ABSTRACT OF THE DISCLOSURE

Disclosed herein is an improved method of coating plywood to eliminate surface checking by electrostatically applying short, acicular Douglas fir bark fibers to an adhesively coated wood surface such as a plywood panel. The fibers are adhesively united to the wood surface with their longitudinal axes perpendicular to the wood surface. The fibers can either be coated with a second adhesive prior to application to the panel or the second adhesive can be sprayed on the fibers after they are applied to the wood surface. The wood surface with the applied fiber is then dried and subjected to heat and pressure to cure the adhesives and increase the coating density, producing a wood surface having a durable, thin coating which resists checking and masks surface defects.

The present invention relates to a process for improving the durability of wood surfaces and more particularly to a process of coating plywood to eliminate surface checking, mask patches and to increase exterior durability, and to the resulting product.

With the advent of excellent exterior bonding systems, large sheets of softwood plywood have been used extensively for sheathing the exterior of industrial and residential buildings. But since the exterior surfaces of plywood are made from latex-impregnated thin veneer sheets, they often contain surface defects and patches and, when exposed to exterior conditions, unsightly surface checks are produced. For this reason, plywood has not been extensively used as an exterior finish surface and is generally covered by shakes, shingles, siding, bricks or stone. If a plywood product could be produced inexpensively which could resist the unsightly surface degradation upon exposure to exterior conditions, such a product would be quite popular as an exterior finish material. The need exists, therefore, for an economical surface treatment for plywood which will eliminate checking, completely mask patches and defects, be readily refinishing and provide long term exterior durability.

Several attempts have been made with only partial success to surface-coat plywood to increase its exterior durability. In general, painting the surface of the plywood has been unsuccessful as a method for eliminating surface degradation, since paint is unable to stop checking or to adequately hide patches and defects in the plywood surface.

As shown in the patent to Loetscher, No. 2,442,422, it is known to bond a resin impregnated paper to the surface of plywood; however, it has been found that adhesion of the surface finish to the panel is dependent upon the internal bond of the paper itself. When tested for adhesion under wet conditions, this strength is comparatively low. Likewise, patches and other defects on the panel surface tend to telegraph through the finish. Other overlays have been developed which provide long term durability; however, such films are expensive and require complex techniques for their application to plywood. None of the overlays known will completely mask defects or patches in the surface of plywood. The use of metal foil, such as aluminum, as an overlay for plywood has been suggested, but the economics of using a thick enough sheet to mask grain and surface deficiencies are unfavorable.

It is also known to apply resin coatings having 100% reactive materials, such as epoxy, to the surface of plywood. Such materials, if applied in sufficient thickness, will hold the surface in such a manner that plywood checks are prevented. However, since epoxy resins chalk on exterior exposure, it is necessary to include some aggregate coating over the resin to reduce or hide the checking. This system has other disadvantages, in that to provide sufficient strength to resist checking, it is necessary to provide a heavy coating of a very expensive resin, and the resulting composite is a very rigid product.

In a series of patents to Welch, Nos. 2,419,614; 2,601,349; and 2,606,138, there are disclosures of the application of a layer of discreet wood particles, such as wood chip, sand and sand dust, mixed in a synthetic resin, to the surface of plywood, which composite is then in turn consolidated in a heated press. In order to be effective the overlay must be of appreciable thickness and the resultant panels are more likened to a composite of plywood and hardboard. This results in an unbalanced construction with the attendant problems of warpage always present in assemblies of this type.

In the patent to Christian, No. 2,853,413, there is a disclosure of the use of a surfacing layer formed from discrete wood fibers, sawdust, ground pulpboard, hogged or disintegrated wood particles in an adhesive, such as soybean flour, with the fibers being combed in a direction transverse to the direction of the grain of the veneer. The coated panel is heated and hot pressed so that the adhesive is cured and the coating is made smooth. While this process was primarily intended to prevent shrinkage of green veneer, the transversely oriented fibers were found to be somewhat effective in restraining surface checking. For decorative panels, such as building siding, this system fails to provide an acceptable product because under wet conditions, such as ordinary rainfall, the wood fibers and particles swell and raise into the painted surface. This particle raising surprisingly is not reversible upon subsequent drying and the result of such exposure is that the roughened, unattractive surface persists throughout the remaining life of the panels.

I have discovered an improved surface coating for plywood and similar woody materials which consists of short, acicular fibers applied in a dense coating with suitable adhesives to the surface of plywood. Such an application results in a thin, dense, durable coating which effectively resists plywood checking, completely masks defects and patches, and provides a durable weather resistant surface which may be easily refinishing. Therefore, the object of this invention is to provide a method for coating plywood that is inexpensive and results in a thin durable surface which can be exposed to exterior conditions while resisting plywood checking, masking plywood surface defects, and supporting finish coatings, and which does not induce panel warping.

Another object of this invention is to provide a method for coating plywood which includes the use of strong needle-like fibers which, when bonded to the surface of the plywood, resist checking.

I have discovered that certain short fibers of relatively cylindrical shape and specified average length-to-diameter ratios, because of their shape, density and stiffness, can be applied with proper adhesives to a wood surface, and, once pressed and bonded, produce a durable coating which is strong enough to resist surface checking, thick enough
to mask defects, but still flexible enough to prevent panel distortion. In accomplishing these and other objects of the invention, I have provided an improved wood surfacing process, the preferred version of which is illustrated in the accompanying drawing wherein:

FIGURES 1a to e show a schematic flow diagram illustrating the process steps for coating wood surfaces in accordance with the present invention.

FIGURES 2a to e show an enlarged fragmentary vertical section through the panels as they are conveyed through the process steps in accordance with the present invention. Referring in more detail to the drawings, and particularly to FIGURES 1a to e, 1 designates an apparatus for practicing the method of applying a durable coating to a wood surfaced article, such as plywood panel 2, having a surface 3 to which the coating is to be applied. The panel 2 is placed on a suitable conveyer 5 and initially fed to the first adhesive coating station 7. The adhesive supply 8 provides to the applicator rollers 9 a suitable quantity of the first adhesive 10.

The adhesive roll 9 is adjustable to provide contact with the panel surface 3 to apply the first adhesive 10 to the panel 2. The panel 2, when coated, is then conveyed to the fiber application station 12. The apparatus for applying the fiber stiffening means, flocking, or gun, or, as shown, an electrostatic flocking apparatus which may include a fiber supply 13 and a flocking discharge 14, which is located above charged electrodes 15. These electrodes orient the fibers 16 so that they fall with their longitudinal axes perpendicular to the panel surface 3.

Since the fibers 16 are oriented perpendicular to the panel surface 3, some of them will not be able to crowd between previously applied fibers and thus will not be in contact with the first adhesive 10. These excess fibers, when the panel 2 is conveyed past a vacuum head 11, are conveyed away from the surface of the panel 3 through a fiber discharge 19 and can be recirculated to supply 13. The resulting assembly includes a panel surface 3 with the first adhesive 10 applied to it and perpendicularly oriented fibers 16 crowded side by side in contact with first adhesive 10.

The panel 2 is then conveyed to a second binder coating station 21, where sprayheads 22 provide a top-coating of a second adhesive 23, which preferably includes pigment and a release agent, to the fibers held to the panel 3 by means of the first adhesive 10. From here the panel 2 may be conveyed through a drying area 25 to reduce the moisture content of the adhesives 10 and 23 prior to being conveyed to a pressing station 27.

The panels 2 may be pressed by means of a roll press, band press, or other suitable pressure applying means. As shown, the pressing station 27 includes a series of heated pressing platens 28, between which are placed the panels 2 to be subjected to heat and pressure. The applied pressure bends over the perpendicularly oriented fibers 16, causing them to lie flat against the panel surface 3. At the same time heat energy is provided to cure the adhesives 10 and 23 to produce an end product, which is a plywood panel coated with a durable thin coating which resists checking and masks surface defects.

Referring now to FIGURES 2a through e there is shown a transverse fragmentary section view of the panel 2 as it passes through the process steps as related in the discussion of FIGURE 1. As noted in FIGURE 2a and b, the panel 2 begins with an uncoated surface 3, and then a first adhesive coating is applied to the surface 3. In FIGURE 2c the fibers 16 are applied in a manner so that they are stuck to the first adhesive 10 in a position perpendicular to the panel surface 3. As is shown, some of the fibers 16 which are not stuck to the first adhesive 10 are pulled off by the vacuum to the fiber discharge 19.

In the FIGURE 2c there is shown the application of the second adhesive 23, which may be a paint, to the fibers 16. FIGURE 2d is a showing of the adhesives 10 and 23 with some of the moisture removed. The effect of the heat and pressure to bend the fibers 16 over on to the panel surface 3 is shown in FIGURE 2e, resulting in a smooth thin resistant coating.

The first adhesive 10 may be any durable adhesive or paint which can be applied to the plywood surface 3. I have preferred to use a mixture of thermoplastic and thermostetting adhesive for bonding the fibers 16 to the panel surface 3. If assembly time requires, it is possible to add hydroxyethyl cellulose or other similar thickening agents if the paint is water based to keep the adhesive mixture from drying out. The second adhesive 23 is suitably a coat of a mixed thermostetting-thermoplastic acrylic paint, such as disclosed in U.S. Pat. No. 502,449, filed Oct. 22, 1965. The adhesive to bond the fibers to the plywood need not be a acrylic specifically, since modified versions of phenolics, melamines, resorcinols and polyvinyl acetate produce satisfactory results. The acrylic, however, is preferred, since a certain amount of resulting flexibility and good exterior durability provides the best check resistance. The end product—that is, that which has been subjected to heat and pressure—may be coated with a top coat, such as any good paint, but for long-term durability, acrylics, polyvinyl acetate, or solvent vinyl paints are preferred.

The key to the process is that the product is provided by the particular characteristics of the fiber chosen. It is requisite to choose a fiber that is relatively cylindrical in overall geometric shape. Fibers that are flat or twisted, such as cotton fibers, present great difficulty in application of a uniform layer and are virtually unsuitable with the preferred electrostatic flocking system. Also, fibers that tend to intertwine and form clumps or clots, such as most wood and asbestos fibers, should not be chosen. Suitable synthetic fibers are available on the commercial market as decorative flocks made from such materials as rayon, nylon and acrylic raw materials. Natural fibers that are suitable are exemplified by chopped sisal and some tree bark fibers.

It has been found that the minimum average ratio of length-to-diameter of the fibers is critical and should be of the magnitude of at least 7:1. Likewise, when the length-to-diameter ratio exceeds an average of about 50:1, the fibers may be too flexible to perform properly, either during application or after exposure to moisture. In similar fashion, the length of the fibers should not exceed about 0.1 inch, since longer fibers cause application problems, such as slitting and intertwining.

A fiber length of about 0.1 inch will be particularly well suited to this process since it is thin and very flexible, particularly, Douglas fir bark fiber. This fiber is a botanically unusual and possibly unique material. The Douglas fir bark fiber which is used in this process is commercially available and is generally produced by a chemical process which dissolves nonfibrous cork and other material in the Douglas fir bark to leave the clean, nonreactive lignocellulosic fibers which are used in the process herein described. One method for producing such fibers is disclosed in a pending application of the same assignee, Ser. No. 301,652, filed Aug. 12, 1963, and now abandoned. These stiff-walled needle-like fibers are very uniform in size and shape. They are about 1 mm. long with a length-to-diameter ratio averaging 15:1. The bulk density of the fibers is in the range of 20-25 lb./cu. ft., and they have a specific gravity of approximately 1.4. The outstanding properties of these fibers are their extreme toughness, hard nonabsorbent surface and free-flowing characteristics.

The bark fibers have been used in quantities of 15 to 50 lb./M sq. ft. of plywood area. The optimum, to give good coverage and to produce an easily paintable surface, is in the range of 25 to 35 lb./M sq. ft. For example, a coating on Douglas fir plywood using bark fibers in accordance with the above teachings, in a quantity of 30 lb./M sq. ft. of plywood, with sufficient paint for good coverage, survived a severe twenty-five cycle accelerated...
aging test without any cracking or checking. The test used was the "Preliminary Test for Exterior Coatings" (June 1, 1961), Procedure No. 2 (Boil) of the American Plywood Association. Each cycle consisted of a four (4) hour water boil using 3 inches by 6 inch test specimens, followed by twenty (20) hours drying in a circulating oven. In order to make the test even more severe a drying temperature of 250° F. was used rather than the 145° F. specified.

The basic procedure for practicing this process is to apply a durable adhesive or paint 10 to the surface 3 of wood and then apply the discreet bark fibers 16 to the wet adhesive film. Various methods of applying the bark fibers have been tried, such as letting them onto the board, spraying them from a flock gun, and by sifting the fibers while vibrating the board and then shaking off or removing the excess by vacuum means. It has been found, however, that the electrostatic floccker apparatus previously described provides the most even distribution of the fibers.

After the application of the fibers, a second adhesive 23, which may be a paint, is spray-coated onto the fibers, which are standing straight up, perpendicular to the panel surface 3. This coating is then permitted to lose most of its moisture prior to subjecting it to a heated press, where the platen pressure is approximately 100 lb./sq. in. The cycle time for the press at this pressure is approximately 3½ minutes at a temperature between 275° to 300° F. This time may optionally be shortened to about 1½ minutes by inclusion of a catalyst in the adhesive. Permissible variations of pressure, time and temperature would be obvious to those using various adhesives and different types of presses.

A variation to the foregoing basic procedure has been found, by which the discreet bark fibers 16 are coated with adhesive 23 prior to being applied to the panel surface 3 which has been coated with the first adhesive 10. In this modified process the fibers 16 are rotated in a tumble drum at a speed which permits them to fall in a rain-like manner from the upper surfaces of the drum. This rain of fiber is sprayed with the second adhesive or binder coat 23, which may be typically composed of water-based acrylic or oil-based alkyd paints. A suitable paint usage has been found to be one-and-one-quarter (1¼) pounds (soldis basis) per pound of fibers, which is roughly equivalent to fifty (50) pounds (wet basis) per thousand square feet of panel surface. After the spraying is completed, the tumbling of the now coated fibers 16 continues until the binder coat 23 is rendered essentially solvent-free. This drying step may be accelerated by oven-heating the coated fibers 16, but care must be exercised so that the coating 23 does not become cured. The resulting coated fibers 16 can then be applied to the coated surface 3 of panel 2 in the previously described ways; however, electrostatic flocking produces the most uniform results. Since the fibers 16 have been precoated with the adhesive 23, the fiber-coated panels 22 can proceed directly from the fiber application station 12 to the pressing station 27. One advantage of this modified process is that it reduces the drying time before pressing is reduced, since approximately half of the coating solvents have been removed.

Once the pressing cycle is completed, the product is ready for a durable paint coat. If desired, it is possible to first add some type of filler material to provide a very smooth surface upon which the final decorative paint is applied.

Since the fibers provide sufficient bulk, it is possible to use embossed press caults to provide textured surface on the panel for decorative purposes. In such cases, in order to provide bulk for deeper embossing, it is permissible to apply a second layer of bark fibers over the second adhesive, applying a third adhesive coat over the second layer of bark fibers, permitting the panels to dry and then pressing the panels under heat with embossed caults.

It is therefore seen that the above process provides optimum resistance to checking of the wood surface, as well as an attractive appearance to the panel. By electrostatic flocking, the optimum distribution of the unique bark fibers results and the application of pressure to the fibers produces the optimum reinforcement to the panel surface which results in an attractive surface for subsequent finishing, all of which in turn provides a durable panel suitable for prolonged exterior service.

It is apparent that many widely different versions of this invention may be practiced without departing from the spirit and scope thereof; therefore, it is not intended to be limited except as indicated in the appended claims.

What I claim and desire to secure by Letters Patent is:

1. A process for treating a wood surface to resist checking and to hide surface defects, which comprises:

    (a) applying to a wood surface a layer of a first curable adhesive,

    (b) applying to said first adhesive layer discrete relatively cylindrical acicular Douglas fir bark fibers having a length no greater than 0.1 inch and a length-to-diameter ratio within the range from 7 to 1 to 50 to 1, in a quantity within the range from 15 to 50 pounds per thousand square feet of surface area by electrostatic flocking so that the longitudinal axes of the fibers are substantially perpendicular to the wood surface, thereafter applying to said first adhesive and said fibers a second curable adhesive, removing excess moisture from the coated surface, and

    (c) applying heat and pressure to said coated wood surface to cure said adhesives and to increase the coating density.

2. The process of claim 1 wherein said pressure may be applied by an embossed surface to result in a textured surface.

3. The process of claim 1 wherein said first adhesive is a mixture of thermoplastic and thermosetting adhesives.

4. A process for treating a wood surface to resist checking and to hide surface defects, which comprises:

    (a) applying to a wood surface a coating of a heat reactive acrylic emulsion consisting of a thermosetting and thermoplastic resin mixture,

    (b) applying to said adhesive coating Douglas fir bark fibers by electrostatic flocking in a quantity within the range from 25 to 50 pounds per thousand square feet of surface area so that the longitudinal axes of the fibers are perpendicular to said surface,

    (c) applying to said fibers a thin spray coating of heat reactive acrylic emulsion consisting of a thermosetting and thermoplastic resin mixture,

    (d) removing excess moisture from the coated surface, and

    (e) applying heat and pressure to said coated surface to cure said adhesives and to bond said fibers.

5. A process for treating a wood surface to resist checking and to hide surface defects, which comprises:

    (a) applying to a wood surface a layer of a first curable adhesive,

    (b) applying to a wood surface a layer of a first curable adhesive, removing excess moisture from the coated surface, and

    (c) applying heat and pressure to said coated surface to cause said adhesives to dry out, applying to said first adhesive layer the said treated fibers in a quantity within the range from 15 to 50 pounds per thousand square feet of surface area by electrostatic flocking so that the longitudinal axis of the fibers are substantially perpendicular to the wood surface, removing excess moisture from the coated surface, and applying heat and pressure to said coated wood surface.
UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,453,132 Dated July 1, 1969

Inventor(s) Albert E. Frankland

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

In Column 4, line 47, delete "slotting" and insert in its place "clotting". In Column 5, line 59, delete "22" and insert in their place "2".

SIGNED AND SEALED

DEC 2 - 1969

(SEAL)
Attest:
Edward M. Fletcher, Jr.
Attesting Officer

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