

United States Patent
Clark

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[54] **CONTINUOUS IMAGING APPARATUS**
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[73] Assignee: **Xerox Corporation**, Rochester, N.Y.
[22] Filed: **April 30, 1969**
[21] Appl. No.: **820,573**

2,979,026 4/1961 Reuter.....355/5 X
3,299,787 1/1967 Kolb.....355/16 X
3,432,231 3/1969 Gardner.....355/16 X

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[52] U.S. Cl.....355/3, 355/16
[51] Int. Cl.....G03g 15/00
[58] Field of Search.....355/3, 16

[57] **ABSTRACT**

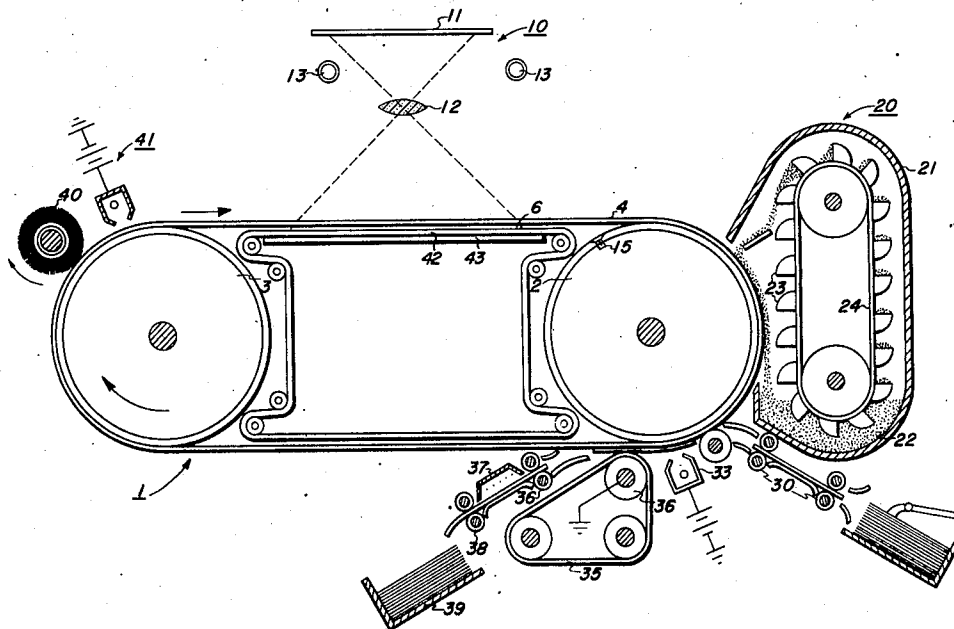
There is disclosed an electrostatic imaging apparatus which incorporates the continuous use of a reusable, flexible imaging member in an imaging system in conjunction with full-frame exposure.

[56] **References Cited**

UNITED STATES PATENTS

3,244,083 4/1966 Gundlach.....355/3

10 Claims, 4 Drawing Figures



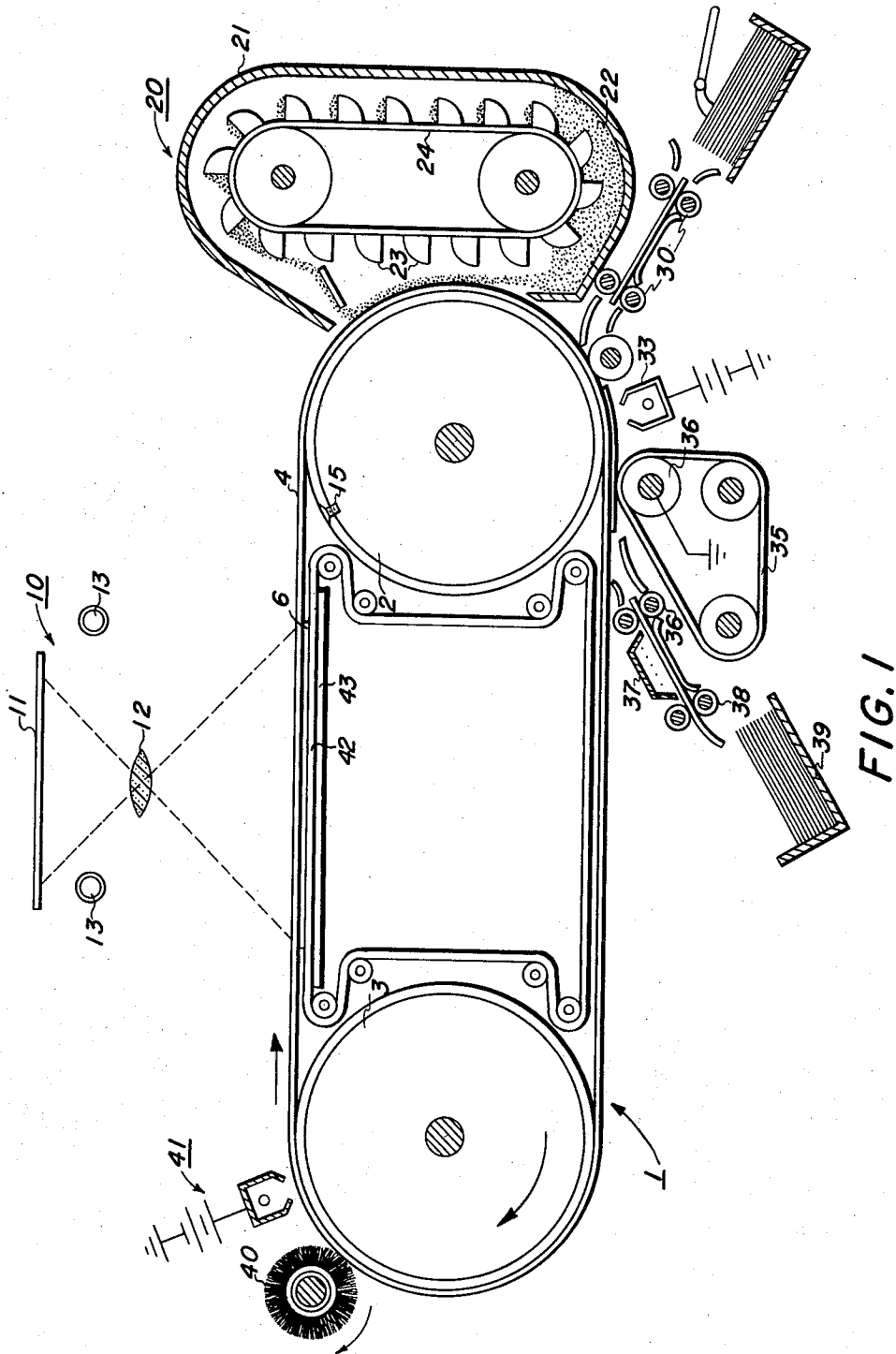


FIG. 1

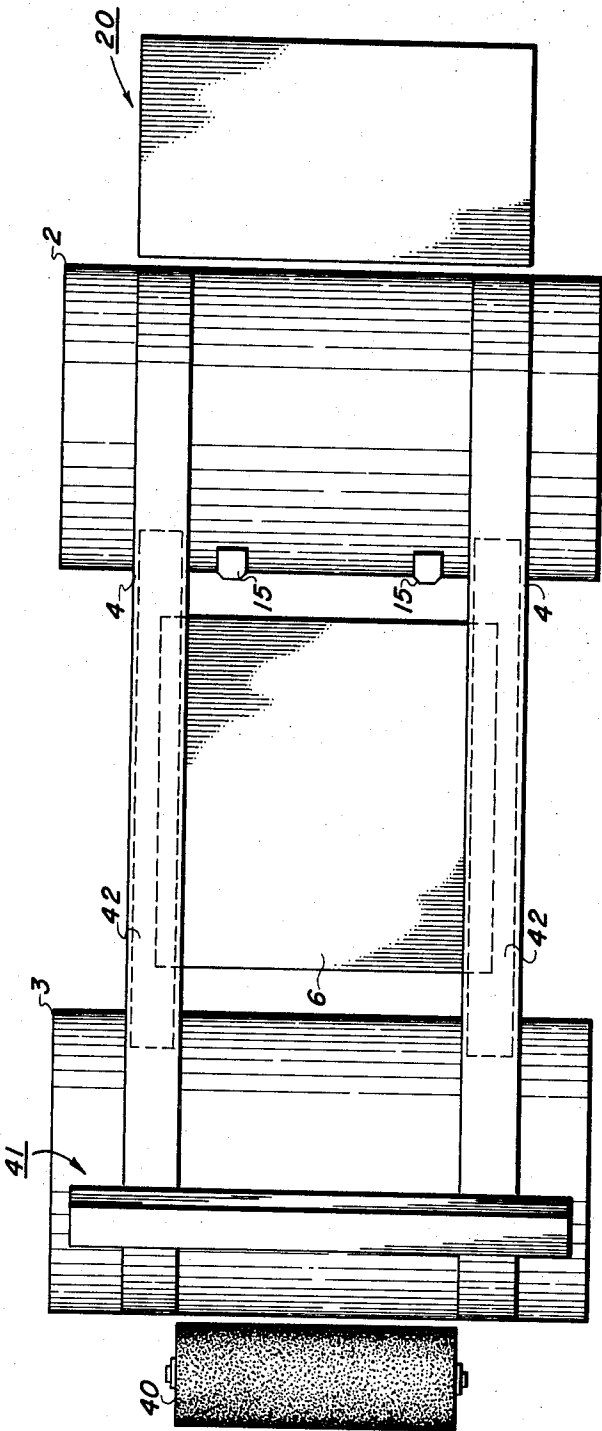
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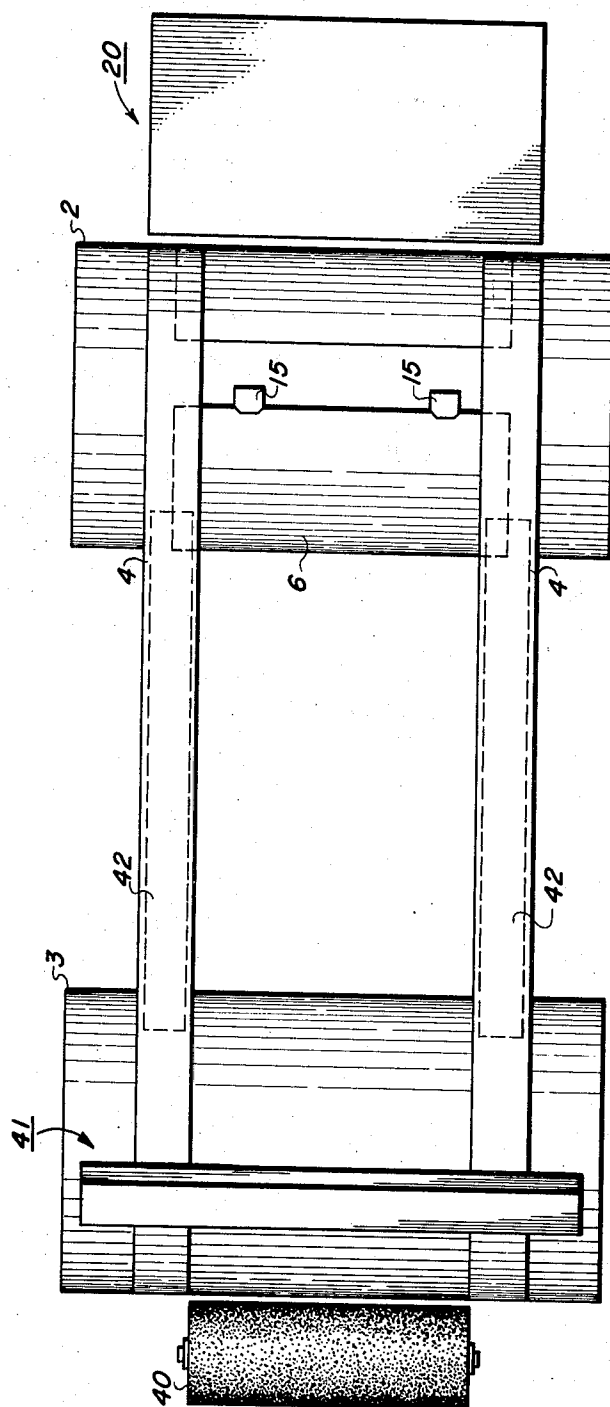


FIG. 3

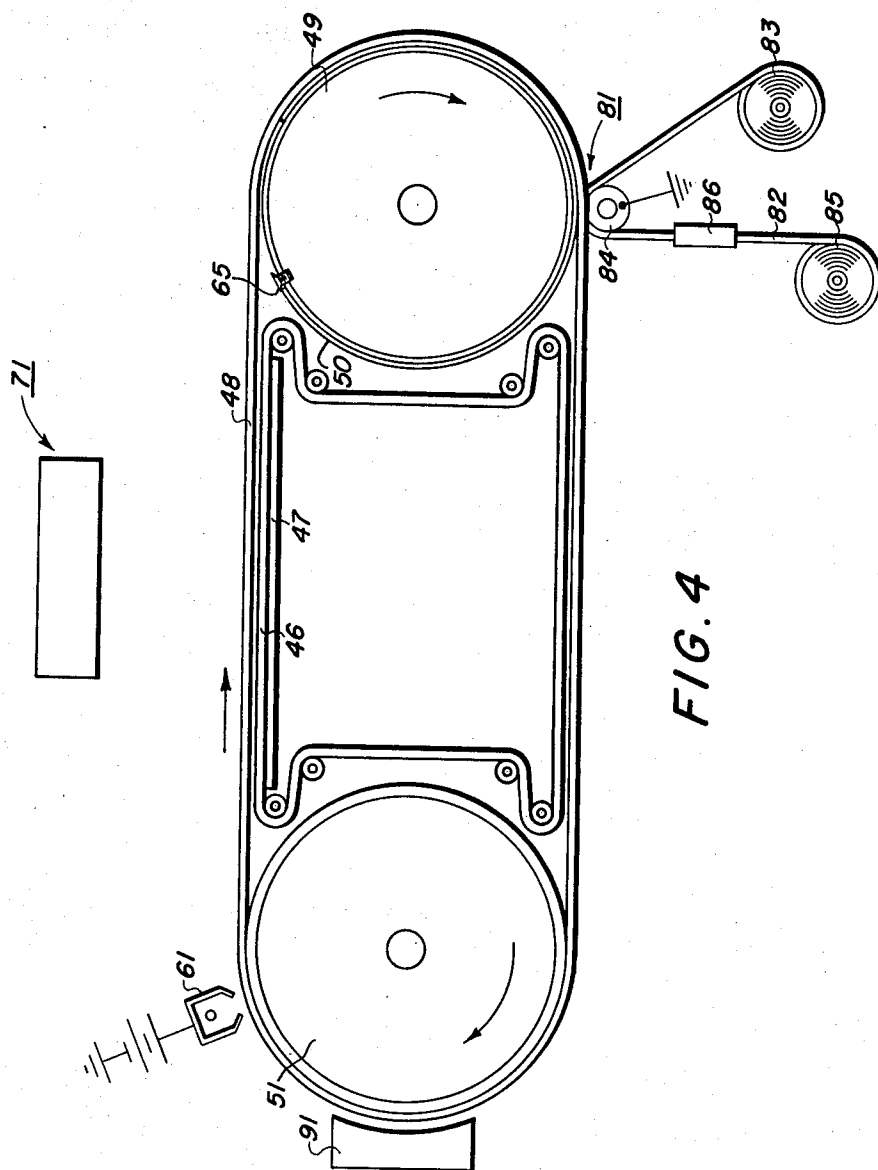


FIG. 4

CONTINUOUS IMAGING APPARATUS

BACKGROUND OF THE INVENTION

This invention relates to a xerographic imaging system and more specifically to a novel xerographic imaging apparatus.

In the xerographic process as described in U.S. Pat. No. 2,297,691 an electrostatic latent image is formed on a photoconductive insulating plate and is developed through the deposition thereon of finely divided, electroscopic marking material referred to in the art as toner. The marking material may be fixed to the surface of the photoconductive plate or transferred to a sheet of copy paper to which it may be permanently fixed. In most applications the photoconductive plate is initially uniformly charged and then selectively exposed to a visible light image or other pattern of activating electromagnetic radiation whereby the uniform charge is dissipated in the radiation struck areas, leaving a charge pattern which conforms to the electromagnetic radiation pattern applied. This exposure step is followed by development and the optional transfer step.

It has been found that, as a general rule, a xerographic plate in the shape of a cylinder lends itself most readily to high speed processing by virtue of the fact that a xerographic plate of this nature may be rotated successively past the various necessary xerographic processing stations in a substantially continuous manner utilizing the necessary drive motors and clutch assembly arrangements. Thus, most commercially successful automatic or semiautomatic xerographic copying machines include a cylindrical xerographic plate or drum with the xerographic processing stations located about the circumference of the drum in the machine. Therefore, in a majority of these machines a point on the periphery of the cylindrically shaped xerographic plate in completing one processing cycle will rotate past a charging station, an exposure station, a development station, a transfer station, and finally a cleaning station. Although this type of machine configuration has been proven to be very efficient because it provides for continuous movement of the xerographic plate through its processing cycle, the curved periphery of the plate imposes certain limitations upon plate exposure. Thus, cylindrical plates are usually exposed to an original to be reproduced by a scanning projection technique in which only a very narrow strip of the original, parallel to the longitudinal axis of the cylinder, is projected onto the moving cylindrically shaped xerographic plate at any one time. In order to project the entire original onto the cylindrical xerographic drum the projector must scan the original synchronously with the rotation of the xerographic drum and the scanning speed must be closely related to the peripheral speed of the drum so as not to distort the image produced on the drum. Such an exposure system generally requires fairly complex mechanisms which add to the expense of the apparatus as a whole. By utilizing a flat xerographic plate, the scanning exposure problems may be replaced by full-frame exposure of the original. However, flat plates do not lend themselves to fast continuous xerographic processing the type which may be utilized with cylindrical plates. To the contrary, the handling problems associated with flat plates carried through automatic cycles are extremely complex and difficult.

A configuration has previously been proposed which incorporates full-frame exposure in conjunction with cylindrical development and multiple copying. Such an apparatus is described in U.S. Pat. No. 3,190,199. However, the disclosed system requires that the xerographic plate be recycled by oscillating the plate in a direction opposite to that of its normal rotational course thereby interrupting the continuous motion of the process. While solving certain problems, therefore, the apparatus disclosed introduces other limitations which detract from the advantages achieved.

SUMMARY OF THE INVENTION

Therefore, it is an object of the present invention to provide an imaging system which will overcome the above noted disadvantages.

It is a further object of this invention to provide a novel xerographic imaging system.

It is a further object of this invention to provide a continuous electrostatic imaging process capable of full-frame exposure.

Yet, still a further object of this invention is to provide a reusable xerographic imaging process utilizing a novel xerographic apparatus.

Still another object of this invention is to provide an expedient xerographic system with built-in flexibility and high speed, high quality capabilities.

Yet, still another object of this invention is to provide a novel continuously rotating, high speed imaging system.

BRIEF DESCRIPTION

The foregoing objects and others are accomplished in accordance with the present invention generally speaking by providing a system whereby an electrostatic latent image or charge pattern may be formed on the surface of a suitable support member such as a photoconductive plate by a single full-frame exposure. The image support member is then wrapped around a rotatably mounted cylinder upon which the electrostatic charge pattern is developed and otherwise processed utilizing conventional techniques. The resulting developed image passes a transfer station which transfers the developer material in imagewise configuration to a specific receiver sheet with the cylinder continuously repeating the development and transfer cycle at continuous high speeds to produce a multiplicity of copies from the single exposure. When copying is complete the image support member continues forward to the exposure station at which it started for reimaging. The configuration of the present invention hence provides a continuous method whereby multiple copies can be made from a single full-frame exposure on an image support member which is reusable once the desired copies have been obtained. The apparatus is designed so that the rotating cylinder upon which the image support member is multiply developed need never stop moving at high speed while at the same time the image support member may be re-exposed without varying its speed or direction of movement of a non-moving original without the need of moving optical parts. In an alternate embodiment the apparatus of the present invention may be readily adapted to an induction imaging system, in which instance the need for cleaning the image support member is eliminated.

DETAILED DESCRIPTION

The invention is further illustrated in the accompanying drawings wherein:

FIG. 1 represents a side sectional view of the imaging apparatus of the present invention;

FIG. 2 represents a top view of the imaging apparatus of the present invention during the image exposure phase of the process;

FIG. 3 represents a top view of the imaging apparatus of the present invention during the copying stage of the process;

FIG. 4 represents a side sectional view of the imaging apparatus of the present invention used in conjunction with an induction imaging system.

Referring now to FIG. 1 there is seen an exemplary copying apparatus of the present invention generally designated 1 comprising rotatably mounted cylinders generally designated 2 and 3 the circumferences of which are at least equal to the length of a standard size subject to be copied. An endless belt 4 revolves about the cylinders 2 and 3 in a manner such that the continuous belt contacts only the lateral extremities of the cylinders. This arrangement will become clearer in further consideration of the subsequent illustrations described below. An image support member generally designated 6, represented in the present illustration as a flexible xerographic plate comprising a photoconductive insulating layer overlying a conductive backing, is presented as being attached or held laterally between the endless belt 4 and the drive belt 42 and as passing beneath the full frame exposure station generally designated 10 comprising the original document to be reproduced 11, lens system 12 and light source 13.

Although for the purposes of the present illustration the electrostatic charge pattern is represented as being formed on a photoconductive insulating surface through the steps of charging the surface and selectively dissipating the charge by exposure to a pattern of electromagnetic radiation, other methods suitable for forming electrostatic charge patterns may be used. For example, selective deposition of an electrostatic charge may be achieved by impressing a charge through an image stencil onto an insulating surface, imposing a potential on a shaped conductor or electrode, cathode ray tube image presentation of computer generated information to a uniformly charged photoconductive surface or the like. Thus, the image may be formed utilizing photosensitive materials, as herein illustrated, or by any suitable technique such as one of the above mentioned conventional methods.

The image support member which bears the electrostatic charge pattern may consist of any suitable material capable of supporting an electrostatic charge for sufficient time to permit multiple copying from a single, full frame exposure. Thus the image support member should have charge retention properties. Typical materials found suitable are polyethylene terephthalate, polytetrafluoroethylene, polyvinylfluoride, polyvinylchloride, styrene polymers, ethyl cellulose, cellulose acetate, polycarbonate resins, polyethylene and polypropylene.

When photoreceptors are utilized typical materials such as disclosed in U.S. Pat. Nos. 3,121,006 and 3,121,007 have been found to be substantially satisfactory. Other typical photoconductive materials include selenium, sulfur, anthracene, inorganic photoconduc-

tive pigments such as zinc oxide, lead oxide, cadmium sulfide, and cadmium sulfoselenide, dispersed in binder resins, organic photoconductive pigments such as phthalocyanine, and sensitized polyvinylcarbazole, and halogen doped selenium and arsenic-selenium alloy compositions as disclosed in U.S. Pat. Nos. 2,803,542 and 3,312,548. Glass binder plates such as disclosed in U.S. Pat. No. 3,151,982 are also representative of the type of plate which may be used in conjunction with the present invention. The conductive support materials utilized in conjunction with the photoreceptors are those which present the desired flexibility so that they may be used in conjunction with the process herein described. Typical conductive materials include aluminum, brass, copper, zinc, conductive paper, and any suitable plastic substrate having the necessary conductivity properties.

Following exposure to the document to be reproduced 11 the image support member 6 is directed by the continuous belt mechanism 4 to the cylinder 2 where the leading edge of the image support member is grasped by clamping means 15 or other equivalent fastening mechanism. The image support member may be held to the continuous belt by any suitable mechanism such as clamps, a vacuum system, by engaging pins, a flat plate, or as herein illustrated, by a second continuously moving drive belt, and when the image support member reaches the development cylinder 2 and is grasped by fastener 15, the means used to hold the image support member to the continuous belt will automatically be disengaged as the clamp or fastening mechanism on the developer drum engages the leading edge of the support member. After having been engaged by fastener 15 the image support member passes a developing unit generally designated 20 of the cascade type as more fully described in U.S. Pat. Nos. 2,618,551, 2,618,552 and 2,638,416. Although any of the conventional xerographic development techniques may be utilized the illustrated cascade unit described below has been found to be one of the more effective development systems. The development unit 20 includes an outer container 21 with a trough at its bottom containing a supply of developer material 22. This developer material is picked up from the bottom of container 21 and dumped or cascaded over the surface of the image support member by a number of buckets 23 on an endless driven conveyor belt 24. This development technique utilizes a two component development mixture including finely divided, electroscopic marking particles or toner and larger carrier beads. The carrier beads serve both to deagglomerate the toner particles and to charge them by virtue of their relative position with respect to the toner in the triboelectric series. Friction between the beads and toner particles during tumbling of the developing mixture causes particles to charge to opposite polarities so that the toner particles cling to the carrier beads. When the carrier beads with the toner particles clinging thereto are cascaded over the image support member the electrostatic fields from the latent electrostatic charge pattern on the member pulls the toner particles off the carrier beads thus serving to develop the image. The carrier beads, along with any toner particles not used to develop the image, fall back into the trough at the bottom of container 21 for reuse with the toner being periodically replenished.

Following the development step the image support member or plate is rotated so that the electrostatic latent image contacts sheets of copy paper presented one at a time by way of rollers 30 which bring each sheet into contact with the plate surface as it rotates around on cylinder 2. The developer particles are transferred in imagewise configuration to the cut sheets of paper by any suitable technique such as by applying a charge to the back of the sheets with a corona generating unit 33. The corona discharge unit 33 is connected to a source of high potential in the transfer step so that it deposits a charge on the back of the copy paper which is opposite in polarity to the charge of the toner particles used to develop the latent image. This charge on the back of the paper pulls the toner particles away from the plate by overcoming the force of attraction between the particles and the charge on the plate. The transfer potential is regulated in such a manner so as not to destroy the latent image on the image support member such as disclosed, for example, in U.S. Pat. No. 2,951,443. It should be noted at this point that any suitable transfer technique may be utilized such that the requirements of the present invention are satisfied. For example, a roller connected to a high potential source opposite in polarity to the toner particles may be placed immediately behind and in contact with the paper to attract the particles, or the copy paper or a copy web used in place of the paper may have an adhesive surface which will attract the toner particles. The sheets then pass between the plate 6 and the conductive belt 35 which is connected to ground through a conductive roller 36. It has been found that this type of ground or conductive contact serves to separate the copy sheet with its transferred image from the plate without effecting the electrostatic latent image. The separated copy sheet is then picked up by rollers 36 and fed past a resistance heating unit 37 which serves to permanently affix the toner image to the cut copy paper. Other techniques may be utilized to fix the transfer toner image to its subsequent support such as the utilization of solvent vapor fixing, by spraying the toner image with an overcoating or by laminating. The finished copies are then fed to a delivery tray 39 by way of rollers 38.

The development cylinder 2 bearing the image support member then continues to rotate according to a preestablished signal designating the number of copies to be reproduced from the initial exposure. Following completion of the reproduction of the desired number of prints the image support member is reengaged by the continuous belt in response to a predetermined signal while simultaneously being disengaged from the development cylinder without a change in speed. The image support member is guided onto the surface of belt 4 by the lip of the drive belt 42. The image support member now being driven by the continuous belt 4 moves past cleaning brush 40 around cylinder 3 and beneath corona generating unit 41 which serves to recharge or sensitize the plate. Although other charging devices known to those skilled in the art of xerography may be utilized it is preferred to charge the photoconductive insulating surface of the present illustration by corona discharge from a wire filament or filament array which is maintained at a high potential such as described in U.S. Pat. Nos. 2,588,699, 2,836,726, or 2,778,946. Corona charging unit 33 is thus similar to

unit 41. Following sensitization the image support member then reenters the exposure area and is ready to be reimaged by full-frame exposure to a second document.

Since the continuous endless belt mechanism 4 operates synchronously with the rotating cylinders 2 and 3 and the drive belt 42, the speeds of the endless belt, the drive belt and the development cylinder 2 are the same, and all three systems continue to rotate at high speeds until the desired number of exposures and copies are made. Inasmuch as the image support member following exposure is transferred by disengagement to the development cylinder both rotating cylinders 2 and 3 may be utilized to drive the continuous belt mechanism. However, if desirable, the belt mechanism may be situated outside the lateral extremities of the cylinders. Guide bars 43 function to maintain the image support member in a planar condition during exposure and add further support to the belts where located.

FIG. 2 represents a plane view of the imaging apparatus of the present invention during the exposure phase. Referring now to FIG. 2 there is seen the endless belt mechanism 4 which is driven by the rotatably mounted cylinders 2 and 3. The image support member 6 in the exposure position rests between the drive belt 42 which is juxtapositioned with respect to the endless belt 4 such that the plate is held taut by the guide bar 43 so that no distortion in the image is realized. If desired other suitable techniques may be used so as to contribute to maintaining the image support member in a planar condition during exposure. However, under normal operating conditions, generally used image support members are adequately maintained in the planar condition as a result of normal pressure applied by the drive belt and bar to the endless belt surface. Fasteners 15 are located on the development cylinder 2 which serve to grasp the leading edge of the image support member following exposure. The developer unit 20 is seen in close proximity to the developer cylinder 2 and the brush cleaner 40 and corona unit 41 are similarly located in relationship to cylinder 3.

FIG. 3 represents the apparatus illustrated in FIGS. 1 and 2 wherein the image support member is now in its development position. The image support member 6 has left the drive belt 42 and has been engaged by fasteners 15. The image support member is then presented to the developer station 20 to complete the copying phase of the process. When the desired number of copies have been made, the fasteners release the image support member and it is guided by the leading lip of drive belt 42 (best illustrated in FIG. 1) onto the surface of the endless belt 4 and is returned by way of roller 3 to the exposure station. Cleaning brush 40 and corona unit 41 are again represented as in FIGS. 1 and 2.

Reference is now made to FIG. 4 wherein there is illustrated an embodiment whereby the apparatus of the present invention is used in conjunction with induction imaging and development. An electrophotographic plate, generally designated 50, comprising a photoconductive insulating layer overlying a conductive backing member is disclosed. Plate 50 moves first through charging station 61, next through the flash exposure station 71 and is then engaged by means 65 and

directed to image induction station generally designated 81. When imaging is complete the image support member 50 is directed to erase station 91 following which the image support member or xerographic plate may be recycled in a continuous manner. The charging station 61 is similar to the corona discharge units discussed in FIG. 1. When the image support member reaches the induction station 81 an insulating rectifying layer 82 supplied from supply spool 83 is contacted with the imaged surface of the image support member by way of roller 84 which, as illustrated in the embodiment, is maintained at ground potential. Speed of movement of rectifying insulator 82 is synchronized with the speed of rotation of the image support member 50 wrapped around roller 49. Charge patterns are induced on the surface of rectifying insulator 82 as described more fully in U.S. Pat. No. 3,172,024. The rectifying insulating layer 82 may in this embodiment comprise a layer of zinc oxide in an insulating binder overlying a conductive backing such as metal foil or paper in a conductive condition or the like. A more complete discussion of the materials utilized and conditions applied to the induction imaging system herein referred to may be found in the above cited patent and said patent is herein incorporated by reference. Following image induction the image rectifying insulator 82 is moved through processing station 86 where the image is developed and fixed. Development techniques such as the above described cascade development process may be utilized. Following processing the insulator 82 is rewound on spool 85. As is well known in the art these webs may be cut into proper lengths and stacked rather than fed to take up spools as shown. In this embodiment there is illustrated one charge induction station. However, it should be realized that in employing the concepts herein described the original image is in no way affected or deteriorated while charge is induced into an adjacent member. Accordingly, although only one station is shown any number of stations may be positioned around a charge inducing member, or a charge inducing member may be moved into contact with an insulating rectifier to induce charge into such rectifier substantially any number of times. Following the copying of the desired number of prints the image support member 50 is directed back onto the surface of and to be driven by the continuous endless belt 48 and carried to the erase station 91 over roller 51 where, in the case of a photoconductive insulating layer, it may be uniformly illuminated with light to erase the charge pattern from its surface and thus prepare the plate for recycling. Alternatively, however, eraser may be omitted and the plate may be recycled immediately to charging station 61 to reestablish a charge at a level to yield a uniformly charged plate. Plate 50 is then directed towards exposure station 71 by the belts 46 and 48 and is ready for re-exposure and further utilization without interruption. Guide bars 47 are again utilized to maintain the image support member rigid during imaging and secondarily to add support where located.

Although the present invention has been generally illustrated in conjunction with cascade development any suitable development means may be used. Typical development techniques include powder cloud

development as more fully described in U.S. Pat. Nos. 2,725,305 and 2,918,910, magnetic brush development more fully described in U.S. Pat. Nos. 2,791,949 and 3,015,305 and the above described cascade system.

Although the present invention has been described with respect to a specific structural arrangement and configuration it is to be understood that it is not intended that the apparatus of the present invention be necessarily restricted to the design as set out herein and it is intended to include all similar configurations which will satisfy the requirements of the present invention. For example, numerous techniques might be employed for engaging and disengaging the image support member as it passes to the surface of the development cylinder and the structure of the belts may take on various configurations. In addition, if the speeds are so high that blurring of the image might occur, the lens could be given a small lateral motion in order to compensate for motion. Furthermore, although one of the advantages of the present invention is to present a system which is readily adapted to full frame flash exposure this is not to say that other forms of exposure cannot be used if desired such as optical scanning as disclosed in U.S. Pat. Nos. 3,062,094, 3,100,112 and 3,221,622.

Anyone skilled in the art will have other modifications occur to him based on the teachings of the present invention. These modifications are intended to be encompassed within the scope of this invention.

What is claimed is:

1. A copying apparatus comprising in combination:

- a. an image support member;
- b. a rotatably mounted cylinder for driving said imaging support member;
- c. a pressure means for holding said image support member in a planar condition, said pressure means comprising an endless belt configuration which contacts only the lateral extremities of said image support member and is juxtapositioned to said drive means;
- d. means for forming an electrostatic latent image by full frame exposure on the surface of said image support member while said member is held in said planar condition;
- e. means for wrapping said image support member about said rotatably mounted cylinder;
- f. means for processing said electrostatic charge pattern on said image support member to produce at least more than one image reproduction; and
- g. means to return said image support member in a continuous manner to said exposure means so as to prepare said member for another cycle for full frame exposure and rapid processing.

2. The apparatus as disclosed in claim 1 wherein said processing means comprises a means for developing said electrostatic latent image with electrosopic developer material and means for transferring said developer material from said support member in imagewise configuration to the surface of a receiving substrate, said developing and transfer means being positioned adjacent to said rotatably mounted cylinder.

3. The apparatus as disclosed in claim 2 further including cleaning means for removing residual developer material from said image support member.

4. The apparatus as defined in claim 1 wherein said image support member comprises a flexible, reusable

xerographic plate comprising a photoconductive insulating layer superimposed upon a conductive substrate.

5. The apparatus as disclosed in claim 4 wherein said processing means comprises a means for developing said electrostatic latent image with electroscopic developer material and means for transferring said developer material from said support member in imagewise configuration to the surface of a receiving substrate, said developing and transfer means being positioned adjacent to said rotatably mounted cylinder.

6. The apparatus as defined in claim 5 further including a means for removing residual developer material from said xerographic plate and means for uniformly recharging said xerographic plate.

7. The apparatus as disclosed in claim 1 wherein said processing means comprises at least one induction imaging and developer means positioned adjacent to said rotatably mounted cylinder, said developer means adapted to deposit electroscopic marking particles on said electrostatic latent image.

8. The apparatus as disclosed in claim 7 further including a means for erasing residual charge from said image support member.

9. A copying apparatus comprising in combination an image support member, a rotatably mounted cylinder for driving said image support member, a pressure means adapted to hold said image support member in a planar condition during exposure said pressure

means comprising an endless belt configuration which contacts only the lateral extremities of said imaging support member and is juxtapositioned to said drive means, means for forming an electrostatic latent image by full frame exposure on the surface of said image support member while said member is held in said planar condition, means for wrapping said image support member about said rotatably mounted cylinder, means for developing said electrostatic latent image with electroscopic marking materials, means for transferring said developer from said image support member in imagewise configuration to the surface of a receiving substrate, said developing and transferring means being positioned adjacent to said rotatably mounted cylinder, said cylinder being adapted to recycle said image support member past said developing and transferring means so as to produce at least more than one image of the original, means for returning said image support member in a continuous manner to said exposure means so as to prepare said member for reexposure and means for cleaning residual developer material from said image support member.

10. The apparatus as disclosed in claim 9 wherein said image support member comprises a flexible, reusable, electrophotographic plate comprising a photoconductive insulating layer superimposed upon a conductive substrate.

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