

960811-9 205

TIEDTKE — BÜHLING — KINNE & PARTNER

3

Tiedtke - Bühling - Kinne & Partner, 8000 München, POB 20 24 03

Patentanwälte
Vertreter beim EPA
Dipl.-Ing. H. Tiedtke
Dipl.-Chem. G. Bühling
Dipl.-Ing. R. Kinne
Dipl.-Ing. P. Grupe
Dipl.-Ing. B. Peilmann
Dipl.-Ing. K. Grams
Dipl.-Chem. Dr. B. Struif

Bavariaring 4,
POB 20 24 03
D-8000 München 2

October 25, 1991
EP 12028

CANON KABUSHIKI KAISHA

Tokyo, Japan

REPLACED SHEETS		SG
☒	Description : paged ..1... to paged ..77...	
☒	Claim(s) : paged ..81... to paged ..102...	
☒	Drawing(s) : paged ..4/1... to paged ..14/1...	
☒	Abstract : paged ..103... to paged	
DATE OF RECEIPT		

DEVELOPER FOR DEVELOPING ELECTROSTATIC IMAGE, IMAGE FORMING
METHOD, ELECTROPHOTOGRAPHIC APPARATUS, APPARATUS UNIT, AND
FACSIMILE APPARATUS

This Sheet Has Been Replaced



Telefon: 0 89-53 96 53
Telex: 5-24 845 tipat
Telefax: 0 89-53 73 77

Dresdner Bank (München) Kto. 3939 844 (BLZ 700 600 00)
Deutsche Bank (München) Kto. 286 1060 (BLZ 700 700 10)
Postgiroamt (München) Kto. 670-43-804 (BLZ 700 100 50)
THE DAICHI KANGYO BANK, LIMITED (München)
Kto. 51042-33-007 (BLZ 700 207 00)

1 Developer for Developing Electrostatic Image,
Image Forming Method, Electrophotographic
Apparatus, Apparatus Unit, and Facsimile
Apparatus

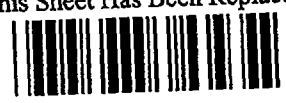
5

BACKGROUND OF THE INVENTION

Field of the invention

The present invention relates to a developer
for developing an electrostatic image, that is used
10 for converting an electrostatic latent image to a
visible image in image forming processes such as
electrophotography, electrostatic recording and
electrostatic printing. It also relates to an image
forming method, an electrophotographic apparatus, an
15 apparatus unit and a facsimile apparatus that make use
of the developer.

More particularly, the present invention
relates to a developer for developing an electrostatic
image, that is used in electrophotographic processes
20 comprising a charging step of bringing a charging
member to which a voltage has been externally applied,
into contact with an electrostatic image bearing
member to effect electrostatic charging, and a
developing step of developing an electrostatic image
25 by using a developer; and an image forming method, an
electrophotographic apparatus, an apparatus unit and a



1 facsimile apparatus that make use of the developer.

Related Background Art

Corona dischargers are hitherto known as
charging means in electrophotographic apparatus and so
5 forth. The corona dischargers, however, have the
problems that a high voltage must be applied thereto
and ozone is produced in a large quantity.

It is recently studied to use no corona
discharger and use a contact charging means. Stated
10 specifically, this is a means in which a voltage is
applied to a conductive roller serving as a charging
member, and then the roller is brought into contact
with a photosensitive member which is a member being
charged, so that the surface of the photosensitive
15 member is electrostatically charged to a given
potential. Use of such a contact charging means makes
it possible to apply a lower voltage than the use of
the corona dischargers and to decrease the generation
of ozone.

20 For example, Japanese Patent Publication No.
50-13661 proposes to use a roller comprising a mandrel
covered with a dielectric material such as nylon or
polyurethane rubber so that a photosensitive sheet can
be electrostatically charged at a low voltage.

25 The roller comprising a mandrel covered with
nylon, however, has no elasticity such as rubber, and

This Sheet Has Been Replaced



1 hence the roller can not be kept in sufficient contact
with the member being charged, so that faulty charging
tends to occur. On the other hand, covering the
mandrel with polyurethane rubber may cause exudation
5 of a softening agent with which the polyurethane
rubber is impregnated, and has involved the problem
that, when a photosensitive member is used as the
member being charged, the roller tends to stick to the
photosensitive member at the former's portion coming
10 into contact with the latter when the photosensitive
member is stopped, or that the region corresponding to
the part where the both had been stickingly in contact
causes unfocused images. Once the softening agent in
the rubber material of the roller has exuded and stuck
15 to the surface of the photosensitive member, the
photosensitive member comes to have a low resistivity
to cause smeared images (i.e., a leak of charges of an
electrostatic image, on the surface of the
photosensitive member) and, in an extreme instance, it
20 becomes impossible to use the apparatus or the toner
remaining on the surface of the photosensitive member
sticks to the roller surface to cause a filming
phenomenon. In the event that the toner has stuck to
the roller surface in a large quantity, the roller
25 surface turns insulative, resulting in a loss of the
charging ability of the roller and a non-uniform



1 charge on the surface of the photosensitive member, to
adversely affect images.

This is due to the fact that the charging
member (the roller) strongly press the developer
5 against the surface of the photosensitive member and
hence the remaining developer sticks to the charging
member or the surface of the member being charged and
also the surface of the charging member and the
surface of the member being charged tend to be damaged
10 or scraped.

In the contact charging means, a direct
current or a direct current overlaid with an
alternating current is applied to the charging member.
In such an instance, abnormal charge or flying
15 movement of the remaining developer particularly
having a small particle diameter and a light-weight is
repeated in the surrounding area of the part at which
the charging member and a photosensitive drum come
into contact each other. Hence, this area is in such
20 a state that the remaining developer is electro-
statically attracted to, or embedded in, the surface
of the charging member or photosensitive drum. This
is quite different from the case where a noncontact
charging means comprised of the conventional corona
25 discharger is used.

Meanwhile, in recent years, copiers, laser

This Sheet Has Been Replaced



1 printers, etc. which are small-sized, inexpensive and
of personal use have come into use. In these small-
sized machines, a cartridge system in which a
photoconductive member, a developing device and a
5 cleaning device are assembled into a unit is used from
the standpoint of making them free from maintenance,
and it is desired to use as the developer a one-
component magnetic developer since the structure of a
developing assembly can be simplified.

10 In order to form a visible image with a good
image quality in the method making use of such a one-
component magnetic developer, the developer must have
a high fluidity and a uniform chargeability. For this
purpose, a fine inorganic powder has been hitherto
15 added and mixed to a toner powder. It has been
proposed to use as the fine inorganic powder a fine
silica powder having been subjected to hydrophobic
treatment, as disclosed in Japanese Patent
Applications Laid-open No. 46-5782, No. 48-47345, No.
20 48-47346, etc. For example, a treated fine silica
powder is used which is obtained by reacting a fine
silica powder with an organic silicon compound such as
dimethyldichlorosilane to substitute silanol groups on
the particle surfaces of the fine silica powder with
25 organic groups so that the powder is made hydrophobic.

The developer having such a fine inorganic

This Sheet Has Been Replaced



1 powder, however, tends to cause scratches particularly
on the contact charging member and photosensitive
member and to cause melt adhesion or filming of the
toner to the contact charging member and
5 photosensitive member, in an image forming step at
which the developer is pressed against the
photosensitive member by contact charging. In an
extreme instance, faulty images tend to be formed.

With regard to addition of fine resin
10 particles to a developer, Japanese Patent Application
Laid-open No. 60-186854 proposes to add to a
developer, spherical or substantially spherical
polymer particles smaller than toner particles.

A developer prepared in the same manner as
15 disclosed therein has been examined to reveal that the
developer is less effective for preventing the melt
adhesion of toner onto the photosensitive member and,
in the apparatus making use of contact charging, the
contact charging device is contaminated to tend to
20 cause charge non-uniformity.

Japanese Patent Application Laid-open No. 1-
121861 proposes a developer prepared by adding fine
organic particles to toner particles containing an
ionically cross-linked vinyl polymer as a binder
25 resin. It is noted therein that this developer may
preferably comprise spherical fine organic particles.

This Sheet Has Been Replaced



1 As methods of fixing a toner image, a contact
heating method as typified by a heat roller fixing
method is commonly used, and there is a demand for a
toner capable of being fixed at a low temperature so
5 that power consumption can be decreased. For this
reason, it is proposed to incorporate a resin with a
low-molecular component and a high-molecular component
so that the low-temperature fixing performance and
anti-offset properties can be improved.

10 When, however, a developer containing the
binder resin in which the low-molecular component has
been increased for the purpose of low-temperature
fixing is used in an image forming apparatus having a
contact charging device or a contact transfer means,
15 the following problems tend to arise.

 Presence of a large quantity of the low-
molecular component in a binder resin brings about so
good a grindability of toner particles that the toner
particles tend to be broken to give ultrafine
20 particles because of shear produced during preparation
and in a developing device, and the ultrafine
particles slip through a cleaning member and adhere to
the contact charging member or contact transfer means
to tend to cause faulty charging or faulty transfer in
25 an environment of low temperature and low humidity,
and cause the melt adhesion of toner to the surface of

This Sheet Has Been Replaced



1 the photosensitive member in an environment of high
temperature and high humidity.

The ultrafine particles produced as a result
of break of toner particles have the same chargeability
5 as the toner particles, and hence inhibit the charging
of toner particles to cause a lowering of image
density.

In the contact heating method, it is required
for the toner to be surely softened and fixed at the
10 heating temperature, and also required to prevent
occurrence of what is called the offset phenomenon,
which is a phenomenon in which part of softened toner
adheres to a heating member and the adhered toner is
transferred to a transfer sheet to contaminate an
15 image. In order to better prevent this offset
phenomenon, it is known to incorporate toner particles
with a polyolefin such as a low-molecular polyethylene
or polypropylene, as disclosed in Japanese Patent
Applications Laid-open No. 49-6523 and No. 50-27546.

20 Japanese Patent Application Laid-open No. 1-
11376 proposes a developer comprising wax-containing
toner particles mixed with fine resin particles
smaller than the toner particles. It is noted therein
that this developer may preferably comprise spherical
25 fine organic particles.

When, however, such a developer comprising the

This Sheet Has Been Replaced



1 toner containing a polyolefin is used in an image
forming apparatus having the contact charging device,
the following problems tend to arise.

5 The polyolefin has so poor a compatibility
with the binder resin in the toner particles that a
polyolefin having a larger disperse diameter tends to
come to be a free polyolefin when toner is pulverized.
Thus, the free polyolefin with a higher resistance,
having been developed at an image portion or non-image
10 portion, is transferred from an electrostatic image
bearing member to a contact charging member to
increase surface resistance, tending to cause faulty
charging.

15 The free polyolefin has a high resistance and
is negatively chargeable with respect to iron powder,
and hence it makes fogging more serious because of the
faulty charging in the case of a negatively chargeable
developer and causes a poor fluidity in the case of a
positively chargeable developer, tending to bring
20 about blank areas in images and a non-uniformity in
image density.

In the meantime, in recent years, with wide
spread of image forming apparatus such as
electrophotographic copying machines, their uses have
25 become wider in a great variety, and demands for their
image quality have become severer. In the copying of

This Sheet Has Been Replaced



1 images as in usual documents and books, it is sought
to reproduce images in a very fine and faithful state
without causing any crushed line images or broken line
images even in the copying of fine characters. In
5 particular, in an instance in which a latent image
formed on a photosensitive member provided in the
image forming apparatus is a line image with a line
width of 100 μ m or less, the fine-line reproduction is
commonly poor and no satisfactory sharpness of the
10 line image has been achieved. Recently, in an image
forming apparatus such as an electrophotographic
printer making use of digital image signals, a latent
image is formed of the assemblage of dots having a
given potential, and its solid portion, half-tone
15 portion and light portion are expressed according to
changes in dot density. There, however, is a problem
that in the state where the toner particles are not
faithfully applied to the dots and hence the toner
particles are out of place from the dots, no gradation
20 of the toner image can be obtained corresponding with
the ratio of dot density at a black area to that of a
white area of the digital image. In the case when the
resolution is improved by making dot size smaller, in
order to improve image quality, it becomes more
25 difficult to achieve the reproduction of a latent
image formed of minute dots, tending to give an image

This Sheet Has Been Replaced



1 having a poor resolution and gradation and also
lacking sharpness.

For the purpose of improving image quality,
several developers have been hitherto proposed.

5 Japanese Patent Applications Laid-open No. 1-
112253 and No. 2-284158 propose a toner with a small
particle diameter having a specific particle size
distribution. The smaller particle diameter a toner
has, the more uniformly charged the toner particle
10 surface must be made. Hence, in order to achieve
both a stable charge quantity and a superior fluidity,
it is preferred to add as a charge control agent a dye
or a derivative of the dye that can give a proper
charge quantity with its use in a small amount.

15 On the other hand, the smaller particle
diameter a toner has, the more tends to be produced a
free charge control agent in the step of its
pulverization and the more tends to cause the
inhibition of fluidity or the contamination of members
20 due to a developer. In particular, the charge non-
uniformity tends to occur when a member coming into
contact with a photosensitive member has been
contaminated.

Japanese Patent Application Laid-open No. 1-
25 113762 proposes a developer comprising a mixture of
fine acrylic resin particles and toner particles

This Sheet Has Been Replaced



1 containing a charge control agent. It is noted
therein that this developer may preferably comprise
spherical fine organic particles.

5 When, however, such a developer containing a
dye or a derivative of the dye as a charge control
agent is used in the image forming apparatus having
the contact charging device, the following problems
tend to arise.

10 Since the charge control agent of a dye type
is soft and viscous, the charge control agent may be
released from toner particles and transferred to the
contact charging member, resulting in an increase in
surface resistance, which tends to cause faulty
charging or faulty transfer.

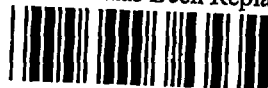
15 Since the released charge control agent has a
high chargeability, it may inhibit the toner particles
from being electrostatically charged and at the same
time make their fluidity poor, tending to cause blank
areas in images and an uneven image density.

20

SUMMARY OF THE INVENTION

An object of the present invention is to
provide a developer for developing an electrostatic
image, that has solved the above problems involved in
25 the prior art, and an image forming method, an
electrophotographic apparatus, an apparatus unit and a

This Sheet Has Been Replaced



1 facsimile apparatus which make use of such a
developer.

Another object of the present invention is to
provide a developer for developing an electrostatic
5 image, that does not cause, or not tend to cause, the
melt adhesion of toner to a photosensitive member.

Still another object of the present invention
is to provide a developer for developing an
electrostatic image, that does not cause no charge non-
10 uniformity even when copies are taken on a large
number of sheets, in an image forming method having
the step of contact charging.

A further object of the present invention is
to provide a developer for developing an electrostatic
15 image, having a high fluidity and also a uniform
chargeability.

A still further object of the present
invention is to provide a developer for developing an
electrostatic image, having a good fixing performance
20 and also a good anti-offset when heat roller fixing is
carried out.

A still further object of the present
invention is to provide a developer for developing an
electrostatic image, that can achieve a high image
25 density and may cause no fogging and no filming onto a
photosensitive member, and an image forming



1 method, an electrophotographic apparatus, an apparatus
unit and a facsimile apparatus which make use of such
a developer.

A still further object of the present
5 invention is to provide a developer for developing an
electrostatic image, that can be free from
contamination of a contact charging member when a
developing system in which an electrostatic image
bearing member is electrostatically charged using a
10 contact charging member is used, and hence is free
from occurrence of faulty charging because of no
increase in surface resistance; and an image forming
method, an electrophotographic apparatus, an apparatus
unit and a facsimile apparatus which make use of such
15 a developer.

A still further object of the present
invention is to provide a developer for developing an
electrostatic image, that can achieve good charging of
toner particles, can well maintain fluidity and may
20 cause neither blank area in images by poor development
nor image density non-uniformity; and an image forming
method, an electrophotographic apparatus, an apparatus
unit and a facsimile apparatus which make use of such
a developer.

25 A still further object of the present
invention is to provide a developer for developing an

This Sheet Has Been Replaced



1 electrostatic image, that does not tend to give
formation of ultrafine particles, does not tend to
cause adhesion of such ultrafine particles even when
a developing system in which an electrostatic image
5 bearing member is electrostatically charged using a
contact charging member is used, and hence does not
tend to cause faulty charging in an environment of low
temperature and low humidity and not tend to cause
melt adhesion of toner to the surface of a
10 electrostatic image bearing member in an environment
of high temperature and high humidity; and an image
forming method, an electrophotographic apparatus, an
apparatus unit and a facsimile apparatus which make
use of such a developer.

15 A still further object of the present
invention is to provide a developer for developing an
electrostatic image, that does not tend to give
formation of ultrafine particles, and hence does not
inhibit charging of toner particles and can yield
20 stable image density; and an image forming method, an
electrophotographic apparatus, an apparatus unit and a
facsimile apparatus using such a developer.

A still further object of the present
invention is to provide a developer for developing an
25 electrostatic image, that may cause no faulty charging
even when a developing system in which an electro-



1 static image bearing member is electrostatically
charged using a contact charging member is used, and
prevents fogging from becoming more serious because of
faulty charging in the case of a negatively chargeable
5 developer and does not bring about the blank areas in
images and non-uniformity in image density caused by
poor fluidity, in the case of a positively chargeable
developer; and an image forming method, an
electrophotographic apparatus, an apparatus unit and a
10 facsimile apparatus which make use of such a
developer.

The present invention provides a developer for
developing an electrostatic image, comprising a toner,
fine resin particles with a surface shape sphericity ψ
15 of from 0.90 to 0.50, and fine inorganic particles.

The present invention also provides a method
of forming an image by a process comprising the steps
of;

bringing a charging member to which a voltage
20 has been externally applied, into contact with an
electrostatic image bearing member to effect
electrostatic charging;

forming an electrostatic image on the charged
electrostatic image bearing member;

25 developing the electrostatic image formed on
said electrostatic image bearing member, using a



1 developer to form a toner image; said developer
comprising a toner, fine resin particles with a
surface shape sphericity ψ of from 0.90 to 0.50, and
fine inorganic particles; and

5 transferring the toner image formed on said
electrostatic image bearing member to a transfer
medium to form a transferred image.

The present invention also provides an
electrophotographic apparatus comprising:

10 an electrostatic image bearing member;

a contact charging member to which a voltage
is externally applied, which electrostatically charges
said electrostatic image bearing member while being
brought into contact with it;

15 an electrostatic image forming means for
forming an electrostatic image on the charged
electrostatic image bearing member;

a developing means for developing the
electrostatic image thus formed; said developing means
20 comprising a developer carrying member and a developer
container that holds therein a developer; said
developer comprising a toner, fine resin particles
with a surface shape sphericity ψ of from 0.90 to
0.50, and fine inorganic particles; and

25 a transfer means for transferring the toner
image formed on said electrostatic image bearing



1 member to a transfer medium.

The present invention still also provides an apparatus unit comprising;

an electrostatic image bearing member:

5 a contact charging member to which a voltage is externally applied, which electrostatically charges said electrostatic image bearing member while being brought into contact with it; and

a developing means for developing an
10 electrostatic image thus formed; said developing means comprising a developer carrying member and a developer container that holds therein a developer; said developer comprising a toner, fine resin particles with a surface shape sphericity ψ of from 0.90 to
15 0.50, and fine inorganic particles;

said contact charging member and said
developing means being held as one unit together with
said electrostatic image bearing member, and said unit
forming a single unit detachably provided in the body
20 of an electrophotographic apparatus.

The present invention further provides a facsimile apparatus comprising an electrophotographic apparatus and a receiver means for receiving image information from a remote terminal;

25 said electrophotographic apparatus comprising;
an electrostatic image bearing member;



1 a contact charging member to which a voltage
is externally applied, which electrostatically charges
said electrostatic image bearing member while being
brought into contact with it;

5 an electrostatic image forming means for
forming an electrostatic image on the charged
electrostatic image bearing member;

 a developing means for developing the
electrostatic image thus formed, said developing means
10 comprising a developer carrying member and a developer
container that holds therein a developer; said
developer comprising a toner, fine resin particles
with a surface shape sphericity ψ of from 0.90 to
0.50, and fine inorganic particles; and

15 a transfer means for transferring the toner
image formed on said electrostatic image bearing
member to a transfer medium.

BRIEF DESCRIPTION OF THE DRAWINGS

20 Fig. 1 is a schematic illustration of an
example of the appearance of fine resin particles used
in the present invention.

 Fig. 2 is a schematic illustration of the
appearance of a fine resin particle having a surface
25 shape sphericity ψ of about 1.

 Figs. 3 and 4 are schematic illustration of

This Sheet Has Been Replaced



1 roller-shaped contact charging devices.

Fig. 5 is a schematic illustration of a blade-shaped contact charging device.

5 Fig. 6 is a schematic illustration of an example of the apparatus for carrying out the image forming method of the present invention.

Fig. 7 is a schematic illustration of an example of the apparatus unit of the present invention.

10 Fig. 8 is a block diagram to illustrate the facsimile apparatus of the present invention.

Fig. 9 shows a GPC chromatogram.

15 Fig. 10 is a schematic illustration of an apparatus for measuring the quantity of triboelectricity of a powder sample.

Fig. 11 is a schematic illustration of a mold for tabletting a powder material.

Fig. 12 illustrates a checker pattern.

20 DESCRIPTION OF PREFERRED EMBODIMENTS

In the following, the reason why the fine resin particles are effective against the melt adhesion of toner to the electrostatic image bearing member such as a photosensitive member can be
25 considered as follows:

The causes of the melt adhesion of toner to

This Sheet Has Been Replaced



1 the photosensitive member is for one thing the
scratches produced when the surface of the
photosensitive member is rubbed by a contact charging
member to which fine inorganic powder has been
5 adhered. In order to prevent the scratches from being
produced, it is preferred to remove the free, fine
inorganic powder from the part at which the contact
charging member and the photosensitive member come
into contact. This can be consequently effective for
10 preventing the melt adhesion of toner to the
photosensitive member. The fine resin particles with
a surface shape sphericity ψ of from 0.90 to 0.50,
used in the present invention each have an uneven or
irregular surface to a certain extent as
15 diagrammatically shown in Fig. 1, as compared with
particles with the shape of true spheres, and hence
they have the action of adsorbing to the surface a
great number of particles of the fine inorganic powder
present in a free state.

20 Spherical polymer particles obtained by
emulsion polymerization or soap-free polymerization
each have, as diagrammatically shown in Fig. 2, very
little irregular surface, and hence the surface shape
sphericity ψ of the polymer particle is more than
25 0.90. In general, its surface shape sphericity ψ is
about 1.

This Sheet Has Been Replaced



1 Fine resin particles obtained from a bulk
resin by mechanical pulverization or by pulverization
using a jet stream have surfaces whose rupture cross-
sections assume a great number of minute
5 irregularities, and hence the surface shape sphericity
 ψ of the fine resin particle is less than 0.50. In
general, the surface shape sphericity ψ of the fine
resin particle is approximately from 0.3 to 0.4.

 It is presumed that, in the image forming
10 apparatus having a contact charging member, the fine
resin particles having slipped through a cleaning
blade are adsorbed to the contact charging member, and
thereafter the fine resin particles present on the
surface of the contact charging member adsorb the
15 free, fine inorganic powder slipping through the
cleaning blade, so that the surface of the
photosensitive member can be prevented from being
damaged. Here, if the fine resin particles slipping
through the cleaning blade are in a very large
20 quantity, the free, fine inorganic powder becomes
small in quantity and hence the melt adhesion of toner
to the photosensitive member can be more effectively
prevented, but on the other hand a thick layer of the
fine resin particles is formed on the contact charging
25 member and hence this can be one of the causes of
faulty charging of the photosensitive member. The



1 fine resin particles used in the present invention
each have an irregular surface to a certain extent as
diagrammatically shown in Fig. 1, and hence they can
be appropriately controlled in the quantity of the
5 particles slipping through the cleaning blade,
compared with particles with the shape of true
spheres, so that the faulty charging of the
photosensitive member can be prevented from occurring.

If the surface shape sphericity ψ of the fine
10 resin particles is more than 0.90, the faulty charging
of the photosensitive member may come to occur when
copies are taken on a large number of sheets (e.g.,
10,000 sheets or more). If the surface shape
sphericity ψ is less than 0.50, the fine resin
15 particles may have a great number of irregularities on
their surfaces to tend to increase moisture absorption
and lower development performance of the developer in
an environment of high temperature and high humidity.
Moreover, the protruded portions on the surfaces of
20 fine resin particles tend to be broken off on the
occasion of their mixing with toner particles or in
the course of development, so that a large number of
fragments of the fine resin particles may become
present in the developer to tend to adversely affect
25 the development.

The fine resin particles used in the present



1 invention may preferably have a primary average
particle diameter of from 0.03 to 1.0 μm . It is more
preferable to use those of from 0.05 to 0.8 μm .
Particles with a primary average particle diameter
5 larger than 1.0 μm have so small a specific surface
area that they can not be suited for adsorption of the
free, fine inorganic powder and can give only a small
effect of preventing the melt adhesion of toner to the
photosensitive member. On the other hand, those with
10 a primary average particle diameter smaller than 0.03
 μm may make the triboelectricity of the developer
excessively high to tend to cause a lowering of
density because of charge-up.

The fine resin particles may have a specific
15 resistance of from 10^6 to 10^{13} $\Omega\cdot\text{cm}$, which can be
preferably used. Use of those having a water-specific
resistance lower than 10^6 $\Omega\cdot\text{cm}$ tends to cause a
lowering of the charge quantity of the developer,
consequently tending to bring about a lowering of
20 image density. Use of fine resin particles having a
specific resistance higher than 10^{13} $\Omega\cdot\text{cm}$ tends to
cause a lowering of the fluidity of the developer, and
tends to give an image with much fogging.

The fine resin particles may preferably have a
25 triboelectric charge quantity of not more than +50
 $\mu\text{C/g}$ in the case of positive charging, and not more



1 than 200 $\mu\text{c/g}$ as the absolute value in the case of
negative charging. They may more preferably have a
triboelectric charge quantity in the range of from +30
2 $\mu\text{c/g}$ to -100 $\mu\text{c/g}$. If the triboelectric charge
5 quantity of the fine resin particles is higher than
+50 $\mu\text{c/g}$, the triboelectricity of the developer tends
to become unstable, and fogging tends to occur when
copies are taken on a large number of sheets. If the
triboelectric charge quantity of the fine resin
10 particles is smaller than -200 $\mu\text{c/g}$, the fluidity
tends to become poor and density unevenness tends to
occur on the image.

The fine resin particles should be used in an
amount of from 0.01 to 1.0 part by weight, and
15 preferably from 0.03 to 0.57 parts by weight based on
100 parts by weight of the toner. The fine inorganic
powder such as hydrophobic fine silica powder may
preferably be used in an amount of from 0.1 part by
weight to 3.0 parts by weight based on 100 parts by
20 weight of the toner. The fine inorganic powder may
preferably be used in a larger amount than the fine
resin particles.

Use of the fine resin particles in an amount
more than 1.0 part by weight tends to cause a lowering
25 of image density. On the other hand, use thereof in
an amount of less than 0.01 part by weight can be less



- 1 effective against the melt adhesion of toner to the
photosensitive member. Use of the fine resin
particles in the same amount as, or in a larger amount
than, that of the fine inorganic powder tends to make
5 the fluidity of the developer poor and also tends to
cause fogging.

The surface shape sphericity ϕ of the fine
resin particles is defined as follows:

$$\phi = \frac{\text{Surface area (m}^2\text{/g) measured assuming fine resin particles as true spheres}}{\text{BET specific surface area (m}^2\text{/g) actually measured on fine resin particles}}$$

The BET specific surface area can be actually
measured, when, for example, a specific surface area
15 meter AUTOSORB-1, available from Quantachrome Co. is
used, by the method as exemplified below.

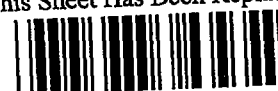
About 0.3 g of fine resin particles are
weighed and put in a cell, and desorption is carried
out at a temperature of 40°C and a degree of vacuum of
20 1.0×10^{-3} mmHg for at least 1 hour. Thereafter,
nitrogen gas is adsorbed on the particles in the state
they are cooled using liquid nitrogen, and the value
is obtained by the multipoint method.

The surface area measured assuming the fine
25 resin particles as true spheres can be determined, for
example, in the following way: From particles in an



1 electron microscope photograph ($\times 10,000$) of the fine
resin particles, 100 fine resin particle images are
collected at random, and their major axes are
measured. A value obtained by averaging the measured
5 major axes is regarded as a diameter (ϕ) measured
assuming the fine resin particles as true spheres. On
the basis of the diameter (ϕ), a radius r (i.e., $1/2$
 ϕ) is determined and a surface area ($4\pi r^2$) of the fine
resin particles is further determined. Then a volume
10 ($4/3\pi r^3$) of the fine resin particles is further
obtained. The weight of the fine resin particles is
determined from a density of the fine resin particles
and the volume thus obtained. The surface area (m^2/g)
measured assuming the fine resin particles as true
15 spheres is determined from the surface area previously
obtained and the weight thus obtained.

The triboelectric value of the fine resin
particles used in the present invention can be
measured by the following method: 0.2 g of the fine
20 resin particles having been left for 12 hours or more
in an environment of 23.5°C and 60 % RH and 20.0 g of
carrier iron powder whose particles are not coated
with resin, having a main particle size at 200 to 300
meshes (e.g., EFV200/300, available from Nihon Teppun
25 K.K.) are precisely weighed in the above environment,
which are then thoroughly mixed in a wide mouthed



1 bottle with a stopper, made of polyethylene and having
a volume of about 50 cc (the bottle is upward and
downward shaken in hand about 125 times for 50
seconds).

5 Next, as shown in Fig. 10, about 2.0 g of the
mixture is put in a measuring container 32 made of a
metal at the bottom of which is provided a screen 33
of 400 meshes, and then the container is covered with
a plate 34 made of a metal. The total weight of the
10 measuring container 32 in this state is weighed and is
expressed by W_1 (g). Next, in a suction device (made
of an insulating material at least at the part coming
into contact with the measuring container 32), air is
sucked from a suction opening 37 and an air-flow
15 control valve 36 is operated to control the pressure
indicated by a vacuum indicator 35 to be 250 mmHg. In
this state, suction is carried out for 5 minutes to
remove the fine resin particles by suction. The
potential indicated by a potentiometer 39 at this time
20 is expressed by V (volt). The numeral 38 denotes a
capacitor, whose capacitance is expressed by C (μF).
The total weight of the measuring container after
completion of the suction is also weighed and is
expressed by W_2 (g). The quantity ($\mu C/g$) of
25 triboelectricity of this fine resin particles is
calculated as shown by the following

This Sheet Has Been Replaced



1. Quantity of triboelectricity = $\frac{C \times V}{W_1 - W_2}$

The specific resistance (volume specific resistivity) referred to in the present invention can be measured, for example, in the following way: Using an apparatus shown in Fig. 11, the sample is molded into a tablet. First, about 0.3 g of a sample 40 is put in a tablet molding chamber 41. Next, a push bar 42 is inserted to the tablet molding chamber, and the sample is pressed by means of an oil pressure pump 45 at 250 kg/cm² for 5 minutes. Thus, a pellet-shaped tablet of about 13 mm in diameter and about 2 to 3 mm in height is molded. In the drawing, reference numeral 46 denotes a pressure gauge.

15 The tablet thus obtained is optionally coated with a conducting agent on its both sides, and the resistivity under application of a voltage of 1,000 V is measured in an environment of a temperature of 23.5°C and a humidity of 65 % RH, using, for example, 20 16008A RESISTIVITY CELL, available from Hewlett Pakard Co., or 4329A HIGH RESISTANCE METER, available from Yokogawa Hewlett Pakard Co. A specific resistance ρ is determined from the following calculation.

$$\rho(\Omega \cdot \text{cm}) = R(\Omega) \times S(\text{cm}^2) / l(\text{cm})$$

25 wherein S is a sectional area of the sample, and l is a height of the sample.

This Sheet Has Been Replaced



1 The fine resin particles can be prepared
by emulsion polymerization or spray drying.
They may preferably be fine resin particles with a
glass transition point of 80°C or above, prepared by
5 subjecting components used in binder resins for toner,
such as styrene, acrylic acid, methylmethacrylate,
butyl acrylate and 2-ethylhexyl acrylate, to
copolymerization according to emulsion polymerization.
Such fine resin particles can have a good effect.

10 The fine resin particles may be those cross-
linked with a cross-linking agent such as
divinylbenzene, and also their surfaces may be treated
with a metal, a metal oxide, a pigment, a dye or a
surface active agent to make adjustment of specific
15 resistance and triboelectric charge quantity.

 The fine resin particles used in the present
invention may particularly preferably be comprised of
a block or random copolymer of a styrene type,
containing 51 % by weight or more of styrene monomers.
20 Such styrene type fine resin particles are usually in
the triboelectric series approximate to styrene-
acrylate resins or polyester resins used in binder
resins of developers, so that they can be less
mutually electrified with respect to toner particles
25 and their fluidity does not tend to become poor.
Thus, styrene resins are preferred as the binder resin

This Sheet Has Been Replaced



1 of the toner.

If the styrene monomers contained in the fine resin particles are less than 51 % by weight, the developer may come to have strong agglomerating
5 properties and poor fluidity, tending to cause blank areas in images and image density non-uniformity.

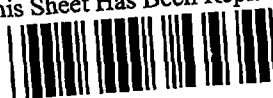
In the preparation methods such as emulsion polymerization, the styrene type fine resin particles have a tendency that the value ψ becomes smaller with
10 an increase in the content of styrene monomers.

The styrene type fine resin particles with a surface shape sphericity ψ of from 0.90 to 0.50 according to the present invention can be obtained by controlling monomer composition, compositional ratios of monomers
15 and polymerization conditions.

The fine inorganic powder used in the present invention can give good results when its particles have a specific surface area of from 70 to 300 m^2/g as measured by the BET method, utilizing to nitrogen
20 adsorption. The fine inorganic powder should be used in an amount of from 0.1 part by weight to 3.0 parts by weight, and preferably from 0.2 part by weight to 2.0 parts by weight, based on 100 parts by weight of the toner.

25 The fine inorganic powder may preferably be those having been subjected to hydrophobic treatment.

This Sheet Has Been Replaced



1 They may particularly preferably be negatively
chargeable, hydrophobic fine silica powder.

The fine inorganic powder used in the present
invention may have a triboelectric charge quantity of
5 from -100 $\mu\text{C/g}$ to -300 $\mu\text{C/g}$, which can be preferably
used. Powder with a triboelectric charge quantity
less than -100 $\mu\text{C/g}$ may lower the triboelectric charge
quantity of the developer itself, tending to bring
about a lowering of humidity characteristics. Use of
10 powder with a triboelectric charge quantity more than
-300 $\mu\text{C/g}$ may promote the developer carrying member
memory, so that the developer carrying member tends to
be affected by the deterioration of the fine inorganic
powder, tending to have difficulties in durability.
15 Powder finer than 300 m^2/g in specific surface area
may give less effect of its addition to the developer,
and powder coarser than 70 m^2/g may give a larger
probability that it is present as a free matter,
tending to cause black dots due to localization of
20 the fine inorganic powder or agglomerated matters.

The triboelectric value of the fine inorganic
powder can be measured by the following method: 0.2 g
of the fine inorganic powder having been left
overnight in an environment of a temperature of 23.5°C
25 and a humidity 60 % RH and 9.8 g of carrier iron
powder whose particles are not coated with resin,

This Sheet Has Been Replaced



1 having a main particle size at 200 to 300 meshes
(e.g., EFV200/300, available from Nihon Teppun K.K.)
are precisely weighed in the above environment, which
are then thoroughly mixed in a wide-mouthed bottle
5 with a stopper, made of polyethylene and having a
volume of about 50 cc (the bottle is upward and
downward shaken in hand about 50 times for about 20
seconds).

Next, the triboelectric charge quantity of the
10 fine inorganic powder may be measured in the same way
as in the measurement of the triboelectric charge
quantity of the fine resin particles as previously
described.

Of the fine inorganic powder used in the
15 present invention, particularly preferred are what is
called dry silica, or dry silica called fumed silica,
produced by vapor phase oxidation of a silicon halide,
and what is called wet silica produced from water
glass or the like, both of which can be used. In
20 particular, the dry silica is preferred, which has
less silanol groups present on the surfaces and the
insides of the silica fine powder particles and may
produce no residues in the manufacture, such as Na_2O
and SO_3^{2-} .

25 In the dry silica, other metal halide as
exemplified by aluminum chloride or titanium chloride

This Sheet Has Been Replaced



1 may be used together with the silicon halide in the
manufacturing process so that a composite fine powder
of silica with other metal oxide can be obtained. In
the present invention, the fine inorganic powder
5 includes such a powder.

The fine inorganic powder may preferably have
a particle diameter ranging from 0.001 to 2 μ as the
primary average particle diameter. It is particularly
preferred to use fine silica powder having a primary
10 average particle diameter ranging from 0.002 to 0.2 μ .

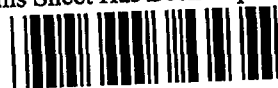
The fine inorganic powder used in the present
invention may preferably be hydrophobic.

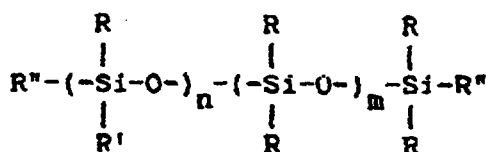
The powder can be made hydrophobic using
conventionally known hydrophobic treatments and
15 methods. As the hydrophobic treatments, it is
preferable to use silicon compounds having
organosiloxane units, such as silicone oil or silicone
varnish.

The silicone oil used in the treatment of the
20 fine inorganic powder used in the present invention
can be exemplified by a compound represented by the
formula:

25

This Sheet Has Been Replaced





wherein R represents an alkyl group having 1 to 3 carbon atoms; R' represents a silicone oil modifying group such as an alkyl group, a halogen-modified alkyl group, a phenyl group or a modified phenyl group; and R'' represents an alkyl group or alkoxy group having 1 to 3 carbon atoms. For example, the compound may include dimethylsilicone oil, alkyl-modified silicone oil, α -methylstyrene-modified silicone oil, chlorophenylsilicone oil, fluorine-modified silicone oil. Examples of the silicone oil are by no means limited to those.

The above silicone oil may preferably be those having a viscosity of from 50 to 1,000 cSt at a temperature of 25°C. Silicone oil with a viscosity less than 50 cSt may be partially evaporated as a result of the application of heat, tending to cause a deterioration of charge characteristics. Those with a viscosity more than 1,000 cSt may become difficult to handle in the treatment. As methods for the silicone oil treatment, any known techniques can be used. For example, they include a method in which fine silica

This Sheet Has Been Replaced T1



1 powder and silicone oil are mixed using a mixer; a
method in which silicone oil is sprayed into fine
silica powder by the use of a sprayer, and a method in
which silicone oil is dissolved in a solvent and then
5 fine silica powder is mixed in the solution. Examples
of the treatment method are by no means limited to
these.

As for the silicone varnish used for the
treatment of the fine silica powder used in the
10 present invention, any known materials can be used.

For example, it may include KR-251 and KP-112,
available from Shin-Etsu Silicone Co., Ltd. Examples
are by no means limited to these.

As methods for the silicone varnish treatment,
15 the same known techniques as in the silicone oil
treatment can be used. The treated fine silica powder
as described above (hereinafter "treated silica") can
be effective when it is added in an amount of from 0.1
part by weight to 1.6 parts by weight based on 100
20 parts by weight of the toner. It can provide an
excellent stability when added in an amount of from
0.3 part by weight to 1.6 parts by weight based on 100
parts by weight of the toner. Its addition in an
amount less than 0.1 part by weight based on 100 parts
25 by weight of the toner may give less effect of its
addition, and addition in an amount more than 1.6



1 parts by weight tends to cause problems in development
and fixing, which are thus not preferable.

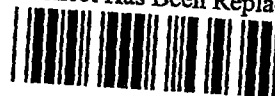
Part of the silicon compound having an
organosiloxane unit, which has treated the particle
5 surfaces of the fine inorganic powder is transferred
onto the electrostatic image bearing member, and is
effective for making easier the cleaning of powder
such as free polyolefin.

To determine the hydrophobicity (the degree to
which powder has been made hydrophobic) of the fine
inorganic powder in the present invention, a value
measured by the following method may be used. Of
course, other method for measurement can also be used
while making reference to the method for measurement
15 according to the present invention.

In a 200 ml separatory funnel with a stopper,
100 ml of ion-exchanged water and 0.1 g of a sample
are put, followed by shaking for 10 minutes using a
shaker (a tumbler shaker mixer, T2C type) under
20 conditions of 90 rpm. After the shaking, the mixture
is left to stand for 10 minutes. After the inorganic
powder layer and the aqueous layer have been
separated, the lower layer, the aqueous layer, is
collected in a quantity of 20 to 30 ml, which is then
25 put in a 10 mm cell to measure its transmittance using
light with a wavelength of 500 nm, on the basis of

This Sheet Has Been Replaced

T1



1 that of a blank, ion-exchanged water in which no fine
silica powder is contained. The value of the
transmittance is regarded as the hydrophobicity of the
fine inorganic powder.

5 In the present invention, the hydrophobic fine
inorganic powder may preferably have a hydrophobicity
of not less than 60 %, and more preferably not less
than 90 %. A hydrophobicity less than 60 % makes it
difficult to obtain images with a high quality level
10 because of adsorption of water to the fine inorganic
powder in an environment of high humidity.

The developer may preferably contain the fine
resin particles having a surface shape sphericity ϕ of
from 0.90 to 0.50 and an average particle diameter of
15 from 0.03 to 1.0 μm and the hydrophobic fine inorganic
powder; said hydrophobic fine inorganic powder being
contained in a larger quantity than the fine resin
powder.

The toner according to the present invention
20 should have an average particle diameter of from 3.5
to 20 μm , preferably from 3.5 to 14 μm , and more
preferably from 4 to 8 μm , as weight average particle
diameter, and from 2.8 to 18 μm , preferably from 2.8
to 13 μm , and more preferably from 3 to 7 μm , as
25 number average particle diameter.

In particular, a toner having a weight average



1 particle diameter (D_4) of from 4 to 8 μ m is preferred
because of its excellent fine-line reproduction and
resolution.

5 Particle size distribution of the toner can be
measured by various methods. In the present
invention, it is measured using a Coulter counter.

A Coulter counter Type TA-II (manufactured by
Coulter Electronics, Inc.) is used as a measuring
device. An interface (manufactured by Nikkaki k.k.)
10 that outputs number distribution and volume
distribution and a personal computer CX-1
(manufactured by Canon Inc.) are connected. As an
electrolytic solution, an aqueous 1 % NaCl solution is
prepared using first-grade sodium chloride.
15 Measurement is carried out by adding as a dispersant
0.1 ml to 5 ml of a surface active agent, preferably
an alkylbenzene sulfonate, to 100 ml to 150 ml of the
above aqueous electrolytic solution, and further
adding 2 mg to 20 mg (as the number of particles,
20 about 30,000 to about 300,000 particles) of a sample
to be measured. The electrolytic solution in which
the sample has been suspended is subjected to
dispersion for about 1 minute to about 3 minutes in an
ultrasonic dispersion machine. The particle size
25 distribution of particles with a size of from 2 to 40
 μ is measured by means of the above Coulter counter

This Sheet Has Been Replaced T

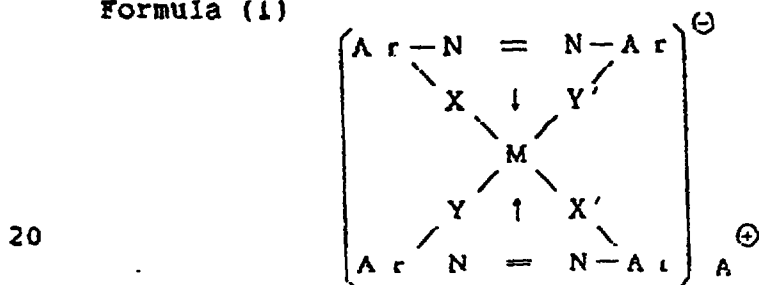


1 Type TA-II, using an aperture of 100 μ as its
aperture. Then the value according to the present
invention is determined.

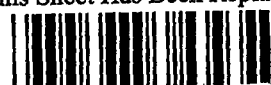
5 The toner used in the developer of the present
invention, when it has a negative triboelectricity,
may preferably contain as a charge control agent an
organic acid metal complex salt such as a salicylic
acid metal complex salt, an alkylsalicylic acid metal
10 complex salt, a dialkylsalicylic acid metal complex
salt or a naphthoic acid metal complex salt, a dye
such as a monoazo dye, and a monoazo dye derivative
such as a metal complex salt of a monoazo dye.

The negative charge control agent comprising a
dye compound may include azo type metal complex salts
15 represented by the following Formula (I).

Formula (I)



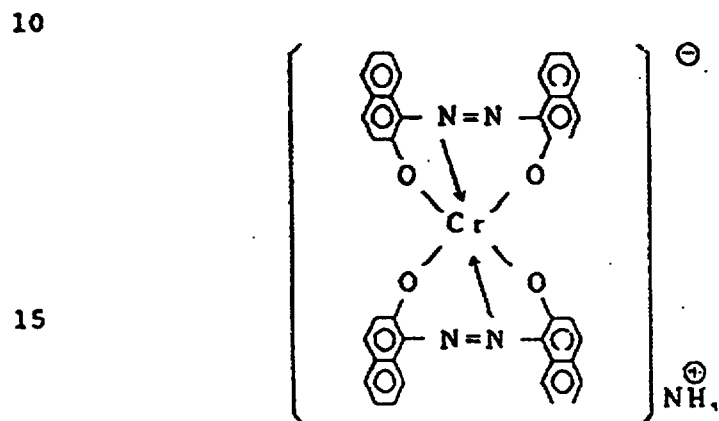
wherein M represents a coordination central metal,
including Cr, Co, Ni, Mn and Fe having the
coordination number of 6; Ar represents an Aryl group,
25 including a phenyl group and a naphthyl group, which
may have a substituent, which substituent may include



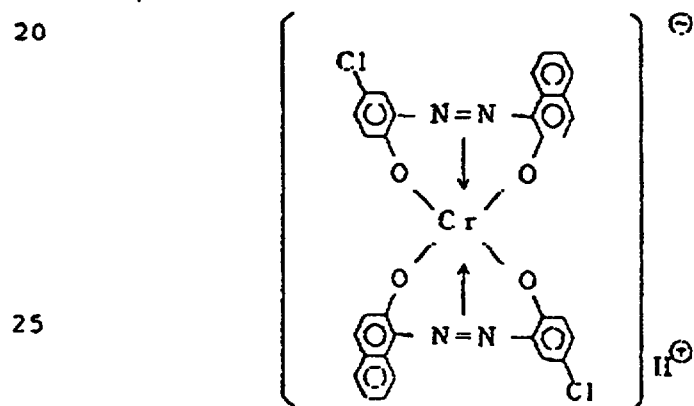
1 a nitro group, a halogen atom, a carboxyl group, an
 anilide group and an alkyl group or alkoxy group
 having 1 to 18 carbon atoms; X, X', Y and Y' each
 represent -O-, -CO-, -NH- or -NR-, where R represents
 5 an alkyl group having 1 to 4 carbon atoms; and A⁺
 represents a hydrogen ion, a sodium ion, a potassium
 ion, an ammonium ion or an aliphatic ammonium ion.

Examples of the complex salt are shown below.

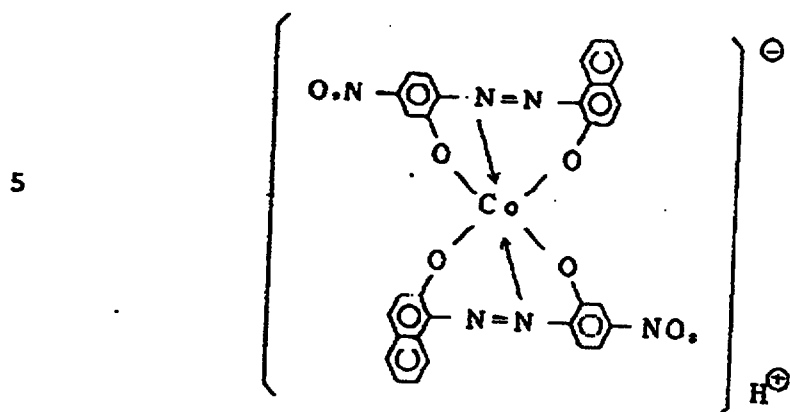
Complex (I)-1



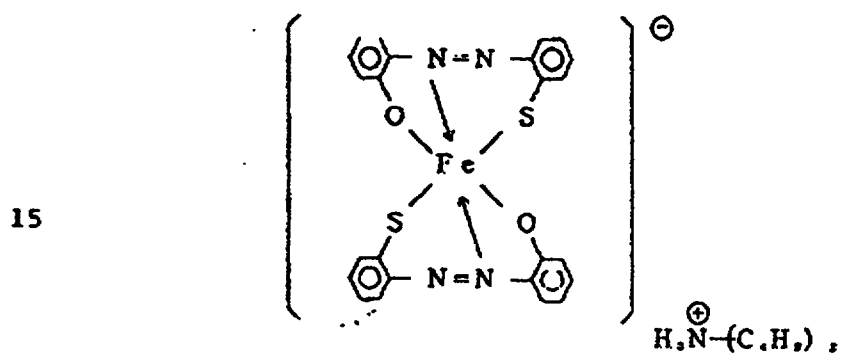
Complex (I)-2



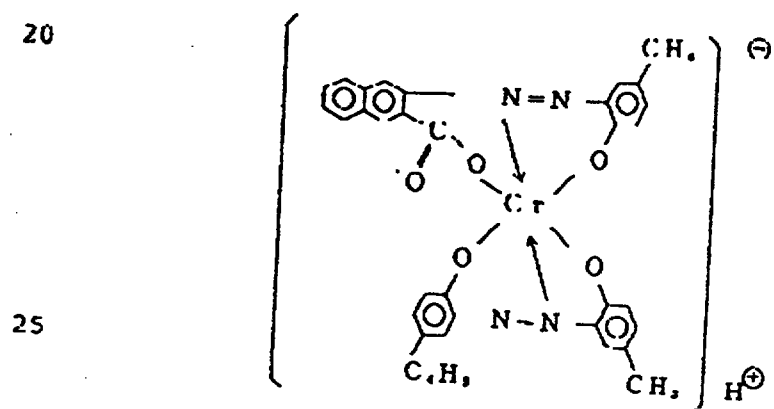
1 **Complex (I)-3**



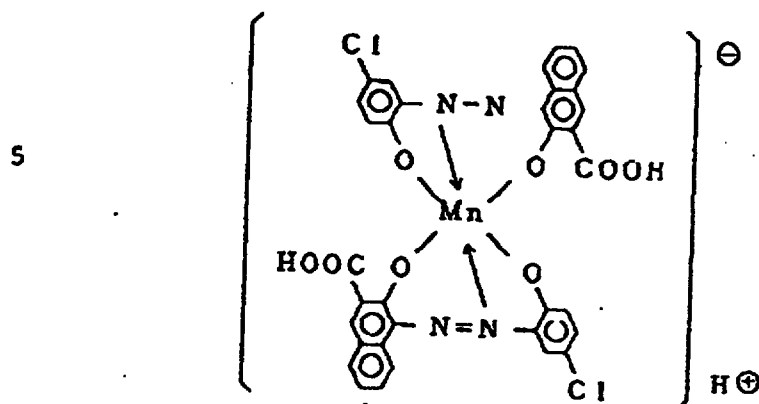
10 **Complex (I)-4**



Complex (I)-5



1 Complex (I)-6



As for a positive charge control agent, it is possible to use, for example, a Nigrosine dye and a derivative thereof.

15 The charge control agent may preferably be contained in an amount of from 0.1 part by weight to 5 parts by weight, and particularly preferably from 0.2 part by weight to 3 parts by weight based on 100 parts by weight of the binder resin for the toner. Use of the charge control agent in an excessively large
20 amount may make poor the fluidity of the toner, tending to cause fogging. On the other hand, use thereof in an excessively small amount may make it difficult to obtain a sufficient charge quantity.

25 As a preferred embodiment of the developer for developing an electrostatic image according to the present invention, it may include a developer for



1 developing an electrostatic image, comprising i) a
toner containing a charge control agent and having a
weight average particle diameter (D_4) of from 4 to 8
µm, ii) styrene type fine organic particles having a
5 smaller average particle diameter than said toner and
having a surface shape sphericity ϕ of from 0.90 to
0.50 and iii) fine inorganic particles having a
smaller average particle diameter than said fine
organic powder.

10 The binder resin for the toner according to
the present invention may include homopolymers of
styrene or derivatives thereof such as polystyrene and
polyvinyltoluene; styrene copolymers such as a
styrene/propylene copolymer, a styrene/vinyltoluene
15 copolymer, a styrene/vinylnaphthalene copolymer, a
styrene/methyl acrylate copolymer, a styrene/ethyl
acrylate copolymer, a styrene/butyl acrylate
copolymer, a styrene/octyl acrylate copolymer, a
styrene/dimethylaminoethyl acrylate copolymer, a
20 styrene/methyl methacrylate copolymer, a styrene/ethyl
methacrylate copolymer, a styrene/butyl methacrylate
copolymer, a styrene/dimethylaminoethyl methacrylate
copolymer, a styrene/methyl vinyl ether copolymer, a
styrene/ethyl vinyl ether copolymer, a styrene/methyl
25 vinyl ketone copolymer, a styrene/butadiene copolymer,
a styrene/isoprene copolymer, a styrene/maleic acid



1 copolymer and a styrene/maleate copolymer; polymethyl
methacrylate, polybutyl methacrylate, polyvinyl
acetoate, polyethylene, polypropylene, polyvinyl
butyral, polyacrylic acid resin, rosin, modified
5 rosin, terpene resin, phenol resin, aliphatic or
alicyclic hydrocarbon resins, aromatic petroleum
resins, paraffin wax, and carnauba wax. These may be
used alone or in the form of a mixture.

The toner in the present invention, may
10 preferably contain a binder resin containing not less
than 15 % of a component with a molecular weight of
not more than 5,000 in molecular weight distribution
as measured by gel permeation chromatography (GPC).

The content of the component with a molecular
15 weight of not more than 5,000 in the binder resin is a
numerical value calculated by determining area
proportion of that component in a chromatogram showing
molecular weight distribution in the measurement by
GPC. Using the chromatogram showing molecular weight
20 distribution in the measurement by GPC, as shown in
Fig. 9, the area of the whole peak indicating the
molecular weight distribution is determined and also
the area of the region corresponding to the component
with a molecular weight of not more than 5,000 is
25 determined. On the basis of the two areas, the
content of the component with a molecular weight of



1 not more than 5,000 in the binder resin is calculated.

If the component with a molecular weight of not less than 5,000 is less than 15 %, fixing performance tends become poor in heat fixing devices of a relatively low pressure as in small-sized machines as typified by desk top LDPs.

The component with a molecular weight of not more than 5,000 may more preferably be in an amount of less than 35 %.

10 The component with a molecular weight of not more than 5,000 tends to exhibit molecular weight dependence of glass transition point (T_g) and hence the T_g of the toner, measured over a long period of time, is presumed to tend to become a little low.

15 Thus, if the amount of this component is more than 35 %, a thermal behavior not higher than the T_g usually measured may come to be exhibited to tend to cause the melt adhesion or filming.

This component can particularly improve the grindability of toners. If, however, its content is more than 35 %, the grindability may become more than is necessary in the manufacture of toners having a weight average particle diameter of from 4 to 8 μ m, resulting in an increase in the formation of ultrafine powder, which makes classification efficiency poor.

Moreover, the ultrafine powder having been not



1 completely classified may gradually increase in its
content with repetition of the supply of the toner,
and may adhere to a toner triboelectricity-providing
member such as a developing sleeve because of
5 electrostatic force to impede triboelectric charging
of the toner, tending to cause a poor development
performance such as a low image density and fogging.

In the present invention, the molecular weight
distribution on the chromatogram obtained by GPC (gel
10 permeation chromatography) are measured under the
following conditions.

Columns are stabilized in a heat chamber of
40°C. To the columns kept at this temperature, THF
(tetrahydrofuran) as a solvent is flowed at a flow
15 rate of 1 ml per minute, and 10 μ l of a THF sample
solution is injected thereinto to make measurement.
In measuring the molecular weight of the sample, the
molecular weight distribution ascribed to the sample
is calculated from the relationship between the
20 logarithmic value and count number of a calibration
curve prepared using several kinds of monodisperse
polystyrene standard samples. As the standard
polystyrene samples used for the preparation of the
calibration curve, it is suitable to use, for example,
25 samples with molecular weights of approximately from
 10^2 to 10^7 , which are available from Tosu Co., Ltd. or



1 Showa Denko K.K., and to use at least about 10
standard polystyrene samples. An RI (refractive
index) detector is used as a detector. Columns should
be used in combination of a plurality of commercially
5 available polystyrene gel columns. For example, they
may preferably comprise a combination of Shodex GPC KF-
801, 802, 803, 804, 805, 806, 807 and 800P, available
from Showa Denko K.K.; or a combination of TSKgel
G1000H(H_{XL}), G2000H(H_{XL}), G3000H(H_{XL}), G4000H(H_{XL}),
10 G5000H(H_{XL}), G6000H(H_{XL}), G7000H(H_{XL}) and TSKguard-
column, available from Toso Co., Ltd.

The sample is prepared in the following way:
A sample is put in THF, which is left to stand for
several hours, followed by thorough shaking so that
15 the sample is well mixed with THF (until the sample
become free of coalescence), which is further left to
stand for 12 hours or more. Here, the sample is so
made as to be left in THF for 24 hours or more.
Thereafter, the sample is passed through a sample
20 treating filter (pore size: 0.45 to 0.5 μ m; for
example, Maiehoridisk H 25 5, available from Toso Co.,
Ltd., or Ekikurodisk 25CR, available from German
Science Japan Ltd. can be used), and the resulting
sample is used as the sample for GPC. Concentration
25 of the sample is so controlled as to give a resin
component of from 0.5 to 5 mg/ml.

This Sheet Has Been Replaced



1 The developer of the present invention may
preferably comprise i) a toner containing the binder
resin containing not less than 15 % of a component
with a molecular weight of not more than 5,000 in
5 molecular weight distribution as measured by GPC, ii)
styrene type fine organic powder having a smaller
average particle diameter than said toner and iii)
fine inorganic particles having a smaller average
particle diameter than said fine organic particles;
10 the surface shape sphericity ψ of said styrene type
fine organic powder being in the range of from 0.90 to
0.50.

 The developer of the present invention may
preferably be a one-component magnetic developer
15 comprising a magnetic toner containing a magnetic
material in the toner particle. In this instance, the
magnetic material serves also as a colorant. The
magnetic material contained in the magnetic toner may
include iron oxides such as magnetite, hematite and
20 ferrite; and metals such as iron, cobalt and nickel,
or alloys of any of these metals with a metal or
metals such as aluminum, cobalt, copper, lead,
magnesium, tin, zinc, antimony, beryllium, bismuth,
cadmium, calcium, manganese, selenium, titanium,
25 tungsten and/or vanadium, and mixtures of any of
these.

This Sheet Has Been Replaced



1 The magnetic material should preferably be a
magnetic material having a BET surface specific area
of from 1 to 20 m²/g, and particularly preferably from
2.5 to 12 m²/g, as measured by the nitrogen adsorption
5 method. It may also preferably be a magnetic powder
having a Mohs hardness of from 5 to 7. This magnetic
powder should be contained in an amount of from 10 to
70 % by weight based on the toner weight.

 Any of these magnetic materials may preferably
10 be those having an average particle diameter of from
0.1 to 2 μm, and more preferably from 0.1 to 0.5 μm,
and should be contained in the toner in an amount of
from 20 to 200 parts by weight based on 100 parts by
weight of the resin component, and particularly
15 preferably from 40 to 150 parts by weight based on 100
parts by weight of the resin component.

 The magnetic material may preferably be those
having a coercive force (Hc) of from 20 to 150 Oe, a
saturation magnetization (σs) of from 50 to 200 emu/g
20 and a residual magnetization (σr) of from 2 to 20
emu/g.

 The colorant usable in the toner may include
any suitable pigments or dyes.

 The pigments may include, for example, carbon
25 black, aniline black, acetylene black, Naphthol
Yellow, Hansa Yellow, Rhodamine Lake, alizarin Lake,

This Sheet Has Been Replaced



1 red iron oxide, Phthalocyanine Blue and Indanthrene
Blue. Any of these may be used in an amount large
enough to maintain the optical density of fixed
images. The pigment may preferably be used in an
5 amount of from 0.1 part by weight to 20 parts by
weight, and more preferably from 1 part by weight to
10 parts by weight, based on 100 parts by weight of
the resin. The dycc may also be used for the same
purpose. They may include, for example, azo dyes,
10 anthraquinone dyes, xanthene dyes and methine dyes.
The dye may preferably be used in an amount of from
0.1 part by weight to 20 parts by weight, and more
preferably from 0.3 part by weight to 10 parts by
weight, based on 100 parts by weight of the resin.
15 The toner used in the present invention may
preferably contain a wax in the toner particle.
The wax may include, for example, polyolefin
waxes, solid paraffin wax, micro wax, rice wax, amide
waxes, fatty acid waxes, fatty acid metal salt waxes,
20 partially saponified fatty acid ester waxes, silicone
wax, higher alcohols, and carnauba wax. The wax may
preferably be contained in an amount of from 0.5 part
by weight to 20 parts by weight, and more preferably
from 1 part by weight to 12 parts by weight, based on
25 100 parts by weight of the binder resin for the toner.
Wax in an excessively large content may result

This Sheet Has Been Replaced



1 in an increase in free wax, making it impossible to
prevent the problems of faulty cleaning, contamination
of fixing rollers, a lowering of developing
performance, etc., even in the developer containing
5 the styrene type fine resin particles of the present
invention. On the other hand, wax in an excessively
small content may result in a lowering of fixing
performance and anti-offset. The wax may preferably
have a broad molecular weight distribution. From the
10 viewpoint of improving cleaning performance of OPC
photosensitive members, it may preferably be not less
than 5, and more preferably from 5 to 10, in weight
average molecular weight/number average molecular
weight (Mw/Mn).

15 In the present invention, polyolefin waxes are
particularly preferred. Of these, polypropylene wax
and polyethylene wax are preferred. Use of such wax
enables achievement of better fixing performance,
cleaning performance and developing performance.

20 As the olefin monomers constituting the
polyolefin waxes, it is possible to use, for example,
ethylene, propylene, butene-1, pentene-1, hexene-1,
heptene-1, octene-1, nonene-1 and decene-1, or isomers
of any of these, having unsaturated bonds at different
25 positions, and also olefin monomers having branched
chains comprising an alkyl group, such as

This Sheet Has Been Replaced



1 3-methyl-1-butene, 3-methyl-2-pentene and 3-propyl-5-
methyl-2-hexene.

The molecular weight distribution of the wax
according to the present invention can be measured,
5 for example, in the following way.

Measurment conditions:

A. Apparatus: Waters Associates GPC-150C

B. Column: Shodex A-80M

C. Solvent: o-Dichlorobenzene (0.1 wt/vol % ionol
10 added), 135°C, 1.0 ml/min

D. Preparation of sample:

Concentration: 0.1 wt/vol %

Solubility: Entirely soluble when used at
high temperatures.

15 Filtration: None

E.. Pour: 400 µl

F. Detector: RI (differential refractometer) 32 x
50 %

G. Molecular weight calibration:

20 On the basis of monodisperse polystyrene
molecular weight.

The developer of the present invention may
preferably comprise i) a toner containing a wax with a
weight average molecular weight/number average
25 molecular weight (Mw/Mn) of not less than 5, ii)
styrene type fine organic particles having a smaller

This Sheet Has Been Replaced



1 average particle diameter than said toner, and iii)
fine inorganic particles having a smaller average
particle diameter than said styrene type fine organic
particles; the surface shape sphericity ψ of said
5 styrene type fine organic powder being in the range of
from 0.90 to 0.50.

To the developer of the present invention,
other additives as exemplified by a lubricant such as
Teflon or zinc stearate or, as a conductivity-
10 providing agent, a metal oxide such as tin oxide may
be added so long as the developer is substantially not
adversely affected.

Methods for the preparation of the toner may
include a method in which component materials are well
15 kneaded using a heat kneader such as a heat roll, a
kneader or an extruder, followed by pulverization and
classification to obtain the toner; a method in which
other materials are dispersed in a binder resin
solution, followed by spray drying to obtain the
20 toner; and a method in which given materials are mixed
in monomers that constitute the binder resin, to form
an emulsified suspension, followed by polymerization
to obtain the toner.

The developer of the present invention can be
25 prepared by dry-mixing the toner, the organic fine
resin particles and the fine inorganic powder by means

This Sheet Has Been Replaced



1 of a mixing machine such as Henschel mixer.

A contact charging process that can be preferably used in the present invention will be specifically described below.

5 Fig. 3 schematically illustrates the constitution of an example of the contact charging device or assembly. Reference numeral 1 denotes a photosensitive drum which is a chargeable member
10 curving as the electrostatic image bearing member, and is comprised of a conductive substrate comprising a drum substrate 1a made of aluminum, on the external surface of which an organic photoconductor (OPC) 1b serving as a photosensitive layer is formed. The
15 photosensitive drum is rotated at a given speed in the direction of an arrow. In this example, the photosensitive drum 1 is 30 mm in outer diameter. Reference numeral 2 denotes a charging roller which is a charging member brought into contact with the
20 photosensitive drum 1 at a given pressure, and is comprised of a metal mandrel 2a, a conductive rubber layer 2b provided thereon, and further provided on its external surface a surface layer 2c, a release film. The conductive rubber layer may preferably have a
25 thickness of from 0.5 to 10 mm, and preferably from 1 to 5 mm. The surface layer in this example comprises a release film. It is preferred to provide this

This Sheet Has Been Replaced



1 release film so that the developer and image forming
method according to the present invention may match
each other. However, a release film with an
excessively large resistivity may give no
5 electrostatic charges on the photosensitive drum 1 and
on the other hand a release film with an excessively
small resistivity may cause an excessively large
voltage applied to the photosensitive drum 1 to tend
to damage the drum or produce pinholes, and hence the
10 release film should have an appropriate resistivity.
The release film should have a volume resistivity of
from 10^9 to 10^{14} Ω -cm. Here, the release film may
preferably have a thickness of not more than 30 μ m.
The lower limit of the thickness of the film may be
15 smaller so long as no peel or turn-up may occur, and
can be considered to be about 5 μ m. Preferably the
release film should have a thickness of from 10 to 30
 μ m.

In this example, the charging roller 2 has an
20 outer diameter of 12 mm. The conductive rubber layer
2b, having a thickness of 3.5 mm, is composed of an
ethylene-propylene-diene terpolymer (EPDM), and the
surface layer 2c is formed of a nylon resin in a
thickness of 10 μ m. The charging roller 2 is made to
25 have a hardness of 54.5' (ASKER-C). Letter symbol E
denotes a power source that applies a voltage to the



1 charging roller 2. It supplies a given voltage to the
mandrel 2a (diameter: 5 mm) of the charging roller 2.
In Fig. 3, the letter symbol E indicates a DC voltage.
It may preferably be a direct current overlaid with an
5 AC voltage as shown in Fig. 4.

Preferable conditions used here for contact
charging process are shown below.

Contact pressure: 5 to 500 g/cm

AC voltage: 0.5 to 5 KVpp

10 AC frequency: 50 to 3,000 Hz

DC voltage: -200 to -900 V

Fig. 5 schematically illustrates the
constitution of another example of the contact
charging member according to the present invention.

15 The members common to those in the device shown in
Figs. 3 and 4 have the same reference number, and
repetitive description thereon is omitted.

In this example, a contact charging member 3
is blade-shaped, which is brought into contact with
20 the photosensitive drum 1 in the normal direction
under a given pressure. This blade 3 is comprised of
a holding metal member 3a to which a voltage is
applied, a conductive rubber 3b supported by the
member 3a, and a surface layer 3c serving as the
25 release film, provided at the part coming into contact
with the photosensitive drum 1. The surface layer 3c



1 is formed of nylon in a thickness of 10 μ m. According
to this example, difficulties such as sticking of the
blade to the photosensitive drum do not occur, and the
same operation and effect as in the previous examples
5 can be achieved.

In the examples described above, the roller-
shaped or blade-shaped member is used as the charging
member. Without limitation thereto, the present
invention can also be carried out using a member with
10 a different shape.

In the above examples, the charging member is
constituted of a conductive rubber layer and a release
film. Its constitution is by no means limited to it.
For example, in some instances, a high-resistance
15 layer (e.g., a hydrin rubber layer with less
environmental variations) may preferably be formed
between the conductive rubber layer and the release
film surface layer so that leakage to the
photosensitive member can be prevented.

20 As the material for the release film, PVDF
(polyvinylidene fluoride) and PVDC (polyvinylidene
chloride) may also be used in place of the nylon
resin. As for the photosensitive member, amorphous
silicon, selenium, ZnO, etc. can also be used. In the
25 case when amorphous silicon is used in the
photosensitive member, emcared images may seriously



1 occur, compared with the case when other material is
used, if the softening agent in the conductive rubber
layer adheres to the photosensitive member even in a
small quantity. Hence, it can be more effective to
5 provide such an insulative coating on the outer side
of the conductive rubber layer.

The present invention is particularly
effective for an image forming apparatus comprising an
electrostatic image bearing member (a photosensitive
10 drum) whose surface is formed of an organic compound.
This is because, in the case when an organic compound
forms a surface layer, the binder resin containing the
toner tends to adhere to the surface layer and hence
the melt adhesion of toner tends to occur at the
15 contact point particularly when the same materials are
used.

Surface materials for the the electrostatic
image bearing member according to the present
invention may include silicone resin, vinylidene
20 chloride, ethylene-vinyl chloride, styrene-
acrylonitrile, styrene methyl methacrylate, styrene,
polyethylene terephthalate, and polycarbonate. The
materials are by no means limited to these, and other
monomers or their copolymers or blends with any of the
25 exemplified resins can also be used.

This Sheet Has Been Replaced



1

The present invention is particularly effective for an image forming apparatus comprising an electrostatic image bearing member with a diameter of 50 mm or less. This is because, in the case of drums
5 with a small diameter, pressure tends to be localized at the contact part because of a large curvature even under the same linear pressure.

10

The same phenomenon is considered to occur in belt type photosensitive members, and the present invention is particularly effective for an image forming apparatus wherein the curvature radius at the transfer portion is 25 mm or less.

15

The developer for developing an electrostatic image according to the present invention can be preferably used particularly in a heat roller fixing system. A heat roller fixing device is usually comprised of a heat roller, a pressure roller provided opposingly thereto, and a heat source built in the heating roller. A cleaning roller is optionally
20 provided opposingly to the heating roller. In the fixing of the developer, a transfer medium with a toner image having been transferred thereto is passed through between the heating roller and the pressure roller while keeping the temperature of the heating
25 roller to a given temperature by means of the heat source, whereby the toner image is brought into direct

This Sheet Has Been Replaced



1 contact with the heating roller so that the toner
image can be fixed by heat and pressure to the
transfer medium. The heating roller may preferably be
made of a fluorine type material or a silicone type
5 material, which can remarkably improve the durability
of the heating roller because of the cooperative
action of the material and the developer of the
present invention.

The image forming method and electro-
10 photographic apparatus of the present invention will
be described below with reference to Fig. 6.

15

20

25

This Sheet Has Been Replaced



1 The surface of a photosensitive member 501
serving as the electrostatic image bearing member is
negatively charged by the operation of a contact
charging assembly 502, the contact charging means
5 previously described, having a voltage applying means
515, and a digital latent image is formed by image
scanning through exposure 505 using a laser beam. The
latent image thus formed is reversely developed using
a negatively chargeable one-component magnetic
10 developer 510 held in a developing assembly 509
equipped with a developing sleeve 504 in which a
magnetic blade 511 and a magnet are provided. In the
developing zone, an AC bias, a pulse bias and/or a DC
bias is/are applied between a conductive substrate of
15 the photosensitive drum 501 and the developing sleeve
504 through a bias applying means 512. A transfer
paper P is fed and delivered to a transfer zone, where
the transfer paper P is electrostatically charged from
its back surface (the surface opposite to the
20 photosensitive drum) through a transfer means 503, so
that the developed image (toner image) on the surface
of the photosensitive drum is electrostatically
transferred to the transfer paper P. The transfer
paper P separated from the photosensitive drum 501 is
25 subjected to fixing using a heat-pressure roller
fixing unit (thermal platen) 507 so that the toner

This Sheet Has Been Replaced



1 image on the transfer paper P can be fixed.

The one-component magnetic toner remaining on the photosensitive drum 501 after the transfer step is removed by the operation of a cleaning assembly 508
5 having a cleaning blade (or a cleaning roller). After the cleaning, the residual charges on the photosensitive drum 501 is eliminated by erase exposure 506 if necessary, and thus the procedure again starting from the charging step using the
10 contact charging assembly 502 is repeated. The erase exposure may be omitted when an AC bias is applied to the contact charging assembly 502.

The electrostatic image bearing member (the photosensitive drum) comprises a photosensitive layer
15 and a conductive substrate as previously described, and is rotated in the direction of an arrow. In the developing zone, the developing device 504, a non magnetic cylinder, which is the developer carrying member, is rotated so as to move in the same direction
20 as the direction in which the electrostatic image bearing member is rotated. In the inside of the non-magnetic cylindrical sleeve 504, a multi-polar permanent magnet (magnet roll) serving as a magnetic field generating means is provided in an unrotatable
25 state. The one-component insulating magnetic toner 510 held in the developing assembly 509 is coated on

This Sheet Has Been Replaced



1 the surface of the non-magnetic cylindrical sleeve
504, and, for example, minus triboelectric charges are
imparted to the developer because of the friction
between the surface of the sleeve 504 and the the
5 developer. A doctor blade 511 made of iron is
disposed opposingly to one of the magnetic pole
positions of the multi-polar permanent magnet, in
proximity (with a space of from 50 μm to 500 μm) to
the surface of the cylinder. Thus, the thickness of a
10 toner layer can be controlled to be small (from 30 μm
to 300 μm) and uniform so that a toner layer smaller
in thickness than the gap between the electrostatic
image bearing member 501 and developer carrying member
504 in the developing zone can be formed in a non-
15 contact state. The rotational speed of this developer
carrying member 504 is regulated so that the
peripheral speed of the sleeve can be substantially
equal or close to the speed of the peripheral speed of
the electrostatic image bearing member. As the
20 magnetic doctor blade 511, a permanent magnet may be
used in place of iron to form an opposing magnetic
pole. In the developing zone, the AC bias or pulse
bias may be applied through the bias means 512, across
the developer carrying member 504 and the surface of
25 the electrostatic image bearing member 501. This AC
bias may have a frequency of from 200 to 4,000 Hz, and



1 a Vpp of from 500 to 3,000 V.

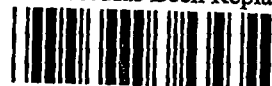
When the toner particles are moved in the developing zone, the toner particles are moved to the side of an electrostatic image by the electrostatic
5 force of the electrostatic image bearing member surface and the action of the AC bias or pulse bias.

In place of the magnetic doctor blade 511, an elastic blade formed of an elastic material such as silicone rubber may be used so that the layer
10 thickness of the developer layer can be controlled by pressure and the developer can be thereby coated on the developer carrying member.

The cleaning step may be simultaneously carried out in the charging step, developing step or
15 transfer step.

The electrophotographic apparatus may be constituted of a combination of plural components integrally joined as one apparatus unit from among the constituents such as the above electrostatic image
20 bearing member, developing means and cleaning means so that the unit can be freely mounted on or detached from the body of the apparatus. For example, at least one of the contact charging means, developing means and cleaning means may be integrally supported
25 together with the electrostatic image bearing member to form one unit that can be freely mounted on or

This Sheet Has Been Replaced



1 detached from the body of the apparatus, and the unit
can be freely mounted or detached using a guide means
such as a rail provided in the body of the apparatus..

In the case when the electrophotographic
5 apparatus of the present invention is used as a
printer of a facsimile machine, optical image exposing
light 505 serves as exposing light used for the
printing of received data. Fig. 8 illustrates an
example thereof in the form of a block diagram.

10 A controller 611 controls an image reading
part 610 and a printer 619. The whole of the
controller 611 is controlled by CPU 617. Image data
outputted from the image reading part is sent to the
other facsimile station through a transmitting circuit
15 613. Data received from the other station is sent to
a printer 619 through a receiving circuit 612. Given
image data are stored in an image memory 616. A
printer controller 618 controls the printer 619. The
numeral 614 denotes a telephone.

20 An image received from a circuit 615 (image
information from a remote terminal connected through
the circuit) is demodulated in the receiving circuit
612, and then successively stored in an image memory
616 after the image information is decoded by the CPU
25 617. Then, when images for at least one page have
been stored in the memory 616, the image recording for



1 that page is carried out. The CPU 617 reads out the
image information for one page from the memory 616 and
sends the coded image information for one page to the
printer controller 618. The printer controller 618,
5 having received the image information for one page
from the CPU 617, controls the printer 619 so that the
image information for one page is recorded.

The CPU 617 receives image information for
next page in the course of the recording by the
10 printer 619.

Fundamental constitution and characteristic
features of the present invention are as described
above. In the following, the present invention will
be specifically described by giving Examples. It
15 should be noted that the working embodiments of the
present invention are by no means limited by these.
In the following examples, "part(s)" refers to
"part(s) by weight".

Preparation of toners:

20

Preparation Example 1

Styrene/n-butyl methacrylate/divinylbenzene copolymer
(copolymerization ratio:70:29:1; Mw: 280,000)

100 parts

Fine magnetic powder (DET value: $7.5 \text{ m}^2/\text{g}$)

25

100 parts

Negative charge control agent (exemplory complex (I)-3)

0.5 part

This Sheet Has Been Replaced



1 The above materials were melt-kneaded using a
twin-screw extruder heated to 140°C. After cooled,
the kneaded product was crushed using a hammer mill to
give coarse particles, which were then finely
5 pulverized using a jet mill. The resulting finely
pulverized product was subjected to air classification
to give a classified magnetic powder (magnetic toner
1) with a weight average particle diameter (D_4) of 6.8
10 μm (number average particle diameter: 5.2 μm) (T_g :
60°C). The magnetic toner obtained had negative
triboelectric chargeability and also had electrical
insulating properties.

Preparation Example 2

15 A classified magnetic powder (magnetic toner
2) having the same average particle diameter as that
in Preparation Example 1 was obtained in the same
manner as in Preparation Example 1 except that as the
charge control agent the exemplary complex (I)-3 was
replaced with exemplary complex (I)-2.

20 Preparation Example 3

A classified magnetic powder (magnetic toner
3) having the same average particle diameter as that
in Preparation Example 1 was obtained in the same
manner as in Preparation Example 1 except that as the
25 charge control agent the exemplary complex (I)-3 was



1 replaced with exemplary complex (I) 6.

Preparation Example 4

5 A classified magnetic powder (magnetic toner 4) having the same average particle diameter as that in Preparation Example 1 was obtained in the same manner as in Preparation Example 1 except that no negative charge control agent was used.

Preparation Example 5

10 A classified magnetic powder (magnetic toner 5) with a weight average particle diameter of 12.5 μm , having the same average particle diameter as that in Preparation Example 1 was obtained in the same manner as in Preparation Example 1 except that the fine magnetic powder was used in an amount of 60 parts.

15 Examples 1 to 5 & Comparative Examples 1 to 5

Fine resin particles and hydrophobic fine silica powder as shown in the following Tables 1 and 2, respectively, were added to 100 parts of the above magnetic toners in the combination as shown in Table 3, and mixed using a Henschel mixer to give one-
20 component magnetic developers.

Next, these respective one-component magnetic developers thus prepared were each loaded in the electrophotographic apparatus as shown in Fig. 6 (a modified machine of LBP-8II, manufactured by Canon
25 Inc.) having a contact charging assembly and a

This Sheet Has Been Replaced



1 cleaning blade made of polyurethane. While applying a
DC voltage (-700 V) and an AC voltage (500 Hz, 2,000
Vpp) to the contact charging assembly, practical copy
tests to form toner images continuously on A4-size
5 paper at a printing speed of 16 sheets/min according
to the reversal development system were carried out in
an environment of low temperature and low humidity
(15°C, 10 % RH), and print-out images were evaluated.
At the same time, the state of the surface of the
10 charging member (roller type) was examined.

The photosensitive member used was an OPC
photosensitive member comprising a drum substrate on
the external surface of which a photosensitive layer
comprised of a charge generation layer and a charge
15 transport layer (comprising a charge transporting
compound dispersed in polycarbonate resin), and the
photosensitive member had a surface with abrasion
characteristics of $2.5 \times 10^{-2} \text{ cm}^3$ as abrasion wear
measured using a Taber's abrasion resistance tester.

20 As previously described, the charging roller 2
has a diameter of 12 mm, the mandrel has a diameter of
5 mm, the conductive rubber layer 2b has a thickness
of about 3.5 mm, and the release film formed of
methoxymethylated nylon has a thickness of 20 μm . The
25 roller was brought into pressure contact with the OPC
photosensitive member at a total pressure of 1.2 kg



1 (linear pressure: 55 g/cm).

In the image forming apparatus, the toner layer on the sleeve was made to have a thickness of 130 μm , and the gap where the sleeve and the OPC
5 photosensitive member become closest was set to be 300 μm . Image reproduction tests were carried out while applying a DC bias (-500 V) and an AC bias (1,800 Hz, 1,600 Vpp) to the developing sleeve.

Tables 1 and 2 show physical properties of the
10 fine resin particles (A) and those of the fine silica powder (B), respectively. Table 3 shows the composition of each developer and the results of evaluation. As the charging device, the blade type charging assembly as shown in Fig. 4 was used in
15 Example 5, and the roller type as shown in Fig. 4 was used in Examples 1 to 4 and Comparative Examples 1 to 5.

Charge non-uniformity due to the contamination of the charging member was evaluated by observing
20 lateral line images of about 100 μ in line intervals and about 100 μ in line width.

Dot reproduction was evaluated by observing with a microscope the reproduction of images formed, after 10,000 sheet running, by developing a checker
25 pattern as shown in Fig. 12, comprised of squares each one side of which was 100 μm or 50 μm .

This Sheet Has Been Replaced



1

Table 1

Fine resin particles A

		Sur face shape spher- icity ψ	Number av. par- ticle dia- meter (μm)	Volume resis- tivity (Ω·cm)	Charge quan- tity (μc/g)	Composition and monomer unit (wt.%)
5						
	Λ-1	0.86	0.5	3×10^{10}	-10	St/MMA/BA (53/35/12)
10	A-2	0.69	0.6	3×10^{12}	-26	St/MMA/BMA (65/20/15)
	A-3	0.78	0.05	6×10^8	-28	St/MMA/2EHA (60/20/20)
	A-4*	0.99	0.5	5×10^{13}	+50	MMA
15	Λ-5*	0.99	0.6	7×10^{16}	-70	MMA/BA (85/15)

* Comparative Example

St: Styrene

20

MMA: Methyl methacrylate,

BA: Butyl acrylate

BMA: Butyl methacrylate

2EHA: 2-Ethylhexyl acrylate

25

This Sheet Has Been Replaced



1

Table 2

Fine silica powder B

5	Fine silica powder	BET Sur- face spe- cific area	Number av. dia- meter of primary particles	Charge quan- tity	Treatment agent
		(m ² /g)	(μm)	(μc/g)	
	B-1	200	0.012	-175	Hexamethyldisilazane +dimethylsilicone oil
10	B-2	300	0.008	-240	Dimethylsilicone oil
	B-3	200	0.012	-30	Control

15

20

This Sheet Has Been Replaced



25

25

20

15

10

5

1

Table 3
Results of Evaluation

										Charge non-uniformity due to contamination of contact charging member			Dot reproduction		Image density nonuniformity			
										30x	60x	100x	x=	x=				
										100	100	100	100	50				
Toner	Fine resin particles	Fine silica powder	Image density							30x sh.	60x sh.	100x sh.	30x sh.	60x sh.	100x sh.	x= μ	x= μ	
			Initial	30x sh.	60x sh.	100x sh.	After 100											
Example:																		
1	1	A-1	0.2	B-1	0.8	1.4	1.4	1.4	1.4	A(No)	A(No)	A(No)	A	A	A			
2	2	A-1	0.2	B-1	0.8	1.4	1.4	1.4	1.4	A(No)	A(No)	A(No)	A	A	A			
3	3	A-1	0.2	B-1	0.8	1.4	1.4	1.4	1.4	A(No)	A(No)	A(No)	A	A	A			
4	1	A-2	0.15	B-2	0.5	1.3	1.35	1.4	1.4	A(No)	A(No)	A(No)	A	A	A			
5	1	A-3	0.05	B-1	1.2	1.4	1.4	1.4	1.4	A(No)	A(No)	A(No)	A	A	A			
6	4	A-1	0.2	B-1	1.5	1.4	1.3	1.2	1.7	A(No)	A(No)	A(No)	A	A	A			
7	5	A-1	0.2	B-1	0.3	1.4	1.4	1.35	1.3	A(No)	A(No)	A(No)	A	B	A			

Comparative Example:																		
1	1	None		B-2	0.5	1.1	1.2	1.2	1.3	A(No)	A(No)	C(*2)	A	A	A			
2	1	A-4	0.2	B-2	1.2	1.2	1.2	1.3	1.4	A(No)	A(No)	C(*3)	A	A	C			
3	3	A-5	0.2	B-3	0.6	1.2	1.1	1.1	1.0	A(No)	C(*1)	-	A	A	C			

*1: Occurred on 5,000 sheets

*2: Occurred on 8,000 sheets

*3: Occurred on 9,000 sheets

Remarks:

- (1) Amounts of the fine resin particles and fine silica powder added are indicated as parts by weight based on 100 parts by weight of the toner.
- (2) Evaluation of dot reproduction (reproduction of 100 black dots):
A: Two or less dots lacked, B: Three or more dots lacked.

This Sheet Has Been Replaced

1 Preparation Example 6

Styrene/n-butyl methacrylate/divinylbenzene copolymer
(copolymerization ratio: 70:29:1; Mw: 280,000)

100 parts

5 fine magnetic powder (BET value: $7.5 \text{ m}^2/\text{g}$)

80 parts

Negative charge control agent: 3,5-di-tert-

butylsalicylic acid chromium complex 2 parts

Low-molecular weight polypropylene (Mw/Mn = 5.8)

10 8 parts

The above materials were melt kneaded using a twin-screw extruder heated to 140°C. After cooled, the kneaded product was crushed using a hammer mill to give coarse particles, which were then finely

15 pulverized using a jet mill. The resulting finely
pulverized product was subjected to air classification
to give a classified magnetic powder (magnetic toner
b) with a weight average particle diameter (D_4) of 7.8
 μm (number average particle diameter: 6.1 μm) (Tg:
20 60°C).

Preparation Example 7

A classified magnetic powder (magnetic toner 7) having the same average particle diameter as that in Preparation Example 6 was obtained in the same manner as in Preparation Example 6 except that a polypropylene of $M_w/M_n = 6.5$ was used as the low-

This Sheet Has Been Replaced



1 molecular weight polypropylene.

Preparation Example 8

A classified magnetic powder (magnetic toner
8) having the same average particle diameter as that
5 in Preparation Example 6 was obtained in the same
manner as in Preparation Example 6 except that the low-
molecular weight polypropylene was replaced with a
blend of a low-molecular weight polyethylene and a low-
molecular weight polypropylene ($M_w/M_n = 8.2$).

10 Preparation Example 9

A classified magnetic powder (magnetic toner
9) having the same average particle diameter as that
in Preparation Example 6 was obtained in the same
manner as in Preparation Example 6 except that no low-
15 molecular weight polypropylene was used.

Examples 8 to 12 & Comparative Examples 4 to 7

Fine resin particles and hydrophobic fine
silica powder as shown in the above Tables 1 and 2,
respectively, were added to the above magnetic toners
20 in the combination as shown in Table 4, and mixed
using a Henschel mixer to give developers.

Using the respective developers thus obtained,
images were reproduced and evaluated in the same
manner as in Example 1 or 5. Results obtained are
25 shown in Table 4.



25

20

15

10

5

1

Table 4
Results of Evaluation

							Charge non-uniformity due to contamination of contact charging member (after 10,000 sheet running)	Anti- offset	Image density non-uni- formity	Contact charging member
Toner		Fine resin particles		Fine silica powder		Image density				
Example:										
8	6	A-1	0.2	B-1	0.8	1.4	A (Not occur)	A	A	Roller
9	7	A-1	0.2	B-1	0.8	1.4	A (Not occur)	A	A	Roller
10	8	A-1	0.2	B-1	0.8	1.4	A (Not occur)	A	A	Roller
11	6	A-2	0.15	B-2	0.5	1.3	A (Not occur)	A	A	Roller
12	6	A-3	0.05	B-1	1.2	1.4	A (Not occur)	A	A	Blade

Comparative Example:							Occur on			
4	6	None		B-2	0.5	1.3	C (/ 6,000 sheets)	A	A	Roller
5	6	A-4	0.2	B-2	1.2	1.3	C (" 8,000 sheets)	A	C	Roller
6	8	A-5	0.2	B-3	0.8	1.4	C (" 4,000 sheets)	A	C	Roller
7	9	A-4	0.2	B-1	0.8	1.3	C (" 8,000 sheets)	C	C	Roller

Amounts of the fine resin particles and fine silica powder added are indicated as parts by weight based on 100 parts by weight of the toner.

This Sheet Has Been Replaced

1 Preparation of toner particles:

Preparation Example 10

Copolymer I 100 parts

Fine magnetic powder (BET value: $7.5 \text{ m}^2/\text{g}$)

5 80 parts

Negative charge control agent: 3,5-di-tert-

butylealicylic acid chromium complex 2 parts

The above materials were melt-kneaded using a
twin-screw extruder heated to 140°C . After cooled,
10 the kneaded product was crushed using a hammer mill to
give coarse particles, which were then finely
pulverized using a jet mill. The resulting finely
pulverized product was subjected to air classification
to give a classified magnetic powder (magnetic toner
15 10) with a weight average particle diameter (D_4) of
 $7.8 \mu\text{m}$ (number average particle diameter: $6.1 \mu\text{m}$) (T_g :
 60°C).

Preparation Example 11 to 13

Classified magnetic powders (magnetic toners
20 11 to 13) having the same average particle diameter as
that in Preparation Example 10 were obtained in the
same manner as in Preparation Example 10 except that
the copolymer I was replaced with copolymer II to IV,
respectively.

25 Table 5 shows the composition of each
copolymer, T_g , and weight fraction of the region with

This Sheet Has Been Replaced



- 1 a molecular weight of not more than 5,000 in the measurement by GPC after the toners have been formed.

Table 5

Composition of copolymer

5

Magnetic toner	Copoly- mer	Composition	Weight	
			Tg	fraction (%)*
10	I	St/DA/MD (75/15/10)	60°C	18.5
10	11	II	St/BA/BMA/MB (70/10/15/5)	59°C 25.4
	12	III	St/2EHA/MB (68/25/7)	60°C 20.1
	13	IV	St/BA (80/20)	61°C 10.3

15

* Weight fraction of region with molecular weight of $\leq 5,000$ in the measurement by GPC after toner formation

St: Styrene

20 BA: Butyl acrylate

BMA: Butyl methacrylate

2EHA: 2-Ethylhexyl acrylate

MR: Monobutyl maleate

Examples 13-17 & Comparative Examples 8-11

25 Fine resin particles and hydrophobic fine silica powder as shown in the above Tables 1 and 2,

This Sheet Has Been Replaced



1 respectively, were added to the above magnetic toners
in the combination as shown in Table 6, and mixed
using a Henschel mixer to give developers.

Using the respective developers thus obtained,
5 images were reproduced and evaluated in the same
manner as in Example 1 or 5. Results obtained are
shown in Table 6.

Similar tests were also carried out in an
environment of high temperature and high humidity
10 (32.5°C, 85 % RH). Print-out images were evaluated,
and the state of the surface of the charging member
was examined.

Charge non-uniformity due to the contamination
of the charging member was examined on lateral line
15 images of about 100 μ in intervals and about 100 μ in
line width (in an environment of low temperature and
low humidity).

Melt adhesion of toner to the surface of the
photosensitive member was evaluated on the basis of
20 the number of white dots in solid black images.
(Since it tends to occur in an environment of high
temperature and high humidity, tests were carried out
in a environment of high temperature and high
humidity.)

25 Criteria for the evaluation are as shown
below.



1 Melt adhesion of toner to the photosensitive member
surface:

A: No melt adhesion at all.

5 AB: Melt adhesion giving 1 to 3 white dots in an
A4 solid black image.

B: Melt adhesion giving 3 to 10 white dots in an
A4 solid black image.

C: Melt adhesion giving 10 or more white dots in
an A4 solid black image.

10 Fixing performance was evaluated in the
following way: In an environment of normal temperature
and normal humidity (23.5°C, 60 % RH), a power source
was switched on after the evaluation machine became
accustomed to that environment. Immediately after
15 wait-up, lateral line patterns of 200 μ in line width
(width: 200 μ ; intervals: 200 μ m) were printed (on A4
paper oct lengthwise). A printed image on the first
sheet was used for the evaluation of fixing
performance. For the evaluation of fixing
20 performance, the image was rubbed to and fro five
times with Silbon paper under a load of 100 g, and
image come-off was examined on the basis of the
average of image density fall rates (%).

In the evaluation, bond paper with a surface
25 smoothness of 10 (sec) or less was used. Criteria
of the evaluation are as shown below.

This Sheet Has Been Replaced



1 Fixing performance:

- A: Good (density fall rate: less than 10 %)
- B: A little poor, but tolerable for practical use
(density fall rate: not less than 10 % and
5 less than 20 %)
- C: Untolerable for practical use (density fall
rate: not less than 20 %).

10

15

20

This Sheet Has Been Replaced



25

Table 6
Results of Evaluation

							Charge non-uniformity in low temp. low humidity environment (10,000 sh. running)	*1 Melt adhesion of toner (after 10,000 running)	Fixing performance	Image density non-uniformity	Contact charging member
Toner		Fine resin particles		Fine silica powder		Image density					
Example:											
13	10	A-1	0.2	B-1	0.8	1.4	A(Not occur)	AB	A	A	Roller
14	11	A-1	0.2	B-1	0.8	1.4	A(Not occur)	AB	A	A	Roller
15	12	A-1	0.2	B-1	0.8	1.4	A(Not occur)	AB	A	A	Roller
16	10	A-2	0.15	B-2	0.5	1.3	A(Not occur)	A	A	A	Roller
17	10	A-3	0.05	B-1	1.2	1.4	A(Not occur)	B	B	A	Blade
Comparative Example:							Occur on				
8	10	None		B-2	0.5	1.2	C(/ 10,000 sh.)	C	A	A	Roller
9	10	A-4	0.2	B-2	1.2	1.4	C(" 7,000 sh.)	B	B	C	Roller
10	12	A-5	0.2	B-3	0.8	1.0	C(" 5,000 sh.)	AB	A	C	Roller
11	13	A-4	0.2	B-1	0.8	1.4	C(" 7,000 sh.)	AB	C	A	Roller

*1: In a environment of high temperature and high humidity.
Amounts of the fine resin particles and fine silica powder added are indicated as parts by weight based on 100 parts by weight of the toner.



Preparation Example 14

Styrene/n-butyl acrylate copolymer (copolymerization
ratio: 8:2; Mw: 270,000)

100 parts

5 Fine magnetic powder (BET value: $8.5 \text{ m}^2/\text{g}$) 60 parts
Negative charge control agent (a monoazo dye chromium complex) 0.6 part
Low-molecular weight polypropylene (M_w : 6,000)

3 parts

The above materials were melt-kneaded using a twin-screw extruder heated to 140°C. After cooled, the kneaded product was crushed using a hammer mill to give coarse particles, which were then finely pulverized using a jet mill. The resulting finely pulverized product was subjected to air classification to give a classified magnetic powder (magnetic toner 14) with a volume average particle diameter of 12 μm (Tg: 60°C).

Preparation Example 15

20	Styrene/2-ethylhexyl acrylate/maleic acid n-butyl half ester copolymer (copolymerization ratio: 7:2:1; Mw: 200,000)	100 parts
	Fine magnetic powder (BET value: $7.5 \text{ m}^2/\text{g}$)	60 parts
	Negative charge control agent (a salicylic acid chromium complex)	2 parts
25		

1 Low-molecular weight polypropylene (Mw: 6,000)

3 parts

The above materials were treated in the same manner as in Example 14 to give a classified magnetic powder (magnetic toner 15) (Tg: 55°C).

Examples 18-22 & Comparative Example 12-14

Fine resin particles as shown in the following Table 7 and fine silica powders as shown in Table 2 previously set out and the above classified magnetic toners were mixed using a Henschel mixer in the combination as shown in Table 8, to give one-component magnetic developers having the toner to which the fine resin particles and fine silica powder had been externally added.

15 Next, these respective one-component magnetic developers thus prepared were each loaded in the image forming apparatus as shown in Fig. 6 (a modified machine of LBP-8II, manufactured by Canon Inc.) having a contact charging assembly. While applying a DC voltage and an AC voltage (500 Hz, 2,000 Vpp), practical copy tests to form toner images continuously on A4-size paper at a printing speed of 16 sheets/min according to the reversal development system were carried out in an environment of normal temperature and normal humidity (25°C, 60 % RH), and print-out images were evaluated. At the same time, the state of

This Sheet Has Been Replaced



1 the surfaces of the charging member (roller type) and
OPC photosensitive drum was examined.

Table 7 shows physical properties of the fine
resin particles (A). Table 8 shows the composition of
5 each developer and the results of evaluation.

Criteria for the evaluation are shown below.

Fogging:

- A: Almost no fogging.
- 10 B: Fogging occurs, but tolerable for practical
use.
- C: Untolerable for practical use.

Melt adhesion of toner to OPC photosensitive member:

- A: No melt adhesion at all.
- 15 AB: Melt adhesion giving 1 to 3 white dots in an
A4 solid black image.
- B: Melt adhesion giving 3 to 10 white dots in an
A4 solid black image.
- C: Melt adhesion giving 10 or more white dots in
an A4 solid black image.

20 Charge non-uniformity:

- A: No charge non-uniformity at all.
- B: Charge non-uniformity a little occurs, but
tolerable for practical use.
- C: Charge non-uniformity clearly occurs.
- 25 Untolerable for practical use.

This Sheet Has Been Replaced



1

Table 7

Fine Resin Particles (A)

		Sphe ric- ity %	Par ticle size (μm)	Spe- cific resist- ance ($\Omega \cdot \text{cm}$)	Tribo- elec- tric- ity ($\mu\text{C/g}$)	Tg ($^{\circ}\text{C}$)	Monomer composi- tion of fine resin particles
5	A-6	0.88	0.6	2×10^8	-40	110	St/MMA/2EHA (70/20/10)
10	A-7	0.65	0.6	3×10^7	-20	101	St/MMA/BMA (75/15/10)
	A-8	0.52	0.5	5×10^6	-60	90	St/MMA/2EHA (80/5/15)
	A-9	0.75	0.9	5×10^{12}	-5	105	St/MMA (55/45)
15	A-10	0.80	0.05	8×10^{11}	200	98	St/MMA/2EHA (70/10/20)
	A-11*	1.00	0.3	2×10^{10}	+90	95	MMA/BA (90/10)
20	A-12*	0.97	1.2	1×10^{14}	-30	102	St/MMA (20/80)

* Comparative Example

25

This Sheet Has Been Replaced



1

Table 8

Results of Evaluation

5

Mag- netic Toner	Fine resin particles-A Type	Amt.	Fine inorganic powder-B Type	Amt.	(1)	Fogg- ing	(2)	(3)

Example:

18	14	A-6	0.1	B 1	0.5	A	A	A	1.4
19	14	A-7	0.05	B-1	0.5	A	A	A	1.4
20	14	A-8	0.2	B-2	0.6	A	A	A	1.4
21	15	A-9	0.9	B-2	1.2	A	A	A	1.35
22	15	A-10	0.02	B-2	0.4	A	A	A	1.4

Comparative Example:

12	14	A-11	0.1	B-1	0.5	A	C	C	1.4
13	15	A 12	0.5	B-2	0.6	C	C	C	1.35
14	15	-	-	B-3	0.5	C	A	A	0.9

20

(1): Melt adhesion of toner to photosensitive member
after 12,000 sheets running

(2): Charge non-uniformity (after 12,000 sheets
running)

(3): Image density

25

This Sheet Has Been Replaced



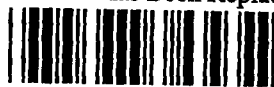
1 As having been described above, use of the
specific fine resin particles in combination with the
fine inorganic powder such as hydrophobic fine silica
powder is effective for removing the free fine
5 inorganic powder to protect the surface of the
photosensitive member, and hence the developer of the
present invention can give a toner image that is free
from toner contamination or fogging and has a high
quality.

10 A developer for developing an electrostatic
image has a toner, fine resin particles with a surface
shape sphericity ψ of from 0.90 to 0.50, and fine
inorganic particles.

15

20

This Sheet Has Been Replaced



25



4

1 CLAIMS:

 1. A developer for developing an electrostatic
 image, comprising a toner, fine resin particles with a
 surface shape sphericity ψ of from 0.90 to 0.50, and
5 fine inorganic particles.

 2. The developer according to claim 1, wherein
 said fine resin particles have an average particle
 diameter smaller than the average particle diameter of
10 said toner and larger than the average particle
 diameter of said fine inorganic powder.

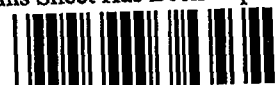
 3. The developer according to claim 1, wherein
 said fine resin particles have a primary average
15 particle diameter of from 0.03 μ to 1.0 μ .

 4. The developer according to claim 1, wherein
 said fine resin particles have a primary average
 particle diameter of from 0.05 μ to 0.8 μ .

20 5. The developer according to claim 1, wherein
 said fine resin particles have a triboelectric charge
 quantity of from -200 $\mu\text{C/g}$ to +50 $\mu\text{C/g}$.

25 6. The developer according to claim 1, wherein
 said fine resin particles have a triboelectric charge

This Sheet Has Been Replaced





- 90 -

1 quantity of from -100 $\mu\text{c/g}$ to +30 $\mu\text{c/g}$.

5 7. The developer according to claim 1, wherein said fine resin particles have a specific resistance of from $10^6 \Omega\cdot\text{cm}$ to $10^{13} \Omega\cdot\text{cm}$.

8. The developer according to claim 1, wherein said fine resin particles comprise a styrene resin.

10 9. The developer according to claim 1, wherein said fine resin particles have not less than 51 % by weight of styrene monomer units.

15 10. The developer according to claim 1, wherein said fine resin particles have a glass transition point of 80°C or above.

20 11. The developer according to claim 1, wherein said toner has a weight average particle diameter of from $3.5 \mu\text{m}$ to $20 \mu\text{m}$, said fine resin particles have a primary average particle diameter of from 0.03μ to 1.0μ , and said fine inorganic powder has a primary average particle diameter of from 0.002μ to 0.2μ ; the primary average particle diameter of said fine
25 inorganic powder being smaller than the primary average particle diameter of said fine resin particles.

This Sheet Has Been Replaced





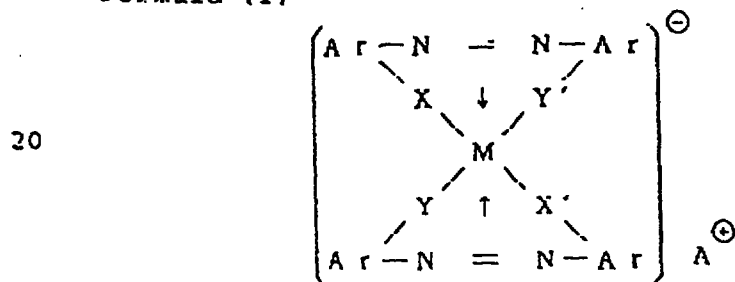
1 12. The developer according to claim 11, wherein
said toner has a weight average particle diameter of
from 3.5 μm to 14 μm .

5 13. The developer according to claim 11,
wherein said toner has a weight average particle
diameter of from 4 μm to 8 μm .

10 14. The developer according to claim 13,
wherein said toner comprises toner particles
containing a charge control agent.

15 15. The developer according to claim 1, wherein
said toner comprises toner particles containing a
negative charge control agent represented by the
following Formula (I).

Formula (I)



25 wherein M represents Cr, Co, Ni, Mn or Fe having the
coordination number of 6; Ar represents an aryl group
which may have a substituent: X, X', Y and Y' may be
the same or different and each represent O, -CO-,

This Sheet Has Been Replaced





* C L M S *

- 92 -

1 -NH- or -NR-, where R represents an alkyl group having
1 to 4 carbon atoms; and A[⊕] represents a hydrogen ion,
a sodium ion, a potassium ion, an ammonium ion or an
aliphatic ammonium ion.

5

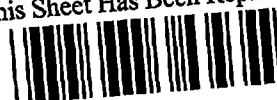
16. The developer according to claim 1, wherein
said toner comprises toner particles containing a wax
having a ratio (Mw/Mn) of weight average molecular
weight (Mw) to number average molecular weight (Mn) of
10 not less than 5.

17. The developer according to claim 1, wherein
said toner comprises toner particles having a binder
resin containing not less than 15 % of a component
15 with a molecular weight of not more than 5,000 in a
GPC chromatogram.

18. The developer according to claim 1, wherein
said toner comprises toner particles having a binder
20 resin containing from 15 % to 35 % of a component with
a molecular weight of not more than 5,000 in a GPC
chromatogram.

19. The developer according to claim 1, wherein
25 said toner comprises magnetic toner particles.

This Sheet Has Been Replaced





- 93 -

1

20. The developer according to claim 1, wherein said toner comprises insulating magnetic toner particles having a negative triboelectric chargeability.

5

21. The developer according to claim 18, wherein said toner comprises toner particles having a binder resin comprising a styrene polymer, a styrene copolymer, or a mixture of these.

10

22. A method of forming an image by a process comprising the steps of:

15

bringing a charging member to which a voltage has been externally applied, into contact with an electrostatic image bearing member to effect electrostatic charging;

forming an electrostatic image on the charged electrostatic image bearing member,

20

developing the electrostatic image formed on said electrostatic image bearing member, using a developer to form a toner image; said developer comprising a toner, fine resin particles with a surface shape sphericity ψ of from 0.90 to 0.50, and fine inorganic particles; and

25

transferring the toner image formed on said electrostatic image bearing member to a transfer

This Sheet Has Been Replaced





1 medium to form a transferred image.

23. The image forming method according to claim
22, wherein said electrostatic image bearing member
5 has an OPC photosensitive member and is negatively
charged by means of a charging member; an
electrostatic image having a negative charge is formed
on said electrostatic image bearing member; and said
electrostatic image is reversely developed by the
10 toner having a negative triboelectric charge.

24. The image forming method according to claim
22, wherein a direct current voltage is applied to
said charging member.
15

25. The image forming method according to claim
22, wherein an alternating current voltage is applied
to said charging member.

26. The image forming method according to claim
22, wherein a direct current voltage overlaid with an
alternating current voltage is applied to said
charging member.
20

27. The image forming method according to claim
22, wherein said electrostatic image bearing member is
25

This Sheet Has Been Replaced





- 95 -

1 cleaned by a cleaning blade after the transfer step.

28. The image forming method according to claim
27, wherein part of the fine resin particles contained
5 in the developer is not cleaned by said cleaning blade
but transferred to the charging member, so that said
fine resin particles adhere to the surface of said
charging member.

10 29. The image forming method according to claim
22, wherein said charging member is brought into
contact with said electrostatic image bearing member
at a contact pressure of from 5 g/cm to 500 g/cm, and
from -200 V to -900 V of direct current voltage and
15 from 0.5 kVpp to 5 kVpp of alternating current voltage
are applied to said charging member.

30. The image forming method according to claim
29, wherein said alternating current voltage has an
20 alternating current frequency of from 50 Hz to 3,000
Hz.

31. The image forming method according to claim
22, wherein said charging member is roller-shaped, has
25 a release film surface layer, and electrostatically
charges the electrostatic image bearing member while

This Sheet Has Been Replaced





1 being rotated.

32. The image forming method according to claim
22, wherein the electrostatic image is developed by
5 the developer according to any one of claims 2 to 21.

33. An electrophotographic apparatus
comprising:
an electrostatic image bearing member;
10 a contact charging member to which a voltage is
externally applied, which electrostatically charges
said electrostatic image bearing member while being
brought into contact with it;
an electrostatic image forming means for forming
15 an electrostatic image on the charged electrostatic
image bearing member;
a developing means for developing the
electrostatic image thus formed; said developing means
comprising a developer carrying member and a developer
20 container that holds therein a developer; said
developer comprising a toner, fine resin particles
with a surface shape sphericity ψ of from 0.90 to
0.50, and fine inorganic particles; and
a transfer means for transferring the toner
25 image formed on said electrostatic image bearing
member to a transfer medium.

This Sheet Has Been Replaced





- 97 -

1

34. The electrophotographic apparatus according to claim 33, wherein said electrostatic image bearing member has an OPC photosensitive layer.

5

35. The electrophotographic apparatus according to claim 33, wherein said contact charging member is connected with a voltage applying means for applying a direct current voltage.

10

36. The electrophotographic apparatus according to claim 33, wherein said contact charging member is connected with a voltage applying means for applying an alternating current voltage.

15

37. The electrophotographic apparatus according to claim 33, wherein said contact charging member is connected with a voltage applying means for applying a direct current voltage overlaid with an alternating current voltage.

20

38. The electrophotographic apparatus according to claim 33, wherein said contact charging member is roller-shaped.

25

39. The electrophotographic apparatus according to claim 33, wherein said contact charging member is

This Sheet Has Been Replaced





1 blade-shaped.

40. The electrophotographic apparatus according
to claim 38, wherein said contact charging member has
5 a release film surface layer.

41. The electrophotographic apparatus according
to claim 33, wherein said electrostatic image bearing
member is provided with a cleaning means for cleaning
10 a toner remaining after transfer.

42. The electrophotographic apparatus according
to claim 41, wherein said cleaning means is provided
with a cleaning blade.
15

43. The electrophotographic apparatus according
to claim 33, wherein said developer container holds
the developer according to any one of claims 2 to 21.

20 44. An apparatus unit comprising;
an electrostatic image bearing member,
a contact charging member to which a voltage is
externally applied, which electrostatically charges
said electrostatic image bearing member while being
25 brought into contact with it: and
a developing means for developing an

This Sheet Has Been Replaced





- 99 -

1 electrostatic image thus formed; said developing means
comprising a developer carrying member and a developer
container that holds therein a developer; said
5 developer comprising a toner, fine resin particles
with a surface shape sphericity ψ of from 0.90 to
0.50, and fine inorganic particles;

said contact charging means and said developing
means being held as one unit together with said
electrostatic image bearing member, and said unit
10 forming a single unit detachably provided in the body
of an electrophotographic apparatus.

45. The apparatus unit according to claim 44,
wherein said electrostatic image bearing member has an
15 OPC photosensitive layer.

46. The apparatus unit according to claim 44,
wherein said contact charging member is roller-shaped.

20 47. The apparatus unit according to claim 44,
wherein said contact charging member is blade-shaped.

48. The apparatus unit according to claim 46,
wherein said contact charging member has a release
25 film surface layer.

This Sheet Has Been Replaced





1

49. The apparatus unit according to claim 44,
wherein said electrostatic image bearing member is
provided with a cleaning means for cleaning a toner
remaining on its surface.

5

50. The apparatus unit according to claim 49,
wherein said cleaning means has a cleaning blade.

10

51. The apparatus unit according to claim 44,
wherein said developer container holds the developer
according to any one of claims 2 to 21.

15

52. A facsimile apparatus comprising an
electrophotographic apparatus and a receiver means for
receiving image information from a remote terminal;

said electrophotographic apparatus comprising;
an electrostatic image bearing member;

20

a contact charging member to which a voltage is
externally applied, which electrostatically charges
said electrostatic image bearing member while being
brought into contact with it;

25

an electrostatic image forming means for forming
an electrostatic image on the charged electrostatic
image bearing member;

a developing means for developing the
electrostatic image thus formed; said developing means





1 comprising a developer carrying member and a developer
container that holds therein a developer; said
developer comprising a toner, fine resin particles
with a surface shape sphericity ψ of from 0.90 to
5 0.50, and fine inorganic particles; and
a transfer means for transferring the toner
image formed on said electrostatic image bearing
member to a transfer medium.

10 53. The facsimile apparatus according to claim
52, wherein said electrostatic image bearing member
has an OPC photosensitive layer.

15 54. The facsimile apparatus according to claim
52, wherein said contact charging member is connected
with a voltage applying means for applying a direct
current voltage.

20 55. The facsimile apparatus according to claim
52, wherein said contact charging member is connected
with a voltage applying means for applying an
alternating current voltage.

25 56. The facsimile apparatus according to claim
52, wherein said contact charging member is connected
with a voltage applying means for applying a direct





- 102 -

1 current voltage overlaid with an alternating current
voltage.

5 57. The facsimile apparatus according to claim
52, wherein said contact charging member is roller-
shaped.

10 58. The facsimile apparatus according to claim
52, wherein said contact charging member is blade-
shaped.

15 59. The facsimile apparatus according to claim
57, wherein said contact charging member has a release
film surface layer.

20 60. The facsimile apparatus according to claim
52, wherein said electrostatic image bearing member is
provided with a cleaning means for cleaning a toner
remaining after transfer.

61. The facsimile apparatus according to claim
60, wherein said cleaning means is provided with a
cleaning blade.

25 62. The facsimile apparatus according to claim
52, wherein said developer container holds the
developer according to any one of claims 2 to 21.

This Sheet Has Been Replaced

