



June 22, 1965

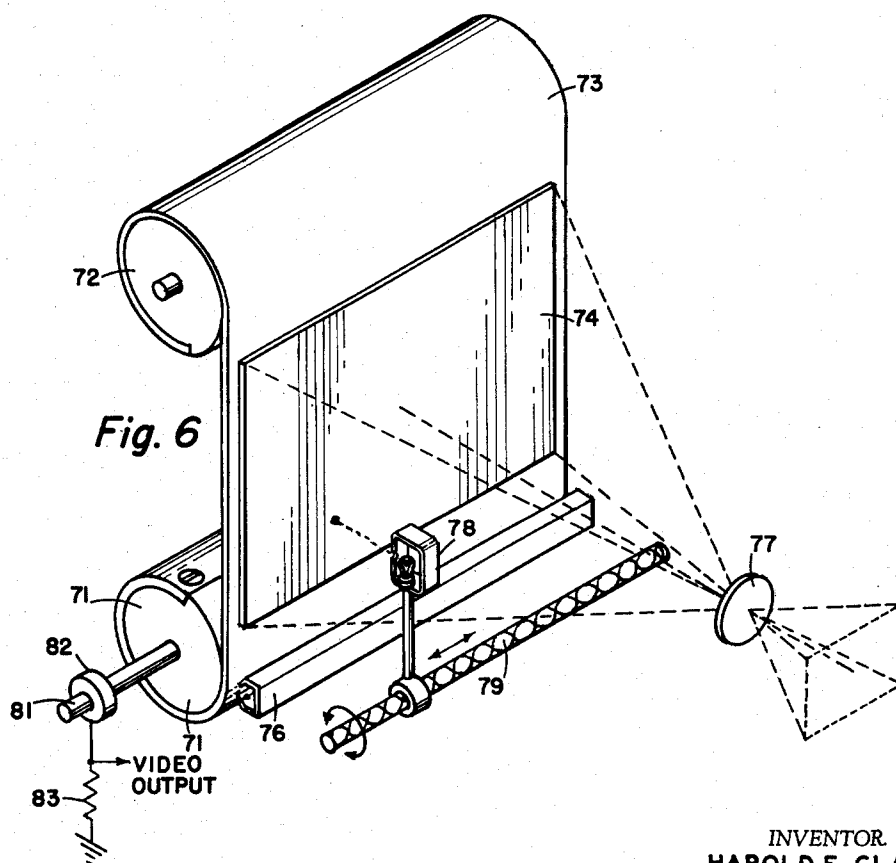
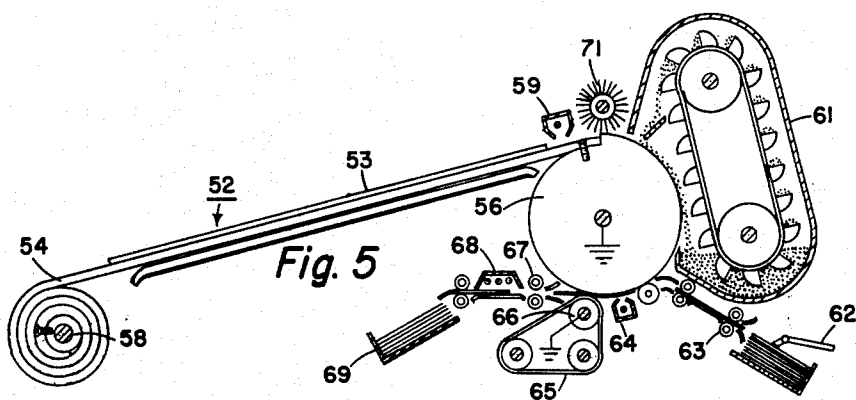
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3,190,199

XEROGRAPHIC COPYING APPARATUS

Filed Jan. 2, 1963

3 Sheets-Sheet 2



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3 Sheets-Sheet 3

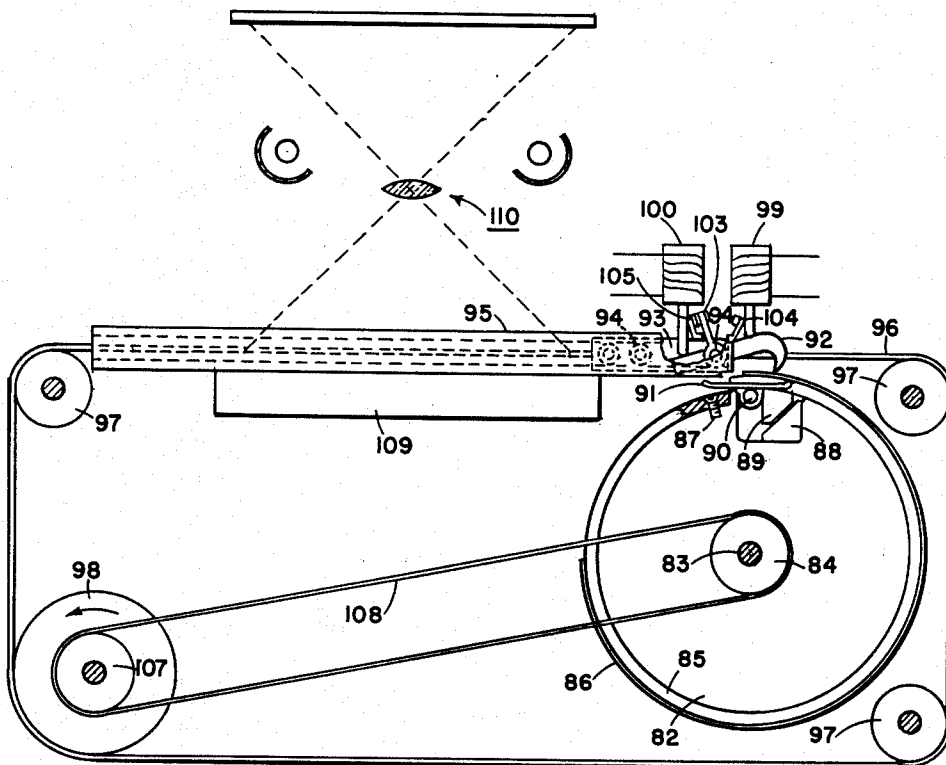


Fig. 7

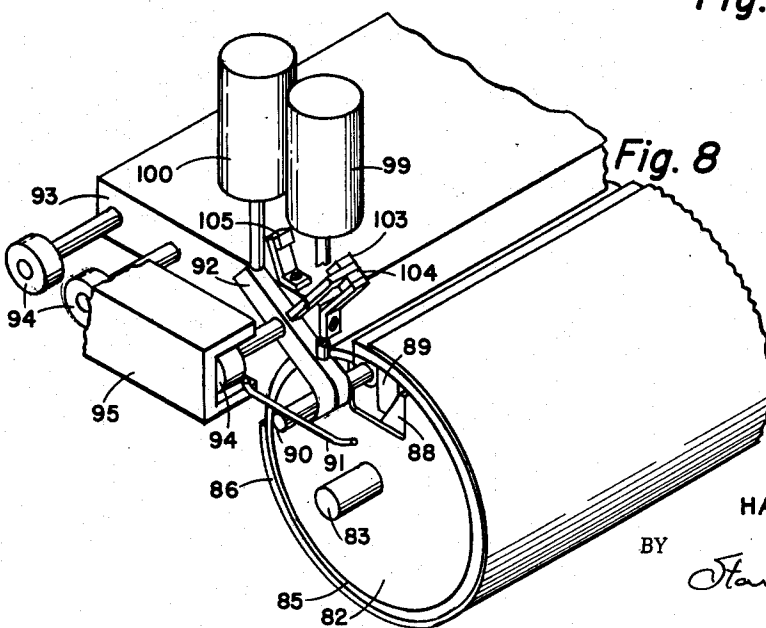


Fig. 8

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3,190,199

## XEROGRAPHIC COPYING APPARATUS

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Filed Jan. 2, 1963, Ser. No. 249,020  
7 Claims. (Cl. 95—1.7)

This invention relates in general to xerography and in particular to an improved xerographic copying apparatus utilizing a novel xerographic plate system.

In the art of xerography as originally disclosed by Carlson in U.S. Patent 2,297,691, and as further amplified by many related patents in the field, an electrostatic latent image is formed on a photoconductive insulating layer and is developed through the deposition thereon of finely-divided, electroscopic, marking material, referred to in the art as toner, which may then be transferred to a sheet of copy paper where it may be permanently fixed. In most applications, the photoconductive insulating layer is first charged to sensitize it and is then exposed to a visible light image or other pattern of activating electromagnetic radiation which serves to dissipate the charge in radiation-struck areas, leaving a charge pattern which conforms to the electromagnetic radiation pattern applied to it. This exposure step is followed by development and optionally by a 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 shape may be rotated past successive xerographic processing stations in a substantially continuous manner with a drive motor and clutch arrangement. Thus, most commercially successful automatic or semi-automatic xerographic copying machines include a cylindrical xerographic plate with the xerographic processing stations located about the circumference of the plate in the machine. In most of these machines then, a point on the periphery of the cylindrical xerographic plate in going through one processing cycle rotates 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 proved to be very efficient because it provides for continuous movement of the xerographic plate through its processing cycle, the curved periphery of the plate gives rise to certain special requirements in 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 cylindrical xerographic plate at any one time. In order to project the entire original onto the cylindrical xerographic drum the projector must scan the original in synchronism with the rotation of the xerographic drum and the scanning speed must be closely tied to the peripheral speed of the drum so as not to distort the image produced on the drum. Such an exposure system requires some fairly complex mechanisms which add to the expense of the device as a whole. Scanning exposure with all of its attendant problems may be avoided by utilizing a flat xerographic plate with full frame exposure of the original to be reproduced, but flat plates do not lend themselves nearly so well to fast continuous xerographic processing of the type which may be utilized with cylindrical plates and further the handling problems associated with flat plates carried through automatic cycles make for extremely complex equipment.

Accordingly, it is an object of this invention to define a novel xerographic plate system having the advantages of both a flat plate system and a cylindrical plate system without the disadvantages of either.

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It is also an object of this invention to describe a xerographic apparatus utilizing this novel plate system.

A further object of this invention to define a simple low-cost xerographic system which is both flexible and capable of high-speed high-quality image reproduction.

Still another object of this invention is to define a novel method of xerographic reproduction.

Yet another object of this invention is to define a novel xerographic plate system which may be utilized in a facsimile transmitter.

FIGURE 1 is a side view of an extended xerographic plate fabricated in accordance with this invention.

FIG. 2 is a side view of the xerographic plate illustrated in FIG. 1 with the plate wrapped around a rotatable mandrel.

FIG. 3 is a side sectional view of a complete xerographic copying apparatus utilizing the novel plate structure of this invention.

FIG. 4 is a plan sectional view taken along section lines A—A of FIG. 3 and showing the xerographic plate in its extended or exposure position.

FIG. 5 is a side sectional view of a second copying apparatus employing a modified version of the novel plate of this invention.

FIG. 6 is an isometric view of a facsimile transmitter using the novel plate structure of this invention.

FIG. 7 is a side view of the novel plate apparatus of this invention with another mechanism for its operation.

FIG. 8 is a partially cut-away isomeric view of a portion of the apparatus of FIG. 7.

Referring now to FIG. 1 of the drawings, there is illustrated a xerographic plate generally designated 11 made up of a photoconductive insulating layer 12 overlying a conductive backing 13. The photoconductive insulating layer 12 may consist of any of the great number of photoconductive insulating materials known to the xerographic art including such diverse materials as vitreous selenium, many different organic photoconductors such as 2,5-bis-(p-amino-phenyl)-1,3,4-triazoles and 2,5-bis-(p-amino-phenyl)-1,3,4-oxadiazole anthracene and the like, both with and without insulating film-forming binders, as well as particulate photoconductive materials such as zinc oxide, cadmium sulfide or lead oxide in an insulating film-forming binder.

The conductive backing 13 of plate 11 is made up of a material having sufficient electrical conductivity for the charging or sensitization of the xerographic plate and to accommodate the release of electrical charge upon exposure of the plate. Desirably, when the photoconductor requires support, this backing is also sufficiently strong to provide such support for the plate while being sufficiently flexible to allow the plate to be coiled or wound about its spiral support mandrel 15. Thus, the conductive backing member 13 may consist of a metallic web, sheet, foil or the like, or a conductive flexible plastic, paper or similar material. The term "conductive" as applied to this backing member should be read in its broadest sense since the backing must only be relatively conductive as compared with the remaining layers of the plate. This, of course, does not imply that a really high conductivity in the range of copper and aluminum is necessary even though useable. However, the backing member should be a resistivity lower than about  $10^{10}$  ohm-cm.

Although the plate is described as made up of a photoconductive insulating layer on a backing which is at least relatively or mildly conductive throughout the body of this specification, it is to be understood that a single photoconductive insulating layer may be used if it is mechanically self-supporting. In this instance, the self-

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supporting photoconductive insulator is attached directly at one end to the mandrel.

One end of the plate 11 is attached to its spiral, mandrel-like support 15 by means of screws 16, rivets, or other equivalent connectors. These connectors establish an electrical connection between the conductive base portions 13 of plate 11 and the mandrel and also allow winding of the plate upon mandrel 15 when the mandrel is rotated in the clockwise direction as seen in FIG. 1.

As seen in FIG. 2, this clockwise rotation of support mandrel 15 serves to wrap the plate closely about the outer periphery of the spiral shaped mandrel while counter clockwise rotation tends to unwrap it. Owing to deflection or bending of the plate 11 in wrapping and unwrapping it about spiral mandrel 15 to carry out the xerographic copying process this whole structure should be constructed with an eye towards avoiding structural failure of the plate. Care must be given not only to avoid cracking or breaking of the plate during its first wrap around spiral mandrel 15, but also to avoid failure from flexural fatigue upon repeated wrapping and unwrapping of the plate about its spiral mandrel 15. Thus, as a general rule, the thickness of the plate 11 should be kept small with respect to the average radius of spiral mandrel 15. It is also desirable to anchor the photoconductive insulating layer of the plate firmly to its conductive backing. Obviously, the degree of care necessary in the design of the plate is dependent not only on the dimensions of the plate and its mandrel, but also upon the materials utilized to make the plate. Testing has demonstrated that the use of average plate thicknesses with spiral mandrels of reasonable average radius will generally serve to avoid structural failure of the flexible plate 11 either in its first flexing or by fatigue. Thus, it was found that a plate fabricated by vacuum evaporation of a 20 micron thick layer of vitreous selenium onto a 4 mil thick grained aluminum backing did not fail even when wrapped around a cylinder having a radius of 1/4 inch for 40,000 cycles at which time testing was discontinued. Grained aluminum has proved to form a very good bond with selenium and is therefore a preferred material. It has also been found that the minimum radius of curvature about which the plate is wrapped has a rather direct relationship to the thickness of selenium layer if selenium is used, on the conductive backing. For example, a 50 micron layer of selenium requires about a minimum 1 inch radius on the cylindrical mandrel. Various binder layers are readily flexed, the selenium type plate having been discussed because not readily thought of as an acceptable flexible member.

FIG. 3 illustrates one embodiment of a complete xerographic copying apparatus embodying the novel plate structure of this invention. This structure is made up of a flexible xerographic plate 17 including a conductive backing 18 and a photoconductive insulating layer 19 attached to a spiral mandrel 21 by screws 22. This portion of the apparatus then is the same as the plate described above in connection with FIGS. 1 and 2. Also illustrated is a fixed cam 23 which may, for example, be mounted on the shaft bearing for rotatable spiral mandrel 21. A duplicate of this cam, which is not illustrated here, is also placed on the opposite end of spiral mandrel 21. Riding on both cams are a pair of bars 24 which reciprocate in guides 26. The two bars 24 are connected at their upper ends with a cross-bar just below the conductive backing 18 of plate 17. Thus, when spiral mandrel 21 rotates to the position shown in FIG. 3, bars 24 and their connecting cross-piece ride up on cam 23 to their uppermost position raising the end of the plate off the surface of spiral mandrel 21. If spiral mandrel 21 is rotating in the clockwise direction, it will merely continue on, allowing bars 24 to ride down on the lower portions of cam 23 thus returning end 27 of plate 17 to the surface of spiral mandrel 21. If, on the other hand, spiral mandrel 21 is rotating in a counter clock-

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wise direction, the end 27 of plate 17 will be picked up and guided by support plate 28 thus serving to unwrap the plate from the spiral mandrel 21 and providing a flat support surface for it. Since the plate may be either quite loose and flexible or somewhat springy (if it has a metallic backing which has taken on a coil set because the plate was wrapped about mandrel 21) it may be preferable to provide guide bars 29 along both edges of the plate surface as shown most clearly in FIGS. 3 and 4 in order to guide the plate onto support 28 and keep it in its flattened condition. Other equivalent mechanisms for holding the plate flat, such as automatically actuated clamps, vacuum systems under the plate and the like will suggest themselves to the designer. As spiral mandrel 21 continues to rotate in a counter clockwise direction past the lip of support 28, bars 24 along with their connecting cross member ride down on cam 23 so that they do not catch on the lip of support 28. Preferably, bars 24 are spring biased toward the center of spiral mandrel 21. As the plate moves onto support 28, its photoconductive insulating surface 19 moves past brush cleaner 30, a corona generating unit 31 which serves to charge or sensitize the plate. Although other charging devices known to those skilled in the art of xerography may be utilized, it is preferable to charge the photoconductive insulating surface by corona discharge from a wire filament or wire filament array which is maintained at a high potential as described, for example, in U.S. Patents 2,588,699 to Carlson, 2,836,726 to Vyverberg, 2,777,957 to Walkup, 2,778,946 to Mayo, and others. When a self-supporting photoconductor or one on a backing of very low conductivity is used as the sole element of a plate, two sided charging as described in U.S. Patent 2,885,556 to Gundlach is preferable. When the plate 17 extends out to the end of support 28 rotary movement of mandrel 21 is stopped as by a limit switch (not shown) and a full frame exposure of an original to be reproduced is made on the plate in its extended position. In order to make this exposure, the original to be reproduced is placed face down on a transparent supporting member 32 which may be fabricated of glass, lucite, or the like. The original is then illuminated by light sources 33 which desirably have back reflectors 34 to prevent direct illumination of the extended xerographic plate by the light sources. Light from light sources 33 is reflected off light-colored portions of the original and imaged onto the sensitized xerographic plate 17 by a lens system 36 while darker portions of the original do not so reflect the light from light sources 33. Thus, a light pattern conforming to the original to be reproduced is projected on the pre-sensitized xerographic plate causing illuminated portions of the plate to dissipate their charge so that a latent electrostatic image conforming to the original to be reproduced is left on the xerographic plate 17 after exposure to the original. After sufficient exposure, light sources 33 are shut off and clockwise rotation of spiral mandrel 21 is initiated so as to remove the flexible plate from support 28 and wrap it about the circumference of the mandrel. Alternatively, a limit switch actuated by the rotation of the mandrel to the ultimate point in its rotational path may be used to activate a flash exposure unit of short duration and high light intensity when the plate is fully extended. During this wrapping operation, the plate passes a developing unit 37 of the cascade type as more fully described in U.S. Patents 2,618,551, 2,618,552, and 2,638,416 to Walkup. Although any one of the other conventional xerographic developing techniques may be utilized, the illustrated cascade unit is described as it has been found to be one of the more effective development mechanisms. This developing unit includes an outer container or cover 38 with a trough at its bottom containing a supply of developing material 39. This developing material is picked up from the bottom of container 38 and dumped or cascaded over the surface of the xerographic plate by a number of buckets 31 on an endless driven conveyor

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belt 42. This development technique utilizes a two-element development mixture including finely-divided, colored, marking particles or toner and grossly larger carrier beads. The carrier beads serve both to deagglomerate the toner particles and to charge them by virtue of the relative position of the toner and the carrier material in the triboelectric series. Thus, friction between the beads and toner particles during tumbling of the developing mixture causes them to charge to opposite polarities so that the toner particles cling to the carrier beads. When the carrier beads with toner particles clinging to them are cascaded over the xerographic plate, the electrostatic fields from the latent electrostatic charge pattern on the plate pulls toner particles off the carrier beads serving to develop the image. The carrier beads, along with any toner particles not used to develop the image, then fall back into the bottom or trough of container 38 for reuse, with the toner being periodically replenished. After this development step, the latent electrostatic image is rotated to come into contact with a copy web 43 which is pressed against the plate surface by two spring-biased idler rollers 44. A transfer unit 45 is placed behind the web and spaced slightly from it between rollers 44. This unit is similar in nature to the plate charging mechanism 31 and also operates on the corona discharge principal. It is connected to a source of high potential of the same polarity as that employed in the charging device so that it deposits a charge on the back of web 43 which is of the same polarity as the charge originally placed on the xerographic plate and is also opposite in polarity to the toner particles utilized in developing the plate. This charge on the back of web 43 pulls the toner particles away from the plate by overcoming the force of attraction between the particles and the charge on the plate. It should be noted at this point, that many other transfer techniques might be utilized with this invention. 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 copy web to attract the particles, or, the copy web itself may be adhesive to the toner particles. After transfer of the toner image to web 36, the web moves beneath a fixing unit 47 which serves to fuse or permanently fix the toner image to the web. In this case a resistance heating type fixing unit is illustrated; however, other techniques known in the xerographic arts may also be utilized including the subjection of the toner image to a solvent vapor or spraying the toner image with an overcoating. After fixing, the web is re-wound on a coil 48 similar in nature to the coil 49 from which it originated. The plate is then ready for another cycle of operation. It should be noted at this point on its return oscillation in the counter clockwise direction the plate is separated from copy web 43 by cams (not illustrated) that act to push the shafts of rollers 44 down as seen in FIG. 3.

If multiple copies of the same original are desired and the toner particles are transferred from the developed electrostatic image to the copy web without destroying the original latent electrostatic image, the xerographic plate, wrapped on spiral mandrel 21, may be continuously rotated in the clockwise direction to produce multiple originals on the original image has been formed. The details of alternative methods and additional apparatus required for this multiple copy operational mode are described in U.S. Patent 2,951,443 to Byrne and 2,901,374 to Gundlach. Since recharging and re-exposure of the plate are not required, and the only process steps are development and transfer, this considerably speeds up the process by making it continuous in nature since it substitutes continuous rotation for oscillation of the plate surface. As is shown in FIG. 3, the whole apparatus is enclosed in a light-tight cabinet 51.

In FIG. 5, there is illustrated a xerographic plate generally designated 52 made up of a photoconductive insulating layer 53 on a conductive backing 54, the conduc-

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tive backing being attached at one end to a spiral mandrel 56 similar to the mandrel described in FIGS. 1-3. Under the xerographic plate 52 is a flat support member 57 adapted to hold the plate in its flattened position for full frame exposure to an original in a manner similar to that described in connection with FIG. 3. It is to be noted that the end of the conductive backing 54 which is not attached to spiral mandrel 56 is attached to a second mandrel 58 which is also mounted for rotation so that the conductive backing 54 of the plate may be wrapped about it. Thus, as the plate wraps about mandrel 56, it unwraps from mandrel 58 and vice versa so that these mandrels oscillate back and forth to move the xerographic plate from its flattened exposure position through its processing step where it is curved about mandrel 56. The plate is charged by a corona generating unit 59 similar to unit 31 described in connection with FIG. 3, and pulled out to its flattened position on support 57 where it is full frame exposed to the original to be reproduced. Mandrel 56 then rotates in the clockwise direction moving the charged and exposed plate past developing unit 61 which is of the same type as the cascade unit described in connection with FIG. 3. At the same time, that spiral mandrel is rotating in the clockwise direction, feeding dog 62 picks up sheets of cut copy paper one at a time and feeds them to a pair of rollers 63 which bring each sheet into contact with the plate surface as it rotates around on mandrel 56. The developed power image is then transferred to these cut sheets of paper by applying a charge to the back of the sheets with a corona generating unit 64 similar to unit 45 described in connection with FIG. 3. The sheets then pass between the plate 52 and a conductive belt 65 which is connected to ground through a conductive roller 66. It has been found that this type of grounded conductive contact serves to separate the copy sheet with its transferred image from the plate. The separated copy sheet is then picked up by a pair of rollers 67 and fed past a resistance heating unit 68 which serves to permanently affix the toner image to the cut copy sheet. The finished copies are then fed to a delivery tray 69 for recovery by the operator while the plate continues moving past a cleaning brush 71. The plate then oscillates back in the counter clockwise direction for recycling.

FIG. 6 illustrates an additional simplified and space-saving apparatus utilizing the xerographic plate of this invention. This apparatus is a facsimile transmitter utilizing a pair of spiral mandrels 71 and 72 similar to the ones previously described, each being connected to one end of a flexible conductive web 73 which has a layer of photoconductive insulating material 74 over a portion of its surface. Both the conductive web 73 and the photoconductive insulating layer 74 may be of any of the material previously described. The spiral mandrels 71 and 72 are connected to synchronized oscillatory drive means which rotate the two mandrels together first in one direction and then in the other. Thus, as the oscillation takes place, conductive web 73 winds onto mandrel 71 and off of mandrel 72 and then off of mandrel 71 and back onto mandrel 72, in a manner similar to the operation of a window shade. As mandrels 71 and 72 rotate in a counter clockwise direction to move photoconductive insulating layer 74 up into the position shown in FIG. 6, this layer moves past a corona charging unit 76 which applies a uniform electrostatic charge across the surface of the photoconductive insulating layer thus operating in a manner similar to the corona charging devices 31 in FIG. 3 and 59 in FIG. 5. Subsequent to this charging step, rotation of the mandrels 71 and 72 is stopped and the charged photoconductive insulating layer 74 is full frame exposed to the original to be transmitted through a lens system 77. Once exposure is completed, mandrels 71 and 72 are rotated in a clockwise direction to re-wind the plate on mandrel 71. As conductive web 73 carrying photoconductive insulating layer 74 begins to move down slowly, a light source and lens system 78 focuses a very small spot

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of light on the order of about 5 microns in diameter on the surface of the photoconductive insulating layer 74. This light source 78 is mounted for actuation by a lead screw 79 which is driven so that the light source scans across the photoconductive insulating layer 74 from left to right and then from right to left while it is moving down onto spiral mandrel 71. In this manner the whole surface of the photoconductive insulating layer is exposed to light from the scanning source with each section being exposed at a predetermined time. This movement of the scanner 78 as related to the photoconductive insulating layer 74 is synchronized with the movement of the recording head at the other end of the facsimile transmission system. Since exposure to the original to be transmitted through lens 77 discharges portions of photoconductive insulating layer 74 according to the light reaching that layer, in different sections, the scanning light 78 has no charge left on photoconductive insulating layer 74 to discharge in sections which had received a large amount of light from the original. However, where the original was dark and no light was transmitted to photoconductive insulating layer 74, the charge remaining on photoconductive insulating layer 74 is discharged by the scanning light 78 and dissipated to ground through the conductive spiral mandrel 71 and its conductive shaft 81 and thence through slip rings 82 and output resistor 83. The voltage drop occurring across output resistor 83 is then applied to modulate the video output of the facsimile transmitter. The transmitted signal is picked up at the receiving end of the system, amplified, and applied to the facsimile recorder which may be of any known type.

FIGS. 7 and 8 illustrate an additional mechanism for pulling a flexible xerographic plate with one of its ends attached to a rotatable mandrel off the mandrel and into planar condition for exposure and then wrapping the plate back on its mandrel for processing. No processing details have been included in these figures since the illustrated mechanism is adapted for use either with a xerographic copying apparatus of the type illustrated in FIGS. 3-5 or the facsimile transmitter of the type illustrated in FIG. 6.

Turning now to FIGS. 7 and 8, the device consists essentially of a mandrel 82 journaled for rotation about a central shaft 83 which also has a pulley 84 affixed thereto. A xerographic plate made up of a conductive layer 85 and a photoconductive insulating layer 86 has one end attached to mandrel 82 by connecting means 87 which may, for example, be a number of screws, rivets, or the like. Mandrel 82 also carries a magnet 88 in a cut-out portion on its periphery and this magnet 88 operates in conjunction with a second magnet 89 which is attached to the bottom of the xerographic plate so as to hold the plate tightly and snugly on the mandrel when the two magnets are in proximity with each other. Just beyond magnet 89 is a bail 90 which is also attached to the underside of the conductive layer 85 of the xerographic plate and which extends out beyond the edges of both the plate and the mandrel which carries it as is seen most clearly in FIG. 8. Just above bail 90 and at both extreme ends thereof there is a small camming plate 91, the function of which is explained hereinafter. As can be seen in the figures, the conductive portion of the xerographic plate overlaps the cut-out section in mandrel 82 so as to completely cover it when the plate is snugged about the mandrel. Immediately above bail 90 as shown in FIGS. 7 and 8, there is an engaging pawl 92 pivotally mounted on a carriage 93. Carriage 93 is mounted on rollers 94 which ride in guide bars 95 so as to allow reciprocation of carriage 93 along the guide bars which are placed on either side of the carriage. The shaft which pivotally carries pawl 92 extends through to the opposite side of carriage 92 and a second identical engaging pawl is mounted at the opposite side of the carriage. Opposite ends of carriage 93 are attached to an endless cable 96 which rides on idle rollers 97 and drive pulley 98 which is connected to a motor through a clutch, neither of which

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is shown in the drawings. Immediately above pawl 92 are a pair of solenoids 99 and 101 on opposite sides of the pivot point for the pawl. As shown in FIG. 8, pawl 92 also carries a latching magnet 103 acting in conjunction with a pair of magnets 104 and 105 which are mounted on carriage 93.

In operation, the system starts from the position shown in FIG. 7 and in order to initiate pull-off of the xerographic plate 85, 86 into its planar position solenoid 99 is actuated and its ram causes pawl 92 to pivot down in a clockwise direction thereby engaging bail 90. The pawl is held in this position by engagement of its latching magnet 103 with magnet 104 on the carriage 93. A delayed action relay then turns on the drive motor to rotate drive pulley 98 in the counter clockwise direction so as to move carriage 93 back along guide bars 95 (to the left as seen in FIG. 7) so as to pull out plate 85, 86 in its planar condition. The drive motor actuating pulley 98 is also connected so as to drive pulley 107 in the counter clockwise direction as seen in FIG. 7 and pulley 107 which drives an endless timing belt 108 so as to rotate mandrel 82 through pulley 84. This drive system is set up so that the peripheral speed of mandrel 82 is the same as the linear speed of carriage 93 and its cable 96. The result of this speed synchronization is that the xerographic plate 85, 86 is kept under tension as it is unwrapped from mandrel 82 and pulled out into its planar condition. Since engaging pawl 92 and bail 90 move in a line which is generally tangential to mandrel 82, magnets 88 and 89 separate under the pulling force exerted by the pawl when bail 90 passes the end of cam 91 and the bottom or conductive layer 85 of the xerographic plate is pulled over a flat support 109 for exposure to a projection system 110 which exposes the xerographic plate to an original subject. Support plate 109 may contain a vacuum box if desired to hold the plate very close against the support so as to allow good focusing of the original over the entire photosensitive surface. When carriage 93 reaches the end of guide rails 95, it hits a limit switch which shuts off the drive to pulleys 98 and 107. Since the xerographic plate is held under tension, it may be very thin and very flexible. Once exposure of the xerographic plate is completed, a second relay operated by the projector timer turns on the drive motor to turn pulleys 98 and 107 in the clockwise direction thereby wrapping xerographic plate 85, 86 back onto the surface of mandrel 82 and allowing magnets 88 and 89 to hold the plate snugly against the periphery of the mandrel. Once the apparatus again reaches the position shown in FIG. 7, a relay is actuated which disengages a clutch from the drive motor to pulley 98 and actuates solenoid 100. The ram of solenoid 100 comes down causing pawl 92 to pivot in the counter clockwise direction and disengage from bail 90. Magnets 88 and 89 facilitate this disengagement. Mandrel 82 may then continue rotating in the clockwise direction for development and transfer of a xerographic image or for multiple copy production utilizing an image-keeping technique and subsequent redevelopment and retransfer or, in the alternative, may make only one rotation in the clockwise direction for single copy reproduction or facsimile transmission. Counter and relay systems necessary to operate the apparatus in this manner will be obvious to the designer.

Clearly, there are many equivalent and alternative structures and uses for the present invention. For example, the conductive base material of the plate may be springy in nature and have been given a coil set so that it tends to wind or coil about a mandrel of its own accord. This type of plate base material would clearly be utilized in the FIG. 3 embodiment of this invention and might also be utilized to advantage in the embodiments of FIGS. 5 and 6, since in that instance only one mandrel drive connection would be necessary. A number of separate sections of photoconductive insulating material may be placed on the conductive backing thus forming a plurality of xerographic plates which may be successively

moved through the processing steps. It also should be noted that the mandrel upon which the flexible plate is mounted need not necessarily be spiral in shape but may be of many other shapes and might advantageously be merely a cylinder especially where the plate is not wound upon itself, (i.e., where it does not encompass more than 360° of the mandrel periphery at any time). Many different known plate materials, mandrel materials and xerographic processing steps may also be substituted in any one of the described embodiments while still coming within the spirit of this invention.

Thus, while the specific embodiments shown and described in this specification and drawings are admirably adapted to fulfill the stated objects of this invention, it should be understood that it is not intended to confine the invention to these disclosed embodiments since it is susceptible of embodiment in many various forms, all coming within the scope of the following claims:

What is claimed is:

1. A xerographic apparatus comprising:

- (a) a mandrel having a substantially cylindrical shape,
- (b) a flexible, web-like, reusable, xerographic plate wrapped on said mandrel and having a first one of its ends fixed thereto,

- (c) means to uniformly charge said xerographic plate,
- (d) plate handling means to unwrap the free end of said xerographic plate, flatten said plate, and hold it in a planar condition while said first end is still fixed to said mandrel,

- (e) means to expose said charged plate to a full frame pattern of actinic electromagnetic radiation while it is being held in a planar condition by said plate handling means thus forming a latent electrostatic image on said plate,

- (f) processing means adapted to process the latent electrostatic image on said plate; and,

- (g) means to rewrap said xerographic plate on said mandrel after each exposure, moving at least the exposed portion of said plate past said processing means so that said plate is readied for another cycle of full frame exposure and rapid processing.

2. Apparatus according to claim 1 in which said processing means comprises developing and transfer means adjacent the curved surface of said mandrel adapted to deposit electroscopic marking material on said latent electrostatic image in image-wise configuration and transfer said marking material to a transfer member, said transfer means being further on in the direction of rewrap rotation of said mandrel.

3. Xerographic apparatus according to claim 1 in which:

- (a) said xerographic plate includes a conductive backing connected to ground through an output resistor,
- (b) said apparatus includes means to detect the voltage across said output resistor and transmit it to a facsimile receiver; and,

- (c) said processing means comprises means to scan back and forth across said xerographic plate with a small spot of light while it is being wrapped upon said mandrel whereby discharge signals will be generated through said output resistor with latent electrostatic image areas on said plate are scanned by said light spot.

4. A xerographic apparatus comprising:

- (a) a mandrel having a substantially cylindrical shape,
- (b) a flexible, web-like, reusable, xerographic plate wrapped on said mandrel and having a first one of its ends fixed thereto,

- (c) means to uniformly charge said xerographic plate,
- (d) plate handling means to unwrap the free end of said xerographic plate, flatten said plate and hold it in a planar condition while said first end is still fixed to said mandrel,

- (e) means to expose said charged plate to a full frame

pattern of actinic electromagnetic radiation while it is being held in a planar condition by said plate handling means,

- (f) developing means adjacent the curved surface of said mandrel adapted to develop a latent electrostatic image on said xerographic plate by depositing electroscopic marking material thereon in image-wise configuration,

- (g) transfer means adjacent the curved surface of said mandrel but spaced around from said developing means, said transfer means being adapted to transfer the electroscopic material making up a developed image from said xerographic plate to a transfer member; and,

- (h) drive means to rewrap said xerographic plate on said mandrel after each exposure and rotate said mandrel so that said exposed plate passes said developing and transfer means in their named order to develop said plate and transfer the developed image to said transfer member thereby readying said apparatus for another cycle of operation with said plate.

5. Apparatus according to claim 4 in which said plate handling means concludes a substantially planar support extending in a plane which is approximately tangential to said mandrel, a pair of cam-like guide bars spaced opposite said support plate a distance slightly larger than the thickness of said xerographic plate, and extending in the direction of travel of said plate over said support and means to raise the free end of said plate off said mandrel as it approaches said planar support during the rotation of said mandrel so that it will feed between said plate and said guide bars upon rotation of said mandrel.

6. Apparatus according to claim 4 in which said plate handling means comprises means to pull the free end of said xerographic plate off said mandrel under tension.

7. A xerographic apparatus according to claim 4 in which said plate handling means comprises a second cylindrical mandrel having its longitudinal axis generally parallel to that of said aforementioned mandrel and spaced therefrom, said xerographic plate having a length in excess of the length required to span said two mandrels and having its free end attached to said second mandrel, the length of said xerographic plate in excess of that required to span said mandrels being wrapped about one of said mandrels so that the spanning portion thereof is substantially planar, and means to rotate said second mandrel at the same peripheral speed as said first mandrel and in a direction such that when said xerographic plate is wrapping on to one of said mandrels it will unwrap off of the other of said mandrels and vice versa whereby the spanning length of said xerographic plate is held in a planar condition.

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