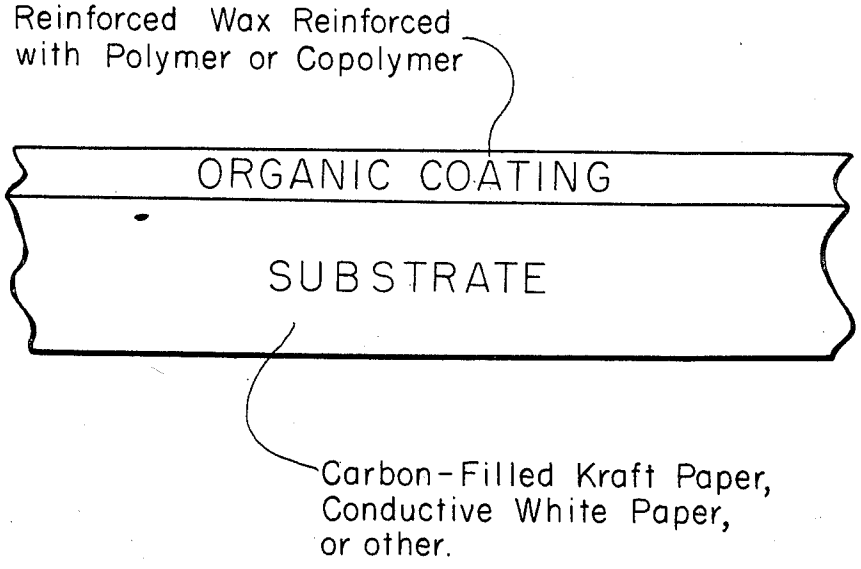
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ELECTROSTATIC PRINTING MEDIA

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ELECTROSTATIC PRINTING MEDIA

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This invention relates to pressure fixing electrostatic printing media and more particularly to electrostatic printing media adapted for use with dry pressure fixing inks.

Electrostatic printing has reached a high degree of prefection and apparatus have been developed to place many hundreds of characters on printing media per minute. An example of high speed electrostatic recording apparatus is that shown and described in United States Patent 2,919,170 issued to Herman Epstein. When utilizing high speed equipment such as that described in the aforementioned United States patent, it is necessary to provide a proper dielectric medium for reception and recording of the electrical signals in order to obtain a clear, non-smudging reproducible copy. Optimum results may be obtained with a coated paper consisting of a thin, strong, smooth electroconductive paper base sheet coated on one side with a continuous film of a high dielectric strength organic composition.

The base or substrate paper of the printing media must be electrically conductive and of uniform thickness, as well as free of pinholes and loose surface fibers. The paper also must have an electrical resistance within a given range to operate as the substrate for electrostatic printing media.

The organic coating applied to the substrate paper is the most critical component of an electrostatic printing media. The coating must strongly adhere to the paper substrate and have good insulating properties as well as an optimum combination of physical properties. For example, the coating must be tough and strong, i.e., it must have high tensile strength and crack resistance to prevent cracking and breaking, as well as being sufficiently flexible, smooth and plastically deformable to allow bonding of dry ink particles by mechanical pressure without adhering to the pressure roll. Also, the media must be non-hydrophilic to prevent moisture pick-up.

The drawing illustrates the article of the present invention.

Generally stated, this invention is directed to unique electrostatic printing media that are tough, flexible, non-blocking and sufficiently strong to withstand pressures exerted by the printing machines during the pressure fixing of dry ink. The printing media in this invention have a unique combination of physical and electrical properties which adapt them for use with electrostatic printing machines to either make single copies or a plurality of copies.

The paper substrate for the printing media of this invention is preferably a carbon-filled kraft paper which may be about 0.001 inch to about 0.005 inch thick. Also, suitably conductive white paper up to .015 inch may be used. The substrate paper has an electrical resistance of from about 150,000 ohms per square plus or minus 75,000 ohms, however, a resistance as high as 10 megohms per square is operable. The organic coating applied to the substrate paper to provide the electrostatic printing media is a dielectric coating of from about 0.0001 inch to about

0.002 inch thick. The organic coating, of necessity, must be thick enough to form a continuous dielectric film over the paper with a dielectric breakdown strength of at least 500 volts and preferably 1000 volts/mil. The thickness of the coating is determined by the finish on the base paper and the smoother, calendared papers will, of course, be operable with thinner coatings thereon.

The organic coating compositions of this invention that are used to coat the substrate paper possess a unique combination of physical and electric properties. For example, the coatings are plastically deformable so as to be capable of retaining ink particles that are pressure fixed thereon. This characteristic is herein referred to as pressure fixability. They are not tacky and therefore do not adhere or transfer to the pressure rolls and are non-blocking. Penetration hardness is a measurement of the plastic deformability of coatings that are pressure fixable and generally the coatings of this invention have a preferred penetration hardness (ASTM D1321–57T) between about 0.6 and 4 mm. at 125° F. As a further measure of pressure fixability, these coatings do not adhere to a 1″ diameter polished, chrome-plated cylinder rolled against it with a force of at least 10 lbs. per inch of cylinder length.

The coating compositions are non-conductive materials capable of retaining an electrical charge over an extended period of time. The charge-holding ability of the non-conductive organic coating materials is measured by the time that a charge is retained on the surface of the coating. The charge retention time is most conveniently measured as the half-life of surface charge retention, i.e., that time required for half the charge placed upon the surface of the coating to become dissipated therefrom. The coatings of this invention have half-life of from about ten minutes to many hours at 50 percent relative humidity. The coatings also have a dielectric strength of at least 500 volts/mil and preferably 1,000 volts/mil.

The organic coating compositions of this invention are characterized by having non-blocking characteristics, i.e., resistance to self-adhesion. Representative blocking tests consist of facing two tapes coating-to-coating and coating-to-back and holding them in contact for four hours at 125° F. under twelve pounds of pressure. If they do not adhere to one another under these conditions, they are considered non-blocking.

The organic coating compositions utilized in this invention are comprised of either a reinforced wax or an oxidized hydrocarbon polymer.

The waxes utilized in the preparation of the reinforced wax surface coating are those having a high degree of electrical resistance such as natural waxes, paraffin, hard microcrystalline waxes and synthetic waxes. Examples of waxes that might be utilized are carnauba, polymekon, ultracera amber wax, modified fatty acid ester wax, petroleum microcrystalline wax, refined paraffin and the like. The preferred polymers that may be added to the wax for reinforcing purposes are ethylene-vinyl acetate copolymers, ethylene-ethylacrylate copolymers, isotactic polybutene - 1, ethylene - vinylclohexane copolymers, polyeicosene polymers, oxidized polyethylene and the like. When a reinforced wax is utilized as the coating composition, the amount of reinforcing polymer or copolymer added to the wax is somewhat dependent upon the pressure utilized in a pressure fixing of the dry ink to the coating of the paper tape. Also, the physical properties of the reinforcing polymer, such as its molec-

ular weight, melt index, adhesion properties, etc., must be considered.

The more polar copolymers containing acetates and acrylates enhance the mechanical strength and adhesion of the wax compositions, however, the less polar hydrocarbon polymers are better insulators and hold an electrostatic charge longer.

If a more polar compound is utilized, such as the ethylene-vinyl acetate copolymers, they are contained in the wax copolymer blend in amounts from about 15 percent by weight to about 45 percent by weight of the total polymeric reinforcing wax composition. The preferred range of ethylene-vinyl acetate copolymer (containing 18 to about 28% vinyl acetate) utilized to reinforce the wax is from about 20 percent by weight to about 30 percent by weight.

If the less polar aliphatic hydrocarbon copolymers or oxidized hydrocarbon polymers are utilized in reinforcing the wax, they are used in amounts of from about 25 percent by weight to 100 percent by weight, i.e., a higher weight range, inasmuch as their reinforcing properties are not as great as the more polar compounds. The polar and non-polar reinforcing polymers may be blended to improve electrical properties and adhesive properties for ink fixing characteristics. It has been found that oxidized hydrocarbon polymers are themselves also useful as organic coatings. Thus, oxidized polymers derived from polyethylene, polypropylene, polybutene, styrene-butadiene copolymers, polybutadienes, vinylcyclohexane-ethylene copolymers, vinylcyclohexane-butadiene copolymers, styrene-ethylene copolymers, mixtures thereof and the like, also provide a proper coating without being mixed with paraffin compounds.

Those reinforced paraffin wax compositions containing from about 20 percent by weight to about 30 percent by weight ethylene-vinyl acetate copolymer or ethylene ethylacrylate copolymer have half-lives of about 6 to 9 minutes under high humidity conditions and from about one-half hour to one hour at 50 percent relative humidity or less. Paraffins reinforced with the less polar copolymers such as ethylene-vinylcyclohexane, isotactic polybutene-1, and polyeicosene polymers have a longer charge half-life of two hours or more. Representative compositions and their charge half-lives at high humidities are given in the examples hereinbelow.

It has been found that the half-life of coating compositions such as the paraffin-ethylene-vinyl acetate copolymer compositions may be improved by adding dimerized rosin. Dimerized rosin contains two free acid groups which would be expected to decrease the charge-half-life, however, it has been found that compositions containing dimerized rosin in a paraffin-ethylene vinyl acetate copolymer composition exhibit an unexpected increase in charge half-life retention under high humidity conditions. Dimerized rosin has also been found to improve the charge half-life of oxidized hydrocarbon polymer compositions such as oxidized polyethylene compositions.

The reinforcing polymers that are utilized in the reinforced wax coatings of this invention should have a relatively low molecular weight to yield compositions of the desired melt viscosity and to be compatible with the wax. An important property of the coating compositions of this invention is the melt viscosity which is within a range that is suitable for hot melt coating. Copolymers with a melt index between about 0.5 and 30 (ASTM D-1238-57T) are preferred, although a melt index as low as 0.09 may be useful. Those copolymers which yield a reinforced wax composition with a viscosity of from about 2,000 to about 10,000 cps. in the range of 250-350° F. are preferred. Compositions with viscosities as low as 375 cps. at 250° F. were coated successfully with a doctor blade type coater. Coatings more viscous than 10,000 cps. can be used, but coating speeds must be reduced to prevent tearing of the paper substrate.

The manner in which the organic coatings are prepared as well as the specific composition of the coating, is dependent upon the aforementioned physical and electrical properties. It will be noted that materials such as pigments, hardeners, and tackifying agents may be added to the coating composition to provide desirable physical and electrical properties. It is desirable that the coating ingredients, with the exception of pigments, be miscible. Chemically unreactive pigments such as zinc oxide, titanium oxide, magnetite, calcined silica, diatomaceous earth, barytes and the like have been added to the coating composition to provide proper physical and electrical properties. Agents such as emulsifiable, oxidized polyethylene and carnauba wax will harden the paraffin-reinforcing resin compositions. Some of the low molecular weight hydrocarbon polymers and polystyrene resins will tackify the compositions and enhance ink adhesion and flexibility.

The reinforced wax or oxidized hydrocarbon polymer coatings may be applied to paper by various methods. For example, they may be applied to the paper as a hot melt by means of a curtain coater, roller coater, dip coater or the like to a thickness of 0.0001 to more than 0.002 inch. It is important that a continuous layer be provided on the substrate which will effectively seal the pores at the surface of the paper base sheet and block the passage of charge from the dielectric surface through the conductive base sheet.

When curtain coating is utilized, the composition should have a viscosity of from about 1,000 to 10,000 cps. at the coating temperature. When an ethylene-vinyl acetate copolymer is mixed with paraffin, it may be coated at a temperature of from about 250° F. to about 350° F. at paper speeds of from about 500 to 1500 feet per minute. The coating thickness may vary from 0.1 mil to more than 2 mils. Though it has been found that one coating is ordinarily sufficient for application to paper, two coatings may be applied for more complete coverage and/or a smoother coating.

Compositions are desired which do not cause the coated paper to curl. A smooth, flat, coated sheet is desired for automatic feeding in printing machines. Coating compositions which shrink excessively on cooling and which are elastic will cause the coated paper to curl as the hot melt coating cools. The compositions disclosed herein deform plastically, and will stress relieve to form flat coated sheets. Low molecular weight resins yield less elastic compositions which stress relieve sooner than more elastic compositions made with higher molecular weight resins.

In the examples set forth hereinbelow, the preferred compositions of this invention and their physical properties are described. The first example illustrates the compounding of the ingredients utilized in making a typical reinforced wax coating of the electrostatic printing media and those examples following Example 1 are set forth in tabular form to indicate certain physical and electrical properties of the coating materials.

EXAMPLE 1

100 parts of paraffin wax having a melting point of 151° F. was melted and 40 parts of ethylene-vinyl acetate copolymer (28% vinyl acetate; melt index 6) along with 60 parts of dimerized rosin were added thereto. The mixture was stirred vigorously for approximately 30 minutes at 250° F. to dissolve the ingredients. The copolymer-wax-rosin composition was applied at a thickness of 0.0015 inch to a carbon-filled kraft paper that was about 0.003 inch thick by means of a curtain coater. The coating had very good coating-to-paper adhesion and did not crack, break, smear or adhere to the fixing roll when passed through a printing machine. A dry electrostatic ink powder was firmly pressure-fixed to the surface of the coating to determine the pressure fixability of the surface coating. The coated paper had no tendency to block, i.e., adhere to itself, after four hours at 12 p.s.i. at 125° F.

The above coating as well as those coatings in Examples 2 through 23 were tested for physical and electrical properties which are shown in tabular form in the table hereinbelow.

TABLE I

Ex.	Coating component	Component Properties: Parts by wt.	Melting point	Melt (1) index	Molecular weight	Coating Properties: Penetration (2) Hardness, .1 mm. 72° F.	125° F.	Viscosity cp. at 250° F.	Charge Half-life humidified tape
1	Ethylene-vinyl acetate	4	(3) 310° F.	5-7		4	9		3-6 hrs.
	Paraffin	10	151° F.						
	Dimerized rosin	6	302° F.						
	Polyeicosene	3							
2	Oxidized polyethylene	1	(3) 106° F.		7,000	6	12		9 min.
	Paraffin	6	151° F.						
3	An oxidized polyethelene	10	(3) 106° F.		7,000	5	8	12,500	6 hrs.
4	Ethylene-vinyl cyclohexane copolymer	3	100° C.	0.009	130,000	4	11		2-6½hrs.
	Paraffin	7	151° F.						
5	Ethylene-vinylacetate copolymer, 28% VAC	5	(3) 280° F.	12-18		9	39	1,200	7 min.
	Paraffin	15	151° F.						
6	Ethylene-vinylacetate copolymer, 18% VAC	5	(3) 390° F.	2-3		8	26	2,500	6 min.
	Paraffin	15	151° F.						
7	Oxidized polyethelene	12	(3) 106° F.		7,000	4	10	1,550	2-6 hrs.
	Paraffin	8	151° F.						
8	Oxidized polyethylene	8	(3) 106° F.		7,000				
	Dimerized rosin	4	302° F.			3	12	800	Over 6 hrs.
	Paraffin	8	151° F.						
9	Oxidized polyethelene	8	(3) 106° F.		7,000	4	18	375	2-6½ hrs.
	Paraffin	12	151° F.						
10	Isotactic polyethylene	7		10	150,000	10	32	11,500	1-2 hrs.
	Paraffin	15	151° F.						
11	Oxidized polyethylene	4	(3) 106° F.		7,000	6	8		Over 5 hrs.
	Waxy polyethelene	6	225-230° F.		5,000				
12	Oxidized polyethylene	4	(3) 106° F.		7,000	5	11		40-75 min.
	Waxy polyethylene	6	220° F.		2,000				
13	Ethylene-ethyl acrylate, 20% Ethyl-acrylate	2	(4) 127° F.	18		7	23	400	8 min.
	Paraffin	8	151° F.						
14	Oxidized polyethylene	19.6	(3) 106° F.		7,000	4	10	12,000	Over 6 hrs.
	Hydrocarbon resin	0.4	(3) 100° F.		1,400				
15	Ethylene vinylacetate copolymer, 18% vinylactate	2	(3) 390° F.	2-3					
	Dimerized rosin	3	302° F.			3	11		3-6 hrs.
	Paraffin	3	151° F.						
16	Oxidized polyethylene	6	(3) 106° G.		7,000				
	Paraffin	3	151° F.			4	8		Over 6 hrs.
	Polystyrene	1	(3) 75° F.		400				
17	Ethylene vinylactate copolymer, 28% vinylacetate	5	(3) 310° F.	5-7					
	Paraffin	10	148° F.			4	24	5,700	3 hrs.
	Dimerized rosin	5	302° F.						
18	Ethylene vinylacetate copolymer, 18% vinylacetate	15	(3) 390° F.	2-3					
	Ethylene vinylacetate copolymer, 28% vinylacetate	10	(3) 310° F.	5-7		3	15	4,000	20 min.
	Oxidized polyethylene	10	(3) 147° F.	1,900	7,800				
	Paraffin	65	151° F.						
19	Ethylene vinylacetate copolymer, 28% vinylacetate	21	310° F.	5-7					
	Paraffin	64	151° F.			5	17	9,000	15 min.
	TiO_2 pigment	15							
20	Ethylene vinylacetate copolymer, 18% vinylacetate	20	390° F.	2-3					
	Ethylene vinylacetate copolymer, 28% vinylacetate	5	(3) 310° F.	5-7		4	13	4,600	1½ hrs.
	Dimerized rosin	5	302° F.						
	Paraffin	61	148° F.						
	TiO_2 pigment	9							
21	Isotactic polybutene	27.5		10	150,000				
	Paraffin	58.8	151° F.			6	19		½ to 1 hr.
	Oxidized polyethylene	5		750,000	1,200				
	TiO_2 pigment	8.7							
22	Ethylene vinylacetate copolymer, 28% vinylacetate	24.5	(3) 276° F.	15					
	Paraffin	36.5	148° F.						
	Polyethylene	24		390	7,000				
	TiO_2 pigment	15							
23	Ethylene vinylacetate copolymer, 28% vinylacetate	40	(3) 276° F.	15					
	Paraffin	60	148° F.			6	21	10,000	1 min.
	TiO_2 pigment	15							

(1) ASTM D-1321-57T.
(2) ASTM D-1238-57T.
(3) Ball & Ring.
(4) Vicat Soft. Pt.

In the table, coating compositions of reinforced wax as well as oxidized hydrocarbon polymers, i.e., oxidized polyethylene are set forth to illustrate the various compositions that may be made in accordance with this invention. It should be noted that these coatings are pressure fixable, i.e., will retain dry ink particles on the surface thereof. Also, it will be noted that the half-life varies between about six minutes and in excess of 6 hours on specimens held at about 12 hours at 100 percent relative humidity and then tested immediately at about 50 percent relative humidity. The penetration hardness in each case was between 0.7 and 4 mm. at 125° F. and less than one mm. at 72° F., i.e., room temperature.

The specific physical properties of the substrate paper are not set forth in the table, however, the resistance of the substrate paper in each case was less than 1 megohm per square.

What is claimed is:

1. A non-blocking, pressure-fixing, electrostatic printing media adapted to be used with dry ink powder, comprising an electrically conductive paper substrate having a dielectric coating composition thereon, said coating composition selected from the group consisting of reinforced wax and oxidized hydrocarbon polymers, said coating composition characterized in having a charge half-life of at least six minutes under humidity conditions in excess of 50 percent relative humidity.

2. The printing media of claim 1 wherein the coating composition is a reinforced hydrocarbon wax reinforced with a copolymer selected from the group consisting of ethylene-vinylacetate copolymers, ethylene-ethylacrylate copolymers, isotactic polybutene-1, ethylene-vinylcyclohexane copolymers, oxidized polyethylene and polyeicosene polymers.

3. The printing media of claim 1 wherein the coating composition is an oxidized hydrocarbon polymer.

4. A pressure-fixing, non-blocking electrostatic printing media adapted to make a plurality of copies when used with dry ink powder, comprising an electrically con-

ductive paper substrate having a dielectric coating compositon thereon, said coating composition comprised of a hydrocarbon wax reinforced with from about 15 percent by weight to about 60 percent by weight of a polymer selected from the group consisting of ethylene-vinylacetate copolymers, ethylene-ethylacrylate copolymers, isotactic polybutene-1, ethylene - vinylcyclohexane copolymers, oxidized polyethylene and polyeicosene polymers, said coating composition characterized in having a charge half-life of at least six minutes under 50% relative humidity, and a viscosity of between 2,000 and 10,000 cps. at a temperature of 250° to 350° F.

5. A pressure-fixing, non-blocking electrostatic printing media, adapted for application of dry ink powder thereto, comprising an electrically conductive paper substrate having a resistance of less than 10 megohm per square, said substrate having a dielectric coating composition applied thereto, said coating composition comprised of a wax containing from about 5 to about 30 percent by weight dimerized rosin and from about 15 percent by weight to about 60 percent by weight of a copolymer selected from the group consisting of ethylene-vinylacetate copolymers, ethylene-ethylacrylate copolymers, isotactic polybutene-1, oxidized polyethylene, ethylene-vinylcyclohexane copolymers and polyeicosene

polymers, said coating composition characterized in having a charge half-life of at least one-half hour at 50% relative humidity and a penetration hardness of less than 1 millimeter at 75° F., and a viscosity of between 2,000 and 10,000 cps. in the range of 250° to 350° F.

6. A pressure-fixing, non-blocking electrostatic printing media adapted for application of dry ink powder thereto comprising an electrically conductive paper substrate having a resistance of less than 10 megohm per square, said substrate having a dielectric coating composition applied thereto, said coating composition comprised of an oxidized polyethylene, said coating composition characterized in having a charge-half-life of at least one-half hour at 50% relative humidity and a penetration hardness of less than one millimeter at 75° F.

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