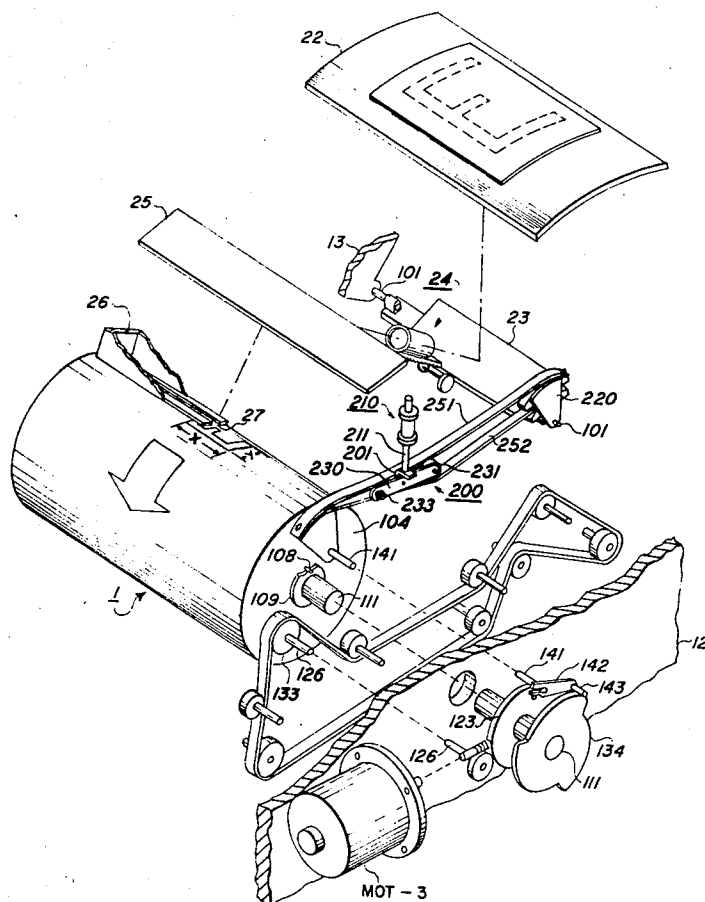


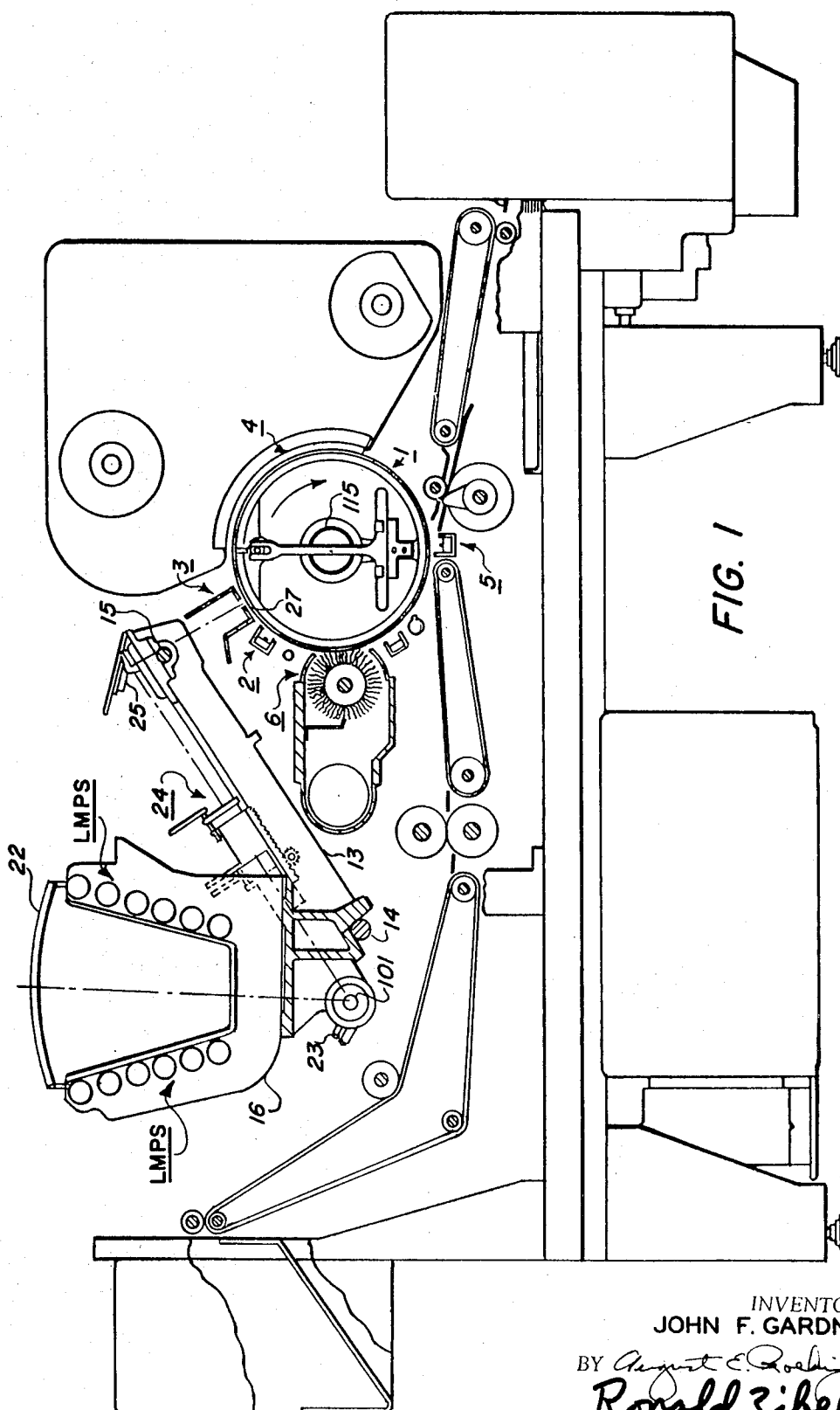
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 [21] Appl. No. **682,848**
 [22] Filed **Nov. 14, 1967**
 [45] Patented **July 6, 1971**
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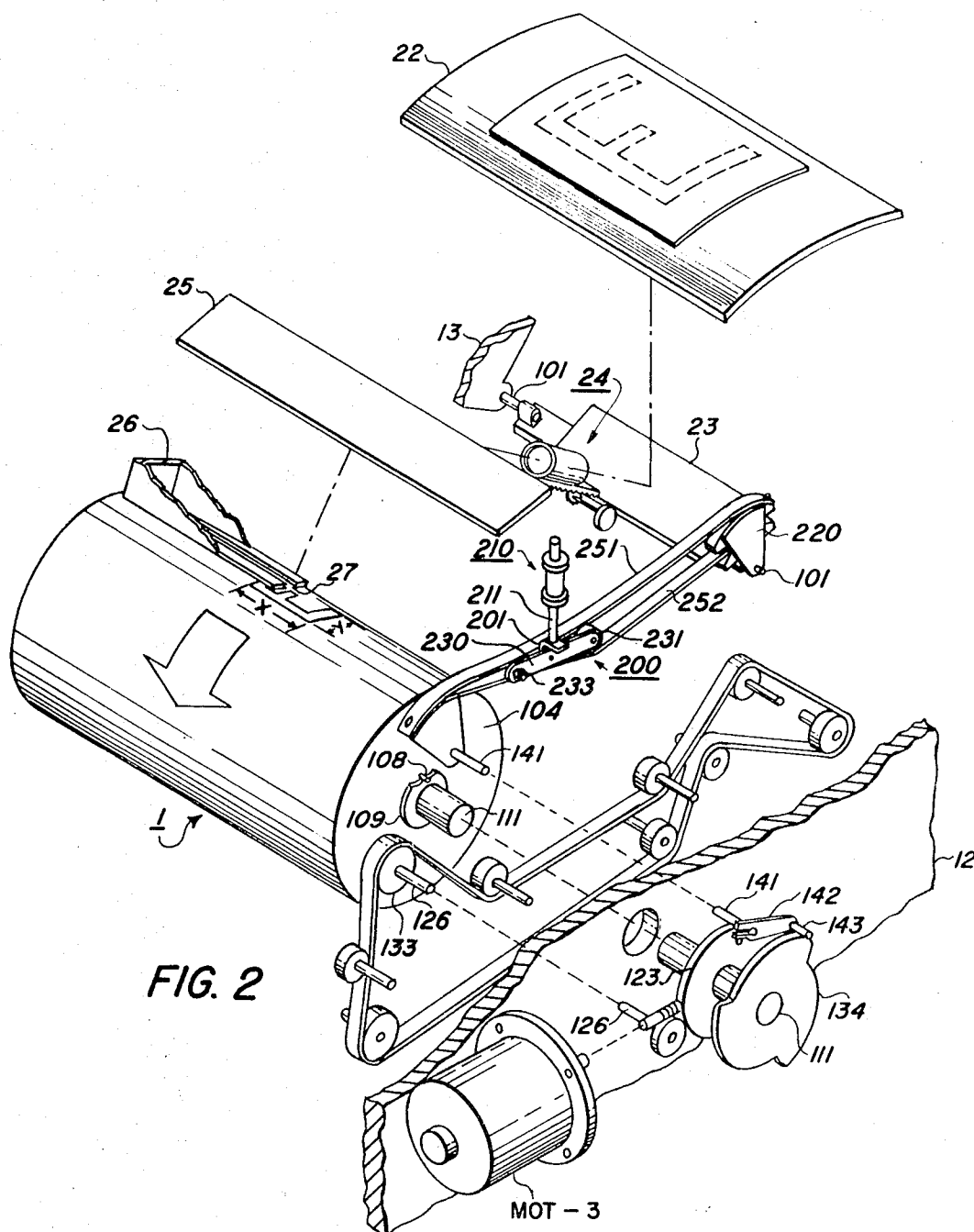
[54] **XEROGRAPHIC REPRODUCING APPARATUS**
 9 Claims, 8 Drawing Figs.
 [52] U.S. Cl..... 355/8,
 355/47, 355/65
 [51] Int. Cl..... G03g 15/04
 [50] Field of Search..... 355/8, 65,
 47; 95/15

ABSTRACT: An automatic xerography machine for producing various size copies of an original document which document remains stationary during the process. The machine is characterized by an optical scanning system which can be made to move at various speeds relative to a moving, image receiving surface. A control which operatively couples a scanning mirror and the imaging surface is selectively adjustable in order to vary the relative speed of the mirror and the image receiving surface.





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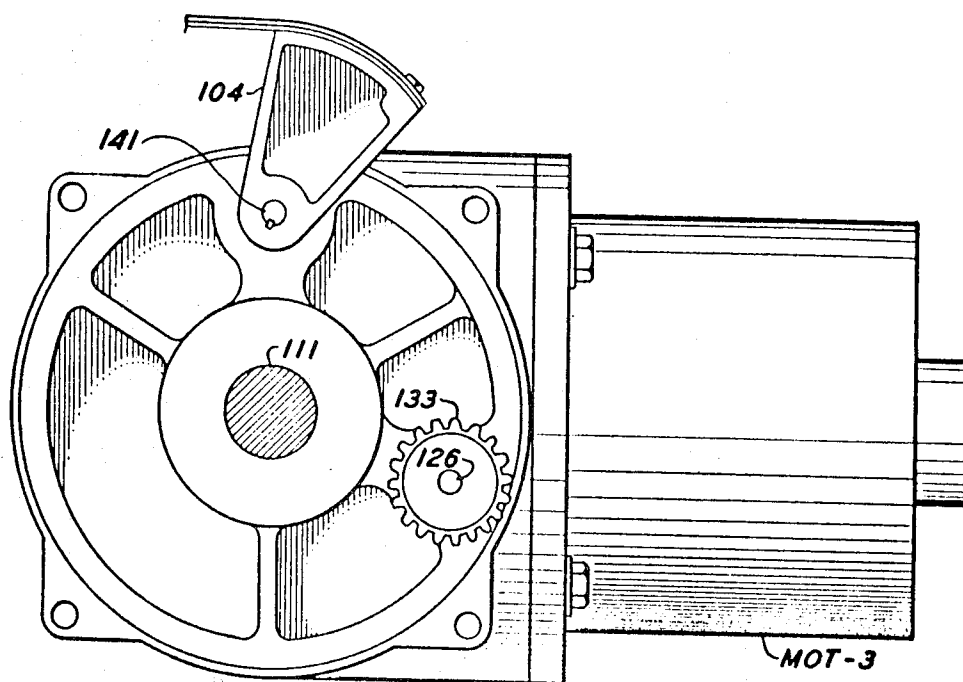


FIG. 3

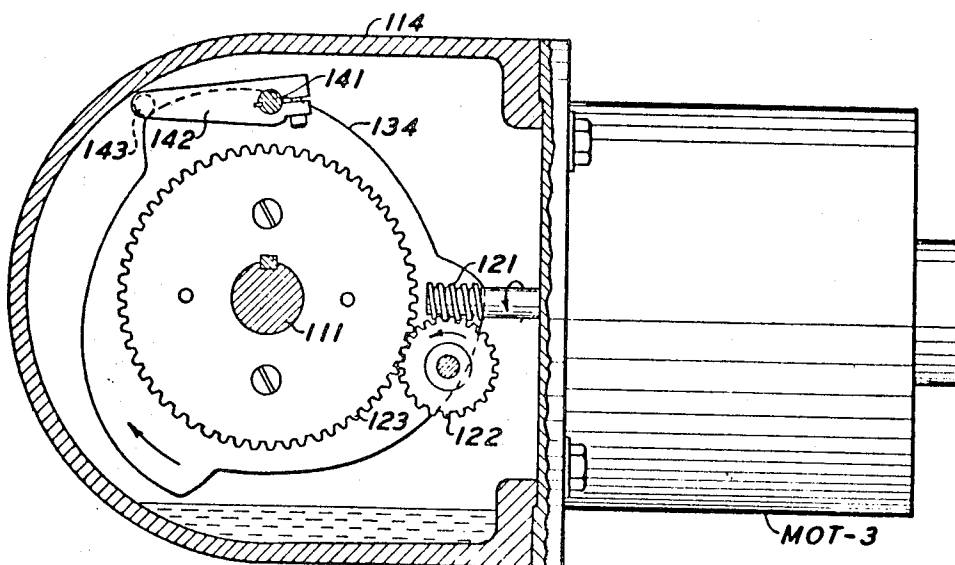


FIG. 4

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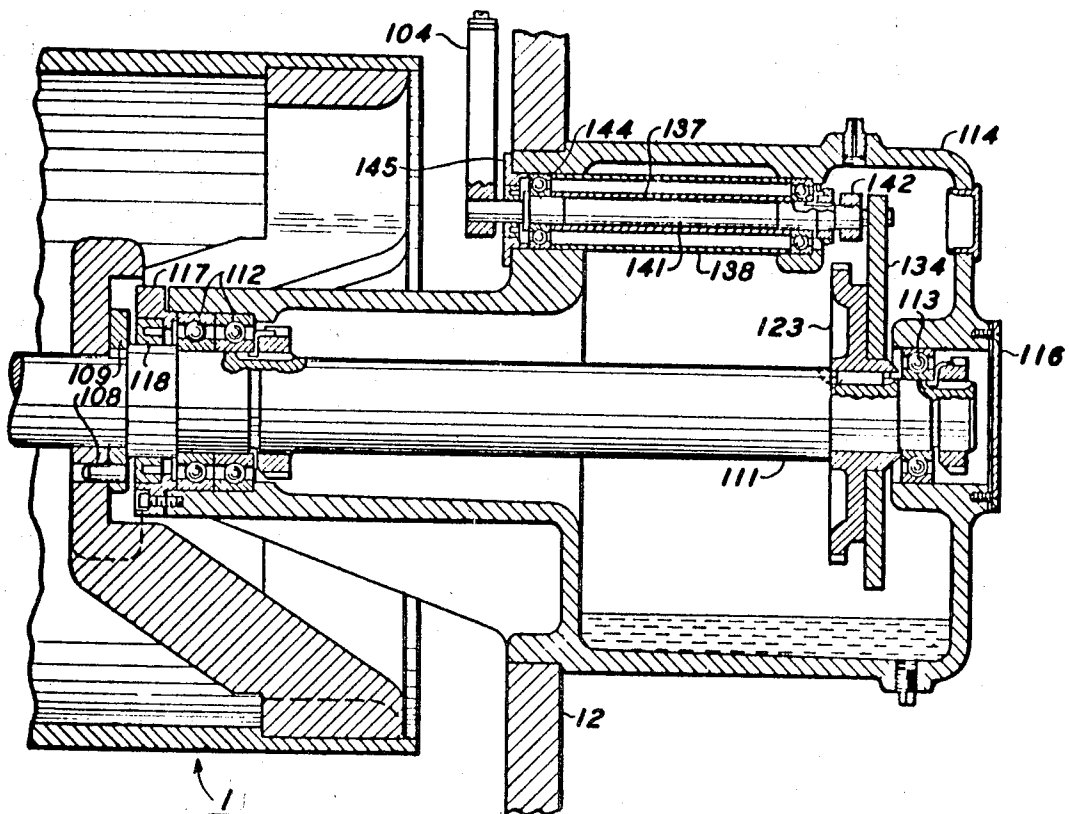


FIG. 5

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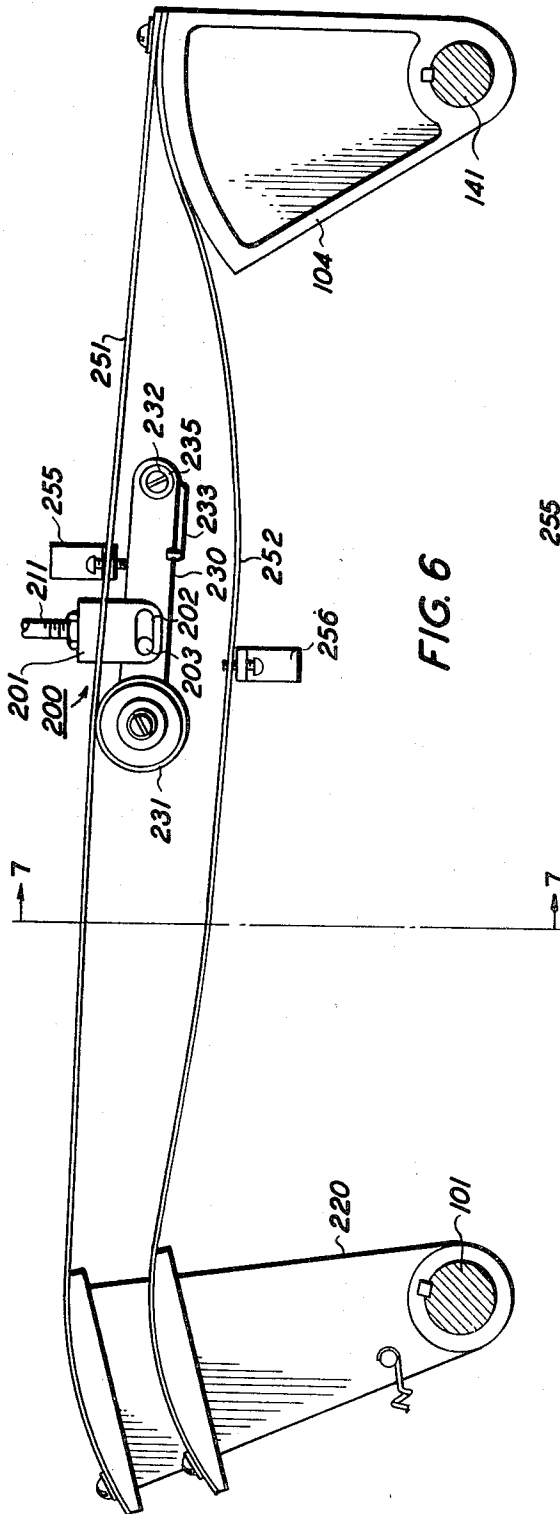


FIG. 6

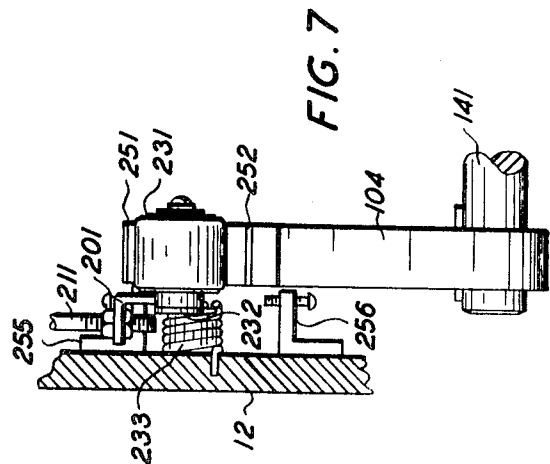


FIG. 7

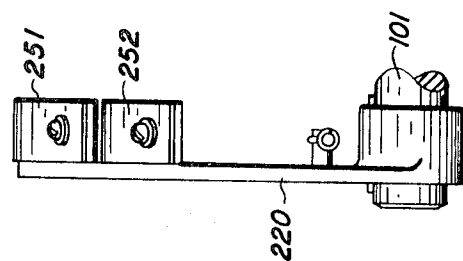


FIG. 8

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XEROGRAPHIC REPRODUCING APPARATUS

BACKGROUND OF THE INVENTION

This invention relates to xerographic reproducing machines and, in particular, to an automatic xerographic reproducing machine adapted to reproduce various sized documents on a photoreceptive surface.

More specifically, this invention relates to an automatic xerographic reproducing machine adapted to selectively vary the scanning of an original document in accordance with the document size.

In utilizing electronic data processing equipment and especially electronic computing apparatus, much time and expense is minimized by the equipment's ability to perform functions which provide information in a fractional time as compared with that required prior to the development of such equipment. However, much of the time and expense saved by this equipment is lost due to the inability of disseminating the information obtained from this equipment to but one or a few persons immediately after this information has been generated. Various printing devices have been developed for creating a permanent copy of the information obtained from electronic data processing equipment, but this equipment has been limited to creating a single or a very few multiple copies by carbon interleaving. In addition, this printout which is generated by the electronic data processing (EDP) equipment is of various sizes and in fanfold form, that is the leading edge of one sheet is separably attached to the trailing edge of the preceding sheet, which is bulky and difficult to manually handle. The need for many multiple copies of this EDP equipment printout in a convenient form to enable the user to evaluate this data and to facilitate its storage for subsequent use has created an information "bottleneck" which precludes the utilization of the data processing equipment at its maximum efficiency and effectiveness. One solution for utilizing data processing equipment at its maximum efficiency and effectiveness by providing multiple copies of printout in a standardized format is disclosed in copending application, "Xerographic Reproducing Apparatus," Ser. No. 682,830 filed concurrently herewith in the name of Robert A. Schaeffer. This aforementioned copending application discloses an automatic xerographic reproducing machine for creating such copies of electronic data processing machine print out by controlling the speed at which the original document is scanned in relationship to the movement of a photoreceptive surface to thereby create an undistorted facsimile of the original document on the photoreceptive surface. The invention of this application is an improvement of the apparatus therein disclosed and provides a more economical, reliable, and easily adjustable control apparatus to obtain a variation in the speed of scanning an original document for creating a facsimile of the document.

SUMMARY OF THE INVENTION

It is, therefore, an object of this invention to improve utilization of electronic data processing equipment output.

Another object of this invention is to reproduce electronic data processing equipment printout in a standardized format for ease and convenience of the user.

A further object of this invention is to improve automatic xerographic reproducing machines to generate multiple copies of standardized computer printout.

Another object of this invention is to improve automatic xerographic reproducing machines utilizing a moving or sweep scanning system by synchronizing the scanning of an original document with the size of an image to be projected onto the photoreceptive surface to create variable sized images of an original document.

Still another object of this invention is to improve automatic xerographic reproducing machines to selectively vary the scanning of an original document in accordance with the document length.

These and other objects are attained in accordance with the present invention wherein there is provided an automatic xerographic reproducing machine including an optical scanning system adapted to be selectively actuated for duplicating electronic data processing equipment printout and creating a reduced facsimile of such printout in a standardized format.

DESCRIPTION OF DRAWINGS

Further objects of this invention, together with additional features contributing thereto and advantages accruing therefrom, will be apparent from the following description of one embodiment of the invention when read in conjunction with the accompanying drawings, wherein;

FIG. 1 is a schematic representation of an automatic xerographic reproducing machine utilizing the invention of this application;

FIG. 2 is a perspective view of the optical system of the invention and the drive system for the various cooperative elements associated with the xerographic drum;

FIG. 3 is a rear view of the drum drive mechanism to show the arrangement of the various drive elements used in synchronizing the improved optical scanning system;

FIG. 4 is a rear view of the apparatus of FIG. 3 with the rear cover broken away to better illustrate the internal components;

FIG. 5 is a sectional view of the drum drive mechanism to better illustrate the synchronization of the scanning system with the xerographic drum;

FIG. 6 is an enlarged view of the apparatus for selectively actuating the drive mechanism for altering the scanning length and speed in relationship to the original document;

FIG. 7 is an end view of the actuator apparatus of FIG. 6; and

FIG. 8 is an end view of a portion of the drive mechanism shown in FIG. 6.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings, there is shown in FIG. 1 an embodiment of the subject invention in a suitable environment such as an automatic xerographic reproducing machine, although it should be noted that the invention is not intended to be limited thereto.

The automatic xerographic reproducing machine includes a xerographic plate 1 having a photoconductive layer or light receiving surface on a conductive backing, journaled in a frame to rotate in the direction indicated by the arrow to cause the plate surface to sequentially pass a series of xerographic processing stations. For the purpose of the present disclosure, the several xerographic processing stations in the path of movement of the plate surface may be described functionally, as follows:

A charging station 2 at which a uniform electrostatic charge is deposited on or in the photoconductive plate;

An exposure station 3 at which a light or radiation pattern of copy to be reproduced is projected onto the plate surface to dissipate the charge in the exposed areas thereof to thereby form a latent electrostatic image of the copy to be reproduced;

A developing station 4 at which xerographic developing material, including toner particles having an electrostatic charge opposite to that of the latent electrostatic image, is cascaded over the plate surface whereby the toner particles adhere to the latent electrostatic image to form a toner-powder image in configuration of the copy being reproduced;

A transfer station 5 at which the toner-powder image is electrostatically transferred from the plate surface to a transfer material or a support surface; and

A drum cleaning and discharge station 6 at which the plate surface is brushed to remove residual toner particles remaining thereon after image transfer, and exposed to a

relatively bright light source to effect substantially complete discharge of any residual electrostatic charge remaining thereon or therein.

It is felt that the preceding description of the xerographic process is sufficient for a better understanding of this invention. Referring again to FIG. 1, a xerographic drum is rotated and an incremental area of a document on a platen is scanned at a rate such that the optical image is projected at a predetermined rate relative to the rotational speed of the xerographic drum. The optical scanning or projection system disclosed herein projects a flowing image onto the surface of the photoconductive drum from a stationary original. The optical scanning or projection assembly comprises a stationary copy board which includes a transparent curved platen member 22 such as, for example, a glass plate or the like positioned on the exterior of the machine and adapted to support a document to be reproduced, the document being uniformly illuminated and arranged in light projection relation to the moving light-receiving surface of the xerographic drum. Uniform lighting is provided by banks of lamps LMPS arranged on opposite sides of the copy board. Scanning of the document on the stationary copy board is accomplished by means of a mirror assembly which is oscillated relative to the copy board in timed relation to the movement of the xerographic drum. The mirror assembly, which includes an object mirror 23, is mounted below the copy holder to reflect an image of the document through a lens unit 24 onto an image mirror 25 which, in turn, reflects the image onto the xerographic drum through a slot in the fixed light shield 26 positioned adjacent to the xerographic drum surface. In the embodiment of the invention shown, the scanning of electrical accounting machine printout is accomplished by placing the original copy on the copy holder and scanning the document by means of oscillating the object mirror through a lens onto an image mirror which, in turn, reflects the image through a slotted light shield onto the xerographic drum. The exposure mechanism includes an optical frame 13 for supporting the object mirror, lens and image mirror. The optical frame 13 is supported at one end by a support bar 14 appropriately secured to and extending laterally between the machine frames (one of which is partially shown in FIG. 2) and at the opposite end by pin support 15 secured to frame 12. Attached to the optical frame, adjacent to the object mirror, is a lamp holder frame assembly 16 which in turn, supports the platen 22.

The platen 22, made of transparent material such as glass, is suitably supported by the lamp holder frame assembly directly over the axis of rotation of the object mirror 23. Platen 22 is curved in the shape of an arc, with the radius thereof equal to the distance from the platen surface to the axis of rotation of the object mirror 23. The printout from the electronic data processing machine to be reproduced is placed on the curved platen 22, for example, by means of the apparatus disclosed in copending application Ser. No. 607,004, filed Jan. 3, 1967, in the name of A. M. Hitchcock et al., although manual placement is also possible and uniformly illuminated by banks of lights such as fluorescent lamps LMPS mounted in conventional fluorescent lamps LMPS mounted in conventional fluorescent lamp holder secured to the lamp holder frame assembly 16.

Object mirror 23 is supported by a suitable mirror support assembly fixed to a mirror shaft 101 journaled by suitable bearings mounted in optical frame 13. A detailed description of the mirror support assembly is not deemed pertinent to a complete understanding of the invention of this application, it being noted that this assembly positions the mirror in a flattened portion of the shaft so that the reflecting surface of the mirror is in a plane extending through the axis of shaft 101.

Oscillation of shaft 101, and therefore the scanning or object mirror 23, is governed by a controller 200 hereinafter described in detail. Motion in one direction, during scanning, is effected by means of drive system 250 comprising steel tapes 251 and 252 secured at one end to a portion of a multi-

ple radii sector 220 and at the other end to a single radius sector 104 driven in synchronization with rotation of the xerographic drum, as described in detail hereinafter. The mirror is then returned to its start-of-scan position by means of spring 105 connected at one end to a pin 106 fixed to the multiple radii sector 220 and at its other end to a pin 107 secured in the optical frame 13 to normally bias the mirror into the start-of-scan position.

The image mirror 25 is secured in a suitable manner in a fixed position on the optical frame 13 in the optical path from object mirror 23. The light shield 26 comprises an open, elongated box having side walls, end walls and a bottom wall provided with a narrow aperture 27 extending across the length of the light shield. Light shield 26 is secured to the optical frame and is positioned with its bottom wall adjacent to the peripheral surface of the drum and with the center line of the aperture parallel to the drum axis of rotation.

The xerographic plate or drum 1 is mounted on horizontal driven shaft 111 that rotates in bearings 112 and 113 positioned in drum drive casing 114 secured to the outer face of inboard frame 12 with a portion of the drum drive casing extending through a suitable opening in the frame 12 toward a similar frame supported parallel thereto on the opposite or outboard side. The free end or outboard end of shaft 111 is threaded to receive a thumb nut 115 to secure the inboard hub to the xerographic drum and into driven engagement with the pin 108 of drive collar 109 secured to the shaft for rotation therewith. The openings in the drum drive casing to receive the shaft 111 are closed at one end by cover 116 and at the opposite end by bearing retaining cap 117 supporting seal 118 encircling the shaft.

The motor 111 is operatively connected to the main drive motor MOT-3 of the automatic xerographic reproducing machine by worm gear 121 suitably secured to the end of the motor shaft and engaging gear 122 which, in turn, drives gear 123 suitably secured to shaft 111. The gear 123 is maintained in axial alignment thereon by means of a washer and bearing threaded onto the end of the shaft and biased into contact with bearing 113 abutting one side of the hub of gear 123, with the opposite of the gear being positioned against a shoulder formed on shaft 111.

Gear 122 is fixed to one end of shaft 126 journaled in suitable bearings mounted in the drum drive casing. The opposite end of shaft 126 extends from the drum drive casing through a seal and bearing retaining cap beyond the output face of the inboard frame 12 and has fixed at the end thereof a sprocket 133 to drive a suitable timing belt to power various mechanisms of the machine.

To effect a scanning cycle of the object mirror 23, there is fixed to the gear 123 a drum shaft 111 a cam 134 having three cam lobes. The sector 104, secured to shaft 141, has one end of the drive tapes 251 and 252 secured thereto and the opposite end of the tapes are secured to the multiple radii sector 220 fixed to one end of shaft 101. The opposite end of shaft 141 is provided with a cam follower arm 142, secured thereto which carries a cam follower 143 adapted to engage cam 134. Shaft 141 is journaled by bearing 144 mounted in the drum drive housing in spaced relation by cylindrical spacers 137 and 138 and secured therein by a seal bearing retaining cap 145 provided with an appropriate seal, washer and retaining nut.

With this arrangement, the object mirror is oscillated three times to scan an image during each revolution of the drum and in synchronization with the rotation thereof, since it is driven during this scanning cycle directly from the drum shaft as the cam follower 143 follows the rise portion on cam 134 secured to the drum shaft. Return motion of the mirror to its start-of-scan position is effected by the biasing action of spring 105 and this return motion is effected rapidly because of the shape of the fall portion of the cam lobe of cam 134, it being apparent that spring 105 will always bias cam follower 143 into cooperative engagement with cam 134.

The length of the scanning arc of mirror 23 and the scan speed is governed by the drive system 250 and more specifi-

cally the activation of one of the drive tapes 251 or 252 to synchronously oscillate the scanning mirror 23 with the rotation of the xerographic drum 1. A pneumatic cylinder 210 of any well known type is which the plunger 211 may be activated to at least two physically discrete positions, or a suitable electrically activated solenoid, is secured to the machine frame 12 by an appropriate bracket 290 in a position whereby an actuator 201, having a slot 202 therein, is secured to the end of the plunger to engage actuator stud 203 of lever arm 230, pivotably supported by machine frame plate 12. A pair of adjustable stops 255 and 256 are supported from machine frame plate 12 by appropriate brackets to engage lever arm 230 to limit the rotational movement thereof to allow the position of each drive tape to be individually adjusted to define the start of scan position for scanning mirror 23 when activated by the controller 200. A tension spring 233, encircling shaft 232 and having an end secured to the machine frame plate 12 and the opposite end in a suitable retaining notch or lever arm 230, is provided to bias lever arm 230 against upper stop 255 and into contact with activator arm 201.

When the plunger 211, and therefore actuator 201 attached thereto, has extended to the lowermost of the two physically discrete positions, lever arm 230, rotatably supported on shaft 232 by means of a bearing 235, is pivoted about its center in a counterclockwise direction as shown in FIG. 6 into contact with lower drive tape 252 and lower stop 256. A bearing 231 rotatably supported from lever arm 230 is positioned thereon to engage the drive tape 252 to tension the tape for forming a synchronous driving connecting link between the scanning mirror 23 and the xerographic drum 1. The length of both drive tapes (251 and 252) is such that the scanning mirror 23 will not be oscillated until a driving connection is formed between wheel sector 104 and the multiple radii sector 220 as by tensioning one of the drive tapes 251 or 252 through engagement with the bearing 231 of lever arm 230.

When the drive connection to the object or scanning mirror 23 is provided through lower tape 252, the scanning mirror is oscillated at a greater angular velocity than the rotation of the xerographic drum and through a greater arc than in the 1:1 reproduction mode of operation resulting in a greater area of the platen 22 being scanned to project a facsimile of the original document through lens 24 onto the xerographic drum at a size reduced from the original document. To achieve this increased speed of scan, the radius from the center of shaft 101 is lesser to the securing portion of lower drive tape 252 onto the multiple radii wheel sector 220 than the radius from the shaft 141 to the securing portion of wheel sector 104 thereby allowing sector 104 to drive the scanning mirror 23 at a greater angular velocity. Due to the scanning operation of the optical system disclosed herein, if the speed of scan was not changed relationship to the rotation of the xerographic drum but the original document merely reduced by a lens, an elongated distorted image would be produced with only the dimension (X) parallel to the axis of drum rotation (shown in FIG. 2) being reduced and the dimension of the original document perpendicular to the axis of rotation being distorted (y). Therefore, to obtain an undistorted image of the original document at any magnification other than 1:1, or approximation thereof which are undiscernible to a machine user, the speed of scan must be varied in relationship to the change in magnification, that is, for example, the image placed on the photoreceptive surface at an increased rate of speed as by oscillating the scanning mirror 23 at an angular velocity greater than that of the xerographic drum 1. This increased speed of image placement results in decreasing the optical image produced on the xerographic drum in the Y direction, and the change in position of the lens unit 24 (as disclosed in copending application "Magnification Change Apparatus", Ser. No. 607,409, filed Dec. 31, 1966, in the name of J. D. Reese, Jr. optically reduces the image in the x direction resulting in a facsimile or magnification of the original document being produced on the photoreceptive surface.

The drive tape 252 is secured to the lower portion of multiple radii wheel sector 220 by means of a threaded stud engaging a hole in the tape and secured thereto as by suitable lock nut and the upper drive tape 251 is similarly secured to the upper portion.

The scanning of a greater area of the platen surface at an increased speed, and changing the lens 24 to reduce the size of the optical image projected onto the drum surface as disclosed in the above mentioned copending application permits large size computer printout to be reproduced in standardized format.

When it is desired to produce a 1:1 copy of the original document, for example, when the individual sheets of original printout are $8\frac{1}{2}$ inches $\times$ 11 inches or less, the plunger 211, and therefore actuator 201 attached thereto, is moved by means of the pneumatic cylinder 210 to its uppermost of the two physically discrete positions thereby pivoting lever arm 230 in a clockwise direction (FIG. 6) releasing the tension on lower drive tape 252, engaging adjustable upper stop 255, and tensioning upper drive tape 251 by means of the bearing 231 engaging the drive tape, to form a synchronous driving connection between the scanning mirror 23 and the xerographic drum 1. When the upper tape 251 is forming the synchronous drive connecting link between the scanning mirror 23 and xerographic drum 1, the platen 22 is scanned by the mirror 23 moving at the same angular velocity as the xerographic drum due to the radius from shaft 101 to the retaining portion of the upper drive tape 251 being the same as the radius from shaft 141 to the retaining portion of wheel sector 104. With upper drive tape 251 controlling the length and speed of the oscillation arc of scanning mirror 23 and the lens assembly 24 positioned as disclosed in the aforementioned copending Reese, Jr., application, an essentially equidimensional optical reproduction of the original document is projected onto the xerographic drum 1. In this mode of operation, the printout from electronic data processing equipment which is $8\frac{1}{2}$ inches $\times$ 11 inches or less may be positioned on the platen 22 and the standardized reproduction projected onto the xerographic drum surface for subsequent transfer to a support material.

While the invention has been described with reference to its preferred embodiments, it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted for elements thereof without departing from the true spirit and scope of the invention. In addition, many modifications may be made to adapt a particular situation or material to the teaching of the invention without departing from its essential teachings.

What I claim is:

1. Apparatus for scanning a document and projecting various size images of the document onto a moving image receiving surface including
 - support means for maintaining a document in a stationary position,
 - lighting means for illuminating a document on said support means,
 - a movable member having an image receiving surface supported in an optical path emanating from an illuminated document positioned on said support means and terminating at said image receiving surface,
 - a scanning mirror positioned to sweep an optical image of a document positioned on said support means across said image receiving surface to form a facsimile image of the document on said image receiving surface,
 - a lens interposed in said optical path to project various size images of a document to said image receiving surface,
 - drive means operatively connected between said scanning mirror and said movable member having an image receiving surface to form a driving connection therebetween for sweeping an optical image of a document positioned on said support means across said image receiving surface, and

control means positioned between said scanning mirror and said image receiving surface operatively connected to said drive means for selectively varying the speed at which said optical image is swept across said image receiving surface to vary the size of the image projected thereto, in accordance with the size of the image projected by said lens to thereby produce an undistorted facsimile of said document.

2. Apparatus for scanning a document and projecting various size images of the document onto a moving photoreceptive surface including

support means for maintaining a document in a stationary position,

lighting means for illuminating a document on said support means,

a movable member having a photoreceptive surface for selectively retaining distributed electrical charges thereon supported in optical path emanating from an illuminated document positioned on said support means and terminating at said photoreceptive surface,

an oscillable scanning mirror positioned to sweep an optical image of an illuminated document on said support means onto said photoreceptive surface to form an electrical charge facsimile image of the document on said photoreceptive surface,

a lens interposed in said optical path to project various size images of a document to said photoreceptive surface,

drive means for oscillating said scanning mirror operatively connected between said scanning mirror and said movable member having a photoreceptive surface to form a driving connection therebetween for sweeping an optical image of a document positioned on said support means across said photoreceptive surface, and

selectively variable control means positioned between said scanning mirror and said photoreceptive surface operatively connected to said drive means for controlling the

oscillation speed of said scanning mirror at a rate determined by the size of the image to be projected onto said photoreceptive surface for creating an undistorted facsimile of the document thereon

3. The apparatus of claim 2 wherein said drive means includes a plurality of drive members operatively connected to said scanning mirror and said movable photoreceptive member selectively actuable to vary the oscillation speed of said scanning mirror in relation to the movement of said photoreceptive member to effect a variable speed scanning of an illuminated document on said support means.

4. The apparatus of claim 3 wherein each of said plurality of drive members is secured to one of a plurality of diverse radii concentric sectors operatively connected to said oscillable scanning mirror to effect a variation in the speed and length of the oscillation arc as defined by the radius of said sectors.

5. The apparatus of claim 3 wherein said control means includes a lever arm selectively actuable to engage one of said plurality of drive members to effect a variation in the speed and length of the oscillation arc of said scanning mirror.

6. The apparatus of claim 5 wherein said lever arm includes a rotatable bearing supported from one end of said lever arm and positioned to selectively engage each of said plurality of drive members to effect a driving connection between said oscillable scanning mirror and said moving photoreceptive surface.

7. The apparatus of claim 5 including means for limiting the movement of said lever arm between predetermined physically discrete positions.

8. The apparatus of claim 7 wherein said means for limiting the movement of said lever arm is adjustable to vary the limits of the physically discrete positions.

9. The apparatus of claim 7 wherein said physically discrete positions each define the start of scan position for said oscillable scanning mirror.

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