Feb. 2, 1960 P. H. PELLEY 2,923,109

APPARATUS AND METHOD FOR CLEANING ABRASIVELY TREATED PLASTIC WEBS

Filed Dec. 8, 1955 2 Sheets-Sheet 1

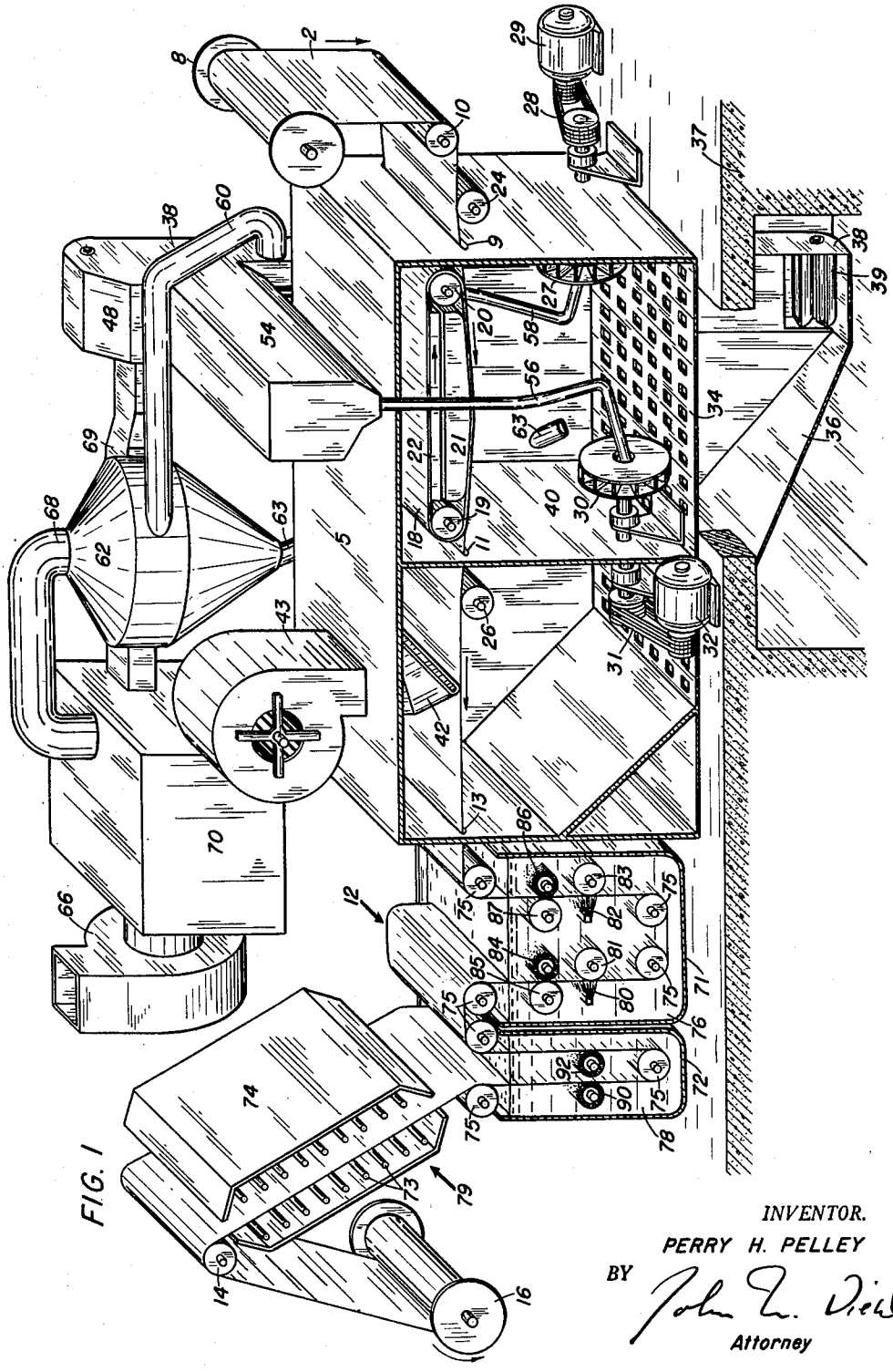


FIG. 1

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FIG. 2

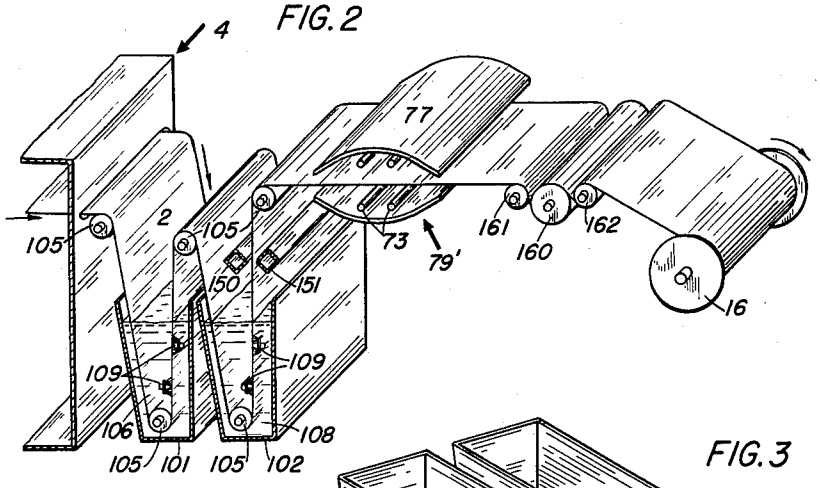


FIG. 3

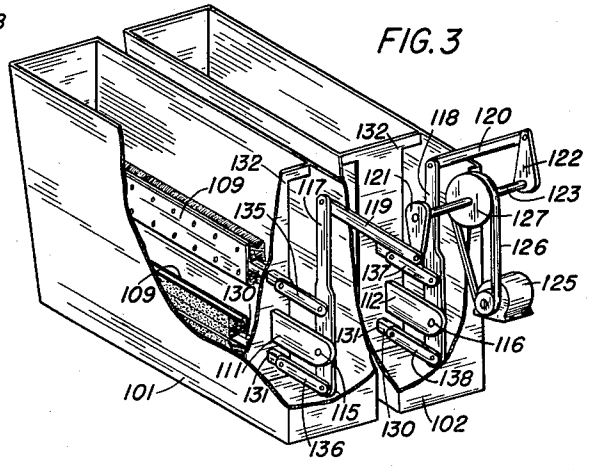


FIG. 4

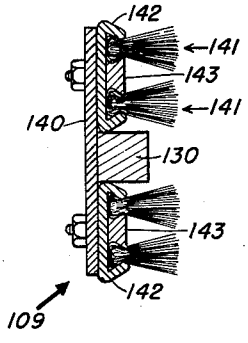


FIG. 5

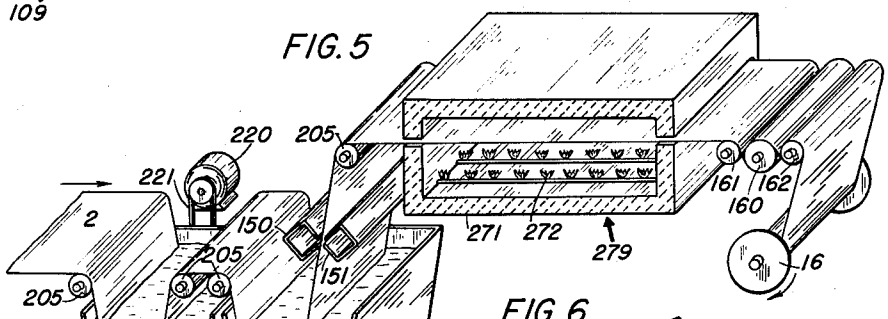
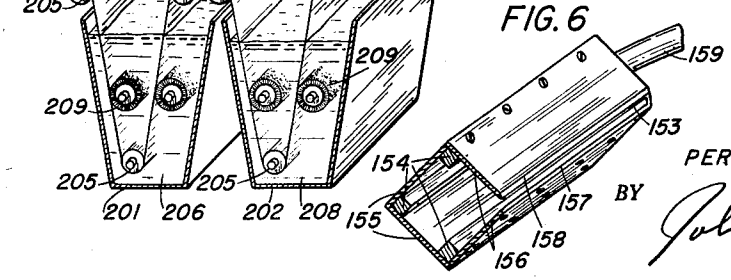


FIG. 6



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2,923,109

Patented Feb. 2, 1960

2,923,109

APPARATUS AND METHOD FOR CLEANING ABRASIVELY TREATED PLASTIC WEBS

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Application December 8, 1955, Serial No. 551,887

5 Claims. (Cl. 51—282)

This invention relates to an apparatus and method for cleaning abrasively-treated plastic webs and more particularly for removing residual abrasive granules from the surfaces of a continuous web of organic synthetic resinous material which has been treated by hurling abrasive granules against one surface thereof with abrasive throwing wheels.

When continuous plastic webs are abrasively treated by means of centrifugal abrasive throwing wheels in the manner described in co-pending applications Serial No. 551,885, filed December 8, 1955 and Serial No. 551,886, filed December 8, 1955 a certain residue of abrasive granules remains adherent to the treated surface thereof and also to the untreated surface thereof and it is necessary to provide means for removing such granules in order to provide a finished web which will meet the requirements of industry with respect to appearance and adherence. Dust created by the abrasive treating action also remains adherent to the web and must be removed. A large portion of the abrasive granules and a certain portion of the dust is removed by conventional mechanical means such as by jets of air directed against one or both surfaces of the web and may be removed by such conventional means as passing the dry webs against rotating brushes. However, these methods are ineffective to remove a certain residual portion of abrasive granules and dust which are sufficient to cause the web to be rejected for industrial applications unless the surfaces be further treated or cleaned to remove such material.

It is conventional to further treat a continuous web of metal which has been abrasively treated by passing it through acid pickling baths, through aqueous baths containing detergents and by like methods in order to accomplish such further cleaning. In the instant case such conventional cleaning methods are inadequate with respect to webs having organic synthetic resinous surfaces for reasons which are not altogether understood but which appear to arise from the fact that a certain electrical attraction exists between such dirt and a web which comprises organic synthetic resin. It is therefore an object of this invention to provide an apparatus and method for cleaning a continuous web comprising organic synthetic resinous material which has been treated by centrifugally throwing abrasive granules against one or both of the surfaces thereof.

Further objects will become apparent from the drawings and the following detailed description in which it is my intention to illustrate the applicability of the invention without thereby restricting its scope to less than that of all those equivalents which will be apparent to one skilled in the art.

In the drawings like reference numerals refer to like parts and:

Figure 1 is a partially cutaway schematic perspective view of apparatus for abrasively treating a surface of a continuous web and apparatus for cleaning residual dirt from the web in accordance with the invention;

Figure 2 is a partially cut-away schematic perspective view of another embodiment of apparatus for removing dirt from an abrasively treated web;

Figure 3 is an enlarged, partially cut-away, schematic perspective view of reciprocating brushes which may form a part of the apparatus of Figure 2;

Figure 4 is a cross-sectional view of a brush which may be used in the apparatus of Figures 2 and 3;

Figure 5 is a partially cut-away perspective view of another embodiment of apparatus for cleaning residual dirt from an abrasively-treated web; and

Figure 6 is a partially cross-sectional, partially perspective view of an air knife such as may be used in the embodiments of Figures 2 and 5.

Referring now to Figure 1 there is shown a device for abrasively treating one surface of a plastic web comprising a housing 5. At one end of housing 5 there is provided storage or feed-roll 8 for web 2 which may be as described elsewhere herein. Roll 8 is provided with drag or brake means adapted to resist unwinding of the web therefrom and thereby to provide tension in the web. Illustration of such means, which are well known in the art, has been omitted for the sake of simplicity. In one end of housing 5 there is provided slot 9 through which web 2 may enter the housing and near slot 9 there is provided direction-changing roll 10 over which the web may pass. At the opposite end of housing 5 there is provided cleaning means indicated generally as 12 for removing residual abrasive granules from the web and there is provided drying means indicated generally as 79 and also idler roll 14 over which the web may pass and wind-up roll 16 which may be driven by any suitable means, which for the sake of simplicity have not been illustrated. Driving means for roll 16 may suitably comprise an electric motor and a variable speed drive of any one of the types well known in the art. Within housing 5 there may be provided back-up belt 18 which may travel continuously in the direction shown over rolls 19 and 20. The lower run may travel in an arcuately downward curve and may be supported in such a curve by shoe 21 disposed against the inner surface thereof; if desired the upper run of belt 18 may be supported by a shoe, such as shoe 22. Near the ends of belt 18 there may be provided idler rolls 24 and 26 over which web 2 may be caused to pass and these may be so arranged as to cause the web to be maintained against the lower run of belt 18 by reason of the tension in the web created by the driving or pulling force of windup roll 16 acting against the resistance of feed roll 8. Within the cabinet and below belt 18 are located two throwing wheels 27 and 30. Wheel 30 may be driven by motor 32 through belts 31 or through any other suitable drive and wheel 27 may be driven similarly by motor 29 through belts 28. The throwing wheels may be of any conventional type described in the art, for example, as described in U.S. Patent 2,170,831.

In place of centrifugal throwing means comprising wheels 27 and 30 for projecting granules against the web in order to accomplish the abrasive treating of the surface thereof, there may be used any other suitable means for hurling abrasive granules at high velocity against the surface of a web (such as, for example, sand blasting or vapor blasting devices) wherein abrasive granules are conveyed from a storage reservoir, thence through a conveying tube and thence through a nozzle and against the surface of a web by means of a current of liquid media passing through the reservoir, the tube and the nozzle with the granules. Such liquid media may be air

or steam or may in some cases be a liquid such as water or a mixture of water and steam. However, for compelling economic and practiced reasons centrifugal throwing wheels have been found preferable.

Housing 5 may be provided with a grating floor 34 and with a hoppered bottom 36 which may extend downwardly into a suitable pit provided in concrete base 37. Hoppered bottom 36 may open into the lower end of flight elevator 38 provided with flights 39.

Web 2 may travel from roll 8 over roll 10 and over roll 24, thence through slot 9 and against the lower surface of belt 18. It may then pass through a slot 11 in wall 40 which may be provided to minimize the distribution of random granules of abrasive within housing 5. It may then pass over idler roll 26 and below cleaning nozzle 42 which may blow air against the upper surface to remove residual granules of abrasive therefrom. It may then pass through slot 13 in the wall of housing 5 and thence through cleaning apparatus 12 to wind-up roll 16. Abrasive granules thrown against the lower surface of web 2 by wheels 27 and 30 rebound therefrom and may thence strike various portions of the interior of housing 5 and rebound several more times so that the interior portion of housing 5 tends to be filled with rebounding abrasive. Therefore a certain amount of abrasive collects on the upper surface of web 2 and this may be removed for the most part by air blown from nozzle 42. However, a certain amount of residual abrasive granules remains adherent to both surfaces of the web and must be removed by cleaning device 12. Abrasive thrown by wheels 27 and 30, after rebounding falls by gravity to the bottom of hopper 36 and thence is carried upwardly by flights 39 and elevator 38. At the top of elevator 38 it is unloaded into a cleaning chamber 48 at the top of hopper 54.

In cleaning chamber 48 large particles of foreign matter, tramp iron and the like may be removed by conventional screening devices, which, for the sake of simplicity, have not been shown. Clean abrasive granules fall into hopper 54 from chamber 48 and may pass downward therefrom through conventional well-known metering devices and thence through tubes 56 and 58 into the hubs of wheels 27 and 30.

The air which is introduced into housing 5 by nozzle 42 passes downward through grating floor 34 and upward through elevator 38 and thence outward through duct 60 into cyclone separator 62. Dust-laden air passing outward from the top of cyclone separator 62 through duct 68 may be introduced into device 70 which may remove residual light-weight dust from the air by causing it to pass through suitable fabric filter cloths and the air thus cleaned may be drawn outward from device 70 by blower 66. The draft within housing 5 and elevator 38 is provided by the combined actions of blower 43 introducing air at nozzle 42 and blower 66. Relatively heavy dust removed from the air in cyclone separator 62 may pass downward through tube 63 into housing 5 from whence it may be recycled. Within cleaning chamber 48 a current of air may be caused to pass through a cascade of abrasive falling therefrom into hopper 54 and relatively light weight dust is thus removed from the abrasive granules and caused to be suspended in the air, which may pass thence through duct 69 to device 70.

The cleaning means indicated generally as 12 may suitably comprise two tanks 71 and 72 adapted to contain liquid baths and a plurality of idler direction-changing rolls 75 for leading the web through these tanks in succession. A greater number of tanks may suitably be used if desired but generally two tanks have been found sufficient. There may be contained in tank 71 an aqueous solution 76 of non-foaming detergent, which also may contain a mild abrasive scouring material as more fully described hereinafter and there may be contained within tank 72 clean rinse water 78. Immersed in solution 76 contained in tank 71 there may be provided two brushes 80 and 82 provided with means for causing them to be reciprocated cross-wise with respect to the direction of advance of the web and these brushes may, if desired, be provided with back-up rolls 81 and 83 adapted to maintain the web in contact with the bristles thereof. Also immersed in solution 76 contained in tank 71 there may be provided rotating brushes 84 and 86 disposed in such manner as to operate against opposite sides of the web and in conjunction with these brushes there may be provided back-up rolls 85 and 87 adapted to hold the web in contact with the bristles thereof. Immersed in the water 78 or other rinsing liquid contained in tank 72 there may be provided two rotating brushes 90 and 92 adapted to operate against opposite sides of the web. These may be provided with back-up rolls in the manner that brushes 84 and 86 are so provided but back-up rolls are not necessary for the proper functioning of the brushes and may be omitted, as shown, if desired. It is essential to the proper functioning of the device that the brushes be operated against the surfaces of the web while both web and brushes are immersed in a liquid such as water, with respect to which the web is chemically inert.

The mode of operation will be apparent from the previous description of the device. A continuous web is abrasively treated in the device by installing in suitable holding means a roll 8 of web material and then threading the web through the machine in the manner indicated. By then driving wind-up roll 16, by means not shown, to cause it to rotate in the direction indicated by the arrow, the web is pulled through the machine and maintained in close contact with the lower run of belt 18. As the centrifugal throwing wheels are rotated, abrasive enters the hubs of these wheels and is centrifugally thrown upward against the under-surface of the web by the vanes or blades in the wheels. Residual granules on the surface of the web are removed by cleaning device 12 and the web is dried by drier 79 and then wound on roll 16.

Referring now to Figure 2 there is shown another embodiment of apparatus for satisfactorily cleaning the surfaces of a web which have been abrasively treated by hurling abrasive granules thereagainst with centrifugal throwing means or other devices as previously described. A web 2 may pass in the direction shown by the arrows from an abrasive-treating device indicated generally as 4 through tanks 101 and 102, thence through drying means indicated generally as 79′ and thence to wind-up roll 16. Idler rolls 105 may be so located as to cause web 2, threaded thereover in the manner shown, to pass respectively through solution 106 contained in tank 101 and then through solution 108 contained in tank 102. As shown in Figures 2, 3, and 4, there may be provided in each of tanks 101 and 102, below the surface of liquids 106 and 108 contained therein, brushes 109. In each tank one brush may operate against one side of the web and the other brush against the other side of the web. Brushes 109 are desirably reciprocated crosswise with respect to the direction of advance of the web and this may be accomplished, as shown in Figure 3 by providing tanks 101 and 102 with supporting plates 132 and with supports 111 and 112 extending respectively therefrom and provided at the extremities thereof with hinge-pins 115 and 116 adapted to serve as fulcrums for levers 117 and 118. The upper ends of levers 117 and 118 may be connected through connecting rods 119 and 120 to cranks 121 and 122 carried on the opposite ends of shaft 123, which may be driven by motor 125 through belt 126 operating on pulley 127 also carried by said shaft 123.

By this mechanism the rotary motion of motor 125 is converted into oscillatory motion shafts of levers 117 and 118. Main brush supporting rods 130 which may be square or rectangular extend through similarly shaped holes 131 in supporting plates 132 contained within

tanks **101** and **102** and may thereby prevent the brushes from rotating while at the same time allowing them to be reciprocated. The ends of the upper and lower bars **130** in tank **102** are respectively connected by links **137** and **138** to lever **118** above and below pin **116**. The oscillatory motion of levers **117** and **118** is thus translated by links **135** to **138** into reciprocating motion of bars **130**. Bars **130** may have attached thereto back plates **140**. On each side of bar **130** there may be provided two rows **141** of bristles attached to back plate **140** by means of channels **142** having wedging members **143** located between the webs thereof in such manner as to provide two bristle-retaining grooves within each of members **142**. Other suitable means for retaining rows of bristles attached to a relatively rigid backing member are well known in the art and any one of such methods or devices which provides adequate retention for the bristles may suitably be used for the device of the invention.

As the web passes upward out of liquid **108** contained in tank **102** it may pass between air knives **150** and **151**. Each of air knives **150** and **151** may be constructed as shown in Figure 6, or in any other suitable manner adapted to provide a slot comparable to slot **153** which may be precise and uniform in its width and to provide a flow of air therethrough which has a negligible differential in velocity between any two points along the length of the slot. As shown, an air knife may suitably be made by attaching to three stringers **154** back plates **155** and front plates **156** which may be provided with precisely machined sharp edges **157** and **158** which may be spaced apart at some predetermined distance such as .020 inches to provide a slot of precise width such as slot **153**. Air may be introduced into the device through a tube such as tube **159**.

The web may then pass through a drier such as **79'** or **79**. Each of driers **79** and **79'** comprises a plurality of rods **73** on each side of the web which when electrically heated are adapted to emit heating radiation of high intensity. Reflector plates **74** and **77** respectively may be provided to cause such radiation, which would otherwise be lost, to be reflected against the web. The particular means of heating the web in order to cause it to be dried is not essential to the invention and other suitable means such as hot air ovens, drying tunnels and the like may suitably be utilized.

From drying means **79'** the web may pass over a slat expander roll **160** and a pair of idler rolls **161** and **162** adapted to maintain the web in contact with major portion of the surface of roll **160**. Roll **160** may be a slat expanding idler roll as shown or any other roll adapted to cause wrinkles to be removed from a thin web. The mode or functioning of slat expander rolls is well known in the art and need not be here further described except to state that roll **160** presents to the web an outer surface consisting of the outer surfaces of a plurality of slats in two sets. One set consists of slats extending parallel to the axis of the roll from about the center of the roll to one end thereof and the other set consists of slats extending similarly from about the center to the other end thereof; each slat in one set corresponds to a slat in the other slat and mechanical means, such as cam means, are provided to cause each of the two slats in such a pair to simultaneously traverse longitudinally, that is parallel to the axis of the roll, so that as the roll rotates a greater or lesser distance is provided between the ends of each of the members of a pair. As each pair comes in contact with a web, this distance is at a minimum and the distance is gradually increased until at the time the web leaves the roll the distance is at a maximum, each slat sliding frictionally over the surface of the web in such manner as to cause it to be smoothed in a manner similar to that which may be accomplished by two persons standing on opposite sides of the web and pulling outwardly on the edge adjacent each. Since the nature and mode of operation of expander rolls such as roll **160** is not essential to the invention, such rolls will not be described or illustrated in further detail.

Referring now to Figure 5 there is shown another embodiment of the invention wherein web **2** is caused to pass successively through solutions **206** and **208** contained in tanks **201** and **202**, passing in the direction shown by the arrows, over idler rolls **205**. Disposed below the surface of liquids **206** and **208** are a plurality of powered rotating brushes **209** located in such manner as to cause each of the surfaces of the web to be brushed in each of the tanks below the surface of the liquid contained therein. Power may be provided for the brushes by any suitable means, such as an electric motor **220** driving through belt **221** which may engage pulleys (not shown) attached to the roll. After passing through liquids **206** and **208** and being brushed beneath the surfaces thereof, the web passes upward between air knives and thence through dryer **279** which may comprise an oven **271** provided with gas burners **272** adapted to heat the air therein. The web may then pass over smoothing roll **160** and idler rolls **161** and **162** to wind up roll **16**.

In operation a web is passed through a first tank containing a washing solution wherein both surfaces of the web are brushed below the surface of the solution. The web may then be passed if desired through one or more additional washing solutions and if desired brushed on either one or both surfaces while immersed in such solutions but generally it has been found sufficient to pass the web through only one washing solution. After being washed the web may be passed through one or more tanks containing a rinsing liquid; for purposes of the invention, clear water has generally been found suitable as a rinsing liquid. It is preferred to brush both surfaces of the web while the web is immersed in the rinsing liquid. If desired, each surface of the web may be brushed below the surface of the liquid by more than one brush in each of the washing tanks and in each of the rinsing tanks. It has generally been found suitable for the purposes of the invention to brush each surface of the web once while the web is immersed in one washing solution and in one rinsing solution. A minimum of tanks and a minimum of brushes is of course preferred for reasons of economy but it is not intended that the illustration of only one tank for washing the web and only one tank for rinsing the web in each of the embodiments of the invention be taken as limiting or preferred for reasons other than economy nor is it to be understood that the number of brushes shown precludes the use of many more brushes. It is essential to the invention that each surface of the web be brushed below the surface of at least one washing solution. Backup rolls for the brushes may be used if desired, but are not necessary. A large portion of the water which clings to the web as the web leaves the rinse tank may be removed by means of air knives. In place of a pair of air knives as shown in Figures 2 and 5, a single air knife may be utilized to remove rinsing liquid from one side of the web, and if desired a backup roll may be provided opposite such a single air knife in order to maintain the spacing of the surface of the web with respect thereto.

The invention has been found particularly suitable for cleaning webs comprising polyester synthetic resins, both linear thermoplastic synthetic resins such as polyethylene terephthalate sold commercially as "Mylar" by du Pont de Nemours and thermosetting polyester synthetic resins which are almost invariably reinforced with such materials as woven cotton fabric, woven glass fabric, unwoven fibrous glass reinforcing mat or paper. Such polyester resins comprise the product of copolymerizing a monomer having a single terminal ethylenic group such as styrene with the product obtained by reacting a multihydroxy alcohol with an ethylenic alpha-beta-dicarboxylic acid

such as maleic, fumaric, itaconic, adipic acid or the like. Suitable as dihydroxy alcohols are ethylene glycol, diethylene glycol, triethylene glycol and propylene glycol. In place of styrene there may be used any one of a large number of unsaturates well known in the art such as vinyl acetate, diallyl phosphenate, diallyl phthalate and the like. Other organic synthetic resinous materials of which the invention is particularly suitable include thermosetting melamine formaldehyde resins, thermosetting urea formaldehyde resins, thermosetting phenol formaldehyde resins, and generally thermosetting polymers of compounds containing active amine or phenol groups with formaldehyde or formaldehyde-generating compounds such as hexamethylene tetramine. Thermoplastic resinous webs may also be treated according to the invention although modification of the process may be necessary for this purpose and the results obtained are generally not equally desirable. Such resins may include polymethyl methacrylate, polyvinyl acetate, polyvinyl chloride-acetate, polyvinyl chloride, polyvinylidene chloride, cellulose acetate, cellulose acetate butyrate, etc.

It is essential that there be contained in the washing liquid both a detergent which may be dissolved in water to provide an aqueous washing solution and a material believed to function as a mild abrasive which can best be described as suspended therein. As a detergent there is preferred an alkyl phenyl ether of polyethylene glycol sold commercially as NP-27 by the Carbide & Carbon Chemical Corporation; a chemically similar alkyl phenyl ether of polyethylene glycol sold under the designation NP-14 by the same company is almost equally good. Mixtures of these two materials, as well as mixtures of either or both of these with other detergents, are also suitable and there may also be used an alkyl phenyl ether of polyethylene glycol sold commercially as Triton X–100 by Rohm and Haas or the compound "Kelite" sold by the Kelite Chemical Company. Denatured ethyl alcohol has been found particularly effective as a detergent when added in sufficient amount to provide a 50% solution of denatured ethyl alcohol in water. Although the use of a non-foaming detergent is not necessarily essential for accomplishing washing action, it is made almost imparative by reason of the extreme turbulence which is created by the brushes which would cause an excess of foam and suds to be generated if any other type were used.

It has been particularly surprisingly found that a most satisfactory additive to the washing bath consists of a quantity, preferably relatively large, of dust of a type it is desired to remove in the washing operation. As has been previously described, such dust is removed in device **70** from the air which traverses the interior of housing **5** and elevator **38**. Dust removed by the fabric filter cloths within device **70** may be added to the detergent solution contained in the wash bath in an amount as great as one pound of dust per gallon of solution to provide superior washing action. It is believed this dust functions as a mild scouring powder or abrasive but its action may be electrical in nature. Other abrasive agents may also be suitable.

The air knives are particularly effective in removing not only water which clings to the web, but in removing dirt which remains suspended in such rinse water which clings to the web and which in the absence of the air knives is redeposited upon the web when the water evaporates.

It is preferable to maintain the water in the rinse bath as clean as possible and this may be accomplished by directing a constant stream of fresh water thereinto and providing an overflow means of any conventional type.

It may thus be seen that the invention is broad in scope and is not to be limited excepting by the claims.

Having thus disclosed by invention, I claim:

1. The method of providing a continuous web comprising organic synthetic resinous material with a clean matte surface which comprises the steps of continuously advancing such a web, continuously abrasively treating a surface of said web to provide said surface with a matte finish having particles of abrasive and particles of abraded web material thereon, then advancing said web into an aqueous washing bath, adding particles abraded from such a web to said bath to provide a mild scouring abrasive therein, mechanically brushing said surface of said web while immersed in said bath to remove said particles of abrasive and said particles of abraded web material from said treated surface and then rinsing and drying the web.

2. The method of providing a continuous web comprising organic synthetic resinous material with a clean matte surface which comprises the steps of continuously advancing such a web, continuously abrasively treating a surface of said web to provide said surface with a matte finish having particles of abrasive and particles of abraded web material thereon, then removing at least some of said particles of abrasive and abraded web material and separating thus removed particles of abrasive from thus removed particles of web material, then advancing said web having remaining particles of abrasive and remaining particles of abraded web material on said surface into an aqueous washing bath, adding such particles of abraded web material abraded and removed from such a web to said bath to provide a mild scouring abrasive therein, mechanically brushing said surface of said web while immersed in said bath to remove said remaining particles of abrasive and said remaining particles of abraded web material from said treated surface and then rinsing and drying the web.

3. The method of providing a continuous web comprising organic synthetic resinous material with a clean matte surface which comprises the steps of continuously advancing such a web, continuously abrasively treating a surface of said web to provide said surface with a matte finish having particles of abrasive and particles of abraded web material thereon, then removing at least some of said particles of abrasive and abraded web material and separating thus removed particles of abrasive from thus removed particles of web material, then advancing said web having remaining particles of abrasive and remaining particles of abraded web material on said surface into an aqueous washing bath, adding said removed particles of abraded web material abraded from said web to said bath to provide a mild scouring abrasive therein, mechanically brushing said surface of said web while immersed in said bath to remove said remaining particles of abrasive and said remaining particles of abraded web material from said treated surface and then rinsing and drying the web.

4. The method of removing particles of abrasive and particles of web material from a surface of a continuous web comprising organic synthetic resinous material which has been abraded with said abrasive to produce said particles of web material, which comprises the steps of providing an aqueous washing bath, adding some of such particles of web material abraded from such a web to said bath to provide a mild scouring abrasive therein, continuously advancing said web into said bath and mechanically brushing said surface of said web while immersed in said bath and then rinsing and drying the web.

5. The method of removing particles of abrasive and particles of web material from a surface of a continuous web comprising organic synthetic resinous material which has been abraded with said abrasive to produce said particles of web material, which comprises the steps of providing an aqueous washing bath, adding some of said particles of web material abraded from said web to said bath to provide a mild scouring abrasive therein, continuously advancing said web into said bath and mechanically brushing said surface of said web while

immersed in said bath and then rinsing and drying the web.

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