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Rattin

[11] **3,872,829**

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[54] **UNIT FOR THE MAGNETIC BRUSH DEVELOPMENT OF LATENT ELECTROSTATIC IMAGES**

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July 13, 1972 Italy 69256/72

[52] **U.S. Cl.** **118/637,** 117/17.5, 118/623

[51] **Int. Cl.** **G03g 13/00**

[58] **Field of Search** 118/4, 7, 623, 630, 637; 117/17.5

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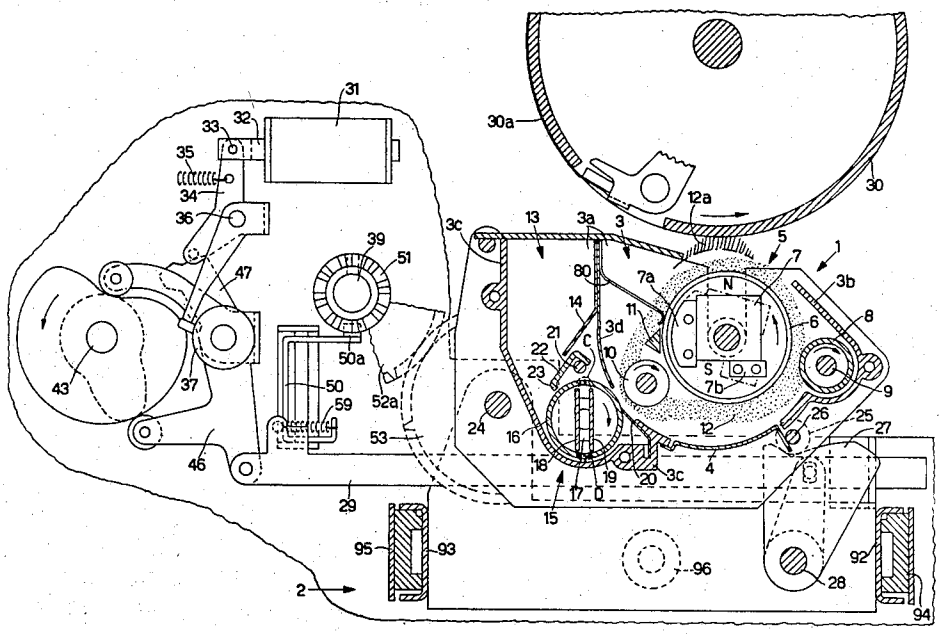
Assistant Examiner—Leo Millstein
Attorney, Agent, or Firm—I. J. Schaefer

[57] **ABSTRACT**

A developer unit for the development, by means of a mixture of carrying magnetic particles and of electroscopic developer, of a latent image of electrostatic charge on an electrically non-conductive support produced in an electrostatic printing or copying machine, which can be approached, cyclically with the machine to the surface bearing the latent image and which comprises a first container for the development unit and a second container for the supply unit, in the first container there being mounted in a revolving manner a tubular cylinder of non-magnetic material containing a magnet normally fixed with regard to the first container, capable of setting up a magnetic field having zones of density of flux which are relatively different, the magnet being adapted to assume selectively two operative positions of development and a third operative position to effect the emptying of the first container from said mixture.

5 Claims, 4 Drawing Figures



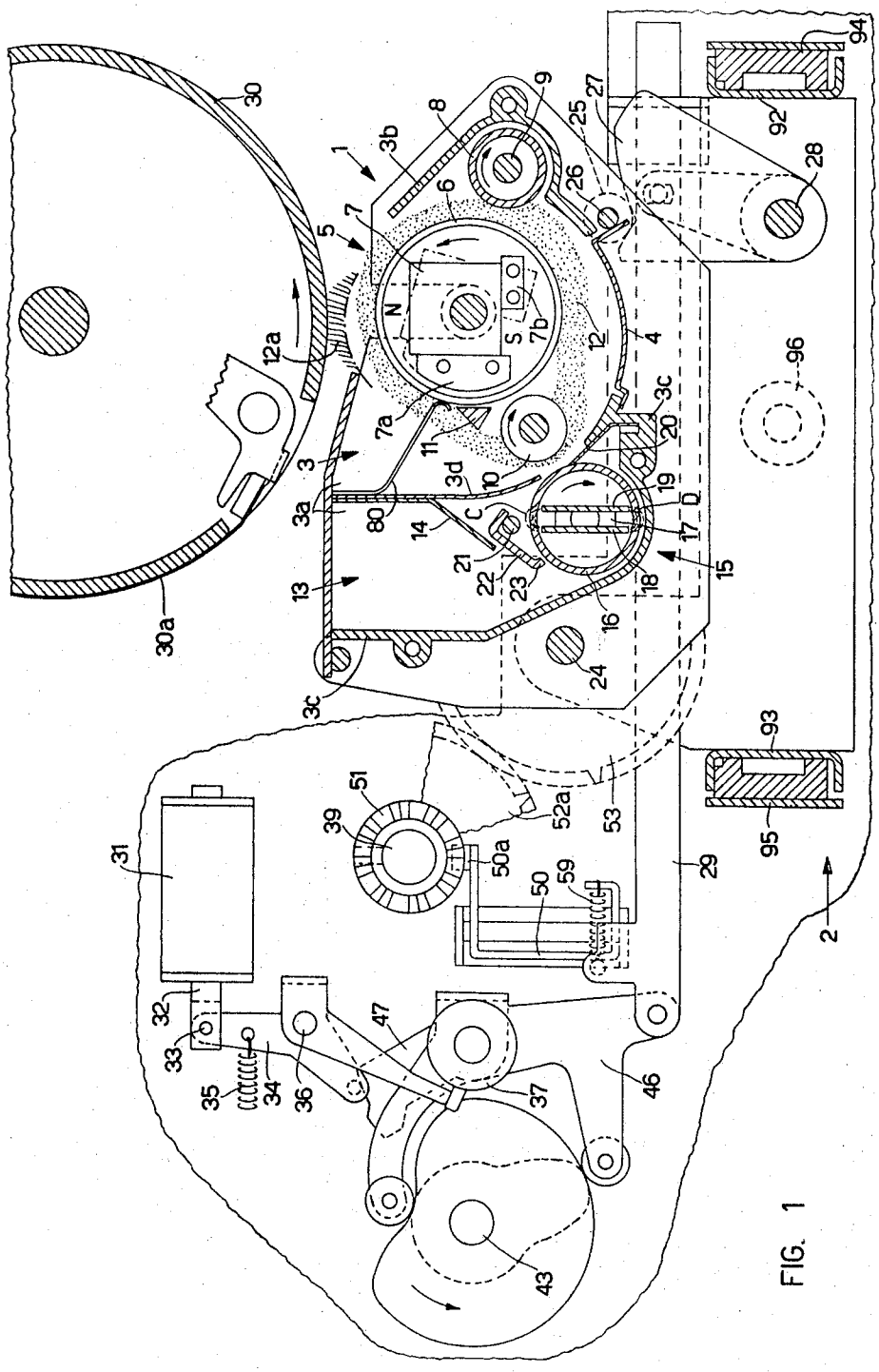

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FIG. 1

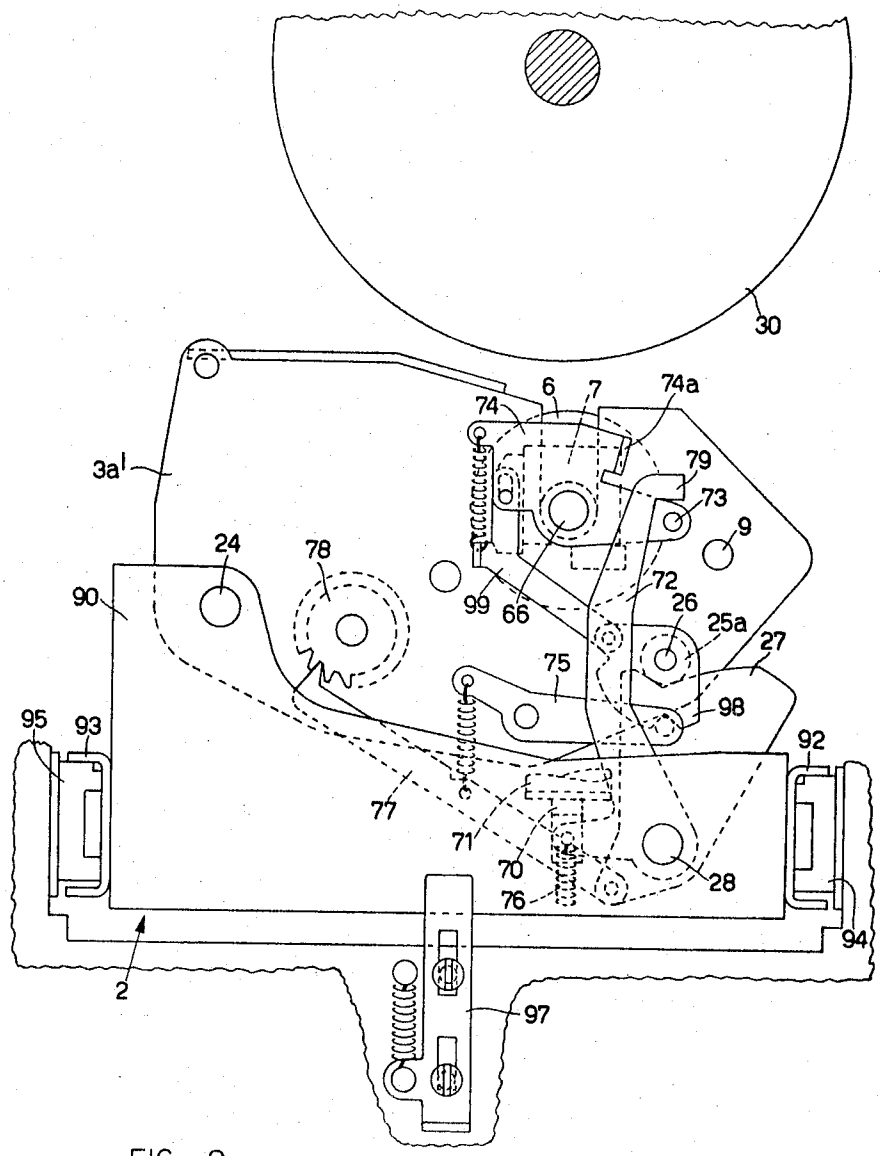
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FIG. 2

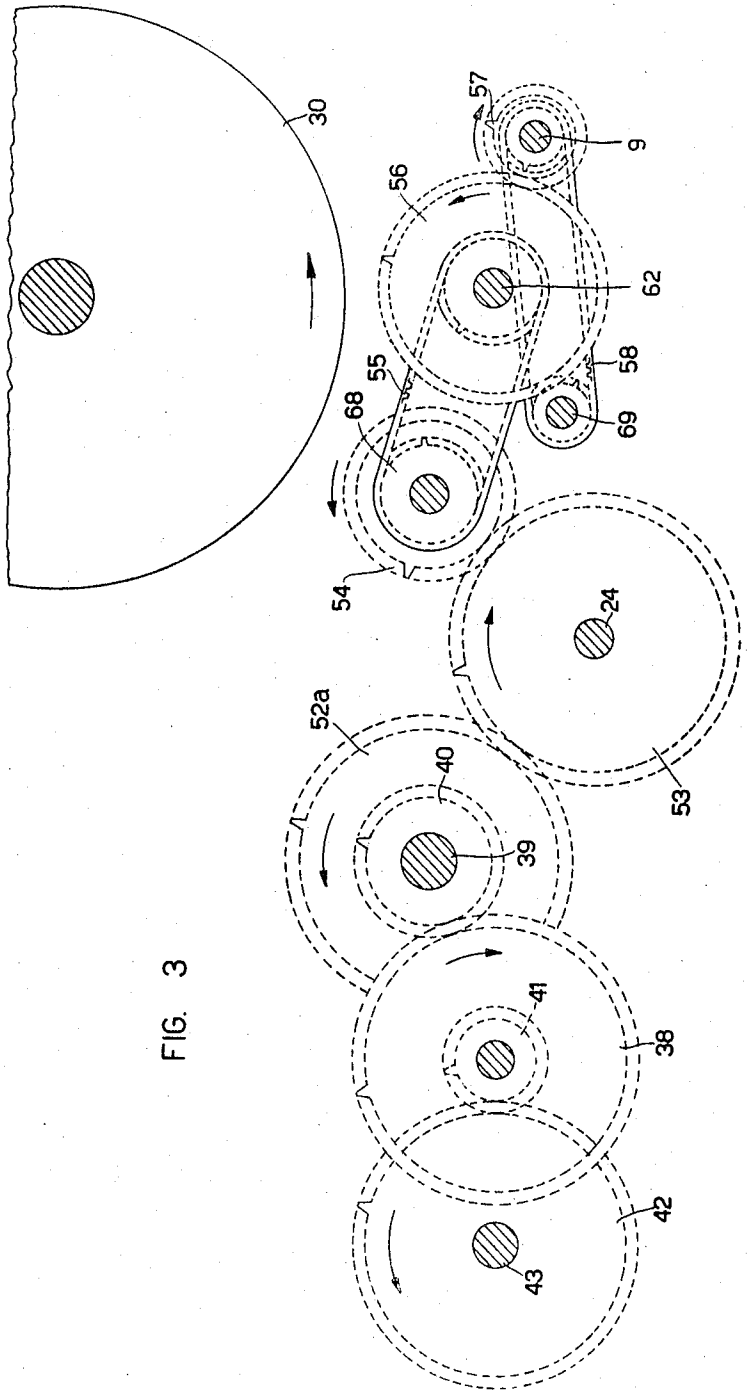

FIG. 3

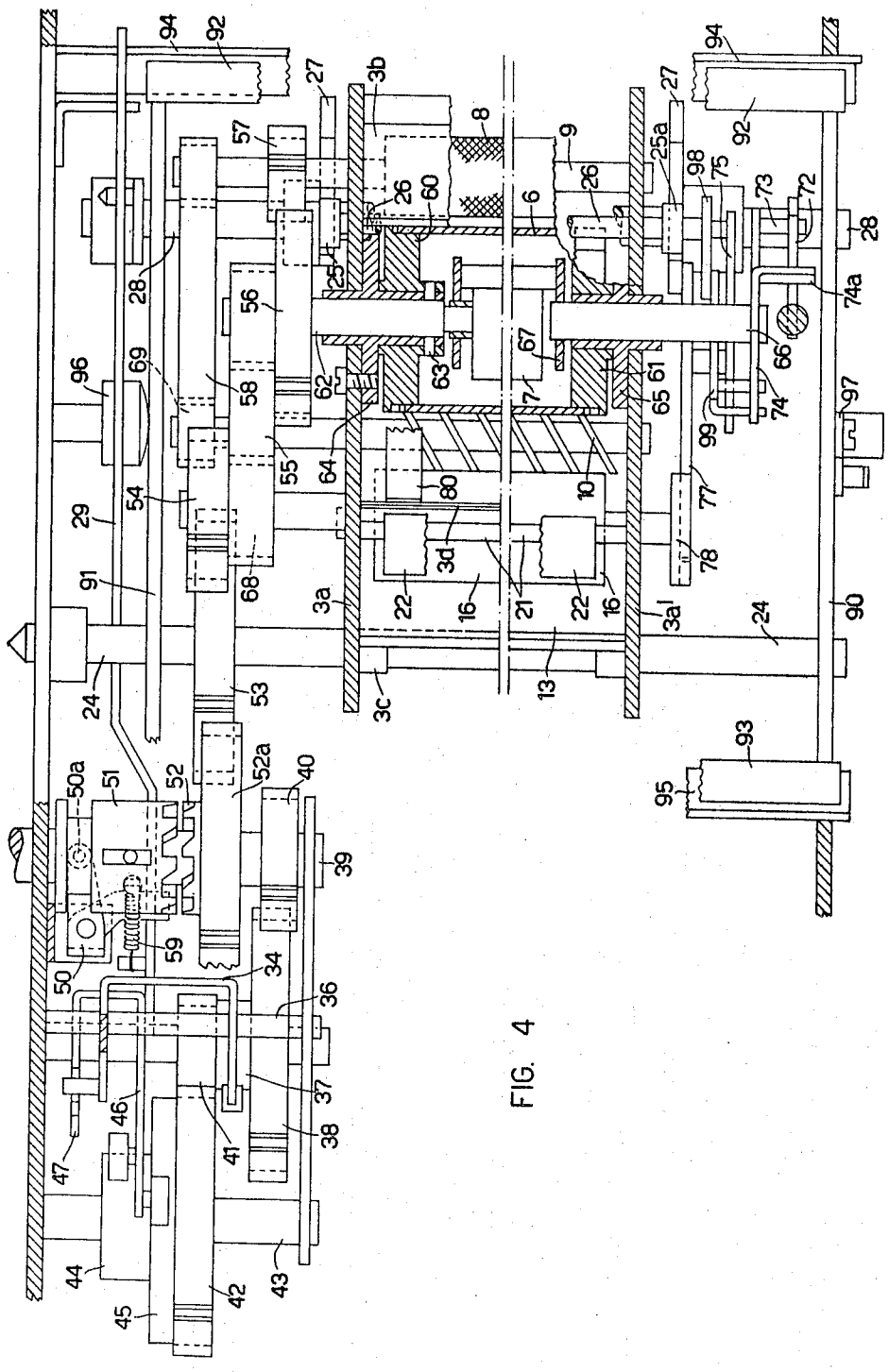

FIG. 4

UNIT FOR THE MAGNETIC BRUSH DEVELOPMENT OF LATENT ELECTROSTATIC IMAGES

BACKGROUND OF THE INVENTION

1. Field of the Invention:

The present invention relates in general to a developer unit for latent electrostatic images, of the type employing a magnetic brush.

2. Description of the Prior Art:

The development of the electrostatic charges on an image support which is electrically non-conductive requires the application to the surface of finely divided electroscopic particles which adhere to the charge zones. The image developed in this way can, in accordance with the known processes, be obtained by fixing it directly on a sheet bearing a photocondutctive layer, or else be transferred from the image surface on to normal paper. The image is finally fixed, e.g. by fusing it on the paper.

The developer mixture comprises a developer or "toner" powder and, normally coarser, carrier particles which occupy an opposite position in the triboelectric series such that the electrostatic charges developed in the mixture hold said particles attracted slidably. It is known to use ferromagnetic particles as carrier particles and to form a magnetic brush on the surface of a non-magnetic cylinder enclosing a magnet. The magnetic brush wipes the image surface and transfers the developer powder, carried by the ferromagnetic particles, to the image surface.

Many prior proposal for magnetic brush development exist but it is difficult to achieve good, consistent results in practice.

In some devices U.S. Pats. No. 2,786,440 and No. 3,003,462) the magnet rotates with the cylinder. It is difficult in this case to achieve uniform development and construction tends to be costly. In other devices the magnet is fixed, e.g. as in U.S. Pats. No. 3,040,704, No. 3,246,629, No. 3,570,453 and No. 3,572,288.

OBJECTS AND SUMMARY OF THE INVENTION

One object of the present invention is to improve such devices by enabling different development densities to be selected, whereby weak electrostatic images can be developed more heavily, and vice versa. Another object of the present invention is to avoid the contact between the developer mixture and the non-image parts of the support carrying the image, so as to not smudge it.

According to the present invention there is provided a device for the development of an electrostatic image formed on an image surface of an electrostatic printing or copying machine, comprising a developer unit which can be approached, cyclically with the machine, to the surface bearing the latent image and which comprises a first container for the development unit and a second container for the supply unit, in the first container there being mounted, in a revolving manner, a tubular cylinder of non-magnetic material containing a magnet normally fixed with regard to the first container, capable of setting up a magnetic field having zones of density of flux which are relatively different, the magnet being adapted to assume selectively two operative positions of development and a third accessory operative position.

In the preferred arrangement, said first container has a trap for emptying the developer mixture therefrom and wherein the magnet is adjustable to said third position which presents a region of minimum flux density towards the trap. This facilitates emptying exhausted developer mixture from the container.

The unit can comprise a dosing roller with a roughened surface arranged to rotate within the container adjacent the cylinder so as to level the development mixture attracted on to the cylinder and promote the formation of the magnetic brush. Such a roller increases the speed of development compared with that obtainable in the devices of U.S. Pats. No. 3,387,586 and No. 3,246,629.

Another object of the invention is to provide improved means for replenishing the developer mixture during use.

According to the invention in another aspect, there is provided a development device utilizing a mixture of carrying magnetic particles and of electroscopic developer, characterised in that the development mixture present in a first container is regenerated by a supply unit constituted by a second container containing concentrated mixture and comprising a tubular cylinder of non-magnetic material containing an integral magnet capable of creating on the surface of the cylinder zones having a greater density of flux which, through rotation of the cylinder, carry the concentrated mixture to an aperture communicating with the first container, means being arranged at this aperture to effect the separation of the mixture from the surface of the cylinder and cause the mixture to enter the first container.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be described in more detail, by way of example, with reference to the accompanying drawings, wherein:

FIG. 1 is a view in longitudinal section of a developer unit embodying the invention;

FIG. 2 is a right-hand side view of the system for inclined positioning of the developer unit, and of its emptying system;

FIG. 3 is a side view of the driving gear train of the developer unit; and

FIG. 4 is a plan view of the developer unit.

DETAILED DESCRIPTION OF THE INVENTION

In FIG. 1 there is shown the developer unit 1 carried on a carriage 2 and comprising a housing 3 constituted by two lateral sides 3*a* and 3*a'* spanned by walls 3*b*, 3*c* and 3*d*. The bottom of the container is closed by a trap 4 fixed to a shaft 26. In the housing 3 there is contained the development unit 5 constituted by a rotatable tubular cylinder 6 of non-magnetic material, for example aluminium, bronze, stainless steel or plastics material, containing a magnet 7 normally fixed with regard to the housing 3 and to which there are fixed a flux diverting shunt 7*a* and a pole shoe 7*b*.

The details of this development unit are shown in plan in FIG. 4. Laterally alongside the development unit 5 there is a dosing roller 8 revolving about a shaft 9 and having a roughened surface (for example a cross-milled surface). On the side opposite the roller 8 there is an agitating roller 10. Adjacent to the cylinder 6 and above the roller 10 there is a scraper bar 11 having a triangular profile.

The housing 3 forms a main container for the developer 12 to the right of the partitioning wall 3*d*, to the left of which (in FIGS. 1 and 4) is formed a feed chamber 13. At the bottom of the container 13 there is positioned a supply unit 15 comprising a tubular, rotary, cylinder 16, of non-magnetic material, within which is fixed a magnet 17 integral with the two pole pieces 18 and 19. A doctor blade 20 acting against the cylinder 16 is fixed to the wall 3*c*. Fixed to a shaft 21 is an adjustable dosing flap 22 having one end 23 spaced a little from the surface of the cylinder 16, underneath a protective flap 14.

The developer unit 1 is fulcrumed on a shaft 24 and rests, at rollers 25, 25*a* on the shaft 26 (extending between the sides 3*a* and 3*a'*), on a pair of oscillating cams 27 carried by a shaft 28 and controlled by a connecting rod 29. In the development phase, the developer unit 1 can be advanced, in consequence of the rotation of the cams 27, to a cylinder 30 bearing an electrostatic charge image on a dielectric surface, which may or may not be provided with a photoconductive layer. The position of the cylinder 6 is then as shown in FIG. 1.

Continuing the description of FIG. 1, to the left there is shown in more detail the raising and starting device of the developer unit 1. A solenoid 31, on receipt of an electrical command from the machine, pulls in its armature 32 which is linked by a pin 33 to a release lever 34. This lever is normally retained in its position of rest by a spring 35 and rotates about a pivot 36. The rotation of the lever 34 frees a clutch 37 of known type. The clutch 37 couples a gear 38 (FIG. 3), which is driven by a driving shaft 39 through a gear 40, to a gear 41. In its turn the gear 41 engages a gear 42 on a shaft 43 to which there are fixed a cam 44 and a counter-cam 45. One rotation of the cam group 44, 45 oscillates a bridge lever 46 to which there is connected the connecting rod 29 which causes the cams 27 to oscillate for raising and re-lowering the developer unit 1. The bridge lever 46 is provided, furthermore, with an arm 47 which controls a lever 34 for opening the clutch 37 when the solenoid 31 is de-energised. When the connecting rod 29 moves to the left in order to act on the cams 27, it leaves at the same time free to rotate about its pivot 50*a* a lever 50 biased by a spring 59.

Connected to the lever 50 there is the driving part of a dog clutch 51 (slidable on but keyed to the driving shaft 39). The driving part 51 engages the driven part 52 of the clutch 52, integral with which there is a gear 52*a*. The gear 52*a* drives a gear 53, integral with a shaft 24, and hence a gear 54. Integral with this latter there is a toothed pulley 68 which, through a belt 55 transmits the motion to a gear wheel 56 which rotates the cylinder 6. The gear 56 moreover drives a gear 57 which imparts the motion to the dosing roller 8 and also, via a belt 58 and pulley 69, to the agitating roller 10 to rotate.

The tubular cylinder 6 is supported at the ends by two flanges 60, 61 (FIG. 4). The flange 60 is keyed to a shaft 62 by a pin 63. The shaft 62 rotates in a sleeve 64 fixed in the side 3*a*. Moreover, the shaft 62 is integral with the gear 56 which ia rotated in the manner described above. The flange 61, integral with the cylinder 6, rotates on a sleeve 65 integral with the lateral flank 3*a'*. Through the sleeve 65 there passes a shaft 66 which, through a yoke 67, keeps the magnet 7 in the desired position. The yoke 67 is journalled at the opposite end on the shaft 62. The flange 61 is free to rotate on the sleeve 65. In this way the rotation of the cylinder 6 is allowed without rotating the magnet 7. However, it is possible, by means of a mechanism shown in FIG. 2, selectively to rotate the magnet 7 between the positions shown in full and broken lines in FIG. 1, in order to select different densities of development.

To this end, an electrical signal, correctly timed within the operative cycle of the machine, moves the armature 70 of a solenoid 71 which rotates a lever 72 about the shaft 28. The lever 72 is biased to its position of rest by a spring 76. When the lever 72 is rotated, a hooked end 79 moves into the trajectory of a pin 73 which forms part of a lever 74 which is integral with the shaft 66 which positions the magnet 7. When the developer unit 1 is raised, the pin 73 then strikes the end 79 of the lever 72 and therefore the shaft 66 undergoes a rotation in the clockwise direction which changes the position of the magnet 7 for the entire duration of the development phase.

When the developer is exhausted, the carriage 2 is slid out of the body of the machine. The carriage 2 comprises plates 90, 91 (FIG. 4) spanned by guides 92, 93 which run on fixed guides 94, 95. The plates 90, 91 support the shafts 24 and 28 of the developer unit 1. The position of the carriage 2 is determined by a stop 96 and by a catch 97.

The trap 4 is integral with the shaft 26, as is a lever 98 which is normally kept in the position of rest by a detent lever 75. A strut 99 connects the lever 74 to the lever 98. The lever 74 is integral with the shaft 66 which positions the magnet 7. By acting on a tongue 74*a* of the lever 74, the operator can open the trap 4 and rotate the magnet 7 and its magnetic shunt 7*a* through about 90°. In this way the magnetic field is weakened in correspondence with the aperture opened by the trap 4, allowing the development mixture 12 to drop out. By turning a knob (not shown) integral with the shaft 24 which causes the cylinder 6 to rotate, the complete discharge of the mixture is obtained.

In operation, the electrostatic image is formed on the drum 30, in known manner, at charging and exposure stations and then passes through the developing station. The developer unit 1, in correctly timed manner, approaches the drum 30 with the cylinder 6 rotating so that the magnetic brush 12*a*, which forms on the surface of the cylinder in accordance with the lines of magnetic flux, wipes against the photoconductive layer 30*a* bearing the latent electrostatic image. This is effected by engagement of the solenoid 31, which allows the engagement of the clutch 37 in mechanical phase with the cylinder 30. The raised position assumed by the developer group 1 persists until the passage of the maximum copiable length provided on the drum 30. When the clutch is close to completion of its cycle, it starts to lower the developer unit 1. In this descent phase, the supply unit 15 is caused to rotate one step and so, every eight operative cycles of the machine feeds some development mixture 12 from the container 13 to the neighbouring container 3, through the aperture comprised between the walls 3*c* and 3*d*. The arrangement of the magnet 17 and of the pole pieces 18, 19 allows the formation of two zones, C, D having a magnetic field relatively high with regard to the remaining surface and which retain a certain quantity of concentrated developer (50 percent "carrier", 50 percent "toner"). During the rotation of the cylinder 16

the quantity of developer retained on it is levelled by the dosing flap **20** and is then scraped into the container **3** by the doctor blade **20.** The development mixture thus mixes with the mass thereof contained in the container **3.** The rotation of the cylinder **16** is controlled by the cams **27** for raising and lowering the developer unit **1,** through a link **77** pivoted on an arm of one of the cams and carrying a pawl which operates a ratchet wheel **78** on the shaft of the supply unit **15.**

Normally the magnet **7** is positioned as shown in full lines in FIG. **1.** If the image is weak, the operator can operate a switch which causes the solenoid **71** to be energised whereby the magnet **71** is rotated about 15° clockwise. This increases the length of the arc over which the magnetic brush wipes the drum **30,** the therefore intensifies the developed image.

The development mixture on the cylinder **6** is subjected to prelevelling by means of the dosing roller **8** which rotates at the same peripheral speed as the cylinder **6.** The roughened or knurled surface of the roller **8** not only levels off the mixture but promotes the formation of the brush and increases the speed of development with regard to known machines.

In operation of the machine, there is permanently supplied to the cylinder **6** a negative potential of 250 volts relative to the cylinder **30,** which is connected to earth, by way of a sliding contact **80.** This expedient, known per se, has the function of limiting background darkening by preventing particles of developer, charged positively, from adhering to the zones of the photoconductive layer **30***a* discharged in consequence of the exposure. The surface of the cylinder **6** having a negative potential tends in fact to retain near itself the particles having positive charge, allowing them to migrate towards the latent image only if this possesses a sufficiently high negative voltage.

What is claimed is:

1. A developer apparatus for the development of a latent image of electrostatic charges on an electrically non-conductive support, produced in an electrostatic printing or copying machine, by means of a mixture of carrying magnetic particles and of electrostaticly chargeable developer particles, comprising:

a container containing said mixture and having in the bottom a discharge trap for the mixture,

a tubular cylinder of non-magnetic material rotatably mounted in said first container,

a magnet mounted in said tubular cylinder capable of setting up a magnetic field having zones of density of flux which are relatively different and adapted to assume selectively two operative positions of development fixed with respect to said first container and a third emptying position fixed with respect to said first container wherein the zone of least flux density of the magnet is downwards in correspondence with said trap for emptying the container from the mixture, and

means for cyclically, in synchronism with the cycle of the machine, advancing and retracting said container towards and from said surface bearing said latent image.

2. A developer apparatus having a development section and a supply section for the development of a latent image of electrostatic charges on an electrically non-conductive support, produced in an electrostatic printing or copying machine, by means of a mixture of carrying magnetic particles and of electrostatically chargeable developer particles, comprising:

a first container for the developing section containing said mixture,

a first tubular cylinder of non-magnetic material rotatably mounted in said first container,

a first magnet mounted in said tubular cylinder capable of setting up a magnetic field having zones of density of flux which are relatively different and adapted to assume selectively two operative positions of development, fixed with respect to said first container, and a third accessory position fixed with respect to said first container,

a second container for the supply section containing said mixture in concentrated form and having an aperture communicating with said first container,

a second tubular cylinder of non-magnetic material rotatably mounted in said second container,

a second magnet mounted in said second tubular cylinder for rotation therewith for feeding concentrated mixture on the surface of said second cylinder towards said aperture,

means at said aperture for scraping concentrated mixture from said second cylinder into said first container, and

means for cyclically, in synchronism with the cycle of the machine, advancing and retracting said development and supply sections towards and from said surface bearing said latent image.

3. An apparatus in accordance with claim **2** wherein the second tubular cylinder accomplishes a predetermined angular rotation in correspondence with each cycle of approach and retraction of the development and supply sections.

4. An apparatus in accordance with claim **3,** wherein a dosing roller contained in the first container has a roughened surface effecting a pre-levelling on the mass of the development mixture and the predisposition of the mass itself to the formation of a magnetic brush.

5. An apparatus in accordance with claim **4,** wherein a single command, in correspondence with the development cycle of the machine, sets in motion a cam device which, in its programmed displacements, commands in sequential manner the approach to the surface carrying the electrostatic image of the magnetic brush which forms on the surface of the first cylinder the circulation of the mixture through the movement of the dosing roller and of a mixing roller, the lowering of the development and supply sections with simultaneous predetermined angular rotation of the second tubular cylinder and the stoppage of the developer apparatus in the position of rest.

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