June 20, 1972 M. R. KUEHNLE 3,671,120

SYSTEM FOR PROCESSING LARGE XEROGRAPHIC PRINTS

Filed Sept. 28, 1970 2 Sheets-Sheet 1

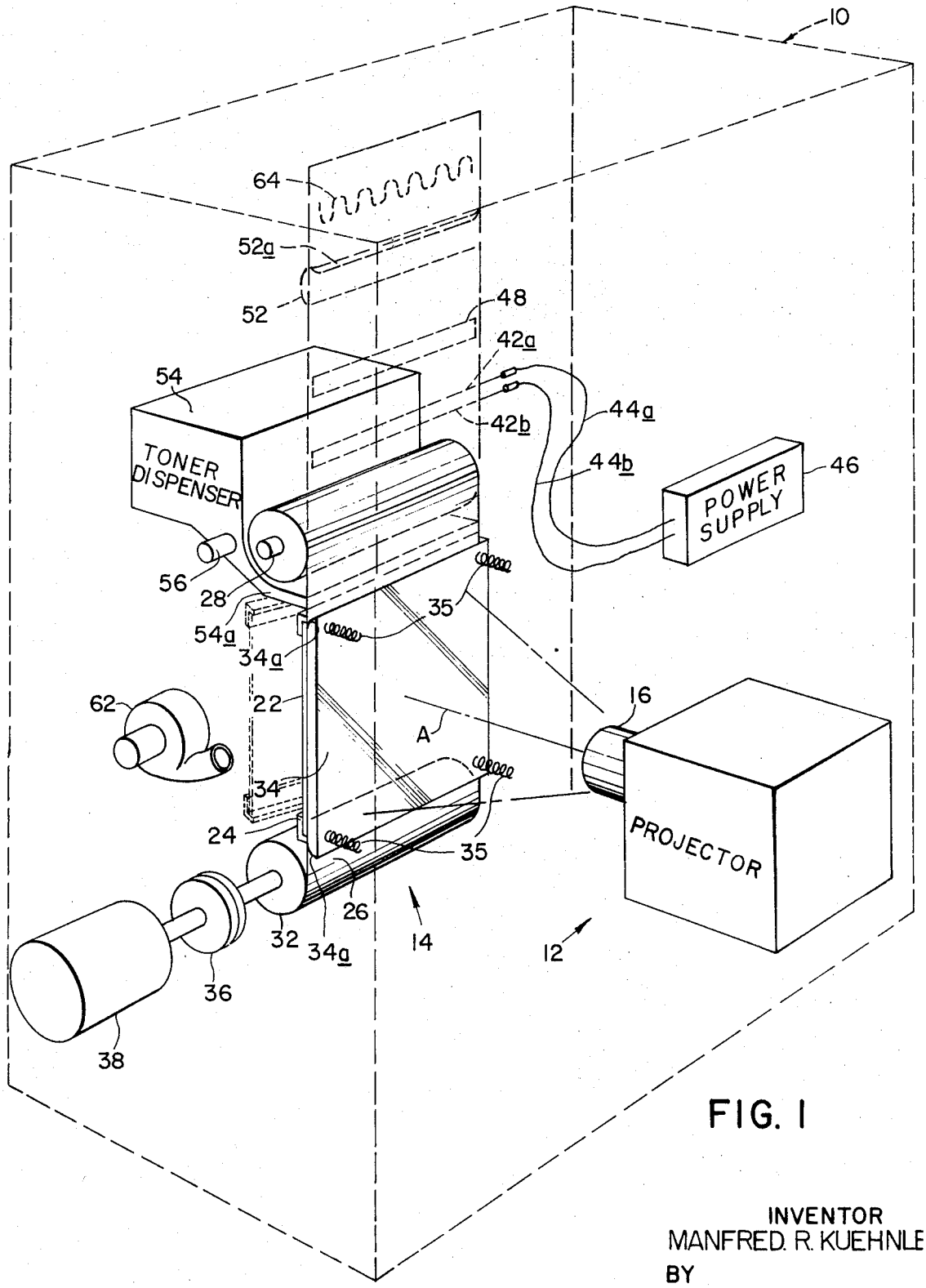


FIG. 1

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SYSTEM FOR PROCESSING LARGE XEROGRAPHIC PRINTS

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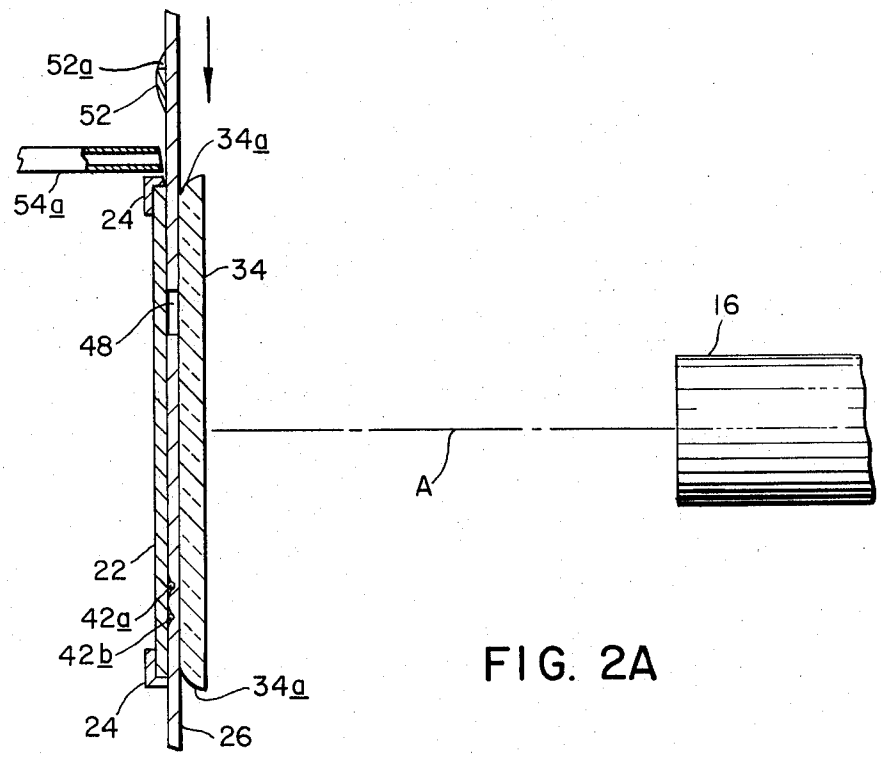


FIG. 2A

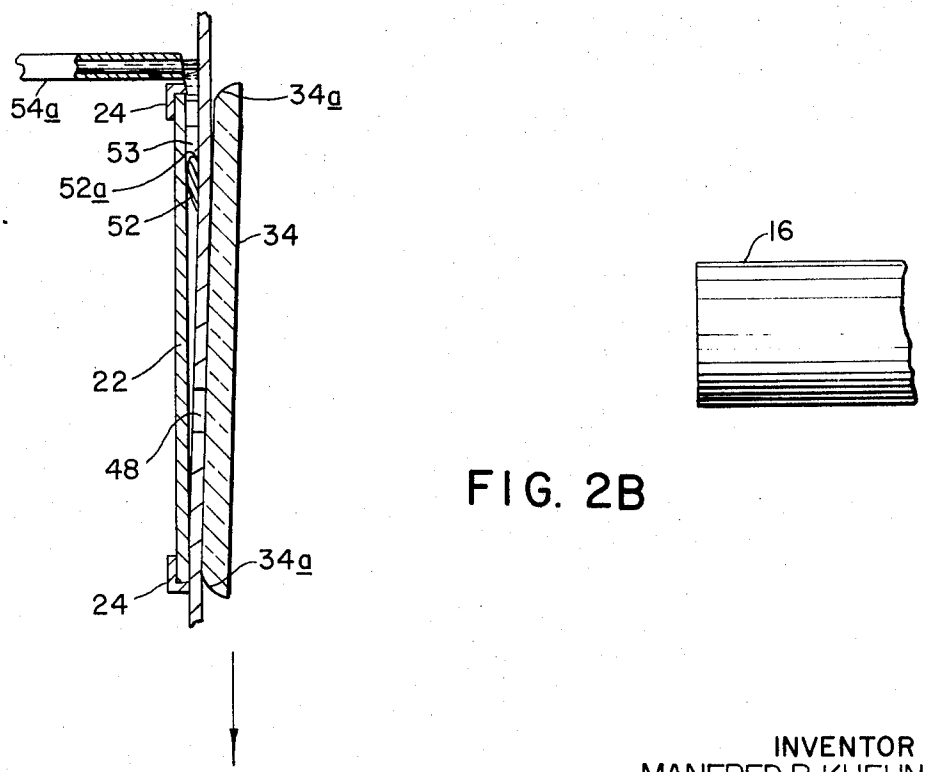


FIG. 2B

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SYSTEM FOR PROCESSING LARGE XEROGRAPHIC PRINTS

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ABSTRACT OF THE DISCLOSURE

Present xerography systems impress an image on an electrostatic sheet or film by charging the entire area of the sheet and then exposing that area to the image and then applying toner to that area to develop the image impressed on the film to permanent visible form. The present system charges, exposes and tones a large area electrostatic sheet or film in sections by positioning a vertically moving curtain between the film and the lens system. Horizontal corona discharge producing electrodes, a horizontal window and a horizontal wiper blade are spaced one above the other on the curtain. As the curtain moves downward, the electrodes charge progressively lower areas of the film across its full width. Then the downwardly moving horizontal window exposes these areas, in turn, to progressively lower portions of the image projected from the lens system so that a latent image is found on the film. Finally, the downwardly moving wiper blade spreads toner from an adjacent supply uniformly over progressively lower areas of the exposed film so that a high-quality visible image is impressed on the film.

BACKGROUND OF THE INVENTION

This invention relates to a system for making film transparencies and prints by xerography. It relates more particularly to a system for making relatively large area xerographic prints and transparencies which are characterized by their relatively high quality.

Conventional xerography systems impress visible images on a sheet or film by charging the entire film and then exposing it to develop a latent image on the film. Finally, toner is applied to the film to reduce the latent image to permanent visible form. This technique has worked quite satisfactorily with relatively small area prints and transparencies, i.e. on the order of 15 by 15 inches. However, when one attempts to make large area xerographic prints and transparencies, e.g. on the order of 30 by 30 inches and larger, using the usual xerography techniques, the results are not always satisfactory. The reasons for this are two-fold. First, conventional charging techniques may not impress a uniform electrostatic charge over a large area. Consequently, the latent image impressed on the charged sheet may not correspond accurately to the image projected from the lens system. Secondly, using conventional procedures, it is very difficult to apply the toner uniformly over the entire area of the sheet or film. Therefore the visible image produced on the film may not correspond accurately to the latent image thereon. As a result of these variables, the lines making up the photographic image tend to be of varying intensity and are sometimes indistinct, with the result that the overall photographic image is of relatively poor quality.

SUMMARY OF THE INVENTION

The present invention aims to provide a xerography system which is capable of making large-area, high quality xerographic prints and transparencies.

A further object of the invention is to provide such a system which is relatively easy to make and maintain.

Another object of the invention is to provide a system

which makes enlarged xerographic prints or transparencies directly.

Yet another object of the invention is to provide a system of this type which is easy to operate.

Other objects of the invention will in part be obvious and will in part appear hereinafter.

The invention accordingly comprises the features of construction, combination of elements and arrangement of parts which will be exemplified in the construction hereinafter set forth and the scope of the invention will be indicated in the claims.

Briefly, the present xerography system processes a large-area xerographic sheet or film in a progressive fashion. The film is positioned on the lens axis of an image-projecting lens system. An opaque curtain is situated between the film and the lens so that it normally prevents projected light from striking the film.

The curtain carries a pair of long, closely-spaced corona discharge producing electrodes which extend across the width of the curtain (and the film). When these electrodes are energized, they develop a narrow horizontal band of corona discharge. The curtain also has a relatively narrow horizontal window spaced above the electrodes. The area of this window corresponds to the area of the corona discharge produced by the electrodes. Finally, a relatively narrow, horizontal wiper blade is attached to the curtain above the window.

When the curtain is moved downwards, first the electrodes, then the window, and finally the wiper blade, are drawn down along the face of the film. As the electrodes move along the film, progressively lower areas of the film are charged. Then, as the window moves along the film behind the electrodes, progressively lower parts of the projected image from the lens system are incident on progressively lower charged areas of the film. Finally, as the wiper blade moves downward along the film behind the window, it spreads toner from a supply adjacent the top of the film smoothly and evenly over progressively lower exposed areas of the film.

Thus when the wiper blade reaches the bottom of the film, the entire image projected from the lens system is permanently impressed on the film. The curtain then returns to its initial position and the film is removed, completing the cycle.

If desired, the curtain may also include a heating element spaced above the wiper blade which can develop sufficient heat to more rapidly dry the toner on the film, and thereby speed up the printing process.

It is apparent then that the present system performs the different steps in the xerography process separately but continuously on relatively small areas of a much larger film. These areas are small enough to be charged and toned uniformly so that the portions of the total photographic image impressed on these areas have the quality and clarity of small xerographic prints or transparencies made in the usual way. Consequently, the entire film, which is the sum of these parts, has comparable quality and clarity.

Furthermore, while the present system employs a single step process to make xerographic enlargements, it is still relatively simple and inexpensive to make and can be operated and maintained by relatively unskilled personnel.

BRIEF DESCRIPTION OF THE DRAWINGS

For a fuller understanding of the nature and objects of the invention, reference should be had to the following detailed description taken in connection with the accompanying drawings, in which:

FIG. 1 is a diagrammatic view with portions developed in dotted lines of a system for making xerographic enlargements embodying the principles of my invention;

FIG. 2A is a side elevation of the portion of the FIG. 1 system at one point in its operating cycle; and

FIG. 2B is a similar view at another point in the operating cycle of the system.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The entire xerography system is enclosed in a housing **10**. It includes a projection section shown generally at **12** which projects a still image to be impressed on a large-area electrostatic sheet or film **22**. The system also includes a processing section shown generally at **14** which processes the image projected onto the film **22** into permanent visible form.

For purposes of discussion, we will talk in terms of an enlarged film or transparency. However, it should be understood that the present system is also equally capable of making print enlargements.

Projection section **12** generates an image in the usual way from a transparency or print. This image is then projected through a lens system **16**, having an optical axis A, toward the processing section **14**.

A suitable frame assembly **24** mounted within housing **10** supports film **22** so that it is centered on lens axis A. Frame assembly **24** is designed to permit ready removal of the film and replacement by another similar film. Of course the lens system **16** is arranged so that an image of a size comparable to the size of film **22** is brought to focus at the opposing face of the film.

An opaque, flexible curtain or sheet **26** is positioned adjacent the face of film **22** opposite lens system **16**. Curtain **26** is stretched between a let-off spool **28** and a take-up spool **32**. Also a transparent glass or plastic platen **34** is supported within the housing and biased by any suitable means such as springs **35** towards frame assembly **24** so that it presses curtain **26** flat against the film **22** in the frame assembly.

Curtain **26** can be wound in either direction between the two spools **28** and **32** so that it slides up and down in the space between film **22** and platen **34**. Preferably the upper and lower edges **34***a* of the platen are beveled on the side adjacent the curtain to facilitate this movement.

Curtain **26** is moved by any convenient means. In the present illustration, the let-off spool **28** is spring-loaded so that it tends to wind up curtain **26**. On the other hand, the take-up spool **32** is connected by way of normally engaged solenoid clutch **36** to a geared down electric motor **38**. When motor **38** is energized and clutch **36** is deenergized, spool **32** is rotated so that the curtain **26** is slowly pulled downwards and rolled up on spool **32**. After the curtain has reached the end of its travel, clutch **36** is energized, thereby disengaging the spool **32** from the motor so that the curtain **26** is immediately rolled up again on the spring-loaded spool **28**. As soon as the solenoid **36** is deenergized again, the curtain will again move slowly downwards as it is wound up on spool **32**, and so on.

Still referring to FIG. 1, film **22** is processed by various elements carried by curtain **26**. For purposes of clarity, we have shown in dotted lines a development of the portion of the curtain wound up on spool **28** in order to show more clearly these elements on the curtain. The terms "above" and "below" as used herein refer to relative positions on the developed portion of the curtain **26**.

More particularly, a pair of narrow corona discharge producing wire electrodes **42***a* and **42***b* are affixed to the curtain on the side thereof facing film **22**. These electrodes extend substantially the full width of the curtain (and the film **22**) and they are closely spaced one above the other. These electrodes are connected by means of long, flexible connectors **44***a* and **44***b* to a power supply **46**. When supply **46** is turned on, a corona discharge is developed in a generally rectangular area around the electrodes **42***a* and **42***b*.

Also a window or slit **48** is formed in curtain **26** directly above the electrodes **42***a* and **42***b*. The shape and area of window **48** is substantially the same as the shape and area of the corona discharge produced by the energized electrodes.

In addition curtain **26** carries a horizontal wiper blade **52** spaced above window **48**. Blade **52** projects out from the side of the curtain facing film **22** and extends substantially the entire width of the curtain and film.

Normally, curtain **26** is wound up on spool **28**. In this condition electrodes **42***a* and **42***b* are positioned just above the frame assembly **24** and the slit **48** and wiper blade **52** are on the curtain portion wound up on spool **28**. To operate the system a film **22** is placed in assembly **24**. Then the power supply **46** is turned on either manually or automatically and the projection section **12** is caused to project an image toward the film in assembly **24**. It should be emphasized, however, that the opaque curtain **26** prevents any of the projected light from stricking the film.

Now, with the motor **38** running, clutch **36** is engaged so that spool **32** commences winding up the curtain **26**. As the curtain moves downwards, the electrodes **42***a* and **42***b* are drawn downwards across the face of film **22**. The corona discharge developed by these electrodes impresses an electrostatic charge on progressively lower horizontal bands or areas of film **22**.

Turning now to FIG. 2A, as the curtain **26** continues moving downwards, window **48** is drawn down along the face of film **22**. This allows progressively lower bands or areas of the film to be exposed to progressively lower portions of the projected image from lens system **16**. Those charged portions of the film **22** which are struck by light from lens system **16** (corresponding to light areas in the original image being projected) are discharged. On the other hand, those portions which do not receive this incident light (corresponding to the darkened areas on the image being projected) remain charged. Thus, by the time the window **48** has reached the bottom of the film, the entire area of film **22** has been charged and exposed to the image from lens system **16** so that a corresponding latent image is impressed on film **22**.

In the meantime, however, as the curtain **26** continues moving downwards, wiper blade **52** is drawn along the face of film **22** as shown in FIG. 2B. Just after the blade arrives at the top of film **22**, liquid toner **53** from a toner dispenser **54** is dispensed onto the top of blade **52** between film **22** and curtain **26**. More particularly, as best seen in FIGS. 1 and 2A, dispenser **54** has a wide mouth **54***a* which extends to curtain **26** between the let-off spool **28** and the top of the frame assembly **24**. When a solenoid actuated valve **56** on the side of the dispenser is energized, a measured amount of liquid toner is deposited onto blade **52**.

Preferably, the top surface **52***a* of blade **52** is slightly concave to hold the toner so dispensed. Thus, as blade **52** proceeds downwards along the face of film **22**, the toner is spread evenly and uniformly over progressively lower areas of the film along their entire widths.

The toner adheres to those portions of the film **22** which still carry an electrostatic charge, i.e. those portions corresponding to the dark areas of the projected image from lens system **16**. On the other hand, toner does not adhere to the uncharged areas of the film, i.e. those corresponding to the light areas of the projected image.

Thus after the blade **52** has reached the bottom of film **22**, toner has been applied to the entire latent image on the film so that that image is reduced to permanent visible form. At this point, clutch **36** is energized, thereby disengaging spool **32** from motor **38**, with the result that the curtain **26** is immediately wound upon the spring-loaded let-off roll **28**, completing the cycle.

The finished film **22** can now be removed from frame assembly **24** and replaced by another similar film which is to receive the next projected image from section **12**.

Operation of the power supply **46**, clutch **36**, motor **38** and solenoid valve **56** can be controlled manually by the operator or in a timed sequence using a conventional timing device.

In order to speed up the printing process, it may be desirable to heat the toner applied to film **22**. One way of accomplishing this is to hinge the assembly **24** so that it can be swung back as shown in dotted lines in FIG. 1 and then to direct heated air from a blower **62** onto the surface of the film therein. Another way of doing this is to include a flexible heating element **64** as shown in dotted lines in FIG. 1 in the curtain above wiper **52**. When an electric current is supplied to the heating element as it proceeds downward along the film **22**, sufficient heat is developed to rapidly evaporate the toner solvent thereby quickly fusing the toner to the film. Also it may be desirable to maintain a humid atmosphere in the vicinity of the film so that the film retains its charge even in a dry climate. This may be accomplished by any convenient means.

It will be seen from the foregoing then that the present system is able to print directly large area xerographic prints and films in one continuous operation. Still, however, the quality and clarity of the printed images are quite high because only relatively small areas of the film are processed at any one time. Finally, the present system is relatively simple to make and to operate and should be comparable in cost to conventional xerography apparatus.

It will thus be seen that the objects set forth above, among those apparent from the preceding description, are efficiently attained and, since certain changes may be made in the above construction without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

It is also to be understood that the following claims are intended to cover all of the generic and specific features of the invention herein described.

I claim:

1. A system for making large xerographic prints and transparencies comprising

(A) a lens system for projecting an image,

(B) means for holding a film of material capable of retaining an electrostatic charge in a stationary position to receive the image projected by the lens system,

(C) means opaque to the light from the lens system positioned adjacent the holding means so as to normally prevent the projected light from striking film in the holding means,

(D) processing means carired by the opaque means, said processing means including

(1) means for impressing an electrostatic charge on the film in the holding means,

(2) a window in the opaque means spaced from the charge applying means, and

(3) means spaced from the window on the other side thereof from the charge applying means for applying toner to film in the film holding means, and

(E) means for moving the opaque means so that first the charge applying means, then the window, and finally the toner applying means are drawn along the face of film in the film holding means so that adjacent portions of the film are progressively charged, then exposed to adjacent portions of the image projected from the lens system through the window and then spread with toner whereby a permanent photographic image is impressed progressively on the sheet.

2. The system as defined in claim **1** and further including a source of toner positioned adjacent the film holding means for dispensing toner onto the applying means prior to their travel across the film in the film holding means.

3. The system as defined in claim **1**

(A) wherein the opaque means is a flexible curtain, and

(B) further including

(1) take-up and let-off spools supporting opposite ends of the curtain, and

(2) means for rotating at least one of the spools so as to draw the curtain along the face of the film in the film holding means.

4. The system defined in claim **3** and further including means for rotating at least one of the spools in the opposite direction so that the curtain returns to its initial position after processing the film.

5. The system defined in claim **1** and further including

(A) a transparent platen adjacent the opaque means on the side thereof facing the lens system, and

(B) means for urging the platen toward the opaque means so as to press the elements thereon against the film in the film holding means.

6. A system for making xerographic enlargements comprising

(A) means for holding a sheet or film capable of retaining an electrostatic charge in a stationary position, and

(B) a curtain positioned adjacent the film holding means so as to normally prevent light from striking film in the film holding means, said curtain

(1) being movable in a selected direction substantially parallel to the film holding means,

(2) means carried by the curtain for applying an electrostatic charge progressively to adjacent portions of the film in the film holding means as the curtain moves in the selected direction,

(3) a window in the curtain adjacent the charge applying means which progressively exposes the charged portions of film in the film holding means to adjacent portions of an image projected toward the film as the curtain moves in the selected direction, and

(4) means on the curtain spaced from the window for progressively applying toner to the exposed portions of the film in the film holding means as the curtain moves in the selected direction so as to produce a permanent visible image on the film.

7. The system defined in claim **6** and further including a transparent platen adjacent the curtain, said platen being biased toward the film holding means so as to press the intervening curtain against the film in the film holding means.

8. The system as defined in claim **6** and further including means for dispensing liquid toner onto the toner applying means prior to their travel across the film in the film holding means.

9. The system as defined in claim **6**

(A) wherein the curtain is stretched between a pair of spools, and

(B) further including

(1) means for driving at least one of the spools so that the curtain moves in the selected direction at a selected speed, and

(2) means for rotating at least one of the spools in the opposite direction to move the curtain in the opposite direction so that it returns to its initial position.

10. The system defined in claim **6** wherein the charge applying means comprise

(A) a pair of electrodes mounted on the curtain, and

(B) means for applying a voltage across the electrodes.

11. The system as defined in claim 6 and further including a projection system for projecting an image toward the film in the film holding means.

12. The system as defined in claim 6 and further including means for applying heat to the toner after it is applied to the film in the film holding means.

13. The system defined in claim 8 wherein the toner dispensing means comprise

(A) a container for liquid toner,

(B) means for conducting toner from the container to a region adjacent the curtain on the side thereof facing the film, and

(C) means for metering toner from the container onto the toner applying means when they approach said region.

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