

[54] LIQUID DEVELOPER FOR
ELECTROPHOTOGRAPHY

[75] Inventors: Hiroichi Morikawa; Keiichi
Nagahashi; Tatsuo Aizawa, all of
Osaka, Japan

[73] Assignee: Mita Industrial Company, Ltd.,
Higashi-ku, Osaka, Japan

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Related U.S. Application Data

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[58] Field of Search 252/62.1

[56] References Cited

UNITED STATES PATENTS

3,438,904	4/1969	Wagner.....	252/62.1
3,554,946	1/1971	Okuno et al.	252/62.1

3,639,243	2/1972	Okuno et al.	252/62.1
3,657,130	4/1972	Machida et al.	252/62.1

Primary Examiner—Ronald H. Smith

Assistant Examiner—J. P. Brammer

Attorney, Agent, or Firm—Leonard W. Sherman

[57]

ABSTRACT

A liquid developer for electrophotography comprising particles of an image forming material selected from dyestuffs, pigments and powdery metals dispersed in a composite dispersion medium comprising a liquid carrier of high electric resistance and an asphalt extract which is at least substantially completely dissolvable in the liquid carrier and which is obtained by extracting an asphalt with a saturated hydrocarbon liquid, in which the image forming material particles are charged negatively by the dispersion medium, thereby giving a reverse visible image in the case of a negative electrostatic latent image or a non-reverse visible image in the case of a positive electrostatic latent image.

13 Claims, No Drawings

LIQUID DEVELOPER FOR ELECTROPHOTOGRAPHY

This application is a Continuation-In-Part application of co-pending application Ser. No. 115,886 filed Feb. 16, 1971, now abandoned.

This invention relates to a liquid developer for electrophotography. More specifically, it relates to a liquid developer for electrophotography comprising particles of an image forming material such as dyestuffs, pigments and powdery metals dispersed in a composite dispersion medium in which the image forming material particles are charged negatively by the dispersion medium, thereby giving a reverse visible image in the case of a negative electrostatic latent image or a non-reverse visible image in the case of a positive electrostatic latent image.

It has been known that when particles of coloring materials such as dyestuffs and pigments are dispersed in a liquid medium of a high electric resistance, the coloring material particles are charged positively or negatively depending on the correlation between the kind of liquid medium and the kind of color material, and that an electrostatic latent image can be converted to a visible image by an action of the resulting suspension. It has also been known in the art that for the purpose of maintaining the charge of the dispersed pigment particles at a certain level, the pigment particles are covered with an alkyd resin, linseed oil or the like and the resulting coated particles are dispersed in a highly electrically insulating liquid. However, in a liquid developer of this type, the resin coating of the particles is gradually eluted out into the liquid during long-time usage or storage, with the result that a change in the polarity in the pigment particles occurs, forming precipitates of agglomerated particles of the coloring material or that degradation of electric properties of the liquid of a high electric resistance is brought about. These defects are inevitable in conventional liquid developers of the above type.

In conventional known liquid developers for electrophotography it is generally difficult to uniformly negatively charge pigment particles. Some combinations of coloring materials with liquid media or of coloring material particles with liquid media and controlling agents have been proposed to produce liquid developers in which the coloring material particles are negatively charged. However, these liquid developers are poor in their durability effect and fail to give a distinct image when used for a long time.

A typical liquid developer of the foregoing type is illustrated in U.S. Pat. 3,554,946 to Okuno et al., the liquid developer being one which contains a pigment coated with a copolymer. The liquid developer is one which is prepared by adding to a pigment an electric charge polarity controlling agent which consists of a synthetic resin having a specifically defined chemical structure, the mixture being kneaded and dispersed either independently or together with a surface-active agent in a carrier liquid which consists of a hydrocarbon having a high electric resistance. The Okuno patent indicates that when a naturally-occurring rosin or asphalt is used in combination with pigment particles such as carbon black which, by its nature, never exhibits a distinct electric charge polarity, it is difficult to control the electric charge of the particles requiring the additional use of an auxiliary organic pigment capable

of making the polarity of the impressed electric charge distinct. The Okuno patent provides an improvement over the conventional use of asphalt or rosin by providing a pigment coated with a specifically defined synthetic resin copolymer.

A further conventional liquid developer is disclosed in U.S. Pat. No. 3,438,904 to Wagner, the liquid developer or toner being one which includes an evaporative liquid hydrocarbon carrier, a minor amount of a finely divided opaque insoluble pigment dispersed in a liquid carrier and a manganese salt of an organic acid to improve the quality of the image produced by the pigment particles. The Wagner patent further indicates that the pigment or particles introduced into the liquid developer or toner may be introduced with or without a coating of a natural or a synthetic resin or oil such as asphalt.

While both the above patents describe the possible addition of asphalt to a liquid developer, each patent is directed to a positive charging of coloring agent particles by controlling the polarity of the same with the addition of a charge controlling agent in the liquid carrier. In accordance with the present invention, however, in a manner totally contrary to these procedures, it has been discovered that through the use of a specifically identified extract of asphalt, it is possible to charge the polarity of coloring agent particles negatively.

Accordingly, it is a principal object of the present invention to provide a liquid developer which eliminates the foregoing deficiencies and disadvantages of previously proposed developers.

It is a further object of the present invention to provide a liquid developer for electrophotography which liquid developer, in a manner unlike previously proposed developers, is capable of negatively charging particles of coloring material thereby giving a reverse visible image in the case of a negative electrostatic latent image or a non-reverse image in the case of a positive electrostatic latent image.

It is yet a further object of the present invention to provide a liquid developer for electrophotography wherein the liquid developer comprises particles of an image forming material dispersed in a composite dispersion medium comprising a liquid carrier of high electric resistance and an asphalt extract which is at least substantially completely dissolvable in the liquid carrier and which is obtained by extracting an asphalt with a saturated hydrocarbon liquid.

Still further objects and advantages of the present invention will become more apparent from the following more detailed description of the present invention.

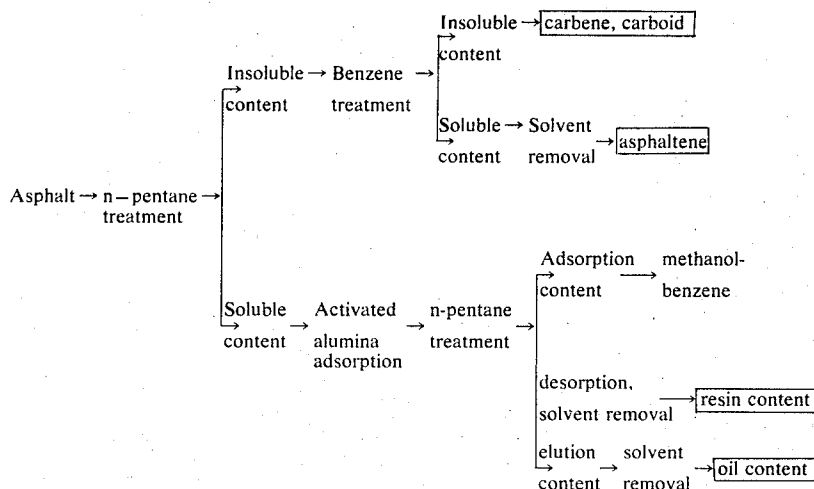
In accordance with the present invention, a liquid developer is provided for converting electrostatic latent images to visible images which consists essentially of a composite dispersion medium of a liquid of high electric resistance containing, dissolved therein, an extract of an asphalt with a saturated hydrocarbon liquid, the liquid of high electric resistance being capable of at least substantially dissolving the extract therein, and dispersed in the composite dispersion medium, particles of at least one image forming material selected from dyestuffs, pigments and powdery metals.

Asphalt is known to be a complicated colloidal mixture comprising a disperse phase composed of high molecular weight aromatic compounds, a dispersion medium composed of saturated aliphatic compounds, and groups of low molecular weight aromatic compounds

and of naphthenic and aromatic compounds or saturated aliphatic compounds, which act as a peptizer dispersing the disperse phase into the dispersing medium. When such asphalt per se is dispersed into a liquid of a high electric resistance, the dispersed asphalt particles, as is well known in the art, are positively charged. Unexpectedly, it has been found that when an extract of an asphalt with a saturated hydrocarbon liquid is dissolved in a liquid of high electric resistance capable of substantially dissolving the extract therein, the resulting composite dispersion medium charges particles of pigments and the like negatively when they are dispersed in the composite dispersion medium.

As indicated above, asphalt is a complicated colloidal mixture, the properties of the extract of which can vary considerably depending on the type of asphalt used, the type of extraction solvent used and the extraction conditions, the exact nature of the extract being difficult to specifically determine. The following discussion, however, will attempt to define the type of asphalt extract which is applicably employed in accordance with the present invention.

According to the composition analysis of asphalt by the U.S. Mining Bureau, asphalt can be analyzed as follows:



It can be seen from the above that the composition of asphalt can be broadly classified into the following three components:

- Asphaltene (n-pentane insoluble content)
- resin content (n-pentane soluble content)
- oil content (n-pentane soluble content).

The extract of asphalt with the saturated hydrocarbon in accordance with the present invention is believed to be substantially composed of the above-noted resin content and oil content. It should be recognized, however, that the exact composition of the extract is not critical to the present invention, the only requirement being that the extract is at least substantially dissolvable, preferably dissolvable to an extent of at least 98%, most preferably completely dissolvable in the liquid carrier which is employed in the liquid developer.

The asphalt which is extracted in accordance with the present invention can be any conventional asphalt, the preferred asphalt being petroleum asphalts, straight asphalts and blown asphalts. While these asphalts are

preferred, the present invention is also applicable to natural asphalt such as, for example, gilsonite, although the extraction of natural asphalt is not preferred since the extraction of the same produces less resin content and oil content.

The straight asphalts and blown asphalts which are capable of extraction in accordance with the present invention can be any of these conventional asphalts regardless of penetration. It is preferred, however, that the penetration of the asphalt, based upon test method JIS K2530-1960, be about 0 - 150 in the case of a straight asphalt and about 5 - 40 in the case of a blown asphalt. Again, however, these penetration values are preferred and the present invention is applicable to the conventionally employed petroleum asphalt, straight asphalt and blown asphalt regardless of specific physical properties.

As indicated above, the extract of asphalt is obtained in accordance with the present invention by extracting the asphalt with a saturated hydrocarbon liquid. The saturated hydrocarbon liquids suitably employed in accordance with the present invention can be selected from straight chain aliphatic hydrocarbons, branched chain aliphatic hydrocarbons and alicyclic hydrocarbons. Specific examples of applicable straight chain ali-

phatic hydrocarbons include those with 5 to 18 carbon atoms, specifically straight chain aliphatic hydrocarbons have 5 to 16 carbon atoms. Representative compounds of the above type include, for example, n-pentane, n-hexane, n-heptane, n-octane, n-decane, n-undecane, n-dodecane, n-tridecane, n-hexadecane, n-octadecane, etc.

Suitable branched chain aliphatic hydrocarbons include those of from 5 to 15 carbon atoms, preferably those of 5 to 12 carbon atoms. Representative examples of such compounds include for example isopentane, isohexane, 2,2-dimethylbutane, isooctane and as isoparaffin type hydrocarbon mixtures, C₉ - C₁₂ isoparaffin mixtures (boiling point 176.7 - 186°C.) commercially available as "Isopar H" of Esso Standard Oil Company, C₉ - C₁₂ paraffin mixtures (boiling point 159 - 176.7°C.) commercially available as "Isopar G" of the same company and Isopar R, a mixture of hydrocarbons available from the same company.

Suitable alicyclic hydrocarbons of the present inven-

tion are those which contain from 5 to 8 carbon atoms, preferably 5 or 6 carbon atoms. Representative examples include cyclopentane, cyclohexane, methylcyclohexane.

In preparing the extract of asphalt by extracting one of the aforementioned alphas with one of the above-noted saturated hydrocarbon liquids, it is merely necessary to contact the asphalt with the suitable saturated hydrocarbon liquid without taking any necessary precautions. In this respect, the temperature of the extraction is in no way critical to the present invention and the extraction is generally carried out at ambient temperature. Certainly slight deviations from ambient temperature, through cooling or heating of the extraction medium, does not in any way effect the extraction or extract of asphalt which is obtained. Similarly, the ratio between the asphalt and extraction solvent is in no way critical to the present invention, although in general practice, 5 to 1000 parts of extraction solvent are employed for 1 part of asphalt, the parts being by weight.

In preparing the liquid developer for electrophotography of the present invention, the extract of asphalt is at least substantially dissolved, preferably completely dissolved in a carrier liquid of high resistance. The carrier liquid of the present invention is a liquid of a dielectric constant of not more than 3, and a resistance of not less than 10^9 ohm-centimeter. Specific types of carrier liquids applicably employed include for example, straight chain aliphatic hydrocarbons, branch chain aliphatic hydrocarbons, halogenated hydrocarbons, alicyclic hydrocarbons, aromatic hydrocarbons, mixed hydrocarbon liquids and other conventional carrier liquids including, for example, siloxanes such as dimethyl polysiloxane.

The straight chain aliphatic hydrocarbons which can be employed as the carrier liquid are generally those having from 5 to 12 carbon atoms, preferably 9 to 12 carbon atoms. Representative examples include for instance, n-pentane, n-hexane, n-heptane, n-octane, n-nonane and n-decane.

The branch chain aliphatic hydrocarbons useful as the carrier liquid in accordance with the present invention are generally those having from 5 to 12 carbon atoms, preferably 9 to 12 carbon atoms. Representative examples include isohexane, isooctane, 2,2-dimethylbutane, isopentane and "Isopar E" (C_{7-9}), "Isopar G" (C_{9-11}), "Isopar H" (C_{9-12}), "Isopar L" (C_{10-12}), "Isopar M" (C_{12} or more), "Shellsol 71" (product of Shell Petroleum Company) and the like which are commercially available as isoparaffin type hydrocarbon mixtures. The halogenated hydrocarbons suitably employed in accordance with the present invention generally include those having up to about 6 carbon atoms. Representative examples include carbon tetrachloride, fluorotrichloromethane (Freon 11) and trifluorotrichloroethane (Freon 13).

The alicyclic hydrocarbons useful in accordance with the present invention are generally those having from 5 to 8 carbon atoms, preferably 5 to 7 carbon atoms, including cyclohexane, methylcyclohexane, and cyclopentane.

The aromatic hydrocarbons useful in accordance with the present invention are those which generally have from 6 to 9 carbon atoms, preferably 6 to 8 carbon atoms including, for example, benzene, toluene and xylene.

As mixed hydrocarbon liquids suitable for use in accordance with the present invention, reference can be

made for example, to kerosene (petroleum distillate with a boiling point of not more than $320^{\circ}\text{C}.$); "Whitesol" (tradename of Kyodo Oil Co., Ltd.), petroleum naphtha (ligroin, benzene), solvent naphtha. Whitesol is a mixed hydrocarbon liquid characterized by the following physical properties:

Specific gravity $15/4^{\circ}\text{C}.$		0.7834
Reaction		Neutral
Initial boiling point $^{\circ}\text{C}.$		152
10	Fractional 10%	$^{\circ}\text{C}.$ 160
	50%	$^{\circ}\text{C}.$ 170
	90%	$^{\circ}\text{C}.$ 184
	95%	$^{\circ}\text{C}.$ 190
	97%	$^{\circ}\text{C}.$ 194
15	Properties Final point	$^{\circ}\text{C}.$ 202
	Flashing point	$^{\circ}\text{C}.$ 38.0
	Color phase (Saybolt)	$^{\circ}\text{C}.$ +30 or more
	Aniline point	$^{\circ}\text{C}.$ 54
	Composition analysis	
saturated content %		84
Composition analysis		
aromatic content %		16

In accordance with the present invention the particular carrier liquid which is selected in preparation of the liquid developer can be freely selected from the above types, it being important only that the carrier liquid which is employed be one which has a solubility for the extract which is equal to or higher than that of the extraction solvent. Such solubility, of course, can be easily determined with a minimum amount of experimentation. For example when a straight or branched aliphatic hydrocarbon is used as the extractant, the electrically insulating liquid used may not only be the above-recited straight and branched aliphatic hydrocarbons, but also the alicyclic hydrocarbons and halogenated hydrocarbons. When an alicyclic hydrocarbon is used as the extractant, alicyclic hydrocarbons and halogenated hydrocarbons are preferably used as the electrically insulating liquid, but use of straight or branched aliphatic hydrocarbons is not preferred. When aromatic hydrocarbons such as benzene are used as the extractant, a considerable portion of the extract remains undissolved in a conventional, electrically insulating dispersion medium and the tendency that the dispersed pigment particles are positively charged increases. Accordingly, it is not preferred to use aromatic hydrocarbons as the extractant for asphalt.

In the liquid developer of this invention, the effective concentration of the asphalt extract in the composite dispersion medium varies depending on the type of coloring material to be dispersed, the extraction medium used for the extraction of the asphalt and the liquid medium of high electric resistance. However, generally speaking, if more than 0.1 g of the asphalt extract is present in 1 liter of the dispersion medium, it is possible to effectively negatively charge the dispersed particles to the image forming material. When too great an amount of the asphalt extract is present in the dispersion medium, no particular advantage is obtained by the increase of the amount of the asphalt extract and a tendency appears that the distinctness of the copy is damaged by the presence of the excessive extract. Accordingly, in the present invention, the asphalt extract is generally used in an amount of 0.1 to 30 g per liter, preferably 0.5 to 3 g per liter of the composite dispersion medium.

There is no critical limitation on conditions for preparing the composite dispersion medium. When the above-mentioned asphalt extract is mixed into a liquid of high electric resistance so that the above-mentioned conditions will be satisfied, a composite dispersion me-

dium can be easily obtained. When the extract is used without isolation of soluble components from the extractant, the resulting composite dispersion medium also contains the saturated hydrocarbon liquid used as the extractant.

The coloring material used in this invention as an image forming material is generally selected from dyestuffs, pigments, powdery metals and mixtures thereof. It is essential that these image forming materials should be free of asphalt especially high molecular weight aromatic components contained in asphalt because these high molecular weight aromatic components contained in asphalt tend to decrease the above-mentioned specific surface-activating property of the composite dispersion medium of this invention.

Any conventional dyestuff insoluble in the composite dispersion medium can be used as the image forming material. Examples of such dyestuffs are as follows:

- | | | |
|-----|-------------------------------------|-----------------|
| (1) | Substantive Dyes: | |
| | Direct Sky Blue 5B | (C. I. 24400) |
| | Direct Fast Yellow A | (C. I. 40000) |
| | Direct Deep Black RW | (C. I. 30245) |
| | Benjamin Black VS | (C. I. 30015) |
| (2) | Acid Dyes: | |
| | Brilliant Scarlet 3R | (C. I. 16255) |
| | Rose Bengale B | (C. I. 45440) |
| | Brilliant Blue FCF | (C. I. 42090) |
| | Acid Blue Black 10B | (C. I. 10470) |
| | Acid Brilliant Green 6B | (C. I. 44090) |
| (3) | Basic Dyes: | |
| | Crystal Violet | (C. I. 42555) |
| | Methylene Blue B Conc | (C. I. 52015) |
| | Janus Brown | (C. I. 33505) |
| (4) | Mordant Dyes and Acid Mordant Dyes: | |
| | Chrome Brown RH | (C. I. 13250) |
| | Alizarin Yellow | (C. I. 14025) |
| | Chrome Black PB | (C. I. 14645) |
| | Chrome Cyanine R | (C. I. 43820) |
| | Eriochrome Azuro I G | (C. I. 43855) |
| (5) | Sulfur Dyes: | |
| | Sulfur Black B | (C. I. 53185) |
| (6) | Vat Dyes: | |
| | Threne Direct Black RB | (C. I. 65230) |
| (7) | Disperse Dyes: | |
| | Disperse Fast Violet 5R | (C. I. 61100) |
| | Disperse Fast Blue FFB | (C. I. 62035) |
| | Disperse Diazo Black D | (C. I. 11365) |
| (8) | Oil-Soluble Dyes: | |
| | Victoria Blue B Base | (C. I. 44045 B) |
| | Nigrosine Base | (C. I. 50415 B) |
| | Spilon Orange 2RH | |

As pigments commercially available inorganic and organic pigments may be used. For instance, in organic pigments such as carbon black, cadmium selenide, cadmium sulfide, black iron oxide, ultramarine and chrome yellow, and organic pigments such as Lithol Red R (C.I. 15630), Phthalocyanine Blue B (C.I. 74160), Diamond Black (C.I. 50440), Lake Red (C.I. 15500), Fast Sky Blue (C.I. 74200), and Monolite Fast Red GG (C.I. 12075) can be used.

As powdery metals powders of metals such as aluminum and copper may be used.

In the present invention these dyestuffs, pigments and powdery metals may be used singly or in combination. Particles of these dyestuffs, pigments and powdery metals, when dispersed in the composite dispersion medium of this invention, are equally negatively charged regardless of whether they are charged positively or negatively when dispersed in ordinary, electrically insulating liquids.

The image forming material such as recited above is usually used in an amount of 0.5 to 5 g per liter, preferably 0.1 to 1.5 g per liter of the composite dispersion medium.

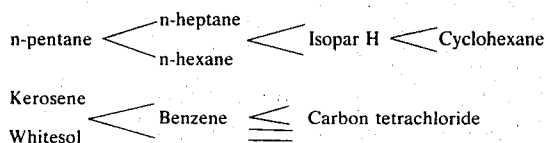
As detailed hereinabove, the present invention a novel effect is provided in that particles of an image forming material such as dyestuffs, pigments and powdery metals can be negatively charged equally by the use of a specific composite dispersion medium formed by dissolving an extract of an asphalt with a saturated hydrocarbon liquid into a liquid medium of a high electric resistance. Further, the charge of the dispersed particles is kept negative by the above-mentioned peculiar surface-activating property of the composite dispersion medium. Accordingly, the liquid developer of this invention is advantageous in that the properties of the liquid developer are not appreciably changed with the lapse of time and it is stable during long-time usage or storage.

From the data shown in Table 1 below it is apparent that it is important in this invention that the asphalt extract is substantially dissolved in a dispersion medium of high electric resistance.

TABLE 1

Image Forming Material		Charge Polarity of Image Forming Material			
		Liquid Used for Extraction			
		n-Heptane	Isopar H	Cyclohexane	Benzene
of Asphalt	Dispersion Liquid of High Electric Resistance				
Kind of Dyestuff, Pigment of Powdery Metal					
Carbon Black	Isopar H	-	-	+	+
Carbon Black	Carbon Tetrachloride	-	-	-	-
Phthalocyanine Blue	Isopar H	-	-	+	+
Phthalocyanine Blue	n-Heptane	-	+	+	+
Phthalocyanine Blue	Whitesol	-	-	-	+
Victoria Blue Base	n-Heptane	-	+	+	+
Lithol Red	Cyclohexane	-	-	-	+
Lithol Red	N-Hexane	-	+	+	+
Crystal Violet	n-Hexane	-	+	+	+
Crystal Violet	Kerosene	-	-	-	+
Rose Bengale	Isopar H	-	-	+	+
Aluminum Powder	n-pentane	-	+	+	+
Copper Powder	Whitesol	-	-	-	+

With reference to the solvents indicated in Table I, the degree of the ability to dissolve asphalt is in the following order:



The liquid developer of the present invention can be used for any of the conventional electrophotographic processes such as the chargeless process, the charging process and the latent image transferring process.

The present invention will now be illustrated by the following specific examples, which examples are presented for purposes of illustration only and the present invention is in no way to be deemed as limited thereby.

EXAMPLE 1

10 parts of straight asphalt of a penetration of 80-100 (product of Maruzen Oil Co.) are added and dissolved into 100 parts of n-pentane, and insoluble matters are removed by filtration. Then n-pentane is evaporated and components of the asphalt soluble in n-pentane are extracted. With use of the resulting asphalt extract, a liquid developer is prepared in the following manner.

2 g of the extract of the straight asphalt with n-pentane are completely dissolved in 1 liter of n-hexane which is an electrically insulating liquid. Then, 0.1 g of Crystal Violet is added to the solution and dispersed therein over a period of 5 minutes under ultrasonic vibration.

Electrode plates are put into the so formed liquid and a direct electric current of 1000 V is impressed for 1 minute. Then, the electrode plates are taken out, and the state of the image forming material particles appended to the electrode plate surface is observed. As a result, it is seen that the particles are completely negatively charged (100%). This liquid developer converts a negatively charged, electrostatic liquid image on a polyvinyl carbazole photosensitive paper to a reverse visible image of a violet color and converts a positively charged electrostatic latent image on a polyvinyl carbazole photosensitive paper to a non-reverse visible image of a violet color.

When these printed sheets are contacted with steam or heated at 120°C. for 2-3 seconds, very distinct bluish violet images of excellent fixation are obtained.

EXAMPLE 2

10 g of straight asphalt of a penetration of 80-100 (product of Maruzen Oil Co.) are added and dissolved in 100 g of Isopar H (isoparaffin type hydrocarbon; product of Esso Standard Oil Co.), and insoluble matters are removed by filtration. With use of the resulting brown extraction liquid, a liquid developer is prepared in the following manner.

10 g of the extract of the straight asphalt with Isopar H are diluted with 1 liter of Isopar H as the electrically insulating liquid, and 0.2 g of carbon black (FV-2V; product of Degussa Co.) is added to the dilution and dispersed therein over a period of 5 minutes under ultrasonic vibration to form a liquid developer.

Separately, a negatively charged zinc oxide photosensitive paper is exposed to light together with a negative original to form a negative latent image. When the so treated photosensitive paper is dipped in the above liquid developer, a positive black image is obtained.

EXAMPLE 3

10 parts of blown asphalt of a penetration of 10-20 (product of Nippon Oil Co.) are added and dissolved into 100 parts of n-pentane, and insoluble matters are removed by filtration. Then, n-pentane is evaporated and components of the blown asphalt soluble in n-heptane are extracted. With use of the so prepared extract, a liquid developer is prepared in the following manner.

1 g of the above extract of the blown asphalt with n-heptane is completely dissolved in 1 liter of kerosene which is an electrically insulating liquid, and 0.3 g of Nigrosine Base, which is an oil-soluble dye, is added to the solution and dispersed therein over a period of 3 minutes by means of a homomixer to form a liquid developer.

Separately, a negatively charged zinc oxide photosensitive paper is exposed to light together with a positive original. The, it is dipped into the above liquid developer. Thus a negative black image is obtained.

EXAMPLE 4

10 g of a blown asphalt of a penetration of 30-40 (product of Nippon Oil Co.) are added to 100 g of n-hexane and dissolved therein. Insoluble matters are removed by filtration. With the use of the resulting extraction liquid of a brown color, a liquid developer is prepared in the following manner.

10 g of the above extract of the blown asphalt with n-hexane are diluted with 1 liter of n-hexane as the electrically insulating liquid and 0.6 g of Lithol Red, which is an organic pigment, is added to the dilution and dispersed therein over a period of 3 minutes under ultrasonic vibration.

When the so formed liquid developer is used for the development of a negative electrostatic latent image on a negatively charged zinc oxide photosensitive paper, a reverse image of a red color is obtained.

In case a liquid developer free of the above extract of the blown asphalt with n-hexane is used, the polarity of the pigment particles is positive.

EXAMPLE 5

10 parts of straight asphalt of a penetration of 80-100 (Product of Maruzen Oil Co.) are added and dissolved into 100 parts of n-pentane, and insoluble matters are separated by filtration. Then, n-pentane is evaporated and components of the straight asphalt soluble in n-pentane are extracted. With use of the so prepared extract, a liquid developer is prepared in the following manner.

4 g of the above extract of the straight asphalt with n-pentane are completely dissolved in 1 liter of n-pentane as electrically insulating liquor, and 1 g of aluminum powder as metallic image forming material is added to the solution and dispersed therein over a period of 5 minutes under ultrasonic vibration to form a liquid developer.

Separately, a negatively charged zinc oxide photosensitive paper is exposed to light together with a negative original. When the so treated photosensitive paper

is dipped into the above liquid developer, a positive image of a silver color is obtained.

When a liquid developer free of the above extract of the straight asphalt with n-pentane is used, the polarity of the aluminum particles is positive.

EXAMPLE 6

10 parts of straight asphalt of a penetration of 80-100 (product of Maruzen Oil Co.) are added and dissolved in 100 parts of n-pentane, and insoluble matters are removed by filtration. Then, n-heptane is evaporated, and components of the straight asphalt soluble in n-pentane are extracted. With use of the so formed extract, a liquid developer is prepared in the following manner.

2 g of the above extract of the straight asphalt with n-heptane are completely dissolved in 1 liter of n-heptane, which is an electrically insulating liquid, and 0.3 g of Victoria Blue Base, which is an oil-soluble dye, is added to the solution and dispersed therein over a period of 3 minutes by means of a homomixer to form a liquid developer.

When the so prepared liquid developer is used for the development of a negative electrostatic latent image of a negatively charged zinc oxide photosensitive paper, a reverse image of a brown color is obtained.

When a liquid developer free of the above extract of the straight asphalt with n-pentane is used, the polarity of the coloring material particles is positive.

EXAMPLE 7

10 parts of blown asphalt of a penetration of 10-20 (product of Nippon Oil Co.) are added and dissolved into 100 parts of n-pentane and insoluble matters are removed by filtration. Then, n-pentane is evaporated, and components of the blown asphalt soluble in n-pentane are extracted. With use of the obtained extract, a liquid developer is prepared in the following manner.

1.5 g of the above blown asphalt extract is completely dissolved into 1 liter of carbon tetrachloride, which is an electrically insulating liquid. Then, 0.15 g of carbon black (FW-ZV) is added to the solution and dispersed therein over a period of 3 minutes under ultrasonic vibration to form a liquid developer.

When this liquid developer is applied to a zinc oxide photosensitive paper having a negative electrostatic latent image, a reverse image of a black color is obtained.

EXAMPLE 8

10 parts of straight asphalt of a penetration of 80-100 (product of Maruzen Oil Co.) are added and dissolved into 100 parts of cyclohexane, and insoluble matters are removed by filtration. With use of the resulting extraction liquid of a brown color, a liquid developer is prepared in the following manner.

20 g of the above extract of the straight asphalt with cyclohexane are diluted with 1 liter of cyclohexane as the electrically insulating liquid, and 0.6 g of Lithol Red, which is an organic pigment, is added to the dilution and dispersed therein over a period of 5 minutes under ultrasonic vibration to form a liquid developer.

When the so formed liquid developer is used for the development of a zinc oxide photosensitive paper hav-

ing a negative electrostatic latent image, a reverse image of a red color is obtained.

EXAMPLE 9

10 parts of straight asphalt of a penetration of 120-150 (product of Maruzen Oil Co.) are added and dissolved into 100 parts of n-pentane, and insoluble matters are removed by filtration. Then, n-pentane is evaporated and components of the straight asphalt soluble in n-pentane are extracted. With use of the resulting extract, a liquid developer is prepared in the following manner.

1 g of the above extract of the straight asphalt with n-pentane is completely dissolved in 1 liter of Shellsol 71 (isoparaffin type hydrocarbon; product of Shell Petroleum Co.) which is an electrically insulating liquid, and 0.1 g of Phthalocyanine Blue which is an organic pigment is added to the solution and dispersed therein over a period of 3 minutes by means of a homomixer to form a liquid developer.

When the so formed liquid developer is applied to a zinc oxide photosensitive paper having a negative electrostatic latent image, a reverse image of a blue color is obtained.

EXAMPLE 10

10 parts of blown asphalt of a penetration of 10-20 (product of Nippon Oil Co.) are added and dissolved into 100 parts of n-pentane, and insoluble matters are removed by filtration. Then, n-pentane is evaporated and components of the blown asphalt soluble in n-pentane are extracted. With use of the so recovered extract, a liquid developer is prepared in the following manner.

1.5 g of the above extract of the blown asphalt with n-pentane is completely dissolved in 1 liter of Whitesol (product of Kyodo Oil Co.), which is an electrically insulating liquid and 0.1 g of Phthalocyanine Blue is added to the solution and dispersed therein over a period of 3 minutes by means of a homomixer to form a liquid developer.

When the so formed liquid developer is used for the development of an electrostatic latent image on a negatively charged zinc oxide photosensitive paper, a reverse image of a blue color is obtained.

EXAMPLE 11

10 parts of straight asphalt of a penetration of 80-100 (product of Maruzen Oil Co.) are added and dissolved in 100 parts of n-pentane, and insoluble matters are removed by filtration. Then, n-pentane is evaporated and components of the straight asphalt soluble in n-pentane are extracted. With use of the so recovered extract, a liquid developer is prepared in the following manner.

2 g of the above extract of the straight asphalt with n-pentane are completely dissolved in 1 liter of Isopar G (product of Esso Standard Oil Co.), which is an electrically insulating liquid, and 0.6 g of Rose Bengale, which is an acid dye, is added to the solution and dispersed therein over a period of 3 minutes by means of a homomixer.

When the so prepared liquid developer is applied to the development of an electrostatic latent image on a negatively charged zinc oxide photosensitive paper, a reverse image of a faintly red color is obtained.

EXAMPLE 12

10 parts of straight asphalt (with a penetration of 10–20) produced by Daikyo Oil Co., Ltd. were mixed with and dissolved in 100 parts of n-octane and the insoluble content was removed by filtration. Then, n-octane was evaporated and the component of the straight asphalt soluble in n-octane was extracted. A liquid developer was prepared by the use of the extract obtained by the method described below.

2 g of n-octane extract of straight asphalt were completely dissolved in 1 liter of Shellsol 71 (Shell Petroleum Co., Ltd. made isoparaffin type hydrocarbon solvent) as an insulating liquid and 0.2 g of carbon black (Degussa Company made FW-2V) as a coloring agent was added thereto and dispersed using ultrasonic wave during a period of 5 minutes. In this way a liquid developer was prepared.

Positively charged polyvinyl carbazole photosensitive paper was exposed to light with the positive original and soaked in the above liquid developer and a positive black image was obtained.

EXAMPLE 13

10 parts of straight asphalt (with a penetration of 40–60) produced by Daikyo Oil Co., Ltd. were mixed with and dissolved in 100 parts of n-dodecane and the insoluble content was removed by filtration. Then, n-dodecane was evaporated and the component of the straight asphalt soluble in n-dodecane was extracted. A liquid developer was prepared by the use of the extract obtained by the following method.

2 g of the n-dodecane extract of the straight asphalt were completely dissolved in 1 liter of Isopar G (Esso Standard Oil Co., Ltd. made isoparaffin hydrocarbon) as an insulating liquid and 0.2 g of carbon black (Degussa Company made FW-2V) as a coloring agent was added thereto and dispersed using ultrasonic wave during a period of 5 minutes whereby a liquid developer was prepared.

Negatively charged zinc oxide photosensitive paper was exposed to light with the negative original and soaked in the above liquid developer and a positive black image was obtained.

EXAMPLE 14

10 parts of straight asphalt (with a penetration of 80–100) produced by Daikyo Oil Co., Ltd. were mixed with and dissolved in 100 parts of n-decane and the insoluble content was removed by filtration. Then, n-decane was evaporated and the component of the straight asphalt soluble in n-decane was extracted. A liquid developer was prepared by the use of the extract obtained by the following method.

2 g of straight asphalt extract were completely dissolved in 1 liter of Isopar G as an insulating liquid and 0.7 g of Spirit Black (C. I. 50415) was added thereto and dispersed using ultrasonic wave during a period of 5 minutes and a liquid developer was prepared.

A positive electrostatic latent image was formed by electrostatic transfer on recording paper obtained by coating Aron S1001 (Toa Gosei Chemical Industry Co., Ltd. made acrylic ester resin) to a thickness of 10 μ on an electroconductive base plate, followed by drying, and soaking in the above liquid developer whereby a highly contrasted black image was obtained.

EXAMPLE 15

10 parts of straight asphalt (with a penetration of 120–150) produced by Daikyo Oil Co., Ltd. were mixed with and dissolved in 100 parts of n-hexadecane and the insoluble content was removed by filtration. Then, n-hexadecane was evaporated and the n-hexadecane soluble component of the straight asphalt was extracted.

A liquid developer was prepared by the use of the extract obtained by the following method.

2 g of n-hexadecane extract of the straight asphalt were completely dissolved in 1 liter of Isopar G as an insulating liquid and 1 g of metal zinc powder was added thereto and dispersed using ultrasonic wave during a period of 5 minutes and a liquid developer was prepared.

Negatively charged zinc oxide photosensitive paper was exposed to light with the negative original and soaked in the above liquid developer and a positive silver colored image was obtained. The reproduction was somewhat poor in fixation, but it was fixed by being soaked in vinyl acetate resin 2% alcohol solution, followed by drying.

EXAMPLE 16

Dia Black SH (Mitsubishi Chemical Industries, Ltd. made carbon black)—30 g

Cyanine Blue GNPS (Kabushiki Kaisha Ozeki-Sha made copper phthalocyanine)—3.5 g

Isopar H (Esso Standard Oil Co., Ltd. made isoparaffin hydrocarbon)—120 g

LR-472 (Dai Nippon Ink & Chemicals Inc. made modified acryl resin)—42 g

Dibutylphthalate—34 g

Asphalt extract [Blown asphalt made by Daikyo Oil Co., Ltd. (with a penetration of 5–10) was extracted with n-tridecane]—2 g

The above mixtures was dispersed by means of a homomixer for 30 minutes and 8 ml of the concentrated solution obtained were dispersed in 1 liter of Isopar L (Esso Standard Oil Co., Ltd. made isoparaffin hydrocarbon) and as a result a liquid developer was prepared.

Electrode plates were inserted into the developer solution and a direct current 1300 V was applied for 30 seconds and thereafter the plates were taken out of the solution and the state of the deposited image forming material particles on the surface of electrode plates was obtained. As a result, it was found that the image forming material had 100% negative electric charge. A reversed black image with excellent fixation was obtained when the negatively charged electrostatic latent image on zinc oxide photosensitive paper was developed by the use of the above liquid developer.

EXAMPLE 17

10 parts of blown asphalt (with a penetration of 20–30) produced by Daikyo Oil Co., Ltd. were mixed with and dissolved in 100 parts of n-undecane and the insoluble content was removed by filtration. Then, n-undecane was evaporated and the n-undecane soluble component of the blown asphalt was extracted. A liquid developer was prepared by the use of the extract so obtained by the following method.

2 g of blown asphalt extract were completely dissolved in 1 liter of Isopar L (Esso Standard Oil Co.,

Ltd. made isoparaffin hydrocarbon solvent) as an insulating liquid and 1.0 g of Brilliant Green (C. I. 42040) was added thereto and dispersed using ultrasonic waves for 5 minutes, thereby preparing a liquid developer.

The particle polarity was negative and the particles were adsorbed to the positive latent image thereby forming a green image.

EXAMPLE 18

Monolite Red—30 g

Pliolite S-5D (U.S. Goodyear Company made styrenebutadiene copolymerized resin)—25 g

Xylene—100 g

Asphalt extract—3 g

[Blown asphalt (with a penetration of 10-20) made by Daikyo Oil Co., Ltd. was extracted with n-octadecane]

10 ml of concentrated solution obtained by dispersing the above mixture using ultrasonic waves for 3 minutes were dispersed in 1 liter of Isopar L (Esso Standard Oil Co., Ltd. made isoparaffin hydrocarbon), thereby preparing a liquid developer.

The liquid developer obtained had negative electric charge and a reversed red image with excellent fixation being obtained when the negatively charged electrostatic latent image on zinc oxide photosensitive paper was developed by the use of this liquid developer.

EXAMPLE 19

10 parts of straight asphalt (with a penetration of 20-40) made by Mitsubishi Oil Co., Ltd. were mixed with and dissolved in 100 parts of iso-octane and the insoluble content was removed by filtration. Then, iso-octane was evaporated and the iso-octane soluble component of the straight asphalt was extracted.

A liquid developer was prepared by the use of the extract by the following method.

2 g of iso-octane extract of straight asphalt were completely dissolved in 1 liter of Isopar L as an insulating liquid and 0.2 g of carbon black (Mitsubishi Chemical Industries, Ltd. made Dia Black SH) was added thereto and dispersed using ultrasonic waves for 5 minutes, thereby preparing a liquid developer.

A reversed black image was obtained when the negatively charged electrostatic latent image on polyvinyl carbazole photosensitive paper was developed by the use of this liquid developer, whereas a positive image was obtained when the positively charged electrostatic latent image was developed.

EXAMPLE 20

10 parts of straight asphalt (with a penetration of 40-80) were mixed with and dissolved in 100 parts of isohexane and the insoluble content was removed by filtration. Then, isohexane was evaporated and the isohexane soluble component of the straight asphalt was extracted.

A liquid developer was prepared by the use of the extract by the following method.

Graft carbon (Japan Gas-Chemical Co., Ltd. made styrene-methacrylic type graft carbon, tradename SLC-512)—5 g

Isohexane extract—15 g

Shellsol 71 (product of Shell Petroleum Co., Ltd.)—200 ml

A concentrated toner was prepared by dispersing the above mixture using ultrasonic waves for 1 minute.

50 ml of concentrated toner were stirred and diluted with Shellsol 71 using a glass stick, thereby preparing a liquid developer.

When negatively charged zinc oxide photosensitive paper was exposed to light with the negative original and soaked in the above liquid developer and a positive black image was obtained.

EXAMPLE 21

10 parts of straight asphalt (with a penetration of 80-100) made by Mitsubishi Oil Co., Ltd. were mixed with and dissolved in 100 parts of 2,2-dimethylbutane and the insoluble content was removed by filtration. Then, 2,2-dimethylbutane was evaporated and the 2,2-dimethylbutane soluble component of the straight asphalt was extracted.

A liquid developer was prepared by the use of the extract by the following method.

Colortex Blue No. 150 (Sanyo Shikiso Kabushiki Kaisha made resin finishing pigment)—5 g

2,2-dimethylbutane extract—15 g

Whitesol (Kyodo Oil Co., Ltd. made aliphatic, aromatic mixed solvent)—200 ml

A concentrated toner was prepared by dispersing the above mixture using ultrasonic waves for 1 minute.

50 ml of the concentrated toner were stirred and diluted with 1 liter of Whitesol using a glass stick, thereby preparing a liquid developer.

When positively charged polyvinyl carbazole photosensitive paper was exposed to light with the positive original and soaked in the above liquid developer a positive blue image was obtained.

EXAMPLE 22

10 parts of blown asphalt (with a penetration of 20-40) made by Mitsubishi Oil Co., Ltd. were mixed with and dissolved in 100 parts of iso-pentane and the insoluble content was removed by filtration. Then, iso-pentane was evaporated and the iso-pentane soluble component of the blown asphalt was extracted.

A liquid developer was prepared by the use of the extract by the following method.

Benzidine Yellow (C. I. 21090)—5 g

Iso-pentane extract—15 g

Whitesol (Kyodo Oil Co., Ltd. made aliphatic, aromatic mixed solvent)—200 ml

A concentrated toner was prepared by dispersing the above mixture using ultrasonic waves for one minute.

50 ml of concentrated toner were stirred and diluted with 1 liter of Whitesol using a glass stick, thereby preparing a liquid developer.

The particle polarity in this liquid developer was charged negatively.

Examples 23-30:

The same procedure as in Example 12 was repeated by the use of the coloring agent, asphalt, extraction solvent and carrier tabulated in the following Table 2.

Comparative Examples:

Sample 1

0.5 g of Dia Black SH (Mitsubishi Chemical Industries, Ltd. made carbon black), 2.5 g of straight asphalt (product of Maruzen Oil Co., Ltd.; penetration: 80-100) and 100 cc of Isopar H (Esso Standard Oil Co., Ltd. made isoparaffin hydrocarbon solvent) were mixed and dispersed by ultrasonic waves for 5 minutes, thereby forming concentrated solution and subsequent

TABLE 2

Exam- ples	Coloring Agent	Type of Asphalt	Extraction Solvent	Carrier	Particle Polarity of liquid developer	
23	Methyl Violet Red Extract Carrier (C.I. 45160)	0.5g 2g 1 liter Mitsubishi Oil Co., Ltd. Blown Asphalt (penetration 20-40)	Isopar G (Esso Standard Oil Co., Ltd. Isoparaffin hydrocarbon)	Whitesol (Kyodo Oil Co., Ltd.)	negative	
24	Rhodamine 6 Extract Carrier	0.5g 2g 1 liter Mitsubishi Oil Co., Ltd. Blown Asphalt (penetration 10-20)	Isopar H (Esso Standard Oil Co., Ltd. isoparaffin hydrocarbon)	Isopar H	do.	
25	Carbon Black Cyanine Blue GNPS Piccolastic A-75 (Nippon Petro.K.K.) Extract Carrier (C.I. 45380)	0.15g 0.02g 0.015g 0.4g 1 liter	Maruzen Oil Co., Ltd. Straight asphalt (penetration: 20-40)	Methylcyclo- hexane	Xylene	do.
26	Eosin Extract Carrier	0.5g 2g 1 liter Maruzen Oil Co., Ltd. Straight asphalt (penetration: 40-60)	Cyclopentane	Cyclopentane	do.	
27	Lithol Red Extract Carrier	0.8g 1g 1 liter Nippon Oil Co., Ltd. Straight asphalt (penetration: 20-40)	n-hexadecane	fluoro- trichloro- methane	do.	
28	Aluminum powder Extract Carrier	Nippon Oil Co., Ltd. 1g 5g 1 liter Straight asphalt (penetration: 20-40)	cyclohexane	do.	do.	
29	Carbon Black J-534(alkyd) (Dai Nippon Ink Chemical Co., Ltd.) Extract Carrier	0.1g 0.3g 0.3g 1 liter Nippon Oil Co., Ltd. Straight asphalt (penetration: 60-80)	Iso-hexane	Iso-hexane	do.	
30	Carbon Black Extract Carrier	0.2g 2g 1 liter Nippon Oil Co., Ltd. Blown asphalt (penetration: 20-30)	n-pentane	dimethylpoly- siloxane	do.	

to cooling, 0.8 ml of the concentrated solution was diluted with 100 cc of Isopar H to prepare a liquid developer.

Sample 2

10 g of straight asphalt (product of Maruzen Oil Co., Ltd.; penetration: 80-100) were dissolved in 100 cc of n-pentane and the insoluble content was removed by filtration. Some 150 mg of this extract were added to the liquid developer of Sample 1 and completely dissolved to prepare a liquid developer.

Sample 3

0.5 g of Dia Black SH, 1.25 g of n-pentane extract substance obtained by Sample 2 and 10 cc of Isopar H were mixed and dispersed by ultrasonic waves for one minute, thereby forming a concentrated solution, and subsequent to cooling, 0.8 ml of concentrated solution was diluted with 100 cc of Isopar H, thereby preparing a liquid developer.

The particle polarity of the above samples was measured and the results are tabulated in Table 3.

TABLE 3

Samples	1 Comparative Example Positive	2 Comparative Example Positive	3 The Instant Invention Negative
Particle Polarity			

Results:

1. The particle polarity of the liquid developer (Sample 1) in which carbon black was coated with asphalt indicated to be positive.

2. The particle polarity of the liquid developer (Sample 2) where the n-pentane extract of asphalt was dissolved in the carrier solution and added to the liquid developer (Sample 1) in which carbon black was coated with asphalt indicated to be positive.

3. The particle polarity of the liquid developer (Sample 3) in which the n-pentane extract of the asphalt was dissolved in the carrier solution and carbon black was dispersed indicated to be negative.

Accordingly, it is found that: in the case of carbon black coated with asphalt being partially insoluble in the carrier solution, particle polarity is positive, whereas in the case of an asphalt extract soluble in the carrier, particle polarity is negative.

It should be evident from the above that the liquid developer for electrophotography in accordance with the present invention produces results unlike previously developed liquid developers through the combination of particles of an image forming material in a composite dispersion medium comprising a liquid car-

rier of high electric resistance and an asphalt extract obtained by extracting an asphalt with a saturated hydrocarbon liquid, the extract being at least substantially completely dissolvable in the liquid carrier.

While the present invention has been described primarily by reference to the foregoing exemplification, it should be understood that the present invention is in no way to be deemed as limited thereto, but rather must be construed as broadly as all or any equivalents thereof.

We claim:

1. A liquid developer for developing electrostatic latent images which comprises

a. a composite dispersion medium consisting essentially of

i. a liquid carrier of a dielectric constant of not more than 3 and a resistance of not less than 10^9 ohm-centimeter, and

ii. an extract of asphalt which is at least substantially completely dissolvable in said liquid carrier, said extract of asphalt being obtained by extracting an asphalt selected from petroleum asphalts, straight asphalts, blown asphalts and natural asphalts with a saturated hydrocarbon liquid from straight chain aliphatic hydrocarbons of from 5 to 18 carbon atoms, branched chain aliphatic hydrocarbons of from 5 to 15 carbon atoms and alicyclic hydrocarbons of from 5 to 8 carbon atoms, and

b. an image-forming material dispersed in said composite dispersion medium selected from dyestuffs, pigments and powdery metals, said extract of asphalt being present in an amount of 0.1 to 30 grams per liter of said composite dispersion medium, the particles of said image-forming material being negatively charged in said composite dispersion medium.

2. The liquid developer of claim 1 wherein said straight chain aliphatic hydrocarbon is selected from n-pentane, n-hexane, n-heptane, n-octane, n-decane, n-undecane, n-dodecane, n-tridecane, n-hexadecane and n-octadecane.

3. The liquid developer of claim 1 wherein said branched aliphatic hydrocarbon is selected from isopentane, isohexane, 2,2-dimethylbutane, isooctane, and C_9 - C_{12} isoparaffin mixtures (boiling point $176.7 - 186^\circ\text{C}.$), C_9 - C_{12} paraffin mixtures (boiling point $159 - 176.7^\circ\text{C}.$) and Isopar R.

4. The liquid developer of claim 1 wherein said alicyclic hydrocarbon is selected from cyclopentane, cyclohexane and methylcyclohexane.

5. The liquid developer of claim 1 wherein said straight chain aliphatic hydrocarbon contains from 5 to 16 carbon atoms, said branched chain aliphatic hydrocarbon contains from 5 to 12 carbon atoms and said alicyclic hydrocarbon contains 5 or 6 carbon atoms.

6. The liquid developer of claim 1 wherein said liquid carrier is selected from straight chain aliphatic hydrocarbons, branched chain aliphatic hydrocarbons, halogenated hydrocarbons, alicyclic hydrocarbons, aro-

matic hydrocarbons, mixed hydrocarbon liquids and dimethyl polysiloxane.

7. The liquid developer of claim 1 wherein said extract of asphalt is present in an amount of 0.5 - 3 grams per liter of said composite dispersion medium.

8. The liquid developer of claim 1 wherein said image forming material is present in an amount of 0.05 to 5 grams per liter of said composite dispersion medium.

9. The liquid developer of claim 8 wherein said image forming material is present in an amount of from 0.1 to 1.5 grams per liter of said composite dispersion medium.

10. A liquid developer for developing electrostatic latent images consisting essentially of:

a. a composite dispersion medium consisting essentially of

i. a liquid carrier of a dielectric constant of not more than 3 and a resistance of not less than 10^9 ohm-centimeter

selected from straight chain aliphatic hydrocarbons, branched chain aliphatic hydrocarbons, halogenated hydrocarbons, alicyclic hydrocarbons, aromatic hydrocarbons, mixed hydrocarbon liquids and dimethyl polysiloxane, and

ii. an extract of asphalt which is at least substantially completely dissolvable in said liquid carrier, said extract of asphalt being obtained by extracting an asphalt selected from petroleum asphalt, straight asphalt and blown asphalt with a saturated hydrocarbon liquid selected from n-pentane, n-hexane, n-octane, n-decane, n-undecane, n-dodecane, n-tridecane, n-hexadecane, n-octadecane, isohexane, 2,2-dimethylbutene, isooctane, C_9 - C_{12} isoparaffin mixture (boiling point $176.7 - 180^\circ\text{C}.$) and C_9 - C_{12} paraffin mixture (boiling point $159 - 176.7^\circ\text{C}.$), cyclopentane and methylcyclohexane, and

b. an image-forming material dispersed in said composite dispersion medium selected from dyestuffs, pigments and powdery metals, said image-forming material being present in an amount of 0.05 to 5 grams per liter of said composite dispersion medium, said extract of asphalt being present in an amount of 0.1 to 30 grams per liter of said composite dispersion medium, the particles of said image-forming material being negatively charged in said composite dispersion medium.

11. The liquid developer of claim 10 wherein said extract of asphalt is present in an amount of 0.5 - 3 grams per liter of said composite dispersion medium.

12. The liquid developer of claim 10 wherein said image forming material is present in an amount of from 0.1 to 1.5 grams per liter of said composite dispersion medium.

13. The liquid developer of claim 10 wherein the extraction of said asphalt is carried out by using 5 to 1000 parts of said saturated hydrocarbon liquid per 1 part of said asphalt.

* * * * *

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,821,113 Dated June 28, 1974

Inventor(s) Hiroichi MORIKAWA ET AL

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

In the Heading, insert patentees' claims for priority as follows: -- Claims priority, application Japan, No. 45/14143, February 20, 1970. --

Signed and sealed this 29th day of October 1974.

(SEAL)
Attest:

McCOY M. GIBSON JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents