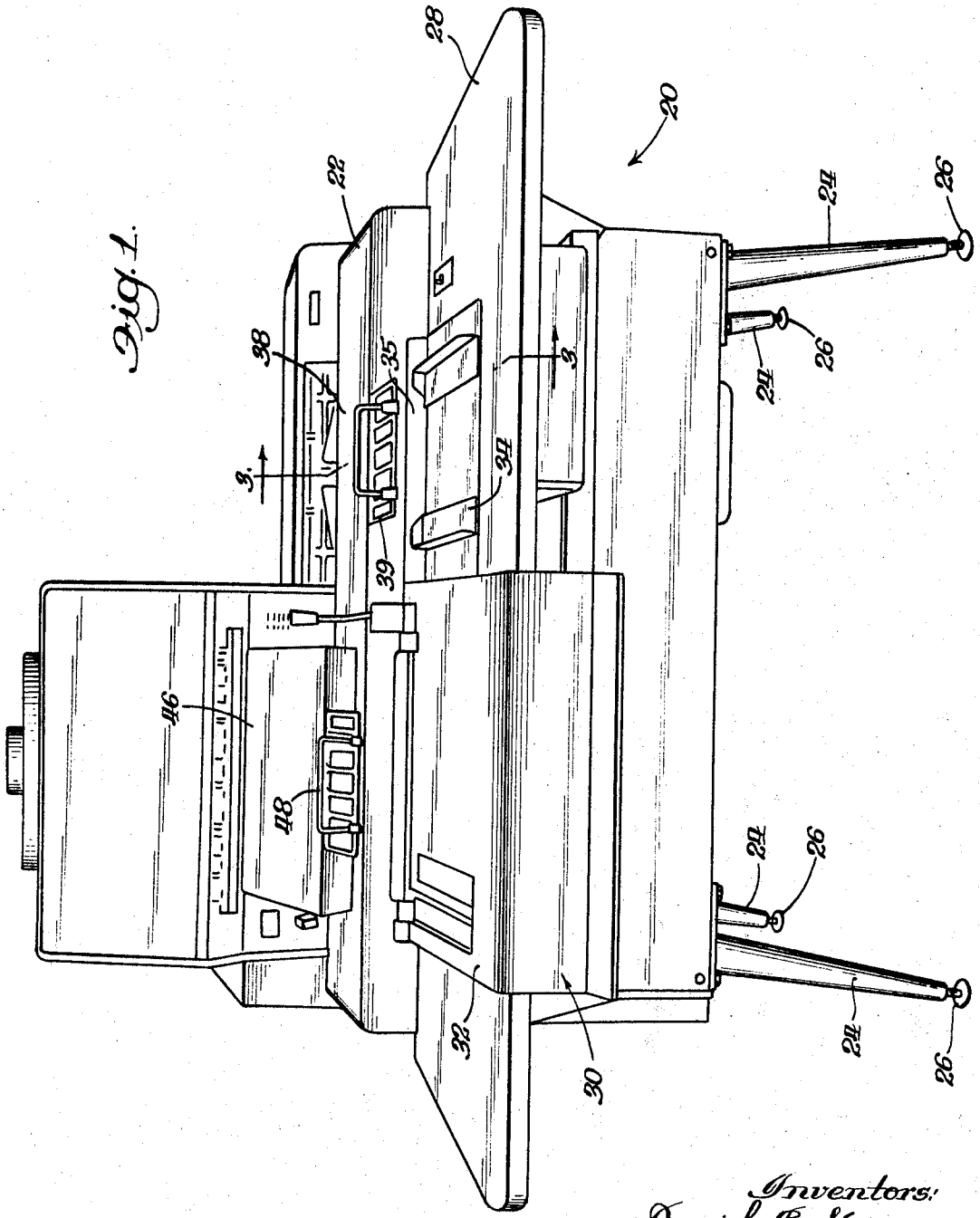
June 18, 1968 D. B. GRANZOW ETAL 3,388,644

PHOTOELECTROSTATIC COPYING MACHINE

Filed March 16, 1965 5 Sheets-Sheet 1

Fig. 1.



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PHOTOELECTROSTATIC COPYING MACHINE

Filed March 16, 1965 5 Sheets-Sheet 2

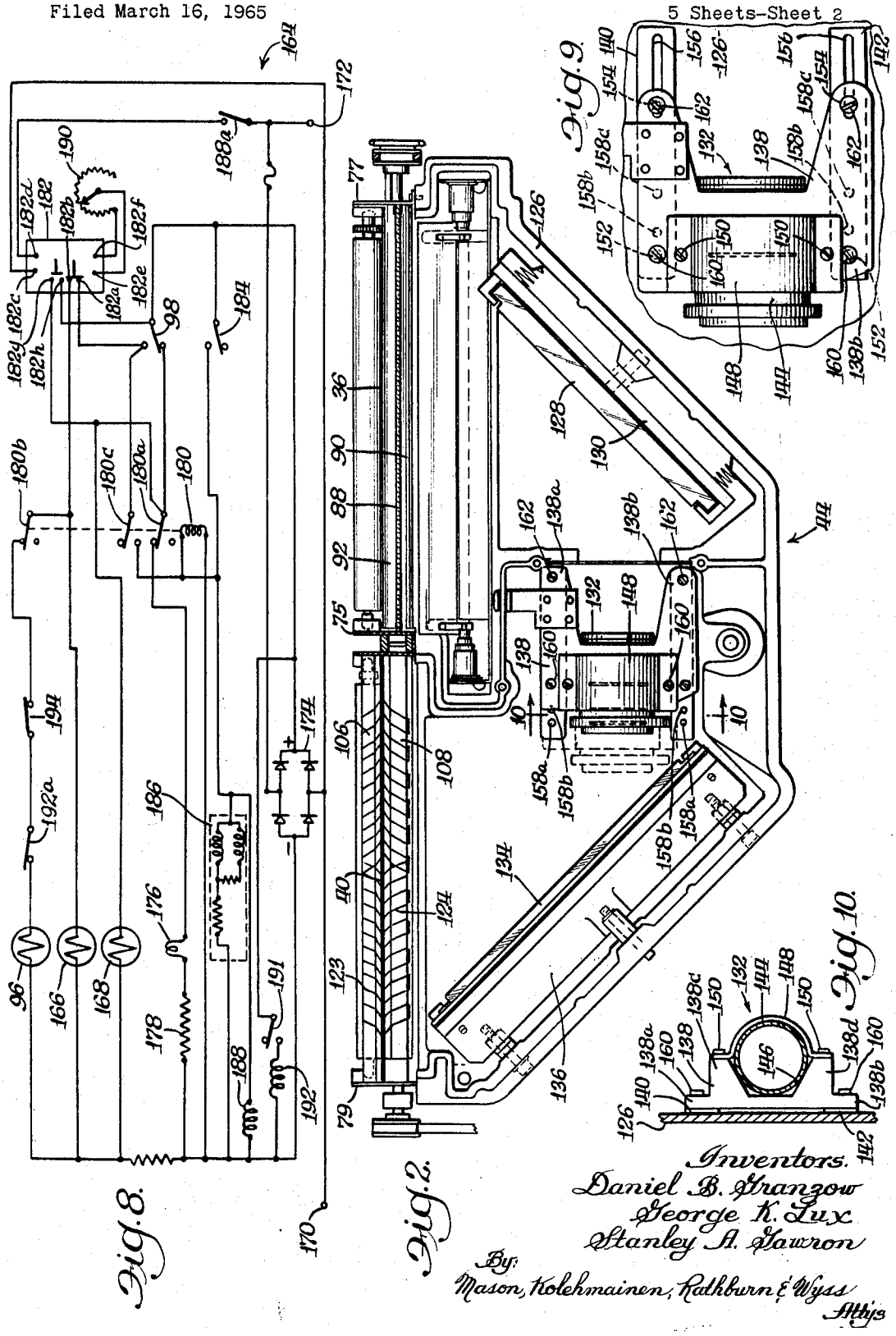

Fig. 8.

Fig. 2.

Fig. 9.

Fig. 10.

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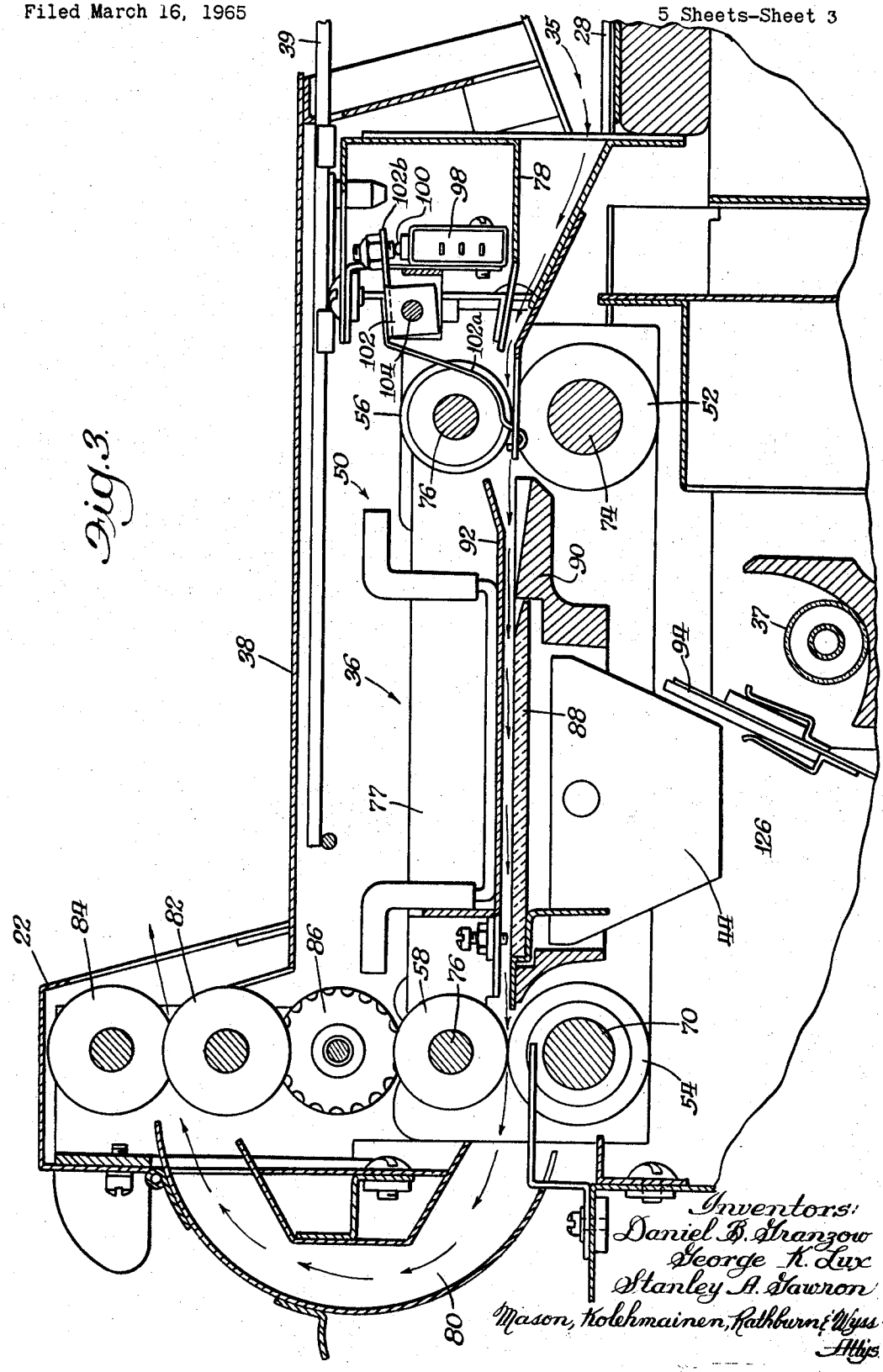
PHOTOELECTROSTATIC COPYING MACHINE

Filed March 16, 1965 5 Sheets-Sheet 3

Fig. 3



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PHOTOELECTROSTATIC COPYING MACHINE

Filed March 16, 1965 5 Sheets-Sheet 4

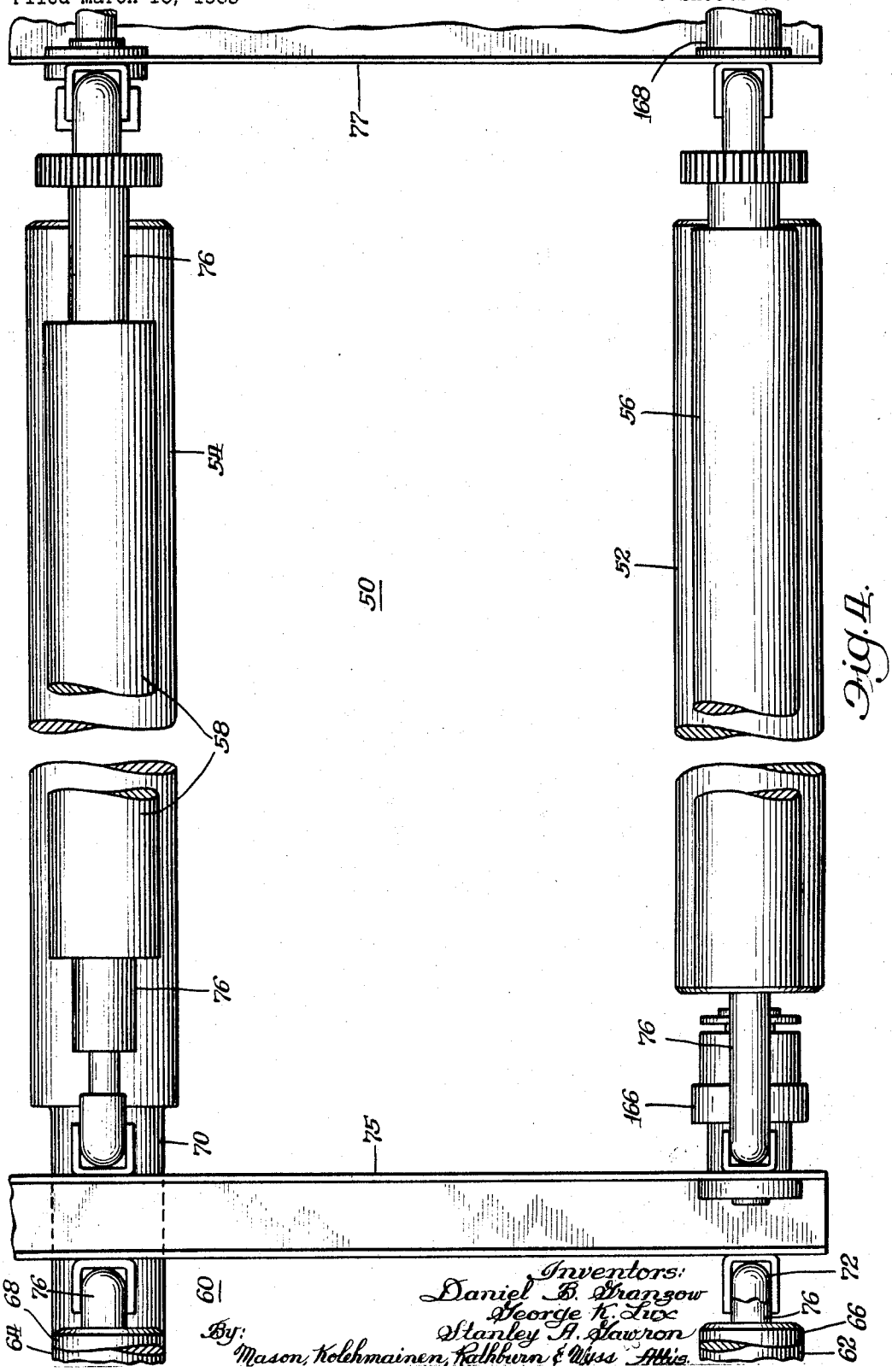

Fig. 4.

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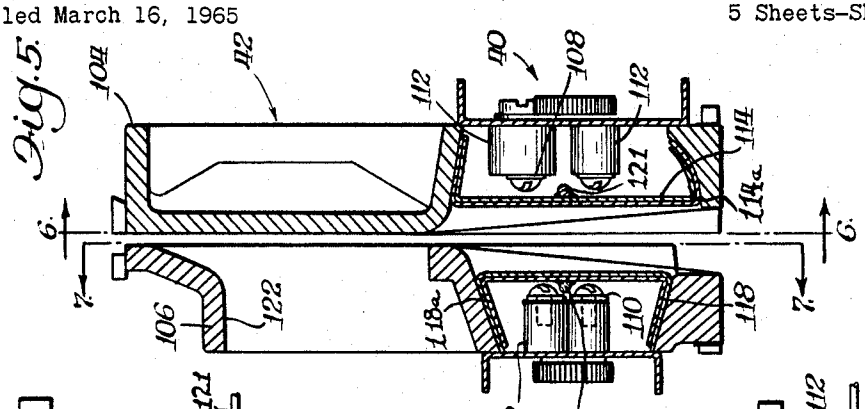
PHOTOELECTROSTATIC COPYING MACHINE

Filed March 16, 1965 5 Sheets-Sheet 5

Fig. 5.



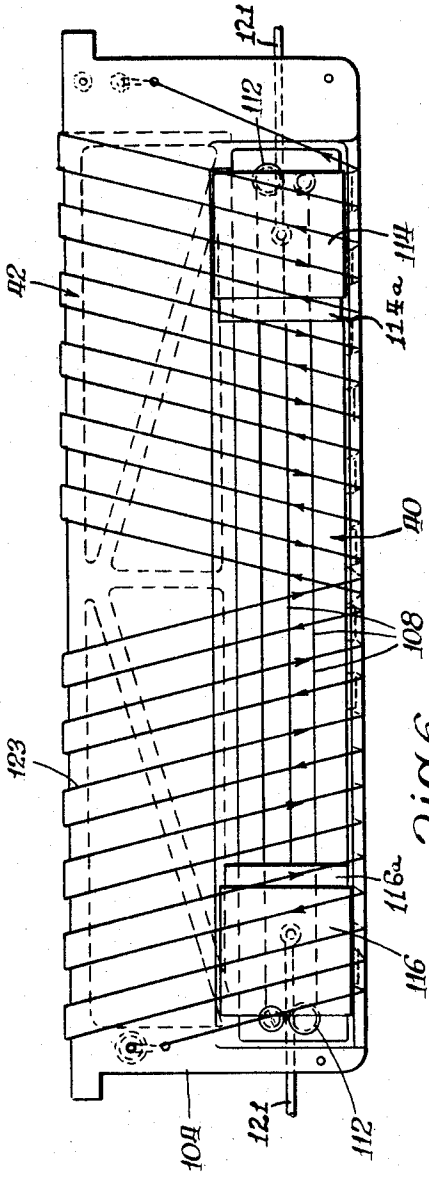
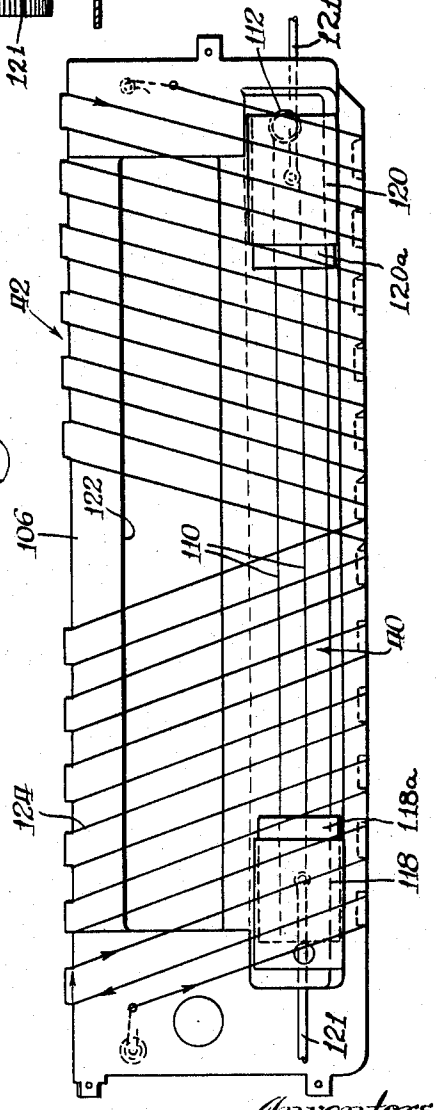


Fig. 6.

Fig. 7.



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United States Patent Office 3,388,644 Patented June 18, 1968

3,388,644

PHOTOELECTROSTATIC COPYING MACHINE

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Filed Mar. 16, 1965, Ser. No. 440,178
8 Claims. (Cl. 95—1.7)

ABSTRACT OF THE DISCLOSURE

An automatic photoelectrostatic copying machine includes drive rollers for moving a graphic original sheet past an illuminating station while other drive rollers move a charged, photoconductive copy sheet past an exposure station where it is exposed by reflected light from the original. The graphic original is driven faster than the copy sheet so that a reduced size copy is produced. The photoconductive copy sheet is electrostatically charged prior to exposure by a corona discharge unit including adjustable shields for preventing charging of non-image regions of the copy sheet. An adjustable drive control holds the copy sheet stationary for a period of time while the graphic original is moving in order to position the copy image at a selected position on the copy sheet.

The present invention relates to photoelectrostatic copying machines, and, more particularly to a new and improved automatic copying machine for producing reduced size copies of a graphic original.

In one type of automatic photoelectrostatic copying machine described in detail in the copending application of John L. Tregay et al., Ser. No. 389,037, assigned to the same assignee as the present application, a copy of a graphic original sheet manually fed into the machine at a feed station is made on a photoconductive copy sheet fed automatically from a supply into the machine in response to feeding an original into the machine. Drive rollers propel the original and the copy sheet through the machine while the photoconductive copy sheet is electrostatically charged in the dark and is then selectively exposed at an exposing station in accordance with a reflected light image produced by illuminating the moving original at an illuminating station. The reflected light image from the original passes along an optical path and is focused onto the copy sheet by means of an optical lens arranged therein. The exposure of the charged copy sheet produces a latent electrostatic exposure image upon the copy sheet in accordance with the light pattern or light image focused thereon by the optical lens by dissipating the charge in those which are light struck and leaving an electrostatic charge in non-exposed areas. As the copy sheet continues to pass through the copy machine, the latent electrostatic exposure image is rendered visible by the application of a granular developer mixture comprising magnetically attractable particles in admixture with a colored thermoplastic resin powder or electroscopic powder in a balanced proportion. In the presence of a magnetic field, the developer mixture forms into a brush-like mass to facilitate the application of the electroscopic powder. The electroscopic powder due to the presence of triboelectric forces in the developer mix adheres to the charged image portions of the exposure image leaving the magnetically attractable carrier particles in the brush. The resulting powder image is then bonded to the copy sheet by a suitable process such as by passing the copy sheet through a heating oven maintained at the fusing temperature of the plastic resin but below the char point of the copy paper.

Photoelectrostatic copy machines of this type are designed to produce a high quality, exact copy of the original having the same size as the original. However, in many office copying applications, it would be desirable to produce a copy of an original at a reduced size. Accordingly, it is an important object of the present invention to provide an improved automatic copying machine capable of producing reduced size copies. As will appear in greater detail hereinafter, in accordance with a feature of the invention, this object is realized in part through the provision of means for driving the original past the illuminating station more rapidly than the copy sheet is driven past the exposure station and in part through changing the focal length of the optical lens and the length of the optical path between the original and the copy sheet. It has been found that changing the focal length and the length of the optical path results in taking the optical lens out of focus. Accordingly, it would be desirable to provide a novel arrangement for properly focusing the optical lens to accommodate different size reduction arrangements.

Using modern mass production manufacturing techniques, it is frequently difficult to satisfy the requirements of various types of customers with a single mass produced item. For example, in the copying machine field, while a large number of customers may desire a photoelectrostatic copy machine such as that disclosed in the above-mentioned Tregay et al., application capable of producing copies of the same size as an original, various other customers may desire machines capable of producing reduced size copies of various different reduced sizes. Thus it would be highly desirable to mass produce a single type of photoelectrostatic copying machine and to provide novel and inexpensive attachments for the machine capable of easily and economically altering the operation of the machine to produce copies of various reduced sizes.

In photoelectrostatic copying machines used in the past, such as that disclosed in the above-mentioned Tregay et al., application, it is desirable to position the copy on the copy sheet in the same location as the original image is positioned on the graphic original. Thus in such machines not only is the original run through the illuminating station at the same speed as the copy sheet is run through the exposure station, but also the copy sheet is run through in synchronization with the original. Thus, in the above referred to copending application, means are disclosed for advancing the leading edge of the original into the illuminating station at the same time as the leading edge of the copy sheet is advanced into the exposure station. However, in many applications for which copy machines are used, it would be very desirable to position the copy on the copy sheet in a different position from the position of the original image on the original sheet. Furthermore, when a reduced size copy is made on a copy sheet of the same dimensions as the graphic original sheet, if the copy sheet and original sheet are propelled in synchronization through the machine, the reduced size copy will appear to be squeezed in at the very top of the copy sheet. Thus it would be desirable to position the reduced size copy at any desired location on the copy sheet, such as at the center of the copy sheet.

Accordingly, it is an object of the invention to provide a new and improved photoelectrostatic automatic copying machine for producing reduced size copies of a graphic original.

It is another object of the invention to provide an improved photoelectrostatic copying machine including novel means for propelling the original through an illuminating station at a greater rate of speed than the copy sheet is propelled through an exposure station.

It is another object to provide an improved photoelectrostatic copying machine including novel adjustable lens mounting means for properly focusing the optical lens when the copy sheet to original optical path distance and lens focal length are altered.

It is a further object to provide an improved photoelectrostatic copying machine having easily adjustable means whereby the machine may be quickly and precisely altered in order to produce copies of various sizes differing from the size of the original.

Still another object of the invention is to provide an improved photoelectrostatic copying machine having novel means for positioning the copy at any desired location on the copy sheet.

It is another object of the invention to provide an improved photoelectrostatic copying machine having a novel control arrangement for selectively feeding the copy sheet into the exposure station a period of time before feeding the original into the illuminating station, and for varying the time lapse in order to position the copy at any desired location upon the copy sheet.

Briefly, in accordance with these and other objects, one embodiment of the present invention comprises an automatic copying machine for producing a copy upon a copy sheet in accordance with an original image on a graphic original, by a photoelectrostatic method. The machine includes paper feeding apparatus for feeding the original and the copy sheet into the machine, where the copy sheet is first electrostatically charged and then exposed at an exposure station by a reflected light image traveling along an optical path from the original at an illuminating station. Drive rollers are provided to propel the original and the copy sheet respectively past the illuminating station and the exposure station. In accordance with a feature of the invention, original drive rollers of various sizes, larger than the copy sheet drive rollers, are employed to move the original past the illuminating station faster than the copy sheet is moved past the exposure station in order to produce a copy that is a smaller, compressed version of the original.

Furthermore, in order to produce a reduced size copy, the length of the optical path between the original at the illuminating station and the copy sheet at the exposure station, including an optical lens, may be changed, and a different focal length used. This results in a change in the position of correct or optimum focusing for the optical lens. In accordance with a feature of the invention, a convenient adjustable lens mount is provided so that the optical lens may easily and precisely be moved to the proper focusing position to produce reduced size copies of different desired sizes.

In accordance with a further feature of the invention, means are provided for positioning the copy at any desired location on the copy sheet. A novel control arrangement controls the energization of the drive rollers so that the copy sheet may be started through the illuminating station a period of time before the original starts through the illuminating station. The novel control arrangement includes means for adjusting this time period to produce the copy at any desired position along the length of the copy sheet.

The invention, together with other objects and advantages thereof, will best be understood from considering the following detailed description in conjunction with the drawings, in which:

FIG. 1 is a perspective view of a photoelectrostatic automatic copying machine embodying the principles of the present invention;

FIG. 2 is an enlarged sectional view of a portion of the machine of FIG. 1 illustrating the optical path between the exposure station and the illuminating station;

FIG. 3 is a greatly enlarged, fragmentary, sectional view of a portion of the machine of FIG. 1 taken along a line substantially corresponding to the line 3—3 of FIG. 1 and illustrating the path of travel of a graphic original through the machine of FIG. 1;

FIG. 4 is a fragmentary broken plan view of a portion of the drive system for the machine of FIG. 1;

FIG. 5 is a greatly enlarged, fragmentary sectional view of a portion of the machine of FIG. 1 illustrating the copy sheet charging and exposure station;

FIG. 6 is a plan view of the structure illustrated in FIG. 5 and taken along line 6—6 in FIG. 5;

FIG. 7 is a plan view of the structure illustrated in FIG. 5 and taken along line 7—7 in FIG. 5;

FIG. 8 is a schematic diagram of a part of the circuit for controlling the operation of the machine shown in FIG. 1;

FIG. 9 is an enlarged plan view of a portion of the structure illustrated in FIG. 2, and illustrates particularly the optical lens and lens mounting structure; and

FIG. 10 is a cross sectional view taken along line 10—10 in FIG. 2.

Referring now to the drawings and particularly to FIG. 1, an automatic photoelectrostatic copying machine characterized by the features of the present invention is designated generally as 20. The machine 20 includes a housing or supporting structure 22 supported by several downwardly extending legs 24 having adjustable feet 26 for leveling the machine 20. The housing 22 includes a feeding table portion 28 defining thereupon a copy sheet supply chamber generally designated as 30 covered by an enclosure 32 for storing a supply of copy sheets upon which copies are to be made.

The machine 20 operates in a fully automatic fashion to make one or more reduced size copies of a graphic original image on an original sheet. Accordingly, the table 28 includes a holder and guiding means 34 for storing original sheets to be copied and for guiding each individual sheet as it is manually fed into the machine at an original sheet feeding station 35. When the original is inserted into the machine it follows along a path illustrated in FIG. 3. The original sheet is illuminated at an illuminating station 36 by means of a light unit 37 (FIG. 3) as it travels through the machine 20 and is thereafter returned to a receiving platform 38 conveniently located at the front of the machine and including an adjustable paper holding tray 39.

As described in the copending Tregay et al. application, a copy sheet is automatically passed through the machine 20 from the supply chamber 30 in response to the feeding of an original. The copy sheet first passes through a charging station 40 (FIGS. 2, 5–7) where the opposite faces of the copy sheet are oppositely charged, and immediately thereafter through an exposure station 42 (FIGS. 5–7) where the copy sheet is exposed to a reflected light image reflected from the original and focused onto the copy sheet by means of an optics assembly 44 (FIGS. 2 and 3). As described in the copending application, after being exposed at the exposure station 42, the copy sheet is passed through a developing unit where an electroscopic powder image is developed thereon and then passed through a fuser assembly where the copy sheet is heated to render permanent the powder image of the original. The completed copy is then deposited in a copy receiving shelf 46 positioned at the front of the machine 20 and including an adjustable paper holding tray 48.

In accordance with a feature of the invention, the machine 20 is capable of producing upon the copy sheet a reduced size copy of the original. This is accomplished by feeding the original sheet through the illuminating station 36 at a faster speed than the copy sheet is fed through the exposure station 42. Thus, in accordance with the invention, the machine 20 includes an original sheet driving assembly generally designated as 50 (FIG. 4) and including a spaced pair of driving rollers 52 and 54 each cooperating with an idler roller 56 and 58. As can best be seen in FIG. 3, the spaced sets of rollers 52–56 and 54–58 are positioned at either side of the illuminating

station 36 in position to propel an original sheet past the illuminating station. Similarly, the machine 20 includes a copy sheet drive assembly 60 described in much greater detail in the copending Tregay et al. application. The copy sheet drive assembly 60 includes a pair of spaced copy sheet drive rollers 62 and 64, each cooperating with an idler roller 66 and 68. The copy sheet rollers are arranged to either side of the exposure station 42 and the charging station 40 in order to propel a copy sheet past these stations.

Suitable driving means, such as the means disclosed in the above-mentioned application, are provided to rotate the original drive rollers 52 and 54 and the copy sheet drive rollers 62 and 64 at the same angular velocity. Thus, the original drive roller 52 and the copy sheet drive roller 62 are mounted upon a common driving shaft 70 in order to assure that the rollers 54 and 64 rotate with the same angular velocity. Furthermore, sprocket and belt drive arrangements (not shown) are provided to drive the original drive roller 52 from the roller 54 and the copy sheet drive roller 62 from the drive roller 64. As can be seen in FIGS. 3 and 4, the drive rollers 52 and 62 are mounted for rotation upon shafts 72 and 74 while the idler rollers 56, 58, 66 and 68 are mounted upon idler shafts 76. The shafts 76 and the shafts 70, 72 and 74 are mounted for rotation upon frame members 75, 77 and 79 suitably supported by the housing 22 of the machine 20.

When an original sheet is fed into the machine 20, a copy sheet is automatically advanced from the supply chamber 30 into the machine 20. In order to feed the original sheet past the illuminating station 36 faster than the copy sheet is fed past the exposure station, and since all the rollers turn at the same speed of rotation, the original drive rollers 52 and 54 are larger in radius than the copy sheet drive rollers 62 and 64. Since the velocity at which a sheet passes through the drive rollers is directly proportional to the radius of the drive rollers, it is apparent that an original is propelled more rapidly past the exposure station 42 by the larger drive rollers 52 and 54 than a copy sheet is propelled past the exposure station by the smaller copy sheet drive rollers 62 and 64. As a result of this difference in speed, the exposure image produced upon the copy sheet by the reflected light image is a compressed or reduced size copy of the graphic original. Furthermore, it will be appreciated that the amount of the image compression as determined by the speed of the original sheet with respect to the copy sheet may be easily altered simply by changing the size of the original drive rollers 52 and 54 while using the same copy drive rollers 62 and 64.

When the original sheet is manually fed into the machine 20 through the original sheet feeding station 35, it is guided by a paper guiding assembly 78 (FIG. 3) until the leading edge of the original sheet is between the original drive roller 52 and the idler roller 56. In the desired operational sequence controlled by a novel control apparatus described hereinafter, the rollers 52 and 56 are actuated to propel the original sheet through the illuminating station 36 to the drive roller 54 and the idler roller 58. After passing through the illuminating station 36, the original sheet is turned around in a turnaround assembly 80 and passed between a pair of rollers 82 and 84 onto the receiving platform 38. Rollers 82 and 84 may be driven in any suitable fashion such as by a gear 86.

The illuminating station 36 includes a transparent glass plate 88 supported by a member 90, and includes a paper guide 92 for guiding the original over the transparent plate 88. As the sheet passes through the illuminating station 36, it is illuminated by means of the light unit 37 through a system of filters 94 (FIG. 3).

As described in detail in the copending Tregay et al. application, the copy sheet supply chamber 30 is provided with a copy sheet feeding mechanism for automatically feeding a copy sheet into the machine 20. The feeding mechanism is controlled by an electrically actuated copy sheet feeder clutch 96 illustrated schematically in FIG. 8 and responsive to electrical actuation to feed a single copy sheet into the machine 20. Located near the original feeding station 35 is an original sheet switch 98 (FIG. 3) mounted above the paper guide assembly 78 and including a switch actuating button 100. A pivotally mounted switch actuating arm 102 mounted upon a pin 104 includes a downwardly extending original sheet engaging portion 102*a* and a switch button actuating portion 102*b*. When an original sheet is manually fed into the machine through the original feeding station 35, the portion 120*a* of the switch actuating arm 102 is engaged by the sheet and the switch 98 is moved from its normally open position illustrated in FIG. 8 to its closed position. Movement of the switch 98 to its closed position serves to energize the copy sheet feeding clutch 96 in order to propel a copy sheet from the copy sheet supply chamber 30 into the machine 20.

When a copy sheet is fed into the machine 20 in response to manual insertion of an original sheet, the copy sheet is propelled between rollers 62 and 66, past the charging station 40 and the exposure station 42, and through the rollers 64 and 68. As can best be seen in FIGS. 5–7, the charging station and exposure station are supported by an upper frame 104 and a lower frame 106. The charging station 40 includes an upper corona discharge wire 108 and a lower corona discharge wire 110 mounted respectively in the frames 104 and 106 upon insulated spacers 112. The corona discharge wires 108 and 110 serve to deposit by corona discharge opposite charges on the upper and lower faces of the copy sheet. Upper corona shields 114 and 116 mounted on frame 104 and lower corona shields 118 and 120 mounted on frame 106 prevent charging of the blank side margins of the copy sheet, and telescoping portions 114*a*, 116*a*, 118*a* and 120*a* may be adjusted by the operator to proper positions for reduced size copies of various sizes by means of rods 121 extending outside of the machine 20.

At the exposure station 42, the lower frame 106 defines an elongated generally rectangular recess 122 over which the charged copy sheet passes to be exposed by a reflected light image traveling through the optics assembly 44 from the original sheet illuminated at the illuminating station 36. In the exposure station 42, those areas of the charged surface of the copy sheet 32 corresponding to light areas of the original are illuminated to dissipate or discharge the electrical charge thereon, in the manner described in greater detail in the copending Tregay et al. application.

The upper and lower frames 108 and 110 are provided with paper guiding means comprising monofilament nylon lines 123 and 124 respectively wound upon the upper and lower frames in a diagonally extending fashion as clearly illustrated in FIGS. 6 and 7. It has been found that while serving to guide the copy sheet through the charging station 40 and exposure station 42, the diagonally arranged nylon lines do not interfere with the forming of an exposure image of charged and uncharged particles at the exposure area.

After the leading edge of the copy sheet has passed through the exposure station 42, it is engaged by the rollers 64 and 68 and propelled out of the exposure station 42 and into a developing unit where a powder image is produced on the copy sheet in accordance with the exposure image or charge image. The copy sheet is next propelled to a fusing unit where the powder image is rendered permanent by heating and then is returned to the copy sheet receiving platform 46.

As best illustrated in FIG. 2, the optics assembly 44 lies beneath the illuminating station 36 and the exposure station 42. The optics assembly 44 includes a housing and light baffle 126 generally in the shape of a triangle. A reflecting mirror 128 is mounted beneath the illuminating station 36 in a mirror housing 130 to direct a reflected light image from an original passing through the illuminating station to a lens assembly generally designated

as 132. After passing through the lens assembly 132, the reflected light image strikes another mirror 134 held in a mirror housing 136 from which it is reflected upwardly against a copy sheet passing through the exposure station 42.

The lens assembly 132 serves to project a finely focused light image onto the copy sheet by means of the mirror 134. As described above, copies of different reduced sizes may be produced with the machine 20 by changing the size of the original sheet drive rollers 52 and 54. In order to further reduce the size of the reduced copy, the lens focal length of the lens assembly 132 may be altered when the roller sizes are changed. When the original sheet drive roller size is altered and the lens focal length changed, it is necessary to reposition the lens assembly 132 along the portion of the optical path extending between the mirrors 128 and 134 in order to precisely focus the light image striking the copy sheet at the exposure station.

In accordance with a feature of the present invention, means are provided for rapidly and precisely adjusting the position of the lens assembly 132 to obtain optimum focusing for copies of different sizes. Accordingly, the lens assembly 192 is mounted upon a lens mounting bracket 138 including a pair of mounting feet 138*a* and 138*b* fastened to a pair of support members 140 and 142. In accordance with this feature of the invention the support members 140 and 142 are provided with precisely oriented means for mounting the lens mounting bracket 138 in a plurality of different positions, each corresponding to a certain size original sheet driving roller, and thus to a certain size copy reduction.

More specifically, the lens assembly 132 includes a generally cylindrical lens casing 144 which may house a series of suitable optical lens elements. The housing 144 is clamped in a recess 146 defined by the lens mounting bracket 138 by means of a clamping bracket 148 held in place by means of fasteners 150 threaded into spaced shoulder portions 138*c* and 138*d*. Each of the mounting feet 138*a* and 138*b* defines a pair of spaced screw receiving mounting holes 152 and 154. The support members 140 and 142 each include an elongated slot 156 for registry with the mounting holes 154 as well as a series of carefully positioned screw receiving holes 158*a*, 158*b* and 158*c* for registry with the mounting holes 152. As illustrated in FIG. 2, the mounting holes 152 are aligned with the holes 158*c* and the mounting bracket 138 is held in place by means of fasteners 160 inserted through these openings. Similarly, fasteners 162 extend through the mounting holes 152 and into the elongated slots 156. In a device constructed in accordance with the invention, the position of the lens assembly 132 illustrated in FIG. 2 is the properly focused position for use with the original drive rollers 52 and 54 as illustrated in FIGS. 4 and 3 and with a lens assembly having a focal length of approximately 201.5 millimeters. This arrangement served to produce a 20% reduction, i.e. a copy 20% smaller than the original. In the position illustrated in FIG. 9 where the mounting holes 152 are aligned with the openings 158*a*, and when a focal length of about 195.4 millimeters is used, the lens is properly positioned to produce approximately a 35% reduction when larger original drive rollers 52 and 54 are mounted upon the shafts 70 and 74. In a similar fashion the lens assembly can be adjusted so that the mounting holes 154 register with the openings 158*b* in order to adjust the lens assembly 192 to produce a 30% reduction when used with an intermediate roller size and a focal length of about 198 millimeters. It will be understood that reductions of any desired size may be produced by properly positioning the openings 158*a*, 158*b*, and 158*c* or additional openings for additional focusing positions, changing the focal length accordingly, and by providing original drive rollers of the proper sizes. Thus, the machine 20 may be easily adapted to produce copy size reductions of various desired sizes, and the adjustments to be made to the machine may be easily accomplished by a relatively unskilled technician with a minimum of effort.

In accordance with a feature of the present invention, the machine 20 is provided with controlling means for controlling the sequence of movement of the original sheet through the illuminating station 36 and the movement of the copy sheet through the exposure station 42 in order to position the exposure image and thus the resulting copy at any desired location upon the copy sheet. When a reduced size copy is made upon the copy machine 20, the original sheet moves through the illuminating station 36 more rapidly than the copy sheet moves through the exposure station 42 whereby the image produced is compressed onto the copy sheet. If the copy sheet and original sheet are fed simultaneously through the machine in the manner disclosed in the above-mentioned Tregay et al. application the compressed copy will appear at the very top of the copy sheet. However, if the copy sheet is started through the exposure station 42 before the original sheet is started through the illuminating station 36, then the resulting copy will appear somewhere below the top of the copy sheet, depending on the time delay. The novel controlling means of the present invention includes a control circuit illustrated in FIG. 8 and generally designated as 164 for feeding the copy sheet ahead of the original by any preselected period of time in order to position the copy at any desired location on the copy sheet.

To enable the control circuit 164 to control the movement of the original sheet in its passage to the illuminating station 36, the drive shaft 74 carrying the drive roller 52 is connected to an electrically operated brake mechanism 166 operative upon being energized to hold the original feeding rollers 56 and 52 in a stationary position. Furthermore, the driving arrangement for driving the shaft 74 from the common drive shaft 70 includes an electric clutch mechanism 168 effective when actuated to connect the drive to the shaft 74.

Having reference to FIG. 8, the operation of the control circuit 164 will now be described. The circuit includes a pair of terminals 170 and 172 for connection to a source of electrical power, such as a 115 volt AC power supply. Connected between the terminals 170 and 172 is a bridge type rectifier circuit 174 for supplying a 90 volt DC potential. The circuit 164 is illustrated in FIG. 8 in its initial condition ready for a copy to be made in the machine 20.

In the initial condition of the machine 20, the original sheet feeding rollers 52 and 56 are rotating, ready to receive a manually fed original sheet. Thus the copy sheet brake 166 is not actuated, and the copy sheet clutch 168 is actuated in order to rotate the shaft 74. Furthermore, the copy sheet supply clutch 96 is not actuated since no copy sheet is being fed into the machine. Furthermore, in the initial condition, a single light 176 visible to the operator is energized to provide an indication that the machine is ready to make a copy. The signal light 176 is illuminated through a circuit including a current limiting resistor 178, a normally closed set of contacts 180*a* on a released relay 180, and the original sheet switch 98.

The copying operation is begun by manually inserting a copy sheet into the original sheet feeding station 35 where it is engaged by the rotating rollers 56 and 52 and moved against the switch actuating arm 102 of the original sheet switch 98, whereby the switch 98 is moved from its initial disengaged condition illustrated in FIG. 8 to its alternate engaged position. Engagement of the original switch 98 causes the signal light 176 and the original sheet clutch 168 to be deenergized, since the initial energization circuit for both of these elements includes the switch 98 in its initial or normal position. In its engaged position, switch 98 connects one side of the rectifier network 174 to a contact 182*a* of a time delay relay 182. The contact 182*a* is normally connected through a

contact 182*b* to the original sheet brake 166. Thus, the engagement of the original sheet switch 98 is effective to energize the original sheet brake 166 as well as to deenergize or release the original sheet clutch 168 so that the original sheet is held clamped between the now stationary rollers 52 and 56 with its leading edge in engagement with the switch arm 102. Furthermore, the copy sheet clutch 96 is simultaneously energized through a circuit including a pair of normally closed contacts 180*b* on the relay 180. Accordingly, when the original sheet engages the switch 98, it is stopped while a copy sheet is advanced from the copy sheet supply chamber 30 and fed to the copy sheet driving rollers 62 and 66.

Associated with the continuously rotating copy sheet driving rollers 62 and 66 is a copy sheet feed switch 184 shown schematically in FIG. 8 but not illustrated in the other drawings. The copy sheet feed switch 184 may be similar in construction and manner of mounting to the original sheet feed switch 98 and is engaged by the leading edge of the copy sheet as it clears the copy sheet driving rollers 62 and 66. Thus, when the copy sheet reaches the copy sheet feed switch 184, it is lined up in the machine 20 with the original sheet being held stationary between the original driving rollers 52 and 56.

When the copy sheet feed switch 184 is moved by the advancing copy sheet from its disengaged position illustrated in FIG. 8 to its alternate engaged position, the relay 180 is energized and the normally closed contacts 180*a* and 180*b* are opened and a normally open set of contacts 180*c* are closed. The opening of the contacts 180*b* disconnects the copy sheet feed clutch 96 since the copy sheet is now advanced into the machine 20. The opening of the contacts 180*a* serves to open the previously interrupted circuit to the signal light 176 so that the light 176 remains off even if the original sheet clears the switch 98 before the copy sheet has cleared the switch 184. The closing of the contacts 180*c* establishes a circuit through the relay 180 including the contacts 180*c* and the original sheet feeding switch 98. In this manner, it is assured that the relay 180 remains energized until both the switches 98 and 184 return to their disengaged initial positions.

The engagement of the switch 184 by the copy sheet being fed into the machine 20 also energizes a counting circuit generally designated as 186 for registering the number of copies made on the machine. Furthermore, a relay 188 is energized through a circuit including the engaged copy sheet switch 184 whereby a set of normally open contacts 188*a* is closed to energize the time delay relay 182. The time delay relay 182 includes a pair of terminals 182*c* and 182*d* connected in a circuit between the AC power input terminals 170 and 172, which circuit is completed by closing the normally open relay contacts 188*a*.

Thus, it can be seen that the time delay relay 182 is energized from the AC power source at the instant that the copy sheet switch 184 is engaged by the copy sheet in registration with the original sheet 20. If it is desired to run the copy sheet and original sheet simultaneously through the machine 20, it is necessary, at this instant, to energize the original sheet driving clutch 168 and deenergize the brake 166 to move the original sheet through the machine along with the copy sheet 20. However, in accordance with the invention and in order to position the copy on the copy sheet at any desired location, the time delay relay 182 is effective to delay the feeding of the original sheet for any selected period of time. Thus, the relay 182 includes a pair of terminals 182*e* and 182*f* connecting the relay 182 with a variable resistance 190 for varying the time delay of the relay 182. Although the time delay relay 182 may be of any suitable type, in an embodiment constructed in accordance with the present invention the relay 182 includes a full wave rectifier circuit for converting the AC voltage received at the terminals 182*c* and 182*d* into direct current for charging a capacitor in accordance with the setting of the variable resistance 190. When the capacitor becomes charged to a preset critical voltage level, it energizes a unijunction transistor to render it conductive and cause the capacitor to discharge across a voltage dividing network. A positive gate voltage thus created fires a silicon controlled rectifier to energize a circuit for opening the relay switching contacts 182*a* and 182*b* and also for closing a pair of normally open contacts 182*g* and 182*h*. It should be understood that any suitable type of automatic or manually controlled time delay device can be substituted for the specific type of time delay relay 182 used in the illustrated embodiment of the invention.

The time delay relay 182 may be set for operation after any desired delay by adjusting the value of the variable resistance 190. The delay period is initiated by the closure of the normally open set of relay contacts 188*a*. In a machine constructed in accordance with the invention, for example, the time delay is variable between 0.2 second and 2 seconds. During the time delay period, the copy sheet is fed through the copy sheet feeding rollers 62 and 66 and across the exposure station 42, while the original sheet is held stationary. When the time delay period terminates, the opening of the relay terminals 182*a* and 182*b* deenergizes the original sheet feeding brake 166. Furthermore, the closing of the normally open contacts 182*g* and 182*h* energizes the original sheet feeding clutch 168 to feed the original sheet through the drive rollers 52 and 56 and across the illuminating station 42.

Thus, through operation of the novel controlling circuit 164, the copy produced on the copy sheet can be located at any desired position on the copy sheet. For example, if the variable resistance 190 is set to one extreme position to produce an essentially immediate operation of the time delay relay 182, the original sheet starts through the illuminating station 36 at the same time the copy sheet starts through the exposure station 42. If a reduced sized copy is made, the reduced size copy will appear at the top of the copy sheet. On the other hand, if the variable resistance 190 is placed in a position to give a somewhat longer time delay, the original sheet is held stationary between the rollers 52 and 56 as the copy sheet starts through the exposure station 42. Thus, the top portion of the copy sheet will be unexposed. At the termination of the time period, the original sheet starts through the illuminating station 36 at a faster rate of speed than that of the copy sheet, and produces a reduced size exposure image on the copy sheet at the center of the copy sheet. If the variable resistance 190 is adjusted to the other extreme position giving the longest possible time delay, the upper and central portions of the copy sheet will have passed through the illuminating station 42 before the original sheet is started through the illuminating station 36. In this instance, the reduced size image will be produced toward the bottom of the copy sheet.

As described in more detail in the copending Tregay et al. application, the circuit 164 also includes a copy sheet supply switch 191 in series with a relay 192. The switch 191 is adapted to be moved from its normally open position to its closed position when the supply of copy sheets runs low, thus actuating the relay 192. At this point, a set of normally closed relay contacts 192*a* in series with the copy sheet feeding clutch 96 is opened to release the clutch. When this occurs, the supply of copy sheets may be replenished by opening a normally closed, manually operated switch 194 in series with the copy sheet feeder clutch 96. The opening of the switch 194 insures that the copy sheet feeding apparatus will not be accidentally actuated while the copy sheet supply enclosure 32 is open.

While the present invention has been described with reference to a particular illustrative embodiment thereof, it should be understood that numerous other modifications and changes will readily occur to those skilled in the art and it is therefore intended by the appended claims to

cover all such modifications and changes that fall within the true spirit and scope of the invention.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. A copying machine for producing an image on a photoconductive member in accordance with an original image on a graphic original, said machine comprising a housing for the original and a second path of travel through said housing for the photoconductive member, an illuminating station along said first path of travel, illuminating means for illuminating the original at said illuminating station, means along said second path of travel for placing an electrostatic charge on the surface of said photoconductive member, an exposure station along said second path of travel, an optics assembly defining a passageway for the passage of reflected light from the original at said illuminating station to the photoconductive member at said exposure station for dissipating the electrostatic charge in areas exposed to light, developer means for applying a developer material to the surface of said photoconductive member for adhesion to those areas retaining an electrostatic charge, first driving means for propelling the photoconductive member past said exposure station at a first rate of speed, second driving means for propelling the original past said illuminating station at a second rate of speed greater than the first rate of speed whereby the image produced upon the photoconductive member is smaller than the original image, and control means for releasing said second drive means to stop the original at the entrance to said illuminating station while the photoconductive member enters said exposure station, and for operating said second drive means a predetermined time after entry of the photoconductive member into said exposure station to advance said original through said illuminating station, said predetermined time being selected to center said smaller image on the photoconductive member.

2. In a copying machine for producing a copy on a copy sheet in accordance with an original image on an original sheet, the combination of original drive means for moving the original sheet through the copying machine, copy drive means for moving the copy sheet through the copying machine where a copy is produced thereon, adjustable control means for releasing said original drive means to hold the original sheet for a period of time while the copy sheet moves through the copying machine, and a time delay device associated with said adjustable control means for determining the duration of the period of time and the location of the copy produced on the copy sheet.

3. The combination of claim 2 further comprising an illuminating station including illuminating means for illuminating the original sheet as it moves past the illuminating station, an exposure station along the path of movement of the copy sheet, and an optics means for focusing the reflected light image from said illuminating station onto the copy sheet at said exposure station.

4. In a copying machine for producing a copy on a copy sheet in accordance with an original image on an original sheet, the combination of an original drive roller for moving the original sheet into the machine, a copy drive roller for moving the copy sheet into the machine, driving means for continuously rotating said copy drive roller, clutch means and brake means for controlling the rotation of said original drive roller, means for disconnecting said clutch means and connecting said brake means when the copy sheet is moved into said machine whereby the original sheet is held while the copy sheet proceeds through the machine, and a variable time delay device for disconnecting said brake means and connecting said clutch means a selected period of time after the copy sheet is moved into the machine whereby the original sheet follows the copy sheet through the machine and a copy is produced thereon at a desired location.

5. A copying machine for producing a reduced size copy on a copy sheet in accordance with an original image on a graphic original, the combination of means for illuminating the graphic original for producing a light image of the original image, means for depositing charge onto the copy sheet by corona discharge, shield means for confining the corona discharge to a portion of the copy sheet, means defining a light path including an optical lens for focusing said light image onto said charged portion of said copy sheet to produce an exposure image in accordance with said light image, said lens being adjustable to different focal lengths for producing exposure images of different sizes on the copy sheet, and shield adjustment means for said shield means for adjusting the size of said portion of the copy sheet in accordance with the focal length used.

6. In a copying machine for producing a reduced size copy on a copy sheet in accordance with an original image on a graphic original, the combination of means for illuminating the graphic original for producing a light image of the original image, means for depositing charge onto the copy sheet by corona discharge, shield means for confining the corona discharge to a portion of the copy sheet, means defining a light path including an optical lens for focusing said light image onto said charged portion of said copy sheet to produce an exposure image in accordance with said light image, said lens being adjustable to different focal lengths for producing exposure images of different sizes on the copy sheet, adjustable lens mounting means for mounting said optical lens in a position of optimum focus for each focal length, and shield adjustment means for said shield means for adjusting the size of said portion of the copy sheet in accordance with the focal length used.

7. In a copying machine for producing an image on a photoconductive member in accordance with an original image on an original sheet, the combination of original drive means for moving the original sheet through the copying machine, additional drive means for moving the photoconductive member along a path in the copying machine where an image is produced thereon, adjustable control means for releasing said original drive means to hold the original sheet for a period of time while the photoconductive member moves along its path in the copying machine, and a time delay device associated with said adjustable control means for determining the duration of the period of time and the location of the image produced on the photoconductive member.

8. The combination of claim 7 further comprising an illuminating station including illuminating means for illuminating the original sheet as it moves past the illuminating station, an exposure station along the path of movement of the photoconductive member, and an optics means for focusing the reflected light image from said illuminating station onto the photoconductive member at said exposure station.

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