Jan. 17, 1967 R. L. LAU ETAL 3,298,831

PAPER LAMINATES FOR ELECTROSTATIC PRINTING SUPPORT MEMBERS

Filed July 2, 1963

Fig. 1

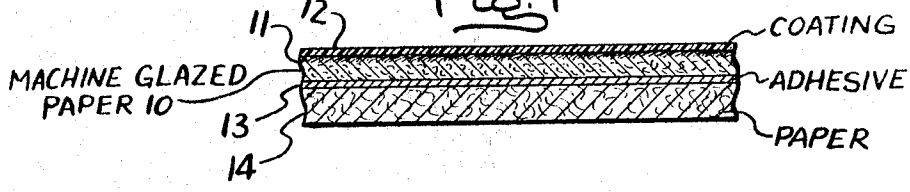


Fig. 2

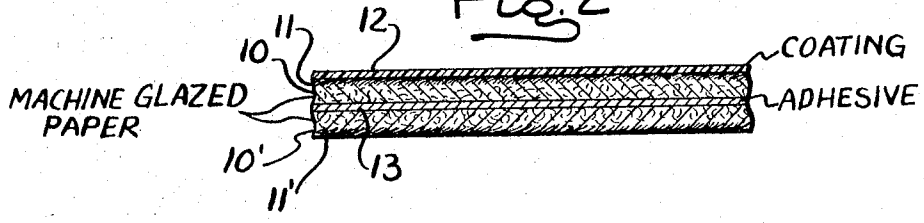


Fig. 3

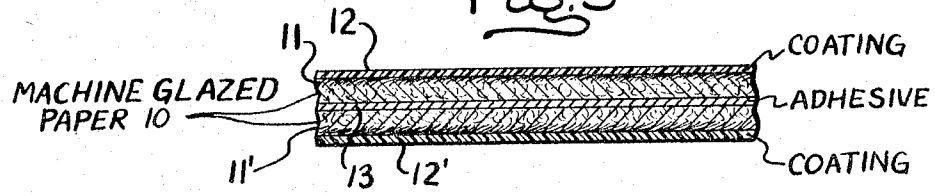


Fig. 4

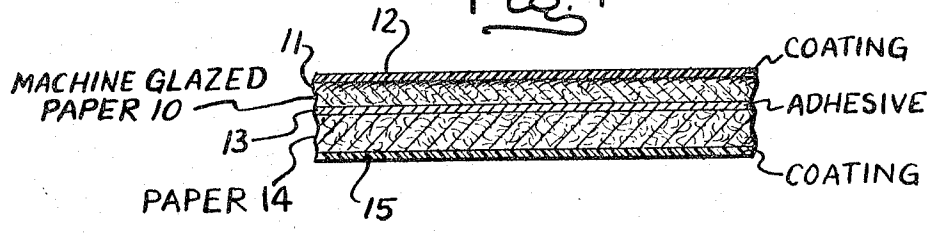
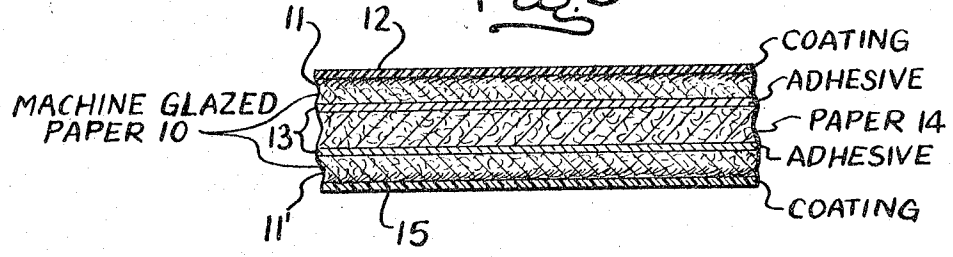


Fig. 5



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PAPER LAMINATES FOR ELECTROSTATIC PRINTING SUPPORT MEMBERS

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This invention relates to the production of novel paper laminates.

More particularly the present invention relates to the production of paper laminate which while flexible is of rigidified character making it suitable for use in business machines such as for example electrostatic printing equipment.

The paper of the present invention is further characterized by having a thickness or zone defining an outer face portion thereof of relatively non-porous, smooth, densified solvent-penetration resistant character making it suitable for printing and particularly for use as a face paper for electrostatic printing and for being coated with dielectric coating composition which will substantially remain on the aforesaid smooth surface of the laminate such as, for example, a dielectric composition composed of zinc oxide and a resin dissolved in a toluene solvent.

Good solvent hold-out or resistance to solvent penetration means that one is enabled to keep a solution of insulating resin binder, in a solvent such as toluene, on top of the sheet rather than having the solvent solution penetrate the sheet. A particular advantage of this is when the resin is employed as a binder for photoconductive material such as zinc oxide if the solvent solution of resin penetrates the sheet it leaves a poorly bonded coating of zinc oxide. This results not only in dusting of the zinc oxide but the particles of the zinc oxide are then not properly insulated from each other.

The organic solvent is necessary for resins used for coatings which are both dielectric and photoconductive.

Thus, in one specific embodiment the present invention relates to a novel paper base laminate for electrostatic printing and to the method of making the same, the laminate of the present invention serving as an expendable paper plate and printing paper for such processes as where, for example, an image is formed by projection exposure techniques and a latent electrostatic image is recorded by dissipation of electrical charges from a photoconductive dielectric coating such as one composed of zinc oxide and resin on the expendable paper plate.

As is known in such electrostatic printing processes the image is developed by fusion of an electrostatically deposited toner in the image areas. Such a print paper produces satisfactory copies if it is stored at conditions of normal or above normal humidity prior to use. However, poor printing results if the print paper is stored at below normal humidity prior to use and thus generally the lower the humidity the poorer the print. It is believed that the reason for such poor results is that the paper substrate becomes non-uniformly more insulating at lower humidities and it is thus necessary to produce a substrate which is conductive and which is substantially independent of the humidity at which it is stored over a broad range. The paper is also of an electroconductive character and this may be enhanced by impregnation with water-soluble, water-stable ionizable metal salt. The salt and humectant may be introduced together such as by using the humectant as a solvent for the salt such as for example potassium chloride in glycerol, an example of such uses being shown in U.S. Patent 2,229,091, to Kline, employing such salts as sodium nitrate dissolved in triethylene glycol, and U.S. Patent 2,346,670, to

Engler, employing ammonium nitrate and other salts in triethylene glycol, and in others.

Thus, in accordance with the present invention laminates for use as electrostatic printing paper base may be formed by densifying a portion of the thickness of a relatively porous paper web at one surface thereof to form an outer defining face of relatively non-porous, smooth, solvent-penetration resistant character and adhesively bonding the opposed surface of said web which is left relatively porous, and undensified, to a similarly porous undensified surface of a second web which also has a relatively porous, undensified fiber zone. The weight of a ream of paper of 500 sheets, 25 x 38 inches which will hereafter be called basis weight, is no greater for the present laminate than, or substantially not greater than, that of a single ply paper heretofore used for similar purposes. Moreover, while flexible, the laminate is of rigidified character to facilitate ease in handling and feeding to the business machine such as the electrostatic or electrophotographic printing devices conventionally employed.

If desired, the opposed surface of the second web may likewise have a densified outer defining zone so that the laminate on its opposed surfaces is similarly or substantially similarly non-porous, smooth, dense and of solvent-penetration resistant character.

The relatively non-porous, smooth, densified fiber zone providing the solvent-penetration resistant surface characterizing the present invention is provided by subjecting a newly formed web of paper in highly moist condition to drying over a single relatively large drying drum having a polished surface, known as a Yankee dryer, to produce what is known as a machine glaze, the machine glazed surface being of densified, non-porous, smooth, flattened fiber character. To enhance the aforesaid solvent-penetration character of the machine glazed paper surface, this machine glazed paper surface is further coated with a mineral pigment-binder paper coating composition, the latter preferably including a synthetic polymeric composition such as for example a rubber of resin latex.

Laminates can be formed by adhesively bonding at least two plies of paper of the foregoing specific machine glazed character to each other by interposing a water-soluble adhesive, such as for example polyvinyl alcohol, between their two uncoated and undensified surfaces. In the alternative, a ply of the aforesaid machine glazed paper can be adhesively joined to an uncoated and undensified surface of wholly uncoated or one side coated paper by bonding the undensified surfaces of the sheets together.

As a specific advantage of the present invention, either of the plies of paper and the adhesive joining them together, or two or more of them, may be precoated or pre-impregnated with the aforesaid humectant and/or conductive salt, or a solution of the salt in the humectant, so as to provide a wide variety of electrical properties both laterally and transversely of the laminate.

Thus, when employing the machine glazed paper web, the undensified porous surface thereof may be coated or impregnated with the aforesaid salt-humectant solution and the salt-humectant material may be incorporated in the solvent which as previously indiacted is desirably of an aqueous nature.

Similarly, when employing conventional paper webs, without the machine glazed surface, these may be coated on one or both surfacse with the salt humectant solution or wholly impregnated therewith prior to lamination, and prior to densifying by coating one surface by means of the mineral-pigment binder composition as aforesaid to provide a smooth backing, similar to when the backing is a machine glazed sheet.

By employing a laminated structure means is provided for providing a conductive paper where the conductive agent can be efficiently distributed in strata or throughout the body of the paper in a controlled manner to give regions or zones which possess precisely controlled electroconductivity. The laminated structure also permits formation or employment of machine glazed paper, which must be formed prior to laminating.

The laminate of the present invention, in addition to having improved stiffness while remaining flexible, has better handling qualities due to slickness, that is, it has smoothness and low resistance to friction which further improves its ability to be handled in business machines as aforesaid. Moreover, the laminate of the present invention has greater resistance to scorching when going through the heating component of electrostatic printers and thus retains its good appearance and physical properties; and the coated surfaces are printable not only by electrostatic printers but by conventional printing process means and thus permits employment of a combination of printing processes.

In the laminate structure as herein provided, the plies can be physically joined while remaining electrically distinct, providing both lateral and transverse controlled conductivity. Although conductive agents made of a solution of for example potassium chloride and glycerol in water has been found to be highly effective and economical, other combinations of salts, and humectants of the character previously described can be employed.

Other objects and advantages of the present invention will be apparent from a consideration of the following specification and accompanying diagrammatic drawinngs, wherein:

FIG. 1 is a schematic section of a laminate formed in accordance with the present invention; and

FIGS. 2, 3, 4 and 5 are similar views of modified forms of laminates in accordance with the present invention.

Thus, referring to FIG. 1, the laminate is comprised of a layer of machine glazed paper **10** having a characterizing densified surface area or thickness **11**, the latter being coated with a paper coating composition **12**. To the opposed undensified layer of the web **10** there is bonded, by means of adhesive **13**, a sheet of conventionally formed paper **14**, of substantially uniform porosity which in the illustration is uncoated. As will also be noted from the illustration of FIG. 1, the machine glazed web **10** is relatively thinner than the web **14**.

It will be understood that the laminate of FIG. 1 may be subjected to calendering or supercalendering which in addition to enhancing the density of the coating **12** will also provide some polish to the exposed surface of the web **14**.

Machine glazed paper web **10** as its name implies, has a zone or thickness **11** defining one surface of flattened, smooth densified fiber character having a glossy surface finish.

Such machine glazed paper is per se conventional and well known in the art resulting from the drying of a web such as 50% moisture content and upwards against a polished surface of a relatively large drum known as a Yankee dryer and stripping it therefrom in dried condition. Such Yankee dryer drums generally have a diameter from about 9 to about 15 feet composed of cast iron or steel having a highly polished surface which is steam heated, whereby when the wet web is dried in pressed contact therewith it develops a fine, glazed smooth surface and the fibers adjacent to the surface become densified as at **11** providing a sheet of characteristic formation known as machine glazed, and sometimes described as having an "ironed" appearance.

In accordance with the present invention the opposed or undensified surface of the web **10** is left uncoated so that the remaining thickness of the web **10** is relatively absorbed and can be coated or impregnated with an aqueous solution of a humectant and/or water-soluble ionizable salt, as will be hereinafter more fully discussed, before being laminated.

Desirably, this impregnant is applied by means of a roll to the undensified surface of the machine glazed web **10** and the degree of penetration can be controlled by the amount of coating applied by means of spacing of the roll coater or by trailing or doctor blade means as will be understood by those skilled in the paper coating art.

If desired the adhesive can also contain humectant and/or water-soluble ionizable salt.

The sheet **14** which is laminated to the sheet **10** in the form illustrated in FIG. 1 is conventional uncoated paper and thus is preferably thicker than the ply **10**, although not essentially so. This web **14** thus being relatively porous can be readily impregnated with desired concentrations of humectant and/or water-soluble ionizable salt by passing the entire sheet through the body of a solution of such material or in the alternative if it is desired to apply such humectant and/or water-soluble ionizable salt in strata, one or both of the surfaces of the sheet **14** can be coated by means of roll coating as above described with a solution of the aforesaid impregnant.

As previously indicated, the assembly can be then subjected to calendering or supercalendering to provide added densification but the laminate must be first formed by adhesive bonding of the separately formed and dried plies **10** and **14**.

By the practice of the present invention great control of the electrical properties of the component plies of the laminate can be obtained as will be apparent by employing different types of webs, and by controlled impregnating or coating of the webs with the humectant and/or water-soluble ionizable salt, which materials may also be incorporated in the adhesive or not as desired, and thus enable the production of laminates of a wide range of electrical properties.

In addition to the conductive agents heretofore indicated as useful, other known conductive agents are for example alkanol amines, polyglycols, quarternary ammonium compounds, alcohol phosphates polyoxyethylene derivatives, etc. Another specific suitable conductive agent is alkyl tolyl methyl trimethyl ammonium chloride, also known as Hyamine 2389, which may be used with equal parts of water. Another suitable conductive agent is Dow resin QX 2611.7 described in United States Patent 3,011,918. Similarly, triethanolamine may be used mixed with equal parts by weight of water. Other compounds useful as conductive agents are described in United States Patents 2,723,246 and 2,723,256.

The coating **12** may be of conventional paper coating composition comprising mineral pigment and binder which may be of amylaceous or proteinaceous character and preferably in the practice of the present invention the binder for the coating composition **12** preferably includes a polymeric synthetic material such as a resin or latex, an example of which is as follows in parts by weight:

Example 1

	Percent solids
100 clay	69.5
5 starch	25.0
25 butadiene-styrene copolymer latex	48.0

While paper coating compositions **12** are known and conventional, the laminates of the present invention characterized by such coating compositions and applied to the machine glazed surface of the machine glazed paper **10** provides added and novel density, smoothness and a solvent penetration barrier for coatings to be subsequently applied over the coating **12** employed in the production of electrostatic printing paper as aforesaid. A top solvent holdout coating of the foregoing material

is suitably applied to the machine glazed paper surface in the amount of from about 4 to about 6 pounds per ream.

Other mineral pigments known to the paper coating art can be employed in whole or partial replacement of the clay such as titanium dioxide, calcium carbonate and zinc oxide. Other adhesives are casein, soybean protein, and various synthetic polymeric materials in aqueous dispersion such as polyvinyl acetateacrylic copolymer resin, polyethylene, polyvinylbutyral, various copolymers of acrylonitrile with butadiene, polyvinyl acetate, vinylidiene chloride, and the like. Thus another example of suitable top coatings **12** in parts by weight is as follows:

Example 2

Titanium dioxide	240
Coating clay	560
Dispersing agent	5
Ammonia diluted with 12 parts water	12
Rhoplex B–20–A (46% solids acrylic copolymer resin aqueous dispersion as in U.S. Patent 2,795,564)	1305

FIG. 2 illustrates a modified form of laminate wherein two machine glazed webs **10**, **10'** are adhesively bonded to each other back to back, that is with their machine glazed faces **11**, **11'** outermost. In this case, while the machine glazed face **11** carries coating **12** the machine glazed face **11'** remains uncoated. However, due to this machine glazed character it still has a smooth surface which is desirable in passing the laminate through business machines because of its low friction character.

FIG. 3 is similar to the laminate of FIG. 2 but in this case the machine glazed surface **11'** also carries a paper coating composition **12'** so that both faces of the laminate are coated with paper coating composition which may be the same or different.

FIG. 4 is similar to the laminate of FIG. 1 with the exception that the paper sheet **14** carries a layer of coating composition **15** on the outermost surface thereof which may be the same or different from the coating composition **12** on the machine glazed paper web **10**.

FIG. 5 is a laminate composed of more than two plies and for the purpose of illustration and not limitation shows a composite of three plies, this being similar to the arrangement of FIG. 2 with an intermediate layer of undensified paper **14** disposed between and adhesively bonded to the two outer machine glazed surfacing sheets **10** and **10'**, the uppermost sheet **10** being shown carrying a paper coating composition **12**.

In the alternative, the machine glazed paper layer **10'** can be another layer similar to the undensified paper layer **14**. This third ply can be impregnated the same as the other two plies are not impregnated. Further, this third ply as well as the other plies shown in FIG. 4 and the other preceding figures can be impregnated with either a humectant such as glycerol and a water-soluble, water-stable ionizable metal salt such as potassium chloride, or a combination of both. As further alternatives the laminate may be constructed so that the conductive agent, i.e. the water-soluble, water-stable ionizable metal salt, is in one or more plies or only in the adhesive layer or layers.

Although electrostatic printing is generally confined to one side of a conventional paper, or to one side of the present paper laminates, by applying a dielectric coating composition over the coating **12**, such as a coating of resin dissolved in a hydrocarbon solvent, i.e. toluene, or a coating composed of a hydrocarbon solvent solution of resin having dispersed therein particles of photoconductive materials such as zinc oxide, such photoconductive coatings can also be applied to the opposed side of our laminates such as for example the laminate shown in FIG. 3 which carries coatings **12** and **12'** on its opposed faces, where it is desired to print by electrostatic means the opposed surfaces of the laminate.

Other examples of suitable dielectric coating compositions which can be applied over our top coating layer **12** are described in U.S. Patent No. 3,052,539 to Greig comprising dielectric resins and solvents therefor and photoconductive particle material such as zinc oxide suspended therein. Other examples of solvent solutions of resins without photoconductive particle material are shown in Relph et al. U.S. Patent No. 3,075,859.

Not only does the laminate of the present invention provide rigidity and stiffness so that the paper will run through the machine without jamming or other transport problems, but in addition the second or third sheet of the laminate provides added body for absorption of the humectant-salt solution for the laminates of the present invention. Thus although the machine glazed sheet employed, due to its inherent partial densification, has a limited absorbability and in general is impregnated or rather sprayed, roll or blade coated on its undensified side rather than passing it through a body of impregnant so as to maintain its dense surface thickness formation, added bulk, rigidity and impregnant holding capacity is provided by the second web bonded thereto.

Thus, a very thin ply of machine glazed paper can be laminated to a relatively bulky second ply to achieve not only good absorbability and required electrical properties, but further it is thus possible to incorporate more conductive agent in two plies than in a single ply. This increase in bulk is also adaquately accomplished by laminating two plies of machine glazed paper back to back since the two absorbent zone components of these sheets can provide adequate absorbability whereas the employment of one machine glazed sheet alone might not be adequate to give required electrical properties.

Rigidity resulting from the laminated structure is in part due to the greater thickness of paper which can be made by this means. Since stiffness or rigidity is greatly dependent on thickness used, this is an important advantage of the present invention making it possible to produce low-density, thick papers, that is to say, by the practice of the present invention one can make a rigid paper of low basis weight. Thus, for example, we have been enabled by the practice of the present invention to prepare laminates which range from about 250 to about 350 milligrams in force or Gurley stiffness. Moreover, the finished caliper of a two-ply paper where one ply is machine glazed paper can be a total of 5 mills, the top or machine glazed ply making up from about 1½ to about 2 mills in thickness and the second bulky ply as of FIG. 1 making up from about 2½ to about 3 mills. The adhesive layer **13** adds further bulk to the paper by swelling the adjacent webs.

As previously indicated, it is possible by the practice of the present invention to provide enhanced stiffness with low basis weight, thereby in a sense giving more yardage per pound of paper, it being known that the rigidity or stiffness of paper is related to the third power of the thickness.

The practice of the present invention gives good electrical conductivity and by treating it with humectants such electrical conductivity is maintained over the range of 10 to 90% relative humidity. Thus, using laminates impregnated with a conductive agent made of an aqueous solution of potassium chloride and glycerol it has been possible to make papers which are highly conductive over a broad range of relative humidity having a resistivity of from about 10^{11} at 10% relative humidity to about 10^{6} at 90% relative humidity.

These resistivities are obtained by treating the plies of the laminate prior to lamination with the impregnants and it has been found that a total of from about 4 to about 8 pounds of potassium chloride-glycerol in 60-pound basis weight laminate paper will give the required resistivity for electrostatic printing paper. It has also been found

in accordance with the practice of the present invention that the most satisfactory means for incorporating the aforesaid agents into the paper plies is by sizing or impregnating the plies prior to lamination. Thus, in a two-ply laminate it has been found that good conductivity can be achieved by applying the conductive agent in the lower ply although the best conductivity is achieved by applying to both plies of the two-ply laminate.

In general in producing the laminates of the present invention, each of the paper plies is separately made on conventional paper making equipment and separately treated. Thus, the machine glazed ply **12**, after being dried on a Yankee dryer to give it its characterized densified smooth surface, is coated on its undensified backside with humectant and/or conductive salts from an aqueous solution thereof, dried, and then coated on the machine glazed side with a solvent holdout coating which can be a paper coating composition such as one of mineral pigment and binder and which desirably includes materials such as a resin or rubber latex. The second or relatively bulky ply **14** can be coated on its opposed sides with the coating conductive agent solution or wholly impregnated therewith. This ply is desirably not calendered before lamination and thereafter the two plies are laminated together by means of an aqeous adhesive and dried to make the final conductive substrate for electrostatic printing. The laminating adhesive is normally applied to the least absorbent of the two plies, that is, the backside of the machine glazed web **10**, so as to achieve maximum adhesion without curl. The laminating can be accomplished by any conventional laminating apparatus.

With the present type of laminate construction, it is possible to impart electrical conductivity on either surface of the laminate or through the laminate by treating one of the plies or both of them, and it is thus possible to impart electrical conductivity to the top surface by treating only the upper or machine glazed ply and leaving the lower ply, whether it be the relatively bulky ply **14** or the second machine glazed ply **10'** as in FIGS. 1 and 2 respectively.

Conversely, it is also possible to impart conductivity to the lower surface of the laminate and leave the top surface or ply unconductive by merely treating the lower ply with the electrically conductive material. Furthermore, it is possible to achieve both the surface and lateral and transverse conductivity by treating both plies with the conductive agent.

Thus, it is possible in accordance with the practice of the present invention to produce a laminate in which there are areas throughout its thickness which can exhibit precisely controlled electrical conductivity or very electrically distinct layers in a single unitized laminate. As it will thus be apparent, it is possible in accordance with the practice of the present invention to provide a unitized composite wherein the operative top surface has a specialized character and yet the laminate as a whole remains relatively inexpensive. That is to say, the bulk of the paper can be made up of lower-cost second or lower ply as in the form of laminates of FIGS. 1 and 4 wherein the bulk of the laminate is made up of lower-cost paper without special surface properties. At the same time, the characterizing top or machine glazed ply aids in providing the necessary solvent resistance or solvent holdout when applying thereover a solution of dielectric coating composition while the second or lower ply functions to provide required thickness, rigidity and electrical conductivity.

Another advantage of the present invention is that it is not necessary that the conductive agent, i.e. the water-soluble, water-stable ionizable metal salt, be uniformly distributed throughout the body of the laminate. On the contrary, it can be confined to one or more strata of the laminate so that this agent may be used in the most efficient manner possible.

The adhesive layers **13** can also contribute to or modify the desired electrical properties of the laminate by including or omitting therefrom the impregnants which

may be employed in the other paper plies. Thus, for example, the adhesive can be composed in parts by weight as follows:

Example 3

Dextrin	2,000
Clay	1,000
Borax	6
Water	4,116

Example 4

Another example is one composed in parts by weight of:

Water	70
Casein	21
Sodium hydroxide	3
Sodium alpha-naphthaline sulfonic acid	6

Other adhesives may be aqueous latices such as butadiene styrene copolymer; polyvinyl acetate emulsions; aqueous solutions of polyvinyl alcohol, and the like. These can contain about 10–20% by weight of a composition composed in parts by weight as follows:

Example 5

Glycerol	40
Potassium chloride	15

A typical adhesive formulation containing the foregoing, is as follows, in parts by weight:

Example 6

Polyvinyl alcohol	64
Boric acid	5
Clay	320
Phosphoric acid	5
Potassium chloride	20
Glycerol	200
Water	500

Other water-soluble ionizable salts which can be used are sodium chloride, calcium chloride and others as in the patents hereinbefore noted, and as further described in U.S. Patent No. 3,075,859 which also lists various other suitable humectants.

The laminates of the present invention can be formed with very small amounts of adhesive due to the fact that the surfaces that are laminated are of relatively porous character, that is uncoated and preferably undensified. Therefore, a substantial merger of the two mating surfaces can be effected with a minimum amount of adhesive such that the adhesive does not appreciably interfere with the electrical conductivity provided in the adjacent plies by the ionizable salt impregnant.

Example 7

The following is an example of a specific laminate formed in accordance with the present invention:

A machine glazed ply of paper composed of kraft and sulfite pulp and dried on a Yankee dryer having a relatively impervious smooth side and an absorbent backside and having a basis weight of 2 pounds and a thickness of .002 inch was treated on its backside with 1 pound (basis weight) of solution of a conductive agent and humectant composed of aqueous sodium chloride and glycerine in water, and then dried. This sheet was then coated on its smooth machine glazed surface with 4 pounds of an aqueous paper coating composition having 65% solids content composed of 69.5 parts of clay, 1.25 parts of starch, 13 parts of butadiene styrene copolymer latex and 46.25 parts of water. After drying this prepared sheet was then laminated to a second paper web of uniform porosity by applying an aqueous adhesive to the uncoated side of the machine glazed web, now carrying a top coating and impregnated on its undensified side. The second undensified web had a thickness of .0024 inch and

was composed of a mixture of groundwood, sulfite and kraft pulp. This second web before being laminated to the former was treated on its opposed sides with 3 pounds of conductive agent as aforesaid by passing the web over a blade which held a pool of the fluid aqueous conductive-humectant agent against the web, and dried before lamination. This laminate had a basis weight of 60–65 pounds per 33,000 square feet (25 x 38)—500; a caliper of .0052 inch; a Gurley stiffness at 73° F. and 50% relative humidity of 300 milligrams; and IGT toluene holdout of 15.9 cm. and electrical resistance as follows:

Electrical Resistance at 73° F.	11±2% RH	50±2%	80±5%
Hart Moisture Meter	DE	KM	M
Surface Resistivity, ohms	2×10^{11}	4×10^{8}	3×10^{7}

In the foregoing IGT toluene holdout is an instantaneous absorption test using toluene in place of dibutyl phthalate and described in IGT Nieuws 11, No. 11/12, 178–80 November/December 1958; I.P.C. Bulletin 29, #9, 5380, 1958–1959. The surface electrical resistance described above is measured in accordance with the method of Hayek & Chromey, American Dyestuff Report, April 2, 1951, pages T225–227.

Example 8

In another specific example two machine glazed sulfite paper webs each having a thickness of .0015 were treated on their absorbent backside with approximately 1–2 pounds of conductive agent in aqueous solution, dried, and the opposed surfaces coated with 4 pounds of latex-starch-clay paper coating composition, dried, and laminated by applying adhesive to their uncoated surfaces and applying them to the opposed faces of a bulky groundwood paper, having a thickness of .0025 inch which had been previously impregnated with a solution of conductive agent as in the foregoing example. This 3 ply laminate gave two electrostatic printing surfaces and a center ply which gave rigidity and added electroconductive material capacity.

Example 9

In another example a .002 inch thickness sulfite machine glazed sheet was coated on its machine glazed surface with a paper coating composition as in previous examples but was not impregnated on its underside with a conductive agent. This was bonded to a .0024 inch thick groundwood sheet which had been impregnated with 3 pounds of an aqueous solution containing potassium chloride and glycerine. This construction had a relative nonconductive top ply and a conductive lower ply while retaining the advantage of the laminated structure, thus the top ply which was coated for solvent resistance and the lower ply provided rigidity and carried the conductive agent. This laminate had the following properties:

Basis Wt.	63.8 lbs./3,300 ft.²		
Caliper	.0051″.		
Gurley Rd Stiffness	294 mg.		
IGT Toluene Holdout	15.8 cm.		
Electrical Resistance at 73° F.	11±2%	50±2%	80±5%
Hart Moisture Meter	BC	GH	M
Surface Resistivity, ohms	8×10^{11}	3×10^{9}	3.5×10^{8}

Example 10

In another example a machine glazed sulfite sheet having a thickness of .002 inch was treated with 2 pounds of conductive agent as aforesaid on its backside consisting of a solution of sodium chloride glycerine and water. The machine glazed surface was subsequently coated with 4 pounds of a toluene resistant coating composition, dried, and then laminated to a .0024 inch thick groundwood paper that was untreated. The laminated paper had the following physical properties:

Basis Wt.	64.8 lbs./3,300 ft.².		
Caliper	.0049″.		
Gurley Rd Stiffness	263 mg.		
IGT Toluene Holdout	15.8 cm.		
Electrical Resistance	11±2%	50±2%	80±5%
Hart Moisture Meter	AB	FG	M
Surface Resistivity, ohms	3×10^{11}	5×10^{8}	6×10^{7}

Example 11

In another example a .002 inch thickness sulfite machine glazed paper was coated on its machine glazed surface with 4 pounds of a toluene penetration resistant paper coating composition composed of titanium dioxide coating clay and an aqueous dispersion of Rhoplex B–60–A resin previously described. The underside of this sheet was left untreated and it was laminated to an untreated groundwood paper web of .0024 inch thickness using an electrically conductive adhesive composed of polyvinyl alcohol, clay, potassium chloride, glycerol and water as previously described. The laminated paper thus produced consisted of 3 plies or strata, that is nonconductive paper web to conductive adhesive to nonconductive paper web, and the following physical properties were observed:

Basis Wt.	63.5 lbs./3,300 ft.².		
Caliper	.0048″.		
Gurley Rd Stiffness	320 mg.		
IGT Toluene Holdout	15.9 cm.		
Electrical Resistance at 73° F.	11±2%	50±2%	80±5%
Hart Moisture Meter	BC	DE	M
Surface Resistivity, ohms	8×10^{11}	8×10^{10}	5×10^{8}

We claim:

1. A laminate for use as an electrostatic printing paper base comprising a plurality of plies of adhesively bonded paper webs, a first surface of one of said webs forming an outer defining face of the laminate and being relatively non-porous and defined by a smooth, densified fiber zone, the opposed surface of said web being defined by a relatively porous undensified fiber zone and bonded thereat by an interposed ply of adhesive, to a similarly porous undensified adjacent surface of a second web defined by a relatively porous undensified fiber zone thereof, said relatively non-porous, smooth, densified fiber zone being resistant to penetration of subsequently applied dielectric coating composition solvent.

2. The laminate of claim 1 wherein said first surface carries a coating of mineral pigment and adhesive.

3. The laminate of claim 1 wherein the opposed surfaces of the laminate each carry a coating of mineral pigment and adhesive.

4. The laminate of claim 1 wherein said first surface carries a first coating of mineral pigment and adhesive and a second coating thereover of a dielectric forming resin.

5. The laminate of claim 1 wherein said first surface carries a first coating of mineral pigment and adhesive and a second coating thereover of a dielectric forming resin having dispersed therein photoconductive particle material.

6. A laminate for use as an electrostatic printing paper base comprising a plurality of plies of adhesively bonded paper webs, a surface of one of said webs forming an outer defining face of the laminate and being relatively non-porous and defined by a smooth, densified fiber zone, the opposed surface of said web being defined by a relatively porous undensified fiber zone and bonded thereat, by an interposed ply of adhesive, to a similarly porous

undensified adjacent surface of a second web defined by a relatively porous undensified fiber zone thereof, at least one of said plies containing water-soluble, water-stable, ionizable metal salt, said relatively non-porous, smooth, densified fiber zone being resistant to penetration of subsequently applied dielectric coating composition solvent.

7. A laminate for use as an electrostatic printing paper base comprising a plurality of plies of adhesively bonded paper webs, a surface of one of said webs forming an outer defining face of the laminate and being relatively non-porous and defined by a smooth, densified fiber zone, the opposed surface of said web being defined by a relatively porous undensified fiber zone and bonded thereat, by an interposed ply of adhesive, to a similarly porous undensified adjacent surface of a second web defined by a relatively porous undensified fiber zone thereof, at least one of said plies containing water-soluble humectant, said relatively non-porous, smooth, densified fiber zone being resistant to penetration of subsequently applied dielectric coating composition solvent.

8. A laminate for use as an electrostatic printing paper base comprising a plurality of plies of adhesively bonded paper webs, a surface of one of said webs forming an outer defining face of the laminate and being relatively non-porous and defined by a smooth, densified fiber zone, the opposed surface of said web being defined by a relatively porous undensified fiber zone and bonded thereat, by an interposed ply of adhesive, to a similarly porous undensified adjacent surface of a second web defined by a relatively porous undensified fiber zone thereof, at least one of said plies containing water-soluble, water-stable, ionizable metal salt and humectant, said relatively non-porous, smooth, densified fiber zone being resistant to penetration of subsequently applied dielectric coating composition solvent.

9. A laminate composed of a plurality of plies of adhesively bonded paper, one of said plies comprising an uncoated web of substantially uniform density and substantially equal opposed porous surface characteristics, and another ply comprising a relatively thinner web, the latter having one uncoated porous face adhesively bonded to a surface of the former web, the opposed surface of the thinner web forming an outer defining face of the laminate being relatively non-porous and defined by a flattened, smooth, densified fiber zone.

10. A laminate composed of two layers of paper bonded by a layer of adhesive interposed between said plies and adapted for use as an electrostatic printing paper base, one of said paper layers comprising a web of substantially uniform density and substantially equal opposed porous surface characteristics, and a second paper layer having one uncoated porous face adhesively bonded to a surface of the former web, the opposed surface of the second web, forming an outer defining face of the laminate and being relatively non-porous and defined by a flattened, smooth, densified fiber zone, at least one of said layers being impregnated with electroconductive material, said smooth, densified, laminate defining surface carrying a coating of mineral pigment and binder and being resistant to solvent penetration.

11. The laminate of claim 10 wherein the opposed surface of said laminate also carries a coating of mineral pigment and binder.

12. A laminate for use as an electrostatic printing paper base comprising two plies of adhesively bonded paper webs, one surface of each of said webs forming outer defining faces of the laminate being relatively non-porous and defined by a smooth, densified fiber zone, the opposed surfaces of said webs being defined by a relatively porous undensified fiber zone and bonded thereat, by interposed adhesive, said relatively non-porous, smooth, densified fiber zones being resistant to penetration of subsequently applied dielectric coating composition solvent.

13. The laminate of claim 12 wherein one surface of the laminate carries a coating of mineral pigment and binder.

14. The laminate of claim 12 wherein both surfaces of the laminate carry a coating of mineral pigment and binder.

15. The laminate of claim 12 wherein at least one of said plies are impregnated on the inner face with an aqueous solution of humectant and water-stable, ionizable metal salt.

16. The method of forming a laminate for use as an electrostatic printing paper base comprising densifying a portion of the thickness of a relatively porous paper web at one surface thereof to form an outer defining face of relatively non-porous, smooth, solvent-penetration resistant character, coating said smooth surface with an aqueous composition of mineral pigment and binder, adhesively bonding the opposed relatively porous undensified surface of said web to a similarly porous undensified adjacent surface of a second web defined by a relatively porous undensified fiber zone thereof and impregnating at least one of said plies prior to lamination thereof with water-soluble, water-stable, ionizable metal salt and a humectant.

17. The method of forming a laminate for use as an electrostatic printing paper base which comprises adhesively bonding the relatively porous undensified surface of a machine glazed paper web to a similarly porous undensified surface of a second paper web and impregnating at least one of said plies prior to lamination with water-soluble, water-stable, ionizable metal salt and a humectant.

18. The method of forming a laminate for use as an electrostatic printing paper base which comprises adhesively bonding the relatively porous undensified surface of a machine glazed paper web to a similarly porous undensified surface of a second paper web, impregnating at least one of said plies prior to lamination with water-soluble, water-stable, ionizable metal salt and a humectant, coating said smooth surface with an aqueous composition of mineral pigment and binder, drying said coating and applying thereover a second coating comprising a solution of dielectric material.

19. The method of claim 18 wherein the solution of dielectric material comprises a hydrocarbon solvent solution of a resin.

20. The method of claim 18 wherein the solution of dielectric material comprises a hydrocarbon solvent solution of a dielectric resin having dispersed therein photoconductive particle materal.

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