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FACSIMILE RECORDING PAPER

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My invention relates to a novel electro-sensitive paper which is discolored by the action of an electric current passing through it and, more particularly, relates to a novel dry electrolytic paper for facsimile reception for the production thereon of pictures or printed matter in accordance with the facsimile current received.

As disclosed in my Patents Nos. Re. 19,575, dated May 21, 1935, and 2,141,975, dated December 27, 1938, I have disclosed a facsimile system in which records are made on a dry electrolytic recording sheet.

One of the important problems in such recording for facsimile is the uniform conductivity of each unit area of the paper so that for a predetermined incoming signal, the current flow and voltage drop through the paper will be predetermined to produce a predetermined discoloration at that area. When this condition is obtained, variable incoming facsimile signals will produce corresponding variable discolorations in the paper and therefore must faithfully reproduce the image being transmitted at the transmitter.

The uniform conductivity of each successive unit area of the paper in turn depends upon uniform thickness of paper at each unit area and the uniformity of the conducting material in the paper. According to my present invention I employ a rag paper which in its original manufacture is saturated with as much powdered conducting metal, such as lampblack, for example, as it can hold. It will be understood, however, that any other powdered metal may be employed, although I have found that any of these so far employed turn black in the process of impregnation while in the manufacture of the paper. This black paper which is now conducting must be provided with a light colored surface which will be discolored in accordance with the electric current, the degree of discoloration being in accordance with the value of the electric current. In order to provide such a light colored surface I coat the surface of the black carbon paper with a composition of a powdered metal. In the manufacture of this paper it is necessary that the conductivity of this unit area be the same throughout the paper and this is accomplished by providing a paper which is saturated with powdered metal in its original production and in which the coating has a uniform thickness resulting in a uniform all over thickness of the paper.

In order to secure a uniform saturation of the rag paper with the powdered metal, I have found that the saturation in its original manufacture with substantially all the metal it can hold insures such a condition.

In the application of the coating, I have found that the composition containing the metal should have such a viscosity that it will not to any material degree penetrate into the paper but will form itself substantially as a coating on the outer surface. I have further discovered that it is preferable that the application of the coating to the black paper be provided by means of a special printing apparatus to be described hereinafter although I may in some cases spray the coating on. In the latter case, however, I have found a tendency for the composition to penetrate the paper.

In actual practice in the facsimile art, the stylus which rides across and carries the current to the recording sheet has a diameter of 10 mils or .01 inch. The stylus traces approximately 100 lines per inch and makes approximately 100 current impressions in the paper per inch. Therefore the degree of composition of the powdered metal making up the dry electrolytic paper must be such that unit areas having dimensions of 10 mils in length and width shall have equal conductivity.

To effect this end the paper in its original manufacture is mixed with a powdered metal such as carbon or lamp black reduced to as fine a powder as possible and carefully incorporated so as to produce a uniform thickness of paper.

On this carbonized paper as it comes from the mill where it has been manufactured, I apply an electrosensitive coating comprising first a binder base, which may consist of cellulose nitrate or cellulose acetate; secondly, a whiting agent, such as titanium dioxide; thirdly, a metal powder adapted to aid in rendering the coating conductive, this element being for example aluminum powder; and fourth, a thinner adapted to render the coating applicable to the carbon coated paper, which thinner may be alcohol or any suitable solvent for the cellulosic base.

I may modify this electro-sensitive coating by adding thereto an agent adapted to accelerate the darkening of the areas which are affected by the electrical impulse. Such an agent enables the coating to be sensitive at a lower voltage and also effects sharper lines of demarcation between the general white appearance of the paper and the black appearance of the area which is subject to the electrical impulse. This agent also effects more gradations from the black print to the white coating so that better tone values are

obtained in photographs. This modifying agent further prevents a so-called bleeding effect and confines the locality of the impulse. As this agent which I have described I prefer to use aniline hydrochloride, or its equivalents may also be employed for the same results.

I have found that by the use of aniline hydrochloride I may obtain seven grades or tones from pure white to pure black.

In addition to the agent above described, I may further modify my composition by employing therewith a material adapted to cause the coating to flake under the electrical impulse and hence drop from the stylus which transmits the electrical impulse through the coating. Without the employment of such a flaking agent the coating tends to become gummy, to adhere to the stylus moving over the sheet, and thereby impair the action of the stylus. As such a flaking agent I employ potassium nitrate, although equivalent materials may be employed.

My paper is characterized by the fact that it is of the traditional, and therefore satisfactory, white appearance. It further is characterized by an extremely desirable sensitivity to such electrical impulses to which it is subjected to facsimile reception. My paper is further non-toxic, inexpensive to manufacture and capable of uniform results.

Accordingly, it is an object of my invention to provide a novel electro-sensitive coated paper.

It is another object of my invention to provide a novel dry paper for the reception of facsimile broadcast.

It is still another object of my invention to provide a paper which has a base which is treated to render it electro-conductive and a coating on this base comprising a binder, a whiting agent, and a material adapted to increase the conductivity of the coating.

It is still another object of my invention to provide a paper which has a base which is treated to render it electro-conductive and a coating on this base comprising a binder, a whiting agent, a material adapted to increase the conductivity of the coating, an agent adapted to cause the whiting agent to turn black at a relatively low current and a material adapted to cause the coating to flake after conversion by an electric current.

It is a further object of my invention to provide a novel material for coating for facsimile paper adapted to accelerate the conversion of the material by an electrical impulse, said agent also effecting by said action half-tone effects, namely sharp gradations from black to white in said coating.

It is a further object of my invention to provide a novel material adapted to be employed in facsimile coatings to cause the electro-conductive and color changing coating to flake after conversion.

Further objects of my invention will become apparent from the description which follows:

Specifically, I first manufacture my conductive paper by impregnating the pulp with as much lamp black as it will hold without falling apart. The final paper comes out about .003 of an inch thick. This paper is now coated with a conducting layer whose thickness is controlled to about .00025 of an inch. Although, as will appear from the following, the coating will contain non-conductive ingredients, these may be controlled to relatively small quantities, and the thickness of the coating itself controlled. The coating compositions are:

Formula A

	Ounces by weight
Binder (nitrocellulose or cellulose acetate)	21
Whiting agent (titanium dioxide)	63
Aluminum powder	1
Thinner (alcohol)	48

Formula B

	Ounces by weight
Binder (nitrocellulose or cellulose acetate)	21
Whiting agent (titanium dioxide)	35
Aniline hydrochloride ($C_6H_5NHC_6$)	14
Aluminum powder	2
Potassium nitrate (KNO_3)	14
Thinner (alcohol)	112

These materials are utilized as follows:

In Formula A, the titanium dioxide is mixed with the binder and sufficient aluminum powder is added so that the coating is rendered conductive but without turning the coating grayish or too dark. The mix so formed is thinned out with the thinner and the solution is then applied to a carbon impregnated paper by any of the well known methods of spraying, flowing, dipping or the like. I have found that I obtain particularly new and unexpected results by applying the solution on to the carbon impregnated paper by the employment of a Benday roll. This roll has a surface engraved like a screen. Coating in this way gives a very uniform and thin coating which has been found pre-eminently desirable.

In Formula B, the titanium dioxide is mixed with the cellulosic binder and the aluminum powder is added to that mix. I then mix the aniline hydrochloride with the thinner and then add the potassium nitrate thereto. Thereupon I mix the solution of aniline compound, thinner and potassium nitrate with the above mentioned mix of titanium dioxide, cellulosic binder and aluminum powder. When these two mixes have been properly combined to form a homogeneous solution, I apply the mix so formed to the carbon impregnated paper as I have set forth above.

After the coating has been properly dried upon the carbon impregnated paper it may be employed for facsimile reception as described above. The electrical impulse transmitted by the stylus which contacts the coating through to the conductive carbon impregnated paper causes the coating (A or B) to turn black.

The aniline compound is heat sensitive and turns brown upon being heated. This tends to accelerate the formation of the black print.

The cellulosic binder is given by way of example only. Any suitable binding material may be employed and for that purpose many plastic materials including cellulosic compounds and resins, natural or synthetic, and gums may be employed. Certain binders, such as casein, are mechanically suitable, but because of the smell engendered by the heat conversion due to the electrical impulse, it has been found undesirable.

Totanium dioxide is very suitable as a whiting agent, but other agents adapted to provide the white effect may be employed. Zinc oxide, lead oxide and lead carbonate are typical of such whiting agents. I may also employ the sulphides which work fairly well. They appear not to be sensitive enough and hence I prefer to employ the titanium dioxide referred to above.

Although I have particularly dealt with whiting agents it is to be understood that any salt or chemical that has a radical color conversion

under the influence of heat from electrical impulse may be employed.

Specifically I employ as much titanium dioxide as the cellulosic base will stand so that in the final product the coating does not break off when the paper is bent; that is, I desire to keep the coating sufficiently plastic to prevent such breaking off.

The aluminum powder is a suitable agent for enhancing the conductance of the coating. At the same time the aluminum when used in proper quantities does not deleteriously darken the coating. However, any suitable metal powder or metal salt that effects this result of enhancing the conductivity of the coating may be employed. Nickel chloride, for example, has been found effective.

The functions of the aniline hydrochloride have been defined above. Summarizing, it adds to the sensitivity of the titanium dioxide and causes it to turn black under lower temperatures and it, therefore, enables lower voltages to be employed in the facsimile receiver. The aluminum hydrochloride further effects a better detail in that it causes sharper lines of demarcation between the black areas and the white areas and hence more gradations from black to white. Therefore, in photographs it produces desirable tone values which give half tone effects and gradations of color in pictures. It sharply confines the area converted in color and prevents bleeding effects. I have found that I can obtain seven grades of color from pure white to pure black. Since titanium dioxide tends to bleed a bit, the aniline hydrochloride or its equivalents are a material aid in sharpening the image. I have found that cadmium iodide may be substituted for the aniline hydrochloride to good effect.

The potassium nitrate acts to cause the converted coating to become flaky. It is my belief that this is effected because the oxygen released from the potassium nitrate aids in the complete oxidation of the carbon compound, the aniline hydrochloride, and therefore gives a flaky residue instead of a gummy compound. Certain other nitrates also act to aid in the complete combustion, that is providing the necessary oxygen. I have found that sodium nitrate may be used to good effect. The nitrate is, therefore, a good combustion agent.

With regard to the dimensions of my coating I prefer to use a coating of about .00020 to .00025 inch thickness.

Although I have discussed before the various methods by which this coating may be applied to the paper, I should like to point out that as a practical matter the application by means of spraying, flowing, dipping, and the like, is very unsatisfactory. Only under almost ideal conditions or true laboratory conditions, can these methods of application be employed.

For practical manufacture I have found the use of an applicator of the type of the Benday roll most satisfactory. The applicator I employ is a roll with criss-cross grooves cut into it in a screen effect with the resultant formation of a large number of individual small block segments separated from each other by grooves. Each of these small blocks picks up a small globule of the coating and applies it to the paper. The coating is of such viscosity that it flows to join the adjacent globule and thus an even coating is formed. The viscosity of the solution preferably is about 3.2 poises.

Inasmuch as the uniformity of this coating on the conductive paper is of extreme importance in obtaining proper results, this method of application which enables the rapid formation of the coating of uniform thickness on to the conductive paper without danger of overloading or underloading material at a particular point, is of extreme importance and forms an important element of my invention.

Broadly, my method of application comprises picking up on a number of separated relatively small surfaces a coating of such viscosity that upon application of that coating to a material, such as paper, each globule of coating will flow sufficiently to join the adjacent globule to form a coating of uniform thickness.

The coating method I have set forth above is particularly applicable for the problem presented in paper for facsimile recording. It is of fundamental importance that that coating be of the greatest possible uniformity and that there be no high spots that would act to interfere with the current transfer or with the stylus traversing the coating. This process of coating, therefore, is peculiar to facsimile recording paper.

I claim:

1. A dry electrolytic facsimile recording paper for discoloring upon the passage of electric currents therethrough comprising a comparatively dark conductive paper sheet, said sheet being uniformly coated with a comparatively light electrosensitive coating, said coating comprising a mixture of titanium dioxide, a conductive metallic powder, aniline hydrochloride, and potassium nitrate.

2. A dry electrolytic facsimile recording paper for discoloring upon the passage of electric currents therethrough comprising a comparatively dark conductive paper sheet, said sheet being uniformly coated with a comparatively light electrosensitive coating, said coating comprising a dried homogeneous mixture of titanium dioxide, a metallic powder, aniline hydrochloride, potassium nitrate, and a dilute solution of a cellulosic binder.

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