April 14, 1953 E. R. SABEL ET AL 2,635,046

DEVELOPING DEVICE FOR ELECTROSTATIC IMAGES

Filed Sept. 2, 1950

3 Sheets-Sheet 1

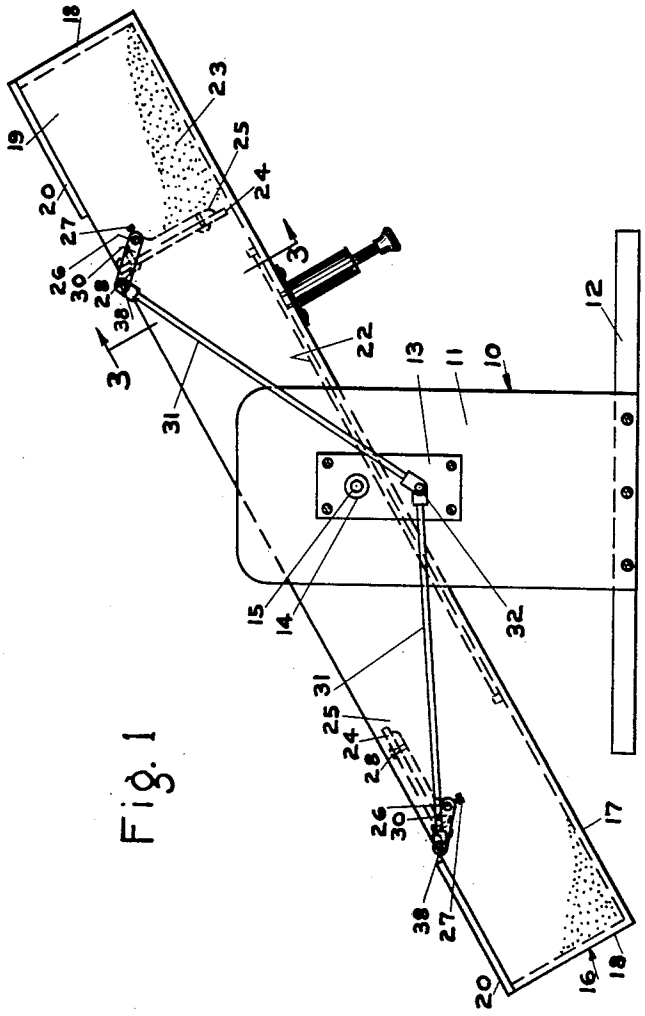


Fig. 1

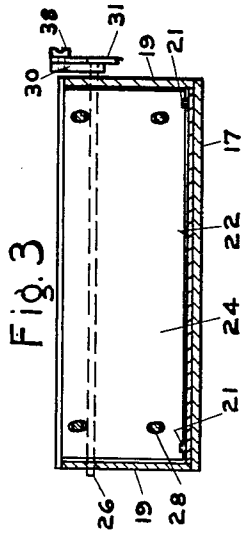


Fig. 3

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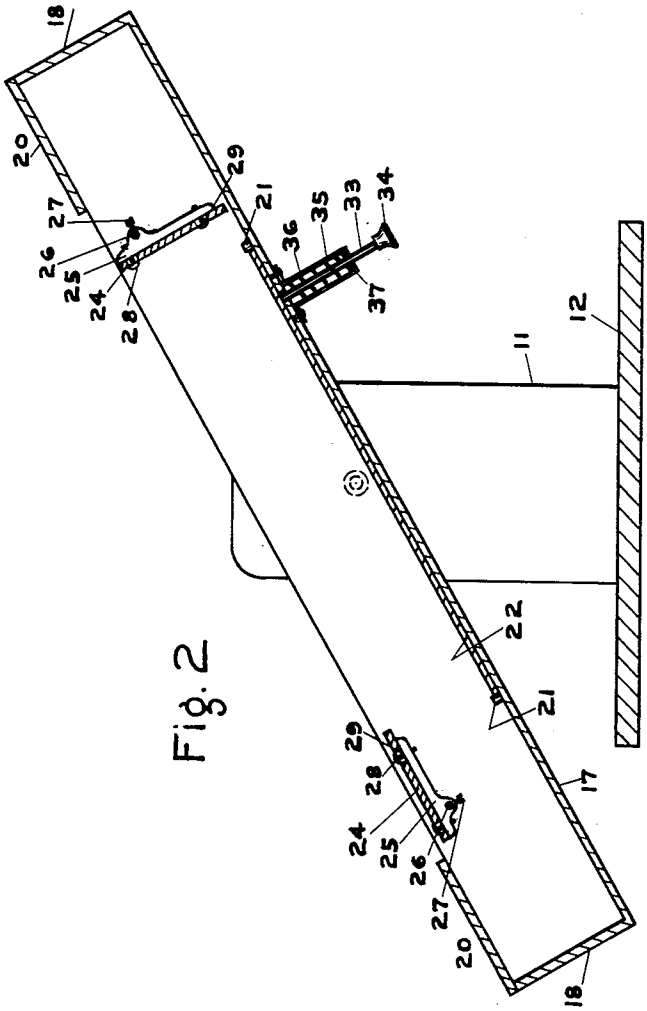


Fig. 2

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Filed Sept. 2, 1950 3 Sheets-Sheet 3

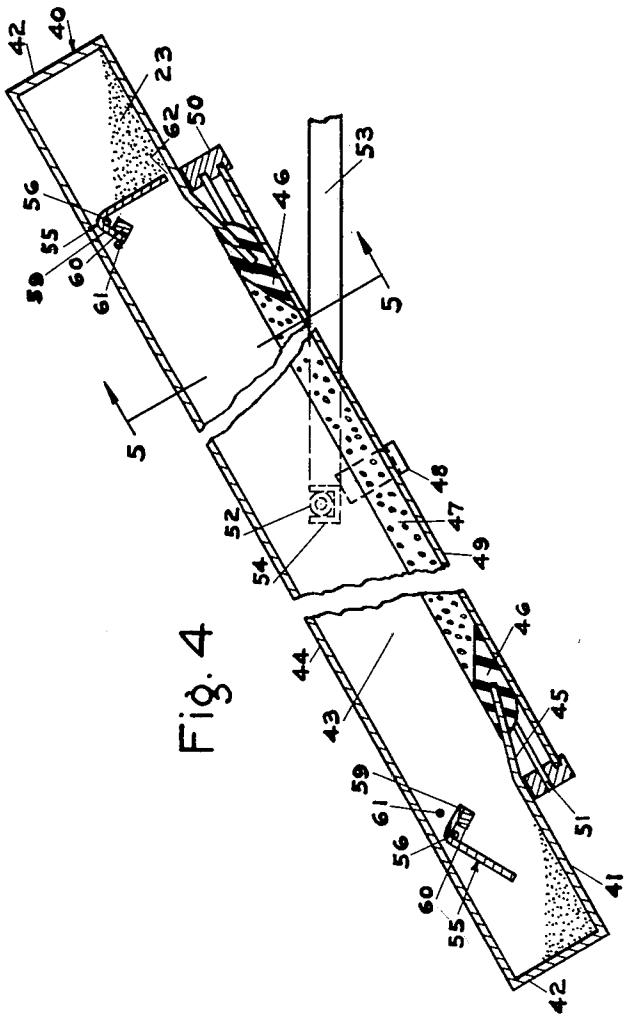


Fig. 4

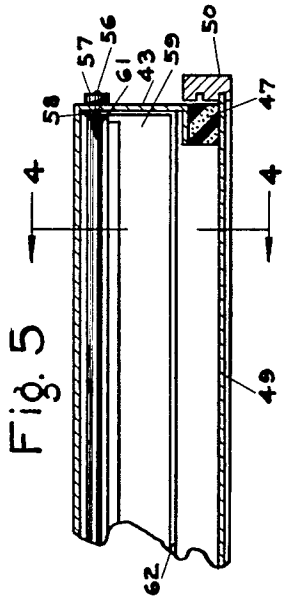


Fig. 5

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DEVELOPING DEVICE FOR ELECTROSTATIC IMAGES

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5 Claims. (Cl. 95—1.9)

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This invention relates to developing devices, and particularly to devices for applying powder to electrostatic images, such as images on electrophotographic plates and the like.

In the process of electrophotography, or xerography, an electrostatic latent image is obtained upon an insulating image layer, such as a layer of photoconductive insulating material supported on a conductive backing. For example, the photoconductive insulating layer may be given a uniform electrostatic charge over its surface and then exposed to a light image to discharge the portions of the layer exposed to light while leaving the electrostatic charges remaining in the dark areas. The image may then be developed by depositing a finely-divided material on the charged areas. Thus, a fine powder may be sprinkled or cascaded over the plate and the excess allowed to pass off the plate leaving the powder image. The image may subsequently be transferred to a sheet of paper or other material and affixed thereto to produce a permanent copy.

Another form of electrostatic image plate comprises a metal plate carrying an insulating image affixed thereto, such as an image of resin fused onto a bare metal plate or one produced by writing on the plate with an insulating ink, consisting of an insulating material dissolved in a volatile vehicle. Such plates may be used to produce powder images by passing the plates under a corona discharge electrode to deposit electrostatic charges on the insulating image and then dusting the plate to produce a powder image.

According to one method of developing the electrostatic image plates, a developer is used comprising a finely-divided, pigmented resin powder mixed with a granular carrier material such as certain crystalline salts or resin-coated glass beads. The composition of the carrier is so adjusted in relation to the resin powder that the carrier imparts to the powder particles electrostatic charges opposite in polarity to the charges on the electrostatic image which it is desired to develop. It has been found that images can readily be developed with such compositions by cascading them over the surface of the electrostatic image plate. One apparatus for doing this comprises a tilting tray in which the plate is placed with its face upward, and a charge of powder composition placed in one end. As the tray is tilted to the left and right the powder composition is cascaded forth and back across the plate surface. Other developing compositions such as a charge of finely-divided pigmented powder without a carrier may sometimes also be used with this developing apparatus.

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While uniform development can be achieved by using a tilting tray it has been found that the speed at which the tray is tilted has a considerable effect upon the quality of results obtained. As a result some experience is required in order to acquire the necessary skill to produce perfect powder images by this arrangement.

The present invention contemplates an improvement in devices for cascading developing powders over electrostatic image plates wherein an automatic metering arrangement is provided to control the rate of powder discharge across the plate surface. In one of its specific embodiments the invention contemplates a tilting developing tray provided with powder reservoirs arranged at the ends and moving gate arrangements for restricting the rate of powder discharge from the reservoirs when the tray is tilted to cascade powder over a plate and to open to freely admit developer when it is returned to the reservoirs.

The invention comprises the features of construction, combination of elements, arrangement of parts, and methods of operation referred to above or which will be brought out and exemplified in the disclosure hereinafter set forth, including the illustrations in the drawing.

In the drawings:

Figure 1 is a side elevation of a developing device embodying features of the present invention;

Figure 2 is a vertical section of part of said device;

Figure 3 is a section on the line 3—3 of Figure 1;

Figure 4 is a vertical section through a modified developing tray. and

Figure 5 is a section on the line 5—5 of Figure 4.

While a preferred embodiment of the invention is described herein, it is contemplated that considerable variation may be made in the construction and arrangement of parts and in the method of operation without departing from the spirit of the invention. In the following description and in the claims parts will be identified by specific names for convenience, but they are intended to be as generic in their application to similar parts as the art will permit.

Referring to Figures 1, 2 and 3, the developing device illustrated comprises a stationary base 10 which may comprise a pair of uprights 11 extending up in spaced parallel relation from a

base plate 12 adapted to rest upon surface of a table or other support. Uprights 11 and base plate 12 may be formed of wood, for example, and the uprights may be provided with a mounting plate 13 of metal, such as brass, on their outer faces near their upper ends, in which are provided bushings 14 in which the axle pins 15 of a tilting tray 16 are pinioned.

Tray 16 may comprise a flat bottom wall 17 to which are attached end walls 18 and side walls 19 to provide a shallow tray. A pair of top walls 20 enclose the two ends of the tray to provide powder reservoirs at the ends, while leaving the central area of the tray exposed. Four locating pins 21 are mounted in spaced relation on bottom 17 to position an electrostatic image plate 22 in the center of the bottom of the tray, for purposes of development. These pins are located close to side walls 19 in order to avoid disturbing the flow of powder over the image area.

A pair of metering gates 24 are provided between the ends of plate 22 and the powder reservoirs. Each gate 24 may comprise a sheet metal plate mounted on a pair of cast ribs 25 drilled to receive a pivot shaft 26 pivoted in the side walls 19 of the tray. A setscrew 27 is threaded into each casting 25 to lock the part to the shaft. Sheet metal gates 24 are secured to cast ribs 25 by setscrews 28 which pass through mounting slots 29 in the sheet metal gate members. It is thus possible by loosening setscrews 28 to adjust the gap or metering opening between the lower edge of gate members 24 and the bottom 17 of the tray. The gate position is adjusted to give the desired rate of developer flow across the plate when the tray is tilted to its maximum angle, which may be, for example, 30° above the horizontal.

A bell crank lever 30 is secured to one end of each of shafts 26. Both levers 30 are preferably on the same side of tray 16. Two connecting rods 31 are both pivoted at one end on a pivot pin 32 mounted on plate 13 below the bushing 14 in which the tray is pivoted. The free ends of the connecting rods are pivoted, respectively, on pivot pins 38 on the swinging arms of bell crank levers 30. The relative angular positions of levers 30 and gates 24 on their shafts are adjusted to bring gate 24 perpendicular to the bottom 17 of the tray when its respective tray end is tilted to uppermost position as shown for the right-hand gate in Figures 1 and 2. The gate thereby restricts the rate of flow of developer powder 23 over the plate, the amount being determined by the metering gap provided between the lower edge of gate 24 and the bottom 17 of the tray. The length of crank levers 30, connecting rods 31 and the distance from the axle 15 of the tray to pivot pin 32 of the connecting rods are so proportioned in relation to each other that when an end of the tray reaches its lowermost position the gate 24 at that end is swung open by connecting rod 31 acting through crank lever 30 to bring the gate 24 completely out of the path of developing powder passing downward over the plate, as shown for the left-hand gate in Figures 1 and 2. In order to permit adjustment of the effective lengths of connecting rods 31 they are threaded into their end blocks.

With a charge of developing powder 23 placed in one end of the tray and an electrostatic image plate 22 positioned between stop pins 21, the tray may be tilted to the left and right so that the developer will pass back and forth over the surface of the plate and some of it will be deposited on the electrostatic image to develop the image. During the tilting of the tray the swinging metering gates 24 are moved by the lever mechanism into and out of metering position to control the rate of flow of powder over the plate without the necessity of skillful control by the operator. The gates are moved out of the path of the descending powder to avoid interference or obstruction of flow as it passes off the plate into an end chamber. In operation, the developing powder will begin to flow out over the plate shortly before the tray reaches the extreme of its tilted position. However, the lever arrangement is such that gate will be substantially in the same metering position through a small angle of travel of the tray. This is effected by virtue of the fact that the connecting rod 31 is nearing dead center position with respect to pivot 32 at this time.

Easy removal of plate 22 after it has been developed is made possible by a plunger 33 mounted in bottom wall 17. The plunger comprises a sliding pin having a cap 34 adapted to be engaged by the hand of the user. The pin is arranged to slide in aligned openings in bottom 17 and in the end of a tube 35 secured to bottom 17 and containing a coil spring 36 to retract the plunger by pressure against a flange 37 provided on the plunger.

It will be evident that an improved developing tray has been provided in which the minimum of skill is required on the part of the operator to control the rate of flow of developing powder and that an automatic control means is provided in which the rate of development is substantially uniform and independent of operator's judgment. The advantage of the invention will be further appreciated when it is considered that developing of sensitive electrophotographic plates must be carried on in a darkroom where the operator is unable to see clearly the operations being performed.

Figures 4 and 5 illustrate a developing tray 40 which does not require darkroom operation but in which the developing operation cannot be observed by the operator. This developing tray is provided with metering means to predetermine the rate of flow of developing powder.

Tray 40 comprises a bottom wall 41, end walls 42, side walls 43 and a solid top wall 44. Bottom wall 41 is provided with a central opening or window and the edges of wall 41 defining the two ends of the window are bent outward at a slight angle at 45 to provide a beveled portion at each end of the window. A tapered rubber blade 46 is mounted, by means of a slot extending into its rear edge on the edge of each beveled portion 45, the rubber blade tapering to a sharp flexible edge terminating slightly below the plane of bottom 41 because of the bevel angle. Strips of sponge rubber 47 are cemented to the face of bottom wall 41 along the two edges of the window and have their outer faces substantially in the same plane as the edges of rubber blades 46 so that the blades, together with the sponge rubber strips, form a flexible gasket completely surrounding the window opening and projecting slightly below the plane of bottom wall 41. A pair of spring clips 48 formed of sheet metal are welded to the mid-portions of side walls 43 and extend down around the two edges of the window to provide mounting clips for an electrostatic image plate to be developed. Plate 49 in a plate holder or frame 50 is shown mounted in

position for development in Figure 4. It will be noted that the plate is mounted by clamping it firmly over the window area with spring clips 48 so that rubber blades 46 and sponge rubber strips 47 yieldingly rest against the marginal areas of the plate surface thus effecting a powder seal as well as a light seal. The beveled portion 45 of the tray permits a seal to be made without interference with the frame or plate holder 50. It will also be apparent that the plate holder is provided with a suitable slide slot 51 to permit insertion of a light slide over the plate to protect it from light while it is being transferred from exposure position to the developing tray 40. The plate can be readily placed in position on the tray and the light slide removed without danger of exposing the plate to light, clamping being completed after the shield is removed.

The tray 40 is provided with a pair of short aligned pivot shafts 52 secured to the middle of side walls 43 to permit tilting on a suitable support such as a pair of parallel arms 53 provided with U-shaped receptacles 54 in their ends in which shaft 52 can be received. Arms 53 may comprise part of a telescoping slide adapted to enable withdrawal and return of tray 40 into a drawer space or recess. Tray 40 can, of course, also be mounted on a base such as base 10 of Figure 1.

Tray 40 is provided with swinging gates 55 between each of the tray ends and beveled portion 45. Each gate 55 may comprise a sheet metal strip bent over a longitudinal axis into a V-shape with one leg longer than the other. The gate is secured as by welding to a shaft 56 mounted horizontally between bushings 57 (Figure 5) in the side walls 43 so that gate 55 swings freely on its pivot. A washer 58 is provided at each end inside walls 43 to prevent jamming. The short arm 59 of the swinging gate member is provided with a relatively heavy ballast weight 60 such as a metal bar which is welded along the edge of portion 59 and stop pins 61 are provided in side walls 43 in such position as to limit the swing of gate member 55 in one direction to stop the gate when it is substantially perpendicular to bottom wall 41 of the tray as shown for the upper end of the tray in Figure 4. In this position the free edge of gate 55 is spaced slightly from bottom wall 41 to leave a metering opening or slot through which developing powder can be fed at a predetermined speed from the end of the tray onto the surface of plate 49.

In operation the tray is prepared for use by turning it about its pivot 52 to bring bottom wall 41 to top position and a charge of developing powder is poured into the tray. An electrostatic image plate 49 in a suitable frame is then clamped over the window in wall 41 by spring clips 48 and the tray is swung about its pivots to bring wall 41 and the plate to the underside of the tray. During this operation the developing powder accumulates in the lower end of the tray. As the rotation of the tray is continued through horizontal position and the once lower end is raised to an angle of 30° or so above the horizontal, gate 55 swings to a position in which its arm 59 is against stops 61 and shortly thereafter developing powder 23 collects above the gate as shown, for example, in Figure 4 and begins to flow through the opening 62 at a predetermined rate. The powder cascades over the surface of plate 49 developing the electrostatic image and flows off the lower edge of the plate into the end of the tray. During this operation gate 55, which is at the lower end of the tray, is swung back to a substantially open position by counterweight 60 thus permitting free access of developing powder into the reservoir at the end of the tray.

It will be evident that this developing tray arrangement provides for accurate and automatic metering of development powder during development and enables the operator to obtain uniform results even though the developing procedure can not be observed.

While the present invention, as to its objects and advantages, has been described herein as carried out in specific embodiments thereof, it is not desired to be limited thereby but it is intended to cover the invention broadly within the spirit and scope of the appended claims.

What is claimed is:

1. A device for developing electrostatic images on image plates, comprising, in combination, a tilting support for an image plate to support said plate face upward and tilt said plate from one inclined position in which one end is uppermost to the opposite inclined position in which the other end is uppermost, a reservoir for developing powder on said tilting support beyond one end of said plate to discharge powder onto said plate when said reservoir is above said plate and to receive powder passing off said plate when said reservoir is below said plate, a movable metering gate between said reservoir and said plate which gate in its fully closed position defines a restricted metering opening from said reservoir to said plate, and control means to open said gate to admit powder to said reservoir when said reservoir is below said plate and to close said gate to its metering position to restrict the rate of flow of powder out of said reservoir onto said plate when said reservoir is above said plate.

2. A device as claimed in claim 1 in which said control means is responsive to the position of said tilting support.

3. A developing device for electrostatic image plates, comprising, in combination, a support, a developing tray pivoted thereon for tilting about a horizontal axis from an inclined position in which a first end is uppermost through horizontal position to a second inclined position in which the second end is uppermost, said tray comprising side and end walls and a bottom wall, locating means for positioning an electrostatic image plate on said bottom wall between the ends of said tray, swinging gates pivoted on horizontal axes on said tray between the ends of said plate and the ends of said tray respectively which gates in their fully closed positions define restricted metering openings from said reservoirs to said plate, and a mechanical interlock between each of said gates and said support for swinging each gate open when its respective end of said tray is lowered, and for swinging each gate closed to the predetermined metering gap when its respective end of said tray is raised.

4. A device for developing electrostatic images comprising, in combination, a base, a tilting tray pivoted about a horizontal axis on said base plate locating means on said tray for positioning a plate in the bottom of said tray between the ends thereof, the ends of said tray providing powder reservoirs for receiving and discharging powder over said plate, a swinging gate pivoted on an axis extending across said tray between each of said reservoirs and the respective ends of said plate, a crank lever on each of said gates and connecting rods between said crank levers and a

pin on said base eccentric to said horizontal axis to open and close said gates respectively responsive to the tilting of said tray on said horizontal axis, said gates being opened when in lower position and closed when in upper position.

5. A developing tray for electrostatic image plates, said tray comprising side and end walls and a bottom wall, pivots for tilting said tray about a horizontal axis from an inclined position in which a first end is uppermost through horizontal position to a second inclined position in which the second end is uppermost, locating means for positioning an electrostatic image plate on said bottom wall between the ends of said tray, swinging gates pivoted on horizontal axes on said tray between the ends of said plate and the ends of said tray respectively which gates

in their fully closed positions define restricted metering openings from said reservoirs to said plate, and gravity-controlled tilting members connected to each of said gates for swinging each gate open when its respective end of said tray is lowered, and for swinging each gate closed to the predetermined metering gap when its respective end of said tray is raised.

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