

[54] PROCESS FOR LIQUID DEVELOPMENT OF ELECTRONIC PHOTOGRAPHY

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[58] Field of Search..... 96/1 LY; 117/37 L; 252/62.1

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[57]

ABSTRACT

A process for developing electrical latent images with a liquid developer containing at least a colouring agent, cyclic rubber and low molecular polyethylene which promote the transferring and fixing of images, and a charge controller which controls the charge of toner, all existing in an electrically insulating liquid medium which process is applicable to the electronic photography and comprises steps of visualizing electrical latent images with the liquid developer and transferring the visualized images to a transfer material.

8 Claims, 5 Drawing Figures

FIG. 1

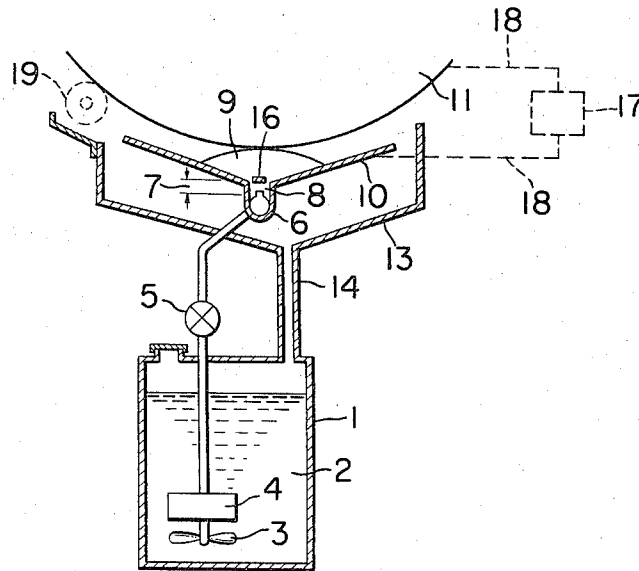


FIG. 2

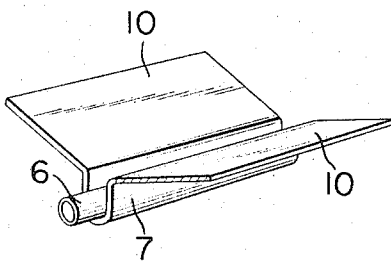


FIG. 3

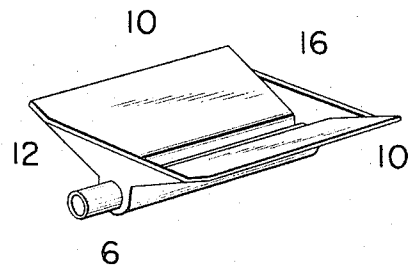


FIG. 4

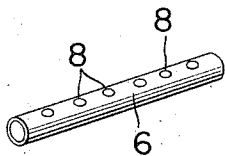
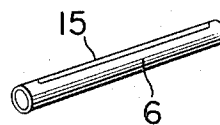


FIG. 5



# PROCESS FOR LIQUID DEVELOPMENT OF ELECTRONIC PHOTOGRAPHY

## BACKGROUNDS OF THE INVENTION

### 1. Field of the Invention

The present invention relates to a process for liquid development of electronic photography suitable to the electronic photography, which comprises steps of visualizing electrical latent images on a surface with a liquid developing agent for electronic photography and then transferring the developed images to a transfer material.

### 2. Description of the Prior Art

So many kinds of electronic photography have been known in which electrical latent images formed by many different processes were developed with liquid developers to obtain visualized images. Such processes of electronic photography have also been known that consisted of visualizing electrical latent images on a surface with liquid developers for electronic photography and transferring the visualized images to a transfer material.

For example, Japanese Patent Publication Sho 45-24077 describes a process for electronic photography in which electrostatic images are formed on the surface of an insulating layer of a photosensitive material composed of electroconductive base plate, photoelectroconductive layer and an insulating layer as basic components.

The liquid developers to be used in the processes in which electrical latent images formed on an insulating layer or a photosensitive layer are developed with a liquid developer and developed images are transferred to a transfer material are required to have following properties: the said electrical latent images are developed into clear fogless images; any force applied to the developed images does not disturb to obtain clear images transferred; the developed images should produce sufficiently clear transferred images on a transfer material; and finally the transferred images are firmly fixed to the transfer material.

Liquid developers so far used for electronic photography are to develop electrostatic latent images formed on electronic photographic paper mostly of zinc oxide-binder mixture. On examining these commercial liquid developers for electronic photography for the purpose to transfer a developed image to a transfer material, the developers were found to have any of the following difficulties: 1) the developed images were so poorly transferred that, even if sufficiently clear images were produced on the photosensitive or insulating layer, the transferred images were of low density and bad quality, (2) transferred images were fixed very poorly to the transfer material and lightly rubbing with a finger when the carrier liquid of the liquid developer was dried up made the images so blurred as to make practical use of these developers impossible.

The present invention can be applied to an electronic photography which have completely solved the above problems, and provides a process for liquid development of electronic photography using a liquid developer which permits images of good quality, excellent property in being transferred and sufficient fixing of the transferred images to be obtained.

## SUMMARY OF THE INVENTION

The present invention relates to a process for devel-

oping electrical latent images with a liquid developer containing at least a colouring agent and cyclic rubber in an electrically insulating liquid, which is applicable to the electrical photography comprising processes of visualizing electrical latent images formed on an insulating or a photoelectroconductive layer with a liquid developer and of then transferring the developed images to a transfer material.

The present invention relates to a process for developing electrical latent images developer containing at least a colouring agent and cyclic rubber in an electrically insulating liquid, which is applicable to the electronic photography comprising processes of uniformly charging the surface of insulating layer of a photosensitive body that is composed of supporting material, photoelectroconductive layer and insulating layer as basic constituents, of obtaining electrical latent images by irradiating an original figure under the simultaneous corona discharge followed by uniformly exposing to light the whole surface of the photosensitive body, of visualizing the latent images with a liquid developer and of transferring the images to a transfer material.

The present invention relates to a process for developing electrical latent images with a liquid developer containing in an electrically insulating liquid at least a colouring agent and cyclic rubber as an accelerating agent of transferring images in a liquid developing process which is applicable to the electronic photography comprising processes of uniformly charging the surface of insulating layer of a photosensitive body that is composed of supporting material, photoelectroconductive layer and insulating layer as basic constituents, of obtaining electrical latent images by irradiating an original figure under the simultaneous corona discharge followed by uniformly exposing to light the whole surface of the photosensitive body, of visualizing the latent images with a liquid developer and of transferring the images to a transfer material, while the process employs a liquid developing apparatus for electrostatic latent images which is provided with a storage tank for the liquid developer, photosensitive body, developing electrode where the said liquid developer could be pooled at a very short distance from the photosensitive body placed thereabove, a distributor of the said liquid developer by which the liquid developer could be distributed from the said storage tank through the central part of the developing electrode to every part of the same, buffering material for the stream of liquid developer which serves to prevent a rapid flow of the developer from coming into direct contact with the photosensitive body, and a circulating device for the said liquid developer by which the developer is recovered from the said developing electrode into the storage tank via a recovering dish and then supplied to the distributor.

The present invention relates to a process for developing electrical latent images with a liquid developer containing in an electrically insulating liquid at least a colouring agent, cyclic rubber and low-molecular polyethylene, which is applicable to the electronic photography comprising processes of visualizing electrical latent images formed on an insulating or a photoelectroconductive layer with a liquid developer and transferring the images to a transfer material.

The present invention relates to a process for developing electrical latent images with a liquid developer containing in an electrically insulating liquid at least a coloring agent, cyclic rubber which serves to accelerate

fixing and transfer properties of the images and low molecular polyethylene (having molecular weight 1,000 to 5,000), which is applicable to the electronic photography comprising processes of uniformly charging the surface of insulating layer of a photosensitive body that is composed of supporting material, photoelectroconductive layer and insulating layer as basic constituents, of obtaining electrical latent images by irradiating an original figure under the simultaneous corona discharge followed by uniformly exposing to light the whole surface of the photosensitive body, of visualizing the latent images with a liquid developer and of transferring the images to a transfer material.

The present invention relates to a process for developing electrical latent images with a liquid developer containing in an electrically insulating liquid at least a colouring agent, cyclic rubber which serves to accelerate fixing and transfer properties of the images and low molecular polyethylene (having molecular weight 1,000 to 5,000) in a liquid developing process which is applicable to the electronic photography comprising processes of uniformly charging the surface of insulating layer of a photosensitive body that is composed of supporting material, photoelectroconductive layer and insulating layer as basic constituents, of obtaining electrical latent images by irradiating an original figure under the simultaneous corona discharge followed by uniformly exposing to light the whole surface of the photosensitive body, of visualizing the latent images with a liquid developer and of transferring the images to a transfer material, while the process employs a liquid developing apparatus for electrostatic latent images which is provided with a storage tank for the liquid developer, photosensitive body, developing electrode where the said liquid developer could be pooled at a very short distance from the photosensitive body placed thereabove, a distribution of the said liquid developer by which the liquid developer could be distributed from the said storage tank through the central part of the developing electrode to every part of the same, buffering material for the stream of liquid developer which serves to prevent a rapid flow of the developer from coming into direct contact with the photosensitive body, and a circulating device for the said liquid developer by which the developer is recovered from the said developing electrode into the storage tank via a recovering dish and then supplied to the distributor.

The present invention relates to a process for developing electrical latent images with a liquid developer containing in an electrically insulating liquid at least a colouring agent, cyclic rubber, low-molecular polyethylene and lecithin, which is applicable to the electronic photography comprising processes of visualizing electrical latent images formed on an insulating or a photoelectroconductive layer with a liquid developer and of then transferring the developed images to a transfer material.

The present invention relates to a process for developing electrical latent images with a negatively charged liquid developer containing in an electrically insulating liquid at least a colouring agent, cyclic rubber and low-molecular polyethylene (molecular weight being 1,000 to 5,000) which serve to accelerate the fixing and transfer properties of images, and lecithin as charge controller to control the charge to be applied to toner, which is applicable to the electronic photography comprising processes of uniformly charging the surface of

insulating layer of a photosensitive body that is composed of supporting material, photoelectroconductive layer and insulating layer as basic constituents, of obtaining electrical latent images by irradiating an original figure under the simultaneous corona discharge followed by uniformly exposing to light the whole surface of the photosensitive body, of visualizing the latent images with a liquid developer and of transferring the images to a transfer material.

The present invention relates to a process for developing electrical latent images with a negatively charged liquid developer containing in an electrically insulating liquid at least a colouring agent, cyclic rubber and low-molecular polyethylene that serve to accelerate the fixing and transfer properties of images, and lecithin as charge controller to control the charge of toner, in the liquid developing process which is applicable to the electronic photography comprising processes of uniformly charging the surface of insulating layer of a photosensitive body that is composed of supporting material, photoelectroconductive layer and insulating layer as basic constituents, of obtaining electrical latent images by irradiating an original figure under the simultaneous corona discharge followed by uniformly exposing to light the whole surface of the photosensitive body, of visualizing the latent images with a liquid developer and of transferring the images to a transfer material, while the process employs a liquid developing apparatus for electrical latent images which is provided with a storage tank for the liquid developer, photosensitive body, developing electrode where the said liquid developer could be pooled at a very short distance from the photosensitive body placed thereabove, a distributor of the said liquid developer by which the liquid developer could be distributed from the said storage tank through the central part of the developing electrode to every part of the same, buffering material for the stream of liquid developer which serves to prevent a rapid flow of the developer from coming into direct contact with the photosensitive body, and a circulating device for the said liquid developer by which the developer is recovered from the said developing electrode into the storage tank via a recovering dish and then supplied to the distributor.

The object of the present invention is to provide a process for liquid developing in the electronic photography using a liquid developer which, when applied to the electronic photography where electrical latent images formed on an insulating or a photoelectroconductive layer are developed and transferred to a transfer material, permits images of excellent quality, good transfer and fixing property of the images to be obtained.

The immersion development so far used in the liquid developing process is likely to be accompanied by fogging when a relatively concentrated developer is used to obtain high density images suitable to be transferred.

The present invention has solved the mentioned difficulty and provides a process for developing in the electronic photography in which use of a relatively concentrated liquid developer enables to obtain high density images of good quality, superior in the transfer property and the transferred images are completely fixed.

The present inventors, through investigations of liquid developers of electronic photography applied to the transferring process of the electronic photography,

have found that a liquid developer containing in the form of dispersion in an electrically insulating liquid a colouring agent, cyclic rubber and a charge controller remarkably improves the transfer property of developed images. The actual effect will be illustrated later in examples with reference to experimental data.

The present inventors have further found that a liquid developer for electronic photography containing in an electrically insulating liquid a colouring agent, cyclic rubber and low-molecular polyethylene are superior in the transfer property and further in the fixing property. The actual effect will be discussed in the later examples referring to experimental data.

The present inventors have further found that a liquid developer for electronic photography containing in an electrically insulating liquid a colouring agent, cyclic rubber, low-molecular polyethylene and lecithin can produce high density images without forming any fogs and the images are capable of being transferred and fixed effectively. The actual effect will be discussed in detail in later examples with particular reference to experimental data.

#### DESCRIPTION OF THE PREFERRED EMBODIMENTS

The composition of the liquid developer of the present invention is as follows: the developer solution contains in the dispersed form 0.2 to 6.0 g, preferably 0.5 to 2.5 g, of dyestuff or pigment, 0.2 to 6.0, preferably 1.0 to 4.0 g, of cyclic rubber, 0.1 to 3.0 g, preferably 0.2 to 2.0 g, of low-molecular polyethylene and 0.005 to 0.1 g, preferably 0.01 to 0.06 g, of lecithin per 1 liter of electrically insulating liquid as carrier liquid.

Those electrically insulating liquids and colouring agents which have been used as constituent for liquid developer of the electronic photography may be used in the present invention. Namely, aliphatic hydrocarbons, aromatic hydrocarbons and halogenated hydrocarbons having the electrical resistance larger than  $10^{10}$  ohm.cm and specific dielectric constant smaller than 3 may be generally used. They include, for example, n-pentane, cyclohexane, isoparaffin, chlorinated paraffin, naphtha. kerosene and light oil. Any pigment and dyestuff which have been used as developer in the electronic photography may be also used in the present invention.

Furthermore, to improve the transferring and fixing property, one or more substances selected from the group consisting of phenolic, coumarone, acrylic, and alkyd resins, liquid paraffin, solid paraffin, chlorinated paraffin, chlorinated rubber, higher carboxylic acids, and metal salts thereof may be added, if necessary, to the liquid developer for the electronic photography of this invention. Especially among them, phenolic and coumarone resins remarkably improve the property.

The liquid developer for the electronic photography of this invention can be applied to the process of electronic photography in which electrical latent images formed on the surface of a photosensitive layer of zinc oxide-binder, an inorganic photoconductive layer such as of amorphous selenium, an organic photoconductive layer or an insulating layer are developed and then transferred to a transfer material, where zinc oxide-binder photosensitive paper of any kind of previous use may be used and well-known organic photoelectroconductive substances including vinylcarbazols such as poly-9-vinylcarbazol and derivatives thereof, aromatic

amino derivatives such as amino-polyphenyl and pyrazolino-pyrazolines derivatives such as pyrazoline, imidazine may be applied to this purpose. Inorganic photoelectroconductive substances which may be used in this invention include amorphous selenium, selenium-tellurium alloys and sulphides of selenium or cadmium.

The developers of this invention are also useful when electrical latent images formed on an insulating layer such as polyester films are developed and transferred.

Particularly when photosensitive materials composed of three layers, that is electroconductive supporter, photoelectroconductive layer and insulating layer, are desired, they can be prepared by finely dispersing N-type photoelectroconductive microcrystals, such as cadmium sulphide and zinc oxide, in binders, such as epoxy resin, acrylic resin, vinyl chloride-vinyl acetate copolymer and polyvinyl chloride, and applying on a metal base plate such aluminum, zinc and copper; or otherwise, by applying organic photoelectroconductive substances, such as poly-N-vinylcarbazol, chlorinated poly-N-vinyl-carbazol, in a 5 to 60 $\mu$  dry thickness and either placing on the layer an insulating film, for example, made of polyester film or further applying an insulating resin layer, for example, of epoxyresin. The mentioned photosensitive materials composed of the three layers, that is supporter, photoelectroconductive substance and insulating layer, are described in detail in Japanese Patent Publications Sho 42-23910 and Sho 43-24748.

An example of a process of the electronic photography in which a photosensitive material composed of above three layers is as follows: at first the surface of the insulating layer of photosensitive material composed of three layers is uniformly charged by a corona discharge at +5 to 8 KV, and is irradiated by the original images under the simultaneous application of the a.c. corona discharge at 5 to 8 KV followed by uniformly exposing to light to form electrostatic latent images on the surface of the photosensitive material, and is then developed with the above liquid developer containing a colouring agent, cyclic rubber, low-molecular polyethylene and lecithin dispersed in an electrically insulating liquid, and the corona discharge at -5 to -7 KV is applied to the surface of the images formed to limit the charged electricity and finally, after an excessive amount of the liquid developer is removed, a transfer paper is applied to the images with the corona discharge at +5 to 8 KV from the opposite side of the paper, then clear figures can be obtained on the transfer paper when the paper is removed from the surface of insulating layer.

The electrically insulating liquid remaining on the transfer paper is removed by blowing with hot air on the surface to obtain completely fixed figures.

Hereinunder, the developing apparatus employed in the present invention will be described in detail with particular reference to the attached drawings.

FIG. 1 illustrates a preferred apparatus in which the developing part of this invention is incorporated;

FIGS. 2 and 3 show two different types of vessel for the liquid developer in the developing part from which the liquid developer overflows; and

FIGS. 4 and 5 show two different shapes of distributor.

In FIG. 1, the storage tank 1 contains the liquid developer 2, and the developer is maintained in a suspension by occasionally agitating with a stirrer 3. While in use, the liquid developer is transported by a pump 4 via the adjusting valve 5 to the distributor 6.

The part 7, to which the liquid developer is transported by the distributor 6, forms an interspace and the dimension is decided in consideration of the flow of the liquid developer and diameter and shape of the orifices 8 of the distributor 6 so that the direction of flow and the flow characteristics of the liquid developer can be substantially eliminated. The diameter of the orifices may be usually larger than 3.175 mm or one-eighth inch, but may be smaller in case when an exceptionally low rate of flow of the liquid developer is required.

A pool 9 of the liquid developer is formed on the said interspace 7 and side plates (10) and the upper surface of the pool is kept in contact with the surface to be developed supported on the photosensitive drum 11.

The contact area of the photosensitive material with the liquid developer may be varied by changing the interval between the side plates 10 and the photosensitive drum 11, and is furthermore controllable by adjusting the flow rate of the liquid developer. Unconsumed liquid developer overflows at the ends of side plates into the recover 13 and then transported back into the storage tank 1 through the pipe 14.

In order to decrease the directional flow characteristics in connection of the orifices 8 and the slot 15, some apparatus is provided with buffering material 16 for the liquid flow above the orifices or the slot, permitting the interspace 7 to be decreased. More particularly, the buffering material for flow serves to prevent direct flow from the orifices 8 of the distributor 6 toward the surface of photosensitive material from excessively washing and marring the images.

The developing unit, 6 and 10, may be insulated from the earth, if necessary, so that a bias voltage is applied to the side plates 10 to control developing, and the circuitry to this end is illustrated by dotted lines in the figure, where 17 is supply source of the bias voltage, and wires 18 are supply leads to the side plates 10 and the photosensitive drum 11, and further accessories such as squeezing roller 19 which controls transportation of the carrier liquid may be installed so long as their functions do not deviate from the essential features of the present invention.

FIG. 2 shows the distributor 6 and the side plates 10 as appears in FIG. 1 in an equiangular projection, where both ends of the unit remain unlimited.

In FIG. 3, side boards 12 are used to increase the depth of the developer pool. Other parts are referred to above as shown by the reference numbers.

FIG. 4 is an equiangular projection of the distributor 6, particularly showing how the developer 2 passes through the orifices 8 and forms the developer pool in FIG. 1.

FIG. 5 shows a modification of the distributor 6 in which orifices are replaced by a single slot 15. In the case when this type of distributor is used, the developer is supplied to the distributor 6 at the center, at both ends, at one end or at any part as desired.

As is evident from the above description, the present developing apparatus is favoured by use of stationarily stirred liquid developer, where the toner particles are uniformly supplied and homogeneously distributed throughout the whole range of images without local de-

pletion nor excess of density because the toner is continuously supplied in a flow pattern. Further, the flow pattern is eliminated and a uniform flow results well below the surface on which development occurs, so that the images do not come into direct contact with a stream of developer which may cause to disturb the image formation. As a result, a concentrated developer can be used to obtain high quality images without introducing fogs.

This is more clearly observed in the experimental data which will appear in later sections to show the effects of the present invention.

When the mentioned apparatus is employed, the liquid developer should preferably be more concentrated than usual ones. Thus, per 1 liter of an electrically insulating liquid as carrier, 0.5 to 6.0 g, preferably 1.0 to 3.0 g, of colouring agent such as dyestuff and pigment, 0.5 to 6.0 g, preferably 1.0 to 4.0 g, of cyclic rubber, 0.2 to 5.0 g, preferably 0.4 to 3.0 g, of low-molecular polyethylene (molecular weight being about 1,000 to 5,000) and 0.005 to 0.1 g, preferably 0.01 to 0.06 g, of lecithin should be contained in a dispersed form.

The present invention will be understood more clearly by the following examples.

#### EXAMPLE 1

|                                                       |       |
|-------------------------------------------------------|-------|
| Photoelectroconductive zinc oxide                     | 100 g |
| Styrene-butadiene copolymer (50% solution in toluene) | 20 g  |
| n-Butylmethacrylate (50% solution in toluene)         | 40 g  |
| Toluene                                               | 120 g |
| Rose Bengale (1% solution in methanol)                | 4 ml  |

The above constituents were mixed for 6 hours using a porcelain ball mill. By applying the mixture on an aluminium plate of 0.05 mm thickness with a wiper bar so as to obtain a 40 $\mu$  dried thickness, and by then evaporating the solvent in a hot air a photosensitive plate of zinc oxide was prepared.

On the other hand, a mixture consisting of

|                                                |       |
|------------------------------------------------|-------|
| Carbon black                                   | 4 g   |
| Cyclic rubber (20% solution in xylene)         | 60 g  |
| Manganese naphthenate (20% solution in xylene) | 5 g   |
| Isopar G                                       | 120 g |

was dispersed for 20 hours in a porcelain ball mill. A 20 ml portion of the resulting dispersoid was added under stirring to 2 liters of isopar G to prepare the liquid developer.

The said photosensitive plate of zinc oxide was subjected to the corona discharge of -6 KV, the electrostatic latent images were formed by irradiating desired images, the latter being immersed in the above liquid developer to obtain visible images.

Immediately, a transfer paper was applied to the obtained images and pressed on the opposite side of the paper with a rolling rubber roller. When the paper was removed, good quality images could be found on the paper and almost no remainder of the images was observed on the zinc oxide photosensitive plate.

#### EXAMPLE 2

In a process according to Example 1, the composition of the liquid developer was changed as follows:

|              |     |
|--------------|-----|
| Carbon black | 4 g |
|--------------|-----|

-Continued

|                                         |       |
|-----------------------------------------|-------|
| Alkali blue toner                       | 1 g   |
| Cyclic rubber (20% solution in toluene) | 45 g  |
| Alkyd resin (80% solution in xylene)    | 2.4 g |
| Isopar G                                | 120 g |

The constituents were dispersed for 20 hours in a porcelain ball mill. A 20 ml portion of the dispersoid was added to 2 liters of isopar G under agitation, to produce the liquid developer. Results were satisfactory as before.

## EXAMPLE 3

Hundred grams of a 20 percent solution of poly-n-vinylcarbazol in benzene was prepared and 2 ml of a 1 percent ethanolic solution of Rose Bengale was added to it. The mixture was thoroughly mixed, applied to an aluminium plate of 0.05 mm thickness so as to obtain a 10 $\mu$  thick dried layer and dried with hot air to prepare a photosensitive plate.

On the other hand, following constituents were dispersed in a porcelain ball mill for 20 hours:

|                                           |       |
|-------------------------------------------|-------|
| Carbon black                              | 4 g   |
| Phthalocyanine clue                       | 0.5 g |
| Cyclic rubber (20% solution in toluene)   | 36 g  |
| Coumarone resin (50% solution in toluene) | 14 g  |
| Linseed oil                               | 2.5 g |
| Isopar G                                  | 120 g |

A 30 ml portion of this dispersoid was added dropwise to 2 liters of Isopar G under stirring to prepare the liquid developer.

The said photosensitive plate was charged by the corona charging at +6 KV and latent images were formed on it by irradiating the surface with original figures. The plate was then immersed in the developer solution. Immediately after the development, a transfer paper was placed on the plate and, while being treated by the corona charging at -7 KV, the paper was removed from the plate. Transferred images of good quality were obtained.

## EXAMPLE 4

In a vessel of Pyrex glass, granular selenium of 99.99 percent purity and powdery tellurium was mixed in ratio of 85 : 15. The mixture was melted in vacuum to obtain a selenium-tellurium alloy. This was placed in a melting boat and vacuum plated to a nickel-plated brass plate of 1 mm thickness at  $2 \times 10^{-5}$  Torr so as to obtain a 60 $\mu$  thick layer. Electrostatic latent images were formed on the plate by charging it with the corona charging at +6 KV followed by irradiation with the original figures.

The liquid developer was prepared from the following constituents:

|                                                       |       |
|-------------------------------------------------------|-------|
| Acylated nigrosin                                     | 2 g   |
| Carbon black                                          | 2 g   |
| Cyclic rubber (20% solution in toluene)               | 40 g  |
| Chlorinated paraffin (40% by weight chlorine content) | 2.5 g |
| Isopar G                                              | 150 g |

The all constituents were dispersed for 20 hours in a ball mill, and 40 ml of the resulting dispersoid was added under stirring to isopar G. The said electrostatic latent images were developed by the liquid developer and transferred as in Example 3 to a transfer paper. The transferred images were extremely sharp-cut.

## EXAMPLE 5

Electrostatic latent images were formed on the surface of a 38 $\mu$  polyester film by negatively applying corona discharge from a needle electrode pointing to the surface in accordance with images appearing on a Braun tube.

The electrostatic latent images were developed with a liquid developer prepared as follows:

|                                         |       |
|-----------------------------------------|-------|
| Carbon black                            | 4 g   |
| Cyclic rubber (20% solution in toluene) | 75 g  |
| Iron naphthenate                        | 2.5 g |
| Toluene                                 | 120 g |

Preparation of the liquid developer and transferring of the developed images to a transfer paper were conducted in the same manner as in Example 1. The transferred images obtained were very sharp-cut.

To illustrate the effect of the present invention, Comparison Examples 1 to 4 are shown below in which procedures were the same as in Examples 1 to 5 except that different developers were used, and experimental data for comparison on the transferring property are shown in Table 1.

Table 1

|                      | Density of images to be transferred (A) | Density of transferred images (B) | A-B  |
|----------------------|-----------------------------------------|-----------------------------------|------|
| Example 1            | 1.20                                    | 1.10                              | 0.10 |
| Example 2            | 1.40                                    | 1.15                              | 0.25 |
| Comparison Example 1 | 1.00                                    | 0.40                              | 0.60 |
| Example 3            | 1.00                                    | 0.95                              | 0.05 |
| Comparison Example 2 | 0.95                                    | 0.40                              | 0.55 |
| Example 4            | 1.40                                    | 1.30                              | 0.10 |
| Comparison Example 3 | 1.20                                    | 0.65                              | 0.55 |
| Example 5            | 0.85                                    | 0.80                              | 0.05 |
| Comparison Example 4 | 0.80                                    | 0.45                              | 0.35 |

In the Comparison Example 1, the liquid developer was prepared in the same manner as in Example 2 from the following constituents:

|                                       |       |
|---------------------------------------|-------|
| Carbon black                          | 4 g   |
| Alkali blue toner                     | 1 g   |
| Alkyd resin (80% solution in toluene) | 4.8 g |
| Isopar G                              | 180 g |

Development and transferring were performed in the same manner as in Example 1 using the developer.

In the Comparison Example 2, a mixture consisting of

|                    |       |
|--------------------|-------|
| Carbon black       | 4 g   |
| Phthalocyanin blue | 0.5 g |
| Coumarone resin    | 32 g  |
| Linseed oil        | 2.5 g |
| Isopar G           | 120 g |

was treated as in Example 3 to prepare the liquid developer and therewith development and transferring were conducted in the same manner as in Example 3.

In the Comparison Example 3, the liquid developer was prepared from the following constituents as in Example 4,

|                                             |     |   |
|---------------------------------------------|-----|---|
| Acylated ligroin                            | 2   | g |
| Carbon black                                | 2   | g |
| Chlorinated paraffin (40% Chlorine content) | 2.5 | g |
| Phenolic resin (50% solution in toluene)    | 17  | g |
| Isopar G                                    | 120 | g |

and the same process as in Example 4 was followed.

The Comparison Example 4 employed the same developer as used in the Comparison Example 1 and the procedure was the same as in Example 5.

As is readily seen from the above experimental data, the images obtained by developing with the liquid developers used in Examples 1 to 5 which contained cyclic rubber exhibited excellent property in transferring to a transfer material.

Following examples are to illustrate the effect of cyclic rubber and low-molecular polyethylene.

#### EXAMPLE 6

|                                                       |     |    |
|-------------------------------------------------------|-----|----|
| Zinc oxide                                            | 100 | g  |
| Styrene-butadiene copolymer (50% solution in toluene) | 20  | g  |
| n-Butylmethacrylate (50% solution in toluene)         | 40  | g  |
| Toluene                                               | 120 | g  |
| Rose Bengale (1% solution in methanol)                | 4   | ml |

The above ingredients were dispersed by mixing with a porcelain ball mill for 6 hours. The resulting mixture was applied with a wire bar to an aluminium plate of 0.05 mm thickness so as to obtain a 40 $\mu$  dried thickness and the solvent was evaporated with hot air to obtain a photosensitive plate of zinc oxide-binder.

On the other hand, the following constituents were dispersed for 20 hours with a porcelain ball mill,

|                                                                                           |     |   |
|-------------------------------------------------------------------------------------------|-----|---|
| Carbon black                                                                              | 4   | g |
| Cyclic rubber (20% solution in toluene)                                                   | 60  | g |
| Low-molecular polyethylene (average molecular weight about 1500) (40% solution in xylene) | 15  | g |
| Alkyd resin (80% solution in xylene)                                                      | 2.4 | g |
| Isopar G                                                                                  | 120 | g |

and a 20 ml portion of the resulting dispersoid was added under stirring to 2 liters of Isopar G to prepare the liquid developer.

Subsequently, the said photosensitive plate of zinc oxide was subjected to the corona discharge at -6 KV and thereupon electrostatic latent images were formed by irradiating original images. The plate was immersed in the said liquid developer to obtain visible images. Immediately a transfer paper was applied to the images and when the paper was removed while the paper was pressed on the opposite side with a rolling rubber roller, transferring images of good density were obtained on the transfer paper.

#### EXAMPLE 7

|                                                                                     |     |   |
|-------------------------------------------------------------------------------------|-----|---|
| Carbon black                                                                        | 6   | g |
| Cyclic rubber (20% solution in xylene)                                              | 40  | g |
| Low-molecular polyethylene (average molecular weight 1000) (20% solution in xylene) | 5   | g |
| Coumarone resin (20% solution in xylene)                                            | 30  | g |
| Isopar G                                                                            | 120 | g |

The above mixture was dispersed with a homogenizer for 10 hours. A 15 ml portion of the dispersoid was added under stirring to 2 liters of Isopar G containing 0.01 percent (by weight) of manganese naphthenate to prepare the liquid developer. Subsequently, negative electrostatic latent images formed on the zinc oxide-binder photosensitive body were developed with the said liquid developer to obtain sharp-cut images of high density. A transfer paper was applied to the images while they were still wet with the carrier liquid, and the paper was removed with an electrically grounded electroconductive rubber roller rolling on the opposite side of the paper, and thus sharp transferred images could be obtained.

The transferring property was so excellent that the density amounted to 1.5 at the highest. Fixing of the images dried by standing in the open air was complete enough to stand rubbing with a finger.

For the sake of comparison, a developing agent prepared from the same constituents of the developer of this example except polyethylene was placed in a test tube along with the developer of this example and the dispersion stability of both solutions was observed. After a week standing, no difference in dispersion was observed with naked eyes, but the microscopic observation revealed coagulation with the solution containing no polyethylene while the developer of this example remained in perfect dispersion.

In place of the polyethylene of the average molecular weight 1,000 used in this example, polyethylenes of the average molecular weight 2,000, 2,200, 3,500 and 5,000 were also used with almost similar results.

#### EXAMPLE 8

When the amount of polyethylene in Example 7 was varied to 8, 16, 32 and 45 percent by weight of the total solid components, the dispersive property was found to be more improved with the increase of the proportion of polyethylene.

However, the developer of 45 percent by weight of polyethylene produced, even immediately after the preparation, images of low density which blot easily.

#### EXAMPLE 9

A 100 g portion of a 20 percent solution of poly-N-vinylcarbazol in benzene was prepared and 2 ml of a 1 percent solution of Rose Bengale in ethanol was added to it and the mixture was stirred to assure uniformity. The resulting mixture was applied to an aluminum plate of 0.05 mm thickness so as to obtain a 10 $\mu$  thickness when dried with hot air. Thus, a photosensitive plate was prepared.

On the other hand, following components were mixed thoroughly in a porcelain ball mill for 20 hours:

|                                                                                     |     |   |
|-------------------------------------------------------------------------------------|-----|---|
| Carbon black                                                                        | 4   | g |
| Cyclic rubber (20% solution in toluene)                                             | 60  | g |
| Low-molecular polyethylene (average molecular weight 1500) (40% solution in xylene) | 15  | g |
| Boiled linseed oil                                                                  | 6   | g |
| Isopar G                                                                            | 120 | g |

and 20 ml of this dispersoid was added to 2 liters of Isopar G under agitation to obtain the liquid developer.

Subsequently, the said photosensitive plate was submitted to the corona charging at +6 KV, electrostatic latent images were formed on it by irradiating the plate

with the original figures, and then the plate was immersed in the liquid developer. Immediately after the development, a transfer paper was applied to the images and the paper was removed while being treated with the corona charging a -7 KV from the opposite side. Transferred images of good quality was obtained by this procedure.

#### EXAMPLE 10

Granular selenium 99.99 percent purity and powdery tellurium were mixed in a ratio of 85 to 15 in a Pyrex glass vessel and fused in vacuum to prepare a tellurium-selenium alloy. This was transferred to a fusion boat and was plated on a nickel-plated brass plate of 1 mm thickness by vacuum-plating under a vacuum  $2 \times 10^{-5}$  Torr to obtain  $60\mu$  thick layer. The photosensitive plate thus formed was subjected to the corona charging at +6 KV followed by irradiation with original figures to obtain electrostatic latent images.

The liquid developer used was prepared as follows:

|                                                     |       |
|-----------------------------------------------------|-------|
| Carbon black                                        | 4 g   |
| Cyclic rubber (20% solution in xylene)              | 60 g  |
| Low-molecular polyethylene (40% solution in xylene) | 15 g  |
| Bitumen (saturated solution in Isopar G)            | 150 g |

against the surface, the discharge being performed in accordance with original figures appearing on a Braun tube. The electrostatic latent images were developed with the liquid developer prepared from the following components:

|                                                                                     |       |
|-------------------------------------------------------------------------------------|-------|
| Carbon black                                                                        | 6 g   |
| Cyclic rubber (20% solution in xylene)                                              | 55 g  |
| Low-molecular polyethylene (average molecular weight 2000) (40% solution in xylene) | 20 g  |
| Coumarone resin (20% solution in xylene)                                            | 30 g  |
| Isopar G                                                                            | 120 g |

A mixture consisting of above constituents was mixed thoroughly with a homogenizer for 10 hours and a 15 ml portion of the resulting dispersoid was added under agitation to 2 liters of Isopar G containing 0.01 percent by weight of manganese naphthenate to prepare the liquid developer.

The above electrostatic latent images were developed with the liquid developer and transferred as in Example 6. The sharpness of the transferred figures was excellent.

For the purposes to illustrate the effect of this invention comparative data are shown in Table 2.

Table 2

|            | Photo-sensitive material | Density of image        |                        |         |                       |         |
|------------|--------------------------|-------------------------|------------------------|---------|-----------------------|---------|
|            |                          | Before transferring (A) | After transferring (B) | (A)-(B) | After fixing test (C) | (B)-(C) |
| Example 6  | ZnO-binder               | 1.05                    | 1.00                   | 0.05    | 0.95                  | 0.05    |
| do. 7      |                          | 1.00                    | 0.90                   | 0.10    | 0.80                  | 0.10    |
| Comparison |                          |                         |                        |         |                       |         |
| Example 4  | Poly-N-vinyl-            | 0.90                    | 0.80                   | 0.10    | 0.45                  | 0.35    |
| do. 5      |                          | 0.85                    | 0.25                   | 0.60    | —                     | —       |
| do. 6      |                          | 1.00                    | 0.90                   | 0.10    | 0.50                  | 0.40    |
| do. 7      |                          | 1.10                    | 0.45                   | 0.65    | 0.20                  | 0.25    |
| Example 9  | Selenium-Tellurium       | 1.20                    | 1.10                   | 0.10    | 1.05                  | 0.05    |
| Comparison |                          |                         |                        |         |                       |         |
| Example 8  |                          | 1.30                    | 1.10                   | 0.20    | 0.60                  | 0.50    |
| do. 9      | Direct discharge         | 1.00                    | 0.45                   | 0.55    | 0.25                  | 0.30    |
| Example 10 |                          | 1.40                    | 1.25                   | 0.15    | 1.20                  | 0.05    |
| Comparison |                          |                         |                        |         |                       |         |
| Example 10 | to film                  | 1.25                    | 1.15                   | 0.10    | 0.75                  | 0.40    |
| do. 11     |                          | 1.00                    | 0.40                   | 0.60    | —                     | —       |
| Example 11 |                          | 0.85                    | 0.80                   | 0.05    | 0.80                  | 0.00    |
| Comparison |                          |                         |                        |         |                       |         |
| Example 12 |                          | 0.90                    | 0.80                   | 0.10    | 0.40                  | 0.40    |

(Density of images was measured with a reflexion densitometer.)

These constituents were dispersed in a ball mill for 20 hours. A 40 ml portion of this dispersoid was added to 2 liters of Isopar G under stirring. The electrostatic latent images produced above were developed with this liquid developer and the images were transferred as in Example 4 to a transfer paper. The transferred images were extremely sharp-cut.

#### EXAMPLE 11

Electrostatic latent images were formed by the negative corona discharge conducted directly on the surface of a  $38\mu$  polyester film with a needle electrode placed

Comparison Examples 4 to 12 were carried out as follows:

#### COMPARISON EXAMPLE 4

|                                         |       |
|-----------------------------------------|-------|
| Carbon black                            | 4 g   |
| Cyclic rubber (20% solution in toluene) | 60 g  |
| Alkyd resin (80% solution in xylene)    | 2.4 g |
| Isopar G                                | 120 g |

A mixture consisting of above components was treated in the same manner as in Example 6 to prepare a liquid developer and transferred images were obtained as in Example 6.

## COMPARISON EXAMPLE 5

|                                      |       |   |
|--------------------------------------|-------|---|
| Carbon black                         | 4 g   |   |
| Alkyd resin (80% solution in xylene) | 4.8 g | 5 |
| Isopar G                             | 120 g |   |

A liquid developer was prepared from the above components in the same manner as in Example 6 and transferred images were obtained as in Example 6. 10

## COMPARISON EXAMPLE 6

|                                          |       |    |
|------------------------------------------|-------|----|
| Carbon black                             | 6 g   |    |
| Cyclic rubber (20% solution in xylene)   | 40 g  | 15 |
| Coumarone resin (20% solution in xylene) | 30 g  |    |
| Isopar G                                 | 120 g |    |

From above materials as components a liquid developer was prepared in the same manner as in Example 7 and transferred images were obtained as in Example 7. 20

## COMPARISON EXAMPLE 7

|                                          |       |    |
|------------------------------------------|-------|----|
| Carbon black                             | 6 g   |    |
| Coumarone resin (20% solution in xylene) | 55 g  | 25 |
| Isopar G                                 | 120 g |    |

A liquid developer was prepared from the above materials as components and transferred images were produced as in Example 7. 30

## COMPARISON EXAMPLE 8

|                                         |       |    |
|-----------------------------------------|-------|----|
| Carbon black                            | 4 g   |    |
| Cyclic rubber (20% solution in toluene) | 60 g  | 35 |
| Boiled linseed oil                      | 6 g   |    |
| Isopar G                                | 120 g |    |

A mixture consisting of the above components was treated in the same manner as in Example 9 to prepare a liquid developer and using this developer transferred images were obtained as in Example 9. 40

## COMPARISON EXAMPLE 9

|                                          |       |    |
|------------------------------------------|-------|----|
| Carbon black                             | 4 g   |    |
| Boiled linseed oil                       | 6 g   |    |
| Phenolic resin (20% solution in toluene) | 40 g  | 45 |
| Isopar G                                 | 120 g |    |

A liquid developer was prepared from the above constituents in the same manner as in Example 9 and using this developer transferred images were obtained as in Example 9. 50

## COMPARISON EXAMPLE 10

|                                          |       |    |
|------------------------------------------|-------|----|
| Carbon black                             | 4 g   |    |
| Cyclic rubber (20% solution in xylene)   | 60 g  | 55 |
| Bitumen (saturated solution in Isopar G) | 150 g |    |

A liquid developer was prepared from the above materials in the same manner as in Example 10 and using this developer transferred images were obtained as in Example 10. 65

## COMPARISON EXAMPLE 11

|                                          |       |  |
|------------------------------------------|-------|--|
| Carbon black                             | 4 g   |  |
| Vinyltoluene (20% solution in xylene)    | 25 g  |  |
| Bitumen (saturated solution in Isopar G) | 150 g |  |

A mixture consisting of above materials was used to prepare a liquid developer in the same manner as in Example 10 and using this developer transferred images were obtained as in Example 10.

## COMPARISON EXAMPLE 12

|                                          |       |    |
|------------------------------------------|-------|----|
| Carbon black                             | 6 g   |    |
| Cyclic rubber (20% solution in xylene)   | 55 g  |    |
| Coumarone resin (20% solution in xylene) | 30 g  | 15 |
| Isopar G                                 | 120 g |    |

A liquid developer was prepared from the above components in the same manner as in Example 11 and transferred images were obtained as in Example 11 using the said developer.

The test for fixing was carried out as follows: five sheets of soft paper were fixed at an end, 6 mm × 10 mm, of a metal bar and the bar was placed with the said end in contact with the transferred figures. The bar was moved 5 times in the horizontal direction while kept in touch with the figures. The pressure during the process was controlled to be 12 g/cm<sup>2</sup>. Density of the images was measured before and after the treatment with a reflection densitometer and the fixing property was defined by the decrease in the value of the density. 30

Examples in which cyclic rubber, low-molecular polyethylene and lecithin were contained are illustrated below.

## EXAMPLE 12

|                                                       |       |    |
|-------------------------------------------------------|-------|----|
| Zinc oxide                                            | 100 g |    |
| Styrene-butadiene copolymer (50% solution in toluene) | 20 g  | 35 |
| n-Butyl methacrylate (50% solution in toluene)        | 40 g  |    |
| Toluene                                               | 120 g |    |
| Rose Bengale (1% solution in methanol)                | 4 ml  | 40 |

A mixture consisting of above components was mixed thoroughly with a porcelain ball mill for 6 hours. This was applied to an aluminium plate of 0.05 mm thickness with a wire bar so as to obtain a 40μ thick layer when dried, and by evaporating the solvent by hot air a photosensitive plate of zinc oxide-binder system was prepared. The resulting photosensitive material was treated by the corona discharge at -6 KV to charge the whole surface uniformly and then electrostatic latent images were formed on it by irradiating with original figures. 45

On the other hand, following components were dispersed for 20 hours with a porcelain ball mill: 50

|                                                                                     |        |    |
|-------------------------------------------------------------------------------------|--------|----|
| Carbon black                                                                        | 4 g    |    |
| Cyclic rubber (20% solution in toluene)                                             | 60 g   | 55 |
| Low-molecular polyethylene (average molecular weight 1500) (40% solution in xylene) | 15 g   |    |
| Lecithin                                                                            | 0.01 g |    |
| Isopar G                                                                            | 120 g  |    |

and a 20 ml portion of the dispersoid was added to 2 liters of Isopar G under agitation to prepare the liquid developer. Using this developer, the electrostatic latent images above were developed to obtain sharp reversal images on the surface of the photosensitive material.

Immediately, a transference paper was placed on the obtained images and it was removed slowly while being pressed with a rolling rubber roller from the opposite side. Thus, transferred images of good quality were obtained on the transfer paper.

#### EXAMPLE 13

One hundred grams of a 20 percent solution of poly-N-vinyl-carbazol in benzene was prepared and stirred to homogeneity with 2 ml of a 1 percent solution of Rose Bengale in ethanol. This was applied to an aluminium plate of 0.05 mm thickness so as to obtain a 10 $\mu$  thick layer when dried with hot air. The photosensitive plate thus formed was treated by the corona charging at +6 KV and electrostatic latent images were formed on the surface by irradiating with original figures.

On the other hand, a mixture consisting of following components:

|                                                            |      |   |
|------------------------------------------------------------|------|---|
| Carbon black                                               | 4    | g |
| Cyclic rubber (20% solution in toluene)                    | 60   | g |
| Low-molecular polyethylene (average molecular weight 1500) | 15   | g |
| Lecithin                                                   | 0.01 | g |
| Isopar G                                                   | 120  | g |

was thoroughly mixed and dispersed with a porcelain ball mill for 20 hours. A 20 ml portion of this dispersoid was added to 2 liters of Isopar under stirring to prepare the liquid developer. Using this developer, the above electrostatic latent images were developed to obtain sharp figures on the surface of the photosensitive material. Immediately after the development, a transfer paper was placed on the surface and the paper was removed while being submitted to the corona charging at -7 KV from the opposite side. Transferred images of good quality were obtained.

#### EXAMPLE 14

Granular selenium of 99.99 percent purity and powdery tellurium were mixed in the ratio of 85 to 15 in a Pyrex glass vessel and melted in vacuum to prepare a selenium-tellurium alloy. This was transferred to a melting boat and was vacuum plated on a nickel-plated brass plate of 1 mm thickness so as to obtain a 60 $\mu$  thick layer under  $2 \times 10^{-3}$  Torr. Electrostatic latent images were formed on this photosensitive plate by treating with the corona charging at +6 KV followed by irradiation of original figures.

On the other hand, following components were thoroughly mixed for 1 hour with a homogenizer:

|                                                                                     |     |   |
|-------------------------------------------------------------------------------------|-----|---|
| Carbon black                                                                        | 6   | g |
| Cyclic rubber (20% solution in xylene)                                              | 40  | g |
| Low-molecular polyethylene (average molecular weight 1000) (20% solution in xylene) | 5   | g |
| Coumarone resin (20% solution in xylene)                                            | 30  | g |
| Isopar G                                                                            | 120 | g |

and a 20 ml portion of the resulting dispersoid was added under stirring to 2 liters of Isopar G containing 40 ml of lecithin to prepare the liquid developer. Using this developer the above electrostatic latent images were developed and fogless sharp figures of high density were obtained. Figures transferred to a transfer paper in the same manner as in Example 13 were sharp and of very high density.

Further, almost the same results were obtained when polyethylenes of the average molecular weight 2,000, 2,200, 3,500 and 5,000 were used instead of 1,000.

#### EXAMPLE 15

When the amount of polyethylene in Example 14 was varied to 8, 16, 32 and 45 percent by weight of the total solid components, the dispersibility was observed to be more improved with the increase of polyethylene. However, for 45 percent by weight of polyethylene images were of low density even with a fresh developer and the images blotted easily.

#### EXAMPLE 16

Electrostatic latent images were formed on the surface of a 38 $\mu$  polyester film by applying directly the positive corona discharge from a needle electrode pointing to the surface in accordance with signals appearing on a Braun tube.

The electrostatic latent images were developed with the following liquid developer:

|                                                                                    |     |   |
|------------------------------------------------------------------------------------|-----|---|
| Carbon black                                                                       | 6   | g |
| Cyclic rubber (20% solution in xylene)                                             | 55  | g |
| Low-molecular polyethylene (average molecular weight 200) (40% solution in xylene) | 20  | g |
| Coumarone resin (20% solution in xylene)                                           | 30  | g |
| Isopar G                                                                           | 120 | g |

A mixture consisting of the above components was dispersed for an hour with a homogenizer. A 15 ml portion of this dispersoid was added under agitation to 2 liters of Isopar G containing 100 mg of lecithin to prepare the liquid developer.

The above electrostatic latent images were developed with the said liquid developer and the figures obtained were transferred in the same manner as in Example 12. The transferred figures were satisfactorily sharp.

To illustrate the effect of this invention, data for the comparison experiments are shown in Table 3.

Table 3

|                       | Photo-sensitive material | Density of image Before transfer (A) | Density of image After transfer (B) | (A)-(B) | Density of fogging | Density of image After fixing (C) | (B)-(C) |
|-----------------------|--------------------------|--------------------------------------|-------------------------------------|---------|--------------------|-----------------------------------|---------|
| Example 12            | ZnO-binder system        | 1.00                                 | 0.95                                | 0.05    | 0.06               | 0.90                              | 0.05    |
| Comparison Example 13 |                          | 0.80                                 | 0.70                                | 0.05    | 0.08               | 0.65                              | 0.05    |
| do. 14                |                          | 0.65                                 | 0.25                                | 0.40    | 0.10               | 0.20                              | 0.05    |
| Example 13            | Poly-N-vinyl-            | 1.20                                 | 1.10                                | 0.10    | 0.02               | 1.00                              | 0.10    |

Table 3 - Continued

|                       | Photo-sensitive material     | Density of image Before transfer (A) | Density of image After transfer (B) | (A)-(B) | Density of fogging | Density of image After fixing (C) | (B)-(C) |
|-----------------------|------------------------------|--------------------------------------|-------------------------------------|---------|--------------------|-----------------------------------|---------|
| Comparison Example 15 | carbazol                     | 0.85                                 | 0.80                                | 0.05    | 0.05               | 0.75                              | 0.05    |
| do. 16                |                              | 0.80                                 | 0.40                                | 0.40    | 0.15               | 0.30                              | 0.10    |
| Example 14            | Selenium-tellurium           | 1.25                                 | 1.15                                | 0.10    | 0.01               | 1.05                              | 0.10    |
| Comparison Example 17 |                              | 0.90                                 | 0.80                                | 0.10    | 0.08               | 0.70                              | 0.10    |
| do. 18                |                              | 0.90                                 | 0.45                                | 0.45    | 0.12               | 0.20                              | 0.25    |
| Example 15            | Direct discharge to the film | 0.80                                 | 0.75                                | 0.05    | 0.02               | 0.70                              | 0.05    |
| Comparison Example 19 |                              | 0.60                                 | 0.50                                | 0.10    | 0.06               | 0.45                              | 0.05    |
| do. 20                |                              | 0.60                                 | 0.25                                | 0.35    | 0.10               | 0.20                              | 0.05    |

(Density of images was measured with a reflexion densitometer.)

Comparison Examples 13 through 20 were conducted as follows:

## COMPARISON EXAMPLE 13

A liquid developer was prepared in accordance with Example 12, wherein lecithin was replaced by 0.1 g of boiled linseed oil and using this developer transferred figures were obtained in the same manner as in Example 12.

## COMPARISON EXAMPLE 14

Carbon black 2 g  
 Linseed oil denatured alkyd resin 8 g  
 (50% solution in xylene) 100 g  
 Isopar G

A mixture consisting of the above components was dispersed in the same manner as in Example 12 to prepare the liquid developer. Using this developer, transferred figures were obtained as in Example 12.

## COMPARISON EXAMPLE 15

A liquid developer was prepared in accordance with Example 13, wherein lecithin was replaced by 0.04 g of calcium alkylsulfonate. Using the said developer transferred figures were obtained in the same manner as in Example 13.

## COMPARISON EXAMPLE 16

Carbon black 2 g  
 Hydrogenated rosin 0.8 g  
 Ethylcellulose (50% solution in toluene) 4.0 g  
 Safflower oil 0.1 g  
 Isopar G 120 g

A mixture consisting of above components was dispersed in the same manner as in Example 13 to prepare a liquid developer. Using this developer, transferred figures were obtained as in Example 13.

## COMPARISON EXAMPLE 17

A liquid developer was prepared in accordance with Example 14, wherein lecithin was replaced by 100 mg of linseed oil, and transferred figures were obtained as in Example 14.

## COMPARISON EXAMPLE 18

25 Carbon black 6 g  
 Coumarone resin (20% solution in xylene) 60 g  
 Polyethylmethacrylate (20% solution in xylene) 40 g  
 Linseed oil 0.4 g  
 Isopar G 120 g

30 A mixture consisting of above components was dispersed in the same manner as in Example 14 to prepare a liquid developer. Using this developer, the same procedure as in Example 14 was followed.

## COMPARISON EXAMPLE 19

35 A liquid developer was prepared in accordance with Example 16, wherein lecithin was replaced by 200 mg of linseed oil, and other procedures were the same as in Example 16.

## COMPARISON EXAMPLE 20

45 Carbon black 6 g  
 Coumarone resin (20% solution in xylene) 60 g  
 Polyethylmethacrylate (20% solution in xylene) 30 g  
 Linseed oil 0.6 g  
 Isopar G 120 g

50 A mixture consisting of above components was dispersed in the same manner as in Example 16 to prepare the liquid developer. Using this developer, transferred figures were obtained as in Example 16. Further, tests for the fixing property were carried out in the same way as before.

## EXAMPLE 17

60 A mixed dispersoid consisting of 100 g of microcrystalline cadmium sulfide, 10 g of a 50 percent solution in toluene of vinyl chloride-vinyl acetate copolymer and 80 g of toluene was applied to an aluminum foil of 0.05 mm thickness and dried to as to obtain a 40 $\mu$  thick dried layer. Further a 38 $\mu$  thick polyester film was attached to it with an epoxy resin adhesive agent which was hardened at room temperature. Thus, a triple layer photosensitive material was prepared. Subsequently the corona discharge at +7 KV was applied uniformly

to the insulating surface of the said photosensitive material, then the surface was irradiated with the original figures along with the alternating current corona discharge at +7 KV followed by uniformly exposing the whole surface to light, to form electrostatic latent images.

Subsequently, a mixture consisting of

|                            |      |
|----------------------------|------|
| Cyclic rubber              | 3 g  |
| Low-molecular polyethylene | 2 g  |
| Carbon black               | 2 g  |
| Xylene                     | 30 g |

was dispersed and kneaded for 12 hours with a ball mill, and then dispersed in a solution of 40 mg of lecithin in 1 liter of an electrically insulating liquid (commercial name, Isopar G) with a homogenizer to obtain a liquid developer. Using this developer, the said electrostatic latent images were developed and sharp figures were produced on the surface of photosensitive material.

The visible figures on the photosensitive surface were subjected to the corona charging at -6 KV to squeeze excessive Isopar G. A transfer paper was applied to the surface and removed from it while the corona charging at +6 KV was being applied on the opposite side. Thus, the images on the photosensitive surface were mostly transferred to the transfer paper.

Then fixed figures were produced by exposing the transferred figures to hot air and evaporating the remaining Isopar G. The density of the transferred figures, as measured with a reflection densitometer, was found at most 1.4. The transferred figures were not erased even by rubbing with a finger, showing perfect fixation.

#### EXAMPLE 18

|                            |       |
|----------------------------|-------|
| Coumarone resin            | 2.5 g |
| Cyclic rubber              | 4 g   |
| Low-molecular polyethylene | 0.5 g |
| Carbon black               | 2 g   |
| Solvesso 100               | 30 g  |

A mixture of the above components was thoroughly dispersed and kneaded for 12 hours with a ball mill and then dispersed in a solution of 60 mg of lecithin in 1 liter of an electrically insulating liquid (commercial name, Isopar G) with a homogenizer to obtain a liquid developer. Using this developer and following the procedure as in Example 17, excellent transferred figures could be obtained.

#### EXAMPLE 19

|                            |       |
|----------------------------|-------|
| Phenolic resin             | 1.5 g |
| Cyclic rubber              | 3 g   |
| Low-molecular polyethylene | 1.5 g |
| Carbon black               | 1.5 g |
| Solvesso 100               | 20 g  |

The above described ingredients were thoroughly dispersed and kneaded for 12 hours with a ball mill, and then dispersed in a solution of 40 mg lecithin in 1 liter of an electrically insulating liquid (commercial name, Isopar-G) with a homogenizer to prepare a liquid developer. Using this developer, excellent transferred figures could be obtained in the same manner as in Example 17.

#### EXAMPLE 20

|                                                                 |       |
|-----------------------------------------------------------------|-------|
| Coumarone resin                                                 | 1.0 g |
| Acrylic resin                                                   | 0.3 g |
| Cyclic rubber                                                   | 1.2 g |
| Low-molecular polyethylene (commercial name, AC polyethylene 6) | 0.4 g |
| Carbon black                                                    | 0.5 g |
| Metal-containing dyestuff (Zapon fast blue)                     | 0.2 g |
| Solvesso 100                                                    | 30 g  |

A mixture of above components was thoroughly dispersed and kneaded for 12 hours with a ball mill and the resulting dispersoid was added to a solution of 10 mg of lecithin in 1 liter of Isopar-H under agitating with a homogenizer to obtain a liquid developer. Using this developer and following the procedure as in Example 17, excellent transferred figures could be obtained.

Table 4 below shows comparative data of density of transferred figures, results of fixation test and the transfer efficiency of this invention which are exhibited in Example 17 through 20 relative to the comparison examples where the same procedure as in Example 17 was followed except using the particular liquid developers specified for individual examples.

Liquid developers for comparison:

#### Comparison example 21

|                                   |       |
|-----------------------------------|-------|
| Carbon black                      | 1.5 g |
| Linseed oil denatured alkyd resin | 3 g   |
| Lecithin                          | 40 mg |

#### Comparison example 22

|               |       |
|---------------|-------|
| Carbon black  | 2 g   |
| Cyclic rubber | 5 g   |
| Lecithin      | 40 mg |

#### Comparison example 23

|               |       |
|---------------|-------|
| Carbon black  | 2 g   |
| Cyclic rubber | 3 g   |
| Acrylic resin | 2 g   |
| Lecithin      | 40 mg |

#### Comparison example 24

|                            |       |
|----------------------------|-------|
| Carbon black               | 2 g   |
| Low-molecular polyethylene | 4 g   |
| Lecithin                   | 40 mg |

A mixture consisting of above components was dispersed and kneaded together with 30 g of Solvesso 100 for 12 hours with a ball mill, and then dispersed in 1 liter of Isopar with a homogenizer to obtain the liquid developer.

The developer in the comparison Example 25 was prepared in accordance with Example 17, wherein lecithin was replaced by linseed oil, and in Comparison Example 26 the same developer as in Example 17 except that lecithin was eliminated was employed.

Table 4

|                      |    | Density of image      |                         |         | Efficiency of transfer (%) |
|----------------------|----|-----------------------|-------------------------|---------|----------------------------|
|                      |    | On transfer paper (A) | After fixation test (B) | (A)–(B) |                            |
|                      |    |                       |                         |         |                            |
| Example              | 17 | 1.40                  | 1.35                    | 0.05    | 90                         |
| do.                  | 18 | 1.30                  | 1.25                    | 0.05    | 85                         |
| do.                  | 19 | 1.45                  | 1.35                    | 0.10    | 90                         |
| do.                  | 20 | 1.20                  | 1.15                    | 0.05    | 80                         |
| Comparison example   | 21 | 0.60                  | 0.45                    | 0.15    | 40                         |
| do.                  | 22 | 1.05                  | 0.60                    | 0.40    | 80                         |
| do.                  | 23 | 1.20                  | 0.75                    | 0.45    | 80                         |
| do.                  | 24 | 0.80                  | 0.70                    | 0.10    | 55                         |
| do.                  | 25 | 0.85                  | 0.80                    | 0.05    | 80                         |
| do.                  | 26 | 0.35                  | 0.30                    | 0.05    | 85                         |
| Commercial developer | A  | 0.75                  | 0.30                    | 0.45    | 60                         |
| do.                  | B  | 0.40                  | 0.20                    | 0.20    | 35                         |

Density of images was measured with a reflection densitometer.

The fixation test was carried out as mentioned before.

The efficiency of transfer was estimated as follows: the density of images on the transfer paper as well as of images peeled with a pressure-sensitive adhesive tape from the images remaining on the photosensitive surface was measured with a reflection densitometer, and therefrom the efficiency of transfer was calculated according to following formula:

(Efficiency of transfer)

$$= \frac{\text{reflection density of image on transfer paper}}{\left( \begin{array}{l} \text{reflection density of images} \\ \text{on transfer paper} \end{array} \right) + \left( \begin{array}{l} \text{reflection density of images remaining} \\ \text{on photosensitive surface} \end{array} \right)} \times 100$$

It is concluded from the foregoing results that Examples 17 through 20 show good transfer property, fixation and density of images, that incomplete fixation of transferred images in spite of excellent transfer efficiency results when cyclic rubber is added, that good fixation but low efficiency of transferred images result when low-molecular polyethylene was added and that both efficiency and fixation of transferred images are poor when a developer containing a linseed oil denatured alkyd resin or a commercial developer is used.

#### Example 21

A mixture dispersoid consisting of 100 g microcrystalline cadmium sulfide, 10 g of a 50 percent toluene solution of vinyl chloride-vinyl acetate copolymer and 80 g of toluene was applied to an aluminum foil of 0.05 mm thickness so as to obtain a 40 $\mu$  thick layer when dried. A 38 $\mu$  thick film of polyester was adhered to it with an epoxy resin adhesive agent which is hardened at room temperature to obtain a triple layer photosensitive material. Subsequently, the insulating surface of the photosensitive material was uniformly charged by the corona discharge at +7 KV, exposed to the original figures accompanied by the ac corona discharge at 7 KV followed by exposing the whole surface to light to form electrostatic latent images.

Then a liquid developer was prepared by dispersing and kneading a mixture consisting of

Cyclic rubber  
Low-molecular polyethylene  
Carbon black  
Xylene

3 g  
2.5 g  
3.0 g  
30 g

- 5 for 12 hours with a ball mill, and then dispersing in a solution of 50 mg of lecithin in 1 liter of an electrically insulating liquid (commercial name, Isopar G) with a homogenizer. Using this developer and the developing apparatus shown in FIG. 1, the said electrostatic latent images were developed and sharp figures were produced on the surface of photosensitive material.

The visible figures on the photosensitive surface were subjected to the corona charging at -6 KV to squeeze excessive Isopar G. A transfer paper was applied to the surface and removed from it while the corona charging at +6 KV was being applied on the opposite side. Thus, the images on the photosensitive surface were mostly transferred to the transfer paper.

- 15 Then, fixed figures were produced by exposing the transferred figures to hot air and evaporating the remaining Isopar G. The density of the transferred figures, as measured with a reflection densitometer, was found at most 1.4. The transferred figures were not erased even by rubbing with a finger, showing perfect fixation.

#### Example 22

30 Cyclic rubber  
Low-molecular polyethylene  
Soybean oil denatured alkyd resin  
Carbon black  
Solvesso 100

4.0 g  
0.4 g  
2.5 g  
2.0 g  
30 g

- 35 A mixture consisting of above components was thoroughly mixed and kneaded for 12 hours with a ball mill, and then dispersed in 1 liter of Isopar H (trade name) containing in it 40 mg of lecithin with a homogenizer to obtain a liquid developer. Using this developer, good transferred figures could be obtained in the same manner as in Example 21.

#### Example 23

45 Cyclic rubber  
Low-molecular polyethylene  
Coumarone resin  
Carbon black  
Solvesso 100

2.5 g  
2.0 g  
4.0 g  
1.5 g  
30 g

- 50 A mixture consisting of above components was thoroughly dispersed and kneaded with a ball mill for 12 hours, and then dispersed in 1 liter of Isopar G (commercial name) containing 40 mg of lecithin with a homogenizer to obtain a liquid developer. Using this developer, transferred figures of good quality could be obtained in the same manner as in Example 21.

#### Example 24

60 Cyclic rubber  
Low-molecular polyethylene  
Phenolic resin  
Carbon black  
Solvesso 800

3.0 g  
0.8 g  
1.5 g  
1.5 g  
30 g

- 65 A mixture consisting of above components was thoroughly dispersed and kneaded for 12 hours with a ball mill, and then dispersed in 1 liter of Isopar G (trade

name) containing 20 mg of lecithin with a homogenizer to obtain a liquid developer. Using this developer, transferred figures of good quality could be obtained in the same manner as in Example 21.

To illustrate the effect of the present invention, comparative data are shown in Table 5 wherein Examples 21 through 24 and results obtained when conventional developers were used and when developing was carried out by the immersion method are described.

Table 5

|                          | Density of<br>image on<br>transfer paper | Density of<br>fog on<br>transfer paper | Fixation |
|--------------------------|------------------------------------------|----------------------------------------|----------|
| Example 21               | 1.45                                     | 0.02                                   | good     |
| do. 22                   | 1.35                                     | 0.01                                   | good     |
| do. 23                   | 1.40                                     | 0.02                                   | good     |
| do. 24                   | 1.30                                     | 0.03                                   | good     |
| Comparison<br>example 27 | 1.30                                     | 0.15                                   | good     |
| do. 28                   | 1.30                                     | 0.13                                   | good     |
| do. 29                   | 1.35                                     | 0.10                                   | good     |
| do. 30                   | 1.20                                     | 0.09                                   | good     |
| do. 31                   | 0.60                                     | 0.03                                   | bad      |
| do. 32                   | 0.60                                     | 0.11                                   | bad      |

In comparison Examples 27 through 30, the same procedure as in Examples 21 through 24 was followed except that developing was carried out by the immersion method.

Comparison Example 31 proceeded as in Example 21 except using the liquid developer below.

|                                   |       |
|-----------------------------------|-------|
| Carbon black                      | 2.5 g |
| Linseed oil denatured alkyd resin | 4.0 g |
| Lecithin                          | 40 mg |

A mixture consisting of above components was thoroughly dispersed and kneaded for 12 hours with a ball mill, together with 30 g of Solvesso 100, and then dispersed in 1 liter of Isopar G with a homogenizer to obtain a liquid developer.

Comparison Example 32 employed the same liquid developer as used in Comparison Example 31 and the immersion method of development was applied, other procedures being the same as in Example 21.

It can be concluded from Table 5 that Examples 21 through 24 of this invention provide transferred figures of good quality on a transfer paper and the fixation was also satisfactory, and, in addition, very few fogging occurred.

In contrast to above examples, good transfer property and fixation of figures were achieved in Comparison Examples 27 through 30, where, however, fogging

was predominant. It may be concluded therefore that a developer of a high concentration is likely to produce fogs on figures when used by the immersion method instead of using the developing apparatus of this invention.

Since transfer property as well as fixation were very poor in comparison Examples 31 and 32, the liquid developers of this invention proved to exhibit excellent transfer and fixation properties. However, in comparison Example 31 which employed the developing apparatus of this invention, there is found less fogging.

What is claimed is:

1. In a method for developing electrical latent images wherein an electrical image is produced on a photoelectroconductive or an insulating layer, a liquid developer is applied to the layer to visualize the image, and then the visualized image is transferred to a transfer material, the improvement wherein the liquid developer comprises a coloring agent, a cyclic rubber and polyethylene having a molecular weight from about 1,000 to 5,000, said components being dispersed in an electrically insulating liquid having an electrical resistance of more than  $10^{10}$  ohm-cm and a specific dielectric constant of less than 3.

2. The method of claim 1 wherein the insulating liquid further contains a phenolic resin dispersed therein.

3. The method of claim 1 wherein the insulating liquid further contains a coumarone resin dispersed therein.

4. The method of claim 2 wherein the insulating liquid further contains a material selected from the group consisting of lecithin, manganese naphthenate, iron naphthenate, alkyl resin, linseed oil, chlorinated paraffine and bitumen.

5. The method of claim 3 wherein the insulating liquid further contains a material selected from the group consisting of lecithin, manganese naphthenate, iron naphthenate, alkyl resin, linseed oil, chlorinated paraffine, and bitumen.

6. The method of claim 1 wherein the insulating liquid further contains lecithin dispersed therein.

7. The method of claim 3 wherein the insulating liquid further contains lecithin dispersed therein.

8. The method of claim 1 wherein the liquid developer contains per liter of electrically insulating liquid:

- 0.2 - 6.0 grams of coloring agent;
- 0.2 - 6.0 grams of cyclic rubber;
- 0.1 - 5.0 grams of polyethylene; and
- 0.005 - 0.1 gram of lecithin.

\* \* \* \* \*

**UNITED STATES PATENT OFFICE  
CERTIFICATE OF CORRECTION**

Patent No. 3,853,554 Dated December 10, 1974

Inventor(s) ISAMU MAKI and MASASHI KIUCHI

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 of the patent,  
add to the recitation of the foreign  
priority data:

--July 30, 1971 Japan.....46-57307.--

Signed and sealed this 4th day of February 1975.

(SEAL)  
Attest:

McCOY M. GIBSON JR.  
Attesting Officer

C. MARSHALL DANN  
Commissioner of Patents