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Davidson

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[54] **MANIFOLD IMAGING PROCESS WITH SPOOL ELECTRODE**

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[73] Assignee: **Xerox Corporation,** Stamford, Conn.

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Related U.S. Application Data

[62] Division of Ser. No. 872,850, Oct. 31, 1969, Pat. No. 3,642,363.

[52] **U.S. Cl.** ..... **96/1 M;** 96/1.3

[51] **Int. Cl.²** **G03G 13/22**

[58] **Field of Search** ..... 96/1, 1.3, 1.4, 1 M

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Primary Examiner—Roland E. Martin, Jr.

[57] **ABSTRACT**

A manifold set of donor layer, imaging material layer and receiver layer is formed between a backing electrode and a tape electrode. The tape electrode is initially wound on a spool and is laid out over the various layers of the manifold set by unwinding it from the spool. The imaging material is exposed to electromagnetic radiation and subjected to electric field. The donor and receiver layers are separated when the tape electrode is wound back onto the spool yielding complementary images formed from the imaging material on the donor and receiver layers.

10 Claims, 6 Drawing Figures

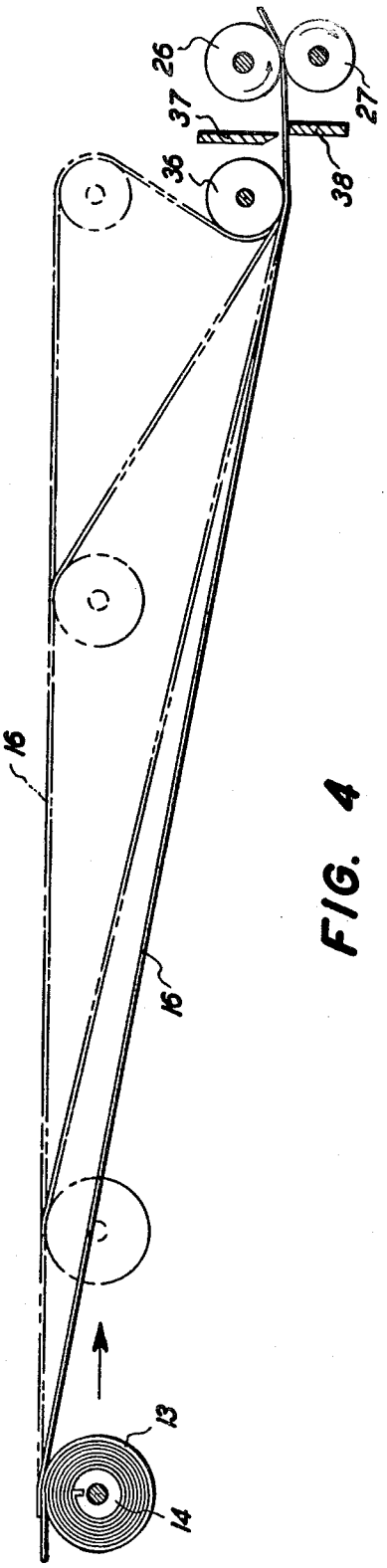


FIG. 4

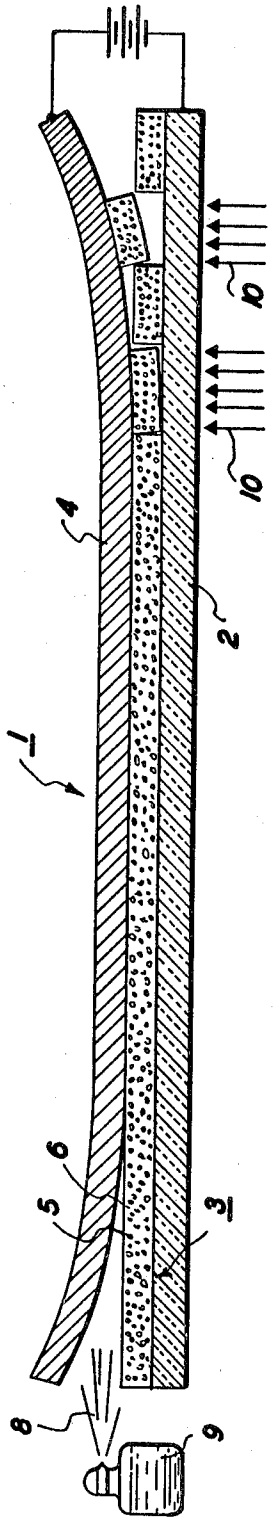


FIG. 1

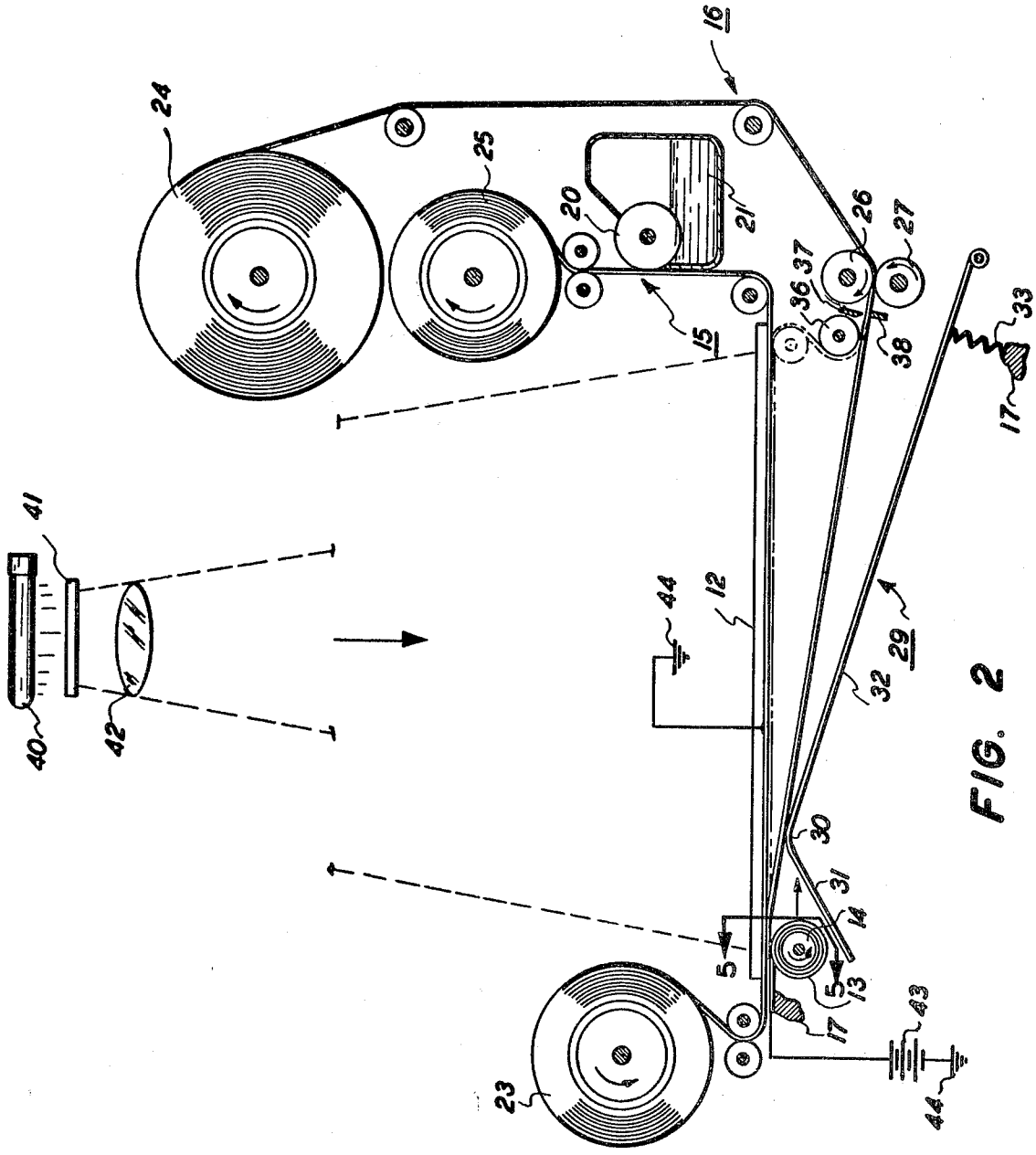

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FIG. 2

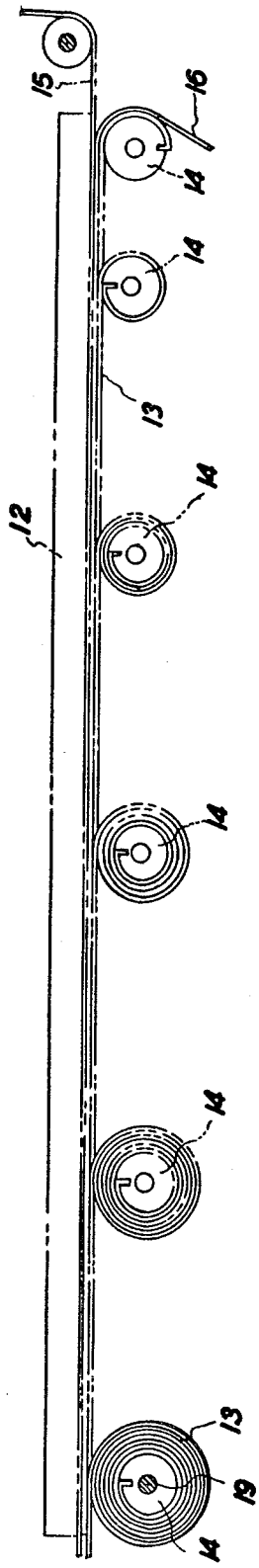


FIG. 3

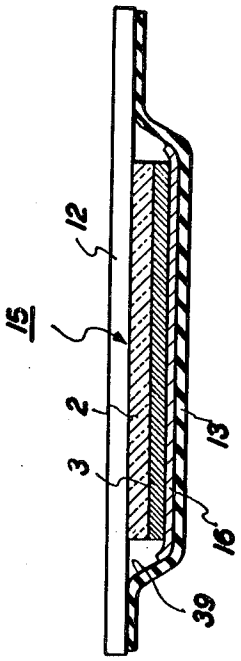


FIG. 5

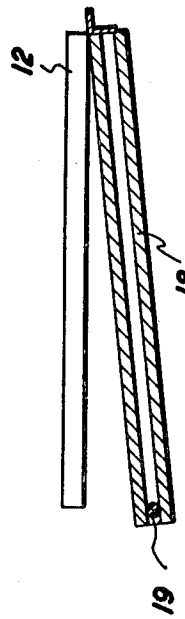


FIG. 6

MANIFOLD IMAGING PROCESS WITH SPOOL ELECTRODE

CROSS REFERENCE TO RELATED APPLICATIONS

This application is a division of application Ser. No. 872,850, now U.S. Pat. No. 3,642,363 filed Oct. 31, 1969 in the U.S. Pat. Office.

BACKGROUND OF THE INVENTION

This invention relates to imaging systems and in particular to systems of the type wherein an image is formed by the selective transfer of a layer of imaging material sandwiched between donor and receiver sheets.

A new imaging system herein referred to as a "manifold imaging system" has been devised wherein an image is formed by stripping apart donor and reciver sheets between which an imaging material resides. The imaging material is divided between the donor and receiver sheets during their separation by virtue of preferential adhesion of the imaging material to one or the other sheet. The preferential adhesion of the imaging material for the donor or receiver layer results from exposing the imaging material to electromagnetic radiation and subjecting it to an electric field.

In general, the imaging material includes photosensitive particles dispersed in a binder. At the time the layers are separated, the imaging material is cohesively weak or structurally fracturable. By this is meant that the cohesive force of the imaging material is less than the adhesive force of the material with either the donor or receiver sheets. In most cases, the imaging material has a stronger adhesive attraction for the donor layer hence giving rise to the name donor sheet. After the imaging material is exposed to imagewise electromagnetic radiation and subjected to an electric field, the adhesive attraction between the imaging material and the receiver layer is greater in areas exposed to radiation hence giving rise to the name receiver sheet. Voltage potentials are coupled to the donor and receiver sheets when the sheets are separated and the imaging material is divided between them yielding positive and negative images. The polarity of the voltages and the shape of the electromagnetic radiation (or alternatively the shape of the electric field) determine on which of the two sheets the positive and negative images are formed.

One theory proposed to explain why the imaging material is more strongly attracted to one abutting sheet than the other is that the photoresponsive material exposed to electromagnetic radiation, e.g. visible light, and that not exposed to the radiation tend to move in opposite directions under the influence of the applied electric field. Since the material is fracturable at time of separation, the imaging material is selectively transferred to the donor and receiver sheets in complementary imagewise configurations. A detailed description of the "manifold imaging process" is found in copending application Ser. No. 609,057 now abandoned.

The instant invention provides a solution for forming a "manifold set" of donor layer, imaging material and receiver layer. In addition, the invention proposes novel means for applying a field across the manifold set, for separating the layers of the set to obtain the desired images and for advancing new materials into place for formation of a subsequent manifold set.

Accordingly, it is an object of the present invention to improve manifold imaging systems.

Another object of this invention is to feed separate layers together to form a manifold set, to cover the manifold set with electrodes for establishing an electric field across it, to strip apart or separate the layers of the manifold set and to eject the processed layers from the system.

Yet another object of this invention is to devise novel and versatile methods and apparatus for obtaining intimate contact between the layers of a manifold set.

Still another object of the present invention is to devise novel means and methods for separating the layers of a manifold set.

Even a further object of the present invention is to rapidly and efficiently move webs from separate reels into intimate contact, strip the webs apart, move one web onto another reel and cut and eject the other web.

These and other objects of the present invention are accomplished by utilizing a flat plate backing electrode and a flexible tape electrode coiled or wound on a traveling spool. A donor web carrying the imaging material is fed into position over the back electrode. A receiver web is fed by pinch drive rollers into the nip formed between the tape electrode and the backing electrode. The spool on which the tape electrode is wound moves to unwind the tape electrode and trap the receiver web and donor web between them forming the manifold set. As the spool travels across the backing electrode the force of the spool directed against the tape electrode drives out the gases between the two electrodes creating a vacuum which brings atmospheric pressure into play. Atmospheric pressure acts in the same direction as the mechanical force of the spool and the electrical force of a field to maintain the various layers of the manifold set in intimate contact. The backing electrode and donor webs are transparent to allow the imaging material to be exposed to the actinic electromagnetic radiation in imagewise configuration. A voltage potential is coupled between the backing and tape electrodes. After exposure, the receiver web is pulled away from the donor web during the winding of the tape electrode resulting in the formation of complementary images on the receiver and donor webs. Means are provided to eject the used portions of the donor and receiver webs and to bring new materials into place for the formation of a subsequent image.

DESCRIPTION OF THE DRAWINGS

Other objects and features of the present invention will become apparent from a further reading of the present description and by reference to the drawings which are:

FIG. 1 schematically illustrates the donor layer, imaging material layer and receiver layer of a manifold set and the division of the imaging material between the donor and receiver layers during their separation;

FIG. 2 is a schematic side elevation view of the present manifold imaging system;

FIG. 3 is a schematic illustration of the tape electrode being unwound from the spool;

FIG. 4 is a schematic illustration of the tape electrode being wound onto its spool and the receiver web being separated from the donor web;

FIG. 5 is a cross sectional view of the manifold set taken along the lines 5—5 in FIG. 2; and

FIG. 6 illustrates apparatus for supporting the spool on which the tape electrode is wound.

DESCRIPTION OF THE INVENTION

FIG. 1 illustrates a manifold set 1 used in manifold imaging systems. Manifold set 1 includes the transparent substrate or donor layer 2 on which is deposited the layer of imaging material 3. The receiver layer 4 is brought into contact with the imaging layer to complete the formation of the manifold set. The imaging material 3 comprises the photosensitive particles 5 dispersed in a binder 6. Commonly, the imaging material has good cohesive strength prior to imaging in order to facilitate its handling and storage. In such cases, the cohesive strength of the imaging material is weakened prior to formation of the manifold set by softening the material by heating or applying a solvent. In FIG. 1 the material is softened by spraying a solvent onto the imaging material with the atomizer 9. The material is softened until its cohesive strength is reduced sufficiently so that the application of electric field combined with the action of actinic radiation on the electrically photosensitive materials will fracture the layer upon separation of the manifold set. Further, the layer must respond to the application of field the strength of which is below that field strength which will cause electrical breakdown or arcing across the layer. The material is softened until its cohesive strength is less than the adhesive force between itself and either the donor or receiver layer. The imaging material is said to be structurably fracturable when softened the prescribed amount.

In the present invention, the receiver and donor layers are electrically insulating. Consequently, an electric field is established across the manifold set by contacting the receiver and donor layers with electrically conductive electrodes between which a voltage is applied. The field can also be established by depositing charge with a corotron on one layer and backing the other layer with a grounded electrode. The receiver and donor layers themselves can be conductive in which case voltage potentials could be coupled directly to them. This is permissible because the binder 6 is normally electrically insulating.

The imaging material 3 may be exposed to electromagnetic radiation through either the donor or receiver layer. In FIG. 1, the arrows 10 represent electromagnetic radiation being directed onto the imaging material through the donor layer. When the receiver and donor layers are separated, i.e. stripped apart, the imaging material divides between the two layers. The imaging material exposed to radiation, as indicated by arrows 10, adheres to the receiver layer and the unexposed material adheres to the donor layer. The separation takes place while the electric field is applied. One theory proposed to explain the division of the imaging material between the two abutting layers is that the photosensitive particles 5 exposed to the radiation tend to move under the influence of the field. The tendency to move creates stresses within the imaging material that alter the adhesive bond with the layer away from which the particles tend to move. The cohesively weak nature of the imaging material is believed to explain why the fracture extends substantially the full thickness of the imaging material.

The copending application Ser. No. 609,057 fully sets forth representative compounds and materials which can be used in forming the manifold imaging process. For purposes of example, the following materials are representative. The donor substrate or layer and the receiver layer may preferably consist of a suitable insulating material. Typical insulating materials include polyethylene, polyethylene terephthalate, cellulose acetate, paper, plastic coated paper, such as a polyethylene coated paper, and mixtures thereof. Suitable activating fluids, i.e. solvents, may include any material which will reduce the cohesive strength of the imaging material. Typical materials include kerosene, carbon tetrachloride, petroleum ether, silicone oils, etc. The imaging layer may comprise any typical photoresponsive material in a binder. Typical photoresponsive material includes photoconductors such as substituted and unsubstituted phthalocyanine; quinacridones; zinc oxide, mercuric sulfide, etc. Binder materials may include insulating resins such as polyethylene, polypropylene, etc. For more complete information on the above compounds and materials reference is made to the aforementioned copending application Ser. No. 609,057.

Turning now to FIG. 2, the present imaging system includes the backing electrode 12 and the tape electrode 13 wound on spool 14. The manifold set includes the donor web 15 and receiver web 16 and is formed between the electrodes, exposed to electromagnetic radiation, subjected to an electric field and stripped apart to yield positive and negative images.

The backing electrode 12 is made from an optically transparent glass plate (it may be in a drum configuration) on which is deposited an optically transparent layer of tin oxide that is electrically conductive. Conductive glass of the type described is available commercially under the trade name NESA glass. The conductive layer of tin oxide is on the surface of the backing electrode closest to the tape electrode 13.

The tape electrode 13 is made from a conductive material that is flexible allowing it to be repeatedly coiled and uncoiled on spool 14. Preferably, the tape electrode is also elastic. An example of a suitable elastic conductive material for the use as a tape electrode is 30 durometer buna-n synthetic rubber. The tape electrode is anchored at its free end by an appropriate fastener 17 to enable the tape electrode to be unwound from the spool 14. The other end of the tape electrode is coupled to the periphery of spool 14 to enable it to be wound onto the spool. The spool is forced upward against the backing electrode either by a hand operation or by an appropriate support means. The spool is moved along the length of the backing electrode while maintaining an upward force on the spool to lay the tape electrode against the backing electrode. An appropriate support means might include an angled track such as the track 18 shown in FIG. 6 in which the spool axle 19 rides. Moving the spool by motor or by hand the track 18 causes the spool to rotate and the tape electrode to be laid out. The angle of incline of the track 18 relative to the backing electrode is selected to cause the spool to force or compress the tape electrode against the backing electrode. The spool and its support therefore compose a compression means for forcing the tape electrode against the backing electrode. When a manifold set is between the electrodes, the compression means helps establish intimate contact between the various layers of the manifold set. This aspect of the present invention is discussed again in connection with FIG. 5.

The donor web 15 includes a donor layer on which a layer of imaging material is deposited such as the layers 2 and 3 shown in FIG. 1. The imaging material is rendered structurally fracturable (its cohesive strength is made less than the adhesive bond between it and the donor or receiver layer) by the application of a suitable solvent. Roller 20 wets the surface of the imaging material on the web 15 and softens it to the point of rendering the material structurally fracturable. The solvent is maintained at a level in tank 21 sufficient to coat the periphery of the roller. As the web 15 moves past the roller 20, friction forces rotate roller 20 to coat the solvent onto the surface of the web.

The donor web 15 is coupled between the take-up reel 23 and the storage reel 25. Appropriate drive means is coupled to the take-up reel to advance an unused portion of web 15 to a position adjacent the backing electrode 12. The receiver web 16 is stored on the feed reel 24. A fresh portion of receiver web is advanced from reel 24 by the pinch drive rollers 26 and 27. The receiver web is guided to the nip (the area of contact between the tape and blocking electrodes) by the guide tray 29. The spool 14 advances a short distance to trap the tip of the receiver sheet between itself and the backing electrode. The spool then continues to move from left to right (as viewed in FIG. 2) along the length of the backing electrode laying out substantially the entire tape electrode or at least an amount sufficient to cover the area exposed to the electromagnetic radiation. The unwinding of the tape electrode is schematically illustrated in FIG. 3.

The guide tray 29 is bent downward at point 30 to form the positive and negative sloped ramps 31 and 32. The tray is biased by the coil spring 33 such that point 30 tends to contact the backing electrode. When the spool moves left to right the spool rides on ramp 31 forcing the tray downward against the action of the spring and out of the way of the spool. The tray is once again forced downward out of the path of the spool when the spool rides on ramp 32 as it travels from the right to the left.

As spool 14 travels from left to right unrolling the tape electrode as illustrated in FIG. 3, the receiver web 16 is pulled forward by the spool to lay the receiver sheet against the imaging material on the donor web 15. Override clutches are coupled to the shaft of the pinch rollers 26 and 27 to allow the receiver web to be advanced by the action of the spool 14. When the spool travels from right to left winding the tape electrode back onto the spool 14, the receiver sheet is stripped from the manifold set by rollers 26 and 27 which are now driven in a reverse direction by appropriate drive and gear means. The winding of the tape electrode back onto spool 14 and the separation of the receiver web from the manifold set is illustrated schematically in FIG. 4. The receiver web is separated from the manifold set at substantially the same rate at which the spool translates. The capstan 36 is positioned such that the force exerted on the receiver web by the pinch rollers includes a downward directed force component. The vertical force component becomes smaller as the spool advances further to the left because the angle between the capstan and the spool relative to the horizon decreases. However, the position of capstan 36 is selected so the vertical force component is sufficient to effect separation of the receiver sheet even when the spool is at its left-most position. The horizontal force component exerted on the receiver web is sufficient to pull the web from the grip of the two electrodes when the spool is returned to a position near its initial starting point. The receiver web is severed by the knife edges on cutter bars 37 and 38, falls onto the ramp 32 of tray 29 and is ejected from the tray by gravity or an otherwise appropriate sheet feeding mechanism.

The performance of the presently described manifold imaging system is improved if the layers of the manifold set are in intimate contact. In the present invention, the imaging material is initially in intimate contact with the donor layer because it is deposited thereon. On the other hand, the contact between the imaging material and the receiver layer is depended upon the action of the present imaging apparatus. The receiver web is forced into contact with the imaging material layer in the present imaging system by at least three forces: one force being the mechanical force exerted by the spool against the tape electrode; another force is the electrical force established by the voltages coupled to the electrodes; and, the third force is the force exerted by atmospheric pressure. As to the latter force, gases present between the electrodes and the layers of the manifold set are expelled by the force exerted by the spool against the two electrodes.

FIG. 5 is a cross section of a manifold set formed between the backing and tape electrodes. The donor web 15 includes the donor layer 2 and imaging material 3 (the same as in FIG. 1). The width of the donor and receiver webs are substantially the same. Preferably the width of the tape electrode is greater than either the width of the donor or receiver web. For one, the greater width of the tape electrode allows for some misalignment between the various layers of the manifold set and the electrodes. In the case shown in FIG. 5, the tap electrode has a thin layer of insulating material 39 coated on its upper surface to prevent electrical shorting between the two electrodes. The tape electrode forms a seal between the two electrodes keeping atmospheric pressure acting on the manifold set. It should be pointed out, however, that gases are expelled between the imaging material and receiver layers as the tape electrode is forced against the backing electrode. Consequently, atmospheric pressure acts to maintain intimate contact between those layers of the manifold set even if the width of the tape electrode is the same or less than that of the receiver sheet.

The exposure of the manifold set to electromagnetic radiation is made by exposure means including the lamp 40, the transparency 41 and the lens 42. The radiation produced by lamp 40 is selectively transmitted by transparency 41 in imagewise configuration, is collected by lens 42 and projected through the transparent donor layer to the imaging material. The electric field used in the imaging system is established by an appropriate voltage source 43 coupled at one terminal to the tape electrode 13 and at a second terminal to a ground potential 44 and the ground potential 44 coupled to the backing electrode 12.

After images are formed on the donor and receiver webs, the donor web remains tacked by electrostatic and other forces to the backing electrode. The donor web is separated from the backing electrode by running a knife edge between them, puffing air between them, raising the backing electrode or by other appropriate means. Thereafter the used donor web is wound onto take-up reel 23 bringing a new portion of web 15 adja-

cent the backing electrode. A new section of the receiver web is advanced to the nip between the two electrodes and the aforedescribed operation is repeated to form another image.

What is claimed is:

1. An imaging process wherein a manifold set comprising an imaging layer, structurally fracturable in response to the combined effects of an applied electric field and exposure to electromagnetic radiation to which said layer is sensitive is sandwiched between a continuous web donor layer and a continuous web receiver layer, at least one of said layers being at least partially transparent to said electromagnetic radiation comprising:

a. providing a flat backing electrode and, in operative association, a flexible tape electrode wound on a traveling spool, at least one of said electrodes being at least partially transparent to electromagnetic radiation to which said imaging layer is sensitive;

b. sandwiching said manifold set between said electrodes by placing one side of said sandwich against said backing electrode and moving said traveling spool across the opposite side of said sandwich whereby said tape electrode unwinds from said spool and covers said side whereby said set is held in a stationary position;

c. applying an electric field across said imaging layer and exposing said layer to an imagewise pattern of electromagnetic radiation to which said layer is sensitive;

d. winding said tape electrode onto said spool; and

e. separating said sandwich while holding one web stationary whereby said imaging layer fractures in imagewise configuration providing a positive image on one of said donor and receiver layers and a negative image on the other layer.

2. The process of claim **1** wherein said tape electrode is elastic.

3. The process of claim **1** wherein said imaging layer comprises an electrically photosensitive material is dispersed in an insulating binder.

4. The process of claim **3** wherein said electrically photosensitive material is an organic material.

5. The process of claim **1** wherein said receiver is fed by a pair of pinch rollers and subsequent to step (d) said rollers are reversed whereby said sandwich is separated by a vertical force component on said receiver layer.

6. The process of claim **5** further including the step of cutting said receiver layer in front of said rollers after said sandwich separation.

7. The process of claim **3** further including the step of softening said imaging layer so as to render said layer structurally fracturable in response to the combined effects of an applied electric field and exposure to electromagnetic radiation to which said layer is sensitive.

8. The process of claim **7** wherein at least one of said donor and receiver layers are electrically conductive.

9. The process of claim **3** wherein said imaging layer is exposed through said donor layer.

10. The process of claim **1** wherein said tape electrode has a layer of insulating material coated on its surface contacting said sandwich.

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