CARBON PAPER AND METHOD OF MAKING SAME

Martin L. Downs and Robert C. Dressler, Appleton, Wis., assignors to Tlmbury Pulp & Paper Company, Kaukauna, Wis., a corporation of Wisconsin

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The present invention relates generally to improvements in the manufacture of carbon paper, and more particularly, it relates to the provision of carbon paper having improved write-off characteristics, limited streaking and pinholing, and greater facility for manufacture. Carbon paper is a particular paper in the paper converting industry which has certain well known characteristics. As is known, carbon paper is used for making duplicate or carbon copies with a pen, pencil or typewriter, and consequently, it comprises a thin tissue sheet usually having a basis weight ranging from about 4 pounds to about 15 pounds per ream of 500 sheets which are 20 inches by 30 inches. The sheets are usually coated on one side, but they may be coated on both sides.

The coating usually comprises coloring matter, such as a pigment or dye, which is carried in a vehicle. The vehicle is preferably a thermoplastic material. The mixture of coloring matter and vehicle, that is, the colored vehicle, is applied by a coating machine including rolls which pick up the mixture and apply it to the thin sheets. The vehicle itself is in molten from at the time of application. Because of the light weight, and consequent thinness of the sheets, the sheets have small openings or pinholes. When the colored vehicle is applied to the sheets, it has a tendency to penetrate the pinholes and frequently will offset on the reverse side when going through the coating equipment, causing spotting and streaking. The formation of these spots or streaks is referred to herein as pinholing, spotting and streaking.

The difficulty of pinholing, spotting or streaking is partially eliminated by means of several steps, all of which are time consuming and expensive. Thus, the paper has been made either heavier or denser and shorter fibered. But both these steps increase the cost of the base paper. Moreover, it is desirable to keep the paper long fibered and porous so as to maintain strong tearing resistance and other properties.

The application of various materials to the face of the paper has been only partly effective in reducing pinholing, spotting or streaking. In addition, such treatments have materially reduced the strength of the paper and introduced stiffness.

The use of additional paper weight is also objectionable for reasons outlined above, and the use of denser papers, in addition to increasing their production cost, results in a sheet which is mechanically weaker.

Pinholing and streaking can also be reduced by utilizing lower coating temperatures so that the coating is more viscous and plastic, and by lowering the speed of the coating equipment. Furthermore, the coating pressure may be reduced to limit pinholing and streaking. However, each of these expedients results in increased production costs through the use of increased amounts of the coating material or loss in production.

Accordingly, the main object of this invention is the provision of an improved carbon paper, and particularly, a carbon paper which does not have objectionable spots, streaks, smudges or smears on the uncoated side, while at the same time permitting rapid and economical manufacture of the carbon paper. Other objects of the present invention will be apparent from a study of the following detailed description and of the accompanying drawings, in which:

Figure 1 is a flow diagram of a preferred embodiment of the process of the present invention; and

Figure 2 is an enlarged, fragmentary sectional view of carbon paper of the present invention, prepared in accordance with the process set forth in Figure 1.

In accordance with the present invention, an oleopholic and hydrophobic, non-film forming substance is applied to a light weight sheet, thereby maintaining the porosity of the sheet and minimizing pinholing and streaking. Thus, through the utilization of this invention, higher coating temperatures and higher coating speeds with greater applying pressures can be utilized in the manufacture of carbon paper.

In the practice of our invention, we apply an oleopholic and hydrophobic substance which is non-film forming to a sheet having a basis weight of below about 15 pounds per ream (500 sheets—20" x 30") The amount of such substance should be such that the porosity of the sheet is substantially unimpaired but should not be so low as to permit pinholing streaking. While the operating conditions used with the coating equipment, such as temperature of the thermostatic coating mixture, the speed of coating and the pressure exerted during coating, in part control the amount of the oleopholic, hydrophobic material required, we have found that the amount of such material should be greater than about 0.2 percent and less than about 0.5 percent of the weight of the sheet.

As a test procedure, we apply a molten paraffin wax (melting point 138° F.) containing an oil soluble dye, at a temperature of 180° F. to a sheet to a depth of one-quarter (1/4) inch. The wax is allowed to cool and the opposite or uncoated side of the sheet is examined. The amount of treatment of the sheet should be such that there is no substantial penetration of the sheet or flow through the pinholes.

As has been pointed out, the material which is applied to the sheets should be a non-film forming, oleopholic and hydrophobic material. In this connection, we have found that a highly desirable material of this type is a metal complex of a fluorinated organic acid, and particularly, we have found that chromium coordination complexes of saturated perfluoromonomocarboxylic acids are highly satisfactory. In order to provide the desired properties, the latter acids should have more than four and less than ten carbon atoms in the acid molecule. The chromium coordination complexes of saturated perfluoromonomocarboxylic acids are well known and are commercially available. In this connection, such compounds are prepared and are distributed by the Minnesota Mining and Manufacturing Company under the name of ScotchGard, No. FC-804. As has been pointed out, the material should be added to the thin sheets in amounts between about 0.2 and about 0.5 percent.

The material, in its intermediate stage, i.e., prior to heat treatment or aging, is, when concentrated, soluble only in alcohol but becomes soluble in water upon large dilution, and upon heat treatment after being applied to the sheet becomes hydrophobic and oleopholic in character. Accordingly, the material is preferably dissolved in a solvent but it may be emulsified. The thin sheets may then be passed through the liquid containing the hydrophobic, oleopholic material in its intermediate or emulsified state. The liquid, of course, may be sprayed onto the thin sheets.

After the liquid is applied to the thin sheets, the sheets
are dried and heated, heating being done under such conditions as to convert the material in the liquid to the oleophobic and hydrophobic state. After such drying and heating, the colored vehicle is applied to the sheet.

The vehicle may comprise blends of one or more synthetic or natural waxes such as paraffin, carnauba, candelilla, and other waxes. Frequently, fatty or wax alcohols are added in order to solubilize the dyes. The vehicle may be colored with carbon black, nigrosine oil soluble base, methyl violet oil soluble base, various inks, and other well known coloring materials. It is common practice to combine the vehicle with the coloring material in a ball mill at temperatures above the melting point of the constituent materials.

Following preparation of the colored vehicle, it is applied to the treated thin sheets at temperatures above the melting point of the colored vehicle, usually at temperatures in the range between about 170°F and about 240°F. The colored vehicle or coating may be applied in excess and adjusted to the proper amount on the sheets by means of blades or rods, referred to generally as “doctoring.” Alternatively, the coating may be applied by a pattern of compound by multiple transfer rolls, squeeze rolls or like equipment. In either method of application, the coating material is applied to the thin sheets while the material is hot and in a fluid state. Also, in either method, the hot and fluid coating is generally subjected to pressure on the sheet. Similar pressure applied in previous processes has caused undesired pinholing, streaking and spotting.

Because of the treatment of the thin sheets in the manner of this invention, certain highly improved results are obtained. In the first place, the carbon sheets of the invention exhibit improved “write-off” characteristics. That is to say, if a series of sheets are interleaved with carbon paper and an impression is then formed by typing or writing on the top sheet, the series of impressions formed on the subsequent sheets will be improved. Secondly, the product of the invention may be made with reduced amounts of coating material, while providing equivalent results of reproduction, i.e., write-off. Furthermore, the practice of the invention permits faster coating of the thin sheets while, at the same time, reducing pinholing, spotting and streaking.

In an actual commercial operation, carbon paper having a basis weight of 10 pounds per ream (20 inches by 30 inches, 500 sheets) was employed. The sheet was made from a kraft pulp furnish. A solution of chromium coordinated complex of saturated perfluorocarboxylic acid was prepared. The complex was Scotch Gard No. FC-894. The paper was passed through the solution, the pickup of the chemical ranging from 0.1 to 0.25 percent of the weight of the sheet, and then dried to 5 percent moisture by passing through a steam heated paper machine dryer.

The sheet was then run through a conventional carbonizing machine and, in one case, an excess of colored vehicle was applied and the amount of material adjusted by means of an equalizer roll. The vehicle was of a blue color and was coated onto the sheet at a temperature of 200°F. The coating weighed 2.93 pounds per ream.

The use of the equalizer rod develops a substantial amount of hydrostatic pressure upon the sheet at the nip between the paper surface and the equalizer rod so that the coating may be “acquired” through any pores or pinholes in the sheet. However, there was no objectionable spotting, streaking or pinholing on the uncoated side of the treated sheet, although a control sample which was run through the machine had quite objectionable spotting, streaking and pinholing. The sheet which has been treated in accordance with this invention has improved write-off characteristics.

In another run, the colored vehicle was applied to the sheet by means of transfer rolls, which, in effect, printed the colored vehicle onto the sheet. In this run, no substantial hydrostatic pressure was developed and the coated vehicle was applied at the rate of 3.1 pounds of coating per ream of paper. The sheet exhibited improved write-off characteristics when compared to a control sample, the base sheet of which had not been treated in accordance with our invention.

In a laboratory test, we employed a base sheet having a weight of 10 pounds (20 inches by 30 inches for 500 sheets) and coated this paper to provide a level of chromium coordinated complex of saturated perfluorocarboxylic acid between .1 percent and .2 percent. To the treated sheet was applied molten paraffin wax containing an oil soluble dye, the wax being at a temperature of 180°F. The wax was applied and maintained at a level on the sheet of one-quarter (.25) of an inch. The wax was allowed to cool. Upon examination of the sheet, it was apparent that in all cases the penetration of the wax was substantially reduced, as compared to a control sheet to which no wax was applied. In the case of each of the treated sheets, there was no marking of the backing paper but, in the case of the control, the backing paper was marked with ink.

From the foregoing, it will be quite apparent that in the practice of the invention, highly improved carbon paper is provided and production of such paper is greatly facilitated.

Various features of the invention which are believed to be new are set forth in the following claims.

We claim:

1. An improved process for the manufacture of carbon paper comprising the steps of applying a non-film forming chromium coordination complex of a saturated perfluorocarboxylic acid, the acid molecule having more than 4 and less than 10 carbon atoms in the molecule, to a sheet having a basis weight of between about 4 pounds and about 15 pounds per ream (20 inches by 30 inches for 500 sheets), said material being applied to said sheet in an amount of between .02 and .5 percent of the weight of said sheet, and coating said sheet with a melted pigmented wax vehicle.

2. A carbon paper comprising a base sheet having a basis weight of between about 4 pounds and about 15 pounds per ream (20 inches by 30 inches for 500 sheets), said base sheet being impregnated with a non-film forming chromium coordination complex of a saturated perfluorocarboxylic acid, the acid molecule having more than 4 and less than 10 carbon atoms in the molecule, the amount of said chromium coordination complex being between about .02 and about .5 percent of the weight of said base sheet, and a thermoplastic coating on said base sheet, the carbon paper being substantially free from spots and streaks.

3. A carbon paper comprising a base sheet having a basis weight of between about 4 pounds and about 15 pounds per ream (20 inches by 30 inches for 500 sheets), said base sheet being impregnated with a non-film forming chromium coordination complex of a saturated perfluorocarboxylic acid, the acid molecule having more than 4 and less than 10 carbon atoms in the molecule, the amount of said chromium coordination complex being between about .02 and about .5 percent of the weight of said base sheet, and a pigmented wax coating on said base sheet, the carbon paper being substantially free from spots and streaks.

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