Oct. 9, 1962 UB IWERKS 3,057,324

XEROGRAPHIC DEVELOPING APPARATUS

Filed Oct. 5, 1959 3 Sheets-Sheet 1

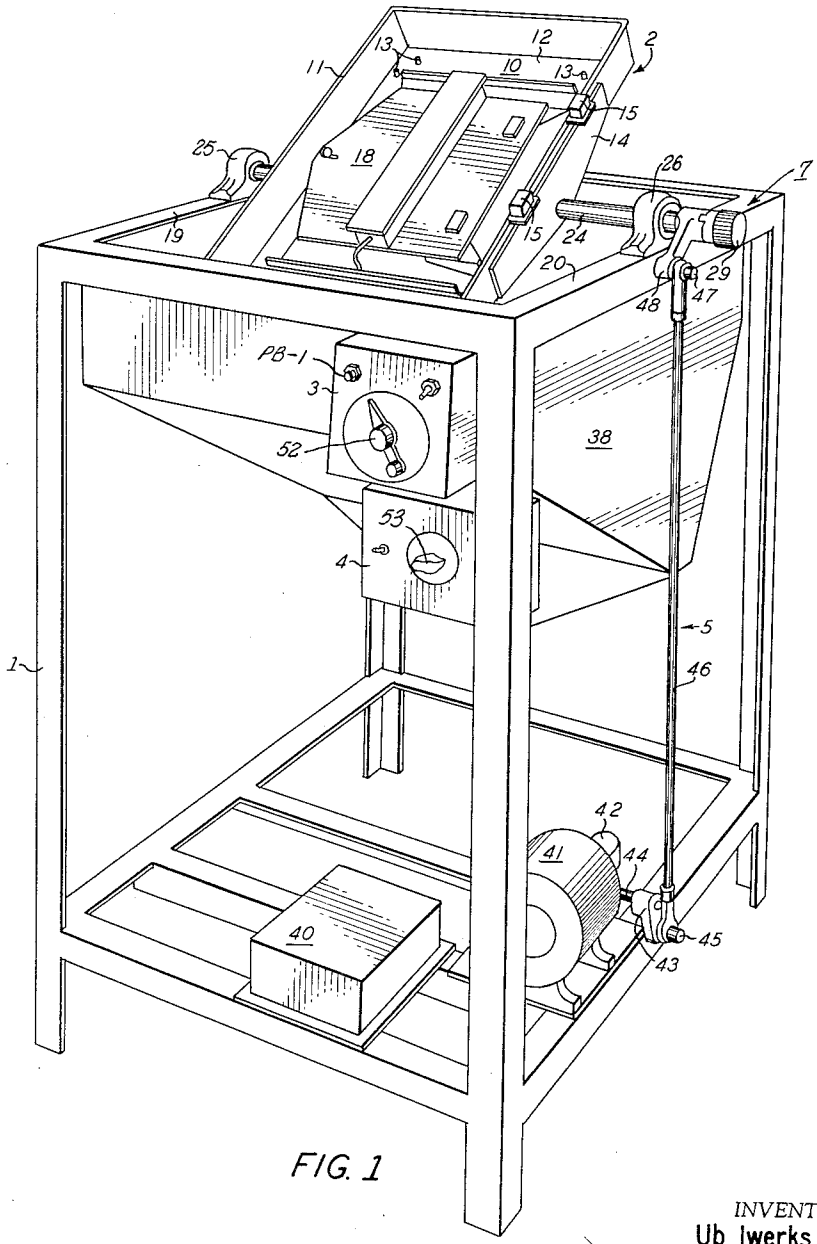


FIG. 1

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XEROGRAPHIC DEVELOPING APPARATUS

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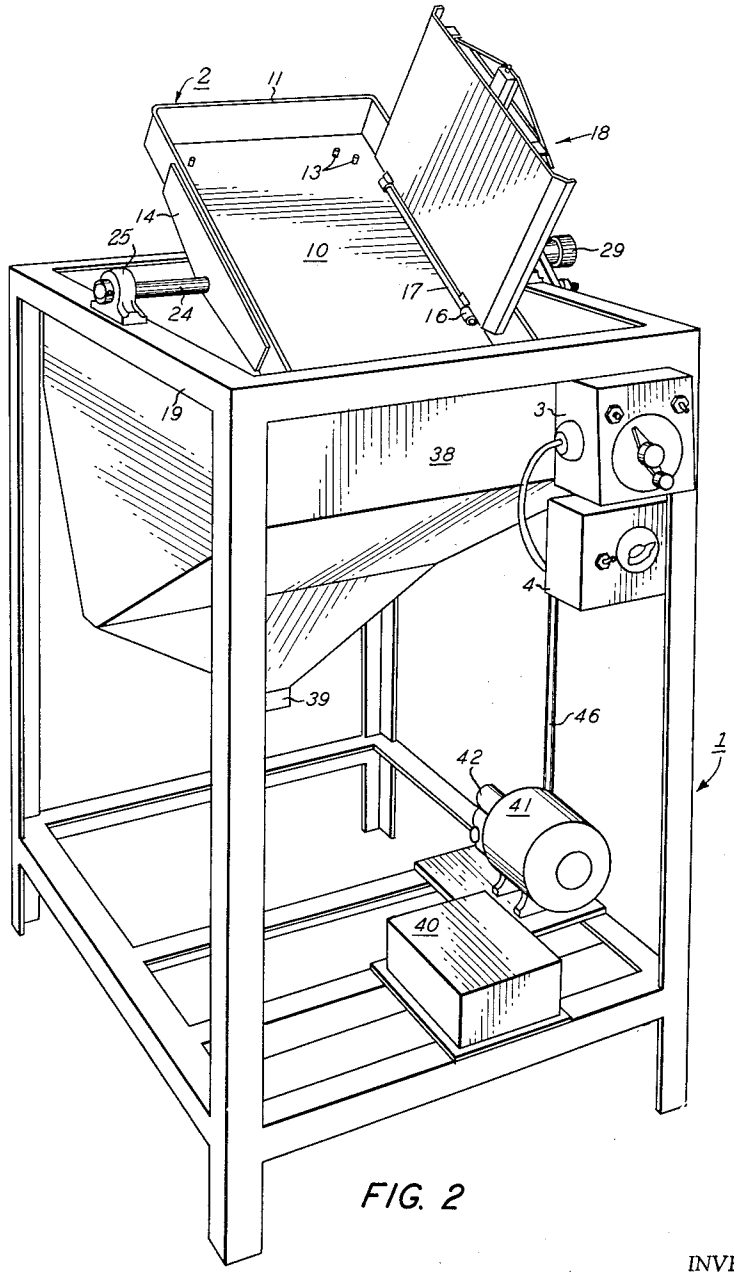


FIG. 2

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XEROGRAPHIC DEVELOPING APPARATUS

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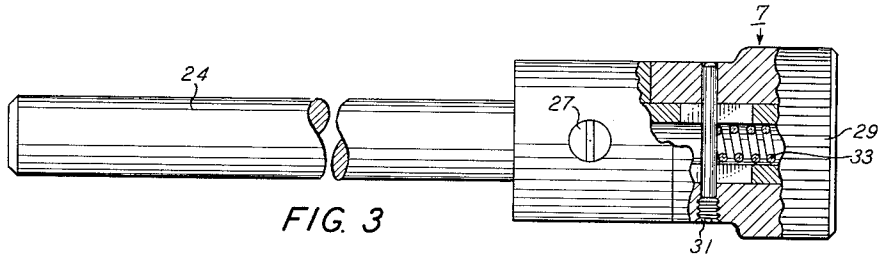


FIG. 3

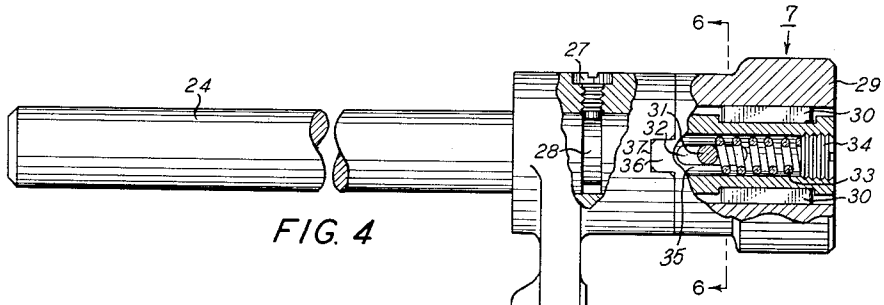


FIG. 4

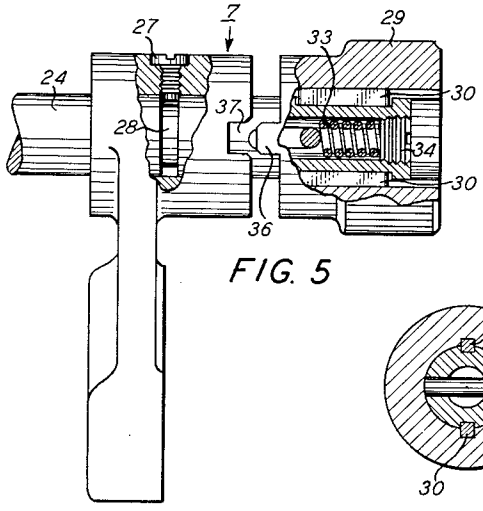


FIG. 5

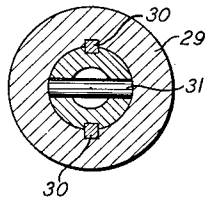


FIG. 6

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3,057,324

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3,057,324

XEROGRAPHIC DEVELOPING APPARATUS

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Filed Oct. 5, 1959, Ser. No. 844,543
3 Claims. (Cl. 118—11)

This invention relates to the field of xerography and, particularly, to an improved apparatus for developing an electrostatic latent image on a xerographic plate.

More specifically, the invention relates to an improved type of xerographic developing apparatus that is particularly adapted for the production of cartoon movies wherein on successive powder image developments of electrostatic latent images on xerographic plates it is required to effect precise homogeneous density duplication of the developed powder image so that transfer and fusing of the image to a support surface and then subsequent photographing of the supporting surfaces will result in a final prepared film which, when projected onto a screen, will bear continuous consistency of image delineation.

In the process of xerography, for example, as disclosed in Carlson Patent 2,297,691, issued October 6, 1942, a xerographic plate comprising a layer of photoconductive insulating material on a conductive backing is given a uniform electric charge over its surface and is then exposed to the subject matter to be reproduced, usually by conventional projection techniques. This exposure discharges the plate areas in accordance with the light intensity that reaches them and thereby creates an electrostatic latent image on or in the photoconductive layer. Development of the latent image is effected with an electrostatically charged, finely divided material such as an electroscopic powder that is brought into surface contact with the photoconductive layer and is held thereon electrostatically in a pattern corresponding to the electrostatic latent image. Thereafter, the developed xerographic powder image is usually transferred to a support surface to which it may be fixed by any suitable means.

In the Carlson patent it is noted that a variety of types of finely divided electroscopic powders may be employed for developing electrostatic latent images. However, as the art of xerography has progressed, it has been found preferable to develop line copy images with a two-component type of developing material such as that disclosed in Walkup Patent No. 2,618,551, issued November 18, 1952, which may include any of a variety of pigmented resins that have been specifically developed for the purpose. A number of such developing materials are manufactured and marketed commercially, being specifically compounded for producing dense images of high resolution and to have characteristics to permit convenient storage and handling.

Such developing materials are specifically designed to permit them to be electrostatically transferred and then fixed to support surfaces either by conventional heat or vapor fixing techniques, in accordance with the particular application in which they are employed. Where the support surface is composed of a material or substance such that it is impractical or considered unfeasible to permit fixing the powder image by conventional application of these methods as, for example, in the fixing of a powder image onto a cellulose acetate support surface or "cell" of the type employed in the preparation of cartoon movies, a method and apparatus disclosed in my copending application, S.N. 674,777, filed July 29, 1957, entitled "Xerographic Fusing Apparatus," may be preferred.

A basic form of xerographic developing apparatus for applying such developing materials is disclosed in Sabel and Macey Patent 2,600,580, issued June 17, 1952, and proposes a tray receptacle for securing a xerographic plate in light-free relation over a deposit of developing material freely supported within the tray. Oscillating the tray alternately in opposite directions through arcs of greater than 180° serves to cascade the developing material over the electrostatic latent image on a xerographic plate, thereby effecting development of a powder image on a xerographic plate.

A modification of the Sabel et al. device is shown in Gundlach Patent 2,777,418, issued January 15, 1957, which discloses a developing apparatus for developing an electrostatic latent image on a xerographic plate to produce more uniformity and greater blackness in the developed image areas and also to reduce the adherence of developer powder to the non-image or discharged areas. This improvement is attained by the addition of a development electrode with an electrical conducting plate which is secured to a powder tray receptacle, as above, whereby the conducting plate is positioned in close proximity to the image layer on a xerographic plate. An electrical charging means imposes a potential on the conductive plate and produces an electric field between the xerographic plate and the development electrode conducting plate. This electric field has the effect of neutralizing a field caused by residual charge on the background non-image areas thereby preventing developing material from adhering to the background areas. The development electrode conductive plate also functions to direct developing lines of force from the image areas in parallel relationship toward the conducting plate and perpendicular to the image surface which otherwise curve back from the image area to adjacent background areas. The development electrode thereby effects a uniform adherence of the developing material over the image area to produce substantially improved solid area coverage of uniform density.

Developing procedure of the electrostatic latent image on a xerographic plate using a development electrode is substantially in accordance with the procedure described in the above Sabel and Macey patent. Oscillating the developing tray with a development electrode supported thereon alternately in opposite directions with a xerographic plate secured thereon, cascades the powder developing material between the development electrode conducting plate and the xerographic plate.

Generally, in the development of electrostatic latent images for conventional xerographic copy reproduction, a developing material composed of developer carrier plus a fixed amount of pigmented resin compound or "toner" is placed in a developing tray receptacle. A xerographic plate with the electrostatic latent image exposed in light-free relation to the developing material is then secured to the tray. The latent image is then developed into powder form by cascading the developing material over the xerographic plate, as previously described. Usually, several latent image developments can be made with the same developing material, but with each development an amount of toner is consumed resulting in increasingly faint powder images on each subsequent xerographic development. When the faintness is perceived by the operator, he will add toner to the developing material to restore its density quality.

In certain applications of xerographic techniques, the matter of developing an electrostatic latent image on a xerographic plate into powder form is a highly critical procedure and requires the employment of special methods and apparatus to effect its proper accomplishment. A typical example of such a situation occurs in the application of xerographic techniques to the production of cartoon movies.

In general, to prepare a cartoon movie, each frame of the finished film is exposed to a group of four or more cellulose acetate transparencies, upon which are drawn and painted the various figures in the cartoon. Usually, each

transparency or "cel" is employed to depict a single character and a progression of cels with minute variances are necessary to portray the successive movements required to simulate motion in a finished film. Sometimes a drawing may appear on only one of the cels that are being photographed, but in all cases in a given film sequence a uniform number of cells are stacked together before exposure in order to maintain consistency of light transmission and reflection. Background scenes are usually painted on one of several types of artist painting boards and may be painted in water color, tempera color, or an oil color, and are positioned behind the cels being photographed.

An illustration of the above application would be a scene portraying an automobile in motion. The automobile must appear continually to advance in its direction of travel relative to its natural surroundings. This effect is attained by slightly displacing the automobile on each succeeding cel, so that when photographed in relation to fixed background scenery, there will result a filmed scene portraying the automobile in continuous movement.

Prior to the application of xerographic techniques to the production of cartoon movies, the preparation of the individual cels required that an artist draw a pencil sketch of the desired figure on heavy white bond paper in exact registration of the scene to be portrayed. The paper employed was specially prepared with a series of holes punched along one edge which were used for alignment and registration purposes. When the drawing was completed, it was passed on to a tracer who placed a cellulose acetate "cel" having similar registration holes over the original drawing and copied all the pencil lines of the original sketch with pen and ink. The inked drawing was then passed to another artist who colored the ink outlines on the reverse side of the cel, according to a predetermined coloring sketch. After the painting was completed, the several cels required to form a particular scene were mounted on a board, using the holes to achieve proper registration, and were photographed to form a single frame of the movie.

Since normal motion picture projection speeds are twenty-four frames per second and a minimum of four cels are required to be prepared for each frame, it is apparent that a full minute of projection requires the preparation of thousands of cels and that the preparation of a two-reel "short" requires the expenditure of a tremendous amount of effort. In addition, since highly skilled artists are required for this work, it is apparent that the cost of making cartoon movies is quite high. In order to decrease these costs, it was found that xerographic techniques could be employed to eliminate a substantial portion of the skilled manual craftsmanship that was previously employed. Specifically, it was found that xerocopies of the original artist sketches could be transferred directly to cels and fused thereon, thereby eliminating completely all of the manual tracing previously required. In addition, it was found that certain of the artist's shading effects, that were normally lost in the manual tracing, could be retained by the careful application of xerographic techniques to improve the quality of the finished cartoon.

In practice, in the application of xerographic techniques to the production of cartoon movies, a xerographic plate comprising a photoconductive layer formed on a conductive backing is provided with a uniform electrostatic charge on the photoconductive layer which then is exposed to a light image of the sketch required to be reproduced, usually by conventional projection techniques. This exposure discharges the xerographic plate in the lighted areas thereof retaining a latent electrostatic image of the sketch on the photoconductive layer. This latent image is then developed by cascading a xerographic developing material over the surface of the plate whereby the pigmented resin component of the developing material or "toner" adheres to the latent image to form a xerographic powder image of the sketch on the plate. Thereafter, the xerographic powder image is transferred to the surface of a cellulose acetate "cel," by conventional electrostatic transfer techniques, and is then fixed on the cel's surface.

The foregoing technique provides an accurate and economical way of forming cels for use in the production of cartoon movies and is presently in commercial use for this purpose.

Developing an electrostatic latent image on a xerographic plate for the preparation of cartoon movies requires the employment of special apparatus not otherwise required for ordinary xerographic copy reproduction. For ordinary copy, reasonably legible image delineation and line density is usually satisfactory and, therefore, a relatively wide range of perceptibly satisfactory image reproduction is considered acceptable. When, in copy work, the reproduced image falls below the minimum acceptable standards of denseness and delineation, subsequent copy can be restored to acceptable standards by the addition of toner to the developing material. Determining when to add toner is usually discretionary as perceived by the human operator of the xerographic apparatus.

However, the standard of variation acceptable in line copy development cannot be applied to the preparation of cartoon movies as will be readily apparent from discussion to follow herein. Further, it is known in the art of xerography that, in the cascade development of an electrostatic latent image on a xerographic plate, each pass of developing material over the latent image deposits an additional amount of toner on the image, thereby increasing image density with each pass. It is also known that the rate at which developing material cascades over the latent image bears a direct relation to the amount of toner which adheres to the latent image, thereby effecting image density. To attain control of developed properties of a xerographic powdered image, control must be had of these factors which influence development.

Also, as a step in the usual ordinary line copy development procedure, an exposed xerographic plate with a latent image thereon is withdrawn from the image projection device in a light-tight receptacle for transfer to a remotely located developing tray. The light-tight receptacle prevents room light from reaching the light sensitive xerographic plate while in the process of transferring the plate between apparatus. After image development, the operator ordinarily visually inspects the powdered xerographic image to insure that complete and adequate development was effected. With precision results required in development for cartoon movie preparation, the development qualities of the xerographic image cannot be trusted to human perception. Handling of the xerographic plate bearing a latent image can therefore be faciliated and time saved by accomplishing the transfer of the image bearing xerographic plate to the developing tray in a room absent of light.

Projection of movie film onto a commercial theatre size screen effects a substantial magnification of the projected image. Flaws and discrepancies in the prepared film are very readily discernible at this increased magnification. The problem is particularly troublesome where the film is comprised of individually prepared frames from thousands of artists' drawings skillfully prepared as in the preparation of cartoon movies. It is apparent that, the animated figures or scenery being depicted must bear identical likeness in successive frames to lend a professional quality of enjoyment to the theatre viewer.

Frequently, each scene of a series of successive frames can comprise repetitions of the same background configuration and the same cartoon feature. For example, in the illustration noted above, namely, an automobile

in motion against a background scene, it may be assumed that in at least a portion of a given film sequence, the automobile will retain a given configuration through a succession of at least several frames. To achieve the illusion of motion, the automobile may be advanced on successive frames relative to a fixed background, or it may remain fixed relative to the projection screen while the background is caused to move. In either case, each scene of a series of successive frames can comprise repetitions of the same background configuration and the same automobile outline merely by displacing one relative to the other. It is apparent, therefore, that to attain professional excellence, each repetition of the same configuration must bear continuous consistency of image delineation in the final projected film. It is further apparent that where a drawing is to be duplicated on successive cels, development of the successive electrostatic latent images into powder form must bear precise homogeneous image denseness on each duplicate development to effect consistency of image delineation in the final projected film.

Prior to the application of xerographic techniques to cartoon movie preparation, duplicate delineation and denseness of image outlines on each cel were manually inked and then by visual perception were stacked to select cels of consistent light transmission and reflection. With the advent of xerography to the art of cartoon movie preparation, namely, the use of xerographic techniques in reproducing the artist's sketch onto the cel, many of the manual processes formerly required could be eliminated and the quality of the finished cartoon vastly improved. The apparatus of this invention further aids in the elimination of skilled craftsmanship while effecting an improved end product.

The principal object of this invention is to improve powder image development of an electrostatic latent image on a xerographic plate. A further object of the invention is to effect precise line density duplication of successive powder image developments of an electrostatic latent image on a xerographic plate. A further object of the invention is to provide means for accurately controlling the number of developing tray oscillations whereby with each oscillation developing material is cascaded over a xerographic plate. A further object of the invention is to provide means for regulating the rate of oscillation of the developing tray and thereby regulate the rate of cascading the developing material over a xerographic plate secured to the tray. A further object of the invention is to provide a means for rapid dumping and collecting of used developing material in combination with the means for effecting control of the number of developing tray oscillations and in combination with the means for effecting regulatory control over the rate of oscillation of the developing tray.

These and other objects of the invention are attained with the apparatus of the invention comprising a support stand, a developing tray for supporting a xerographic plate and for the containment of developing material, means for rotatably mounting the tray on the support stand, means for oscillating the developing tray to effect cascading of developing material over a latent electrostatic image on a xerographic plate supported in said tray, variably presettable means for controlling the number of oscillations of said developing tray, and variably presettable means for regulating the rate of oscillations of said developing tray. In addition, the invention includes conveniently settable means for disengaging the developing tray from its actuating means whereby the tray may readily be inclined to effect dumping of the developing material contained therein, and means for collecting the developing material.

By means of such an apparatus it is possible to attain the extreme degree of uniformity of development required for cartoon movie preparation by employing a large quantity of developing material that is premixed to a homogeneous consistency. Preferably, a fixed amount of the premixed developing material is deposited in a developing tray to which a xerographic plate with an electrostatic latent image thereon is secured in developing relation. The developing tray with the xerographic plate secured thereto is then oscillated alternately in opposite directions to effect cascading of the developing material over the latent image on the xerographic plate. The number of cascading passes or oscillations is carefully and accurately controlled and the rate of oscillation or cascadement is precisely regulated. After each powdered image development, the used developing material is preferably dumped from the tray and a fresh quantity of the same premixed consistency is added. Each succeeding development is effected with fresh developing material and precisely duplicated as to number of oscillations and the rate of oscillation to effect identical image development properties in each instance. When the premixed developing material is exhausted, a new quantity of developing material is prepared having the same homogeneous consistency as before and the developing process is continued. Successive developments are precisely controlled with means provided for variably presetting the controls. Extreme care is thereby exercised in developing the latent image on a xerographic plate to effect duplicate developed image properties. Also, with the employment of precision apparatus to control xerographic image development qualities, there is a lessened need to conduct the developing procedure in an illuminated room thereby eliminating the need of a light-tight receptacle enclosing the image bearing xerographic plate when transferring the plate to the developing apparatus. By thus eliminating use of the light-tight receptacle, handling of the xerographic plate can be facilitated and further saving in the overall cost of producing cartoon movies can be effected.

A preferred form of the invention is disclosed in the accompanying drawings, in which:

FIG. 1 is a perspective view of the xerographic developing apparatus of the invention;

FIG. 2 is a perspective view of the apparatus of the invention, showing the mechanism of the developing tray in position to receive a xerographic plate; and

FIGS. 3 through 6, inclusive, are detail views of the clutch apparatus for engaging and disengaging the developing tray and its actuating mechanism.

In the form of apparatus shown in the drawings, the invention includes a support stand **1**, an oscillating mechanism **5** for actuating developing tray assembly **2**, a control mechanism **3** for variably presetting the number of developing tray oscillations, and a speed control mechanism **4** for variably presetting the rate of developing tray oscillations; as well as a clutch mechanism **7**, for engaging and disengaging the developing tray and its actuating mechanism.

Development of a previously formed electrostatic latent image in a xerographic plate is effected with a developing material in developing tray assembly **2** illustrated in FIGS. 1 and 2 which includes a tray **10** for the containment of developing material having four side walls **11** that are integrally connected on their lower edges by a flat bottom plate **12**. Extending upwardly from bottom plate **12** and secured thereto are cylindrical locating pins **13** which are positioned to correspond to holes in a xerographic plate and serve to secure a plate (not shown) in the assembly in parallel relation to bottom plate **12**. On the sides of tray **10** are side rails **14** each secured to rotatable shaft **24** and integrally connected with side walls **11** whereby oscillation of the shaft will oscillate the tray by means described below. A development electrode assembly which may be of the aforementioned type and generally designated **18** is arranged to be moved outwardly and away from bottom plate **12** to make the bottom plate accessible for installing or removing a xerographic plate. Movement of the electrode is effected by

pivoting on stabilizer pin 17 which is rotatably mounted in hinge clasp 16 secured to side plate 11. Magnets 15 maintain the development electrode assembly in the outward ineffective position illustrated in FIG. 2. For development of line copy reproduction, the development electrode assembly 18 may be dispensed with and omitted from the structure and a xerographic plate bearing a latent image is cascaded with developing material as described below.

For actuating the tray assembly oscillating mechanism 5 is adapted to be driven by electric motor 41 that is energized from rectifier 40. The motor drive is transmitted to gear box 42, secured to the motor shaft. Eccentric 43 is driven through trunnion 44 which extends from and is driven by the gear box 42. The lower journaled end of connecting rod 46 is rotatably mounted on crank pin 45 secured to and extended outward from the eccentric. The upper journaled end of connecting rod 46 is rotatably mounted on crank pin 47 secured to and extended from rocker arm 48.

The developing tray assembly is effectively supported on lateral shaft 24 which extends through the upper bossed end of rocker arm 48 (see also FIGS. 3, 4 and 5) and is rotatably supported in journaled bearings 25 and 26. Each of the journaled bearings is secured to the support stand's top surface irons 19 and 20. Set screw 27 engages shaft 24 in recess 28 to maintain lateral alignment of rocker arm 48 relative to the shaft without restricting shaft rotation independent of the rocker arm.

Drive of the oscillating mechanism is transmitted through the rocker arm to knurled knob 29 which is secured to the end of shaft 24 through keys 30. Knob 29 acts as a clutch whereby to engage the oscillating mechanism with the shaft and can be moved laterally on the shaft 24 to disengage rocker arm 48 as is illustrated in FIG. 5. Positioning screw 31 which is inserted through knob 29 and oval slot 32 limits the knob's lateral movement of the shaft. Spring 33, compressed between positioning screw 31 and lock screw 34 within hollow 35 of shaft 24, urges knob 29 to engage the oscillating mechanism 5 by engaging tongue 36 in groove 37 of the rocker arm. Eccentric member 43 transmits a substantially harmonic rise and fall to connecting rod 46 effecting oscillation of rocker arm 48 that is transmitted to knob 29 and thence to shaft 24 to oscillate developing tray assembly 2. With a xerographic plate secured to the bottom of developing tray 10 as above, oscillation thereof effects cascading of developing material over the electrostatic latent image on the plate to effect development thereof.

Oscillating control mechanism 3 (FIGS. 1 and 2) serves to interrupt the electric circuit of motor 41 after a preset number of developing tray oscillations. Any suitable counting means can be employed which can be preset to permit a predetermined number of oscillations. In preferred embodiment, oscillating control mechanism 3 consists of a variably presettable electric timing device 52 series connected to the motor 41 to interrupt potential supplied thereto after completion of the oscillating cycle which has been preset. The required oscillating cycle is determined by mathematically converting from a required number of oscillations at the known oscillating rate to a corresponding unit of time which can then be preset on the timer. Depressing push button PB–1 closes the circuit to initiate motor operation. For controlling the tray oscillation rate speed control mechanism 4 effects speed regulation of motor 41. Any means effecting variable preset speed regulation may be employed, but in preferred embodiment, speed control mechanism 4 includes a variably presettable rheostat 53 connected to the circuitry of motor 41 whereby to introduce therein a variable electrical resistance and effect motor speed variations by means well known to those skilled in the art.

After any number of powder image developments in the above-described manner, it may be desired to replenish the developing tray 10 with unused developing material. To remove developing material from the tray, knob 29 is slidably retracted on shaft 24 so as to disengage tongue 36 from groove 37 thereby disengaging the shaft from the oscillating mechanism 5. Turning of knob 29 when so disengaged rotates the shaft and the developing tray 10. As the tray becomes inverted, developing material contained therein dumps into collection hopper 38 suspended within support stand 1 and secured thereto and serves to collect all dumped-out developing material from tray 10. Developing material may be subsequently removed from hopper 38 through hopper outlet 39.

In operation a xerographic plate having a previously formed electrostatic latent image on its surface is secured to bottom plate 12 of tray 10 by means of pins 13. If a development electrode 18 is employed, it is pivoted outwardly to permit insertion or removal of the xerographic plate, and afterward it is secured in developing relation.

With a xerographic plate secured in the developing tray assembly stocked with developing material, rheostat 53 is preset to effect a desired oscillating rate. Thereafter timer 52 is preset to a time which effects an oscillating period that includes a predetermined number of oscillations. Depressing push button PB–1 energizes motor 41 to effect tray oscillation during which developing material is cascaded over the plate surface to develop a xerographic powder image on the plate. After timer 52 expires, the circuit to motor 41 is interrupted and tray oscillation ceases. The xerographic plate is then removed from the apparatus of the invention to another apparatus whereat the powder image is transferred to a support surface.

If it is desired to replace the previously employed developing material with a fresh unused quantity, knob 29 is retracted until disengaged from rocker arm 48. Thereafter knob 29 is rotated to invert the tray and dump developing material from the tray into collection bin 38. With a fresh quantity of developing material in the tray, a subsequent development can be effected.

By the arrangement thus described, there is provided a xerographic powder image developing apparatus that is operative in a room with the absence of light and that precisely duplicates the homogeneous density of successively developed electrostatic latent images on xerographic plates.

Since many changes could be made in the above construction and many apparently widely different embodiments of this invention could be made without departing from the scope thereof, it is intended that all matter contained in the drawings shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. Apparatus for developing an electrostatic latent image previously formed on a xerographic plate of a cartoon picture frame of which images corresponding to successive frames must be developed with density uniformity, said apparatus comprising:

(*a*) a support stand,

(*b*) a rectangular shaped developing tray having a bottom wall, side walls and end walls to contain a measured amount of two-component particulate developing material of pre-mix concentration of carrier and toner,

(*c*) said tray having means to mount a xerographic plate against said bottom wall with the image-bearing surface of the plate facing upward,

(*d*) a rotatable shaft connected to said developing tray to support said tray on said support stand,

(*e*) means connected to said shaft to oscillate said shaft with the developing tray secured thereto through an angle sufficient to cascade developing material from one end of said tray toward the other end over an electrostatic latent image on a xerographic plate mounted in said tray, and

(*f*) control means operatively connected to the oscil-

lating means to define the number of developing tray oscillations per development,

(*g*) said control means being variably pre-settable in accordance with predetermined developing requirements as correlated to said developer mix concentration to quantitatively control the physical presentation of developing material to a xerographic plate bearing an image to be developed to develop the image with a defined control density.

2. Apparatus for developing an electrostatic latent image previously formed on a xerographic plate of a cartoon movie picture frame of which images corresponding to successive frames must be developed with density uniformity, said apparatus comprising

(*a*) a support stand,

(*b*) a rectangular shaped developing tray having a bottom wall, side walls and end walls to contain a measured amount of two-component particulate developing material of pre-mix concentration of carrier and toner,

(*c*) said tray having means to mount a xerographic plate against said bottom wall with the image-bearing surface of the plate facing upward,

(*d*) a rotatable shaft connected to said developing tray to support said tray on said support stand,

(*e*) means connected to said shaft to oscillate said shaft with the developing tray secured thereto through an angle sufficient to cascade developing material from one end of said tray toward the other end over an electrostatic latent image on a xerographic plate mounted in said tray,

(*f*) control means operatively connected to the oscillating means to define the number of developing tray oscillations per development,

(*g*) said control means being variably pre-settable in accordance with predetermined developing requirements as correlated to said developer mix concentration to quantitatively control the physical presentation of developing material to a xerographic plate bearing an image to be developed and

(*h*) a second control means operatively connected to the oscillating means to regulate the oscillating rate of said tray,

(*i*) said second control means being variably pre-settable to effect a refinement of control over said first control means whereby to develop the image with a defined control density.

3. Apparatus for developing an electrostatic latent image previously formed on a xerographic plate of a cartoon movie picture frame of which images corresponding to

successive frames must be developed with density uniformity, said apparatus comprising:

(*a*) a support stand,

(*b*) a rectangular shaped developing tray having a bottom wall, side walls and end walls to contain a measured amount of two-component particulate developing material being a portion of pre-mix concentration of carrier and toner, which portion is discarded after each development,

(*c*) said tray having means to mount a xerographic plate against said bottom wall with the image-bearing surface of the plate facing upward,

(*d*) a rotatable shaft connected to said developing tray to support said tray on said support stand,

(*e*) a D.C. motor operatively connected through linkage to said shaft to oscillate said shaft with the developing tray secured thereto through an angle sufficient to cascade developing material from one end of said tray toward the other end over an electrostatic latent image on a xerographic plate mounted in said tray,

(*f*) control means operatively connected to said motor to define the number of developing tray oscillations per development,

(*g*) said control means being variably pre-settable in accordance with predetermined developing requirements as correlated to said developer mix concentration to quantitatively control the physical presentation of developing material to a xerographic plate bearing an image to be developed and

(*h*) a second control means operatively connected to the oscillating means to regulate the oscillating rate of said tray,

(*i*) said second control means being variably pre-settable to effect a refinement of control over said first control means whereby to develop the image with a defined control density.

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