Jan. 18, 1938. L. L. LARSON ET AL 2,105,484

FLOOR COVERING

Filed March 20, 1935 2 Sheets-Sheet 1

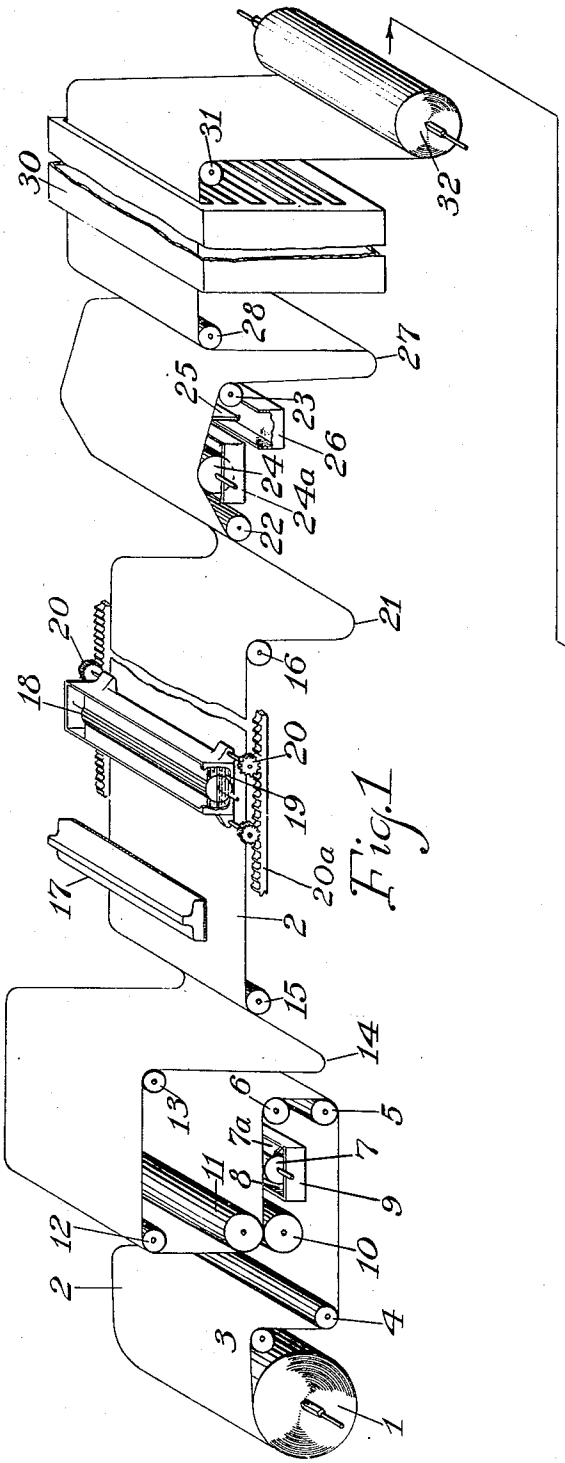


Fig. 1

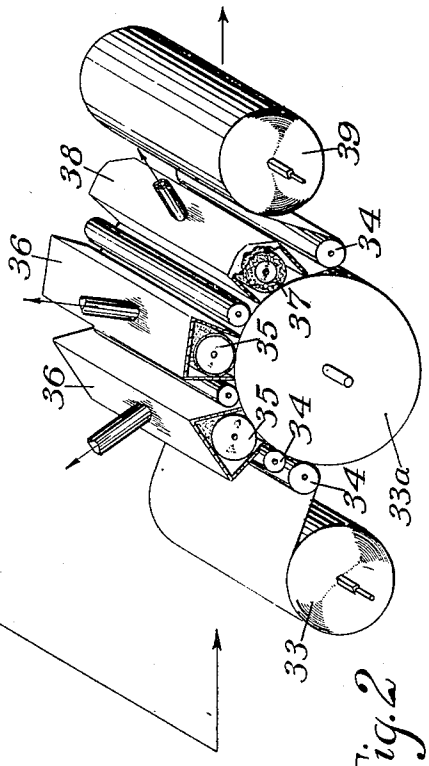


Fig. 2

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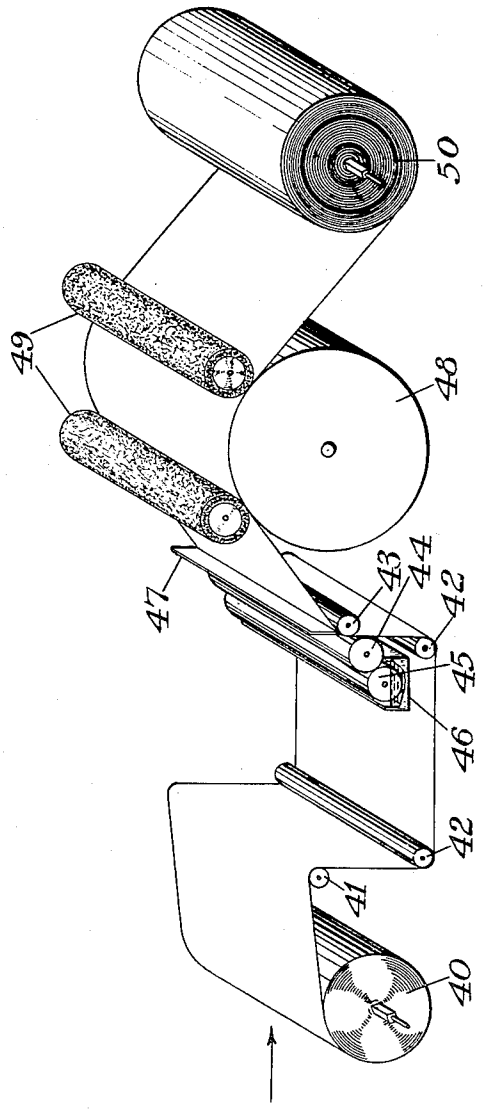


Fig. 3

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Patented Jan. 18, 1938

2,105,484

UNITED STATES PATENT OFFICE

2,105,484

FLOOR COVERING

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Application March 20, 1935, Serial No. 12,110

7 Claims. (Cl. 91—68)

This invention relates to floor covering, and more particularly to an improved process for producing smooth surface floor coverings carrying the coloring or pattern substantially through the sheet.

Floor coverings of the type described herein have previously been made by decorating a fibrous material with a coloring visible on at least one face thereof and extending well down into the body of the sheet and tinting the fibers but not filling the voids between the fibers, drying the sheet thus decorated, filling the voids with a transparent saturant filling material, and finally a surfacing coat of lacquer or varnish may be applied. In accordance with the present invention, an improvement in both process and product is effected by saturating the sheet from the face to a considerable extent before printing, this process involving the special procedure and materials more fully described hereinafter.

This invention has as its object process and product improvements in the manufacture of a smooth surface floor covering having the color or pattern visible on the surface and extending substantially through the sheet. A further object is to reduce to a minimum the number of steps required for the production of a floor covering of this type. A further object is the production in a continuous operation of a filled sheet having a pattern extending well through the sheet. A further object is a process in which a printed and filled sheet is obtained at the curing stage and in which additional application of saturant after the curing stage is not required. A further object is to provide product improvements through mechanical treatments of the surface during the finishing operation. A still further object is to provide a process utilizing improved compositions which permit the production in a continuous operation of a substantially filled sheet having a pattern extending well through the sheet and which impart to the product the properties that are required in a smooth surface floor covering. Other objects will appear hereinafter.

In the preferred method of carrying out our process the following steps are included: (1) the sheet is partially saturated from the face to an extent of about 50% with a definite amount of selected pigmented varnish composition; (2) the sheet is printed in pattern or in solid color by the application to its face of a definite amount of print paint which penetrates substantially through the sheet; (3) the printed sheet is completely saturated from the back with a selected pigmented varnish composition; (4) the printed and saturated sheet is pulled into a festoon or curing rack. These steps constitute a continuous operation. Where further finishing is desired the remaining operations may consist in sanding the completely cured sheet to obtain a smooth even surface and finishing with a thin coat of suitable finishing composition, or finishing may consist in pressing the partially cured sheet to obtain a smooth even surface and then completing the cure, or in pressing the cured sheet, and if desired a thin coat of a suitable finishing material may be applied for the purpose of appearance.

The steps involved in the manufacture of our improved floor coverings from a fabric base, saturating and printing compositions, etc., all later described in detail, will be better understood by reference to the diagrammatic views of the accompanying drawings in which

Fig. 1 is a view in elevation of an assembly for performing the saturating, printing and curing steps of the first operation;

Fig. 2 is an elevational view of sanding mechanism;

Fig. 3 is an elevational view of mechanism used for waxing.

The numeral 1 designates a supply roll of absorbent sheet material from which the strip of sheet material indicated by the numeral 2 passes over roller 3, under rollers 4 and 5 and over roller 6. Saturant is applied to the face of the sheet material by a transfer roll 7 contacting the sheet material and dipping into the saturant 8 which is heated to about 120–130° F. contained in the pan 9. The transfer roll 7 is equipped with a doctor knife 7a. The sheet material then passes between squeeze rolls 10 and 11, over rollers 12 and 13 and over adjustable rolls 15 and 16. The short loop 14 formed in the sheet material between rolls 13 and 15 permits continual operation of the face saturating step at a speed equal to the average forward movement of the sheet on the printing mechanism. The printing of the sheet material on the same face to which the saturant was applied takes place between the rollers 15 and 16.

The mechanism for applying the print paint may be the well known felt base printing machine of conventional construction which includes a suitable support for the sheet material between rollers 15 and 16, this printing mechanism being shown but diagrammatically in the drawings. The printing ink is applied to the print block 17 by means of a roller 18 dipping into the printing

ink contained in the receptacle 19 carried by cog wheels 20 riding in racks 20a which are disposed parallel to the sheet material and spaced somewhat from its edges. As the receptacle containing the print paint is moved either manually or mechanically to contact the roller 18 with the face of the print block 17, the cog wheels cause rotation of the roller 18 by means of suitable connecting mechanism not shown. After application of the print paint to the print block 17 the latter is lowered in the usual way by mechanism forming part of the printing machine to contact its inked face against the sheet material 2, and the forward movement of the sheet material is interrupted during contact of the print block with the sheet material.

After the sheet material is printed, rolls 22 and 23 pull it over a middle roll 24 which transfers saturating composition from the receptacle 24a to the back of the sheet material, that is, to the side opposite to which the saturant 8 and the print paint were applied. The numeral 25 designates a doctor knife for removing excess saturant which is collected by a drip pan 26. The material is now completely saturated in the sense that it will not accept any more saturating materials. The loops 21 and 27 in the sheet material are for the purpose of permitting continual operation at a speed equal to the average forward movement of the sheet on the printing mechanism. The saturated and printed sheet material passes over adjustable roll 28 into a drying chamber 30 heated to 140–150° F. The drying chamber may be of the usual type provided with a source of heat, ventilators, and drying racks. The curing may also be effected by a drying chamber of the festoon type. The product thus cured at a temperature of approximately 150° F. for a period of several days is then passed over a roll 31 and is wound into a roll 32.

The mechanism for sanding is shown in Fig. 2 where the printed and saturated material unwinds from roll 33 over a revolving drum 33a and under pull rolls 34 and under sanding rolls 35. The sanding rolls are provided with hoods 36 from which abrasive loosened from the rolls 35 is drawn by suction. The numeral 37 indicates a roll brush provided with a hood 38 similar to the ones over the sanding rolls. The sheet material passes under the last pull roll 34 and is wound into a roll 39.

The product after the sanding step may be finished with a thin coat of wax, lacquer, varnish, or any other suitable finishing composition. When a wax finish is used the preferred method is to apply two coats by a hot melt application with a transfer roll. The first coat is applied to the sheet while it is heated above the melting point of the wax which causes the wax to impregnate the fine pores in the surface. The second application of wax coats the surface and for this purpose it is applied after it has cooled below the melting point of the wax. In these waxing steps the sanded material may pass directly to the waxing machine or, as shown in Fig. 3, it may unroll from a supply roll 40 over carrying roll 41, and under carrying rolls 42 and over carrying roll 43 adjacent to which the wax is applied to the printed surface of the sheet from a wax roll 44. The roll 44 bears against a roll 45 which dips in wax contained in receptacle 46, and as the rolls 44 and 45 revolve with the movement of the sheet material the wax is transferred from the receptacle to the sheet material. The numeral 47 indicates a doctor knife. The waxed material then passes over a revolving drum 48 and under two roll brushes 49 and is then wound into a roll 50.

Instead of producing a smooth and even surface by means of the waxing or other finishing methods previously mentioned, we may accomplish this end by a pressing operation. An advantage of the pressing operation over the sanding operation is that it tends to solidify the sheet. The best results are obtained by pressing the sheet at a stage of partial cure. In this form of the invention we prefer to cure the sheet for approximately 24–36 hours, press, and then complete the cure in a festoon or straight rack. For plate pressing the best conditions are 1200 pounds per square inch pressure, a pressing period of about 15 seconds and a pressing temperature of about 140° C. The sheet should be preheated before it enters the plate press. After the sheet has been pressed and completely cured, a thin coat of wax, varnish, or lacquer may be applied.

In addition to solidifying the sheet and producing a smooth surface, pressing eliminates the tendency possessed by unpressed sheets to curl upwards at the edges. Another method of preventing edge curl that may be used in connection with a sanding operation is boarding the sheet by flexing it sharply over a roll about 1 inch in diameter. A suitable apparatus consists of a small roll about 1 inch in diameter supported by two larger rolls about 6 inches in diameter. The sheet passes under the first supporting roll, sharply over the small roll, and under the second supporting roll. The sheet is pulled through this boarding machine, and the supporting rolls may be driven.

Several factors have a fundamental influence on the successful operation of the above process. Saturant should be applied only from the face before the printing operation in order to obtain the most satisfactory penetration of the print paints and working properties of the sheet on the print machine. The operation of the face saturant at an elevated temperature substantially decreases the amount of solvent required to produce an operating viscosity. It is of great importance in this process of producing a substantially filled sheet in a continuous operation that the solvent content of all filling materials should be held to a minimum. By continuous operation we mean that the sheet from a roll of porous felt in a continuous band is threaded through the entire system of machinery for performing the step of applying saturant to the face, applying print paint to the face, applying additional saturant to the back, and delivering the filled sheet into the drying chamber. Each of these steps is performed in their regular sequence without rewinding the sheet into a roll which would smear the pattern. The application of saturant from the back after printing completely fills the sheet by raising the level of the still liquid paint and improves the brightness of colors on the face without impairing the definition of design. Thus the production of a substantially filled sheet carrying a well defined pattern well through it in a continuous operation depends upon introducing part of the saturant before printing and part of the saturant after printing. In the surfacing operation, the composition of the materials must be such that the sheet will sand easily without gumming the sandpaper. If the sheet is plate pressed this should be done for best results at a stage of partial cure while the saturants and paints are still somewhat thermoplastic. The

compositions and properties of the saturants and print paints and the amounts of each have a fundamental influence upon the operation of the process and the quality of the finished product. A discussion of materials follows:

The saturating base is a porous, absorbent, continuous sheet. The width of the sheet is regulated to the width of the print machine, and the printed area is commonly two or three yards wide with an extra inch or more on each side for the bands that carry the sheet over the print machine.

The saturating base should have an absorptive capacity and porosity as defined respectively by a kerosene absorption of around 260% to 320% and a porosity on the Gurley densometer of around 1.8 to 2.2 seconds for a sheet approximately 0.049" thick. The kerosene absorption is measured by the standard A. S. T. M. method for roofing felts. The porosity given is the seconds required for the displacement of 400 cc. of air through a 3 ply thickness of the sheet on a Gurley densometer. The reference to kerosene absorption and porosity in this specification is in terms of these definitions. A saturating base which meets the above preferred requirements is the absorbent and porous sheet formed from artifically crinkled fibers by the process described in United States Patent 1,857,100.

The saturant applied before printing may contain only neutral or essentially non-coloring pigment such as calcium carbonate, or it may also contain colored pigments.

We prefer to use as the face saturant a pigmented varnish comprising pigment, drying oils, resins, oxidation inhibitor, driers, and solvent. In formulating the varnish, the types and proportions of the drying oils are important. The use of linseed oil or its equivalent adds solubility to the varnish and flexibility to the dried film. China-wood oil imparts rapid drying characteristics, strength, hardness, dryness, waterproofness, moisture-proofness, and grease-proofness. We prefer to use an amount of China-wood oil equal to about 50% to 80% of the total weight of drying oil. We have found that the resin content of the varnish has a pronounced influence on the quality of the product especially in regard to wearing and cleaning properties. We prefer to use a varnish the non-volatile content of which consists of about 17% to 34% of resin. Also, we prefer to use a resin that is fairly alkali and grease resistant, such, for example, as Amberol, cumar, hydrocarbon resins, or rosin modified glyceryl phthalate and similar polyhydric alcohol-polybasic acid resins. A varnish of low body should be used because the body of the varnish is the controlling factor in the amount of solvent required to cut the face saturant to a working viscosity. It is of fundamental importance that the solvent content of the face saturant should be held to a minimum because an object of the process is to produce a substantially filled product in a single continuous operation. Also the use of excessive amounts of solvent increases cost and fire hazards. The preferred body of the varnish defined in terms of viscosity is from 3 to 5 poises at 77° F. for a 90% solution in mineral spirits.

The incorporation of pigment into the saturant lowers the materials cost, decreases drying time, and improves the quality of the finished product such as sanding properties, cleanability, resistance to expansion and to indentation, and wearing properties. A pigment should be selected which when dispersed in the varnish will not filter to any appreciable extent on the surface during the face saturating operation prior to printing. We prefer a pigment that has low covering power. Certain calcium carbonate pigments and certain clays have been found to meet the requirements. The proportion of pigment to non-volatile vehicle in the face saturant should be fairly high. We prefer that the non-volatile content of the face saturant should consist of 40% to 60% by weight of pigment.

The viscosity of the face saturant should be as high as possible consistent with satisfactory penetrating properties. The preferred operating viscosity is from 1.4 to 3.0 poises. The face saturant should not contain more than about 35% by volume of solvent, and the preferred amount is 25% or less by volume.

An oxidation inhibitor of the phenolic ether type such as creosol, guaiacol, eugenol, or vanillic acid is incorporated into the saturant in order to eliminate fire hazard through spontaneous combustion during the early stages of the curing operation. The amount of inhibitor should be approximately 0.8% by weight based on non-volatile binder.

The print paints serve to fill the sheet as well as to impart a pattern substantially through it, so they have an important influence on the quality of the finished product, especially in regard to cleanability. In order to obtain the maximum filling of the sheet, it is important that the solvent content of the paint should be as low as possible consistent with satisfactory penetrating properties. Also, the paint should be formulated so that the finished product will have good wearing and cleaning properties. As the binder for the paint, we prefer to use a varnish consisting of a resin, such as one of those previously mentioned, China-wood oil, and linseed oil, and the optimum composition is around 10–20% by weight of resin and a China-wood oil content equal to approximately 20% by weight of the total oil. A factor which limits the use of higher China-wood oil contents is the tendency of the paint to skin on the print blocks. However, the addition of an oxidation inhibitor to the paint permits the use of a China-wod oil content as high as 50% or more of the total oil.

The paint should contain sufficient pigment to have good covering power, brightness and depth of color, and satisfactory hardness, dryness, cleanability, and resistance to expansion through changes in atomspheric humidities. These properties are best obtained by using a high pigment content. We prefer to use a paint that contains about 55 or 60 parts by weight of covering pigment to 45 or 40 parts by weight, respectively, of non-volatile vehicle.

The viscosity of the paint should be as high as possible consistent with satisfactory printing properties. The object is to hold the solvent content of the paint to a minimum, and obtain a finished product substantially free from large pores. A viscosity around 2.0 poises has been found to give excellent results although the process is not limited to this viscosity. The print paints should contain not more than about 20% by volume of solvent, and the preferred amount is 15% or less by volume.

We prefer to use as the back saturant a pigmented varnish consisting of pigments, drying oils, resins, driers, oxidation inhibitor, and solvent. We have found it desirable to use in the back saturant a high proportion of pigment such

as 60 parts of pigment to 40 parts of non-volatile binder. The pigment may be a low cost filling pigment, such as gilder's whiting, China clay, asbestine, talc, etc. The binder may be essentially the same as that used in the face saturant. As in the face saturant and print paints, the amount of solvent should be held to a minimum. We have found that a good operating viscosity is around 4 poises. The back saturant should contain not more than about 30% by volume of solvent, and the preferred amount is 20% or less.

The amounts of the above-described face saturant, print paint, and back saturant have a fundamental influence on the operation of the process and the quality of the finished product. If the amount of face saturant is too low the print paints do not penetrate satisfactorily, and if too high the print paints flood excessively and run on the surface. The preferred amount of saturant applied before printing is the amount that will occupy from 45 to 55% by volume of the saturating capacity of the sheet. The minimum amount should not be less than 35% and the maximum amount not be much more than 70% by volume of the saturating capacity of the sheet. The saturating capacity may be determined by measuring the volume of kerosene absorbed by a unit weight of the sheet. The amount of print paint should be sufficient so that (1) the pattern extends well into the sheet, (2) the colors of the pattern are bright and strong, and (3) the product is well filled. We prefer that the print paints should occupy 20 to 30% by volume of the initial saturating capacity of the sheet, although the process is not limited to this range. The back saturant should then fill the sheet so that 95 to 100% of the saturating capacity is occupied by the filling materials at this stage in the process, and if desired an excess of saturant may be left on the back as a coating. In the event that the saturant applied before printing and the print paints occupy 95% or more of the initial saturating capacity of the sheet, the application of back saturant may be omitted, although in the preferred operation of the process back saturant will occupy 20 to 35% of the initial saturating capacity of the sheet.

The degree of filling of the finished product should be above a certain minimum value in order that the product will have satisfactory cleanability, resistance to indentation and expansion, wearing qualities, etc. The degree of filling may be expressed by the non-fibrous to fibrous ratio of the product. This ratio for material of about 0.045" and greater thicknesses should not be less than 2.75 to 1.0 by weight, and we prefer that it should be 3.0 or higher to 1.0. These ratios by weight are based on a mean specific gravity of 1.61 for the filling materials (saturants and print paints). A change in the mean gravity of the filling materials requires an adjustment in the above ratios so that the same ratio by volume exists. The ratio by volume of non-fibrous to fibrous materials in the product should be not less than 2.55 to 1.0, and preferably 2.8 or higher to 1.0.

The following examples are illustrative of the method of carrying out our invention:

Example I

The base is an absorbent sheet formed on a paper machine, such as a Fourdrinier, from a furnish consisting of a artificially crinkled and bleached kraft fibers, starch (for strengthening purposes), rosin size, and alum. The artificially crinkled fibers are prepared by the process of the above mentioned patent U. S. 1,857,100. For this purpose, the best crinkling results are obtained by wetting kraft pulp with an 18% solution of sodium hydroxide at about 25° C., at a fiber consistency of about 20%, and promptly washing the fibers until neutral. Following this, the pulp is bleached with a suitable bleach such as calcium hypochlorite, and again washed. The crinkled and bleached pulp is then charged into a beater and treated with swollen corn starch (approximately 10% based on the fiber weight), rosin size, and alum. The treated pulp is then diluted to a suitable paper making consistency and formed into a sheet on a Fourdrinier paper machine by modified regular procedures.

An absorbent sheet suitable for this process may have the following properties:

Weight	lbs. per sq. yd.	0.66
Thickness	inches	0.049
Kerosene absorption	per cent	300
Porosity (Gurley densometer, 400 cc. displacement of air through 3 plies of sheet)	seconds	2.0
Mullen bursting strength	pounds	40.0
Color (Ives tintphotometer)		165

The absorbent base is converted into a floor covering as follows:

The sheet is partially saturated from the wire side (the side next to the forming wire during the manufacture of the base) by application by means of the roll 7 of 1.31 lbs. per square yard of saturant "A" hereinafter described. The saturant is usually heated (120–130° F.). The pattern is then printed into the sheet from the wire side by the application of 0.66 lbs. per square yard of print paint "B". After being printed, the sheet passes off the printing machine and over the back saturating mechanism shown in the drawing where 0.51 lbs. per square yard of saturant "B" is applied at the temperature of the print room, which for best results should be approximately 80–90° F. The sheets cut to proper length are then pulled into the drying chamber and cured about four days at 150° F.

Following the curing operation, the product is finished by sanding and waxing the surface by mechanisms of the kind shown in the drawing. The surface is sanded with a fine sand paper such as 2/0 flint paper, until smooth and even. Approximately 0.5% by weight of the sheet is removed in sanding to a smooth surface. A wax coating (0.03 lbs. per square yard) is applied to the surface as a hot melt by the transfer roll method. A suitable wax composition consists of 82.5 parts of carnauba and 17.5 parts of a 125–130° F. melting paraffin.

The finished product weighs 2.77 lbs. per square yard, and its thickness is 0.049". Its non-fibrous to fibrous ratio is 3.2:1.0 by weight. The pattern extends approximately 70% through the sheet, and it is characterized by brightness of color and excellent definition of design. The product has excellent wearing properties and a smooth surface is maintained with wear. The surface has good initial cleanability and it continues to clean well with wear. The initial pliability and permanence of initial pliability are very satisfactory. For example, the stiffness (at 25° C. 50% relative humidity) measured by the Smith-Taber stiffness tester with the 2,000 unit weight on the pendulum is 21 in the machine direction and 14 across the sheet, and these

values increase only 25% after four weeks of aging at 150° F.

Example II

An absorbent sheet as described under Example I was partially saturated from the wire side with 1.05 lbs. per square yard of saturant "A" thinned 5% by weight with mineral spirits, printed on the wire side with 0.75 lbs. per square yard of print paints, and saturated from the back with 0.62 lbs. per square yard of saturant "B", by the procedure given under Example I with the exception that the saturant bath was operated at the temperature of the print room (80–90° F.) instead of 120–130° F.

The sheet was then pulled into a festoon and cured for 30 hours at 150° F. It was then plate pressed to produce a smooth and even surface and to solidify the sheet. The conditions for plate pressing were a pressure of 1200 lbs. per square inch, 15 seconds at pressure, and a pressing temperature of 280° F., the sheet being preheated before it entered the press by passing it over a hot plate.

Following the pressing operation, the cure was completed by stoving the sheet in a festoon for 60 hours at 150° F. Finally, the surface was finished with a thin coat of lacquer (0.03 lbs. per square yard of lacquer solids). A suitable lacquer consists of 16.6 parts by weight of ½ second cellulose nitrate, 13.4 parts by weight of castor oil, and 70 parts by weight of solvent.

The finished product of the foregoing example weighs 2.63 lbs. per square yard, and its thickness is 0.045". Its non-fibrous to fibrous ratio is 2.98:1.0 by weight. The pattern extends approximately 70% through the sheet. It has excellent wearing properties and excellent cleanability with wear.

Example III

An absorbent sheet as described under Example I was partially saturated from the wire side with 1.30 lbs. per square yard of saturant "C", printed with 0.66 lbs. per square yard of print paints, and completely saturated from the back with 0.60 lbs. per square yard of saturant "C" by the procedure given under Example I. The sheet was cured for 5 days at 150° F., following which it was finished by the procedure given under Example I.

The finished product weighs 2.93 lbs. per square yard, and its thickness is 0.049". Its non-fibrous to fibrous ratio is 3.44:1.0 by weight. The product wears well and cleans well with wear.

Example IV

In this example, a thicker sheet was processed in a solid color. The properties of the sheet are: a weight of 0.73 lbs. per square yard, a thickness of 0.057", a kerosene absorption of 305%, a Mullen bursting strength of 47 lbs., and a porosity as defined above of 3.1 seconds. The sheet was partially saturated from the wire side with 1.50 lbs. per square yard of saturant "A" thinned 5% by weight with mineral spirits. The saturant was applied by the transfer-roll method, and the bath of saturant was operated at 80–90° F. The sheet was then printed on the wire side with 1.02 lbs. per square yard of print paint. Two impressions of paint were applied to the sheet, the second impression registering directly over the first impression. This was done by using two print blocks to carry paint to the sheet. Each print block is cut to give a solid coverage of paint over the entire surface. The first block applied 0.62 lbs. per square yard of print paint "B", and the second block applied 0.40 lbs. per square yard of print paint "A". Following the printing operation, the sheet passed from the print machine and was saturated from the back by the application of 0.50 lbs. per square yard of saturant "B". The sheet was then cured and finished as under Example I.

The finished product weighs 3.32 lbs. per square yard, and its thickness is 0.059". Its non-fibrous to fibrous ratio is 3.55:1.0 by weight. The product has excellent wearing and cleaning properties.

Example V

An absorbent base which was formed from cotton linters pulp and which has a thickness of 0.049", a weight of 0.64 lbs. per square yard, a kerosene absorption of 278% and a porosity of 2.9 seconds, was converted into a floor covering as follows: The sheet was partially saturated from the wire side with 1.01 lbs. per square yard of saturant "A", printed on the wire side with 0.75 lbs. per square yard of print paint "B", and completely saturated from the back with 0.40 lbs. per square yard of saturant "B", cured, and finished in accordance with the procedure given under Example I.

The finished product weights 2.69 lbs. per square yard and its non-fibrous to fibrous ratio is 3.2:1.0 by weight.

Example VI

An absorbent base which had been formed from a highly purified bleached sulphite wood pulp of high alpha cellulose content and which had a thickness of 0.047", a weight of 0.46 lbs. per square yard, a kerosene absorption of 419%, and a porosity (as defined under Example I) of 3.8 seconds, was converted into floor covering as follows: The sheet was partially saturated from the felt side with 1.02 lbs. per square yard of saturant "A", printed on the felt side with 0.76 lbs. per square yard of print paint "B", and completely saturated from the back with 0.43 lbs. per square yard of saturant "B", cured, and finished in accordance with the procedure given under Example I.

The finished product weighs 2.5 lbs. per square yard, and its non-fibrous to fibrous ratio is 4.4:1.0 by weight.

The compositions of the saturants and print paints in the above examples are as follows:

Saturant "A"

	Parts by weight
Pigment (such as precipitated calcium carbonate treated with a wetting agent)	40.50
Varnish "A"	
Resins, drying oils, and driers 40.5	
Mineral spirits 4.5	45.00
Creosol	0.32
Mineral spirits	14.18

The above ingredients are ground in a pebble mill for approximately 20 hours.

The saturant has a viscosity of 4.5 poises at 77° F. This viscosity will vary somewhat from batch to batch.

Varnish "A", which is a constituent of this saturant, is prepared as follows: 100 parts of a rosin modified phenolic resin (such as BS–1 Amberol), 769.3 parts of China-wood oil, and 77.8 parts of varnish maker's alkali-refined linseed oil are run to 525° F. The kettle is then removed from the fire and 100 parts of French

rosin (combined fused resinates of lead and calcium) and 1.25 parts of manganese resinate are added. When these have fused, 115 parts of a heat bodied alkali-refined linseed oil (body of S on the Gardner-Holdt scale) is added. Finally, 131 parts of mineral spirits and 2.8 parts of a lead-manganese liquid drier (4.77% lead, 1.42% manganese) are added. The above amounts are in parts by weight. The varnish is strained while hot. The varnish has a viscosity of Z–1±1 bubble at 77° F. on the Gardner-Holdt scale.

Saturant "B"

Mill base (roller mill grind)	Parts by weight	
Pigment (such as gilder's whiting)		57.40
Varnish "A"		
Resins, drying oils, and driers	38.34	42.60
Mineral spirits	4.26	
Formulation of saturant		
Mill base		84.10
Creosol		0.36
Mineral spirits		15.54

The saturant has a viscosity of 3.60 poises at 77° F.

Saturant "C"

	Parts by weight	
Pigment (such as precipitated calcium carbonate treated with a wetting agent)		43.60
Varnish "A"		
Resins, drying oils, and driers	21.8	24.20
Mineral spirits	2.4	
Varnish "B"		
Resins, drying oils, and driers	21.8	24.20
Mineral spirits	2.4	
Creosol		0.17
Mineral spirits		7.83

The above ingredients are ground in a pebble mill for approximately 20 hours.

The saturant has a viscosity of 4.5 poises at 77° F.

Varnish "B" is prepared as follows: 100 parts of a rosin modified phenolic resin (such as BS–1 Amberol), 192 parts of China-wood oil, and 763 parts of varnish maker's alkali-refined linseed oil are run to 550° F., and held at this temperature for 5 minutes. The kettle is then removed from the fire and 100 parts of French rosin and 1.25 parts of precipitated manganese resinate are added. After the temperature has dropped to 450° F., 131 parts of mineral spirits and 2.8 parts of lead-manganese liquid drier (4.77% lead, 1.42% manganese) are added. The amounts given above are in parts by weight. The varnish is strained while hot.

Varnish "B" has a viscosity of G at 77° F. on the Gardner-Holdt scale.

Print paint "A"

Pigments	Parts by weight	
White pigment (such as lithopone treated with a wetting agent)	53.60	55.20
Tinting pigment (such as chrome yellow)	1.60	
Varnish "B"		
Resins, drying oils, and driers	36.72	40.80
Mineral spirits	4.08	
Mineral spirits		4.00

A thorough dispersion of the pigments in the vehicle is obtained by roller mill or pebble mill grinding.

The paint has a viscosity of 4.0 poises at 77° F. A more practical procedure for preparing the paint is to make individual grinds of the pigments with the vehicle, and then tint the white paint with the colored paint.

Print paint "B"

	Parts by weight
Print paint "A"	100.0
Varnish "B"	9.2
Mineral spirits	2.0

The paint has a viscosity of 1.65 poises at 77° F.

In the production of a floor covering by the process of this invention, the base may be any absorbent sheet that has satisfactory porosity and absorbency. The kerosene absorption of the sheet may vary some from the preferred range given above. It may be as low as 250% and it may be higher than 320%. The process is not limited to any special thickness of sheet, although the most practical thickness is around 0.050"±15%, but wide variations from this value may be used in practicing the invention.

Numerous changes in the process described above may be made without departing from the scope of this invention. The sheet, for instance, may be treated throughout with saturant prior to printing, providing due care is taken so that the pores in the back of the sheet are not sealed with saturant and the amount of saturant placed in the sheet before printing falls within the limits previously prescribed herein. This may be accomplished by impregnating the sheet by immersion in saturant such as saturant "A" thinned 5% by weight with mineral spirits, and then passing the sheet between squeeze rolls to express saturant in excess of the desired amount and to obtain uniform distribution of the saturant in the sheet. The impregnated sheet is then printed, saturated from the back, cured, and finished by procedures previously described herein. This modified process is particularly applicable for the manufacture of solid color floor coverings, and in this case for application of the paint the print machine may be replaced by a machine having a transfer roll and squeeze rolls such as the machine described for application of saturant to the face prior to printing. Another procedure particularly applicable for solid color floor covering is to fill 60 to 70% by volume of the saturating capacity of the sheet with saturant, such as saturant "A" for example, by the impregnation and squeezing process given above, and print in solid color with one or more applications of paint to the face. The amount of paint applied is sufficient to fill the remaining 30 to 40% by volume of the initial saturating capacity of the sheet. After the paint is applied the sheet is pressed by applying a mash block to the face on the print machine. This causes the paint to penetrate the sheet so that all of the pores in the sheet are filled. The treated sheet is then cured and finished by procedures previously described herein.

Another variation that may be suggested consists in partially saturating the sheet with a strengthening composition such as varnish or lacquer before the sheet is processed as described above. A special back coat may be applied to the sheet after it has been processed and cured. The special back coat improves waterproofness, moisture-proofness, resistance to expansion, and resistance to curl at the edges. Suitable compositions for back coating are waxes, wax-resin compositions, varnishes, paints, lacquers, rubber compositions, etc.

In the formulation of the saturants, we prefer to use a pigmented varnish because the introduction of pigment lowers materials cost, decreases curing time, and substantially improves quality. The amount of pigment may be varied over wide limits. In the face saturant, the pigment should not filter appreciably on the surface of the sheet. Any pigment which has the proper dispersing properties and penetrating properties when ground with the vehicle, and which does not impair the colors of the print paints may be used.

A certain amount of a strong covering pigment, such for example as lithopone, may be used in the face saturant in order to improve the brightness of color of the light colored print paints. For example, lithopone may constitute 10 to 20% of the pigment content of the face saturant. A colored back may be produced by adding tinting colors (colored pigments ground in the vehicle) to the back saturant. Also in producing a solid color product the saturant may contain the same pigments as used in the paints. The resin content and the types and proportions of drying oils of the saturants and print paints may also be varied within rather wide limits. For satisfactory results the resin content should not be lower than 10% nor much higher than 40% by weight of the non-volatile content of the varnish. The pigment content of the saturants may be decreased as the resin content of the varnish is increased. Any drying oil or combination of drying oils may be used with the resin that will give a varnish of satisfactory working properties and satisfactory product quality. Numerous drying oils may be used as a substitute for linseed oil, such as soya bean oil, perilla oil, and menhaden oil. Softeners such as processed corn oil, tricresyl phosphate, and chlorinated wax may be used in amounts up to 10% of binder.

Likewise, in the formulation of the print paints, any pigment or combination of pigments that has satisfactory working properties in the process may be used. In floor covering print paints, the white pigments and filling pigments generally constitute 80% or more of the total weight of pigments. The remainder is made up of tinting pigments. In addition to lithopone, titanium dioxide pigments are satisfactory as the white pigment. White pigments that are coated with a small amount of wetting agent are preferable. Most any of the tinting pigments commonly used in the floor covering industry may be used in the process, such as Prussian blue, ultramarine blue, carbon black, ochers, sienna, red oxide, chrome greens, chrome yellows, etc. In practice the paints are prepared by grinding individual pigments with the vehicle and then tinting white paint with colored paints to give the various colors desired.

The process is not limited to the operating temperatures for the saturants and print paints given above. For example, the saturants may be operated at higher temperatures than 120–130° F., and the print paints may be operated at temperatures higher than the temperature of the print room by heating the paints in the carriages.

A modification of our process utilizing the materials described above is the production of a sheet which, although not completely filled at the curing stage as in the preferred method, contains a substantial portion of the saturating materials at the curing stage. The sheet is then filled by saturating after partial or complete cure with a suitable composition. The steps in this modified process comprise, therefore, partially saturating the saturating base from the face with an amount of saturant somewhat less, especially in non-volatile constituents, than mentioned in the foregoing examples (about 45% preferred, but not less than 35%, of the saturating capacity), printing a pattern into the sheet with print paints, applying saturant from the back, partially curing the sheet, completing the saturation of the sheet from the face or by immersion with a suitable saturant, continuing the cure until ready for pressing, pressing to produce a smooth and even surface, completing the cure, and finally finishing the surface with a thin coat of a suitable finishing material. The following example illustrates this process:

Example VII

An absorbent sheet 0.057" in thickness, weighing 0.77 lbs. per square yard and having a kerosene absorption of 310% is processed by the modified method mentioned above as follows: 1.3 lbs. per square yard of saturant "A" thinned 7% by weight with mineral spirits is applied to the felt side of the sheet by the transfer roll method. The sheet is then printed on the felt side with 1.3 lbs. per square yard of print paints corresponding to Print Paint "B" thinned 7% by weight with mineral spirits. This amount of paint is applied by two impressions of each color on the sheet, so that two blocks are provided in the print machine for each color making up the pattern. Following this 0.35 lbs. per square yard of saturant "A" thinned 7% by weight with mineral spirits is applied to the back by the transfer roll method. The sheet is then pulled into a festoon and cured 6 hours at 150° F., following which it is removed from the festoon and saturated from the face side by the application of 0.16 lbs. per square yard of saturant "A". The sheet is then returned to the festoon and cured for 10 hours at 150° F. It is then removed from the festoon and plate pressed. The pressing conditions are a pressure of 1200 lbs. per square inch, a temperature of 270° F. and 15 seconds at pressure. The sheet is preheated before it enters the press by passing over a hot plate. Following the pressing operation, the cure is completed by stoving for 68 hours at 150° F. Finally, a thin finishing coat of lacquer is applied (0.03 lbs. per square yard of lacquer solids)

The product in the above example has a finished weight of 3.45 lbs. per square yard and a thickness of 0.052". The non-fibrous to fibrous ratio is 3.67:1.0. The product has exceptionally good wearing and cleaning properties.

Numerous compositions may be used for the final filling of the sheet. Softened pyroxylin is of particular value in this application in that it imparts unusually good cleaning properties and also it improves the resistance of the product against changes in dimension through changes in atmospheric humidities. A suitable softened pyroxylin composition may consist of 13.9 parts of ½ second cellulose nitrate, 11.1 parts of castor oil, and 75 parts of solvent. Other compositions such as ethyl cellulose, clear varnishes, certain waxes such as carnauba wax or hydrogenated vegetable oils, rubber compositions, vinyl resins, phenolic resins, etc., may be used.

In the modified process it is not necessary to apply saturant to the back after printing because the printed sheet is again impregnated to nearly complete saturation after it has been partially

cured. Saturants and print paints used during the printing operation may contain more volatile (not more than 10% by weight more than limits prescribed for solvent content of saturants and print paints in the operation of preferred process) when designed for this modified process in order that there will be sufficient residual porosity to permit good impregnation with the final saturant. However, the volatile contents should not be much greater than in the above example or the print paints will run and thus ruin the definition of design.

An important and distinguishing feature of our invention is the saturating of the sheet in substantial amount before printing. The minimum amount of saturant applied should not be much less than 35% by volume of the saturating capacity of the sheet and it should not be substantially more than 70%. In the case of the preferred process where the sheet is completely filled or substantialy so with or without back saturation, the face saturant is applied before the printing step in amounts of from 35% to 70%. In the modified process in which the sheet is not completely filled the saturant is applied to the face before printing in amounts of from 35% to 55%. In any event the amounts of materials introduced into the sheet during the first step of partially saturating from the face, printing and applying saturant to the back, should constitute at least 77% by weight of all filling materials in the finished product. The finished product should have a non-fibrous to fibrous ratio by volume not lower than 2.8:1.0 and the preferred ratio is in the range of 3.2:1.0 and 3.5:1.0.

When following the procedure given in Example I, the saturant is applied to the face of the sheet in an amount which, after removal of solvent, reduces the initial saturating capacity about 45%. After the printing step the saturating capacity is reduced 74%.

The application of the saturant as described herein in substantial amount to the face, and to the face only, of the porous sheet before printing results in the most satisfactory penetration of the printing and produces a sheet having the best working properties on the printing machine. The application of the saturant from the back after printing tends to push the print or design toward the surface and markedly improves the brightness of the coloring of the face without impairing the definiteness of the design. Our method of manufacture also gives a product of excellent sanding properties.

A particular advantage of our invention illustrated by the embodiment in the first six examples is the production of a substantially filled sheet carrying a pattern well through the sheet in a single continuous operation. Subsequent processing involves simply the surface finishing steps, further application of saturant to fill the sheet and additional time-consuming curing steps are avoided. Another advantage is the excellent brightness of colors and definition of design that are obtained in the practice of the process. Another advantage is the short period required for the production of the product. In addition, the product has advantages in its quality as a result of the types and properties of the materials used in its production.

The product of the present invention is especially useful for floor coverings. It also has many similar uses such as wall coverings and for this purpose the sheets processed are somewhat thinner than in the case of the floor coverings.

As many apparently widely different embodiments of this invention may be made without departing from the spirit and scope thereof, it is to be understood that we do not limit ourselves to the specific embodiments thereof except as defined in the appended claims.

We claim:

1. In a process for making floor coverings and the like the application to forwardly moving sheet material the successive steps which comprise partially saturating absorbent paper felt sheet material by applying saturant containing solvent in amount not more than about 35% by volume to the face only of said sheet material, then while the saturant is still liquid printing without intermediate curing the sheet material from the face with print paint which penetrates substantially through the sheet, and subjecting the printed and saturant-containing material to a temperature sufficiently elevated for the curing of said material, said absorbent sheet material being saturated by said saturant and print paint at the curing stage in such amount that a substantially filled sheet is produced.

2. A process for making floor coverings which comprises applying to forwardly moving sheet material the successive steps of partially saturating absorbent paper felt sheet material by applying saturant containing solvent in amount not more than about 35% by volume to the face only of said material, immediately while the saturant is still liquid, printing the sheet material from the face with print paint, applying saturant to the back of the printed material to push the print toward the surface, and subjecting the printed saturant-containing material to a temperature sufficiently elevated for the curing of said material, said absorbent sheet material being saturated by the face saturant, print paint, and back saturant at the curing stage in such amount that a substantially filled sheet is produced.

3. A process for making floor coverings which comprises applying to forwardly moving sheet material the successive steps of partially saturating absorbent paper felt sheet material by applying saturant containing solvent in amount not more than about 35% by volume to the face only of said material, immediately while the saturant is still liquid, printing the sheet material from the face with print paint, applying saturant to the back and of said material, partially curing the printed and saturated sheet material at elevated temperature, pressing the material, and completing the cure, said absorbent sheet material being saturated by said saturant and print paint at the curing stage in such amount that a substantially filled sheet is produced.

4. A process for making floor coverings which comprises applying to forwardly moving sheet material the steps of partially saturating absorbent paper felt sheet material by applying saturant containing solvent in amount not more than about 35% by volume to the face only of said material while the saturant is still liquid, printing the sheet material from the face with print paint, partially curing at elevated temperature, completing the saturation of the sheet material, further curing at elevated temperature, pressing to impart a smooth even surface to the sheet material and completing the cure at elevated temperature, said absorbent sheet material being saturated by said saturant and print paint at the

curing stage in such amount that a substantially filled sheet is produced.

5. A process for making floor coverings which comprises applying to forwardly moving sheet material the steps of partically saturating absorbent paper felt sheet material by applying saturant containing solvent in amount not more than about 35% by volume to the face only of said material immediately while the saturant is still liquid, printing the sheet material from the face with print paint, applying saturant to the back of said material, partially curing at elevated temperature, completing the saturation of the sheet material, further curing at elevated temperature, pressing to impart a smooth even surface to the sheet material and completing the cure at elevated temperature, said absorbent sheet material being saturated by the face saturant, print paint, and back saturant at the curing stage in such amount that a substantially filled sheet is produced.

6. The process set forth in claim 1 in which the sheet material is saturated from the face in an amount of not less than about 35% by volume of the initial saturating capacity of the sheet, and in which the saturant is a pigmented low body drying oil-resin varnish, and in which said print paint is a high viscosity paint of low solvent content applied in an amount of from 20% to 30% by volume of the initial saturating capacity of the sheet.

7. The process set forth in claim 1 in which the sheet material is an absorbent paper felt having a kerosene absorption of 250–320% and a porosity of 1.8 to 2.2 seconds and in which the sheet material is saturated from the face in an amount of 35% to 70% by volume of the initial saturating capacity of the sheet with a pigmented low body drying oil-resin varnish of low solvent content and in which said print paint is a high viscosity paint of low solvent content applied in an amount of from 20% to 30% by volume of the initial saturating capacity of the sheet.

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