing in the cold to form a partially consolidated blank which is self-sustaining, and may be cut into lengths and handled with facility and without likelihood of its disintegration.

Having now described my invention in preferred embodiments, I claim:

1. In the manufacture of composite, consolidated products, the step of coating with adhesive the constituent particles thereof prior to their consolidation by introducing the bulk particles into a plurality of high velocity gaseous streams to separate the particles from each other, directing the particles propelled by said streams against each other in a space removed from said high velocity streams, whereby to effect the impingement of the particles against each other with consequent arresting of their motion, combining the said particles into another stream of low velocity to diffuse said particles throughout substantially the entire stream, and introducing into the said another stream a spray of adhesive material, whereby to coat the particles uniformly with the said adhesive material.

2. In the manufacture of composite, consolidated products, the step of coating the constituent particles thereof with adhesive prior to their consolidation by introducing the bulk particles into a plurality of high velocity gaseous streams

to separate the particles from each other, directing the particles propelled by said streams against each other in a space removed from said high velocity streams, thereby causing the particles to strike against each other and lose their momentum in substantial degree, combining the said particles in another gaseous stream of low velocity to diffuse said particles over substantially the entire cross-sectional area thereof, and introducing into the said another gaseous stream and counter-current thereto a spray of adhesive material for coating the said particles with adhesive.

3. In the manufacture of composite, consolidated products the step of coating the constituent particles thereof with adhesive prior to their consolidation by providing aggregates of the said particles, subjecting the said aggregates to the action of a plurality of gaseous streams of substantial velocity, whereby to disintegrate the said aggregates, directing the particles propelled by said streams against each other in a space removed from said high velocity streams, thereby causing the particles to impinge against each other and lose their momentum in substantial degree, and passing the particles through a spray of adhesive material for coating them with the same.

4. In the manufacture of composite, consolidated products the step of coating the constituent particles thereof with adhesive prior to their consolidation by providing aggregates of the said particles, subjecting the said aggregates to the action of a gaseous stream of substantial velocity, whereby to disintegrate the said aggregates, entraining the resulting individual particles in a plurality of high velocity gaseous streams, directing the particles propelled by said gaseous streams against each other in a space removed from said high velocity streams, thereby causing the particles to impinge against each other and lose their momentum in substantial degree, combining the particles in another gaseous stream of low velocity wherein they are diffused over substantially the entire cross-sectional area thereof, and introducing in the said another gaseous stream and counter-current thereto a spray of adhesive material for coating the said particles with adhesive.

5. In the manufacture of composite, consolidated products, the step of coating the constituent particles thereof with adhesive prior to their consolidation by introducing the bulk particles into a plurality of high velocity gaseous streams to separate the particles from each other, directing the particles propelled by said streams against each other in a space removed from said high velocity streams, thereby causing the particles to strike against each other and lose their momentum in substantial degree, and permitting the particles to fall through a spray of adhesive material for coating them with the same.

6. The method of making composite, consolidated products from material in particle form which comprises entraining the particles of the said material in a plurality of high velocity gas streams, directing the particles propelled by said streams against each other in a space removed from said high velocity streams, thereby causing the particles to strike against each other and lose their momentum in substantial degree, passing the said particles through a spray of adhesive material for coating them with adhesive, shaping the coated particles, and consolidating the shaped particles by the application of pressure.

7. The method of making composite, consolidated products from material in the form of small pieces which comprises providing aggregates of the said pieces, subjecting the said aggregates to the action of a gaseous stream of substantial velocity, thereby disintegrating the said aggregates, entraining the resulting individual pieces in a plurality of high velocity gaseous streams, directing the pieces propelled by said gaseous streams against each other in a space removed from said high velocity streams, thereby causing the pieces to strike against each other and lose their momentum in substantial degree, passing the pieces through a spray of adhesive material for coating them therewith, shaping the coated pieces, and consolidating the shaped pieces by the application of pressure.

8. The method of making consolidated, composite board products from pieces of woody material which comprises entraining the pieces in a plurality of high velocity gas streams, directing the pieces propelled by said streams against each other in a space removed from said high velocity streams, thereby causing the pieces to strike against each other and lose their momentum in substantial degree, passing the said pieces through a spray of adhesive material for coating them with adhesive, forming a felt from the coated pieces, and consolidating the felt by the application of heat and pressure.

9. The method of making consolidated board products from pieces of woody material which comprises providing aggregates of the said pieces, subjecting the said aggregates to the action of a gaseous stream of substantial velocity, thereby disintegrating the said aggregates, entraining the resulting individual pieces in a plurality of high velocity gaseous streams, directing the pieces propelled by said gaseous streams against each other in a space removed from said high velocity streams, thereby causing the pieces to strike against each other and lose their momentum in substantial degree, passing the said pieces through a spray of adhesive material for coating them therewith, forming the coated pieces into a felt, and consolidating the felt by the application of heat and pressure.

10. The method of coating particles which comprises introducing the bulk particles into a plurality of high velocity gaseous streams to separate the particles from each other, directing the particles propelled by said streams against each other in a space removed from said high velocity streams, whereby to effect the impingement of the particles against each other with consequent arresting of their motion, combining the particles into another stream of low velocity to diffuse said particles throughout substantially the entire stream, and introducing into the said another stream a spray of coating material, whereby to coat the particles uniformly with the said coating material.

11. Apparatus for coating small pieces of material with adhesive prior to their consolidation into composite products which comprises a chamber, means for introducing the said pieces into said chamber, means within the chamber for entraining said pieces in a plurality of high velocity gaseous streams, means for directing the flow of said pieces propelled by said streams into each other to effect the impingement of the pieces against each other with consequent arresting of their motion, means for combining the arrested pieces in another gaseous stream of low velocity, and means for introducing into the said another

gaseous stream a spray of adhesive material whereby to coat the said pieces uniformly with the same.

12. Apparatus for coating small pieces of material with adhesive prior to their consolidation into composite products which comprises a chamber, means for subjecting the said aggregates to the action of a gaseous stream of substantial velocity whereby to disintegrate the said aggregates, means for entraining the resulting individual pieces in a plurality of high velocity gaseous streams, means for directing the pieces propelled by said gaseous streams against each other in a space removed from said high velocity streams, thereby causing the particles to come in contact with each other and lose their momentum in substantial degree, and means for contacting the particles with a spray of adhesive material.

13. Apparatus for coating small pieces of material with adhesive prior to their consolidation into composite products which comprises a chamber, means for introducing the pieces into the chamber, means for entraining the pieces in a plurality of high velocity gaseous streams, means for directing the flow of pieces propelled by the streams counter-current to each other, thereby causing the pieces to impinge against each other in a space removed from the high velocity streams and lose their momentum in substantial degree, and means for permitting the pieces to fall through a spray of adhesive material for coating them with the same.

14. Apparatus for coating small pieces of material with adhesive prior to their consolidation into composite products which comprises a chamber, means for introducing the pieces into the chamber, air jets communicating with the chamber and adapted to entrain in high velocity air streams the said pieces as they enter the chamber, a plurality of baffle plates disposed within the chamber opposite the air jets and adapted to direct the pieces propelled by the air streams against each other in a space removed from the high velocity streams to arrest the motion of and diffuse the said pieces, and a spray head for directing a spray of adhesive material against the diffused pieces whereby to coat them uniformly with adhesive.

15. Apparatus for coating small pieces of material with adhesive prior to their consolidation into composite products which comprises a chamber, means for introducing the pieces into the chamber at a predetermined rate, air jets communicating with the chamber and adapted to en-

train the said pieces in high velocity air streams as they enter the chamber, a plurality of baffle plates disposed within the chamber opposite the air jets and adapted to direct the pieces propelled by the air streams against each other in a space removed from the high velocity streams to arrest the motion of and diffuse the said pieces, and a spray head for directing a spray of adhesive material against the diffused pieces whereby to coat them uniformly with a predetermined amount of adhesive.

16. Apparatus for coating small pieces of material with adhesive which comprises a vertically elongated chamber, means for introducing the pieces into the top of the chamber at a controlled and predetermined rate, first baffle means for dividing the pieces entering the chamber into a pair of streams of said pieces, first air jet means within the chamber, second baffle means adjacent the first air jet means for directing the first of said streams thereagainst, thereby entraining in air the constituent pieces of the said first stream, second air jet means within the chamber, third baffle means adjacent the second air jet means for directing the second of said streams thereagainst, thereby entraining in air the constituent pieces of the said second stream, all of the said baffle means acting to direct the two streams of air-entrained pieces against each other, the resulting collision of the pieces causing them to lose their momentum and become uniformly diffused throughout the entire cross-section of the chamber, falling downwardly therethrough, and spray means within the chamber for coating the downwardly falling pieces uniformly with a predetermined amount of adhesive.

MORTIMER D. MACDONALD.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
1,473,165	Steigmeyer	Nov. 6, 1923
1,698,436	Hendrickson	Jan. 8, 1929
1,931,570	Brown et al.	Oct. 24, 1933
1,938,982	Smith	Dec. 12, 1933
2,059,983	Dent et al.	Nov. 3, 1936
2,066,734	Loetscher	Jan. 5, 1937
2,067,012	Loetscher	Jan. 5, 1937
2,197,792	Erickson	Apr. 23, 1940
2,270,341	Ransburg	Jan. 20, 1942
2,476,282	Castellan	July 19, 1949
2,544,019	Heritage	Mar. 6, 1951
2,569,169	Heritage	Sept. 25, 1951