XEROGRAPHIC INDUCTION RECORDING

Filed May 17, 1963 5 Sheets-Sheet 1

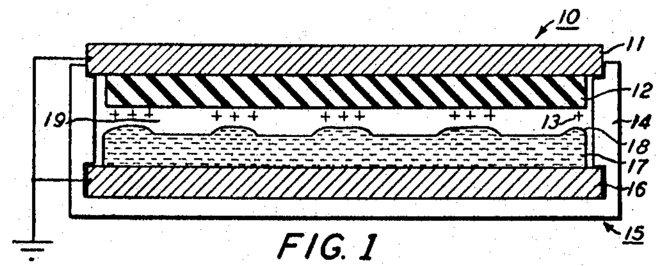

FIG. 1

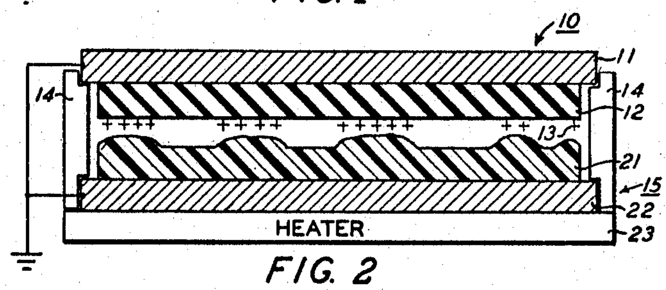

FIG. 2

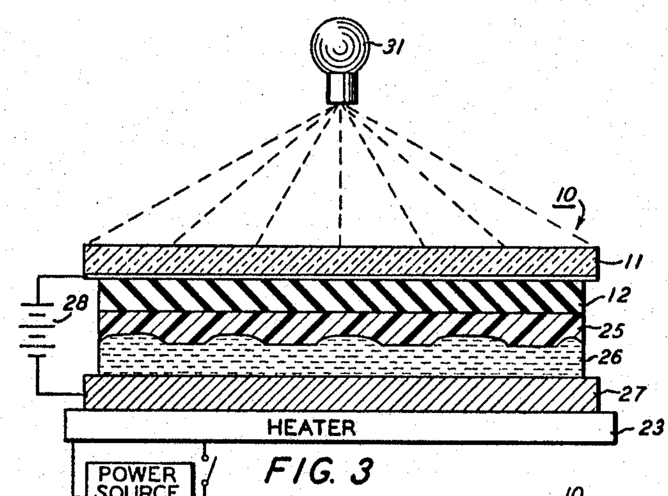

FIG. 3

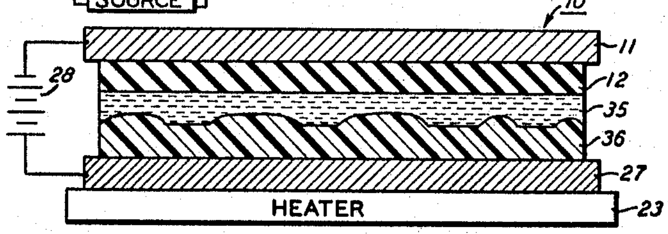

FIG. 4

INVENTOR.
LEWIS E. WALKUP

BY Stanley Z Cole

ATTORNEY

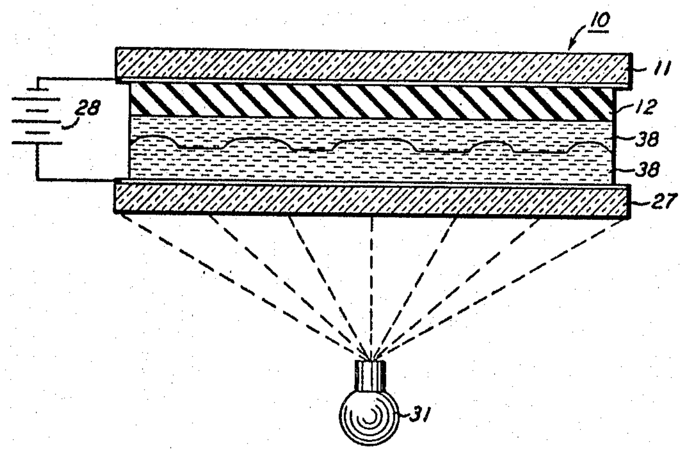

FIG. 5

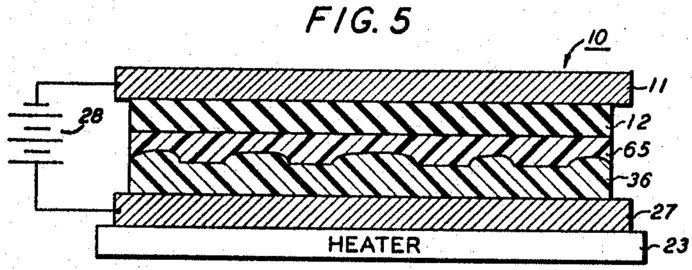

FIG. 6

INVENTOR.
LEWIS E. WALKUP
BY Stanley Z. Cole
ATTORNEY

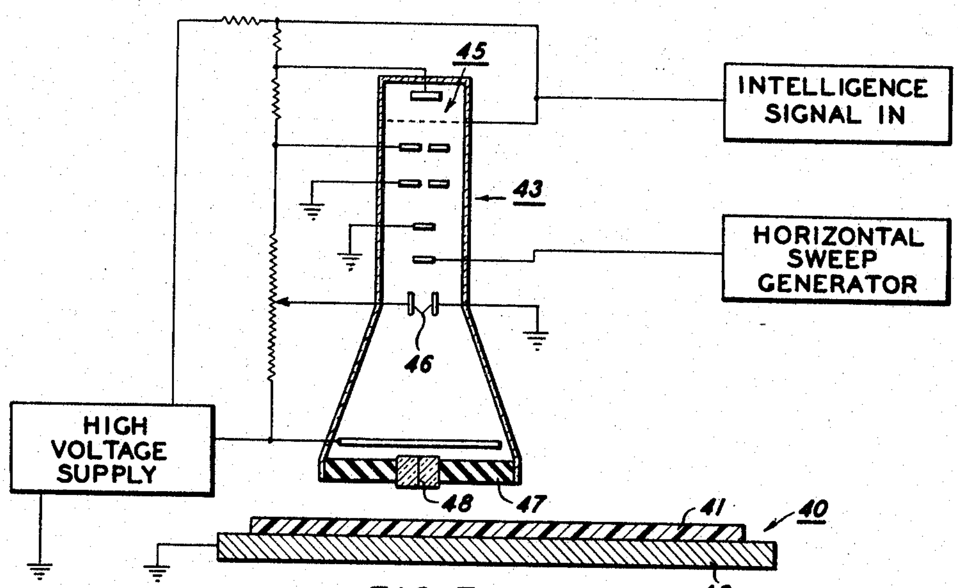

FIG. 7

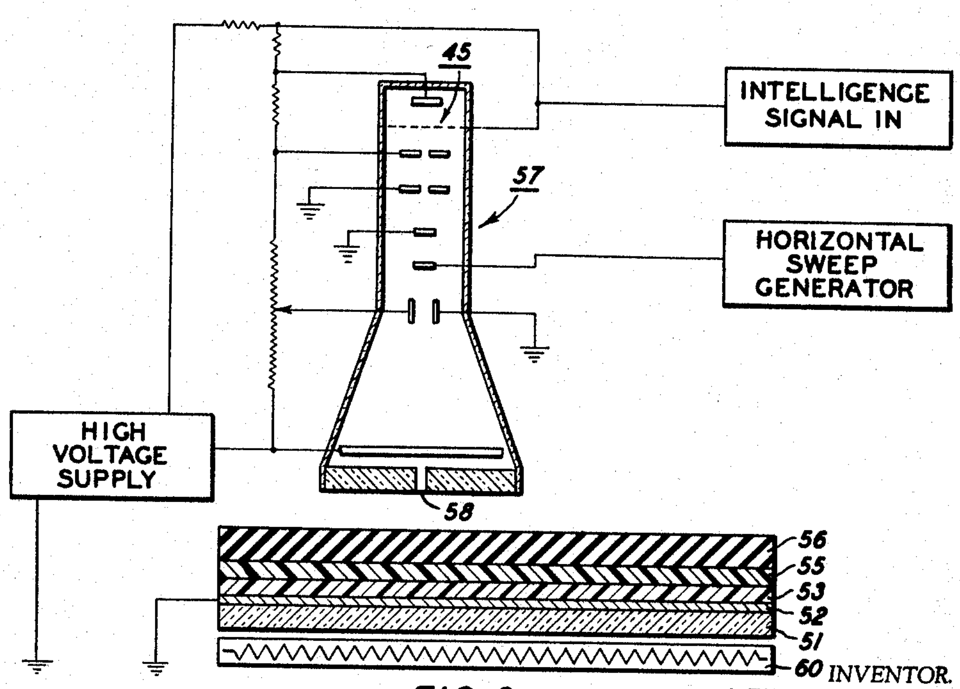

FIG. 8

INVENTOR.
LEWIS E. WALKUP

BY Stanley Z. Cole

ATTORNEY

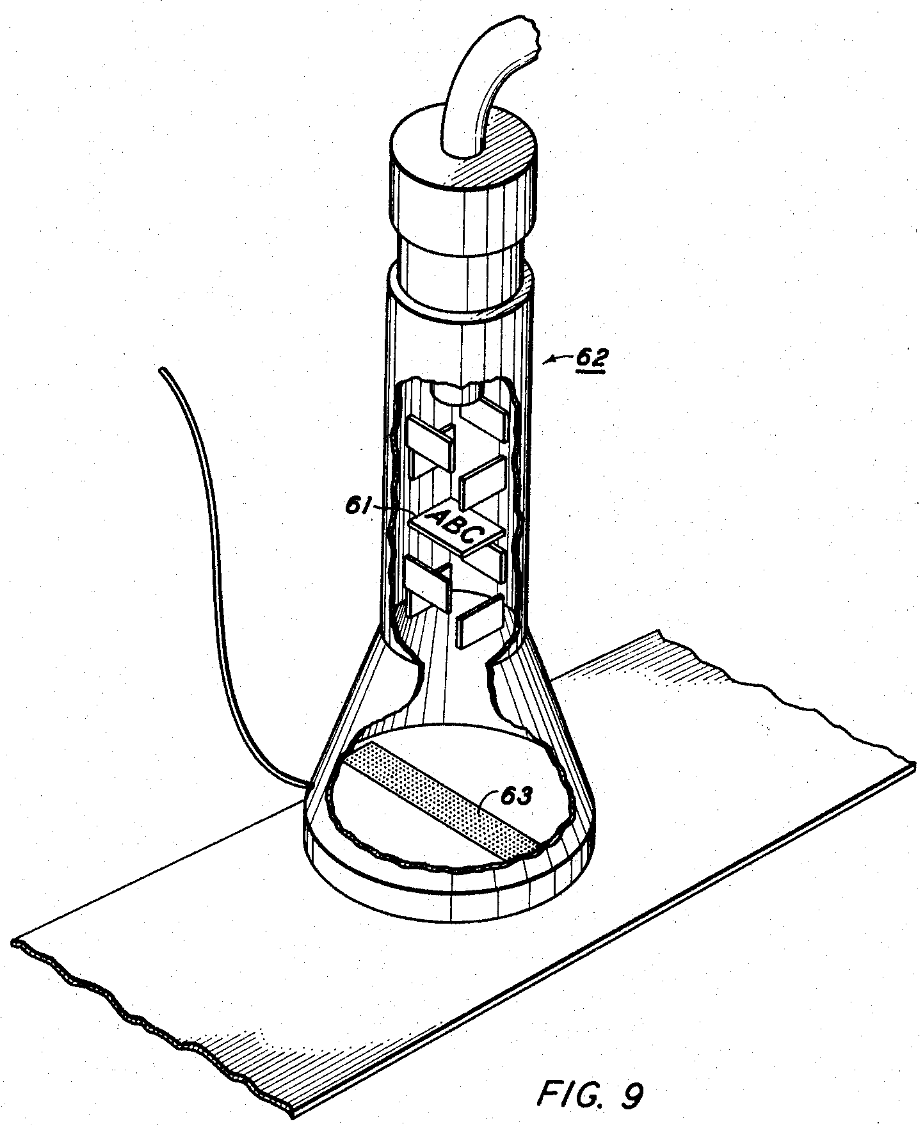

FIG. 9

INVENTOR.
LEWIS E. WALKUP
BY Stanley Z. Cole
ATTORNEY

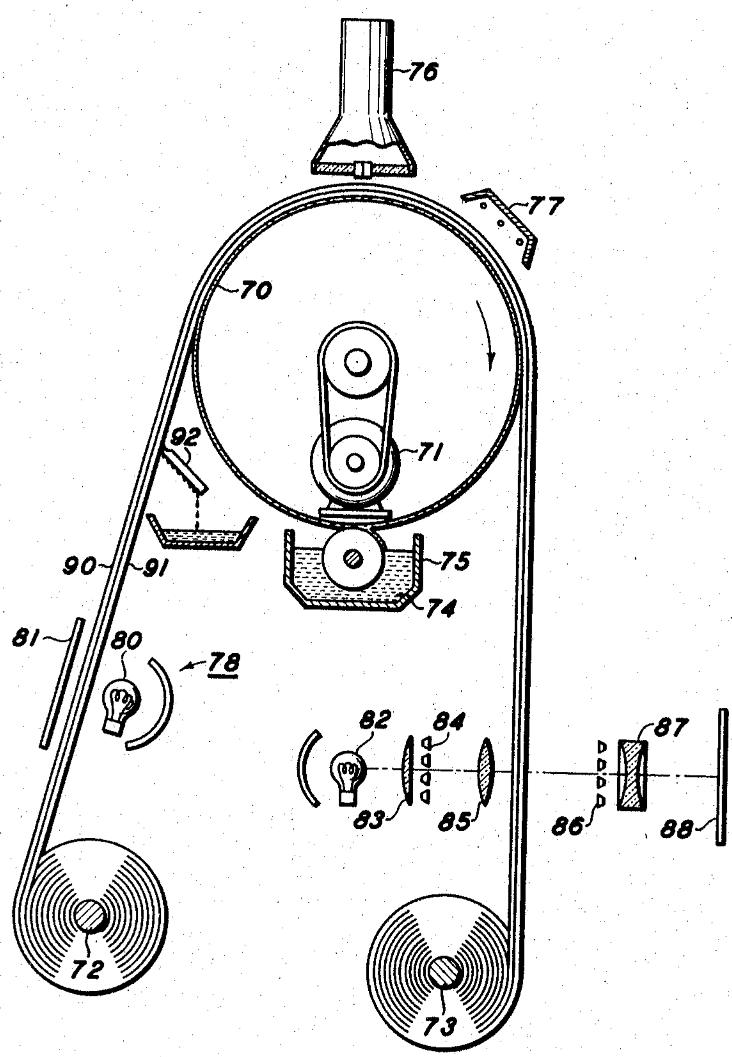

FIG. 10

INVENTOR.
LEWIS E. WALKUP
BY Stanley Z. Cole
ATTORNEY

United States Patent Office

3,321,308

Patented May 23, 1967

3,321,308

XEROGRAPHIC INDUCTION RECORDING

Lewis E. Walkup, Columbus, Ohio, assignor, by mesne assignments, to Xerox Corporation, Rochester, N.Y., a corporation of New York

Filed May 17, 1963, Ser. No. 281,181

1 Claim. (Cl. 96—1.1)

This invention relates in general to xerography and in particular to deformation development of latent electrostatic images. This application is a continuation-in-part of application Ser. No. 200,848, filed June 7, 1962, now U.S. Patent No. 3,196,013.

In conventional xerography, the latent electrostatic image on a xerographic plate is developed by applying a particulate pigmented developer material characterized in that it is attracted selectively by a latent electrostatic image. Once the latent electrostatic image has been developed on a xerographic plate, there is no way to reuse the xerographic plate until the developed image has been transferred and the plate cleaned of remaining developer material or the material has otherwise been cleaned off the plate. Thus, conventionally, it has been the practice to transfer the developed image from a xerographic plate to a copying paper and then by some means cleaning the remaining material off the plate. Such transfer and/or cleaning procedures necessarily introduce a considerable time factor into the operation. In some instances, it has been found desirable to eliminate this time factor. Such instances occur, for example, in the cases of television, facsimile and radar applications where it is desired to display the image and then immediately replace it with further images in fairly rapid succession. It has been suggested that a liquid or thermoplastic layer over the surface of the xerographic plate may be deformed by the effects of the latent electrostatic image and may then be displayed by the use of schlieren optics or the like. In the case of the liquid layer, the image is erased by removal of the electrostatic image. In the case of the thermoplastic layer, the image is formed by softening the layer in the presence of the latent electrostatic image and is later erased by removing the electrostatic latent image and softening the thermoplastic material. It is plain, however, this this suggestion also involves a considerable delay factor. Although it is not necessary to remove one developer material and add further developer material, the plate cannot be used for a second image until the first image has been displayed and erased.

Now in accordance wtih the present invention, it has been found that such a deformation image on a liquid or thermoplastic layer may be formed on such a layer that is spaced or separable from a latent image-bearing member so that the layer may be removed from proximity with the latent image-bearing member, displayed, erased and then returned for reuse while the xerographic plate may be used in the meantime. Also, it has been found that latent electrostatic images may be formed by pin tubes, charactron tubes, Lenard window tubes, and the like on a variety of insulating surfaces, and then used to produce a deformation image on a spaced separable or inseparable layer. To achieve this, the present invention encompasses methods and means of deforming a separate or separable layer by the induction effects of an electrostatic latent image. Thus, it is an object of the invention to define methods of deforming a deformable layer by electrostatic induction.

It is a further object to define a method of deforming a liquid layer by induction effects of a latent electrostatic image.

It is a further object to define a method of deforming a deformable plastic by induction from a latent electrostatic image.

It is a further object to define a method and structures for deforming a deformable layer by induction from an image produced by a cathode-ray tube.

And, it is a further object to define novel methods and means for simultaneously forming an electrostatic image and an induced deformation image.

Further objects and features of the invention will become apparent while reading the following description in connection with the drawings wherein:

FIGURE 1 is a diagrammatic illustration of induction deformation of a liquid layer.

FIGURE 2 is a diagrammatic illustration of induction deformation of a thermoplastic layer.

FIGURE 3 is a diagrammatic illustration of induction deformation of the interface between a conductive liquid layer and an insulating thermoplastic layer.

FIGURE 4 is a diagrammatic illustration of induction deformation of the interface between an insulating liquid layer and a conductive thermoplastic layer.

FIGURE 5 is a diagrammatic illustration of induction deformation of the interface between an insulating liquid layer and a conductive liquid layer.

FIGURE 6 is a diagrammatic illustration of induction deformation of the interface between a conductive thermoplastic layer and an insulating thermoplastic layer.

FIGURE 7 is a diagrammatic illustration of an embodiment for forming a latent electrostatic image with a pin tube.

FIGURE 8 is a diagrammatic illustration of an embodiment of the invention for induction deformation with a Lenard window tube.

FIGURE 9 is a diagrammatic illustration of an embodiment of the invention for induction deformation with a charactron tube.

FIGURE 10 is a digramматic illustration of apparatus inaccordance with the invention for induction deformation readout from a cathode-ray tube.

The present invention utilizes the physical effects of electrical field forces for image reproduction. Thus, the fields emanating from an electrostatic latent image may be used to displace material in such a way as to form a useable image. In one embodiment of the invention, as shown in FIGURE 1, plate **10** carries latent electrostatic image **13**. This image may be previously formed in a conventional xerographic manner as by electrostatically charging insulating layer **12** and, if layer **12** is photoconductive, exposing it to an image pattern to selectively dissipate some of the charge. The xerographic plate as shown comprises layer **12** of a photoconductive insulating material such as vitreous selenium, zinc oxide in a binder, or other known photoconductive insulator, and conductive backing **11** such as brass, aluminum, conductive paper, glass with a conductive coating of tin oxide or the like. As illustrated, layer **12** has been charged positively, and the charges have been dissipated in the areas where the layer has been illuminated. The charges remaining after forming the electrostatic latent image emanate fields or lines of force in the direction of available charges of the opposite polarity. Thus, these positive charges as illustrated will emit lines of force in the direction where there are no charges indicated on the surface of the layer or else down through the layer to the conductive layer underneath.

In accordance with the invention, xerographic plate **10** bearing the latent electrostatic image is maintained in the dark and is positioned on supports **14** immediately over the image plate **15** comprising a conductive layer **16** which may suitably be made of conductive paper, metal, or other conductive material, and a conductive liquid layer **17** such as water, alcohol, mercury, "Aquadag" (Acheson Colloids Corp.), or a liquified conductive resin material. The two plates are positioned as closely together as possible while avoiding actual physical contact. Thus, gaseous space **19** is maintained between the adjacent surface preferably with a gap width of between 1 and 5 mils. A narrower gap width presents too great a problem in precisely positioning the plates and raises the probability of dielectric breakdown which produces image defects. A gap width exceeding about 5 mils reduces the field effects obtained, lowers the quality of the reproduced image and reduces resolution and contrast. With the conductive liquid layer connected in common, through ground and conductive backing plates **11** and **16**, to the back of xerographic plate **10**, the electrical charges representing the latent electrostatic image attract charges of opposite polarity to the adjacent areas of conductive liquid **17**. As a result, the lines of force emanating from the latent electrostatic image find proximate points of opposite polarity charges in the liquid layer **17** and exert physical forces of attraction on those charges producing a deformation in the liquid layer. As illustrated in FIGURE 1, the surface of liquid layer **17** is displaced in accordance with the latent electrostatic image to form relief image **18**.

An embodiment of the invention similar to that illustrated in FIGURE 1 is shown in FIGURE 2 wherein deformable layer **21**, which is a solid at normal room temperatures, is used in place of the liquid layer **17** in FIGURE 1. Thus, deformable layer **21** is appropriately a thermoplastic material such as esters of hydrogenated rosin sold as "Staybelite" by Hercules Powder Co., styrene and styrene homologue resins sold as "Piccolastic" by Pennsylvania Industrial Chemical Corp., "Amberol" sold by Rohm and Haas Co., and other thermoplastic materials preferably having softening temperatures between about 90° F. and 200° F. in order to maintain stability at room temperature and yet soften readily for image formation.

Such plastic materials are commonly electrically insulating, but their conductivity is readily increased by appropriate additives. Thus, when there is no desire to pass light through the deformable layer, the plastic may contain carbon black or like conductivity agent such as a "dag" graphite suspension obtainable from Acheson Colloid Corp.

Where it is desirable to expose through the deformable layer, it is necessary to use an additive that will not reduce the transparency of the layer. Stannic chloride has been found suitable for this purpose.

Throughout this specification, the relatively conductive deformable layer is described as "conductive." This is not intended to mean conductive in the general sense, but rather in the sense specific to the electrophotographic art. In the general sense, conductors are considered to have resistivities of less than 1 ohm-cm. Semiconductors are considered to occupy the range up to 10^9 ohm-cm., and materials with still higher resistivities are considered insulators. In electrophotography insulators are generally considered to be materials having resistivities of 10^{13} ohm-cm. and higher with materials capable of some charge retention having resistivities higher than 10^{10} ohm-cm. Thus, for electrophotographic purposes, it is conventional to speak of materials with lower resistivities than 10^{10} ohm-cm. as conductors. While no fine line can really be drawn, it is necessary for the present invention that the material used have a number of "free" charges available with sufficient mobility to neutralize induced potential differences without any substantial time lag. Accordingly, it is the intent that throughout the present disclosure, "conductive" shall be interpreted to include resistivities of 10^{10} ohm-cm. or less.

The deformable layer **21** is supported by a conductive layer **22** against which is appropriately positioned a heating element **23**. After the xerographic plate carrying the latent electrostatic image is positioned adjacent to the deformable layer, the deformable layer can be liquified by energizing heating element **23**. The deformable layer will deform in the image pattern as described in connection with FIGURE 1 during the liquid phase, and then upon deenergization of the heating element, the deformable layer will freeze in the image pattern and may be removed from the presence of the latent electrostatic image for separate use. Re-heating in the absence of the latent electrostatic image will cause complete erasure of the image.

An embodiment of the invention for simultaneous formation of both the latent electrostatic image and the induction deformation image is illustrated in FIGURE 3. The embodiment of FIGURE 3 has the advantage of not requiring separate movement of the xerographic plate **10** and the image plate **15** during the process step. A further advantage is that no corona charging is used, reducing the required voltage, equipment, and process steps. Also, this can work in a vacuum where corona charging is not possible. Thus, a xerographic plate **10** such as described in connection with FIGURE 1 is positioned in a sandwich with a deformable insulating layer **25** and a conductive liquid layer **26** in turn supported by a conductive backing **27**. The deformable layer **25** which coats the conductive liquid layer **26** serves a dual function of providing a layer which may be frozen in a deformed condition and also providing an insulating barrier between the conductive liquid **26** and the photoconductive insulating layer **12**. With this insulating barrier **25**, it is possible to reduce the spacing between the photoconductive insulating layer and the conductive liquid layer down to a gap in the order of 5 microns or more. With this decrease in spacing gap as compared to the embodiment of FIGURE 1, improved image contrast and resolution is obtainable. As well as various thermoplastics listed in connection with FIGURE 2, the deformable layer **25** in FIGURE **3** is appropriately low melting point paraffin. A voltage is applied between the conductive layers **11** and **27** from a voltage source **28**. While conventionally the voltage used for charging a xerographic plate is in the order of several thousand volts, in the embodiment of FIGURE 3, the desired effects may be obtained by a considerably lower potential so voltage source **28** is accordingly in about the range of 100 volts or higher. The limiting high voltage is one that would cause a dielectric breakdown in insulating layer **25** or photoconductive insulating layer **12**. The sandwich of layers is heated as by a heating element **23** so as to liquify the deformable layer **25** to a highly compliant condition. The photoconductive insulating layer is exposed to a light image as by a projector **31** as illustrated in FIGURE 3. The backing layer of the xerographic plate is made of a transparent material such as glass coated with a conductive layer such as tin oxide. This permits exposure of the photoconductive insulating layer **12** through the back of the xerographic plate. Under the influence of the light image, the electrical capacity of the sandwich varies in the image configuration. A greater charge density is achieved in the discrete areas of relatively greater capacity producing stronger field effects and selectively deforming both the conductive liquid layer **26** and the deformable layer **25** which yields to the forces induced in the conductive layer **26**. When the heating element is disconnected, the deformable layer **25** will freeze, producing a fixed deformed interface between it and the liquid layer **26**. The image plate with the deformed frozen layer and the liquid layer may then be removed from the xerographic plate and an image projected from it by virtue of differences in refraction at the deformed interface. One of the advantages that is obtained in this embodiment and similar embodiments disclosed below is that when both the insulating deformable layer and the conductive deformable layer are in a liquid state the effects of surface tension and the like are greatly reduced and viscosity of the layers offers the principle resistance to deformation.

FIGURE 4 illustrates the variation of the embodiment of FIGURE 3 in which an insulating liquid layer **35** is positioned between the latent electrostatic image-bearing surface and a conductive deformable layer **36**. In this embodiment, layer **36** is made of a material that is solid at room temperature and readily liquifies on the application of heat. This has a slight advantage over the embodiment of FIGURE 3 in that the thermally liquifiable layer **36** is closer to the heat source **23**. Thus, in FIGURE 4, the heating requirements are slightly less, and there is less chance of deterioration of the xerographic plate **10** due to repeated application of heat.

The use of an insulating liquid and a conductive liquid is illustrated in FIGURE 5 in which an insulating liquid **38** is positioned in between the latent electrostatic image-bearing surface and a conductive liquid layer **39**. These two liquid layers must be selected so as to be non-miscible, and the insulating liquid must have a lower density than the conductive liquid. For example, the conductive liquid may be water and the insulating liquid may be oil. In the embodiment of FIGURE 5, the resistance against the deformation effects of the latent electrostatic image is produced almost entirely by liquid viscosity and interfacial tension between the two liquids. Since materials may be selected to minimize interfacial tension, deformation is readily obtained enabling the use of lower voltages, thinner layers, and larger solid relief areas.

In FIGURE 6, both the insulating deformation layer and the conductive deformation layer are made of thermally liquifiable materials that are solid at normal room temperatures. With both of these layers made of a material such as thermoplastic, it is possible to strip them apart after the image has been formed and solidified so as to obtain two separate deformation images. In this embodiment, the conductive layer would have a direct reading image, while the insulating layer would have a mirror reverse image on its deformed surface. In FIGURE 6, as well as in FIGURE 3, it is possible to use an insulating layer that is bonded permanently to the photoconductive insulating layer of the xerographic plate. However, this would require slightly different xerographic steps from those customarily used. Thus, sensitizing the plate would have to be performed by a method such as disclosed in U.S. Patent 2,833,930 in which charge is induced to the photoconductor surface under illumination and then trapped at the surface by discontinuing the illumination.

FIGURES 3, 4, 5, and 6 are all illustrated with a voltage source **28** applied across the conductive layers **11** and **27**. However, if a latent electrostatic image is formed on xerographic plate **10** before the layers are sandwiched together, the common electrical reference connections as shown in FIGURES 1 and 2 produce the desired results. It is also possible to charge plate **10**, then sandwich the layers together, and then form the latent image by exposing with a light image through a transparent side of the sandwich. In this latter case, either a common reference as in FIGURES 1 and 2 or a voltage source **28** connected between layers **11** and **27** will establish the desired references for deformation.

While the embodiments of the invention illustrated in FIGURES 1 through 6 have all been described using the xerographic plate as the latent image-forming member, various other methods and apparatus for forming a latent electrostatic image have been found operative. Particularly where it is desirable to print out images in a facsimile receiver or in electronic computers or information retrieval equipment, it is desirable to reproduce information supplied through a cathode-ray tube or comparable device. Thus, FIGURES 7, 8, 9 and 10 are directed to the embodiments of the invention which are particularly applicable for use with such electronic equipment.

Referring to FIGURE 7, plate **40** is analogous to xerographic plate **10** in FIGURES 1 through 6. However, electrically insulating layer **41** is a layer of most any electrically insulating material having a resistivity higher than 10^{13} ohm-cm., and no photoconductive layer is used. Appropriate materials are plastic materials such as polyethylene terephthalate, polyvinyl chloride, or a highly insulating acrylic plastic, polyethylene, or acetate material. Glass is also suitable where flexibility is not desired. Generally, the material used for this insulating layer should maintain dimensional stability when exposed to temperatures of at least 200° F. and maintain electrical resistance of greater than 10^{13} ohm-cm. under the same temperature range up to at least 200° F. Plate **40** also has a conductive backing **42** of metal or, in some cases, a transparent material with a conductive transparent coating such as glass or a transparent plastic coated with tin oxide, copper iodide, or the like. As illustrated in FIGURE 7, a type of cathode-ray tube **43**, known in the art as a pin tube, can be used to form a latent electrostatic image on plate **40**. A more detailed description of pin tubes may be found in U.S. Patent 3,001,848 to L. E. Walkup. Pin tube **43** generally consists of cathode-ray gun structure **45**, deflection plates **46** and face **47** of glass or other highly insulating material in which a plurality of conductive pins **48** are embedded in a uniform array. Conductive layer **42** of plate **40** is connected to a reference potential in common with the electrical circuits operating pin tube **43**. In operation, face **47** of the pin tube is positioned in proximate contact with the surface of layer **41**. Electron gun **45** generates a cathode-ray beam which is caused to sweep back and forth in a uniform pattern across pins **48**. The cathode-ray beam is intensity modulated by control signals in accordance with the intelligence to be reproduced. Whenever the intensity of the beam exceeds the level for electrical breakdown of the space between the pins and insulating layer **41** while it is in contact with a particular pin or group of pins, an electrical charge transfer is produced between the pin or pins and the surface of insulating layer **41**. While pin tube **43** selectively transfers charge to member **40** in accordance with the intelligence to be reproduced, relative movement (indicated by arrow **50**) between pin tube **43** and member **40** enables the continual presentation of new surface for the pin tube to act on. After a latent electrostatic image has been formed in accordance with FIGURE 7, plate **40** may be substituted for plate **10** in embodiments similar to those illustrated in FIGURES 1 through 6 in which the latent electrostatic image is formed separately from the deformable layers.

While FIGURE 7 is illustrated using a pin tube, other forms of cathode-ray tubes capable of producing latent electrostatic images may be used as will be seen in the embodiments below.

With the layer for carrying the latent electrostatic charge pattern positioned adjacent or permanently bonded in a sandwich with the deformable layers during formation of the latent electrostatic image, development of the deformation image can be performed without the necessity of in-between handling. Accordingly, FIGURE 8 illustrates an embodiment of the invention comprising a support layer **51** coated with a conductive layer **52**. This arrangement of layers **51** and **52** is preferred when a transparent support is desired since the support layer **51** can be glass or transparent plastic coated with a transparent conductive material such as tin oxide or copper iodide. Such transparency is usually desirable, since the preferred utilization of the deformation image is by transmission of light through the deformed layers. It should be understood, however, that, where light transmissibility is not a desired characteristic for the sandwich, a single conductive layer such as a metal plate may be used instead of the two layers **51** and **52**. Over the conductive coating **52**, a deformable conductive layer **53** either liquid or solid of a low viscosity when heated is applied. This material may have the characteristics of any of the conductive deformable materials previously disclosed and, for the reasons just given, is preferably transparent. Insulating deformable layer **55** is applied over conductive deformable layer **53**. This insulating deformable layer should have a resistivity of 10^{13} ohm-cm. or higher as previously described and may suitably be a low softening point plastic material such as Staybelite Ester 5 or Staybelite Ester 10 available from the Hercules Powder Company, Piccolastic A–50 or Piccolastic A–75 available from Pennsylvania Industrial Chemical Company or other material that is soft or softenable at a temperature between about 90° F. and 200° F. to a viscosity between about 10^4 and 10^7 poises. It is a further requirement, as previously stated, that the deformable insulating layer **55** and the deformable conductive layer **53** be non-miscible. They may be separable or non-separable, but where both layer **53** and layer **55** are deformable solid materials, it has been found preferable to bond them permanently together to minimize non-uniformity of contact. Where one of the layers is a liquid, uniformity can be achieved readily without permanent bonding. Where readout of the image is to be by light transmitted through the sandwich, it is a further desirable characteristic that a high refractive index differential exist between the two deformable layers. Where the deformable layers are permanently bonded together and the image is to be readout while the layers are so bonded, it becomes essential that refractive index differential exist between the materials so that the image can be detected. The difference in absolute refractive index is preferably about .2 or greater if no special optics are to be used for viewing. Where a schlieren or other contrast enhancing optical system is permissible, the difference in refractive index may be as low as .05 as long as the layers have a high optical quality and foreign material such as dust is very minimal. Deformable insulating layer **55** is, in turn, bonded to a highly insulating support layer **56**. Support layer **56** in this embodiment serves a dual purpose. First, it acts as a surface for receiving and maintaining the latent electrostatic image, and, secondly, it operates as a non-deformable support to prevent deformation of deformable layer **55** except at the interface between layer **55** and layer **53**. Support layer **51** and support layer **56** serve the further function of incapsulating and providing a protective cover for the deformable material and for the deformation images after they are formed. The cathode-ray tube **57** is positioned over the surface of insulating support layer **56** for forming the latent electrostatic image. This cathode-ray tube is essentially similar to that illustrated in FIGURE 7 and operates in the same way except that instead of having a face carrying a multiplicity of conductive pins it has a face area that is substantially transparent to electron flow, thus permitting the electrical charges in the cathode-ray beam to flow directly through the face of the tube and impinge on the insulating surface of support layer **56**. This electron transparent face area **58** is known to the art as a Lenard window. An example of a Lenard window tube is given in U.S. Patent 2,200,741. In the embodiment of FIGURE 8, the conductive layer **52** is connected to a common reference potential with the operational circuits of cathode-ray tube **57** so as to attract the electrical charges deposited by the electron beam. Heating element **60** of any conventional type for supplying heat is positioned adjacent to the sandwich structure to supply the necessary heat permitting deformation of deformable layers **53** and **55**. This heating may be simultaneous with the formation of the latent electrostatic image from cathode-ray tube **57**, or it may be in a later step.

FIGURE 9 illustrates an embodiment using a sandwich structure essentially identical to that of FIGURE 8, but using a different form of cathode-ray tube. In this embodiment, pin tube **62**, essentially similar to that used in FIGURE 7, is modified by use of a character forming screen **61** in the nature of that commonly found in charactron tubes. See U.S. Patent 2,777,745 for examples of charactron tubes. This screen **61** is a plate containing minute shaped holes in the configuration of alphabetical letters and the like. Control circuits for supplying the intelligence to be reproduced are so designed as to position the electron beam in coincidence with the desired characters to be reproduced in a sequence determined by the signals carrying the intelligence. Thus, in this instance, the electron beam, shaped in the form of a given character, coincides with a series of pins **63** according to the pattern of the character and prints the latent electrostatic image on the insulating support layer character by character rather than by painting it on in a continuously sweeping motion as is the case for FIGURE 8.

While many obvious applications are apparent for the present invention, one that is felt to be of particular interest at present is its ready utilization as a printout and storage medium for electronic devices using cathode-ray tube displays. An exemplary embodiment of such a utilization is illustrated in FIGURE 10. The apparatus of FIGURE 10 uses separable deformable layers so that only the insulating support layer and the insulating deformable layer need be transparent. The apparatus comprises a conductive drum **70** rotated by a motor **71** with slip-clutch operated drive to supply reel **72** and take-up reel **73**. Positioned around the drum in the direction of rotation is a bath station **75** for applying a coating of conductive liquid **74** to the drum surface, a latent electrostatic image-forming station **76** depicted as a pin tube and a developing station **77** for heat development of the deformation image. Between supply reel **72** and drum **70** is an erasure station **78** comprising a high intensity heat source **80** and a black plate **81** for absorbing and concentrating infrared energy in the form of heat. Between take-up reel **73** and drum **70**, an optical readout station is illustrated comprising a light source **82**, a collimating lens **83**, annular ring grating **84**, a focusing lens **85** for focusing the image of grating **84** at second annular grating **86** and a projection lens **87** for focusing the deformation image on an image receiving member **88**. This constitutes a schlieren optical system for detecting and projecting the deformation image.

In operation, an imaging web of insulating transparent support layer **90** coated with deformable insulating layer **91** is placed in supply reel **72**, passed in between high intensity heat source **80** and black plate **81** of erasing station **78** around a portion of drum **70** with the deformable layer adjacent to the drum surface and on through the schlieren projection system to take-up reel **73**. With drum **70** revolving, the imaging web is drawn through erasure station **78** which heats the web causing erasure of any residual deformation image thereon. The web then comes in contact with the conductive liquid placed on the surface of drum **70** by bath station **75**. As it passes under latent electrostatic image-forming station **76**, a latent electrostatic image is recorded on the surface of layer **90**. The motion of the web past the image-forming station may be compensated for by the proper control circuitry operating the cathode-ray tube as disclosed by way of example in U.S. Patent 2,736,770. This provides for a displacement of the cathode-ray sweep in the direction of and synchronized with the movement of the web. For this purpose, a pin matrix for the pin tube would have to have adequate vertical width to cover this sweep displacement. In embodiments where the imaging member stops during cathode-ray operation, then moves a line at a time, only a single row of pins can be utilized as in FIGURE 1. After the latent electrostatic image has been formed on the surface of the insulating support layer, the web is carried past development station **77** where heat softens deformable layer **91** so that the induction effects of the latent electrostatic image produces a deformation in accordance with the image at the interface of the conductive liquid coating and deformable layer **91**. As the image-forming web passes on around drum **70**, it cools again freezing the deformation image before separating from the surface of the drum. After leaving the surface of the drum, the deformable web passes through the schlieren projection system and onto take-up reel **73**. The deformation image may be readout of the web by the schlieren projection system as it passes on to take-up reel **73** or optionally it may be readout at a later time in a separate projection system. As a portion of the circumference of drum **70** separates from the image-forming web, it is carried through bath station **75** where the conductive liquid coating is cleaned and restored to uniformity. A portion of the conductive liquid tends to remain on the deformable surface of the image-forming web. In the embodiment of FIGURE 10, this remaining portion of liquid serves a further useful purpose in acting as a cleanable coating over the deformable surface of the web so that foreign material such as dust and lint does not become permanently embedded in the web. Thus, when it is desired to erase and reuse a reel of the material, a wiper blade **92**, positioned just before contact of the web with drum **70** as it is drawn from supply reel **72**, removes the residual conductive liquid along with stray foreign material that would otherwise be detrimental in the reuse of the web.

What is claimed is:

A method of deformation recording by induction comprising:

(a) coating a deformable layer of conductive material over a dimensionally stable conductive support layer;

(b) coating a softenable layer of insulating material having a thickness range of 5 microns to 5 mils over a dimensionally stable insulating support layer;

(c) positioning said softenable layer in uniform contact against said deformable layer;

(d) connecting said conductive support layer to an electrical reference in common with a cathode ray tube of a type designed to pass electrical charges from the cathode ray beam through the face of the tube;

(e) selectively charging said insulating support layer by said cathode ray tube to form a latent electrostatic image corresponding to modulations of said cathode ray beam; and,

(f) softening said softenable layer to compliancy so that charges induced between the interface of said softenable layer and said deformable layer produce a relief image at said interface in the pattern of said latent electrostatic image.

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NORMAN G. TORCHIN, *Primary Examiner.*

D. PRICE, J. RAUBICHEK, C. E. VAN HORN, *Assistant Examiners.*