

Jan. 11, 1966

B. GROWALD ETAL

3,228,785

METHOD OF MAKING HEAT REACTIVE COPYING PAPER

Filed April 18, 1963

3 Sheets-Sheet 1

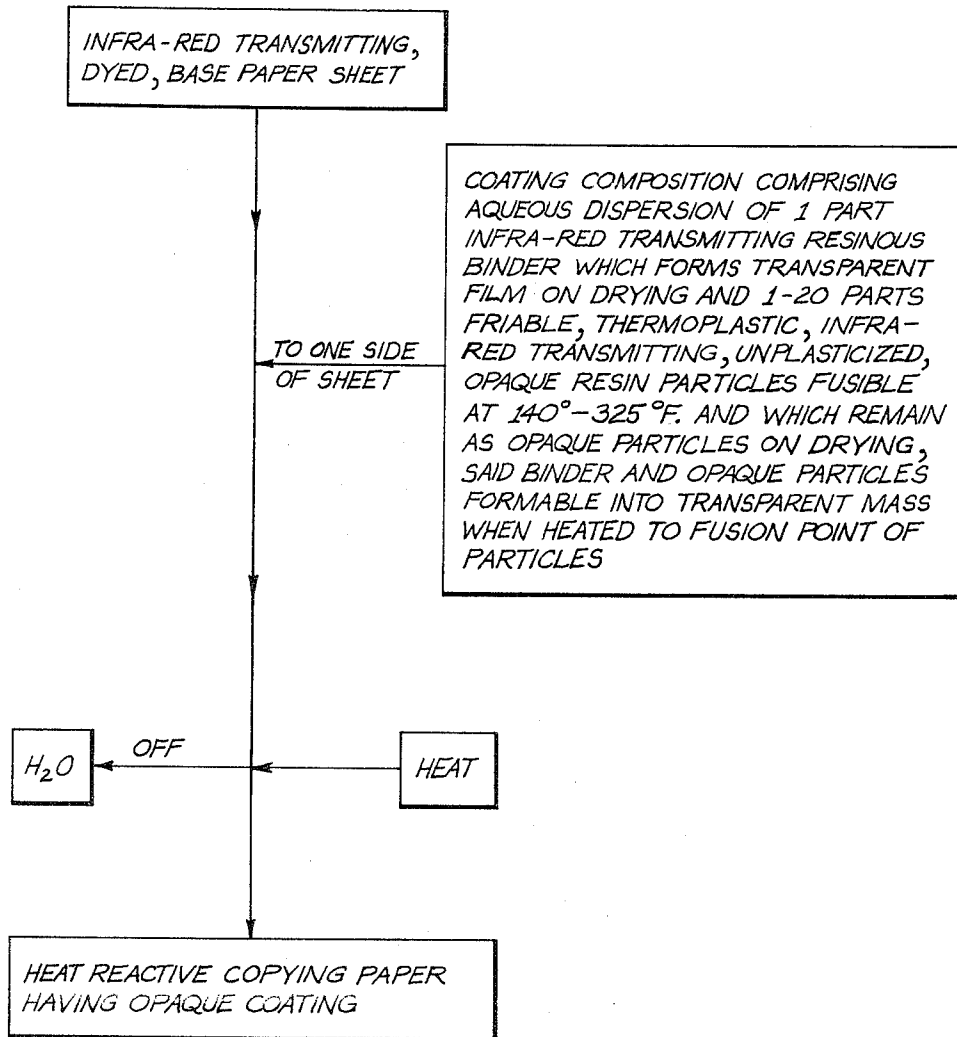


Fig 1

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3 Sheets-Sheet 2

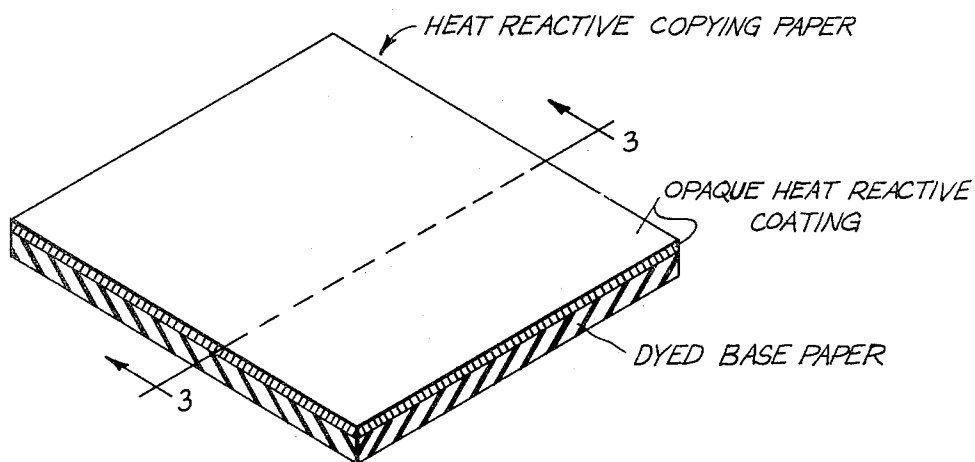


Fig 2

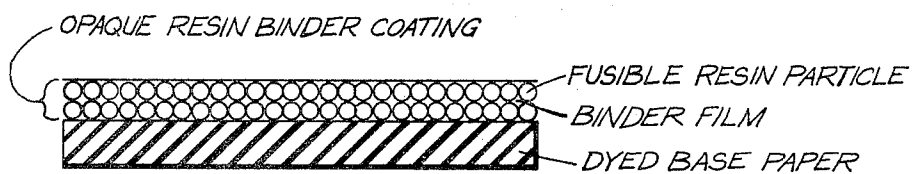


Fig 3

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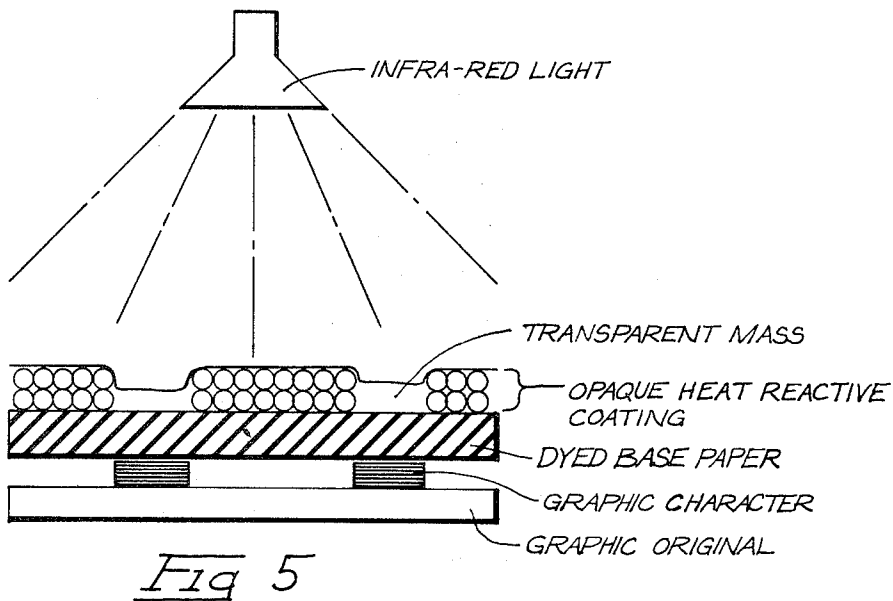
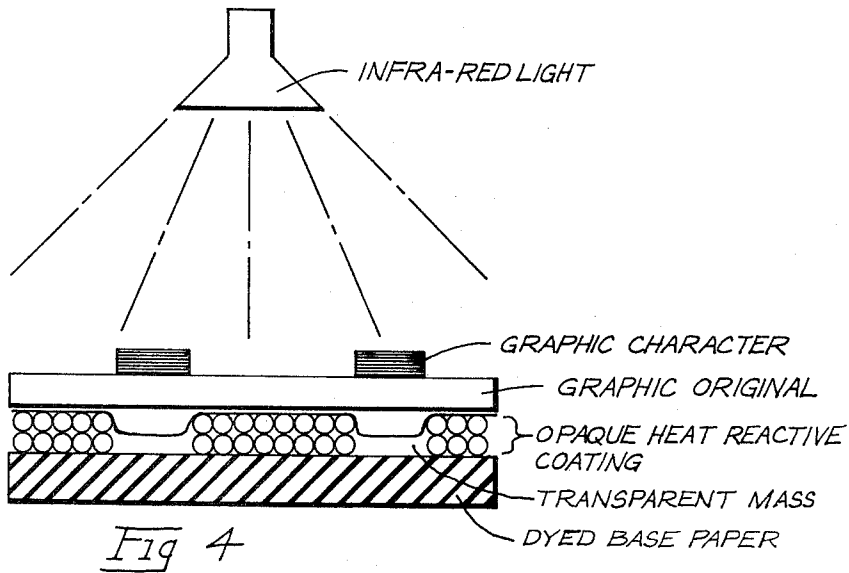
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3 Sheets-Sheet 3



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1

2

3,228,785 METHOD OF MAKING HEAT REACTIVE COPYING PAPER

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6 Claims. (Cl. 117—36.7)

The present application is a continuation-in-part of our copending U.S. patent applications Serial Nos. 90,968, filed February 23, 1961 and 239,981, filed November 26, 1962, both abandoned.

The present invention relates to a novel heat reactive thermographic copying paper that is useful for reproducing written, printed, pictorial and lineal material, and to the method of making said heat reactive copying paper.

The heat reactive copying paper of the present invention is characterized by being economical to produce, non-fading, non-light sensitive, and non-heat sensitive within practical limits of use, e.g. non-heat sensitive at temperatures below the fusion point of the heat reactive coating. This paper is capable of receiving images from transparent, translucent and thick opaque originals, and also from documents that have been printed on both sides.

The method of the present invention is characterized in that it comprises a method of making an improved heat reactive copying paper, said method comprising the steps of applying to a substantially smooth, infra-red transmitting, colored paper base sheet a single coating of a composition comprising essentially an aqueous dispersion of 1 part of infra-red transmitting, substantially transparent, resinous binder, said binder being further characterized in that it forms a substantially transparent film when coated and dried from a dispersion consisting of water and said resinous binder, and from 1 to 20 parts of friable, thermoplastic, infra-red transmitting, unplasticized, opaque resin particles having a fusion point within the range of 140° F.—325° F., said particles being further characterized in that they remain as opaque particles when coated from a dispersion consisting of water and said particles and dried at temperatures below their fusion points, and said binder and resin particles being further characterized in that they coalesce at and above the fusion point of the resin particles to form a transparent mass that remains transparent on cooling, and thereafter drying said paper at a temperature below the fusion point of the resin particles, whereby an opaque coating is formed on the paper. The resin particles in the coating composition are in opaque particulate form when the water in the coating composition is evaporated at temperatures below their fusion point, and are bound to the sheet by the transparent binder film.

There are several types of heat reactive copying paper on the market and each has disadvantages in terms of technical performance and cost of production.

One of the popular types of heat reactive copying paper presently on the market is a very thin sheet of about 0.0020" total thickness after coating. This is a double coated copying paper comprising a base sheet of expensive, highly uniform, thin, translucent paper having on the underside thereof, positioned adjacent to the base paper, a coating of chemical reactants consisting essentially of a high molecular weight metallic fatty acid salt and a phenolic compound, and a separate coating of titanium pigment on top of the reactive coating. This paper is used primarily for "frontprinting," in which case the copying paper, uncoated side upward, is placed on top of the graphic original, graphic characters upward, and irradiation with infra-red occurs through the copying paper. The irradiation, e.g. heat application, results in

darkening from a preliminary melting or softening of the metallic salt, making possible the mixing or co-dissolving of the metallic salt and phenolic compound and resulting in a reaction to form a dark colored and opaque reaction product in the form of the characters being reproduced.

Thus, the reproduced characters are viewed through the translucent base paper, and consequently the base paper must be relatively thin and uniform, otherwise the characters could not be clearly seen. Another difficulty encountered with this paper is that the heat reactive coating chemical attacks the fibers in the paper and causes deterioration on aging, causing the paper to become embrittled. The paper is light sensitive, e.g. it will darken upon standing in the light over a period of time. The paper will also darken if stored in a warm place, even at temperatures below those that are customarily used to obtain the printing reaction.

A second prior art heat reactive copying paper consists of a dark colored base paper having thereon two coatings. The first coating is a transparent wax or resin film, over which is applied a second coating, which second coating is a non-fusible "blush" coating. Upon heating, the first coating melts, and transparentizes the "blush" coating, revealing the dark colored base paper.

The above prior art papers require special and expensive base paper. Organic solvent systems are commonly used in coating these papers, because the coating compositions are not suitable for application from aqueous systems. Organic solvents are objectionable because they are toxic, inflammable and expensive.

Others have suggested coating compositions containing waxy particles and a solution of a binder in organic solvents. Papers made according to these suggestions have not been a commercial success, probably because a change in one of the components of the base sheet may have a considerable effect on the ability of the material to produce acceptable copies; dense backing papers, increased thickness of the base coat, and use of a dyed paper backing adversely affect the copying characteristics of the sheet; purity of the components in the coating composition is critical; degree of dispersion of the fusible material is critical; and variation in the thickness of the coating produces noticeable differences in copying characteristics of the sheet.

The heat reactive copying paper of the present invention overcomes the disadvantages and limitations of the prior art products described above as follows. We have provided a reliable copying paper, using an inexpensive aqueous coating system on an inexpensive paper base sheet. The base paper is colored, which term includes color coated, and has thereon a single top coating applied from an aqueous system consisting essentially of a dispersion of a friable, thermoplastic, non-waxy, resin, hereinafter referred to as an "opacifying resin," and a binder.

Our copying paper is very economical to produce because inexpensive pulps and fillers may be utilized in the base paper and it can be produced at high speeds on modern paper machines. An inexpensive coating composition is utilized, which coating composition may be applied at high speeds using conventional coating equipment; and water is utilized in the coating composition rather than expensive and dangerous organic solvents. The entire operation consists of a single coating and drying step rather than several. Technically, our paper is non-heat sensitive within the practical limits of use, that is non-heat sensitive below the fusion temperature of the opacifying resin. It is non-light sensitive, non-blocking, non-tacky, non-curling, and the coating is firmly bonded to the paper. Moreover, the base paper does not deteriorate or become embrittled with age because the coating composition is essentially inert.

Both thick and thin copying papers may be made according to the method of the present invention. When papers less than 0.0026" in thickness are to be coated, they should be coated and dried under tension to avoid wrinkling that otherwise results from coating thin papers with aqueous systems. One convenient and suggested method for coating and drying under tension is through use of a Mayer rod application and drying on conventional heated drying cans. Coating and drying thin papers under tension to avoid wrinkling when using aqueous systems is an old expedient in the paper industry, and is disclosed in the following enumerated United States patents: 3,063,864; 2,384,722; 2,299,026; 1,994,835; 3,078,822; 2,681,636; 2,918,897; 1,949,237; 2,676,119; and 3,082,735.

Copies may be made with our heat reactive copying paper using the standard "backprinting" method; that is, the graphic original is placed, graphic characters upward, over the heat reactive paper, coated side upward. The graphic original is irradiated with infra-red energy; absorption of the radiation by the graphic characters results in generation of heat which is then conducted through the original to the heat sensitive surface below, producing a visible change therein. The copying paper may be of any desired thickness in backprinting, and if one desires such things as poster board could be used as the base paper sheet.

The backprinting papers of the prior art are limited to coping transparent and translucent thin documents that have graphic material on only one side of the sheet. Surprisingly, we have found that our backprinting copying paper will make acceptable reproductions from transparent, translucent and many heavy opaque graphic originals, such as 30 lb. (17" x 22"—500 sheet ream) opaque bond paper, and will also make acceptable reproductions from many opaque and translucent originals with graphic material on both sides—and the ability of our backprinting copying paper to make acceptable reproductions from heavy opaque graphic originals and from translucent and opaque originals having graphic material on both sides of the sheet is a marked departure from the prior art. The reasons for these surprising results are not clearly understood, except that we believe it is a result of the nature of our coating composition.

Copies may also be made with our heat reactive copying paper using the standard "frontprinting" method, in which case it is preferred that the copy paper be not more than 0.0020" in thickness. In the frontprinting method, the copying paper is placed on top of the graphic original and the infra-red energy is directed at the copying paper; the copying paper transmits the energy, which is absorbed by the graphic characters on the original document, and heat is conducted back up through the copying paper, fusing the heat reactive coating, and thus revealing the colored base to produce a facsimile copy of the original document. By use of the frontprinting method, our copying paper will make facsimiles of graphic originals, regardless of their thickness, and will make copies of documents having graphic material on one or both sides. It will be understood that the only limitation is that the graphic material must absorb infra-red energy.

The accompanying drawings, forming a part of our application, are rendered self descriptive by suitable legends, wherein:

FIG. 1 is a flow sheet illustrating the method for making the copying paper of the present invention;

FIG. 2 is an enlarged diagrammatic perspective view of the copying paper of the present invention;

FIG. 3 is an enlarged diagrammatic cross-sectional view taken along the line 3—3 of FIG. 2;

FIG. 4 is an enlarged cross-sectional view taken through a graphic original superposed on the heat reactive paper of the present invention and illustrating the heat reactive paper in the "backprinting" copying position after exposure to infra-red radiation; and

FIG. 5 is an enlarged cross-sectional view taken through the heat reactive copying paper of the present invention superposed on the graphic original and illustrating the heat reactive paper in the "frontprinting" copying position after exposure to infra-red radiation.

Our invention is more fully described as follows. A substantially smooth, colored base paper that is not highly adsorbent to infra-red radiation (infra-red transmitting) is coated with a single coating of our aqueous coating composition.

The coating composition is essentially an aqueous dispersion of an opacifying resin and resinous binder.

The opacifying resins which may be utilized in the coating composition comprise an aqueous dispersion of friable, infra-red transmitting, non-waxy, unplasticized, thermoplastic resin having a fusion point within the range of 140°–325° F., said resins being further characterized in that they remain in the form of discrete, opaque particles when coated and dried from the aqueous dispersion at a temperature below their fusion point, and which do not coalesce with the binder below said fusion point, but coalesce with the binder at and above the fusion point of the resin to form therewith a transparent mass which remains transparent on cooling. These resins may be produced from synthetic, natural or naturally derived materials. The dispersions are commonly produced either by emulsion-polymerization or post emulsification by conventional methods.

A non-limiting list of opacifying resins which may be utilized in the coating composition includes butadiene-styrene copolymer formed from 1–15% butadiene and 85–99% styrene; polystyrene; vinyl chloride-vinyl acetate copolymer; polymerized rosin glycerol ester; vinyl chloride-vinylidene chloride copolymer, formed from 75% vinyl chloride and 25% vinylidene chloride; gum rosin; polymerized rosin; and dark wood rosin.

Inasmuch as the opacifying resins suitable for use in the present invention comprise a broad group that does not readily lend itself to narrow and accepted chemical classification and have physical and chemical properties that are not common to every member of the group, the following reference standard is set up to aid anyone wishing to practice the invention to determine easily whether the opacifying resin he may select is suitable for use in the present invention.

The opacifying resin selected for testing is dispersed in water. The ratio of opacifying resin to water used in making the dispersion is not critical, except that enough water should be used to disperse the resin; also, the ratio of opacifying resin to water is preferably set having in mind that 3.5 pounds of opacifying resin calculated as dry solids is to be applied per thousand feet of paper in making the test and that excessive amounts of water are unnecessary. Therefore, it is suggested that the aqueous dispersion of opacifying resin for testing contain approximately 40% by weight of opacifying resin calculated as dry solids. The dispersion of opacifying resin selected for testing is coated at room temperature on one surface of a sheet of black infra-red transmitting paper having a reflectance as measured according to TAPPI standard #T452-m58 of not more than 8%. The coating is applied by making a standard drawn-down using a wire wound Mayer rod with a wire size such that 3.5 pounds of opacifying resin calculated as dry solids is applied per thousand square feet of paper. The coated paper is then dried to substantial dryness at 125° F. or less, after which the opacifying resin should be opaque and in discrete particulate form, and in this opaque state scatter incident light to give a substantially increased reflectance over the black paper; the TAPPI reflectance of the coated surface should be not less than 50%. When the coated black paper is heated in an oven or on a hot plate to the fusion point of the resin particles, e.g. not less than 140° F. nor more than 325° F., the opaque resin particles should melt, and on cooling form a substantially transparent film, which

when measured on the black paper base, should have a TAPPI reflectance of not more than 10%.

A modifying agent may be added to the opacifying resin in order to adjust its melting point. The modifying agent does not otherwise affect the opacifying resin or the action of the other constituents.

Opacifying resins fulfilling the above criteria do not have sufficient bonding or adhesive power to be used in coating compositions for heat reactive paper without the addition of binder material to secure the opacifying resins to the paper.

The addition of a binder to the coating composition is necessitated by the fact that if the above thermoplastic opacifying resins only are coated on paper from an aqueous dispersion, they are easily removed by light abrasion. The binder serves to provide good film integrity and abrasion resistance and does not reduce the opacifying value of the heat reactive opacifying resin. The ratio of binder to opacifying resin can vary from 1:20 to 1:1.

The binders which may be utilized in the coating composition comprise any aqueous dispersion or solution of a resinous substance which does not coalesce with the opacifying resin below the fusion point of the opacifying resin, which forms a substantially transparent film when coated and dried, and which at and above the fusion point of the opacifying resin forms therewith a transparent mass that remains transparent on cooling. The binder may be infusible, or may fuse at, above or below the fusion point of the opacifying resin.

The following is a non-limiting list of resinous substances which may be utilized in forming the aqueous dispersion or solution of binder: butadiene-styrene copolymer formed from 20-60% butadiene and 40-80% styrene; polyvinylidene chloride; polyvinyl acetate; and ammonium casein.

Inasmuch as the binders suitable for use in the present invention comprise a broad group that does not readily lend itself to narrow and accepted chemical classification and have physical and chemical properties that are not common to every member of the group, the following reference standard is set up to aid anyone wishing to practice the invention to determine easily whether the binder he may select is suitable for use with the opacifying resin selected.

The resinous binder selected for testing is dispersed or dissolved in water. The ratio of binder to water is not critical, except that enough water should be used to dissolve or disperse the binder. A 15% by weight dispersion or solution of binder is suggested as being convenient. Enough of the 15% binder solution or dispersion is added with stirring to above described 40% by weight aqueous opacifying solution so that the resulting aqueous mixture of opacifying resin and binder contains 1-20% by weight of binder based on the opacifying resin weight. The mixture should be stirred until it is smoothly blended. The aqueous mixture of opacifying resin and binder is coated at room temperature on one surface of a sheet of black infra-red transmitting paper having a reflectance as measured according to TAPPI standard #T452-m58 of not more than 8%. The coating is applied by making a standard draw-down using a wire wound Mayer rod with a wire size such that a coating weight of 3-4 pounds, calculated as dry solids, per thousand square feet of paper will result. The coated paper is dried to substantial dryness at a temperature of 125° F. or less. The dried coating should be opaque, and the TAPPI reflectance of the coated sheet material should be at least 50%. The coating should not flake when the sheet is sharply creased. The coating is heated and should transparentize at substantially the transparentizing temperature of the opacifying resin, e.g. 140° F.-325° F., and the coating should remain transparent (reflectance of not more than 10%) on cooling.

We have found that certain binders tend to impart a slight degree of tack to the finished copying paper. In

order to overcome any slight tackiness that might result in the finishing coating, a small amount of a high molecular weight straight chain paraffinic hydrocarbon may be added to the coating composition.

A thickener may be added to the coating composition primarily to control the viscosity and thereby minimize penetration into the sheet; the thickener may additionally set as a protective colloid and stabilizer, but does not otherwise enter into the reaction. Various thickeners may be utilized, including but not limited to starch, cellulose derivatives such as hydroxyethylcellulose, methylcellulose and carboxymethylcellulose, sodium polyacrylate, acrylic acid copolymers, and the alkali metal salts of alginic acid. Generally speaking, the thickener should not exceed 15% by weight of the dry solids in the coating composition.

The ratio of solids to water in the coating composition is not critical, except that enough water must be used to disperse or dissolve the solids. Also, it is unnecessary to use excessive amounts of water. For convenience, we prefer that the ratio of solids to total water in the coating composition be about 40:60 parts by weight.

In the event that the opacifying resin dispersion, when compounded with the binder dispersion or solution, coagulates, a stabilizing non-ionic surfactant, such as non-ionic isooctylphenoxypoly (ethyleneoxy) ethanol, may be added during the compounding to stabilize the system. We have found that the addition of a stabilizer is especially desirable when an opacifying resin containing an unplasticized vinyl chloride-vinyl acetate copolymer latex is compounded with a polyvinylidene chloride latex binder.

Also, a very small amount of defoamer, such as butanol, may be optionally added to the coating composition to minimize foaming.

All of the components of the coating composition should be substantially infra-red transmitting.

We have found that any substantially smooth, colored paper may be used as the base sheet in our heat reactive copying paper. The base paper may be colored or color coated to provide a suitable contrasting background. The only limitation on the dye used in or on the base paper is that the dye not be appreciably infra-red absorbing. A few examples of suitable dyes are Pontamine Black Double E, Pontacyl Fast Red AS, Pontamine Blue BB, Pontamine Green GXN and Seristan Black B. Materials that appreciably absorb infra-red radiation, such as carbon, heavy metals and salts of heavy metals, must not be a component of the base paper since infra-red absorbers would cause reaction at undesirable locations on the copying paper upon heating. Our base paper may be produced from bleached, semi-bleached, or unbleached woodpulp, groundwood, rag, or from any of the paper-making fibers and may have normal filler loadings of clay, titanium dioxide, silica and the like. Thus, a very inexpensive base paper may be coated with our coating composition. This is a marked departure from prior art copying papers in which relatively costly and specially prepared base papers are required.

The practical limit for the coating weight on our reactive pares is about 1½ lbs.-5 lbs. of dry coating per 1,000 sq. ft. of base paper.

The coating composition is opaque after it is applied to the base paper and dried. The coating, when heated, becomes substantially transparent and remains so on cooling, thus exposing the colored base paper.

Several examples of coating compositions suitable for use in the present invention follow, all parts by weight. The components may be mixed at room temperature to form a suitable aqueous dispersion. It is suggested that the components be blended into the mixture in the order listed in each example, and that after each component is added the mixture be blended until smooth so that the final coating composition will be homogeneous.

Example I

	Pts. by wt.
Opacifying resin (49.5% aqueous dispersion of un- plasticized polystyrene) -----	139
De-tackifier (50% aqueous emulsion of paraffine wax) -----	24
Binder (42% aqueous dispersion of butadiene-sty- rene copolymer, formed from 20% butadiene and 80% styrene, all parts by weight) -----	82
Thickener (3% aqueous solution of hydroxyethyl- cellulose) -----	90
Water -----	30
Total -----	365

Example II

This example is identical to Example I above, except that a binder consisting of a 48% aqueous dispersion of butadiene-styrene copolymer, formed from 40% butadiene and 60% styrene, all parts by weight, is substituted for the binder specified in Example I.

Example III

	Pts. by wt.
Opacifying resin (56% aqueous dispersion of un- plasticized vinyl chloride-vinyl acetate copoly- mer) -----	30
Modifying agent (45% aqueous emulsion of hydro- genated wood rosin, plasticized) -----	9
Stabilizer (20% solution of non-ionic-isooctylphe- noxypoly (ethyleneoxy) ethanol) -----	3
Binder (50% aqueous dispersion of polyvinylidene chloride) -----	18
Water -----	20
Total -----	80

Example IV

	Pts. by wt.
Opacifying resin (56% aqueous dispersion of unplas- ticized vinyl chloride-vinyl acetate copolymer) ---	30
Modifying agent (45% aqueous emulsion of hydro- genated wood rosin, plasticized) -----	9
Stabilizer (20% solution of non-ionic isooctylphe- noxypoly (ethyleneoxy) ethanol) -----	3
Binder (50% aqueous dispersion of polyvinylidene chloride) -----	18
Thickener (3% aqueous solution of hydroxyethyl- cellulose) -----	15
Water -----	20
Total -----	95

Example V

Opacifying resin (45% alkaline emulsion of polym- erized rosin glycerol ester) -----	30
Thickener (3% aqueous solution of hydroxyethyl- cellulose) -----	15
Binder (50% aqueous dispersion of polyvinylidene chloride) -----	18
Total -----	63

Example VI

Opacifying resin (50% aqueous dispersion of unplas- ticized vinyl chloride-vinylidene chloride copoly- mer, formed from 75% vinyl chloride and 25% vinylidene chloride) -----	30
Thickener (3% aqueous solution of hydroxyethyl- cellulose) -----	15
Binder (50% aqueous dispersion of polyvinylidene chloride) -----	18
Total -----	63

Example VII

Opacifying resin (50% aqueous dispersion of unplas- ticized vinyl chloride-vinylidene chloride copoly- mer) -----	30
Binder (18% aqueous solution of ammonium casein) -----	15
Total -----	45

Example VIII

Opacifying resin (40% aqueous emulsion of gum rosin) -----	30
Thickener (3% aqueous solution of hydroxyethyl- cellulose) -----	5
Binder (48% aqueous dispersion of butadiene-styrene copolymer, formed from 40% butadiene and 60% styrene, all parts by weight) -----	2
Total -----	37

Example IX

The components of this example are identical to Example VIII above, except that 2 parts of 51.8% aqueous dispersion of polyvinyl acetate is substituted for the binder specified in Example VIII.

Example X

	Pts. by wt.
Opacifying resin (40% alkaline emulsion of polym- erized rosin glycerol ester) -----	30
Thickener (3% aqueous solution of hydroxyethyl- cellulose) -----	5
Binder (51.8% aqueous dispersion of polyvinyl acetate) -----	1
Total -----	36

Example XI

Opacifying resin (45% alkaline emulsion of polym- erized rosin) -----	30
Thickener (3% aqueous solution of hydroxyethyl- cellulose) -----	5
Binder (51.8% aqueous dispersion of polyvinyl ace- tate) -----	2
Total -----	37

Example XII

	Pts. by wt.
Opacifying resin (40% alkaline emulsion of dark wood rosin) -----	30
Thickener (3% aqueous solution of hydroxyethyl- cellulose) -----	5
Binder (51.8% aqueous dispersion of polyvinyl ace- tate) -----	2
Total -----	37

Example XIII

Opacifying resin (49.5% aqueous dispersion of un- plasticized polystyrene) -----	102
De-tackifier (50% aqueous emulsion of paraffine wax) -----	24
Binder (42% aqueous dispersion of butadiene-styrene copolymer, formed from 20% butadiene and 80% styrene, all parts by weight) -----	129
Thickener (3% aqueous solution of hydroxyethyl- cellulose) -----	90
Water -----	30
Total -----	375

Example XIV

Opacifying resin (52% aqueous dispersion of unplasticized butadiene-styrene copolymer latex formed from 10% butadiene and 90% styrene, all parts by weight) -----	78	5
Binder (48% aqueous dispersion of unplasticized styrene-butadiene copolymer formed from 60% styrene and 40% butadiene, all parts by weight) -----	18	
48.5% aqueous emulsion of paraffin wax -----	10.65	10
Thickener (3.93% aqueous solution of hydroxyethylcellulose) -----	1.65	
Water -----	98	
Defoamer (butanol) -----	0.75	15
Total -----	207.05	

The paraffin in Example XIV is optional, but advantageously increases the flexibility and improves the finish of the coated paper.

The components utilized in the above coating compositions are readily available commercially under the following trade names. Unplasticized polystyrene latex is available as "Latex 586" from Dow Chemical Co., Midland, Michigan; paraffin wax emulsion is available as "Alwax A200" from American Cyanamid Co., New York city, and as "Paracol 500A" from Hercules Powder Co., Wilmington, Del.; 20/80 butadiene-styrene latex and 10/90 butadiene latex are available respectively as "Latex X3326" and "Latex X3379" from Dow Chemical Co.; hydroxyethylcellulose is available as "Cellosize WP300" from Carbide and Carbon Chemical Co., New York city; unplasticized vinyl chloride-vinyl acetate copolymer latex is available as "Geon 351" from B. F. Goodrich Chemical Co., Cleveland, Ohio; hydrogenated wood rosin is available as "Dresinol 210B" from Hercules Powder Co., Wilmington, Delaware; isooctylphenoxypoly (ethyleneoxy) ethanol is available as "Igepal CA630" from General Aniline & Film Corp., New York city; polyvinylidene chloride latex is available as "Resyn 78-3121" from National Starch Products, Inc., New York city; polymerized rosin glycerol ester is available as "Dresinol 155" from Hercules Powder Co., Wilmington, Delaware; 75/25 vinyl chloride-vinylidene chloride copolymer latex is available as "Latex 744B" from Dow Chemical Co.; gum rosin is available as "Dresinol 40" from Hercules Powder Co.; 40/60 butadiene-styrene latex is available as "Latex 512K" and "Latex 630" from Dow Chemical Co.; polyvinyl acetate latex is available as "Geon 970X11" from B. F. Goodrich Chemical Co.; polymerized rosin is available as "Dresinol 215" from Hercules Powder Co.; and dark wood rosin is available as "Dresinol 238" from Hercules Powder Co.

Each of the above examples is a suitable coating composition for application to the above described infra-red transmitting base paper. Only a single coating is put on the paper and then dried.

An advantageous, illustrative, and non-limiting method for making the base paper follows. The base paper has a furnish coating consisting of bleached deinked ledger and magazine waste paper with 10% kaolin filler clay. The pulp was beater dyed with 40 lbs. of Pontamine Black Double E dye per ton of paper. The paper was sized with 2% rosin size and produced as continuous sheet on a Fourdrinier paper machine. For base paper which is to be used in "frontprinting," a paper of basis weight 20 lb. or less (25 x 38"-500 sheet ream) is preferred; and for paper which will not be used in frontprinting, a paper of 50 lb. or greater is suggested.

The coating composition described in Example I above was continuously and uniformly applied to the above 50 lb. base paper by means of a conventional air knife coater, in amount sufficient to give a dry coat weight of 3 lbs. of coating material per 1,000 sq. ft. of paper. The coated paper was then dried with hot air in a tunnel

drier. In the drying step, care should be taken so that the coating is not heated above the fusion point of the opacifying resin. The paper is thereafter cut to desired size and packaged. An excellent heat reactive copying paper which will make copies by the backprinting method results.

In the case of thinner papers, e.g. those less than 0.0026" in thickness, the coating and drying should be under tension to avoid wrinkling of the paper. or example, the above 20 lb. or less paper may be coated and dried under tension by using the Mayer wire wound rod method for applying the coating, followed by drying under tension through use of conventional heated drying cans. Other than for the tensioning, the methods for coating and drying the thicker and thinner papers are identical. By using the above 20 lb. base sheet with our coating, an excellent heat reactive copying paper which makes facsimilies by the backprinting and frontprinting methods results.

We claim:

1. The method of making an improved heat reactive copying paper, said method comprising the steps of applying to a substantially smooth, infra-red transmitting, colored, paper base sheet a single coating of a composition comprising essentially an aqueous dispersion of 1 part of infra-red transmitting, substantially transparent, resinous binder, said binder being further characterized in that it forms a substantially transparent film when coated and dried from a dispersion consisting of water and said resinous binder, and from 1 to 20 parts of friable, thermoplastic, infra-red transmitting, unplasticized, opaque resin particles having a fusion point within the range of 140° F. to 325° F., said resin particles being further characterized in that they remain as opaque particles when coated from a dispersion consisting of water and said particles and dried at temperatures below their fusion points, and said binder and resin particles being further characterized in that they coalesce at and above the fusion point of the resin particles to form a transparent mass that remains transparent on cooling; and thereafter drying said paper, whereby an opaque coating is formed on the colored sheet.

2. The method of making an improved heat reactive copying paper, said method comprising the steps of applying to a substantially smooth, infra-red transmitting, colored, paper base sheet a single coating of a composition comprising essentially an aqueous dispersion of one part of a binder selected from the group consisting of polyvinylidene chloride, polyvinyl acetate, ammonium casein, and butadiene-styrene copolymer formed from 20-60% butadiene and 40-80% styrene, and from 1 to 20 parts of an opacifying resin selected from the group consisting of polystyrene, vinyl chloride-vinyl acetate copolymer, polymerized rosin glycerol ester, gum rosin, polymerized rosin, dark wood rosin, butadiene-styrene copolymer formed from 1-15% butadiene and 85-99% styrene, and vinyl chloride-vinylidene chloride copolymer formed from 75% vinyl chloride and 25% vinylidene chloride; and drying said paper.

3. The method of making an improved heat reactive copying paper, said method comprising the steps of applying to a substantially smooth, infra-red transmitting, colored, paper base sheet a single coating of an aqueous composition comprising approximately 73% water, 20% butadiene-styrene copolymer formed from 10% butadiene and 90% styrene, 4% butadiene-styrene copolymer formed from 40% butadiene and 60% styrene, 2.5% paraffine wax, 0.03% hydroxyethylcellulose, and 0.36% butanol, all parts by weight, and drying said sheet.

4. The method as defined in claim 1, and said composition being further characterized in that an amount thereof containing 3-4 pounds of solids is coated on one surface of 1,000 sq. feet of black, infra-red transmitting paper having a reflectance of not more than 8% and dried at 125° F., the resulting dried coating is opaque, the re-

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flectance of the coated sheet is at least 50%, the coating transparentizes at the fusion point of said resin particles, and the coating has a reflectance of not more than 10% on cooling.

5. The method as defined in claim 1, and in which said paper is dried at a temperature below the fusion point of said resin particles.

6. The method of making a thermographic copy paper which comprises the steps of applying to an infra-red transmitting, colored, paper sheet a coating of a composition comprising essentially an aqueous dispersion of a minor proportion of infra-red transmitting, substantially transparent, resinous binder, said binder being further characterized in that it forms a substantially transparent film when coated and dried from a dispersion consisting of water and said resinous binder, and a major proportion of friable, thermoplastic, infra-red transmitting, unplasticized, opaque resin particles having a fusion point within the range of 150° F. to 325° F., said resin particles being further characterized in that they remain as opaque particles when coated from a dispersion con-

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sisting of water and said particles and dried at temperatures below their fusion points, and said binder and resin particles being further characterized in that they coalesce at and above the fusion point of the resin of the resin particles to form a transparent mass that remains transparent on cooling; and thereafter drying the coated paper at a temperature below the fusion temperature of said resin particles, whereby an opaque coating is formed on the colored sheet.

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