April 22, 1958 W. E. BIXBY ET AL 2,831,409

XEROGRAPHIC CAMERA

Filed July 18, 1955

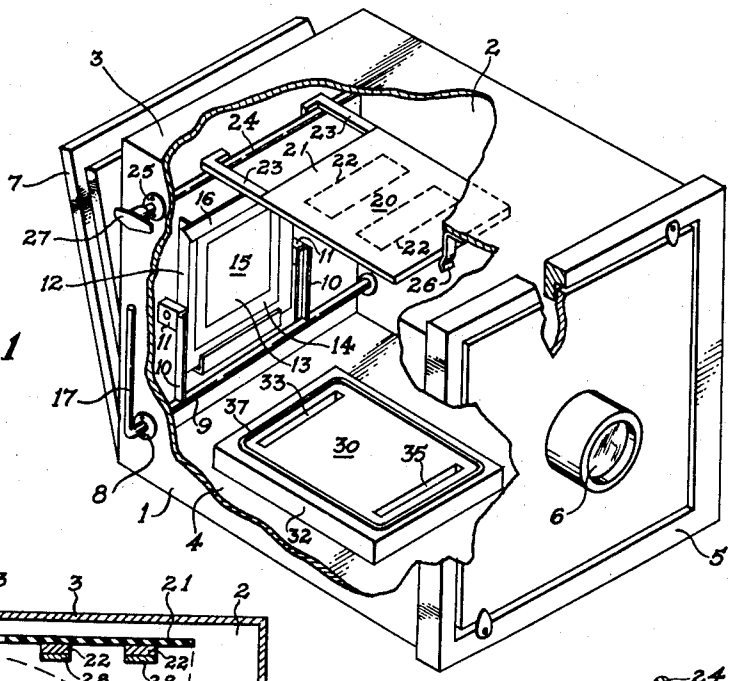


Fig. 1

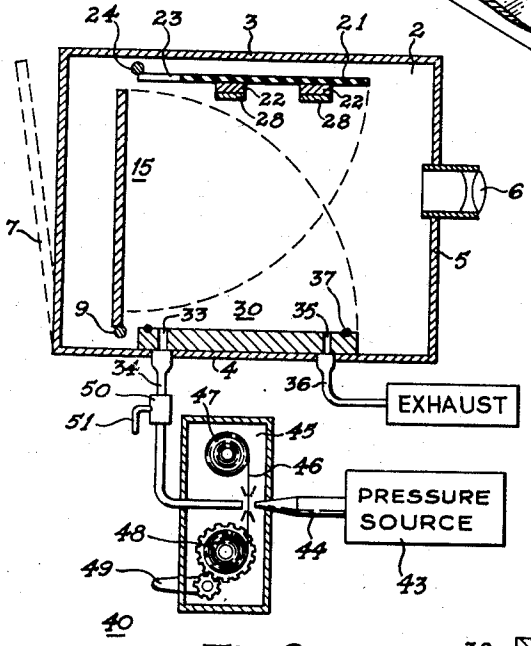


Fig. 2

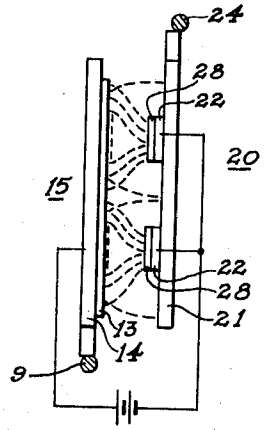


Fig. 3

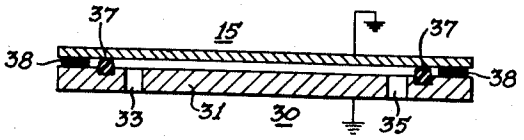


Fig. 4

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XEROGRAPHIC CAMERA

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Application July 18, 1955, Serial No. 522,540

6 Claims. (Cl. 95—1.7)

This invention relates to the field of xerography and particularly to an improved xerographic camera apparatus for the rapid processing of xerographic plates.

A process of electrophotography or xerography is described and claimed in Carlson Patent 2,297,691, issued October 6, 1942, and certain forms of xerographic apparatus for use in such a process are disclosed in Carlson Patent 2,357,809, issued September 12, 1944. Basically, the process of xerography utilizes a xerographic plate which in one form may consist of a metal plate or foil coated with a photoconductive insulating material such as sulphur, anthracene, an insulating form of selenium, or the like. This coating is given a uniform electrostatic charge on its surface, as by frictional rubbing with a cloth or brush, after which the plate may be exposed to a light image. The light discharges the coating in the areas which are struck by the light. The remaining electrostatic latent image may then be developed with a finely divided material, such as a powder or a liquid mist, to form a visible image. This visible image may then be transferred to paper or other suitable surface and the plate may be cleaned and used again.

During the development of the art of xerography, many advances and improvements have been made in the various materials and methods that constitute the process to the point that xerographic systems are currently in wide commercial use for the production of line copy and continuous tone copy, and adaptations of such systems for the production of photographs by xerographic methods are in a highly advanced stage of experimental use. The most significant advances that have permitted the wide application of this art are improvements in the methods and apparatus required for charging and for developing the xerographic plates, as well as improvements of the photographic response of the xerographic plates themselves, whereby xerographs may now be made at speeds and under conditions approaching those common in conventional silver photography.

For example, one advance which has been made in charging devices comprises the substitution of a corona charging device, i. e., a filament connected to a high voltage source, for the frictional charging means. Arrangements employing such a device are disclosed in Carlson Patent 2,551,582, issued May 8, 1951, in Carlson Patent 2,588,699, granted March 11, 1952, and in copending application Serial No. 319,472, filed by C. R. Mayo et al. on November 8, 1952. This arrangement permits the charging of a plate to a higher potential than can be obtained frictionally and the plate potential can be predetermined approximately, by regulating the charging voltage and controlling the speed at which the plate is passed under the charging source. Such an arrangement requires the regulation of the high voltage source and of the speed of the plate if close control of the plate voltage is to be obtained so that it is ideally suited for stationary equipment in which power supply requirements can readily be fulfilled.

A further innovation in plate charging apparatus is disclosed in Carlson Patent 2,701,764, issued February 8, 1955, wherein a radioactive source is provided to generate ions in front of a plate to be charged and an electrical field is imposed to carry the ionic charges to the surface of the plate. In an embodiment of that invention a radioactive source is supported in front of the plate and a potential source is connected to apply an electric field between the source and the plate. By this arrangement the plate may be held stationary during the charging cycle. With a device of this sort it is only necessary for the operator to place the plate and the charging unit in juxtaposition for a period of a few or more seconds, depending upon the size of the plate and the arrangement and type of radioactive material, in order to place a uniform electrostatic charge over the entire surface of the plate and condition it for use in making an exposure to a light image or other source of radiation to be recorded.

A further significant advance that has facilitated the production of xerographic copy has been in the improvement of powder development mechanisms, for example, such as that disclosed in application Serial No. 353,520, filed in the name of Eugene C. Ricker on May 7, 1953. In a device of this sort a high pressure stream of gas is directed against a powder or carbon impregnated belt or ribbon and the powder particles are blown through a capillary tube whereby they are electostatically charged, and are then blown through a chamber formed by the xerographic plate and a development electrode wherein the charged powder is attracted to the electrostatic latent image on the plate and forms a powder image corresponding thereto. Using a device of this sort it is now possible to develop a complete image in a period of from one to three seconds.

A variety of improvements have also been made in the selection of materials and methods of fabrication of xerographic plates whereby the photographic sensitivity and the spectral response of these plates has been substantially improved. For example, the sulphur or anthracene faced plates disclosed in Carlson Patent 2,297,691 have, in general, been replaced for commercial applications by selenium-surfaced aluminum-backed plates. Plates of this short are of such characteristics that they are ideally suited for use in the production of line copy although they are somewhat limited from the standpoint of photographic sensitivity and spectral response. Plates of this type are particularly useful for general commercial use because they may readily be charged to a uniform potential by any of a variety of types of charging devices and, when so charged, retain the charge for appreciable periods of time when protected from exposure to light prior to the actual working exposure.

The improvements in the field of xerographic plate development have led to a number of methods for producing highly sensitive, panchromatic xerographic plates capable of yielding good quality pictures. In general, these plates comprise a layer of vitreous and/or noncrystalline selenium in combination with one or more materials spread on a metallic backing. Such plates have been found to have better than ten to fifteen times the photographic speed of commercial selenium plates and are essentially panchromatic in their response to light. However, it is noted that as photographic speed and panchromaticity are increased, the dark-decay rate of such plates also increases, i. e., even through plates such as these are charged and handled under darkroom conditions the electrostatic charge placed thereon tends to decay in a very short period when compared with conventional selenium plates. For example, in some instances it was found that in periods of from three to fifteen seconds after charging the plates had lot sufficient of their electrostatic charge to make them unusuable for recording a xerographic image. Such high dark-decay rates

makes plates of this type impractical for use with usual darkroom procedure, inasmuch as too much time is required in handling the plate between the end of the charging operation and the end of the development operation.

In usual darkroom procedure the plate is charged by passing it under a corona discharge and placing it in a plate holder. The plate is then carried to and placed in a camera, exposed, and returned to the darkroom where it is removed from the plate holder. It is then placed on the development unit and the electrostatic image on the plate is developed. The shortest time in which this proceduce can be carried out in any parctical commercial method is about one minute. However, in appreciably less than one minute the potential on certain high sensitivity xerographic plates tends to drop too far, even in darkness, for the plate to be usable in making a picture.

In order to use such plates, the present invention discloses a rapid processing xerographic camera, whereby the plates can be manipulated extremely rapidly in the interval between charging and development. In a preferred embodiment of the invention the camera comprises a hinge-type construction wherein the camera back opens to permit placing the plate on a holder. When the back is closed the holder is positioned so that the plate is in the image plane of the camera lens. The plate is then charged by means of a radioactive charging unit that is swung from the top of the camera to a position directly in front of the plate. In this position, electrical contact is made and voltage is applied between the plate and the charging unit during the charging cycle. When charging is complete the charging unit is restored to its original position and the plate is exposed to the subject to be reproduced through a conventional lens mounted at the forward end of the camera. Immediately after exposure, the hinged plate holder is swung into operative relationship with the electrode of a powder cloud development unit. A charged carbon powder is then blown into the development chamber formed by the plate and the development electrode whereby the electrostatic latent image remaining on the plate is coated with charcoal particles. When development is complete the plate may be removed from the camera to transfer the charcoal particle image by an conventional means, since the charged charcoal particles when one in contact with the plate remain affixed thereto by electrostatic attraction even though the original charge placed on the plate may decay entirely. By means of the arrangement thus proposed, the entire operation of exposure and development can be completed in a period of from two to three seconds after the charging of the plate is completed.

The principal object of the present invention is to improve the construction of xerographic cameras for use with high speed xerographic plates. A further object is to provide improved apparatus for the rapid processing of xerographic plates. A further object is to provide a compact and convenient apparatus for charging, exposing, and developing high speed xerographic plates. Other objects of the invention will be apaprent from the following description.

A preferred form of the invention is shown in the appended drawings in which:

Fig. 1 is a cutaway isometric view of the xerographic camera of the invention;

Fig. 2 is a functional schematic side elevation of the xerographic camera of the invention in conjunction with a conventional powder cloud developing unit.

Fig. 3 is a schematic side elevation of the charging unit of the camera in operated position to charge a plate; and

Fig. 4 is a schematic sectional view of the development electrode, showing a xerographic plate in operative relationship therewith.

In the arrangement shown in Figs. 1 and 2 the rapid-process xerographic camera of the invention includes a light-tight, box-like structure having side walls **1** and **2**, top and bottom walls **3** and **4**, respectively, and a front wall **5** in which is mounted any suitable and conventional lens and shutter element **6**. The rear wall **7** of the camera is conveniently hinged on bottom wall **4** to provide ready access to the interior of the camera and may be latched in closed position by any convenient means. Journaled in suitable bearings **8** in side walls **1** and **2** is a transverse shaft **9** that is mounted in a manner to have its axis of rotation parallel to the plane of the focal plane of lens element **6**. Fixed on shaft **9** are a pair of vertically extending angle members **10** having rearwardly extending bars **11** that serve to support a plate holder **12** that is provided with suitable internal grooves on its side and bottom rails to support a xerographic plate **15** which includes a suitable metallic backing plate **14** having a photoconductive surface layer **13**. An upper rail **16** is provided to retain plate **15** in position in frame **12**. The rearward ends of bars **11** abut the inner face of rear wall **7** when it is latched in closed position and serve to position plate holder **12** so that xerographic plate **15** is held in the focal plane of lens element **6**. A suitable detent device (not shown) may be provided to retain shaft **9** so that plate holder **12** is maintained in a vertical position despite any movement of the camera. A vertically extending handle **17** is fixed to the outwardly extending end of shaft **9** whereby the shaft may be positioned as indicated in the drawings for charging and exposing operations, or may be rotated counter-clockwise to facilitate the insertion and removal of a plate, or may be rotated in a clockwise direction through an angle of approximately 90° for developing operations, as described below. Preferably, plate holder **12** is formed of a suitable insulating material to permit the application of a biasing voltage during the developing cycle, if desired.

In order to place a uniform electrostatic charge on xerographic plate **15** the camera of the invention may include a radioactive charging unit **20** which, for convenience, may be of the type disclosed in Figs. 2 to 4, inclusive, of the above-mentioned Carlson Patent 2,701,764. In a device of this type of radioactive source is provided to generate ions in front of a plate to be charged and an electrical field is imposed to carry the ionic charges to the surface of the plate. In the present unit this device comprises an insulating plate **21** having affixed to its underside a pair of narrow metal strips **22** which are electroplated with a layer of polonium **28**, which in turn may be electroplated with a very thin coating of gold which serves to protect the polonium but is sufficiently thin to permit radioactive emission of alpha particles from the polonium into the air. Plate **21** is supported by a pair of bar members **23** which in turn are fixed to a transverse shaft **24** that is journaled in bearings **25**, mounted in side walls **1** and **2**, for rotation about an axis that is parallel to the plane of the focal plane of lens element **6**.

When the charging unit is inactive, plate **21** is held in a substantially horizontal position by a suitable resilient detent **26** that is secured to top wall **3** of the camera. When the charging unit is to be rendered operative for charging purposes, shaft **24** is rotated clockwise by a handle **27** until the underside of plate **21** abuts the forwardly facing portions of angle members **10**. This movement places the polonium plate bars **22** in proper spaced relationship to xerographic plate **15** (see Fig. 3) and, simultaneously, closes suitable electrical contacts (not shown) whereby, as fully disclosed in Carlson Patent 2,701,764, a D. C. potential source is connected between bars **22** and base plate **14** of xerographic plate **15**. The potential source has a voltage equal to or slightly greater than the potential desired on the charged xerographic plate. The operator maintains this relationship for the required time to effect complete charging of photoconductive layer **13** on plate **15** and then returns the charging unit to its substantially horizontal position. Plate **15**

is then ready for use in making an exposure to a light image or other source of radiation to be recorded.

The following is belived to be an explanation of the process which takes place during the charging operation just described: Alpha particles emitted by the polonium layer into the air produce both positive and negative gas ions (and electrons) in the space between bars **22** and backing plate **14** of xerographic plate **15**. If bars **22** are connected to the positive terminal of the battery, the field is such as to drive positive ions toward the plate **15** and negative ions and electrons in the direction of bars **22**. While many of the ions and electrons probably recombine to form neutral molecules before reaching either surface, there are many positive ions which reach photoconductive coating **13** on xerographic plate **15** and deposit their charge on it. As a positive charge builds up on this photoconductive layer the effective potential of its surface is raised, thereby reducing the electrical field between backing plate **14** and bars **22**. Ions continue to deposit until a state of equilibrium is reached as the potential of the charged photoconductive layer on plate **15** becomes substantially equal to, or slightly less, than the potential of bars **22**. In other words, the plate has then acquired a potential nearly equal to that of the D. C. source.

Although shown in conjunction with a radioactive charging unit it is apparent that the rapid process camera of the invention could readily have incorporated, as an alternate form of charging means, a stationary corona charging unit of the type shown in copending application Serial No. 495,945, filed in the name of James P. Ebert on March 22, 1955.

After xerographic plate **15** is fully charged, charging unit **20** is restored to its inactive position (as in Figs. 1 and 2) and xerographic plate **15** is exposed to a subject in a conventional manner by means of lens and shutter element **6**. The apparatus is so arranged that a minimum of time passes between the end of the charging cycle and the actual exposure so that the plate potential will not decay to an unusable extent. As soon as the exposure is complete, handle **17** is rocked clock-wise to engage xerographic plate **15** with the development mechanism so that the development cycle may be initiated immediately, as described below.

The development of the latent electrostatic image on the photoconductive layer of xerographic plate **15** is accomplished in a development mechanism **30** that includes a development electrode **31** (see also Fig. 4) that is mounted in an insulating base member **32** which, in turn, is supported on bottom wall **4** of the camera. Electrode **31** is preferably of brass and is provided with milled slots at either end one of which, slot **33**, serves as an inlet slot to receive charged powder particles from a powder cloud generator, and the other, slot **35**, serves as an exhaust slot through which excess powder particles and air are passed to an exhaust tube **36**. Electrode **31** is surrounded by a resilient rubber gasket or O-ring **37** which, when xerographic plate **15** is moved downwardly, is engaged by the surface of plate **15** and thereby forms the side walls of a developing chamber, of which plate **15** forms the top and electrode **31** forms the bottom. Suitable shims **38** are mounted on electrode **31** and engage the outer edges of base plate **14** of the xerographic plate and serve to maintain the proper spacing between the photoconductive layer on plate **15** and the surface of electrode **31**.

In order to provide charged powder particles to develop the latent electrostatic image on plate **15**, the apparatus includes a powder particle generator **40**, of the type more fully disclosed in above-mentioned application Serial No. 353,520, that is connected to inlet slot **33** of the development electrode by a capillary tube **34**. In this arrangement a suitable pressure source **43**, such as a pressure pump or pressure reservoir which may, for example, be a container of pressurized gas, is arranged to feed air or gas into a tube **44** connected to powder cloud generator **40**. Generator **40** comprises a suitable box or chamber **45** that is preferably sealed and relatively dust tight and contains a powder impregnated tape or ribbon **46** that is fed from a supply reel **47** to a take-up reel **48** which may be rotated by any suitable means such as a manually operated handle **49**.

In operation, pressure supply **43** maintains the powder cloud chamber at a greater than ambient pressure. The output of generator **40** is controlled by a suitable valve **50** controlled by a lever **51** which is actuated by a operator when xerographic plate **15** is engaged with the developement assembly. When valve **50** is opened, a jet of pressurized air or gas is forced through nozzle **44** and blows a supply of powder particles from tape **46** into capillary tube **34**. Inasmuch as tube **34** is a capillary, the powder particles in the air suspension will be in turbulent flow and, through repeated contact with the walls of the tube, become charged triboelectrically to the proper polarity to be actuated to the latent electrostatic image on the surface of photoconductive layer **13**.

These particles enter the development chamber formed by plate **15**, development electrode **31** and gasket **37**, and are attracted to the latent electrostatic image on the face of the plate. In usual operation, development of an entire electrostatic image is completed in a period of approximately one second by this type of apparatus.

In operation, the camera is loaded by releasing rear wall **7** and inserting a plate **15** in plate holder **12**. To do this, shaft **17** is rocked counterclockwise to move shaft **9** from its vertical detent position so that plate **15** may more readily be inserted in plate holder **12**. When the plate is inserted, handle **17** is returned to its vertical position and rear wall **7** is latched in closed position. The camera is then placed in a position in which the ultimate exposure is to be made. Immediately before such an exposure, charging unit **20** is rotated into juxtaposition with xerographic plate **15** and is held there until the plate is fully charged. This charging operation may require from five seconds to one minute, depending upon the size of the plates involved and the size and relative strength of the radioactive units that are employed. When charging is complete, unit **20** is swung to its horizontal position by handle **27** and the exposure is made by means of lens and shutter element **6**. Immediately after exposure, handle **17** is rocked clockwise to press xerographic plate **15** into engagement with gasket **37** of the development mechanism whereby plate **15** is placed in proper relationship to development electrode **31**. As soon as this proper relationship is attained, the operator initiates a flow of charged powder particles into the development chamber by means of lever **51** to effect development of the electrostatic image.

With the type of equipment just described, the operations required from the end of the charging operation to the end of the developing operation can be completed in from two to three seconds. Thus, regardless of the rate of dark-decay of the xerographic plate employed, the camera is capable of effecting exposure and development of a xerographic image well within the usable period of plate potential.

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. A xerographic camera comprising a light tight box-like structure having a lens element mounted in one wall thereof, a shaft journaled in said structure for rotation about an axis parallel to the focal plane of the lens element, plate holding means arranged on said shaft to support a xerographic plate in the focal plane of the lens element, a second shaft journaled in said structure for rotation about an axis parallel to the focal plane of the

lens element, a xerographic plate charging unit fixed on said second shaft, a development assembly supported on a second wall of the box-like structure, means to rotate the second shaft to move the charging unit into and out of charging relationship with a plate supported in the plate holding means, and means to rotate the first shaft to move the plate holding means to a position to place a plate supported therein in operative relationship to the development assembly.

2. A xerographic camera comprising a light tight box-like structure having a lens element mounted in one wall thereof, hinged plate holding means arranged to support a xerographic plate in the focal plane of the lens element, a xerographic plate supported by the plate holding means, a xerographic plate charging unit mounted for movement about an axis parallel to the focal plane of the lens element, a development assembly mounted on a second wall of the box-like structure, said development assembly including inlet and outlet ports for powder particles and a gasket on the face thereof surrounding the effective area of the development assembly and said inlet and outlet ports, means to move the charging unit into and out of charging relationship with said xerographic plate, means to move the plate holding means to engage the xerographic plate with said gasket, whereby to form a developing chamber, and means for passing electrostatically charged powder particles through said developing chamber.

3. A xerographic camera comprising a light tight box-like structure having a lens element mounted in the front wall thereof, a shaft journaled in the side walls of said structure for rotation about an axis parallel to the focal plane of the lens element, plate holding means fixed on said shaft to support a xerographic plate in the focal plane of the lens element, a second shaft journaled in the side walls of said structure for rotation about an axis parallel to the focal plane of the lens element, a xerographic plate charging unit fixed on said second shaft, releasable detent means to retain the charging unit in an ineffective position adjacent the top wall of the structure, a development assembly supported on the bottom wall of the box-like structure, means to rotate the second shaft to move the charging unit into charging relationship with a plate supported in the plate holding means and to restore the charging unit to its ineffective position, and means to rotate the first shaft to move the plate holding means to a position to place a plate supported therein in operative relationship with the development assembly.

4. A xerographic processing apparatus comprising a light tight box-like structure having a lens element mounted in the front wall thereof, a shaft journaled in the side walls of said structure for rotation about an axis parallel to the focal plane of the lens element, plate holding means fixed on said shaft to support a xerographic plate in the focal plane of the lens element, a second shaft journaled in the side walls of said structure for rotation about an axis parallel to the focal plane of the lens element, a xerographic plate charging unit fixed on said second shaft, releasable detent means to retain the charging unit in an ineffective position adjacent the top wall of the structure, a development assembly supported on the bottom wall of the box-like structure, means to rotate the second shaft to move the charging unit into charging relationship with a plate supported in the plate holding means to form an electrostatic charge thereon and to restore the charging unit to its ineffective position, means to expose the plate to a light image to form an electrostatic latent image on said plate, and means to rotate the first shaft to move the plate holding means to a position to place a plate supported therein in operative relationship with the development assembly.

5. A xerographic processing apparatus comprising a light tight box-like structure having a lens element mounted in the front wall thereof, a shaft journaled in the side walls of said structure for rotation about an axis parallel to the focal plane of the lens element, plate holding means fixed on said shaft to support a xerographic plate in the focal plane of the lens element, a second shaft journaled in the side walls of said structure for rotation about an axis parallel to the focal plane of the lens element, a xerographic plate charging unit fixed on said second shaft, releasable detent means to retain the charging unit in an ineffective position adjacent the top wall of the structure, a development assembly supported on the bottom wall of the box-like structure, means to rotate the second shaft to move the charging unit into charging relationship with a plate supported in the plate holding means to form an electrostatic charge thereon and to restore the charging unit to its ineffective position, means to expose the plate to a light image to form an electrostatic latent image on said plate, means to rotate the first shaft to move the plate holding means to a position to place a plate supported therein in operative relationship with the development assembly, and means for developing the electrostatic latent image on said plate.

6. A xerographic charging, exposing and developing assembly comprising a light tight box-like structure having a lens element mounted in one wall thereof, hinged plate holding means arranged to support a xerographic plate in the focal plane of the lens element, a xerographic plate supported by the plate holding means, a xerographic plate charging unit mounted for movement about an axis parallel to the focal plane of the lens element, a development assembly mounted on a second wall of the box-like structure, said development assembly including a development electrode having inlet and outlet ports for powder particles and a gasket on the face thereof surrounding the effective area of the development electrode and said inlet and outlet ports, means to move the charging unit into and out of charging relationship with said xerographic plate, means for exposing said plate to a light image to form an electrostatic latent image thereon, means to move the plate holding means to engage the plate with said gasket, whereby to form a developing chamber, and means for passing electrostatically charged powder particles through said developing chamber.

References Cited in the file of this patent

UNITED STATES PATENTS

256,148	Lefeuvrier	Apr. 11, 1882
2,588,675	Walkup et al.	Mar. 11, 1952
2,588,699	Carlson	Mar. 11 ,1952
2,711,481	Phillips	June 21, 1955

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 2,831,409

April 22, 1958

William E. Bixby et al.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 2, line 42, for "short" read --sort--; line 70, for "lot" read --lost--; line 71, for "unusuable" read --unusable--; column 3, lines 11 and 12, for "proceduce" read --procedure--; line 12, for "parctical" read --practical--; line 43, for "an" read --any--; line 44, for "one" read --once--; column 4, line 41, for "type of" read --type a--; line 63, for "plate" read --plated--; column 6, lines 11 and 12, for "developement" read --development--.

Signed and sealed this 8th day of July 1958.

(SEAL)
Attest:

KARL H. AXLINE
Attesting Officer

ROBERT C. WATSON
Commissioner of Patents

UNITED STATES PATENT OFFICE

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