

## UNITED STATES PATENT OFFICE

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PREPARATION OF PHOTOGRAPHIC PAPER  
HAVING GOOD CURL CHARACTERISTICSGlen G. Gray, Rochester, N. Y., assignor to East-  
man Kodak Company, Rochester, N. Y., a cor-  
poration of New JerseyNo Drawing. Application April 24, 1951,  
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7 Claims. (Cl. 117—34)

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This invention relates to a method of mak-  
ing photographic paper to minimize the curl-  
ing characteristics thereof, which involves wet-  
ting the paper base before or at the time of  
the application of the emulsion coating thereon,  
followed by drying of the photographic paper.

The preparation of photographic paper has  
been known for years, as illustrated by U. S.  
Patents Nos. 370,110 and 370,111 of Walker and  
Eastman. Those patents describe a method of  
coating paper base with a photographic emul-  
sion, followed by drying of the paper by moving  
it along at a slow speed and ordinary temper-  
ature. With the slow rate of drying used in  
the manufacture of photographic paper in those  
days, the curling characteristics of the paper  
thus prepared were not too unfavorable, par-  
ticularly where the paper was stored in a place  
where there was not a great deal of variation  
in the relative humidity of the air in the place  
of storage. In recent years, however, the tend-  
ency has been to speed up the rate of drying  
of the emulsion-coated paper, which has involved  
the use of elevated temperatures in those dry-  
ing operations.

The cellulose fiber in the paper base of photo-  
graphic paper and the gelatin in the emulsion  
layer thereof are both hygroscopic. They ex-  
pand as they adsorb water vapor at high hu-  
midity, and contract as they desorb water vapor  
at low humidity. The rates of expansion and  
contraction of the two materials are not nec-  
essarily the same under a given set of condi-  
tions, so that the stresses and strains set up in  
photographic paper often result in curl. This  
is especially true in the case of light-weight  
paper stocks, such as those having a weight of  
8-15 pounds per thousand square feet. When  
such paper is coated with emulsion, often the  
stress in the emulsion layer is sufficiently great  
to result in face curl, or in other words, the  
curling of the paper is towards the emulsion-  
coated side.

When wet photographic emulsion is applied  
to dry paper, some of the moisture from the  
emulsion penetrates the paper, resulting in ex-  
pansion of the paper base, while loss of water  
by the emulsion causes its contraction. Thus,  
the expansion of the paper and the contraction  
of the emulsion at that time sets up a balance  
of forces, somewhat different from that which  
obtains in the paper and the emulsion imme-  
diately prior to the adsorption of water by the  
paper.

One object of my invention is to minimize the

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stresses and strains resulting in emulsion-coated  
paper after the drying of that paper has taken  
place. Another object of my invention is to  
provide a method for manufacturing photo-  
graphic paper, which paper will withstand wide  
variations in the relative humidity of the air  
with which it is in contact without any ap-  
preciable curl. A further object of my inven-  
tion is to provide a method of preparing photo-  
graphic paper in which opposite forces are not  
set up by the paper base and the emulsion coat-  
ing before and at the time of drying. Other  
objects of my invention will appear herein.

I have found that the stresses and strains  
in photographic paper may be prevented by im-  
parting a moisture content to the wire side of  
the paper base prior to or upon the application  
of the emulsion coating to the other side of that  
base, followed by a drying operation in which  
both the paper and the emulsion are dried si-  
multaneously. I have found that the paper  
which results from the practice of my invention  
may be stored under widely variable relative  
humidity conditions without exhibiting excessive  
curl, as has been encountered previously with  
photographic papers. My invention is especially  
adaptable to photographic papers in which a  
light-weight paper base is used, such as a paper  
base having a weight of 8-15 pounds per thous-  
and square feet. By means of my invention, the  
influence of the emulsion-coated side under ex-  
tremely dry conditions does not over-balance  
the flattening tendency of the paper base under  
those conditions so that curling of the coated  
paper is kept at a minimum.

In preparing photographic paper in accord-  
ance with my invention, the procedure which  
is followed is no different as far as applying  
the emulsion coating to the paper is concerned  
from that which is standard in the art, namely,  
spreading the gelatin-silver halide emulsion  
coating onto the surface of the paper under  
darkened conditions. A successful method of  
applying emulsion to paper is described in U. S.  
Patents Nos. 370,110 and 370,111. After the  
emulsion is applied to the paper it is preferred  
that the paper be chilled so as to set the emul-  
sion, whereupon the paper may then be dried  
by the method described in the patents referred  
to, or preferably, by conducting the paper  
through a chamber where it is subjected to a  
current of warm, dry air passing over the sur-  
face of the emulsion, all being carried out under  
darkened conditions. My invention involves the  
application of moisture to the paper base in



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this procedure prior to the application of the emulsion coating thereto. This application of moisture to the paper may be, for instance, by means of an ordinary applicator roll, over which the paper sheet is conducted, or by subjecting the paper to a steaming operation. The moisture which is applied to the paper is applied to the wire side of the paper which is other than the side upon which the emulsion coating is applied. The paper which is employed for preparing photographic paper ordinarily has a moisture content of approximately 5 percent. The use of a water applicator roll supplying moisture to the paper ordinarily brings the moisture content of the paper up to 7 percent or more, the additional moisture being concentrated on the side of the paper opposite that upon which the emulsion coating is applied.

Instead of using a water applicator roll, the paper may be steamed by directing a steam jet to the side of the paper opposite that upon which the emulsion coating is to be applied. In the coating operation for the manufacture of photographic paper, in accordance with my invention, either the water applicator roll or the steam jet may be conveniently provided as the first step in the operation immediately prior to the emulsion coating step, so that my invention is readily adaptable to a continuous method for the manufacture of photographic paper.

For example, a photographic paper was prepared by passing paper base first over a water applicator roll, imparting a water content to the paper of 7 percent, the added moisture being concentrated on one side of the paper. The opposite side of the sheet was then coated with a gelatin-silver halide photographic emulsion. The paper was subjected to treatment with chilled air, whereby the emulsion layer was set whereupon the paper was run through a chamber having a current of warm, dry air, the resulting paper having good curling characteristics, as was determined by tests thereof. The curling characteristics of photographic paper were determined by means of discs 10 cm. in diameter cut from photographic paper sheets that had been conditioned at 18 percent relative humidity. To obtain the curl value of the paper under a given condition, the chord of the arc formed by the disc when under that condition is measured and this value is subtracted from 10. For instance, a flat sheet would have a value of 0, while a paper which curled until the two portions met would have a value of 10. Where the disc curls more than once, the overlap is measured and added to 10. For instance, a disc curling 1½ times would have a disc curl value of 15. If the disc curled twice, the curl value would be taken as 20. In testing the paper for curl after measurement of the discs in air having 18 percent relative humidity, they were placed in air having a 70 percent relative humidity, and after equilibrium was reached, measurements were again taken. The discs were then returned to air having 18 percent relative humidity and were measured again. The curl of the disc was also measured by placing such discs which had been conditioned at 18 percent relative humidity in a developer, and measuring the maximum curl occurring before penetration of the paper by the developer relaxed the stresses in the paper and the emulsion. This latter curl value was entitled "processing curl."

The following examples illustrate the improve-

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ment which is obtained by my invention over paper which has been regularly coated and dried:

*Example 1.*—Photographic paper was prepared by the ordinary method of applying a photographic emulsion coating thereto and drying. Papers were also prepared using the same weight paper base, but in one case steaming the paper lightly on the wire side prior to the application of a gelatin-silver halide photographic emulsion layer to the opposite side thereof, and in another case, by moistening the paper on the wire side with a water applicator roll and then applying a gelatin-silver halide photographic emulsion layer on the opposite side of the paper. The regularly coated paper was designated "A," that which was steamed lightly was denoted "B," and the paper which was moistened with a water applicator roll was designated "C." The results obtained were as follows:

Sample	18% R. H.	70% R. H.	18% R. H.	Processing Curl
A -----	8.4	11.9	18.8	13.0
B -----	2.0	0.9	11.3	7.5
C -----	1.4	0.2	6.7	0

It will be noted that the application of moisture to the paper before applying the emulsion thereto gives significantly improved curl characteristics over paper which has been prepared without any such moistening operation in all the various conditions where the curl characteristics were measured.

*Example 2.*—Photographic emulsion was applied to a paper base having a weight of 12 pounds per square foot. In one case, the emulsion was applied directly to the paper without any previous moistening thereof, chilled and dried. In a second case, the paper was wetted with a water applicator roll at substantially the same time as the application of the emulsion coat thereon. These samples were designated as "A" and "B" respectively. The curl characteristics were tested and were found to be as follows:

Sample	18% R. H.	70% R. H.	18% R. H.	Processing Curl
A -----	8.2	16	21.8	9.7
B -----	0.2	0.2	5.6	0.2

This example illustrates the fact that the wetting of the side of the paper opposite the emulsion layer prior to the drying operation appreciably improves the curl characteristics of the paper, over the curling characteristics of paper prepared without any moistening operation occurring. The advantage in the hereindescribed method of preventing curl in paper is that such a method is readily adapted to any of the ordinary methods of coating photographic paper, but with the addition that at, or preferably, immediately prior to the application of the emulsion coating to the paper, moisture is applied to the paper on the opposite side to that on which the emulsion coat is applied, so as to increase the moisture content of the paper 2-5 percent (based on the paper).

I claim:

1. A method of preparing photographic paper whereby the curling characteristics thereof are minimized which comprises applying to the paper a photographic emulsion coating and, on the opposite side of that paper, no later than the application of the emulsion coating, moisture in



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a sufficient amount to increase the moisture content of the paper 2-5% based on the weight of the paper, followed by a drying operation in which the moisture content of both the paper and the emulsion is reduced.

2. In a method of preparing photographic paper in which a photographic emulsion is applied to one side of the paper, the step which comprises applying water to the opposite side of the paper immediately prior to the application of the emulsion in sufficient amount to increase the moisture content of the paper 2-5% based on the weight of the paper.

3. A method of preparing photographic paper having good curl characteristics which comprises applying a photographic emulsion layer to one side of the paper and on the other side no later than the time of application of the photographic emulsion, sufficient moisture to increase the moisture content of the paper 2-5% based on the weight of the paper by means of a water applicator roll followed by a drying operation in which the moisture content of both the paper and the emulsion is reduced.

4. A method of preparing photographic paper having good curl characteristics which comprises applying a photographic emulsion layer to one side of the paper and on the other side no later than the time of application of the photographic emulsion, sufficient moisture to increase the moisture content of the paper 2-5% based on the weight of the paper by means of a steam jet followed by a drying operation in which the moisture content of both the paper and the emulsion is reduced.

5. In a process of preparing photographic paper

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the step which comprises applying moisture to one side of the paper in a sufficient amount to increase the moisture content of the paper 2-5% based on the weight of the paper immediately prior to the application of the photographic emulsion layer to the opposite side of the paper.

6. In a process of making photographic paper the step which comprises applying to one side of the paper sufficient moisture to increase the moisture content of the paper 2-5% based on the weight of the paper, at substantially the same point as the photographic emulsion layer is being applied to the opposite side of the paper.

7. A method of preparing photographic paper having good curl characteristics which comprises applying a layer of a photographic emulsion comprising silver halide in suspension in an aqueous solution of gelatin to one side of a paper sheet and to the other side thereof, no later than the time of application of the photographic emulsion, sufficient moisture to increase the moisture content of the paper 2-5%, based on the weight of the paper followed by a drying operation in which the moisture content of both the paper and the emulsion is reduced.

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#### References Cited in the file of this patent

#### UNITED STATES PATENTS

Number	Name	Date
2,229,741	Hinz	Jan. 28, 1941
2,314,797	Morris et al.	Mar. 23, 1943
2,425,553	Stewart	Aug. 12, 1947