

[54] **ELECTROSTATIC REPRODUCTION MACHINE HAVING SELECTABLE MAGNIFICATION RATIOS**

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[51] Int. Cl. **G03g 15/00**

[58] Field of Search **355/3, 8, 11, 55, 355/56, 57, 50, 51**

[56] **References Cited**

UNITED STATES PATENTS

3,542,467	11/1970	Ferguson et al.	355/8
3,397,627	8/1968	Bruning et al.	355/55 X

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[57] **ABSTRACT**

Apparatus for regulating the magnification ratio be-

tween a copy produced by an electrostatic reproduction machine and the original document from which the copy is produced is provided in accordance with the teachings of the present invention. Movable lens means projects a light image of the original document onto a moving photoreceptor disposed in an image plane, said lens means being movable along a rectilinear path to determine a magnification ratio in accordance with the relative position of said lens means with respect to said original document and said photoreceptor. Manually operable selecting means produce electrical representations of selected magnification ratios. Positioning means responds to the produced electrical representations to position the lens means at a selected location along the rectilinear path to thereby establish the selected magnification ratio. In one embodiment of the instant invention, the copy of the original document is produced by flashing a pulsed light image of the original onto the photoreceptor. Flash control means applies a flash energizing pulse to illumination means for the generation of the light pulse in timed relation with the movement of the photoreceptor. The flash control means is responsive to a preselected one of the selected magnification ratios for delaying the application of the flash energizing pulse to the illumination means for a predetermined interval of time.

15 Claims, 4 Drawing Figures

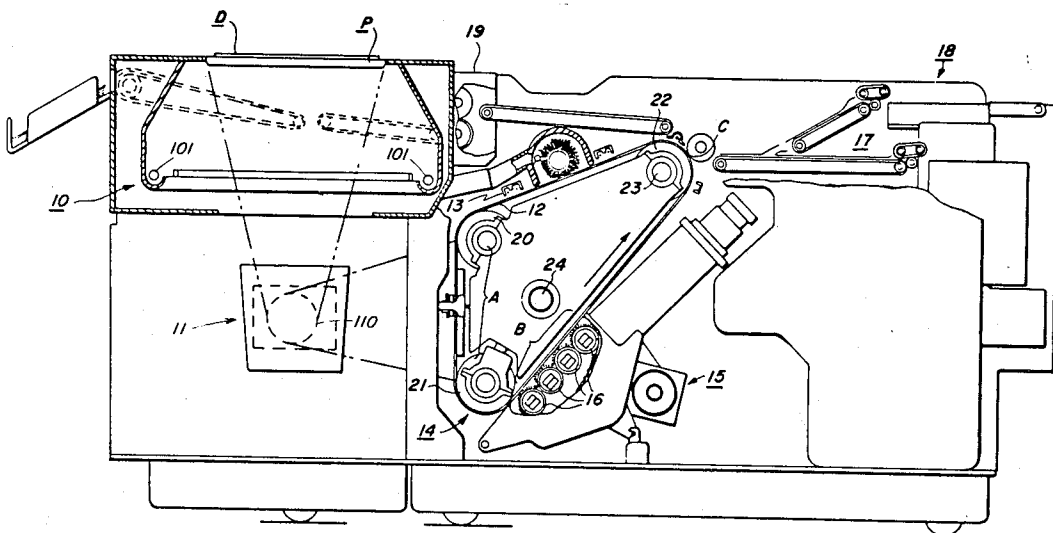


Fig. 2.

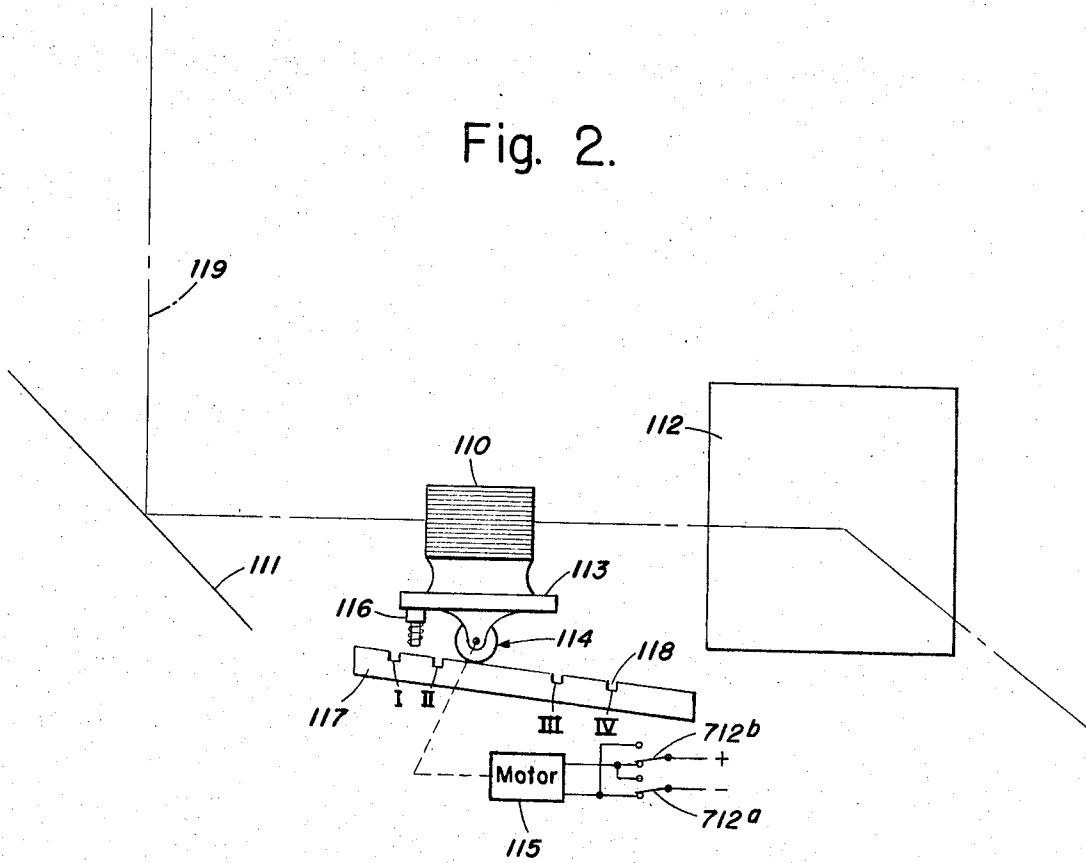
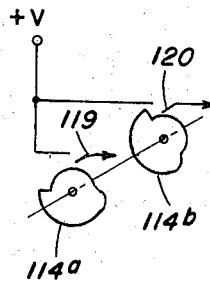
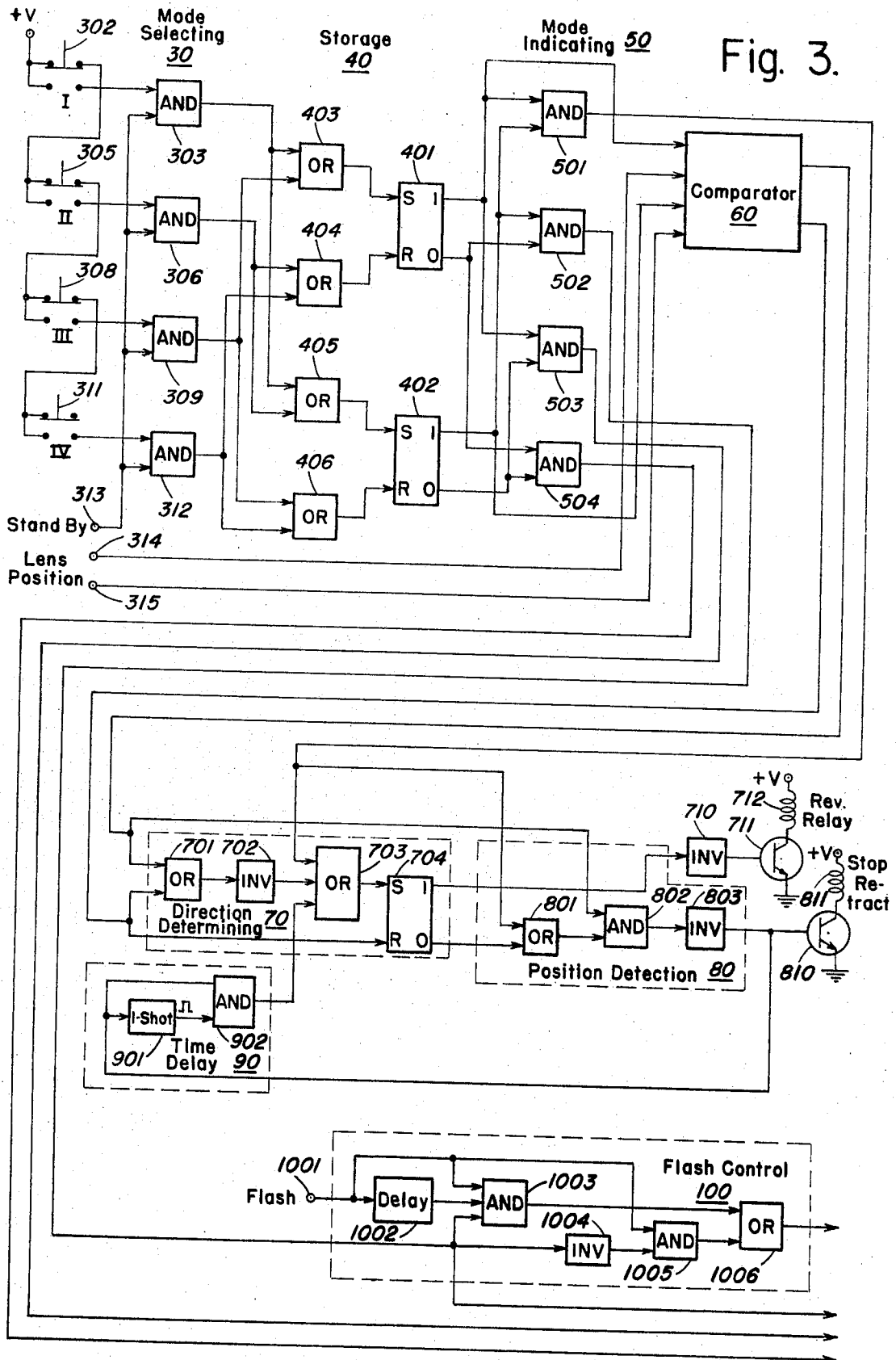


Fig. 2A.

Fig. 3.



ELECTROSTATIC REPRODUCTION MACHINE HAVING SELECTABLE MAGNIFICATION RATIOS

This invention relates to an electrostatic reproduction machine capable of producing copies exhibiting selectable magnification ratios with respect to the original document from which said copies are produced, and more particularly, to apparatus for regulating and determining such magnification ratios.

In the practice of xerography as described in U.S. Pat. No. 2,297,691 to Chester F. Carlson, a xerographic surface comprising a layer of photoconductive insulating material affixed to a conductive backing is used to support electrostatic images. In the usual method of carrying out the process, the xerographic plate is electrostatically charged uniformly over its surface and then exposed to a light pattern of the image being reproduced to selectively dissipate the charge in the areas where light strikes the layer. The undischarged areas of the layer thus form an electrostatic charge pattern in conformity with a configuration of the original light pattern.

The electrostatic latent image may then be developed by contacting it with a finely divided electrostatically attractable material, such as a resinous powder. The powder is held in the image areas by the electrostatic fields on the layer. Where the field is greatest, the greatest amount of material is deposited; and where the field is least, little or no material is deposited. Thus, a viewable powder image is produced in conformity with the light image of the copy being reproduced. The powder is subsequently transferred to a sheet of paper or other support surface and suitably fused to thereby form a permanent print.

It is contemplated that the electrostatic reproduction machine be capable of producing copies that may be either full sized copies of the original document, reduced in size from the original document or magnified in size from the original document. Accordingly, the magnification ratio exhibited by the reproduced copy with respect to the original document may be greater than, equal to or less than one. Various prior art electrostatic reproduction machines have attempted to incorporate these foregoing features by providing a plurality of magnifying lenses that may be selectively interposed into the optical path of the light image projected from the original document to thereby establish corresponding magnification ratios. Many of these systems utilize a movable turret assembly upon which are mounted the various magnifying lenses. However, since only one lens can be used at a time, the total number of lenses that must be provided should be equal to the number of magnification ratios desired. Thus, it has been found that the variety of sizes of the reproduced copies is limited to the number of magnifying lenses that may be mounted on such turret. Moreover, the size of the turret assembly and, therefore, the total number of magnifying lenses that may be employed, are constrained by the amount of space within the electrostatic reproduction machine that is allotted to the optical system. The severe space requirements that have heretofore plagued prior art electrostatic reproduction machines have significantly limited the capability of such machines to produce variably sized copies.

Another disadvantage of prior art electrostatic reproduction machines adapted to produce magnified or reduced copies of an original document has been non-

uniform resolution among the various magnifying lenses that may be used. Thus, the visual quality of copies that are reduced in size as well as the visual quality of magnified copies have been seriously impaired. In addition, in some machines the differing focal lengths of each magnifying lens that is used has required a corresponding adjustment in the total optical path length from the original document to the photoreceptor upon which the image of the original document is projected. Accordingly, it has been found necessary to compensate for such optical path length changes by displacing the position of the original document or the position of the light receiving photoreceptor with each magnifying lens that is utilized. Alternatively, the various other optical components must be repositioned.

A further disadvantage of prior art electrostatic reproduction machines admitting of the selectable magnification of an original document to be reproduced is the criticality of alignment between the scanning of the original, the movement of the photoreceptor and the movement of the copy paper upon which the magnified image is printed. Thus, although the transport speed of the photoreceptor and the copy paper must remain equal, the ratio between the speed of the photoreceptor and the scanning speed of the document scanning devices must be equal to the selected magnification ratio. Extremely precise variable speed electric motors and highly complex speed regulating circuitry have heretofore been required to effect the necessary speed changes.

Therefore, it is an object of the present invention to provide apparatus for regulating the magnification ratio exhibited by a copy produced by an electrostatic reproduction machine with respect to the original document from which said copy is reproduced.

A further object of this invention is to provide apparatus for enabling the selection of a large number of magnification ratios without requiring an equally large number of magnifying lenses.

Another object of this invention is to provide a linearly movable lens in an electrostatic reproduction machine wherein the magnification ratio between an original document and a reproduced copy is determined by the relative position of said lens with respect to said original document and an image plane.

It is an additional object of this invention to provide an electrostatic reproduction machine capable of producing selectively magnified copies of an original document wherein a magnifying lens is linearly movable but the optical path length remains fixed for all selections of magnification.

It is a further object of the present invention to provide an electrostatic reproduction machine capable of producing selectively magnified copies of an original document wherein each reproduced copy exhibits a high degree of resolution regardless of the magnification ratio selected.

Yet another object of the present invention is to provide an electrostatic reproduction machine capable of producing variably magnified copies of an original document wherein the photoreceptor upon which the magnified image of the original document is projected need not be moved in rigid synchronism with the scanning of the original document for each magnification ratio selected.

A still further object of the present invention is to provide control apparatus for aligning the printing of a

magnified image of an original document on a sheet of copy paper by flashing a light image of the original onto a moving photoreceptor at a time determined by the selected magnification ratio.

Another object of this invention is to provide apparatus for aligning the disposition of a magnified light image of an original document on a moving photoreceptor with respect to the movement of a sheet of copy paper upon which said magnified light image is printed by advancing said photoreceptor a predetermined amount prior to the flashing of a magnified light image thereon, said predetermined amount being a function of the magnification ratio.

Various other objects and advantages of the invention will become clear from the following detailed description of an exemplary embodiment thereof, and the novel features will be particularly pointed out in connection with the appended claims.

In accordance with this invention, there is disclosed an electrostatic reproduction machine for producing copies exhibiting selectable magnification ratios with respect to an original document, said magnification ratios being regulated by apparatus including movable lens means for projecting a light image of the original document onto an image plane, whereby the relative position of said lens means with respect to said original document and said image plane determines the magnification ratio; manually operable selecting means adapted when energized to produce electrical representations of correspondingly selected magnification ratios; and means coupled to said manually operable selecting means for positioning the lens means at a selected location along its path of movement in accordance with the produced electrical representations. In one embodiment of the present invention, the light image of the original document projected onto the image plane is produced by flashing a pulsed light image of said original document in timed relation with the movement of a photoreceptor disposed in said image plane. Flash control means is provided to delay the flashing of said pulsed light image in accordance with selected ones of the magnification ratios to thereby effect the proper alignment of the produced copy on the copy support medium.

The invention will be more clearly understood by reference to the following detailed description of an exemplary embodiment thereof in conjunction with the accompanying drawings in which:

FIG. 1 is a schematic sectional view of an electrostatic reproduction machine embodying the principles of the instant invention;

FIGS. 2 and 2A are schematic illustrations of mechanical apparatus for positioning a lens to determine the magnification ratio exhibited by a copy with respect to the original document from which said copy is produced by the electrostatic reproduction machine of FIG. 1; and

FIG. 3 schematically illustrates control apparatus that serves to regulate the mechanical apparatus of FIG. 2.

It is to be understood that the term "magnification ratio", as used throughout, pertains to a copy that is of reduced size or of magnified size with respect to an original document from which said copy is produced. Therefore, a numerical representation of such magnification ratio may be less than, equal to or greater than unity.

For a general understanding of the illustrated copier/reproduction machine in which the invention may be incorporated, reference is had to FIG. 1 in which the various system components for the machine are schematically illustrated. As in all electrostatic systems, such as a xerographic machine of the type illustrated, a light image of a document to be reproduced is projected onto the sensitized surface of a photoreceptor to form an electrostatic latent image thereon. Thereafter, the latent image is developed with an oppositely charged developing material to form a xerographic powder image, corresponding to the latent image on the photoreceptor surface. The powder image is then electrostatically transferred to a support surface and fixed by a fusing device to cause the powder image to adhere permanently to the support surface.

In the illustrated machine, a document D to be copied is placed upon a transparent support platen P fixedly arranged in an illumination assembly, generally indicated by the reference numeral 10, positioned at the left end of the machine. The illumination assembly may be a conventional scanning device composed of a suitable source of light and a movable slit capable of traversing the document D placed upon the support platen P. Such conventional scanning device is disclosed in detail in U.S. Pat. No. 3,062,094 which issued to C. R. Mayo on Nov. 6, 1962 and is assigned to Xerox Corporation, the assignee of the present invention. Another embodiment of a conventional scanning assembly is described in U.S. Pat. No. 3,301,126 which issued to R. F. Osborne et al. on Jan. 31, 1967 and is assigned to Xerox Corporation. In the embodiment illustrated herein, it is contemplated that the illumination assembly includes suitable lamps capable of being rapidly discharged to create a bright flash of light. The lamps may, therefore, comprise conventional xenon flash lamps, two of which are indicated herein by reference numeral 101. Light rays from the lamps are flashed upon the document to produce image rays corresponding to the informational areas. The image rays are projected by means of the optical system onto the photosensitive surface of a photoreceptor which is in the form of a flexible photoconductive belt 12 arranged on a belt assembly, generally indicated by the reference numeral 14. The optical system, generally indicated by the reference numeral 11, includes an object mirror for receiving the pulsed light image projected from the original document and an image mirror for reflecting the light image onto the photoreceptor. The object and image mirrors are angularly disposed to provide a folded optical path from the document to the photoreceptor. Magnifying lens means 110 is interposed between the object mirror and the image mirror and is adapted to provide a selectable magnification ratio between the copy produced by the illustrated electrostatic reproduction machine and the original document D. As will be described hereinbelow, the lens means is movable to thereby establish the selected magnification ratio in accordance with the relative position thereof with respect to the object and image mirrors and, therefore, in accordance with its relative position with respect to the original document D and the photoreceptor disposed in the image plane.

The belt 12 comprises a photoconductive layer of selenium, which is the light receiving surface and imaging medium for the apparatus, on a conductive backing. The surface of the photoconductive belt is made photo-

sensitive by a previous step of uniformly charging the same by means of a corona generating device, or coronotron, 13.

The belt is journaled for continuous movement upon three rollers 20, 21, and 22 positioned with their axes in parallel. The photoconductive belt assembly 14 is slidably mounted upon two support shafts 23 and 24 with the roller 22 rotatably supported on the shaft 23 which is secured to the frame of the apparatus and is rotatably driven by a suitable motor and drive assembly (not shown) in the direction of the arrow at a constant rate. During exposure of the belt 12, the portion exposed is that portion of the belt running between rollers 20 and 21. During such movement of the belt 12, the reflected light image of such original document positioned on the platen is flashed on the surface of the belt to produce an electrostatic latent image thereon at exposure station A.

As the belt surface continues its movement, the electrostatic image passes through a developing station B in which there is positioned a developer assembly generally indicated by the reference numeral 15, and which provides development of the electrostatic image by means of multiple brushes 16 as the same moves through the development zone.

The developed electrostatic image is transported by the belt to a transfer station C whereat a sheet of copy paper is moved between a transfer roller and the belt at a speed in synchronism with the moving belt in order to accomplish transfer of the developed image by an electrical bias on the transfer roller. There is provided at this station a sheet transport mechanism generally indicated at 17 adapted to transport sheets of paper from a movable platform included in a paper handling mechanism generally indicated by the reference numeral 18 to the developed image on the belt at the station C.

After the sheet is stripped from the belt 12, it is conveyed into a fuser assembly, generally indicated by the reference numeral 19, wherein the developed and transferred xerographic powder image on the sheet material is permanently affixed thereto. After fusing, the finished copy is discharged from the apparatus at a suitable point for collection externally of the apparatus.

Further details regarding the structure of the belt assembly 14 and its relationship with the machine and support therefor may be found in the copending Application Ser. No. 102,312 assigned to Xerox Corporation, the assignee of the present invention.

Referring now to FIG. 2, there is a schematic illustration of bi-directionally movable lens means 110 capable of projecting a light image of the original document D to the exposure station A, and mechanical apparatus for moving the lens means along a rectilinear path to thereby determine the magnification ratio of the projected image in accordance with the relative position of the lens means with respect to the original document D and the exposure station A. More particularly, bi-directionally movable lens means 110 is supported by carriage means 113 and is adapted to be driven along the rectilinear path defined by guide rail means 117. As noted hereinabove, the optical path extending between the original document D and the exposure station A is here described as being a folded optical path, generally designated by the reference numeral 119, and is defined by object mirror 111, which receives the pulsed light image projected from the original document, and

image mirror 112, which transmits the pulsed light image to the exposure station A. The magnification ratio is thus determined by the relative position of lens means 110 with respect to object mirror 111 and image mirror 112. It should be noted, however, that the optical path 119 need not be folded and, therefore, object mirror 111 and image mirror 112 may be omitted. In this latter embodiment, lens means 110 would be adapted for linear movement between the original document and the exposure station.

Carriage means 113 is adapted for linear movement along guide rail means 117 and is provided with wheel means 114 mechanically coupled to a source of motive power 115, hereinafter a reversible electric motor. Although a single guide is here illustrated, it should be understood that a plurality of guide means, such as a pair of rails, guide bars, or the like, may be provided to both define the rectilinear path along which lens means 110 travels and to provide a stable support for carriage means 113. Wheel means 114 may include conventional wheels adapted to be guided along the guide rail means, a conventional roller or other conventional device capable of movement along the guide rail means while maintaining lens means 110 in a suitable disposition for optical transmission. Carriage means 113 is additionally provided with a mechanical stop 116 adapted for mating engagement with apertures 118 disposed in the guide rail means. The mechanical stop 116 may comprise a conventional spring loaded electromechanical device, such as a solenoid, having an armature normally biased in an extended position whereby a suitable electrical signal applied to said electromechanical means is effective to retract the spring loaded armature, thereby removing said armature from the aperture 118 with which it is engaged. The spring biasing force exerted on the armature of the electromechanical means is sufficient in the absence of an electrical signal applied to said electromechanical means to drive said armature into mating engagement with one of the apertures 118. A more detailed explanation of the manner in which mechanical stop 116 is controlled is provided hereinbelow with respect to FIG. 3.

Reversible electric motor means 115 is mechanically coupled to wheel means 114 by any suitable coupling such as speed reduction gear means, drive shaft means, an endless wire and pulley arrangement or the like. Alternatively, reversible electric motor means 115 may be provided on carriage means 113 and would thus be movable with said carriage means and, therefore, with said wheel means 114. As illustrated herein, reversible electric motor means 115 may be coupled to a suitable source of supply voltage by switch means 712a and 712b. The switch means may comprise the movable armatures of a conventional relay circuit, which movable armatures are adapted for simultaneous and parallel operation. The reversible electric motor means 115 may comprise a conventional DC motor and the source of supply voltage to which it is coupled may comprise a conventional DC supply having positive and negative supply terminals, as indicated herein, or alternatively, the reversible electric motor means may comprise a conventional AC motor and the source of supply voltage to which it is coupled may comprise a conventional AC supply wherein the voltage potential provided at the output terminals thereof exhibit a 180° phase relationship. In the alternate embodiments, the direction of rotation of reversible electric motor means 115 is de-

pendent upon the relative polarity or phase relationship, respectively, of the voltage supplied to the input terminals thereof. It will soon be seen that when switch means 712a and 712b exhibit the configuration illustrated herein such that the switch means are in contact with their respective lower fixed terminals, reversible electric motor means 115 is driven in a first direction. However, when switch means 712a and 712b are activated to be in contact with their respective upper fixed terminals, the polarity or relative phase relationship of the voltage applied to the input terminals of reversible electric motor means 115 is reversed and said reversible electric motor means 115 is driven in a second direction opposite in sense to said first direction. Thus, switch means 712a and 712b are effective to supply the reversible electric motor means with energy admitting of a first sense when the switch means are in engagement with respective first fixed contacts and to supply the reversible electric motor means with energy admitting of a second sense when the switch means are in engagement with respective second fixed contacts.

FIG. 2 illustrates guide rail means 117 disposed in inclined relationship with respect to an arbitrary horizontal plane. This inclined relationship, however, is seen to have no effect upon the proper optical disposition of movable lens means 110. Thus, although the optical axis of the movable lens means may be seen to be gradually lowered as carriage means 113 moves in a left to right direction, said optical axis is nevertheless maintained in a parallel relation. The inclination exhibited by guide rail means 117 is effective to properly align the magnified light image projected to the exposure station A on the photoconductive belt 12. It will be seen that as the size of the produced copy is to be reduced, movable lens means 110 is transported down the inclined guide rail means to maintain a proper position of the reduced image of original document D on the photoconductive belt. In this manner, the produced copy of a reduced size image will be properly disposed on the sheet of copy paper to which it is transferred. Similarly, movable lens means 110 is adapted to be transported up the inclined guide rail means 117 to properly position on the photoconductive belt 12 a magnified light image of original document D. It is, of course, appreciated that guide rail means 117 may exhibit an actual horizontal disposition exclusive of the aforescribed inclination in those applications of the present invention where the just noted considerations of proper positioning of a light image on the photoreceptor is of no concern.

Guide rail means 117, illustrated in FIG. 2, is depicted as being provided with four apertures 118. The apertures are respectively designated I, II, III, and IV. It may be noted that when the armature of mechanical stop 116 is engaged with one of said apertures 118, the lens means 110 is fixedly positioned to thereby establish a respective one of the plurality of preselected magnification ratios. Accordingly, the present invention is not intended to be limited merely to the four apertures 118 illustrated herein. Any suitable number of apertures may be provided in accordance with the number of selectable magnification ratios desired. It is appreciated that the relative position of each of the apertures 118 along guide rail means 117 is directly related to, and is in fact determinative of, a corresponding selectable magnification ratio. Hence, the light image projected by lens means 110 onto the photocon-

ductive belt 12 when the armature of mechanical stop 116 is engaged in aperture 118 at position I is greater in size than the image projected by lens means 110 when the armature of mechanical stop is engaged in aperture 118 at position II. Similarly, the projected image is larger in size when lens means 110 is situated at position II than when the lens means is situated at position III and, likewise, the projected image is larger when the lens means is situated at position III than when the lens means is situated at position IV.

In operation, carriage means 113 upon which lens means 110 is supported is driven along guide rail means 117 until mechanical stop 116 is aligned with one of apertures 118 corresponding to a selected magnification ratio. More particularly, if carriage means 113 is initially situated at, for instance, position I and the magnification ratio determined by, for example, position III is selected by an operator suitable signals applied thereto effect the removal of the armature of mechanical stop 116 from aperture 118. Since carriage means 113 must be transported down inclined guide rail means 117, switch means 712a and 712b are activated into engagement with their respective upper fixed contacts and reversible electric motor means 115 drives wheel means 114 such that carriage means 113 is transported down inclined guide rail means 117 until the armature is aligned with aperture 118 associated with position III. At that time, the signals applied to mechanical stop 116 by the control apparatus to be described are terminated and the force exerted on the armature of the mechanical stop by the biasing spring is sufficient to engage the armature with the aperture 118 at position III. The obstacle thus interposed into the rectilinear path of carriage means 113 is sufficient to halt the carriage means at position III thereby maintaining lens means 110 in a properly secured position to determine the selected magnification ratio.

If, now, a magnification ratio determined by the positioning of lens means 110 at position II is selected, suitable signals are applied to mechanical stop 116 by the control apparatus to be described whereby the armature of the mechanical stop is retracted from the aperture 118 at position III. Moreover, switch means 712a and 712b are activated into engagement with their respective lower fixed contacts to supply reversible electric motor means 115 with a source of voltage potential admitting of a reversed polarity or phase. Reversible electric motor means 115 thus rotated in an opposite direction to drive wheel means 114 such that carriage means 113 is transported up inclined guide rail means 117. As carriage means 113 is transported up inclined guide rail means 117, mechanical stop 116 approaches alignment with the aperture at position II. However, the signals applied to the mechanical stop from the control apparatus to be described are not, at this time, terminated and carriage means 113 continues to be transported up inclined guide rail means 117. Once mechanical stop 116 overruns position II, switch means 712a and 712b are activated into engagement with their respective upper fixed contacts to thereby reverse the direction of rotation of reversible electric motor means 115. Consequently, carriage means 113 is now transported down inclined guide rail means 117. Now, when mechanical stop 116 approaches alignment with the aperture associated with position II, the signals applied thereto by the control apparatus to be described are terminated and the spring bias force exerted on the ar-

mature of the mechanical stop is sufficient to force said armature into engagement with the aperture at position II. Lens means 110 is thus securely positioned at a location relative to object mirror 111 and image mirror 112 to determine a corresponding magnification ratio. Further operation of the apparatus illustrated in FIG. 2 is similar to that just described and, therefore, need not be repeated here. It should be noted, however, that when a magnification ratio associated with position I is selected, carriage means 113 is transported directly to position I and mechanical stop 116 is not, in this instance, driven to an overriding relationship with respect thereto. It may now be readily appreciated that reversible electric motor means 115 is effective to drive carriage means 113 such that lens means 110 may be driven in an upward or downward direction along guide rail means 117. Lens means 110 is driven from an initial upper position in a downward direction along guide rail means 117 directly to a lower position corresponding to a selected magnification ratio. However, when the lens means is initially at a lower position and a magnification ratio is selected such that lens means 110 must be driven in an upward direction along guide rail means 117, the lens means effectively overruns the selected upper position, thereby returning to said selected position in a downward direction. Engagement of the armature of mechanical stop 116 with an aperture 118 is effected when carriage means 113 approaches that aperture in a downward direction.

In should be recognized that lens means 110 undergoes bi-directional movement along guide rail means 117. The lens means may thus be moved in a left-to-right configuration, up-down configuration or any other suitable configuration, dependent upon the disposition of the guide rail means.

In the foregoing description of the apparatus illustrated in FIG. 2, the operation thereof is seen to be a function of the instantaneous position of lens means 110 and the relationship between said instantaneous position and the position associated with the selected magnification ratio. It may be recognized, therefore, that an indication of the location of lens means 110 might be an advantageous feature in implementing the operation of the apparatus illustrated in FIG. 2. Accordingly, an exemplary embodiment of sensing means for sensing the position of lens means 110 as the lens means traverses the rectilinear path defined by guide rail means 117, and for providing an indication thereof, is illustrated in FIG. 2A. The sensing means here illustrated is comprised of a pair of rotatable cam means 114a and 114b and a pair of switch means 119 and 120. Cam means 114a and 114b may be positioned on the shaft which rotationally drives wheel means 114. Each cam means is seen to be divided into a lobed portion extending partially about the circumference thereof and a nonlobed portion. The lobed portion of cam means 114a is adapted to be rotated into intimate contact with switch means 119, thereby driving the switch means into engagement with a fixed contact thereof to enable a supply of voltage +V to be coupled therethrough. Similarly, the lobed portion of cam means 114b is adapted to be rotated into intimate contact with switch means 120, thereby driving the switch means into engagement with a fixed contact thereof to thus provide a transmission path for the source of voltage potential +V.

In operation, cam means 114a and 114b are initially aligned in a predetermined manner such that the simultaneous rotation of said cam means selectively drives switch means 119 and 120 into engagement with their respective fixed contacts. The cam means are fixedly secured to the shaft which rotationally drives wheel means 114 and are simultaneously rotated with said wheel means. As carriage means 113 is transported along guide rail means 117, cam means 114a and 114b rotate in the following manner: (a) The nonlobed portion of cam means 114a may be rotated opposite switch means 119 simultaneously with the rotation of a nonlobed portion of cam means 114b opposite switch means 120. Consequently, both switch means 119 and 120 may be opened. (b) Cam means 114a may be rotated in a clockwise direction simultaneously with the clockwise rotation of cam means 114b such that a nonlobed portion of cam means 114a may be opposite switch means 119 simultaneously with a lobed portion of cam means 114b being in intimate contact with switch means 120. Consequently, switch means 119 may be opened and switch means 120 may be closed. (c) A further rotation of the cam means may result in a lobed portion of cam means 114a being in intimate contact with switch means 119 simultaneously with a lobed portion of cam means 114b being in intimate contact with switch means 120. Consequently, switch means 119 and switch means 120 may both be closed. (d) A further rotation of the cam means may position a lobed portion of cam means 114a in intimate contact with switch means 119 simultaneously with the positioning of a nonlobed portion of cam means 114b opposite switch means 120. Consequently, switch means 119 may be closed and switch means 120 may be opened. One of ordinary skill in the art may, therefore recognize that the simultaneous rotation of cam means 114a and 114b as wheel means 114 is driven to transport carriage means 113 may result in a binary code that is representative of the instantaneous angular positions of the respective cam means. Furthermore, the initial alignment of the cam means with respect to wheel means may effect the following relation: (a) switch means 119 and switch means 120 are both opened when lens means 110 is situated at position I; (b) switch means 119 is opened and switch means 120 is closed when lens means 110 intimately approaches position II; (c) switch means 119 and switch means 120 are both closed when lens means 110 intimately approaches position III; and (d) switch means 119 is closed and switch means 120 is opened when lens means 110 intimately approaches position IV.

The foregoing is merely exemplary of the manner in which the instantaneous position of lens means 110 may be indicated. It is recognized that any suitable combination of switch means may be utilized to represent the position of the lens means. Utilizing the foregoing binary notation, and recognizing that each switch means is capable of assuming two selective states, two switch means may be employed to provide an indication of any of four positions assumed by lens means 110. Generally n switch means may be provided to suitably indicate the assumption by lens means 110 of any of 2^n positions. An obvious alternative to the switch means indicated in FIG. 2A may comprise suitable switching devices, such as microswitches or the like, disposed at discrete locations along guide rail means 117 and adapted to be activated by suitable mechanical

activating means extending from carriage means 113. Thus, as carriage means 113 is transported along guide rail means 117, the mechanical activating means extending therefrom will activate selected ones of the switch means in accordance with the instantaneous position assumed by lens means 110. More particularly, when lens means 110 is situated at position I, a first such switch means may be activated. Similarly, when lens means 110 is situated at position II, a second such switch means may be activated, and so on. Other equivalent embodiments will become apparent to those of ordinary skill in the art wherein a suitable indication of the position of lens means 110 is provided as said lens means moves along the rectilinear path established by guide rail means 117.

Referring now to FIG. 3, there is illustrated a schematic representation of control apparatus in accordance with the present invention that serves to regulate the operation of the apparatus described hereinabove with respect to FIG. 2. The control apparatus is comprised of mode selecting means 30, storage means 40, mode indicating means 50, comparing means 60, direction determining means 70, and position detection means 80. Mode selecting means 30 is comprised of manually operable selecting means for producing electrical representations of the magnification ratios selected by an operator. Thus, the mode selecting means is capable of responding to a manual operation to generate signals representing a desired mode of magnification. The mode selecting means includes manually operable switch means 302, 305, 308 and 311, each adapted, when operated, to provide a transmission path therethrough. The manually operable switch means may be energized by an operator to select a desired mode of magnification. It is recalled from the foregoing description of FIG. 2, that a magnification ratio is determined in accordance with a relative position of lens means 110 with respect to the original document and the exposure area. Thus, energization of a corresponding switch means serves to transport the lens means to an associated position. Accordingly, the operation of switch means 302 serves to advance lens means 110 to position I and said switch means is hereinafter designated switch means I. Similarly, the operation of switch means 305 serves to advance lens means to position II and said switch means is hereinafter designated switch means II. In similar fashion, switch means 308 and 311 are hereinafter designated switch means III and IV, respectively.

Switch means I-IV may comprise any conventional switching device such as a single-pole single-throw switch, a single-pole double-throw switch or the like. The switch means are here illustrated as conventional push-button switching devices connected in series to a suitable source of voltage potential +V in a predetermined hierarchy of priority. Thus, the activation of switch means I causes switch means II-IV to be nonresponsive to a subsequent manual operation of the latter switch means. Similarly, the activation of switch means II prevents switch means III-IV from responding to a manual operation thereof; but a subsequent manual operation of switch means I serves to deactivate previously operated switch means II. The remaining switch means exhibit an analogous mode of operation. Each of switch means I-IV includes two pairs of fixed terminals and a selectively movable armature capable of providing a transmission path between one of said pairs. A

first pair of said fixed terminals may be termed the quiescent pair of terminals and, as illustrated herein, the quiescent pairs of terminals of the switch means are connected in series relationship. The second pair of terminals may be designated the active pair of terminals and are interconnected when the associated switch means is operated. A first terminal of said active pair of terminals is coupled to a suitable source of potential +V and the second terminal of said active pair of terminals is coupled to the input terminal of an associated coincidence means.

Coincidence means 303, 306, 309 and 312 of mode selecting means 30 each includes an input terminal coupled to the active pair of terminals of switch means I, II, III, and IV, respectively. A second input terminal of coincidence means 303, 306, 309 and 312 are coupled in common relationship to terminal 313. As is appreciated by those of ordinary skill in the art, a coincidence means is adapted to produce an output signal when each input terminal thereof is provided with an appropriate signal in coinciding relationship. Thus, the illustrated coincidence means may comprise a conventional AND gate wherein a binary "1" is provided at the output terminal thereof in response to a binary "1" applied to each input terminal thereof. For the purpose of the instant discussion, it may be assumed that a binary "1" may be represented by a positive DC voltage potential and a binary "0" may be represented by ground potential or, in the alternative, by a negative DC voltage potential. Nevertheless, it should be clearly understood that any suitable voltage potentials may be utilized to represent the binary signals. In addition, each of the illustrated AND gates may be replaced by conventional NAND gates wherein a binary "0" is produced at the output terminal thereof when a binary "1" is applied to each input terminal thereof. Other conventional devices capable of detecting a coinciding relationship between input signals supplied thereto may be freely substituted for the illustrated AND gates.

Coincidence means 303, 306, 309 and 312 are coupled to storage means 40, the latter being adapted to store a unique coded representation of the particular switch means that has been activated by an operator. Storage means 40 is comprised of flip-flop means 401 and 402, and coding means coupled to the input terminals of said flip-flop means and responsive to the signals produced by the aforescribed coincidence means. Flip-flop means 401 and 402 may comprise conventional bistable multivibrators such as R-S flip-flops, J-K flip-flops, timing pulse controlled flip-flops, or the like. As indicated herein, each of flip-flop means 401 and 402 includes set and reset input terminals and one and zero output terminals. The flip-flop means are capable of storing signals supplied thereto by assuming first or second stable states in response to the particular signals applied to the set and reset input terminals thereof. More particularly, each flip-flop means is adapted to be set to its first state when a binary "1" is applied to the set input terminal thereof and a binary "0" is applied to the reset input terminal thereof. Conversely, each flip-flop means is adapted to be reset to its second state when a binary "0" is applied to the set input terminal thereof and a binary "1" is applied to the reset input terminal thereof. An indication of the particular state assumed by the flip-flop means is provided at the one and zero output terminals thereof, respectively.

An exemplary embodiment of coding means to be utilized with the present invention is comprised of OR circuits 403-406. As is appreciated by those of ordinary skill in the art, an OR circuit is a conventional logic element capable of producing a signal at the output terminal thereof when an appropriate signal is applied to any input terminal thereof. Each illustrated OR circuit may, therefore, produce a binary "1" at the output terminal thereof when a binary "1" is applied to any input terminal thereof. It is recognized that, if desired, conventional NOR circuits may be utilized in place of the illustrated OR circuits.

OR circuit 403 includes an input terminal coupled in common relationship with an input terminal of OR circuit 405 to the output terminal of coincidence means 303. A second input terminal of OR circuit 403 is coupled in common relationship with an input terminal of OR circuit 406 to the output terminal of coincidence means 309. OR circuit 404 includes an input terminal coupled in common relationship with the remaining input terminal of OR circuit 405 to the output terminal of coincidence means 306. The remaining input terminals of OR circuits 404 and 406, respectively, are coupled in common relationship to the output terminal of coincidence means 312. As may be observed, the set and reset input terminals of flip-flop means 401 are coupled to the output terminals of OR circuits 403 and 404, respectively; and the set and reset input terminals of flip-flop means 402 are coupled to the output terminals of OR circuits 405 and 406, respectively. As will be appreciated from the forthcoming description of the operation of the illustrated apparatus, the activation of one of switch means I-IV serves to energize two of the illustrated OR circuits in a unique combination, resulting in a unique coded representation of such activation. Consequently, a two-bit code is stored in flip-flop means 401 and 402 to uniquely represent the one switch means that has been operated. It is recognized that an n -bit code may be stored in n flip-flop means to uniquely represent the operation of a selected one of 2^n switch means.

Flip-flop means 401 and 402 are coupled to mode indicating means 50 and comparing means 60. Mode indicating means 50 is adapted to decode the coded representation stored by flip-flop means 401 and 402 to provide an indication of the particular switch means operated. Although any conventional decoding means may be utilized therefor, mode indicating means 50 is here illustrated as being comprised of coincidence means 501-504. Each of coincidence means 501-504 may be similar to coincidence means 303 and, therefore, may each comprise a conventional AND gate. Coincidence means 501 is coupled to flip-flop means 401 and 402 and is adapted to detect when switch means I has been operated. The input terminals of coincidence means 501 are coupled to the one output terminal of each of flip-flop means 401 and 402. The output terminal of coincidence means 501 is coupled to OR circuit 703 of direction determining means 70 and to OR circuit 801 of position detection means 80 for a purpose soon to be described. It may be noted, however, that the detection of a predetermined coded signal stored in flip-flop means 401 and 402 by coincidence means 501 is effective to drive lens means 110 directly to position I. Hence, a detection of the operation of switch means I is effective to activate switch means 712a and 712b of FIG. 2 into engagement with their respective lower

fixed contacts. The output terminal of coincidence means 501 may additionally be coupled to suitable indicating means to apprise an operator that a magnification ratio determined by position I has been selected.

Coincidence means 502 is coupled to flip-flop means 401 and 402 and is adapted to detect when switch means II has been operated. The input terminals of coincidence means 502 are coupled to the zero output terminal of flip-flop means 401 and the one output terminal of flip-flop means 402, respectively. The output terminal of coincidence means 502 may be coupled to suitable indicating means to apprise an operator of the selection of a magnification ratio determined by position II. Coincidence means 502 is additionally coupled to flash control means 100 for a purpose to be described hereinbelow. Coincidence means 503 is coupled to flip-flop means 401 and 402 and is adapted to determine when switch means III has been operated. The input terminals of coincidence means 503 are coupled to the one output terminal of flip-flop means 401 and the zero output terminal of flip-flop means 402, respectively. The output terminal of coincidence means 503 may be coupled to suitable indicating means to apprise an operator that a magnification ratio determined by position III has been selected. Coincidence means 504 is coupled to flip-flop means 401 and 402 and is adapted to determine when switch means IV has been operated. The input terminals of coincidence means 504 are coupled to the zero output terminals of flip-flop means 401 and 402, respectively. The output terminal of coincidence means 504 may be coupled to suitable indicating means to apprise an operator that a magnification ratio determined by position IV has been selected.

Comparing means 60 is adapted to compare the signals produced by that one of switch means I-IV that has been selectively operated with sensing signals that represent the actual position of lens means 110. More particularly, comparing means 60 is capable of comparing the actual position of lens means 110 with a desired position thereof. This is achieved by comparing the coded signals stored in flip-flop means 401 and 402 with sensing signals representative of the actual position of lens means 110, which sensing signals are applied to terminals 314 and 315. Terminals 314 and 315 are adapted to be coupled to switch means 119 and 120 illustrated in FIG. 2A. Accordingly, suitable signals, such as binary coded signals, may be applied to terminals 314 and 315, which signals, it is recalled, represent a position of lens means 110 along guide rail means 117. The comparing means serves to produce a first output signal when the coded signals stored in flip-flop means 401 and 402 admit of a corresponding relationship with the signals applied to terminals 314 and 315. Comparing means 60 serves to produce second and third output signals when the coded signals stored in flip-flop means 401 and 402 admit of first and second differing relationships with respect to the signals applied to terminals 314 and 315. The comparing means may be provided with a single output terminal at which each of the first, second and third output signals may be provided, or in the alternative, may be provided with three output terminals for each of the respective output signals to be produced. In the embodiment illustrated herein, the first, second and third output signals produced by comparing means 60 are binary signals and the comparing means is here provided with two output

terminals, represented as upper and lower output terminals, respectively, at which the output binary signals are provided. An exemplary embodiment of comparing means 60 comprises a conventional binary adding circuit capable of adding two two-bit binary signals and being provided with a sum output terminal and a carry output terminal, well known to those of ordinary skill in the art. Alternatively, comparing means 60 may comprise a conventional subtracting circuit, a two-bit comparing circuit, a gating circuit or other well known circuit adapted to compare the coded signals stored in flip-flop means 401 and 402 with the coded signals applied to terminals 314 and 315 and to indicate which signals are greater.

Comparing means 60 is coupled to direction determining means 70 and, in addition, to position detection means 80. Direction determining means 70 is adapted to regulate the activation of switch means 712a and 712b of FIG. 2 and, therefore, to drive reversible electric motor means 115 in a first direction when the sensing signals applied to terminals 314 and 315 represent that lens means 110 is positioned to one side of the position selected by operating one of switch means I-IV and to drive the reversible electric motor means in a second direction when the sensing signals applied to terminals 314 and 315 represent that lens means 110 is positioned to the other side of the position selected by operating one of switch means I-IV. The direction determining means 70 includes direction store means coupled to comparing means 60 for selectively storing the second and third signals, respectively, produced by comparing means 60 in response to the signals applied to the input terminals of said comparing means. The direction store means comprises flip-flop means 704 having set and reset input terminals and one and zero output terminals. Flip-flop means 704 may be similar to aforedescribed flip-flop means 401, and therefore, in the interest of brevity need not be further described.

The illustrated upper output terminal of comparing means 60 is coupled to the set input terminal of flip-flop means 704 via the signal path comprised of OR circuit 701, inverting means 702 and OR circuit 703. The illustrated lower output terminal of comparing means 60 is coupled to the reset input terminal of flip-flop means 704. OR circuits 701 and 703 are similar to aforedescribed OR circuit 403. Inverting means 702 is a conventional logic element capable of performing a logic negation operation on a signal applied thereto. Hence, a binary "1" applied to the input terminal of inverting means 702 will result in a binary "0" at the output terminal thereof. Conversely, inverting means 702 is capable of generating a binary "1" at the output terminal thereof in response to the application of a binary "0" to the input terminal thereof. It will soon be described in detail, that when the actual position of lens means 110 is such that the lens means must be transported up guide rail means 117 to arrive at the position selected by the operation of one of switch means I-IV, comparing means 60 produces its second output signal which is supplied to the set input terminal of flip-flop means 704 as a binary "1". Similarly, when the actual position of lens means 110 is such that the lens means must be transported down guide rail means 117 to arrive at the position selected by the operation of a corresponding one of switch means I-IV, the comparing means produces its third output signal which is supplied to the reset input terminal of flip-flop means 704 as a

binary "1". It may thus be appreciated that flip-flop means 704 is capable of assuming one of its respective first and second states to represent the relative position of lens means 110 with respect to the position selected by the operation of one of switch means I-IV.

The one output terminal of flip-flop means 704 is coupled to switch control means 711 via inverting means 710. The inverting means is similar to aforedescribed inverting means 702. Switch control means 711 is coupled to energization coil 712 and is adapted to energize said energization coil when a predetermined signal is applied thereto. The energization coil 712 may comprise a conventional relay energizing coil capable of activating one or more armatures magnetically coupled thereto when current flows through said relay energizing coil. Accordingly, energization coil 712 and switch means 712a and 712b may comprise a conventional relay device wherein the switch means are the movable armatures magnetically coupled to the relay energizing coil. Switch control means 711 may comprise a conventional driving circuit capable of permitting current to flow through the energization coil 712 in response to a predetermined binary signal, such as a binary "1", applied thereto. An exemplary embodiment of switch control means 711 is here illustrated as a transistor having a base electrode coupled to inverting means 712 and including collector and emitter electrodes coupled in series relationship with energization coil 712 and a suitable source of energizing potential +V.

The zero output terminal of flip-flop means 704 is coupled to coincidence means 802 via OR circuit 801 of position detection means 80. The position detection means is capable of detecting when lens means 110 approaches the position selected by the manual operation of one of switch means I-IV in a downward direction. Coincidence means 802, which may comprise a conventional AND gate, includes a second input terminal coupled to comparing means 60 and is adapted to produce an inhibit signal when flip-flop means 704 is reset to its second state and comparing means 70 produces its first output signal. More particularly, the inhibit signal is produced when comparing means 60 produces its third output signal followed by its first output signal. The first input terminal of coincidence means 802 is additionally coupled to coincidence means 501 of mode indicating means 50 via OR circuit 801. It will soon be seen that this additional connection is provided to enable coincidence means 802 to produce an inhibit signal when lens means 110 approaches a predetermined selected position irrespective of the direction of approach of the lens means to said predetermined position. The output terminal of coincidence means 802 is coupled to mechanical stop control means 810 via inverting means 803. Inverting means 803 is similar to aforedescribed inverting means 702. Mechanical stop control means 810, which may be similar to switch control means 711, is effective to energize an energization coil 811 coupled thereto in response to a predetermined signal supplied to the mechanical stop control means. It is recalled that mechanical stop 116 may comprise a conventional electromechanical device, such as a selenoid. Accordingly, energization coil 811 may comprise a selenoid energizing coil magnetically coupled to a movable armature of the mechanical stop. Current flow through the energization coil 811 serves to retract the armature of the mechanical stop 116

whereby said armature is withdrawn from an engaging position with an associated one of apertures 118. In the absence of a current flow through the energization coil 811 the spring biasing force exerted on the armature of the mechanical stop is sufficient to drive said armature into mating engagement with one of the apertures 118. Mechanical stop control means 810 may comprise a suitable driving means similar to aforesaid switch control means 711 and, therefore, may be a conventional transistor having a base electrode coupled to inverting means 803 and including collector and emitter electrodes connected in series relationship with energization coil 811 and a source of energizing potential +V. It will be seen that mechanical stop control means 810 responds to an inhibit signal produced by coincidence means 802 to inhibit the energizing of energization coil 811, thereby permitting an obstacle to be interposed into the path of lens means 110. Alternatively, if the armature of mechanical stop 116 is spring biased into its retracted position, inverting means 803 may be omitted and the inhibit signal will energize energization coil 811 to drive the armature of the mechanical stop into an extended position.

A time delay means 90 is provided for temporarily preventing flip-flop means 704 from storing the selected second and third output signals, respectively, produced by comparing means 60 for a duration of time sufficient to enable mechanical stop control means 810 to condition the apparatus of FIG. 2 to properly respond to the selection of a magnification ratio. Time delay means 90 is interconnected between position detection means 80 and direction determining means 70 and includes one-shot means 901 and coincidence means 902. One-shot means 901 may comprise a conventional monostable multivibrator, such as a Schmitt trigger circuit, or the like, adapted to produce an output pulse of determined duration in response to a positive transition applied to an input terminal thereof. The input terminal of one-shot means 901 is coupled to inverting means 803 and the output terminal of said one-shot means is coupled to coincidence means 902. The coincidence means may be similar to aforesaid coincidence means 303 and may comprise a conventional AND gate including a first input terminal coupled to inverting means 803 and a second input terminal coupled to one-shot means 901. The output terminal of coincidence means 902 is coupled to the set input terminal of flip-flop means 704 via OR circuit 703. It may be appreciated that flip-flop means 704 is initially set to its first state by time delay means 90 prior to responding to the output signals applied thereto by comparing means 60. It will soon become apparent that, if desired, time delay means 90 may be omitted.

The operation of the control apparatus illustrated in FIG. 3 will now be described. To simplify the following explanation thereof, it will be assumed that lens means 110 is initially situated at, for example, position I and that a magnification ratio determined by positioning lens means 110 at position III is selected. Subsequently, a magnification ratio determined by positioning the lens means at position II is then selected. It will be recalled that this assumption corresponds to the assumed example described hereinabove with respect to the operation of the apparatus illustrated in FIG. 2. Since lens means 110 is initially assumed to be located at position I, the signals applied to terminals 314 and 315 by

switch means 119 and 120 of FIG. 2A will represent the actual position, i.e., position I, of the lens means. The manual operation of switch means III serves to establish a transmission path between the active pair of terminals of the operated switch means and a current path is established from the source of energizing potential +V, through the quiescent pair of terminals of switch means I, through the quiescent pair of terminals of switch means II and through the established transmission path to an input terminal of coincidence means 309. It may be appreciated that the operation of switch means III is effective to remove the energizing potential +V from the quiescent pair and active pair of terminals of switch means IV. Accordingly, a subsequent operation of switch means IV is ineffective to alter the signal applied to coincidence means 309 by the previously operated switch means III. If the electrostatic reproduction machine with which the present invention finds utilization admits of its "standby" mode, that is, if a reproducing cycle has not been commenced, a binary "1" is applied to terminal 313. Accordingly, of the coincidence means included in mode selecting means 30, only coincidence means 309 is provided with a binary "1" at each input terminal thereof. Consequently, OR circuits 403 and 406 are each provided with a binary "1" at respective input terminals. A coded representation of the selected switch means that has been operated is thus generated and applied to flip-flop means 401 and 402. OR circuit 403 is effective to set flip-flop means 401 to its first state and OR circuit 406 is effective to reset flip-flop means 402 to its second state. The coded signals stored in the flip-flop means are detected by coincidence means 503 which produces an output signal that may be utilized by suitable indicating means, not shown, to apprise an operator that a magnification ratio associated with switch means III has been selected.

The coded signals stored in flip-flop means 401 and 402 are additionally applied to comparing means 60 which, it is recognized, detects that the actual lens position as represented by the signals provided at terminals 314 and 315 does not correspond to that position selected by the operation of switch means III. Moreover, as may be observed from FIG. 2, the actual location of lens means 110 at position I is to the left of the desired position III and, therefore, comparing means 60 produces its third output signal. This may be represented as a binary "0" at the upper output terminal of comparing means 60, indicative of a difference between the actual and desired locations of the lens means, and a binary "1" at the lower output terminal of comparing means 60, indicative of the relative position of the lens means with respect to the desired position thereof. Hence, a binary "1" is applied to the reset input terminal of flip-flop means 704 and to inverting means 702 via OR circuit 701. The inverting means is effective to apply a binary "0" to the set input terminal of flip-flop means 704. It should be noted, however, that prior to the resetting of flip-flop means 704 in response to the third output signal produced by comparing means 60, the binary "0" produced at the upper output terminal of the comparing means is effective to deactivate coincidence means 802 such that a binary "0" is supplied thereby to inverting means 803. The inversion by the inverting means of the binary "0" applied thereto serves to apply a positive transition to the input terminal of one-shot means 901. Accordingly, a pulse of determined duration is applied to coincidence means 902 in

coinciding relationship with the binary "1" applied by inverting means 803. Thus, a binary "1" is applied to the set input terminal of flip-flop means 704 by coincidence means 902 via OR circuit 703. Flip-flop means 704 may be of the type wherein priority is awarded to the signal applied to the set input terminal thereof in those instances wherein coinciding signals are applied to the set and reset input terminals thereof. Thus, it may be seen, that the operation of switch means III initially sets flip-flop means 704 to its first state whereby the flip-flop means is now prevented from storing the third output signal produced by comparing means 60. Moreover, the inversion by inverting means 803 of the binary "0" applied thereto by coincidence means 802 permits mechanical stop control means 810 to establish a current transmission path from the source of energizing potential +V through the energization coil 811. Consequently, the armature of mechanical stop 116 is retracted from aperture I to thereby enable carriage means 113 to transport lens means 110 to the location selected by the operation of switch means III.

After the armature of mechanical stop 116 has been retracted, the pulse of determined duration produced by one-shot means 901 will terminate and coincidence means 902 will apply a binary "0" to OR circuit 703. At this time, the binary "1" produced at the lower output terminal of comparing means 60 is effective to reset flip-flop means 704 to its second state. Hence a binary "1" is applied to coincidence means 802 by the zero output terminal of flip-flop means 704 via OR circuit 801. Coincidence means 802 fails to respond to the applied binary "1" until a binary "1" is applied thereto by the upper output terminal of comparing means 60. It is appreciated that the resetting of flip-flop means 704 to its second state is effective to apply a binary "0" to inverting means 710 from the one input terminal of the flip-flop means. This applied binary "0" is inverted by the inverting means to activate switch control means 711. More particularly, the output of inverting means 710 is effective to drive the transistor comprising switch control means 711 into a conducting state whereby a current transmission path is established from the source of energizing potential +V through the energization coil 712. The flow of current through energization coil 712 serves to activate switch means 712a and 712b into engagement with their respective upper fixed terminals. Thus, reversible electric motor means 115 is supplied with energy admitting of a sense sufficient to drive the reversible electric motor means in direction such that wheel means 114 is rotated to transport carriage means 113 from position I to position III.

It may here be noted that reversible electric motor means 115 is capable of operating in a stall condition whereby energy may be supplied thereto notwithstanding an arrest of the rotating armature thereof. Thus, when mechanical stop control means 810 is activated by inverting means 803 to retract the armature of the mechanical stop 116, the armature of reversible electric motor means 115 commences its rotation to transport carriage means 113 in a direction determined by the polarity or phase of the voltage supplied to the electric motor by switch means 712a and 712b.

As lens means 110 is driven toward position III, the signals applied to terminals 314 and 315 are determined by the relative angular disposition of cam means 114a and 114b. It may be recognized that the coded signals stored in flip-flop means 401 and 402 will not

be equal to the signals supplied to terminals 314 and 315 until lens means 110 intimately approaches position III. Hence, until that time, comparing means 60 produces a binary "0" at the upper output terminal thereof and a binary "1" at the lower output terminal thereof. The armature of mechanical stop 116 remains in a retracted position and switch means 712a and 712b remain in engagement with their respective upper fixed contacts.

When lens means 110 intimately approaches position III, the signals applied to terminals 314 and 315 will exhibit a corresponding relationship with the coded signals stored in flip-flop means 401 and 402. A comparison between these signals by comparing means 60 is effective to produce a binary "1" at the upper output terminal thereof and a binary "0" at the lower output terminal thereof. Coincidence means 802 is now provided with a binary "1" at each input terminal thereof to produce an inhibit signal indicating that said lens means has approached that position corresponding to the magnification ratio selected by switch means III. The inhibit signal produced by coincidence means 802 is inverted by inverting means 803 and is applied as a binary "0" to mechanical stop control means 810. The transistor which comprises mechanical stop control means 810 is thus driven out of its conducting state to interrupt the flow of current through energization coil 811. Consequently, the energization coil is de-energized and the force exerted on the armature of the mechanical stop 116 by the biasing spring therein is sufficient to engage the armature with aperture 118 at position III. It may be noted that if the signals applied to terminals 314 and 315 exhibit the aforescribed corresponding relationship with the coded signals stored in flip-flop means 401 and 402 just prior to the time that carriage means 113 would be driven to prior alignment with the aperture at position III, the armature of mechanical stop 116 would, nevertheless, be extended by the spring bias force exerted thereon and would, therefore, slide along guide rail means 117 into engagement with aperture III as carriage means 113 is transported into the proper alignment therewith. Once the armature of mechanical stop 116 is engaged with aperture III, the movement of lens means 110 is arrested in a properly secured location to determine the selected magnification ratio. As lens means 110 now is located at selected position III in accordance with the manual operation of switch means III, it is appreciated that the manually operated switch means may be returned into engagement with the quiescent pair of terminals thereof. At this time, flip-flop means 704 is maintained reset in its second state.

After the electrostatic reproduction machine with which the present invention may be readily utilized has completed a reproducing operating cycle and has assumed a "standby" condition, a binary "1" is applied to terminal 313 and a subsequent mode of magnification may be selected. In accordance with the previously assumed example, a magnification ratio associated with switch means II is assumed to be selected. Upon the manual operation of switch means II by an operator, a transmission path is established across the active pair of terminals thereof. The source of energizing potential +V may thus be supplied across the quiescent pair of terminals of switch means I to the active pair of terminals of switch means II and thence to a corresponding input terminal of coincidence means 306. It is noted

that the manual operation of switch means II removes the energizing potential +V from switch means III and IV, respectively, in accordance with the established hierarchy of priority of the illustrated switch means. Coincidence means 306 is the sole coincidence means included in mode selecting means 30 to receive a binary "1" at each input terminal thereof and, therefore, a binary "1" is supplied thereby to OR circuits 404 and 405. A coded manifestation of the operation of switch means II is produced by OR circuits 404 and 405 and applied to flip-flop means 401 and 402, respectively. Flip-flop means 401 is reset to its second state and flip-flop means 402 is set to its first state to thereby store the coded manifestation produced by the OR circuits. Coincidence means 502 included in mode indicating means 50 decodes the stored signals and applies an output signal to suitable indicating means, not shown, to apprise an operator that a magnification ratio associated with position II has been selected.

It is appreciated that when switch means II is operated, the lens means 110 is, for the present example, located at position III. Accordingly, sensing signals representing the location of the lens means at position III are applied to terminals 314 and 315 and thence to comparing means 60. The coded signals now stored in flip-flop means 401 and 402 and representative of the operation of switch means II are also applied to comparing means 60 and, as is recognized, differ from the sensing signals applied to terminals 314 and 315. Comparing means 60 thus produces its second output signal which includes a binary "0" provided at the upper output terminal thereof, which binary "0" is applied to coincidence means 802. The application of a binary "0" to an input terminal of coincidence means 802 is effective to deactivate the coincidence means and to apply a binary "0" to inverting means 803. The logic negation performed by inverting means 803 supplies a binary "1" to mechanical stop control means 810 whereupon a flow of current is established through energization coil 811. Consequently, the armature included in mechanical stop 116 is retracted and carriage means 113 is now enabled to be transported from position III.

The binary "1" produced by inverting means 803 is further applied to one-shot means 901 whereby the positive transition applied to the one-shot means triggers one-shot means 901 to apply a pulse of determined duration to coincidence means 902. This pulse is applied in coinciding relationship with the binary "1" applied to coincidence means 902 by inverting means 803 such that the pulse of determined duration is coupled by OR circuit 703 to the set input terminal of flip-flop means 704. Hence, flip-flop means 704 is inhibited from responding to the second output signal that is now produced by comparing means 60 until the armature of mechanical stop 116 is withdrawn from the aperture at position III. At the conclusion of the determined duration, the pulse produced by one-shot means 901 terminates and coincidence means 902 is deactivated. Flip-flop means 704 may now store the second output signal that is now produced by comparing means 60.

In the instant example, lens means 110 must be transported in a leftward direction to reach selected position II. Accordingly, comparing means 60 responds to the difference in the signals applied thereto by terminals 314 and 315 and by flip-flop means 401 and 402 to produce its second output signal. The second output signal produced by comparing means 60 is here manifested as

a binary "0" provided at the upper and lower output terminals of the comparing means. Consequently, OR circuit 701 responds to the second output signal produced by the comparing means to supply inverting means 702 with a binary "0". The logic negation performed by inverting means 702 upon the binary "0" applied thereto is effective to supply the set input terminal of flip-flop means 704 with a binary "1" via OR circuit 703. Flip-flop means 704 is thus set to its first state to supply inverting means 710 with a binary "1". As may be appreciated, inverting means 710 performs a logic negation upon the binary "1" applied thereto to supply switch control means 711 with a binary "0". The transistor comprising switch control means 711 is thus maintained in a nonconducting state and current is inhibited from flowing through energization coil 712. Consequently, the relay device which may be comprised of energization coil 712 and switch means 712a and 712b of FIG. 2 is not energized. Switch means 712a and 712b thus engage their respective lower fixed contacts and reversible electric motor means 115 is supplied with energy admitting of a polarity or phase to drive wheel means 114 in a direction whereby carriage means 113 is transported from position III to position II. It should be recognized that switch means 712a and 712b may be operated to supply reversible electric motor means 115 with energy admitting of a first or second sense in accordance with the state assumed by flip-flop means 704, as described hereinabove or in a converse manner. Hence, inverting means 710 may be omitted.

As wheel means 114 is driven by reversible electric motor means 115, carriage means 113 is transported up guide rail means 117 into an approaching relationship with the aperture associated with position II. When the carriage means intimately approaches position II, cam means 114a and 114b rotate to operate switch means 119 and 120 such that the sensing signals applied thereby to terminals 314 and 315 exhibit a corresponding relationship with the coded signals stored in flip-flop means 401 and 402. This corresponding relationship is detected by comparing means 60 such that the comparing means produces its first output signal. Accordingly, a binary "1" is provided at the upper output terminal of comparing means 60 and a binary "0" is provided at the lower output terminal thereof. Coincidence means 802 is thus supplied with a binary "1" at the input terminal thereof that is coupled to comparing means 60. However, it is recalled that carriage means 113 is being transported in a leftward direction, as viewed in FIG. 2, and flip-flop means 704 thus assumes its first state. Consequently, coincidence means 802 is maintained in a deactivated condition. Accordingly, inverting means 803 is provided with a binary "0" at its output terminal and thus applies a binary "1" to the transistor comprising mechanical stop control means 810. It may be recognized, therefore, that current continues to flow through energization coil 811 and the armature of mechanical stop 116 is maintained in a retracted position. Hence, the movement of lens means 110 is not arrested even through mechanical stop 116 is disposed in an aligned relationship with the aperture 118 at position II. The lens means thus overruns position II and continues to be transported up guide rail means 117 by reversible electric motor means 115.

As wheel means 114 continues to rotate, cam means 114a and 114b selectively contact switch means 119

and 120 such that the sensing signals applied to terminals 314 and 315 represent that carriage means 113 has continued past position II and is now approaching position I. The sensing signals applied to comparing means 60 by terminals 314 and 315 no longer correspond to the coded signals applied to the comparing means by flip-flop means 401 and 402. However, lens means 110 is now located to the left of the selected position II and comparing means 60 produces its third output signal. It is recalled that the third output signal produced by comparing means 60 is manifested by a binary "0" at the upper output terminal thereof and a binary "1" at the lower output terminal thereof. The reset input terminal of flip-flop means 704 and the input terminal of inverting means 702 are now supplied with the binary "1" provided at the lower output terminal of comparing means 60. Accordingly, flip-flop means 704 is reset to its second state and a binary "1" is applied from the zero output terminal thereof through OR circuit 801 to a corresponding input terminal of coincidence means 802. In addition, a binary "0" is applied to inverting means 710 by the one output terminal of flip-flop means 704. The logic negation performed by inverting means 710 upon the binary "0" applied thereto is effective to supply switch control means 711 with a binary "1". The transistor comprising switch control means 711 is thus rendered conductive and current is permitted to flow from the source of energizing potential +V through the energization coil 712. Consequently, the relay device comprising energization coil 712 and switch means 712a and 712b is energized to drive switch means 712a and 712b into engagement with their respective upper fixed contacts. The polarity or phase of the energy supplied to reversible electric motor means 115 is now such to reverse the direction of rotation of the reversible electric motor means, thereby driving wheel means 114 in a direction opposite to that assumed hereinbefore. Carriage means 113 is now transported down guide rail means 117 to return to position II.

Now, when carriage means 113 intimately approaches position II, the angular positions assumed by cam means 114a and 114b are such that switch means 119 and 120 are operated to apply sensing signals to terminals 314 and 315 that exhibit a corresponding relationship with the coded signals stored in flip-flop means 401 and 402. As may now be appreciated, this corresponding relationship is detected by comparing means 60 whereby the comparing means produces its first output signal. The first output signal is manifested by providing a binary "1" at the upper output terminal of the comparing means and a binary "0" at the lower output terminal thereof. Coincidence means 802 receives the binary "1" provided at the upper output terminal of comparing means 60 and is now provided with a binary "1" at each input terminal thereof. Accordingly, the inhibit signal is produced by coincidence means 802 and inverted by inverting means 803 to supply mechanical stop control means 810 with a binary "0". The transistor comprising mechanical stop control means 810 is driven out of its conducting state to inhibit the flow of current through energization coil 811. Consequently, the spring bias force exerted upon the armature of mechanical stop 116 is sufficient to extend the armature into engagement with aperture 118 at position II. It is appreciated that the armature may be extended prior to the proper alignment of mechanical

stop 116 with aperture 118 such that the extended armature slides into engagement with the aperture as carriage means 113 is transported down the guide rail means 117 into its properly aligned position. The movement of lens means 110 is thus arrested at position II and the lens means is now maintained in a properly secured position to determine the selected magnification ratio in accordance with the manually operated switch means II. The electrostatic reproduction machine with which the present invention may be utilized is now capable of reproducing copies of the original document, which copies exhibit a magnification ratio with respect to the original document in accordance with the selected operation of switch means II.

Let it now be assumed that lens means 110 is initially positioned at any of positions II, III, or IV and that a magnification ratio determined by locating lens means at position I is selected. The selection of this mode of magnification is obtained in the now understood manner by manually operating switch means I. The operation of switch means I completes a transmission path across the active pair of terminals of switch means I to apply an energizing potential +V to a corresponding input terminal of coincidence means 303. In addition, the operation of switch means I removes the source of potential +V from the remaining switch means II-IV in accordance with the pre-established hierarchy of priority. If the electrostatic reproduction machine with which the present invention may be utilized admits of its "standby" mode, a binary "1" is applied to terminal 313, thereby enabling coincidence means 303 to produce a binary "1" at the output terminal thereof. This produced binary "1" is applied to OR circuits 403 and 405 to obtain a corresponding coded manifestation of the operation of switch means I.

As is now fully appreciated, the coded signals produced by the OR circuits are stored in flip-flop means 401 and 402. The stored coded signals are applied to comparing means 60 whereat they are compared with the sensing signals applied to terminals 314 and 315. Comparing means 60 detects a differing relationship in the signals applied thereto and, moreover, detects the position of lens means 110 to be to the right of position I. Consequently, comparing means 60 produces its second output signal which is manifested by a binary "0" at the upper and lower output terminals thereof, respectively. The binary "0" provided at the upper output terminal of comparing means 60 is applied to coincidence means 802 to deactivate the latter coincidence means. Accordingly, the binary "0" applied to inverting means 803 is subjected to a logic negation, whereupon a binary "1" is supplied to mechanical stop control means 810. The transistor comprising mechanical stop control means 810 is driven to a conducting state, thereby enabling current to flow through the energization coil 811. The energizing of coil 811 is effective to retract the armature of mechanical stop 116 from the aperture within which it is engaged. The obstacle now removed from the path of travel of carriage means 113 enables reversible electric motor means 115 to drive wheel means 114.

It is appreciated that the binary "1" produced at the output terminal of inverting means 803 is effective to provide a positive transition at the input terminal of one-shot means 901. Accordingly, the one-shot means applies a pulse of determined duration to the input terminal of coincidence means 902 coupled thereto. The

binary "1" supplied to the other input terminal of coincidence means 902 by inverting means 803 activates the coincidence means to apply a pulse of determined duration to the set input terminal of flip-flop means 704 via OR circuit 703. The flip-flop means is thus prevented from storing the second output signal now produced by comparing means 60 until the armature of mechanical stop 116 is withdrawn from the aperture within which it is engaged. At the completion of the determined duration, the pulse produced by one-shot means 901 terminates and coincidence means 902 is deactivated. Flip-flop means 704 is now enabled to store the second output signal produced by comparing means 60.

The coded signals now stored in flip-flop means 401 and 402 in response to the manual operation of switch means I are detected by coincidence means 501. Accordingly, this coincidence means applies a binary "1" indicative of the selection of a predetermined magnification ratio to the set input terminal of flip-flop means 704 via OR circuit 703 to maintain the flip-flop means in its first state, and to coincidence means 802 via OR circuit 801. The first state assumed by flip-flop means 704 results in the application of a binary "0" to switch control means 711 by inverting means 710. The transistor comprising the switch control means is thus maintained in its nonconducting state to thereby inhibit the flow of current through energization coil 712. Accordingly, switch means 712a and 712b engage their respective lower fixed contacts. The polarity or phase of the energy supplied to reversible electric motor means 115 is thus of a sense to enable the reversible electric motor means to rotate wheel means 114 in a direction to transport carriage means 113 toward position I.

It is appreciated that as carriage means 113 is transported along guide rail means 117, the sensing signals representing the actual location of lens means 110 change accordingly. When the lens means intimately approaches position I, the signals applied to terminals 314 and 315 exhibit a corresponding relationship with the coded signals stored in flip-flop means 401 and 402. Comparing means 60 detects the corresponding relationship to product its first output signal. A binary "1" is thus applied to coincidence means 802 by the upper output terminal of comparing means 60. The coincidence means is now provided with a binary "1" supplied by comparing means 60 and the binary "1" supplied by coincidence means 501 to produce the inhibit signal. It should be noted that in this instance when the predetermined magnification ratio is selected, the inhibit signal is produced by coincidence means 802 notwithstanding the state assumed by flip-flop means 704. The produced inhibit signal is applied as a binary "0" to mechanical stop control means 810 by inverting means 803. The transistor comprising the mechanical stop control means is thus driven to a nonconducting state thereby impeding the flow of current through energization coil 811. The force exerted on the armature of mechanical stop 116 by the biasing spring is now sufficient to extend the armature into engagement with aperture 118 at position I. The lens means is thus securely positioned at the location that determines the magnification ratio selected by the manual operation of switch means I.

It may be noted that when position I is selected by an operator, lens means 110 is directly transported thereto without overrunning the selected position. However, if

desired, lens means 110 may be transported to override selected position I and to return to said position from its overriding location in a manner similar to that described hereinabove with respect to the positioning of the lens means at position II.

In the foregoing description of the operation of the control apparatus illustrated in FIG. 3 in response to the selection of a magnification ratio determined by locating lens means 110 at position I, it was noted that comparing means 60 produces its second output signal. Accordingly, coincidence means 501 need not be coupled to OR circuit 703 since flip-flop means 704 will be set to its first state in response to the second output signal produced by comparing means 60. Alternatively, coincidence means 501 may be coupled to inverting means 710 or to switch control means 711 to regulate the operation of the latter means in accordance with the selection of the predetermined magnification ratio.

The illumination assembly of the electrostatic reproduction machine with which the present invention finds ready utilization may include suitable lamps, such as, for example, conventional xenon flash lamps, capable of being rapidly discharged to create a bright flash of light. Light rays from the lamps are flashed upon the original document D to produce image rays corresponding to the informational areas on said document. The generation of a light pulse by the lamps obviates the necessity heretofore required in conventional electrostatic reproduction machines of linearly scanning an original document in synchronism with the movement of a photoreceptor. It has been found that in most instances the projection of magnified pulsed light images onto photoconductive belt 12 in the electrostatic reproduction machine with which the present invention may be employed is accurately aligned on said photoconductive belt such that an ultimate transfer of the developed magnified image onto a sheet of synchronously transported copy paper exhibits a proper alignment on said copy paper. However, when a preselected one magnification ratio is selected by an operator, the projection of a pulsed light image admitting of said selected magnification ratio onto photoconductive belt 12 results in a misaligned transfer onto the synchronously transported sheet of copy paper. More particularly, the symmetry of the transferred magnified image with respect to the copy paper is slightly distorted. To compensate for this misalignment, it is preferable to alter the position on the photoconductive belt 12 to which the image admitting of said selected magnification ratio is projected. In this manner, the transfer of the magnified image from the belt to the synchronously transported sheet of copy paper yields the desired alignment.

FIG. 3 schematically illustrates flash control apparatus in accordance with the present invention whereby a potential misalignment of an image admitting of a selected magnification ratio is avoided. In one embodiment of the present invention the aforementioned preselected one magnification ratio is determined by locating the lens means 110 at position II. Flash control means 100 is thus responsive to the manual operation of switch means II and is seen to be coupled to coincidence means 502. Flash control means 100 is comprised of delay means 1002, coincidence means 1003 and 1005 and OR circuit 1006. An input terminal 1001 is provided and is adapted to receive a flash energizing pulse applied thereto by machine control apparatus,

not shown, in timed relation with the movement of photoconductive belt 12. More particularly, when an area of the photoconductive belt 12 is sufficiently disposed at exposure station A to receive a projected magnified image, the flash energizing pulse is applied to terminal 1001. The flash energizing pulse admits of a proper magnitude and duration to rapidly discharge the lamps included in the illumination assembly of the electrostatic reproduction machine with which the present invention may be utilized. Delayed gating means comprised of delay means 1002 and coincidence means 1003 is coupled to input terminal 1001 and is adapted to apply the flash energizing pulse to the lamps included in the illumination assembly in a delayed manner. It should be recognized that the purpose of delaying the application of a flash energizing pulse to the lamps included in the illumination assembly is to permit the photoconductive belt 12 to advance a predetermined distance prior to receiving a magnified image such that the image now projected onto the belt is slightly displaced from a normal image receiving position. Consequently, when the displaced image is transferred to the synchronously transported sheet of copy paper, the aforementioned misalignment is now compensated. Accordingly, delay means 1002 is adapted to provide at the output terminal thereof the identical signal applied to the input terminal thereof but delayed in time. The time delay intrinsic to delay means 1002 corresponds to the amount of displacement exhibited by the image projected onto the photoconductive belt 12. Delay means 1002 may thus comprise a conventional time delay device such as a conventional delay line, a shift register, a delay multivibrator or the like.

Coincidence means 1003 included in the delayed gating means may be similar to aforescribed coincidence means 303 and may thus comprise a conventional AND gate. The coincidence means includes a first input terminal coupled to the output terminal of delay means 1002 and an enabling input terminal coupled to the output terminal of coincidence means 502. It should be understood that coincidence means 1003 is activated when a binary "1" is applied thereto by coincidence means 502 in response to the detection of preselected coded signals stored in flip-flop means 401 and 402. A second input terminal of coincidence means 1003 is coupled to input terminal 1001. The output terminal of coincidence means 1003 is coupled to the lamps included in the illumination assembly of the electrostatic reproduction machine via OR circuit 1006. OR circuit 1006 is similar to aforescribed OR circuit 403.

Coincidence means 1005 is similar to aforescribed coincidence means 303 and includes an input terminal coupled to input terminal 1001. Coincidence means 1005 is adapted to apply the flash energizing pulse supplied to terminal 1001 to the lamps included in the illumination assembly via OR circuit 1006. The coincidence means further includes a disabling input terminal coupled to coincidence means 502 via inverting means 1004. The inverting means is similar to aforescribed inverting means 702. It may be appreciated that the operation of coincidence means 1005 is disabled when coincidence means 502 detects preselected coded signals stored in flip-flop means 401 and 402. OR circuit 1006, which includes first and second input terminals coupled to coincidence means 1003 and 1005, respectively, is capable of selectively applying the flash ener-

gizing pulse applied to terminal 1001 and the time delayed flash energizing pulse produced by the delayed gating means to the lamps included in the illumination assembly.

In operation, a flash energizing pulse is applied to input terminal 1001 in timed relation with the movement of photoconductive belt 12. During most modes of magnification, the flash energizing pulse applied to input terminal 1001 is coupled to coincidence means 1005 as a binary "1" and thence through OR circuit 1006 to the lamps included in the illumination assembly. The lamps are discharged in response to the pulse supplied thereto whereby a light pulse of limited duration is produced. It is recognized that the light pulse is employed to generate the pulsed light image of the original document D, which pulsed light image is projected through lens means 110 to an area of the photoconductive belt 12 that is disposed at exposure station A. The flashing of a pulsed light image onto the moving photoconductive belt permits high speed operation of the electrostatic reproduction machine without requiring the moving photoconductive belt to be halted. Moreover, the limited duration of the pulsed light image minimizes the possibility of a blurred exposure of the photoconductive belt, yet maintains a satisfactorily high degree of resolution.

The foregoing operation of flash control means 100 is an accurate representation of the operation thereof in response to the selection of most modes of magnification. However, when the magnification ratio determined by locating lens means 110 at position II is selected it is necessary that the expected misalignment of the magnified image on the copy paper to which said image is transferred be compensated. When switch means II is operated, a coded manifestation of the operation thereof is stored in flip-flop means 401 and 402. Coincidence means 502 detects such coded manifestation and applies a binary "1" to the enabling input terminal of coincidence means 1003 and, through inverting means 1004, applies a binary "0" to the disabling input terminal of coincidence means 1005. Now, when a flash energizing pulse is applied to input terminal 1001 in timed relation with the movement of photoconductive belt 12, coincidence means 1005 is deactivated and cannot supply the applied flash energizing pulse to the lamps included in the illumination assembly. However, delay means 1002 responds to the applied flash energizing pulse to supply coincidence means 1003 with a time delayed representation thereof. Coincidence means 1003 is thus provided with a binary "1" at the enabling input terminal thereof, with a delayed flash energizing pulse at the input terminal thereof coupled to delay means 1002 and with the originally applied flash energizing pulse at the input terminal thereof coupled to input terminal 1001. The coinciding relationship of the signals applied to coincidence means 1003 results in a time delayed flash energizing pulse applied to the lamps included in the illumination assembly by coincidence means 1003 via OR circuit 1006. It is recognized that the originally applied energizing pulse will coincide in time with the time delayed flash energizing pulse for a duration that is less than the flash energizing pulse duration. Nevertheless, this period of coincidence is sufficient to satisfactorily discharge the flash lamps included in the illumination assembly. If desired, coincidence means 1003 need not be coupled to input terminal 1001. However, this inter-

connection is preferred to guard against gating to the illumination assembly spurious pulses that might be produced by delay means 1002 in the absence of an applied flash energizing pulse.

It is now apparent from the foregoing description thereof that flash control means 100 is effective to delay the projection of a magnified image onto photoconductive belt 12 for a predetermined time duration when a preselected one of the magnification ratios is selected by an operator. In an actual reduction to practice of the concepts of the present invention as disclosed herein, the magnification ratio to which flash control means 100 is responsive has been selected to be 98 percent. Thus, when a 98 percent magnification ratio is selected by an operator, flash control means 100 operates to displace the projected 98 percent image by approximately 88 mils on the photoconductive belt 12. Delay means 1002 may, therefore, exhibit an intrinsic time delay equal to 88 mils divided by the velocity of the photoconductive belt 12. Typical examples of the magnification ratios that may be selected by operating switch means I, III and IV may be 101 percent, 74 percent and 65 percent, respectively. However, it should be clearly understood, that the present invention is not limited to these specific numerical examples. On the contrary, any suitable magnification ratios may be utilized herewith. Moreover, these magnification ratios may exhibit a value that is greater or less than unity.

While logic circuits comprised of conventional AND gates and OR circuits have been illustrated herein, it is contemplated that other conventional logic components such as NAND gates, NOR circuits and the like, may be substituted therefor. Similarly, the precise mode of logic operation employed by such substituted components may differ from that described hereinabove in a manner that is obvious to those of ordinary skill in the art. Moreover, any conventional bistate device may be utilized for the flip-flop means illustrated in FIG. 3. Comparing means 60 has been electrically described as a two-bit binary adding circuit. However, any suitable adding circuit or other comparing device may be utilized to produce output signals analogous to that described hereinabove. Also, although specific switch means I-IV have been described herein and a hierarchy of priority has been established therefor, any suitable manual switch device may be utilized with the present invention and the illustrated hierarchy of priority may be altered or eliminated if desired.

It will be obvious to those skilled in the art that the foregoing and various other changes and modifications in form and details may be made to the present invention without departing from the spirit and scope of the teachings thereof. It is therefore intended that the appended claims be interpreted as including all such changes and modifications in addition to the exemplary embodiment described above.

What is claimed is:

1. In an electrostatic reproduction machine wherein copies of an original document are produced on copy sheets by generating a light image of the original document on a photoreceptor and developing said image, the image receiving surface of said photoreceptor being disposed in a predetermined image plane, said copies exhibiting selectable magnification ratios with respect to said original document, said machine including ap-

paratus for regulating said magnification ratios, comprising:

bi-directionally movable lens means for projecting a light image of said original document onto said image plane, said lens means being movable along a path to determine the magnification ratio in accordance with the relative position of said lens means with respect to said original document and said image plane;

selecting means for producing electrical representations of selected magnification ratios when energized,

means coupled to said selecting means for positioning said lens means at a selected location along said path in accordance with said produced electrical representations, and

means responsive to said selecting means adapted on selection of a predetermined magnification ratio to effect preset displacement of the image produced on said photo-receptor whereby to enhance alignment of the image on said sheet in accommodation of the change in image size.

2. In an electrostatic reproduction machine wherein copies of an original document are produced, said copies exhibiting selectable magnification ratios with respect to said original document, apparatus for regulating said magnification ratios, comprising:

bi-directionally movable lens means for projecting a light image of said original document onto an image plane, said lens means being movable along a rectilinear path to determine the magnification ratio in accordance with the relative position of said lens means with respect to said original document and said image plane;

manually operable selecting means for producing electrical representations of selected magnification ratios when energized, and

means coupled to said manually operable selecting means for positioning said lens means at a selected location along said rectilinear path in accordance with said produced electrical representations, said means for positioning said lens means including:

a reversible electric motor mechanically coupled to said lens means for imparting a motive force thereto sufficient to move said lens means along said rectilinear path;

sensing means included in said lens means for sensing the position of said lens means as said lens means moves along said rectilinear path and for generating sensing signals representative of said position; and

means coupled to said sensing means for arresting the movement of said lens means when said sensing signals correspond to said produced electrical representations such that the magnification ratio determined by the position represented by said sensing signals is identical to said selected magnification ratio.

3. The apparatus of claim 2 wherein said means for arresting the movement of said lens means comprises: comparison means for comparing said sensing signals with said produced electrical representations; direction determining means coupled to said comparison means for driving said electric motor in a first direction when said sensing signals represent that the position of said lens means is to one side of the selected position corresponding to said selected

magnification ratio and for driving said electric motor in a second direction when said sensing signals represent that the position of said lens means is to the other side of the selected position corresponding to said selected magnification ratio; and position detection means coupled to said comparison means and said direction determining means for halting said lens means at said selected position when said lens means approaches said selected position from said other side thereof.

4. The apparatus of claim 3 wherein said comparison means comprises arithmetic means for producing a first signal when said sensing signals and said electrical representations are equal, a second signal when said sensing signals and said electrical representations are not equal and said lens means is positioned to said one side of said selected position, and a third signal when said sensing signals and said electrical representations are not equal and said lens means is positioned to said other side of said selected position.

5. The apparatus of claim 4 wherein said direction determining means comprises:

direction store means coupled to said arithmetic means for selectively storing said second and third signals, and

means coupled to said direction store means for supplying said electric motor with energy admitting of a first sense when said second signal is stored and for supplying said electric motor with energy admitting of an opposite sense when said third signal is stored.

6. The apparatus of claim 5 wherein said position detection means comprises:

coincidence means coupled to said arithmetic means and said direction store means for producing an inhibit signal in response to said first signal and said stored third signal; and

electromechanical means coupled to said coincidence means for interposing an obstacle into the rectilinear path of said lens means in response to said inhibit signal and for removing said obstacle from said rectilinear path of said lens means in the absence of said inhibit signal; whereby said lens means overruns said selected position when said selected position is approached from said one side, thereby returning to said selected position from said other side.

7. The apparatus of claim 6 further including time delay means coupled to said direction store means for temporarily preventing said direction store means from selectively storing said second and third signals until said obstacle is removed from said rectilinear path of said lens means when a subsequent magnification ratio is selected.

8. The apparatus of claim 6 wherein said manually operable selecting means comprises:

manual switch means for selectively producing switch signals upon the selected energization thereof, each said switch signal representing a selected magnification ratio; and

coding means coupled to said manual switch means for producing a unique coded electrical representation for each said switch signal.

9. The apparatus of claim 8 wherein said coding means comprises:

code store means for storing each of said coded electrical representations and for supplying said stored

coded electrical representations to said arithmetic means; and

gating means coupled to said manual switch means and responsive to said switch signals for supplying said coded electrical representations to said code store means.

10. The apparatus of claim 9 further including detecting means coupled to said code means for detecting a predetermined stored coded electrical representation to drive said lens means directly to the position represented by said predetermined stored coded electrical representation such that said selected magnification ratio is determined.

11. The apparatus of claim 10 wherein said detecting means includes:

means for supplying said electric motor with energy admitting of said first sense to thereby drive said electric motor in said first direction in response to said detected predetermined stored coded electrical representation; and

means responsive to said detected predetermined stored electrical representation for activating said coincidence means to produce said inhibit signal in response to said first signal.

12. In an electrostatic reproduction machine wherein copies of an original document are produced by flashing a pulsed light image thereof onto a photoreceptor disposed in an image plane in timed relation with the movement of said photoreceptor, said copies exhibiting selectable magnification ratios with respect to said original document, apparatus for regulating said magnification ratios, including:

selectively movable lens means for projecting a pulsed light image of said original document onto said photoreceptor, said lens means determining the magnification ratio in accordance with the relative position of said lens means with respect to said original document and said photoreceptor;

means for producing a flash energizing pulse;

manually operable selecting means for producing electrical representations of selected magnification ratios to selectively position said lens means; and flash control means coupled to said producing means and said selecting means for applying said flash energizing pulse to illumination means to generate a light pulse, said flash control means being responsive to a preselected one of said selected magnification ratios for delaying the application of said flash energizing pulse to said illumination means for a predetermined time duration.

13. The apparatus of claim 12 wherein said flash control means comprises:

gating means coupled to said producing means for applying said flash energizing pulse to said illumination means, said gating means including a disabling input for disabling the operation thereof in response to an electrical representation applied to said disabling input;

delayed gating means coupled to said producing means for applying a time delayed flash energizing pulse to said illumination means, said delayed gating means including an enabling input for enabling the operation thereof in response to an electrical representation applied to said enabling input; and means for applying a preselected one of said electrical representations produced by said manually op-

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erable selecting means to said disabling input and to said enabling input.

14. The apparatus of claim 13 wherein said delayed gating means comprises:

time delay means having an input terminal coupled to said producing means for generating an output signal at said predetermined time subsequent to the production of said flash energizing pulse; and coincidence means including a first input terminal coupled to said time delay means for receiving said output signal, a second input terminal coupled to said producing means for receiving said flash energizing pulse and an enabling terminal for receiving

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said preselected one of said electrical representations, whereby said time delayed flash energizing pulse is generated in response to said output signal, said flash energizing pulse and said preselected one of said electrical representations.

15. The apparatus of claim 14 wherein said flash control means further includes selective gating means coupled to said gating means and said coincidence means for selectively applying said flash energizing pulse and said time delayed flash energizing pulse to said illumination means.

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