United States Patent

[11] 3,613,637

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[54] **DEVELOPER FOR ELECTROSTATIC IMAGES**
2 Claims, 4 Drawing Figs.

[52] **U.S. Cl.** **118/637,** 117/17.5
[51] **Int. Cl.** **G03g 13/00**
[50] **Field of Search** 118/637; 117/17.5

[56] **References Cited**

UNITED STATES PATENTS

2,378,025	6/1945	Melton et al.	118/627
3,254,625	6/1966	Armstrong	118/429 X
3,357,399	12/1967	Fisher	118/637
3,393,663	7/1968	Donalies	118/637
3,484,265	12/1969	Swyler	118/637

FOREIGN PATENTS

181,524	6/1966	U.S.S.R.	118/627

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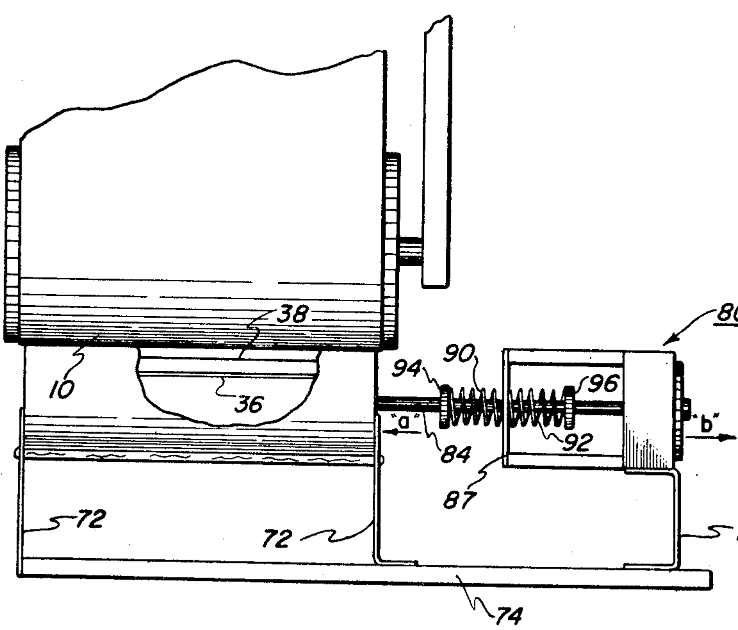
ABSTRACT: Apparatus for developing a latent electrostatic charge pattern including a developer bed comprising a supporting plate positionable beneath at least a portion of a surface having the latent electrostatic charge pattern formed thereon. The developer bed is vibrated by a driving member to fluidize the developer material supported thereon for contacting and developing the latent charge pattern. The bed and driving member are suspended by flexors and are coupled together by resilient means to minimize the drive force requirements by permitting operation at mechanical resonance and to isolate the noise and vibrations generated by the vibrating bed and driving member.



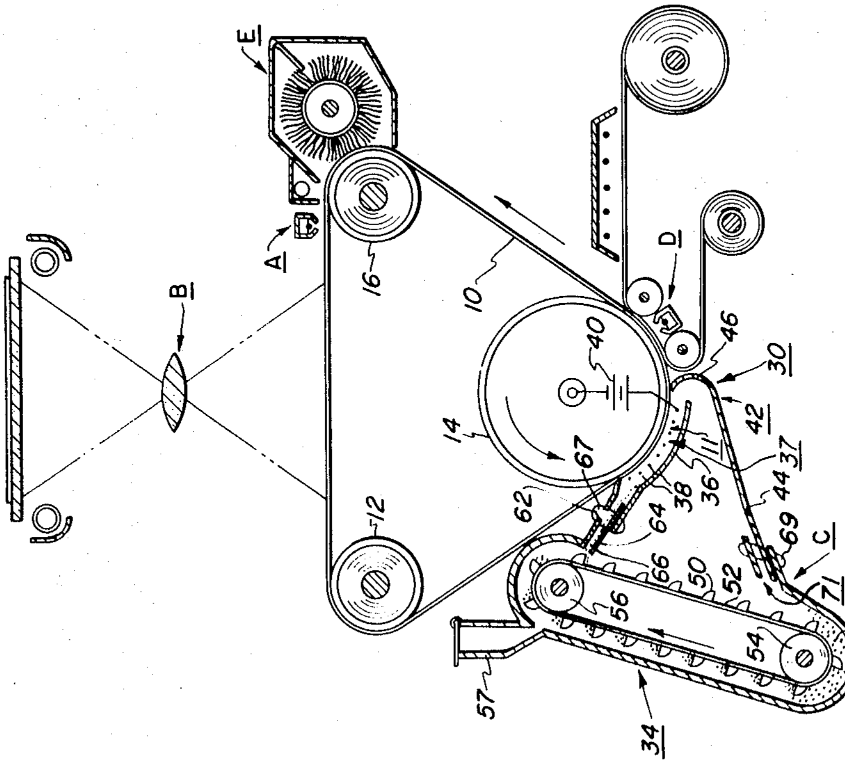


FIG. 1

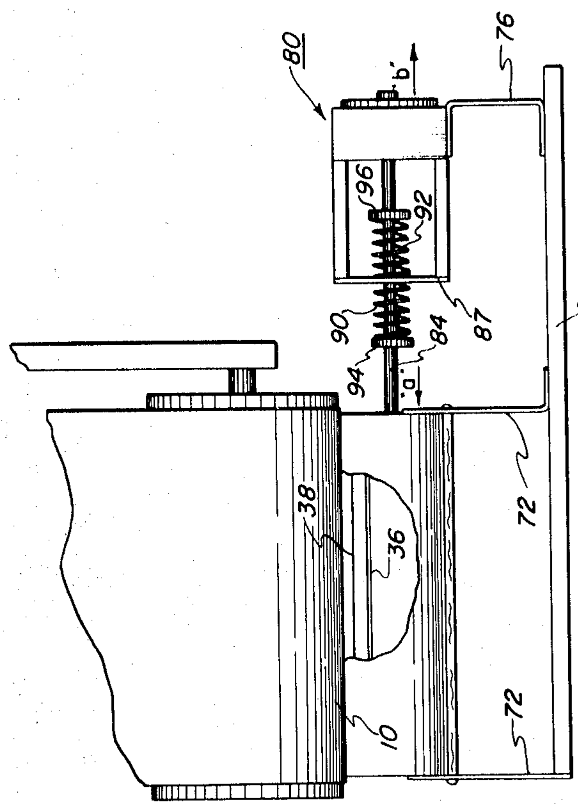


FIG. 2

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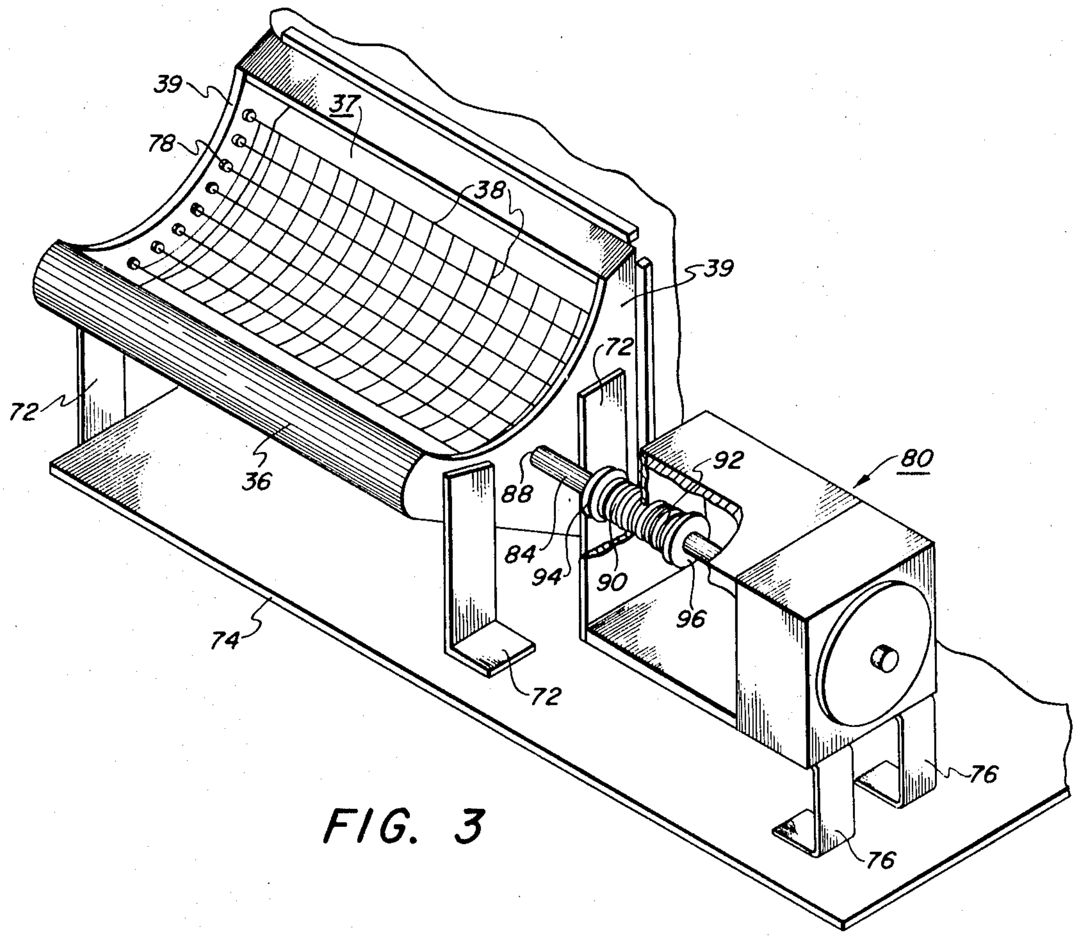
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FIG. 3

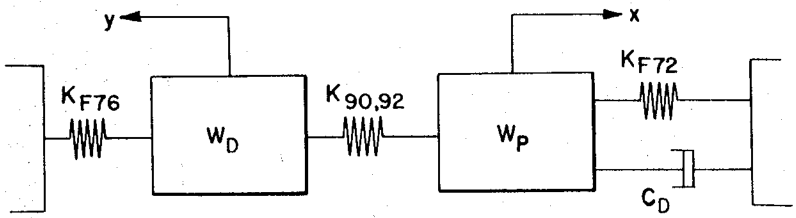
y
x
K_{F76}
W_D
$K_{90,92}$
W_P
K_{F72}
C_D

FIG. 4

DEVELOPER FOR ELECTROSTATIC IMAGES

BACKGROUND OF THE INVENTION

In the practice of xerography, as described in U.S. Pat. No. 2,297,691, a xerographic surface comprising a layer of photoconductive insulating material affixed to a conductive backing is used to support electrostatic images. In the usual method of carrying out the process, the xerographic plate is electrostatically charged uniformly over its surface and then exposed to a light pattern of the image being reproduced to thereby discharge the charge in the areas where light strikes the layer. The undischarged areas of the layer thus form an electrostatic charge pattern in conformity with the configuration of the original light pattern.

The latent electrostatic charge pattern can then be developed by contacting it with the finely divided electrostatically attractable material such as resinous powder. The powder is held in charge areas by the electrostatic charges on the layer. Where the charge is greatest, the greatest amount of material is deposited; and where the charge is least, little or no material is deposited. Thus, a powder image is produced in conformity with the light image of the copy being reproduced. Powder is subsequently transferred to a sheet of paper or other surface and suitably affixed thereto to form a permanent print.

The electrostatically attractable developing material commonly used in xerography consists of a pigmented resinous powder referred to here as "toner" and a granular material called "carrier". The carrier is usually coated with a material removed in the triboelectric series from the toner so that a triboelectric charge is generated between the powder and the granular carrier. Such charge causes the powder to adhere to the carrier. The carrier also provides mechanical control so that the toner can be readily handled and brought into contact with the exposed xerographic surfaces. The powder particles are then attracted to the electrostatic images to produce a visible powder image on the xerographic surface.

In one method of development, herein referred to as cascade development, the contact between the image and developing material, or developer, is achieved by pouring or cascading the two-component developer across the xerographic surface. During such cascading, the individual carrier particles bounce or roll across the image-bearing surface contacting the image at randomly spaced points. The amount of developer flowing across the xerographic surface and the number of contact points between the developer and the image areas control the degree of development or the quantities of toner deposited on image areas. The developer flow, and the number of developer particles contacting each incremental area of the xerographic surface, can be increased by increasing the speed with which the developer is cascaded across the xerographic surface. This approach has limitations since the speed at which the developer material flows across the image is that of a freely falling body and in order to increase the speed it is necessary to impart an initial velocity to the developer. With an initial velocity the carrier portion of the developer strikes the photoconductor with a force which may either damage the photoconductor or jar excessive amounts of toner free from the carrier on initial impact.

An improved method of xerographic development of latent electrostatic images by fluidizing a two-component developer material in a development zone is described in U.S. Pat. No. 3,380,437. As described in that case, a quantity of two-component developer material is vibrated beneath a latent electrostatic image. The vibrations are so rapid that they cause the mass of developer material to suspend itself in a fluidized mass or bed. As an image-bearing xerographic surface is passed through the developer zone, it is contacted by the fluidized or constantly moving developer and image areas of the xerographic surface are developed with the toner material in the developer.

Development electrodes may be used to provide solid area development and more efficient vibration imparting to the developer material. The electrode consists of a grounded or biased member positioned as closely as possible to the xerographic surface to create an electric field in conjunction with the electrostatic charge pattern. The electrode may comprise a plate or grid parallel to the xerographic surface and spaced therefrom.

Although the previously employed fluidized bed development techniques have provided good solid area development, disadvantages of the reproducing systems utilizing fluidized bed development have limited its use. These disadvantages include the vibrations and noise introduced into the system when the fluidized bed is vibrated, the force and power required to rapidly reciprocate the vibration-imparting elements, the reliability of the system which of necessity requires a number of mechanically actuated elements, and the effect of the vibrations on the life of the system.

SUMMARY OF THE INVENTION

The present invention provides novel apparatus for developing latent electrostatic charge pattern by vibrating a two-component developer material into a partial or total fluidized state in contact with the charge pattern for development thereof. In particular, the apparatus of the present invention utilizes, a flexoral, or flexing, suspension for the bed and driver, the bed being coupled to the driver by coil springs. The flexing suspension of the bed and driver isolates the vibrations induced therein from the other elements of the reproducing system utilizing fluidized bed development. The flexing suspension and coils springs are chosen to minimize the forces transmitted to the system during vibration of the bed. The advantages of utilizing flexoral suspension and coupling as described hereinabove are low power and force requirements for vibrating the bed, low system vibration and noise, and high system reliability and life.

It is, therefore, an object of the present invention to provide apparatus for developing latent electrostatic charge patterns.

It is a further object of the invention to provide improved fluidized bed development apparatus for developing latent electrostatic charge patterns.

It is still a further object of the present invention to provide improved fluidized bed development apparatus for developing latent electrostatic charge patterns wherein the plate supporting the fluidized bed and associated driver are suspended on flexors, and wherein the bed is coupled to the driver by coil springs.

It is still a further object of the invention to provide a novel fluidized bed development technique for developing latent electrostatic charge patterns wherein the vibrations and noise introduced into the system utilizing the bed development are minimized, the reliability and life of the system is increased, and the power necessary to vibrate the bed is such that the developer fluidized is minimized.

BRIEF DESCRIPTION OF THE DRAWINGS

For a better understanding of the invention as well as objects and further features thereof, reference is made to the following description which is to be read in conjunction with the accompanying drawings and wherein:

FIG. 1 is a diagrammatic sectional view illustrating xerographic apparatus capable of carrying out the instant invention;

FIG. 2 is a front view of development apparatus utilized in the apparatus shown in FIG. 1;

FIG. 3 is an upper right perspective of the vibrating elements utilized in the apparatus shown in FIG. 1 for imparting axial vibrations to the bed; and

FIG. 4 is a schematic representation of the drive system of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

According to the present invention developer material is brought into contact with a surface bearing latent electrostatic charge patterns in a manner such that the number of contacts between the material and the surface is increased over former techniques. Accordingly, a surface bearing the latent electrostatic charge pattern is moved through a bed of two-component developer in which the individual carrier particles are in a state of constant motion, and are impinged against the surface. Due to the constant motion of the developer particles, each incremental area of the surface is being continually contacted by different carrier beads and toner particles. The speed of agitation of the developer results in a substantial increase in the number of developer-charge pattern contacts for a given unit of time.

In carrying out the development method of the present invention, a two-component developer is vibrated beneath a latent electrostatic charge pattern, or image. The vibrations are so rapid as to cause the toner-holding carrier to fluidize, as that term is known in the art, or to become suspended in a fluidlike state wherein the individual particles are in constant motion. The developer bed is then brought into contact with the surface to develop a latent electrostatic charge pattern. The developer bed, alternately, may be continuously in contact with the charged surface.

The developer composition may be of the conventional type as presently employed in commercial xerographic machines which use cascade techniques. Such a composition is defined, for example, in Walkup U.S. Pat. No. 2,618,551. An example of such a composition comprises carrier beads of glass or steel which may be covered with and encased in a suitable coating, such as vinyl chloride, ethyl cellulose or phenyl formaldehyde which triboelectrically charges the toner upon contact. The toner is usually a pigmented resinous material, or the like, which can be used to develop xerographic images. According to the apparatus illustrated herein, to carry out the method of the instant invention, the two-component developer is positioned and supported in an even and continuous layer over the surface of an arcuate plate, or tray, the plate then being vibrated transverse to the direction of movement of the member supporting the electrostatic charge pattern.

The surface having the latent electrostatic charge pattern thereon may then be positioned above the developer and plate so that the vibrated or fluidized developer bed will contact and develop the charge pattern. In automatic and continuous xerographic reproducing machinery, the surface may be moved across the developer to thereby sequentially present new portions of the charge pattern for development. It should be noted that techniques for than xerography may be utilized to deposit an electrostatic charge pattern on the surface of a support member, such as the electrostatic printer disclosed in U.S. Pat. No. 3,289,209. For illustrative purposes, the xerographic process will hereinafter be described.

The constant movement of the developer material within the fluidized bed causes the individual particles to continually move into and out of contact with the surface. The transfer of the toner particles from their associated carrier beads to charge pattern areas occurs during this contact period. The deposition of toner to the areas is physically caused either by the attraction of the charge pattern exceeding the attraction of the carrier for the toner or the toner being jarred loose from the carrier by the force of contact as it strikes the xerographic surface whereupon the charge in the image areas attract the loose toner. The constant agitation or motion of the developer causes new or fresh developer to be continually brought into contact with the image-bearing surface and reduces the attraction of the carrier for the toner.

As shown schematically in FIG. 1, an automatic xerographic reproducing apparatus includes a xerographic surface formed in the shape of a flexible belt **10**, which is mounted to move in the direction indicated by the arrows to thereby cause the xerographic surface to sequentially pass through a plurality of processing stations. The elements of this machine are all conventional in the xerographic art with the exception of the development station which is constructed to carry out the method of the instant invention.

For the purpose of the present disclosure, the several xerographic processing stations in the path of movement of the xerographic surface may be described as follows:

A charging station A, at which a uniform electrostatic charge is deposited on the photoconductive layer of the xerographic belt;

An exposure station B, at which the light or radiation pattern of copy to be reproduced is projected onto the belt surface to dissipate the charge in the exposed areas thereof to thereby form a latent electrostatic charge pattern, or image, of the copy to be reproduced;

A development station C, which forms the basis of the present invention, at which a xerographic developing material, including toner particles having an electrostatic charge opposite to that of the electrostatic latent image, are in contact with, or moved into contact with, the belt surface, whereby the toner particles adhere to the electrostatic latent image to form a xerographic powdered image in the configuration of the copy being reproduced;

A transfer station D, at which the xerographic powdered image is electrostatically transferred from the belt surface to a transfer material or a support surface; and

A drum cleaning and discharge station E, at which the belt surface is brushed to remove residual toner particles remaining thereon after image transfer, and at which the belt surface is exposed to a relatively bright light source to effect substantially complete discharge of any residual electrostatic charge remaining thereon.

As shown in the drawings, a xerographic surface in the form of a flexible belt **10** is supported for continuous motion through a xerographic development zone **11**. The surface is shown as a flexible belt trained over a plurality of rollers **12**, **14** and **16**, at least one of which is driven by any suitable power source, not shown, to drive the belt through the several processing stations.

While the disclosed embodiment illustrates a flexible belt as the xerographic surface, it is obvious that any xerographic surface is equally suitable for carrying out the method of the instant invention, as for example, a drum or flat plate. If a flat plate is used, it may either be movable across the development zone or fixed with respect thereto.

The development station C illustrated in FIG. **1** is constructed of two major sections, a developer-vibrating assembly located at **30** (shown in detail in FIGS. **2** and **3**) and a developer recirculation assembly **34**. The purpose of the developer-vibrating assembly is to impart vibrating motion to the two-component developer adjacent to the latent electrostatic image bearing surface. The purpose of the developer recirculation assembly it to move developer to the input end of the developer-vibrating assembly after is has been moved beyond the developer-vibrating elements. An arcuate plate **36** is positioned concentric with the belt **10** in an area vertically offset from the vertical centerline of the belt **10**, to facilitate rapid movement of the developer through the development zone **11**. A suitable electrode grid **37**, composed of **a** plurality of electrode wires **38**, may be secured concentric with and between the belt **10** and arcuate plate **36**. The screen is grounded or provided with a bias from any suitable source of potential, not shown, to thus create an electrical field adjacent the image to aid in solid area development. To allow a bias to be placed on the grid **37** but not plate **36** the axial electrodes shown are mounted in end plates **39** (FIG. **3**) through suitable insulating barriers. In order to guide the vibrating developer in a return path towards the developer recirculation assembly **34**, a plate **42** with a J-shaped cross section is provided. Plate **42** is stationary and is isolated from the vibrating bed. The arcuate plate **36** is vibrated during operation of the xerographic apparatus for maintaining the developer in a fluidized state as described hereinabove. The developer thus exhibits a movement down the longer leg **44** of the plate **42** towards the developer recirculation assembly **34** after reversing direction at the curved portion **46**.

The developer recirculation assembly 34 is similar to the conventional type employed in most cascade development units. In the lower portion of this housing a developer sump 48 is provided containing a supply of two-component developer for feeding into the development zone 11. A bucket conveyor assembly comprising a plurality of buckets 50 mounted on a flexible endless belt 52 is held in position by two rollers 54 and 56. Roller 54 is connected to a suitable source, not shown, for moving the buckets in a direction of the arrow. The buckets act to raise the developer from the sump 48 to an elevated position for gravity feed to the development zone 11. A toner dispenser 57 is provided for adding toner to the system to replace toner which has been depleted due to the development of images. Also within the developer-recirculating assembly are upper and lower plates 62 and 64, respectively, spanning the distance across the developer-recirculating assembly 34. This distance is equivalent to the width of the belt 10. These plates act as a stationary developer input chute 66 for the introduction of developer into the space between the arcuate plate 36 and belt 10.

To insure that the development system is enclosed in the areas between the developer-recirculating assembly 34 and the developer return path, resilient seals 67 and 69 are provided for coupling input chute 66 to the bed and return chute 71 to plate 44, respectively. Edge seals may be employed to effectively seal in the developer between J portion 46, upper plate 62 and belt 10. The seal should preferably be made of a low-friction resilient material to minimize friction drag on the belt and bed drives.

The return and developer systems as described hereinabove are merely illustrative of such systems which may be utilized in the present invention. Other systems may be utilized, such as that disclosed in copending application Ser. No. 731,902. The present invention is directed to novel means for vibrating the arcuate plate 36 and electrode grid 37 to fluidize the developer.

Motion to the developer-vibrating assembly is accomplished by the novel drive means described hereinafter in reference to FIGS. 2 and 3.

To operate the development apparatus of FIG. 1 it is first necessary to activate the various processing stations outlined above. Such activation may be done by a general cycle-initiating means similar to that used in any of the known continuous and automatic xerographic machines. Such general cycle-initiating means will activate all operative stations including the drum-driving means, developer-conveying apparatus and the vibrating instrumentalities in the development zone in addition to initiating the bias on the grid.

As the image-bearing surface passes the development zone, the development conveyor is continually bringing the two-component developer into the input chute for gravity-feeding developer to the development zone 11 above the arcuate plate 36 and between the electrode grid 37 and belt 10, the continuous bed vibrations reciprocating the developer between the plate and image-bearing surface.

The ground or bias on the vibrating electrode grid 37 establishes an electric field adjacent the image. In addition to creating the field, the vibrations of the grid assist in fluidizing the developer contacted thereby. The grid, as mentioned above, allows the vibrated developer particles to freely move between the arcuate plate and image-bearing surface without interference therefrom.

As the fluidized cloud of developer flows past the arcuate plate and image, it contacts the arcuate portion of the J-shaped plate. Here the direction of the entire fluidized bed of developer is reversed. The developer continues to move in the reverse direction back towards the sump. It is noted that the longer leg portion 44 of the J-shaped plate is tilted in the direction of flow to facilitate the developer return to the sump. As the developer passes the nonvibrating final portion of the J-shaped plate, it moved into contact with the sump area of the developer-recirculating assembly 34 wherein the developer resettles in the sump for subsequent recycling through the development zone.

Referring now to FIGS. 2 and 3, positioned immediately beneath a portion of the belt 10 is arcuate plate 36, shaped concentrically with belt 10. The arcuate plate 36 is mounted adjacent opposite ends of the belt by mounting plates 39. The lower portion of mounting plates 39 are attached to flexible metallic sheets, or flexors, 72, the lower ends of which are mounted to a base 74 by any suitable mounting mechanism. Also positioned in the development zone 11 between the belt 10 and arcuate plate 36 is vibrating electrode grid 37. The grid is also mounted arcuately and concentric with both the belt and arcuate plate. The opposite ends of the axial electrodes shown are mounted to mounting plates 39 through any suitable insulating barrier 78, such as polyethylene foam, plastic spacers or the like. The grid 37 is adapted to be grounded or receive an electrical bias by a potential source not shown. Such electrical connection is adapted to render the grid a development electrode for the establishment of electric field adjacent the image for improved solid area development. It should be noted that development may take place without the inclusion of the grid element.

Motion to the vibrational elements may be imparted, in the novel technique of the present invention, by an axially mounted electromagnetic driver 80, such as the V-50 voice coil type of linear vibrator manufactured by the Goodman Corporation. The driver may be mounted off axis through suitable lever or bellcrank devices. The electromagnetic driver 80 is attached to flexible metallic sheets 76, the lower ends of which are mounted to base 74 by any suitable mounting mechanism. The driving shaft 84 of the electromagnetic driver 80 is affixed to the mounting plate 39 at 88 either by riveting, bolting, or any other suitable mounting method. The driver alternately may comprise a pneumatic driver actuated by a pulsating air supply, or the like.

In operation, the electromagnetic driver 80 is energized by applying pulsed current to a coil mounted adjacent shaft 84 (not shown). The current, by known electromagnetic principles, causes an axial force to act on shaft 84. As shown in FIGS. 2 and 3, coil springs 90 and 92 are mounted to shaft 84 by collars 94 and 96, respectively. When the electromagnetic driver is energized by current of a given polarity, shaft 84 is driven in the direction indicated by arrow "*a*," shaft 84 compressing or pushing spring 92 while pulling or placing spring 90 in tension. The axial motion of shaft 84 is coupled to plate 39 by virtue of the mounting connection at 88. During the period of time when the electromagnetic driver is not energized, the shaft 84 is forced in the direction of arrow "*b*," applying a compressive force to spring 90 and tension to spring 92. The low power and force requirements of the system herein described results from the energy stored in the springs when the shaft is forced in the direction of arrow "*a*." When the current applied to the coil is removed, the stored energy, or resilience, of the springs, is released and drives the shaft in the direction of arrow "*b*." The axial-driving force described imparts the motion to the developer material as described hereinabove. Utilizing coil springs 90 and 92 in the push-pull arrangement between plate 39 and driver 80 produces the fluidization of the developer material with several attendant advantages. The displacement of the arcuate plate containing the developer is readily controlled by limiting the current through the driver coil. The suspension of plate 36 and driver 80 by using flexing means 72 and 76 isolates the vibrations introduced by the driver 80 from the rest of the xerographic apparatus. In the preferred embodiment, the bed is vibrated at the resonant frequency of the mechanical system described hereinabove in order to minimize the force-power requirements necessary to fluidize the developer. The advantages of using the driving system described hereinabove, other than low force-power requirements, are low machine frame vibrations and noise and high reliability and life. In addition, the suspension of the bed on the flexing means 72 provides axial and radial movement thereof, thereby providing radial as well as axial developer flow. This type of flow, characterized by an 8-shaped flow, provides additional developer-image contact areas, thereby producing higher quality images than heretofore possible.

The flexing sheets **72** and **76** are chosen for vibration isolation primarily, while the driver is operated at the resonant frequency of the driven system which in part comprises the flexing sheets and the coupling of coil springs **90** and **92**. Thus, the amplitude of vibration will be determined by the condition when the input energy to driver **80** equals or balances the dissipative energy due to hysteresis and interface damping. It should also be noted that there are no sliding parts in the developer system except for the seals.

The drive system described hereinabove may be schematically represented as a two-mass (static weight of the bed and electrode grid plus the dynamic weight of the developer when it is flowing through the bed and the weight of the driver), three-spring (flexors **72**, **76**, coil **90** an **92**) system.

As discussed previously, when operating the driver **80** at the resonant frequency of the developer system, a relatively low force is required to drive the system in order to fluidize the developer.

The schematic representation of the drive system is illustrated in FIG. 4. The symbol K_{F76} represents the spring constant of flexing means **76**, W_D represents the weight of driver **80**, $K_{90,92}$ represents the spring constant of springs **90** and **92**, W_P represents the static weight of the plate **36**, grid electrode **37** and the dynamic weight of the developer flow, K_{F72} is the spring constant of flexing means **72**, C_D is a dashpot representing the damping in the system and x and y are the directions in which the bed is to be vibrated. The spring constants K_{F72} and K_{F76} preferably are small and are matched with their respective displacements, i.e., $K_{F72}x = K_{F76}Y$.

The bed may be deflected to the left or right, represented by x and y, respectively, and, as is well known, when released will oscillate about its rest position with a predetermined period (or frequency and ever-decreasing amplitude due to the damping effect of the system as represented by dashpot C.

Simplified mathematical equations relating the various elements of the system to the x and y displacement y the system operates at the resonant frequency are:

1. $F_R = K_{F72}x + c\dot{x} + m\ddot{x} + K_{90,92}x + K_{90,92}Y$

2. $F_R = K_{90,92}x + M\ddot{y} + K_{F76}y + K_{90,92}Y$ wherein

F_R = force necessary to vibrate plate to fluidize developer
m = mass of the bed
M = mass of the driver
c = proportional to the system damping effect
$\dot{x}$ = first derivative of x (velocity)
$\ddot{x}$ = second derivative of x (acceleration)
$\ddot{y}$ = second derivative of y (acceleration)

Although calculations utilizing equations (1) and (2) will not be given since the equations may also be solved either by experimentation or by the use of analog or digital computation techniques, it has been determined, as stated hereinabove, that minimum force is required to vibrate the bed when the system is operating at the resonant frequency.

The resonant frequency of the system may be approximated by solution of the following second order differential equations:

3. $m\ddot{x} + (K_{90,92} + K_{F72})x + K_{90,92}Y = 0$

4. $m\ddot{y} + (K_{90,92} + K_{F76})Y + K_{90,92}x = 0$ Equations (3) and (4) may be solved by the techniques suggested for the solution to equations (1) and (2) described hereinabove. It is to be noted that the solutions to equations (1)-(4) are within the capabilities of those skilled in the art.

When such motion is imparted to the vibratory elements with two-component developer in the development zone **11** above the arcuate plate **36**, the vibrations imparted to the developer by plate **36** as well as the grid **37** will cause the developer to rise, suspending itself in a fluidized mass or bed throughout the space of the development zone **11** between the plate **36** and the image bearing surface of the belt **10**.

In operation, after the latent electrostatic image is formed on belt **10**, the belt is set in motion by an conventional power source not shown. Concurrent with the movement of the belt, the vibration-imparting elements are set in motion by the activation of electromagnetic driver **80**. At the same time, two-component developer is then gravity fed through the development zone **11** and the grid **37** is given an electrical bias to thereby produce a development electrode field adjacent the image-bearing surface. The vibrations of the plate **36** and grid **37** thus cause the developer thereabove to fluidize itself for contacting and developing the image on the belt **10**. After one or plural passes of the belt through the development zone **11**, motions of the belt and vibrational elements may be stopped since development has been accomplished.

It should be noted that the driving system of the present invention may be readily adapted to vibrate the fluidized bed in a direction substantially normal to or in the direction of the movement of the latent electrostatic image-bearing surface and still be within the purview of the present invention.

What is claimed is:

1. Apparatus for developing a latent electrostatic charge pattern formed on a support member with a two-component developer material comprising carrier particles and an electrostatically attractable powder comprising:
   - support means positioned adjacent to and beneath at least a portion of said support member for supporting a quantity of said developer material on the surface thereof;
   - first flexible means for suspending said support means;
   - second flexible means for suspending **a** vibratory member;
   - a resilient member for coupling the vibratory member to said support means;
   - a vibratory member for producing vibrations when energized, said vibratory member positioned adjacent said support means and suspended by said second flexible suspending means; and
   - means for energizing said vibratory member, the vibrations produced thereby being coupled to said support means by said resilient member producing fluidization of the developer material in contact with the latent electrostatic charge pattern on said support member, whereby said charge pattern is developed.

2. The apparatus as defined in claim **1** wherein said vibratory member is operated at the resonant frequency of said developing apparatus thereby minimizing the force required to vibrate said support means to produce fluidization of the developer material.