

June 11, 1968

L. E. SHEFFO ET AL  
MAGNETIC DEVELOPER APPARATUS

3,387,586

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2 Sheets-Sheet 1

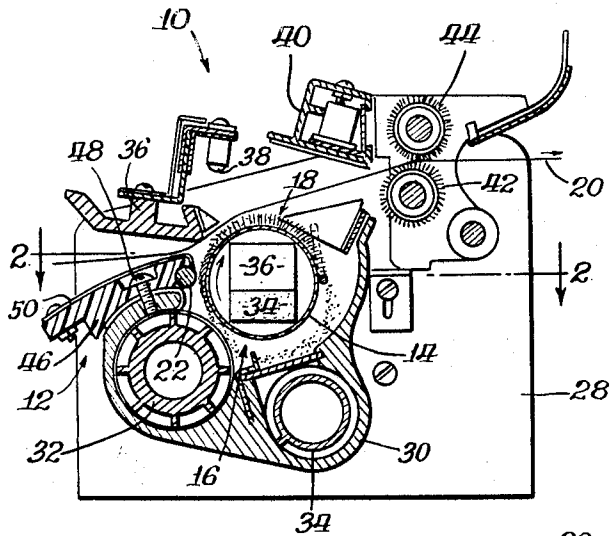


Fig. 1.

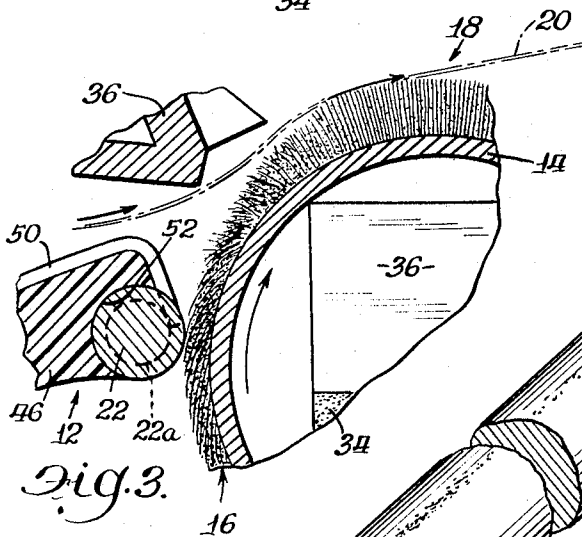


Fig. 3.

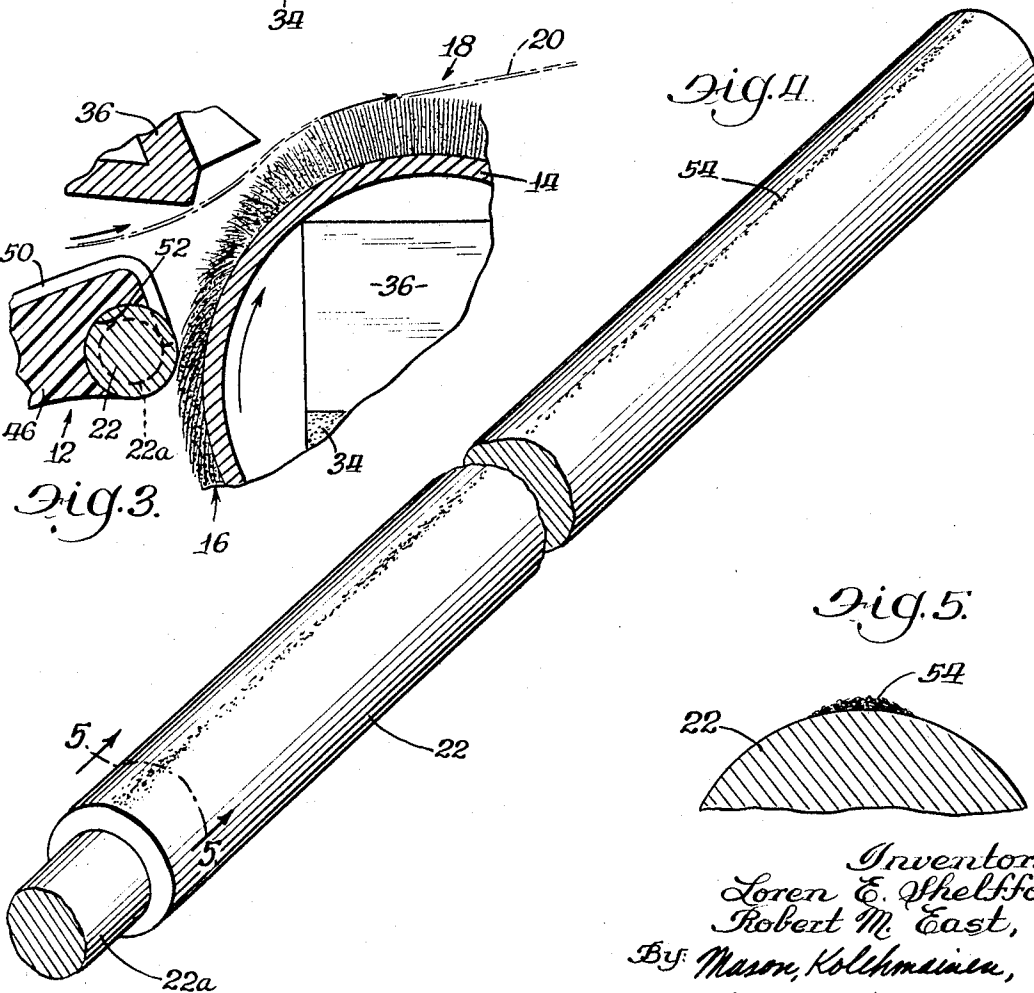
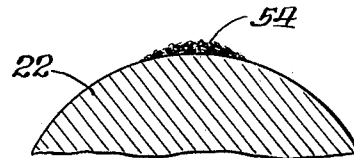


Fig. 4.

Fig. 5.



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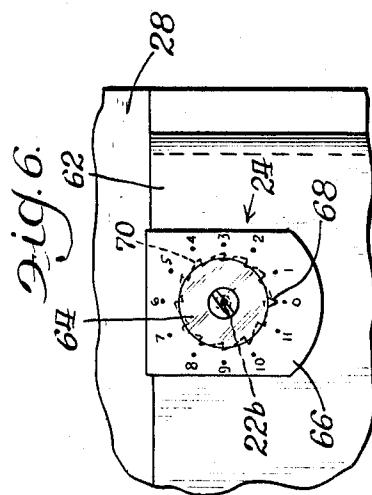
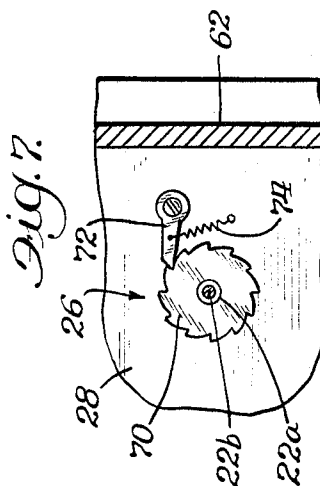
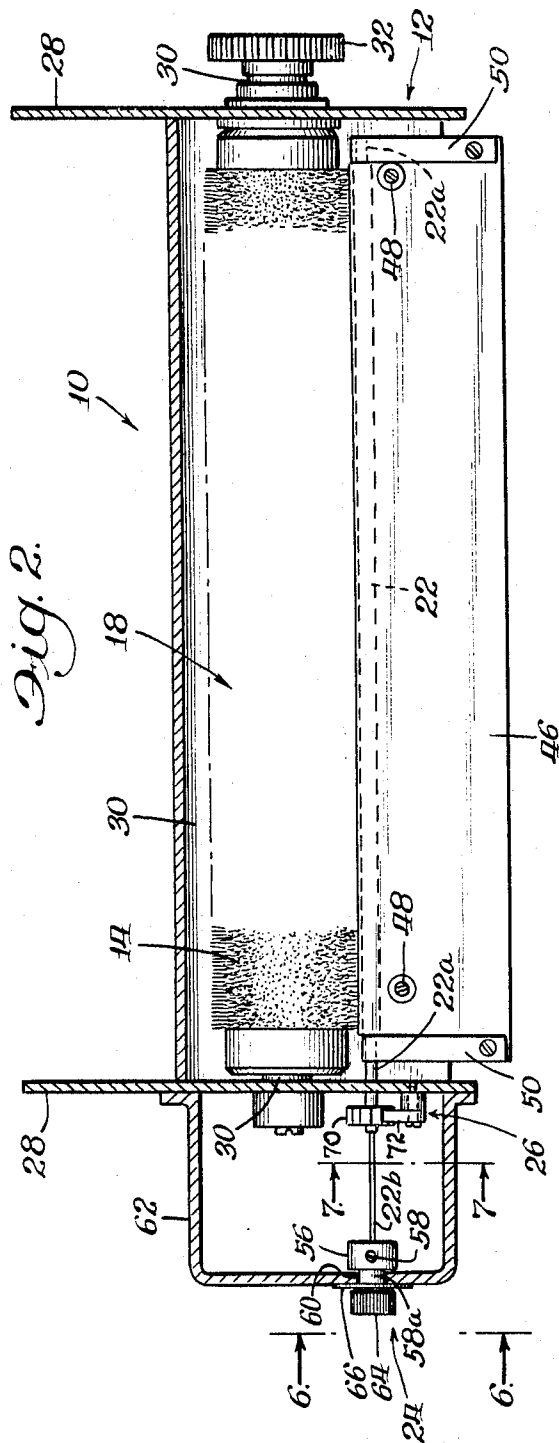
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MAGNETIC DEVELOPER APPARATUS

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2 Sheets-Sheet 2



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3,387,586

## MAGNETIC DEVELOPER APPARATUS

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### ABSTRACT OF THE DISCLOSURE

Developer mixture including magnetic and developer particles is supported adjacent a carrier drum mounted for rotation around a magnet structure establishing a region of relatively high flux density for forming developer material adhering to the drum into a brush. A circular cylindrical rod is positioned near the drum for evening or leveling the layer of adhering mixture before it enters the high flux density region. The rod may be rotated to present a fresh surface when the rod surface becomes uneven due to adhering developer material.

The present invention relates to apparatus for developing electrostatic images, and more particularly to improved apparatus for leveling a layer of developer mixture on a magnetic brush assembly.

Copying processes are known wherein a copy is produced on a copy sheet by depositing an electrostatic charge on the surface of a photoconductive member, selectively discharging the surface by exposing the charged surface with a pattern of light corresponding to an original graphic item to be copied, and developing the resulting electrostatic charge image. In the step of developing the image, finely divided electroscopic particles are applied to the surface, and the particles adhere to the charged portions of the surface. One such process is the photoelectrostatic process wherein a light sensitive copy sheet serves as the photoconductor member. Alternatively, a photoconductive transfer member may be used to transfer the image onto a copy sheet.

Known developing apparatus for applying electroscopic powder to an electrostatically charged member includes a carrier member movable in a magnetic field through a supply of developer mixture including both magnetically attractable metallic particles and electroscopic particles of a toner or developer material, which may be a thermoplastic resin. The magnetic field causes a layer of the developing mixture to adhere to the carrier member, and the carrier member subsequently moves through a region of increased flux density where the developer mixture is arranged into a bristle-like configuration or brush. The electrostatically charged member is brought into contact with the brush of developer mixture where the electroscopic particles are attracted by and deposited onto the charged member. One example of this type of apparatus is disclosed in the co-pending application of Daniel B. Granzow and John L. Tregay, filed Sept. 10, 1963, Ser. No. 307,887, entitled Electrostatic Developing Apparatus and Method, and assigned to the same assignee as the present invention.

Problems are encountered in known developing units in achieving an even layer of developer mixture on the carrier member. If the layer is uneven, the brush formed by the developer mixture is not uniform and the powder is not deposited evenly onto the electrostatically charged member. As a result, the copies produced may be unsatisfactory due to streaks, blank areas, and relatively lighter and darker regions.

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In order to overcome such problems, it has been proposed to position a leveling element adjacent the carrier member between the supply of developer mixture and the region of high flux density. In accordance with this proposal, the leveling element engages the layer of developer mixture and evens it off so that it is arranged into a uniform brush configuration. In practicing this proposal, however, difficulties are encountered because, over a period of time, the thermoplastic electroscopic developer material exhibits a tendency to adhere to the surface of the leveling member, thus producing a non-uniform surface after a period of use. Instead of leveling the layer of developer mixture on a carrier member, the non-uniform surface of the leveling element produces an uneven, unsatisfactory layer. To correct this difficulty, the leveling element must either be cleaned, or discarded and replaced. Cleaning is quite difficult due to the strength of the adherence between the leveling means and the electroscopic powder. Thus expensive maintenance and frequent replacements are required.

Accordingly, it is an object of the present invention to provide improved developing apparatus including improved leveling means for providing a uniform layer of developer mixture, and thereby to overcome the above and other disadvantages of known apparatus.

It is another object of the invention to provide developing apparatus including leveling means effective to level the layer of developer mixture for a substantial period of time without the necessity of frequent cleaning or replacement.

Another object is to provide an improved leveling arrangement together with novel apparatus for indicating the remaining life of the leveling element.

A further object of the invention is to provide indexing and latching structure for aiding in positioning the leveling element.

Still another object of the invention is to provide indicating means for indicating the position of the leveling element.

In accordance with these and many other objects of this invention, an embodiment of the invention may comprise a developer unit including a carrier member movable in a magnetic field through a supply of developer mixture, and then movable through a region of increased magnetic flux density so that a layer of developer mixture adheres to carrier member and is then arranged into an upstanding bristle-like configuration, or brush. In order to level the layer of developer mixture so that a uniform brush is formed, a leveling element is positioned adjacent to the carrier member.

In accordance with a feature of the invention, the leveling element includes a cylindrical surface and is rotatably mounted in order that when one surface of the leveling member becomes uneven due to the adherence of electroscopic particles, a fresh, even surface may be presented. In this manner the life of the leveling member is greatly extended, and frequent maintenance or replacement of the leveling element is avoided.

In accordance with an additional feature of the present invention, indicating means are associated with the movable leveling element in order to provide an indication of the position of the leveling element. Furthermore, indexing and latching structure is provided to constrain the movement of the leveling element to a single direction, and additionally to restrain the leveling element sequentially in a finite number of positions. The indicating means cooperates with the indexing and latching structure in order to provide an indication of the number of portions of the surface of the leveling element remaining unused at any given time.

Many other objects and advantages of the present in-

vention will become apparent from considering the following detailed description in conjunction with the drawings in which:

FIG. 1 is a vertical sectional view of a developer unit constructed in accordance with the present invention;

FIG. 2 is a sectional view of the apparatus of FIG. 1 taken along the line 2—2 of FIG. 1, and with some structure omitted for clarity;

FIG. 3 is a greatly enlarged fragmentary sectional view of a portion of the apparatus of FIG. 1;

FIG. 4 is a broken perspective view of a portion of the leveling element of the present invention;

FIG. 5 is an enlarged fragmentary sectional view of the leveling element of FIG. 5;

FIG. 6 is fragmentary greatly enlarged side view of the developer unit taken from the line 6—6 of FIG. 2; and

FIG. 7 is a greatly enlarged partial sectional view taken along the line 7—7 of FIG. 2.

Referring now to the drawings and initially to FIGS. 1 and 2, there is illustrated a developer unit designated as a whole by the reference numeral 10 and provided in accordance with the present invention with improved leveling means generally designated as 12.

The developer unit 10 includes a carrier member comprising a rotating drum 14 movable in a magnetic field through a supply of developer mixture indicated by the numeral 16 and then into a region of relatively high flux density designated by the numeral 18. A layer of the developer mixture is attracted to the drum 14 as it moves through the supply of material 16, and as the carrier member moves through the high flux density region 18, the mixture is arranged by the magnetic field into a bristle-like brush configuration. An electrostatically charged photoconductive copy sheet 20 (FIGS. 1 and 3) is brought into contact with the magnetic brush assembly in the region 18 whereby electroscopic particles from the developer mixture are deposited on the charged areas of the copy sheet 20.

In order evenly and uniformly to develop the charge image on the copy sheet 20, it is desirable that the magnetically formed brush of developer mixture be uniform. In order to even off the layer of developer mixture, the leveling means 12 is provided. This leveling means includes a rod 22 formed preferably of metal and having a cylindrical surface, illustrated as being circular in cross-section. However, it should be understood that cylindrical surfaces of many other cross-sectional shapes, such as, for example, surfaces with polygonal cross-sections, could be used without departing from the scope of the present invention.

The rod 22 is supported adjacent the drum 14 between the supply of developer mixture 16 and the high flux density region 18 and is parallel with the surface of the drum 14. Thus, as the drum rotates past the rod 22, a portion of the surface of the rod evens off, and levels the layer of developer mixture adhering to the carrier member. When the even and level layer of developer mixture reaches the region 18 of relatively high flux density, the material is formed into a uniform and even brush. Accordingly, the image produced by engagement of the copy sheet 20 with the magnetic brush is of an even quality throughout and includes no streaks or blank spots resulting from an uneven brush.

It has been found that as the rod 22 is used to level the layer of material, the surface of the rod eventually becomes uneven due to an accumulation of electroscopic particles from the developer mixture. When the surface becomes uneven, it is no longer suitable for leveling the layer of developer mixture. In order to overcome this difficulty, and in accordance with the present invention, the rod 22 is mounted for rotational movement whereby different portions of the surface of the rod may selectively be brought into engagement with the layer of developer material. Accordingly, when the adherence of electro-

22 renders that portion unserviceable for leveling the layer, the rod may be rotated to a different angular position so that a fresh and even portion of the surface of the rod 22 is presented.

In accordance with other features of the invention, indicating means generally designated as 24 are provided for indicating the position of the rod 22. There is also provided indexing and latching structure generally designated as 26 for constraining the rod 22 to rotation in a single direction, and also for sequentially restraining the rod 22 in a finite number of angularly displaced positions. The indicating means 24 is effective, in cooperation with the indexing and latching means 26, to provide an indication of the remaining unused surface portions of the rod 22, thus indicating the remaining life of the rod.

More specifically, the developer unit 10 includes a supporting or frame structure having a pair of opposed side or end walls 28 (FIGS. 1 and 2) which may be supported on the main frame of a copying machine with which the developer unit is to be used. Supported between the side walls 28 is a trough-like member 30 preferably formed of a dielectric material and defining a group of communicating troughs or channels in which the mixture of developer material is contained. A pair of feeding and distributing elements 32 and 34 (FIG. 1) are positioned in two of the channels, and serve uniformly to distribute the developer mixture along the length of the drum 14. The carrier member or rotating drum 14 is supported between the side walls 28 upon shaft extensions 30, one of which carries a gear 32 for rotating the drum 14 in a clockwise direction as viewed in FIGS. 1 and 3.

In order to establish a magnetic field in the neighborhood of the rotating drum 14, a magnetic assembly including a permanent bar magnet 34 and a soft iron cross piece 36 are disposed within the drum 14. The magnet 34 and cross piece 36 are stationary, and are arranged to establish a magnetic field about the periphery of the drum 14, with a region of high flux density in the region 18 above the drum.

The developer mixture comprises a mixture of magnetically attractable material, such as iron filings, and electroscopic particles of a developer material such as thermoplastic resin. As the rotating drum 14 moves through the developer mixture, the magnetic field attracts the iron filings, and causes a layer of the developer mixture to adhere to the surface of the drum. As the drum rotates, this layer is carried into the region 18 of greater flux density and the mixture is formed into a brush.

As illustrated in FIGS. 1 and 3, the copy sheet 20, bearing a pattern of electrostatic charge on its surface, is moved from left to right through the region 18, where the brush of developer mixture sweeps over the sheet. Electroscopic toner particles from the developer mixture adhere to charged areas on the surface of the sheet and a powder image is formed. This powder image may subsequently be rendered permanent, as by fusing.

The sheet 20 is guided into the region 18 by a guiding structure 36. A corona discharge wire 38, supported on the guiding structure 36, serves to prevent the adherence of the developer powder to the non-image areas of the sheet, as described in the above-identified co-pending applications. A magnetic cleaning assembly 40 removes any magnetic particles that may be deposited on the back surface of the sheet, and the sheet is propelled away from the developer unit 10 by a pair of drive rollers 42 and 44.

As described above, the rod 22 serves to level off the layer of developer mixture before it is engaged by the copy sheet 20. The rod is supported by an elongated holder 46, formed of a dielectric material, and held to the trough-like member 30 by screws 48. The rod includes reduced diameter end portions 22a engaged and held in an elongated channel 52 (FIG. 3) at the inner edge of the holder 46 by a pair of spring clips 50.

As the rotating drum moves past the rod 22, the rod engages and levels the layer of material so that a uniform

brush is formed and a smooth, even and clean image is produced on the copy sheet. After the rod has been used for a period of time, the electroscopic particles in the developer mixture build up on the surface of the rod. This condition is illustrated in FIGS. 4 and 5 wherein the uneven surface caused by adherence of these particles is designated as 54. This uneven surface renders the rod 22 unsatisfactory for leveling the layer of developer mixture.

In order to overcome the necessity for replacing or removing and cleaning the leveling element, and in accordance with a feature of the present invention, the rod 22 is mounted for rotation so that when one portion of its surface is rendered unsuitable for further use, a fresh, even portion of the surface may be advanced. To this end, the rod includes a stem 22b extending from one end and fastened to a journalling member 56 by a screw 58. The journalling member 56 has a stem 58a extending through an opening 60 in a bracket 62, and is connected to an operating handle 64 conveniently accessible to the operator of the machine. Thus when one portion of the surface of rod 22 becomes coated with the electroscopic particles, the rod may be rotated by moving the handle 64, thereby presenting another portion of the rod surface to the layer of developer mixture.

In order to provide an indication to the user of the machine of the position of the rod 22, an indicator plate 66 is secured to the outer surface of the bracket 62. The handle 64 is provided with a pointer 68 (FIG. 6) cooperating with suitable indicia on the indicator plate whereby the operator is apprised of the angular position of the rod 22.

In order to constrain the rod 22 to movement in a single direction, and in order to retain the rod 22 sequentially in a finite number of angular positions, a ratchet wheel 70 is mounted on the rod 22 within the enclosure formed between one side plate 28 and the bracket 62. A pawl lever 72 is biased by a spring 74 into engagement with the ratchet wheel, and each time the handle 64 is turned in order to rotate the rod 22, the pawl lever serves to restrain the rod 22 in the next adjacent angular position. Furthermore, the rod 22 is able to move only in one direction. Accordingly, it will be understood that as the rod 22 is moved from the zero position illustrated in FIG. 6 of the drawings, the pointer 68 will provide to the operator of the machine an indication of how many unused portions of the surface of the rod 22 remain, and thus an indication of the remaining life of the rod 22.

Although the present invention has been illustrated and described in connection with the details of a single illustrative embodiment thereof, it should be understood that numerous other modifications and embodiments can be devised by those skilled in the art that will fall within the spirit and scope of the principles of this invention. For example, although the invention has been described in

connection with apparatus for developing a copy sheet carrying a pattern of electrostatic charge, it should be understood that the invention may have application as well to arrangements wherein a photoconductive transfer member is used.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. Developer apparatus for applying developer mixture to an electrostatically charged member comprising means for establishing a magnetic field having a region of relatively greater flux density, means for supporting a supply of the developer mixture in said field outside of said region, a carrier member mounted for movement first through the supply of developer mixture and then through said region of greater flux density so that a layer of developer mixture adheres to the carrier member and is arranged into a brush configuration as the carrier member moves through said region, means for supporting the electrostatically charged member adjacent said carrier member in the path of the developer mixture in said region, a circular cylindrical leveling rod supported parallel and adjacent to said carrier member between said supply of developer mixture and said region for leveling the layer of developer mixture, means supporting said rod for rotation about its axis to permit different surface portions of said rod to engage the layer of developer mixture without altering the spacing between said rod and said carrier member, latching means operatively connected to said rod for holding said rod stationary against rotation in one of a predetermined number of angularly spaced positions, and a manual operating member for moving said rod to another position to present a fresh rod surface when the rod surface becomes uneven due to the adherence of developer material thereto.

2. Developer apparatus as claimed in claim 1 additionally comprising indicating means operatively associated with said rod providing an indication of the position of the rod.

3. Developer apparatus as claimed in claim 1, said latching means comprising a ratchet wheel fixed for rotation with said rod, and a spring biased pawl engaging said wheel.

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