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## 3,058,914 NON-INFLAMMABLE LIQUID DEVELOPERS FOR

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bourne, Victoria, Australia No Drawing. Filed Sept. 24, 1958, Ser. No. 762,912 Claims priority, application Australia, Oct. 1, 1957 2 Claims. (Cl. 252–62.1)

This invention relates to non-inflammable liquid developers for electrostatic images.

It is already known to develop electrostatic images by applying either a dry powder to the image or by subjecting the image to liquid development in a carrier 15 having a sufficiently high electrical resistivity to prevent destruction of the electrostatic image during development.

Liquids having the required characteristics are generally of an inflammatory nature and while the hazard 20 of using them is extremely small or non-existent under suitable operating conditions, an object of this invention is to provide an improvement with respect to this type of developer which will ensure that the danger of fire is completely removed or substantially reduced. 25

As such liquid developers are generally handled by operators, it is desirable that they be non-toxic and this invention therefore seeks to provide a liquid developer for electrostatic images which is both non-inflammable and non-toxic in ordinary use.

We have found that such a developer can be formed by using as the liquid carrier having the necessary high electrical resistivity, substances of the chlorofluoromethane, or ethane, group.

Amongst the substances which we have found of par- 35 ticular interest are the chlorinated fluorinated hydrocarbon solvents or refrigerants or propellants.

These substances are non-inflammable, non-explosive, are relatively non-toxic, and, provided the correct grouping is chosen, are sufficiently stable in use to permit them 40 to be used commercially as the suspending medium for pigment or developer substance in electrostatic image development.

The substances of the invention should have a dielectric constant less than 3, preferably less than 2.5 and 45 should be sufficiently stable under various conditions.

One of the advantages of using fluorinated hydrocarbon solvents or refrigerants or propellants is that a high degree of volatility can be attained, the effect of this 50 being to speed up development and permitting very quick removal of the carrier medium and thereby ensuring the rapid fixing and drying of the developed image.

Two substances which have been found to give very favorable results are trichloromonofluoromethane 55 (CCl<sub>3</sub>F) as sold under the trademark "Freon MF" and trichlorotrifluoroethane (CCl2 CClf2), sold under the trademark "Freon TF."

The substances are good carriers for the pigment ma-60 terials, and have the necessary solvent action for the resins or other substances which may be used with liquid developers to act as control and fixing agents.

To enable the invention to be fully understood the following examples are given:

## Example 1

15 grams of a phenol modified penta-erythritol ester of rosin such as that known under the trade name "Pentarol 20" (acid value 7-15, specific gravity at 20° C. 1.09, melting range 110-120° C.) is digested in 25 grams of xylene (a non-polar liquid having a volume 2

resistivity of at least 1010 ohm-centimetre and a dielectric constant of less than 3), and when solution is completed, 15 grams of a linseed oil modified alkyd resin of medium oil length such as that known under the trade name "Rhodene L6/100 (oil length 52%, acid value 6-10, specific gravity at 20° C. 0.955-0.965) is added.

150 grams of phthalocyanine blue is then added to the above coating mix and blended either in a ball mill or 10 a triple roller mill until mixing is complete and pigment particle size is reduced to the required fineness, such as 0.5 micron, average.

Eight hours' milling in a ball mill is usually sufficient, after which it will be found that the pigment particles are coated with a thin film, continuous or discontinuous, of the coating mix one component being relatively insoluble in the carrier to act as the control agent and the other suffifficiently soluble to act as the fixing agent when the carrier liquid is evaporated.

This coating mix will thus influence the surface charge of the coated particles and will form the bonding means after the pigment is applied in a liquid development process.

The paste so produced is used as the basis for a dispersion in the chlorinated fluorinated hydrocarbon solvent forming the developer carrier liquid, approximately 0.5 gram of the developer paste being dispersed in 100 mils of the liquid.

To develop an electrostatic image, the liquid devel-30 oper so formed is simply contacted with the image, and the coated pigment particles, which are free to move in the liquid, deposit on those areas of the image where a suitable potential exists, until the charge of the image has been satisfied by the particles deposited, the particles being held in position by the electrical force until the carrier liquid is evaporated, whereupon the pigment particles are held by direct adhesion of the resin on the surface of the particles.

During development, the presence of the resin influences the particle charge, and it is found that rapid deposition is possible of the particles when they are so coated.

The coating mix according to the above example is, as said, only partly soluble in the carrier liquid, and therefore, while the partly dissolved surface of the coating is in a condition where it will form an effective bonding medium after evaporation of the solvent, it will act as a surface charge modifier during development to control the migration of the particles in an electrical field.

In the case of the trichlorotrifluoroethane it is desirable to grind the paste into the carrier liquid as otherwise solubility of the paste in the liquid will be too low and difficulty may be experienced in getting effective adhesion of the coated pigment particles after evaporation of the carrier.

The developer paste described is more soluble in the trichloromonofluoromethane and simple mixing, without grinding, is found sufficient.

If desired, a mixture of the two carriers referred to may be used, for instance 60% of "Freon MF" and 40% of "Freon TF." "Freon MF" or "Freon TF" may be combined with a less volatile, or an inflammable type of carrier provided the compounded carrier has a

65 volume resistivity in excess of 1010 ohm-centimetre and a dielectric constant of not greater than 3. A suitable mixture would be "Freon MF" 80 parts and xylene 20 parts the resulting mixture still being non-inflammable.

The percentage can, of course, be varied according 70 to conditions.

## Example 2

The developer of Example 1 can be modified by re-

placing the "Rhodene L6/100" with an equal percentage of "Pentarol 20," whereupon it will be found that the developer will have good fixing qualities but will not have the same degree of modification of the surface charge of the pigment particles as the "Pentarol 20" is 5 relatively soluble in the hydrocarbon carrier liquid and is a tacky substance, so that it tends to leave the pigment particles when in the developer and deposit as a fixing substance.

If sufficient tacky substance is present on the pigment 10 substances to cause it to remain there during development, the developer can be said to have both a charge modifying agent and a fixing agent.

#### Example 3

The developer of example 1 has the "Pentarol 20" replaced by an equal percentage of "Rhodene L6/100," a substance less soluble in the hydrocarbon liquid and the developer then acts as one with a high degree of control of the surface charge of the pigment particles 20 due to the coating substance remaining on the pigment particles with possibly even so little solubility on the surface that no appreciable bonding of the pigment particles will take place after evaporation of the carrier liquid. 25

We claim:

1. A liquid developer for electrostatic images comprising a chlorinated fluorinated hydrocarbon carrier liquid selected from the group consisting of trichloro-

monofluoromethane and trichlorotrifluoroethane and mixtures thereof, pigment particles dispersed in said liquid, and resins constituting a coating on said particles, one of said resins being relatively soluble in said liquid and constituting a fixing agent for said particles whereby the particles may be fixed to a surface, another of said resins being relatively insoluble in said liquid and being of such composition as to constitute an electrostatic charge modifier for said particles, said liquid having a substantial volatility to insure a rapid fixing of said particles to said surface.

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2. A developer as defined in claim 1 further comprising a non-polar liquid having a volume resistivity of at least 1010 ohm-centimetre and a dielectric constant of 15 less than 3.

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