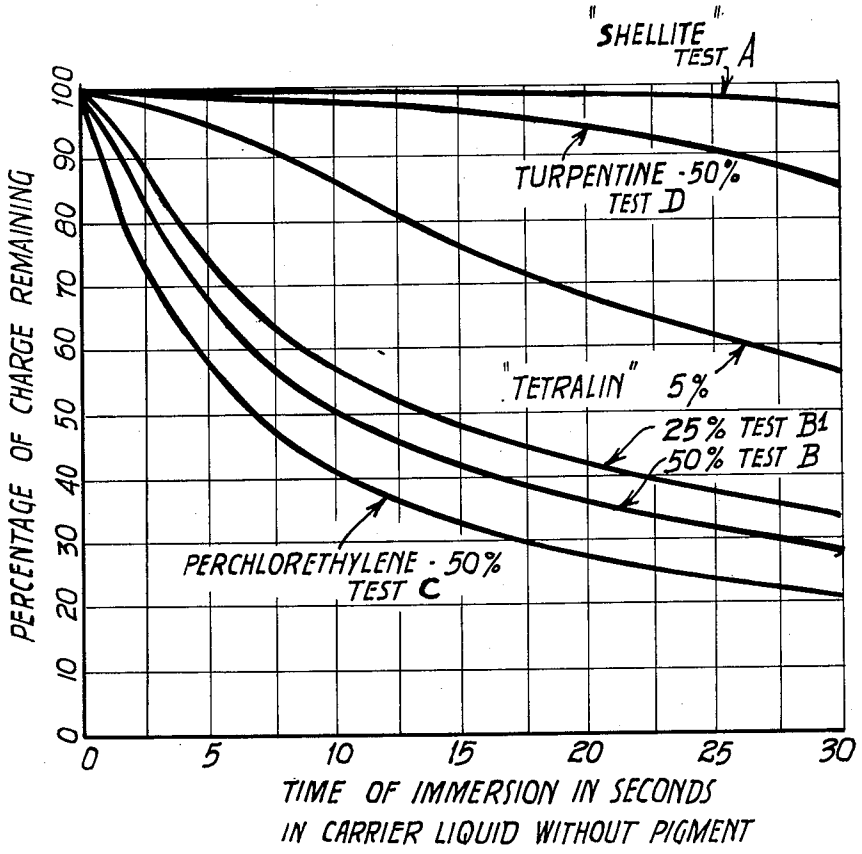
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CONTROLLED TONE DEVELOPMENT FOR ELECTROPHOTOGRAPHY

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CONTROLLED TONE DEVELOPMENT FOR ELECTROPHOTOGRAPHY

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This invention relates to controlled tone development for electrophotography.

When carrying out development processes in silver halide photography it is possible to regulate the tone of the developed image by a selection of the characteristic of the emulsion as well as a selection of the type of developer.

When using known methods of development as applied to electrophotography certain difficulties exist in that it is not possible with the methods at present in use to provide desirable tone variation of the image.

The present invention, which is directed particularly to what is known as "liquid" development, has as its object the attaining of adequate tone control and the removal of the limitations otherwise existing with respect to xerographic development processes.

The object is achieved by varying the electrical conductivity of the materials which are affected by the development so that the image charge can be bled away at a varying rate in relation to the rate of development.

The object of the invention is achieved by the embodiments illustrated in the drawing in which:

The sole FIGURE shows a graph of six tests of liquid developer compositions.

Thus if the bleeding away of the image charge is controlled by the development, and if the time of development is correctly chosen, a close control of a tone of the picture will result.

Probably the simplest method of controlling the tone is to vary the electrical resistivity of the liquid developer, variation of this being of course possible in a number of ways, such as by choosing a carrier liquid having the required electrical resistivity, or by the addition of tone control agents or substances which change the electrical resistivity of the developer alternatively, the solubility of the control agent and its sensitivity can be varied, or the viscosity of the liquid may be appropriately selected as slower development results with a liquid of greater viscosity and thus the ratio of time of development in relation to decay of the electrostatic image is varied.

In carrying our invention into effect it is for instance possible to start off with a high resistivity liquid such as an so-octane or hexane, and if it is required to tone down the contrast of the image, further additives may be included wth this high resistivity liquid such as chloroform or acetone in small quantities.

It is probable that the more applicable substances are the aromatic and cyclic hydrocarbons and the chlorinated hydrocarbons, but the additives may take various forms as previously indicated.

To fully understand the invention, the following examples are referred to.

A standard developer paste, as now well known in liquid development techniques, and comprising a pigment suspended in a high resistivity carrier liquid, in this case the low boiling point petroleum fraction known under the trade name "Shellite," to which a resin was added as the combined control and fixing agent, was broken down to its correct development concentration, by adding various

suspending liquids of different volume resistivity and the results noted.

The formula for the developer paste used was as follows:

	Grams
Rhodene L6/100 (a linseed oil modified alkyd resin of medium oil length)	15
Pentarol 20 (a phenol modified pentaerythritolester of resin)	15
Xylene	25
And a pigment comprising a mixture of phthalocyamine blue, chrome yellow, and organic red pigment	150

("Rhodene L6/100" and "Pentarol 20" are the trademarks of Polymer Corporation.)

In test "A," 10 ml. of the standard concentrated developer was diluted with 90 ml. "Shellite" and this was found to produce an extremely contrasting picture with considerable variation in tone in the maximum and minimum deposition areas.

In test "B," 10 ml. of the concentrate had added to it 40 ml. of "Shellite" and 50 ml. of tetrahydronaphthalene, or as it is known under its trade name of "Tetralin," and this produced a print of low contrast. Tetralin has the effect of both lowering the resistivity and also decreasing mobility.

In test "B1" the same substances were used but the proportions were varied so that to the 10 ml. of concentrate were added 65 ml. of "Shellite" and 25 ml. of "Tetralin" this producing a print of average contrast with very good rendition of light and shadow, being between the results obtained in "A" and "B."

In test "C," 10 ml. of the concentrate had added 40 ml. of Shellite and 50 ml. of perchlorethylene, the result being a print with less contrast than "B."

In test "D," 10 ml. concentrate had added to it 40 ml. of Shellite and 50 ml. of mineral turpentine, the result of this being to produce a print very similar to "B1" but with slightly greater contrast but not as high as "A."

The results of the test can be summed up by stating that where the basic concentrate was suspended in Shellite, test "A," a high electrical resistivity was maintained together with high mobility due to low viscosity, and the result was rapid development with a low relative decay rate of the electrostatic image. The maximum contrast was therefore achieved.

Where the Shellite had added to it a cyclic paraffin namely tetrahydronaphthalene, in a relatively large percentage, test "B," the rate of decay of the electrostatic image was increased in relation to development time for full saturation of the image, and a print of low contrast resulted.

By reducing the percentage of the cyclic paraffin, test "B1," a rate of decay intermediate that a "A" and "B" resulted, and a pleasing contrast for the particular negative was the result.

In tests "C" and "D," the cyclic paraffin was replaced by a chlorinated hydrocarbon and an aromatic hydrocarbon respectively, the first materially increasing the decay rate, the second increasing the decay rate only slightly over that of the aliphatic hydrocarbon developer of test "A."

The tests show that a convenient approach is to break down the concentrated developer paste with a liquid having a high volume resistivity and a high rate of mobility, and to add to this a substance or substances of lower volume resistivity which then increases the leakage rate and has the effect of reducing contrast.

In the illustration is shown the relative decay rate which exists with tests "A," "B," "B1," "C" and "D," the percentage of charge remaining after immersion in the

substances concerned being plotted against time of immersion, the liquid being without pigment, so that the graph indicates decay due to the carrier itself.

Instead of adding a substance to the carrier which itself forms a carrier, other substances can be added which could control the electrical leakage rate, and it has been found, for instance that if the control and fixing substance, such as a resin, is more soluble in the carrier it changes the rate of decay and therefore again affects the final image.

As an example of the addition of a substance to reduce mobility, to the solution of test "A" can be added a percentage of transformer oil which has a high volume resistivity but also a relatively high viscosity so that while the leakage factor is not materially altered, the rate of movement of the pigment is reduced, and as there always is a certain amount of decay during development, the print is consequently reduced in contrast.

It will be clear from the foregoing that control of the development can thus be readily effected, provided the rate of decay of the electrostatic image is controlled during development in relation to the time of development, this therefore allowing sharp or soft development by simply selecting the developer in such a manner that during development the rate of decay in relation to development time is altered.

By development time is meant the time needed to satisfy the charge on the image. This time can be shortened by lowering the resistance of the developer liquid as a lesser charge then remains to be satisfied in a given time, while the decreasing mobility the development time is increased to satisfy the charge and consequently the total leakage is increased because of the greater time over which leakage takes place.

What is claimed is:

1. In a method of developing an electrostatic image with a liquid developer comprising a pigment substance dispersed in a low boiling point petroleum fraction of high volume resistivity, the improvement comprising adding to the liquid developer a tone control agent selected from the group consisting of tetrahydronaphthalene, perchlorethylene, mineral turpentine, and transformer oil to control the contrast of the developed image .

2. A method as claimed in claim 1, wherein said pigment substance is coated with a control agent.

3. A method as claimed in claim 1, wherein said tone control agent is tetrahydronaphthalene.

4. A method as claimed in claim 1, wherein said tone control agent is perchlorethylene.

5. A method as claimed in claim 1, wherein said tone control agent is mineral turpentine.

6. A method as claimed in claim 1, wherein said tone control agent is transformer oil.

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