

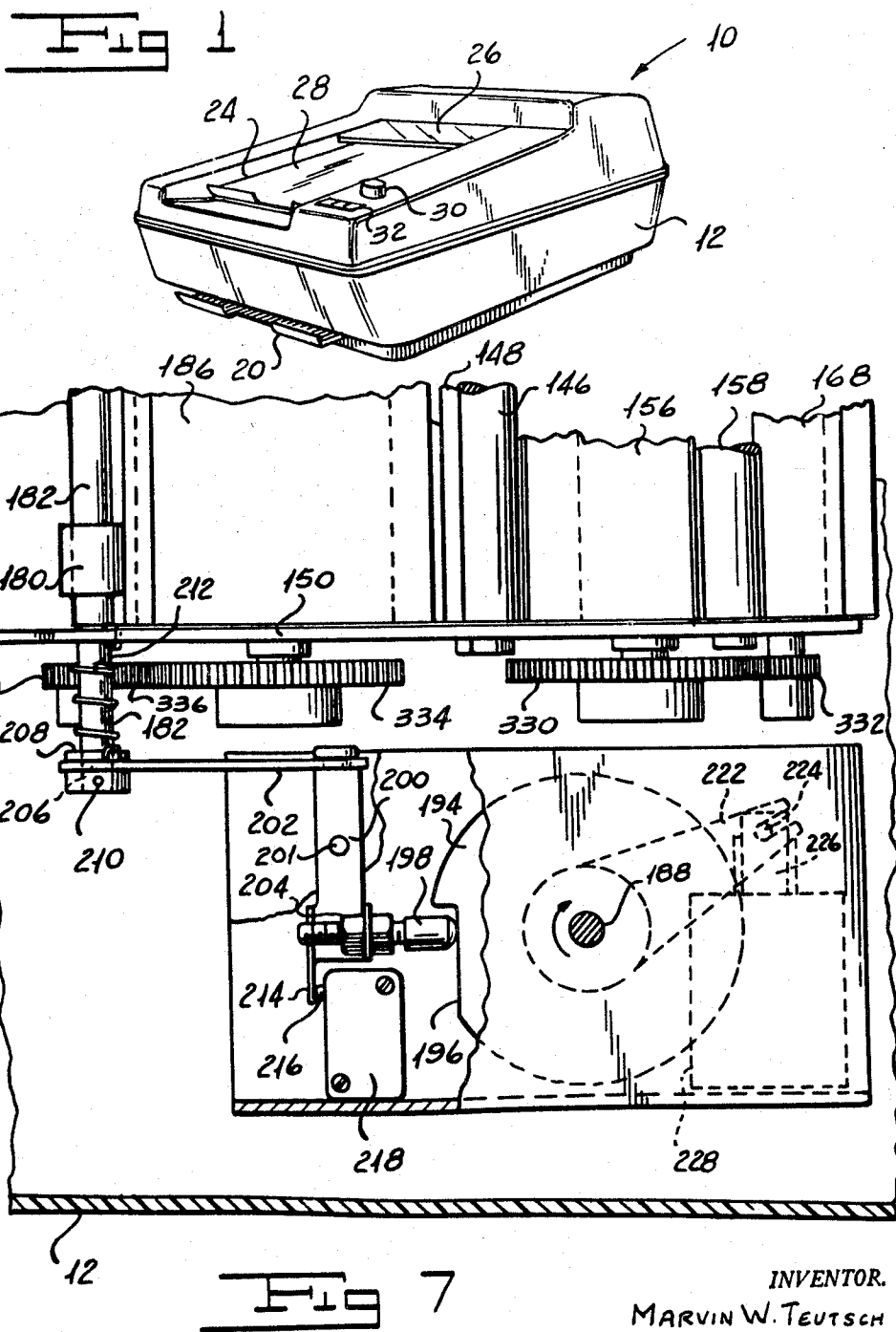
June 25, 1968

M. W. TEUTSCH

3,389,635

Original Filed Oct. 30, 1963

7 Sheets-Sheet 1



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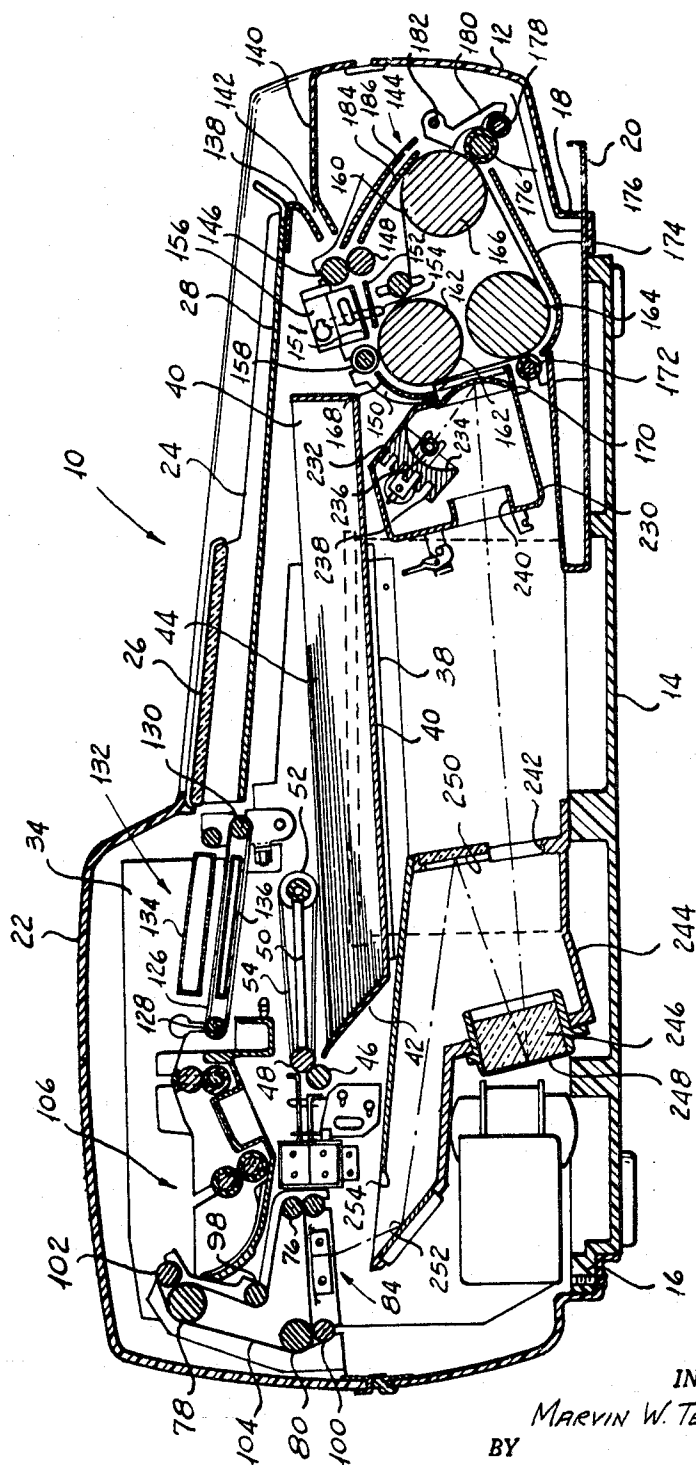
3,389,635

ELECTROSTATIC COPIER

Original Filed Oct. 30, 1963

7 Sheets-Sheet 2

FIG 2



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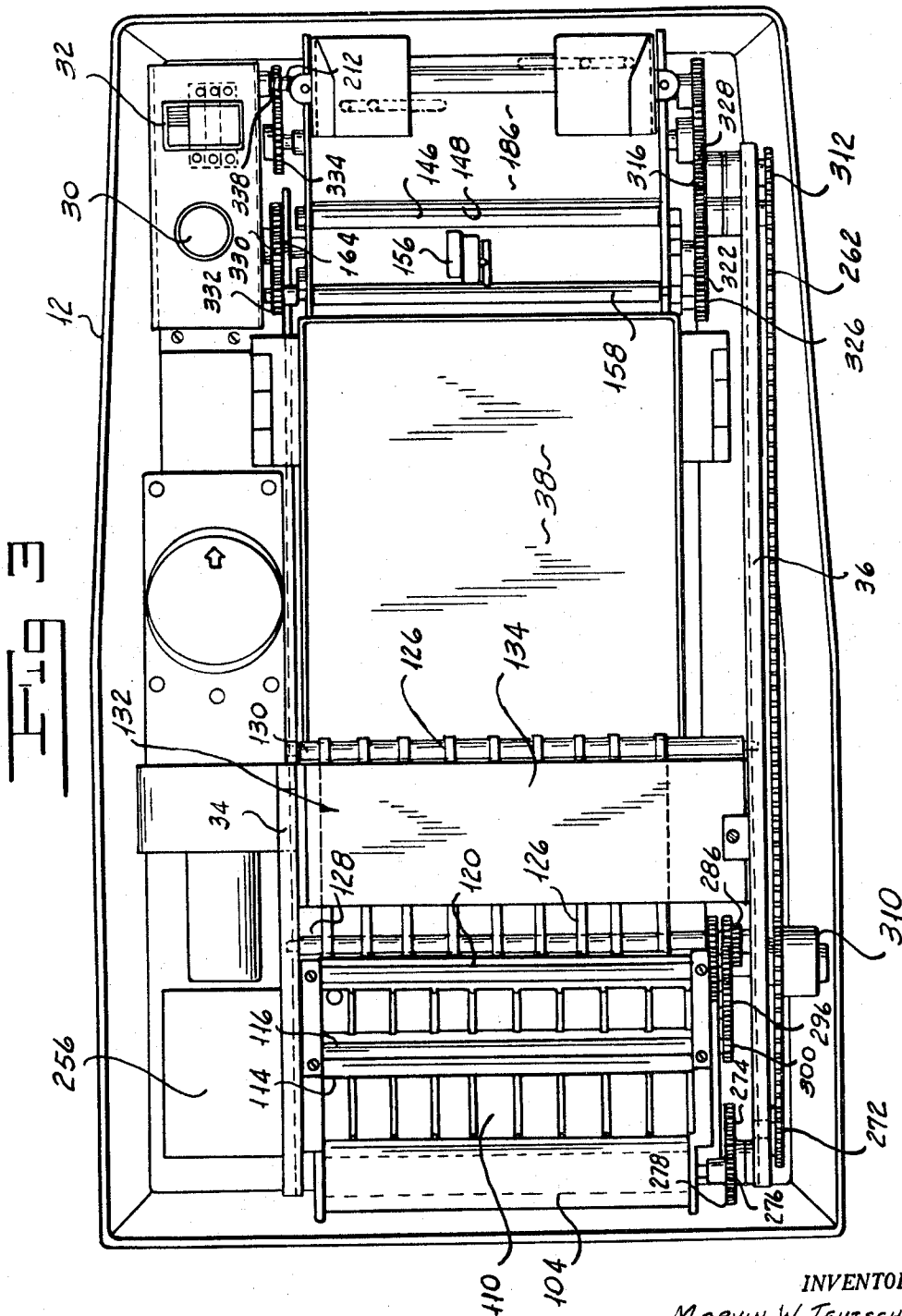
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ELECTROSTATIC COPIER

Original Filed Oct. 30, 1963

7 Sheets-Sheet 3



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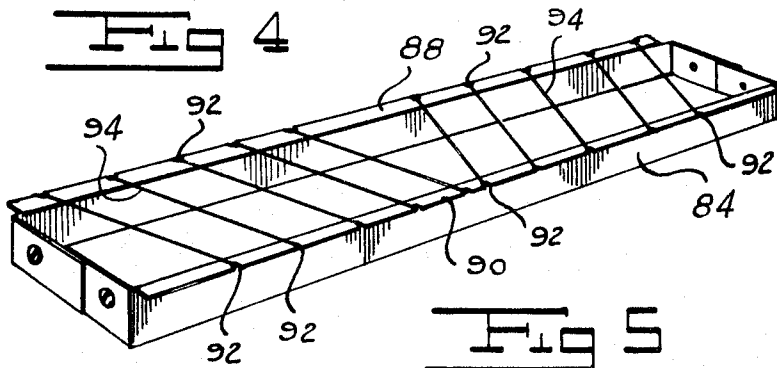
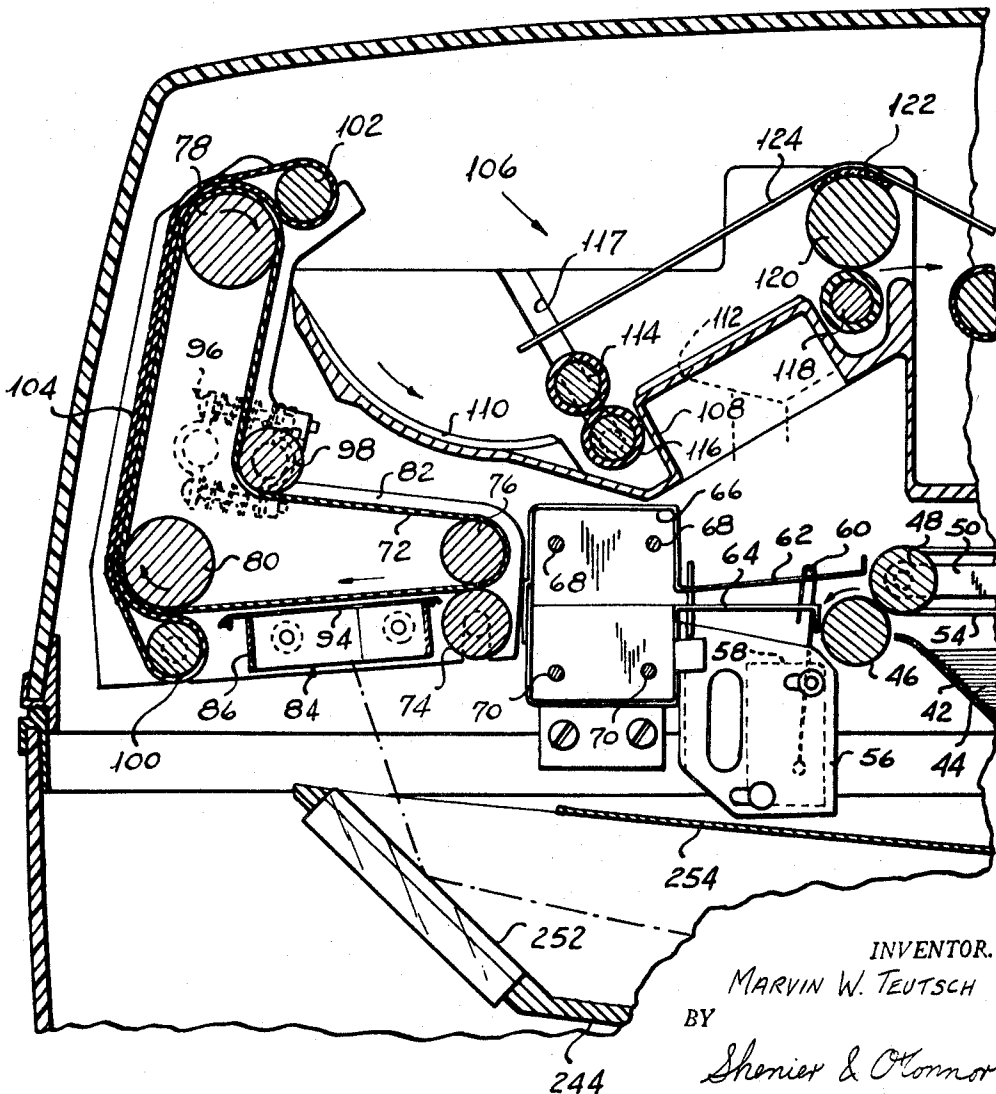
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ELECTROSTATIC COPIER

Original Filed Oct. 30, 1963

7 Sheets-Sheet 4



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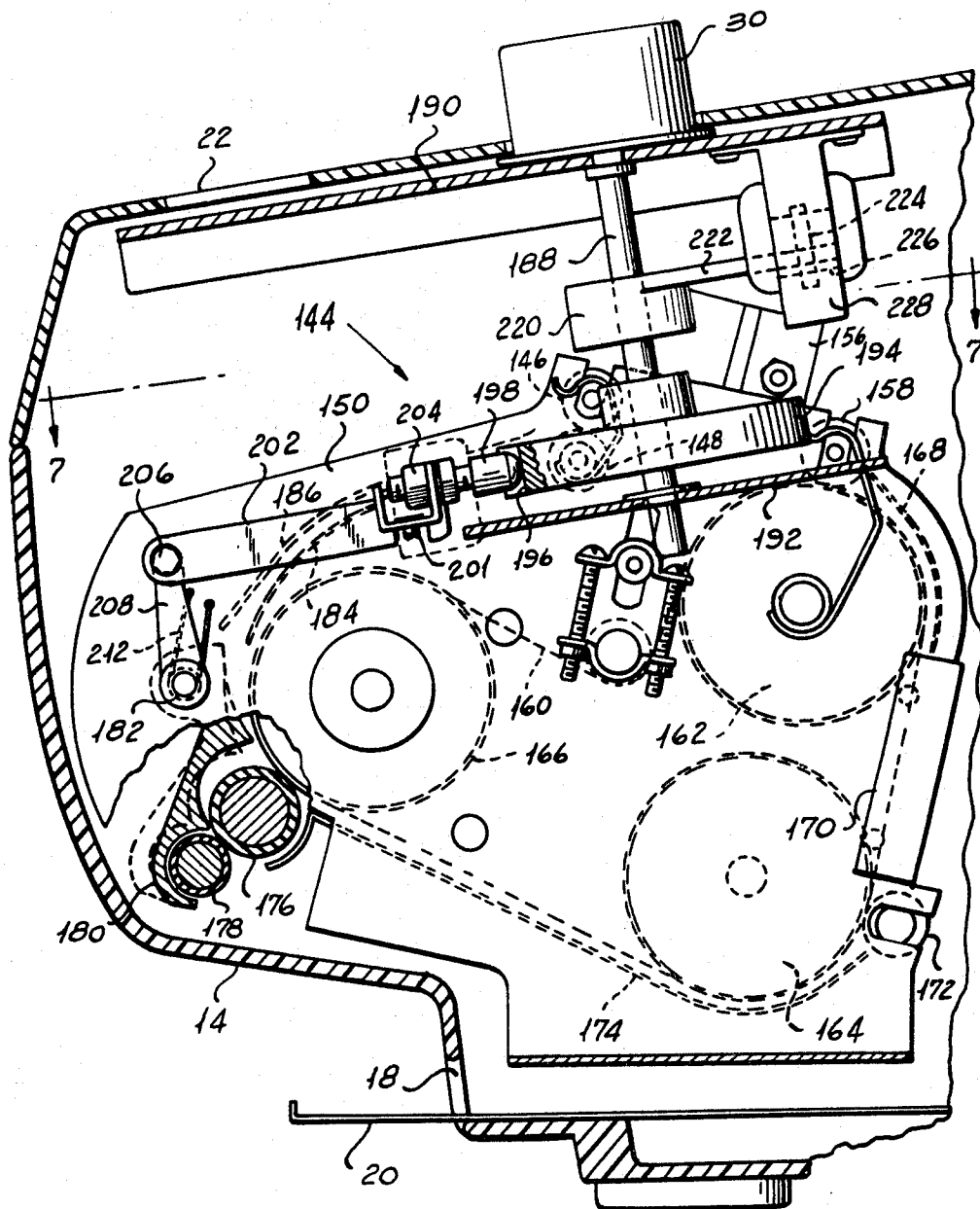
3,389,635

ELECTROSTATIC COPIER

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7 Sheets-Sheet 5

Fig 6



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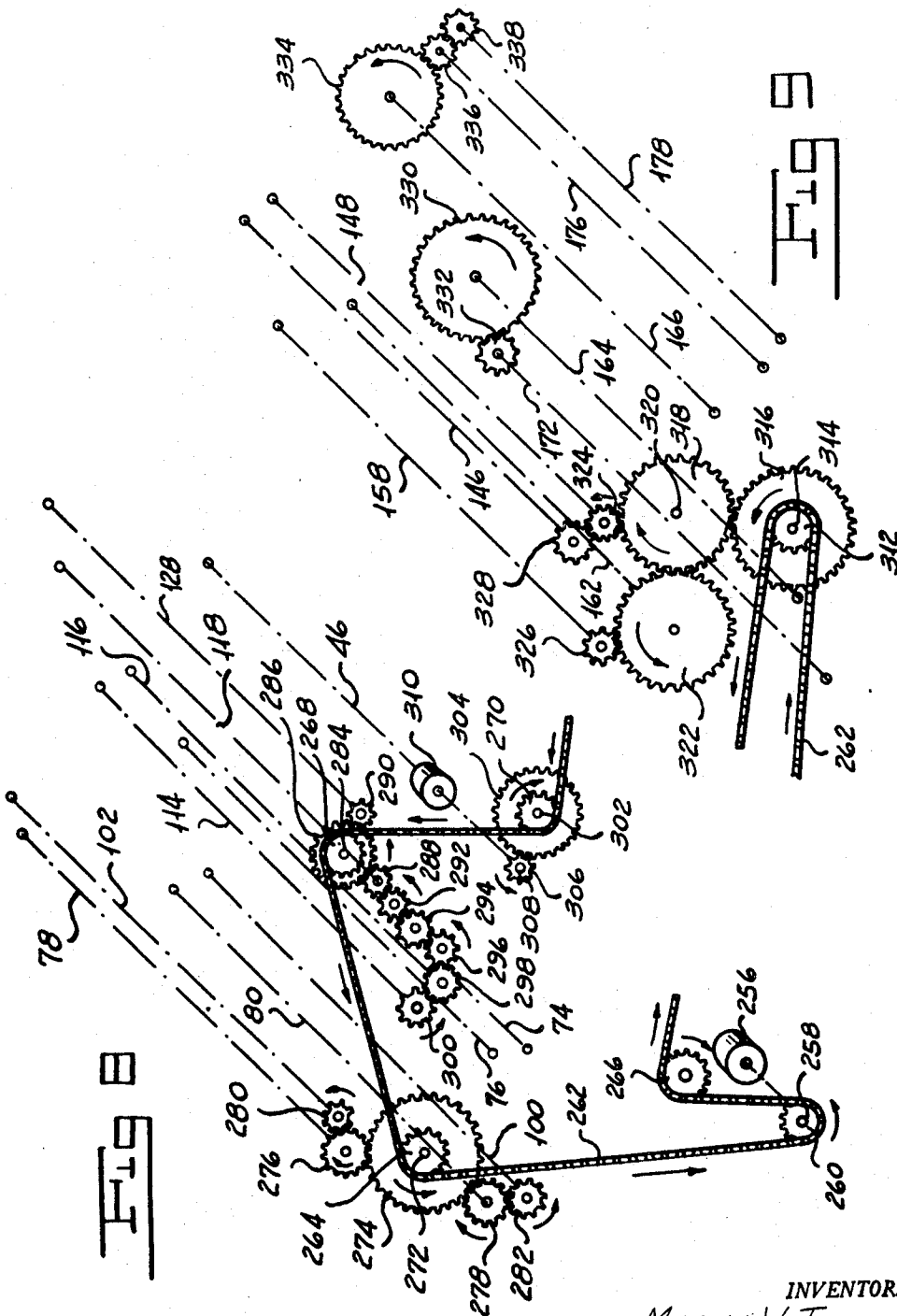
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ELECTROSTATIC COPIER

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7 Sheets-Sheet 6



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ELECTROSTATIC COPIER

Original Filed Oct. 30, 1963

7 Sheets-Sheet 7

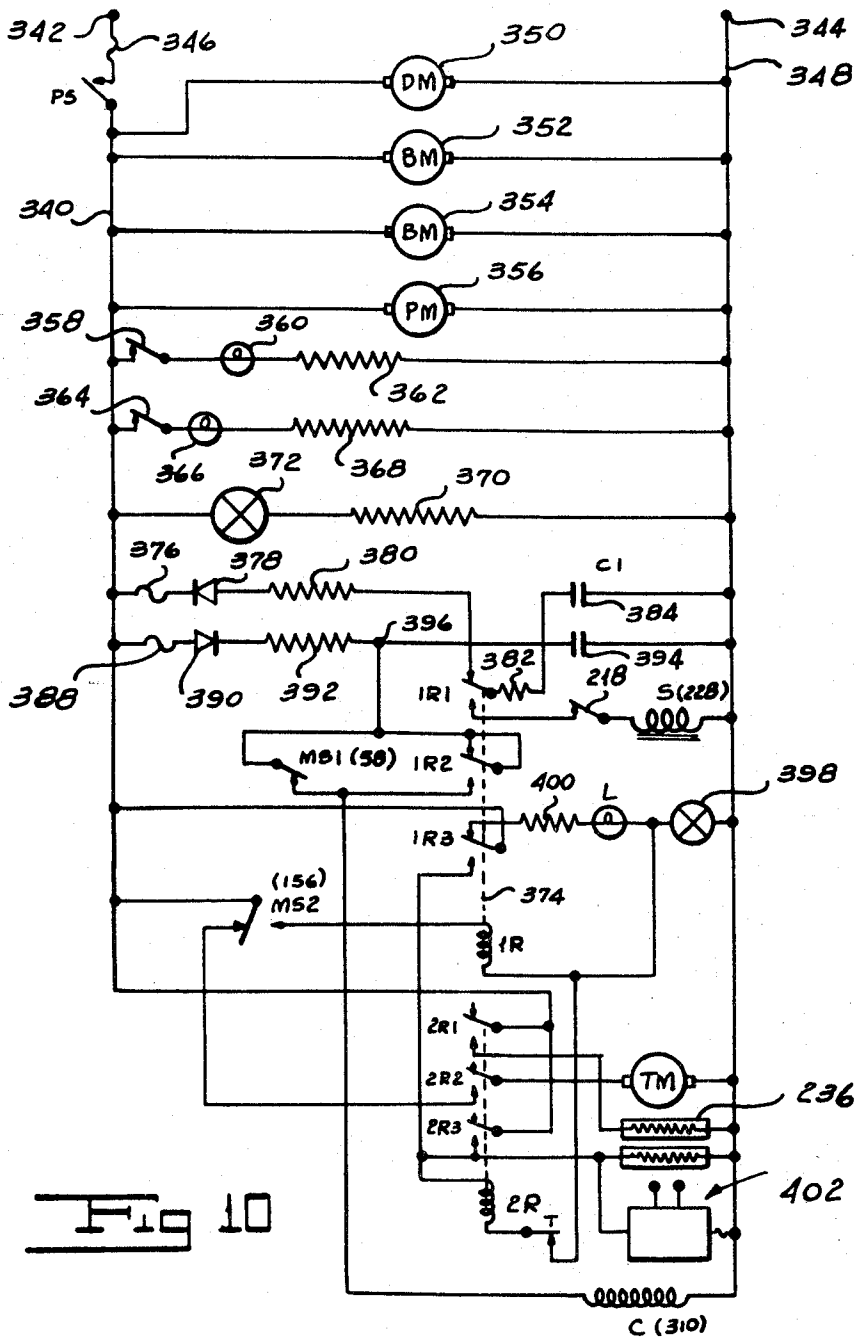


Fig 10

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1

3,389,635

ELECTROSTATIC COPIER

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Original application Oct. 30, 1963, Ser. No. 320,159, now Patent No. 3,272,100, dated Sept. 13, 1966. Divided and this application Dec. 3, 1965, Ser. No. 529,165

4 Claims. (Cl. 88—24)

ABSTRACT OF THE DISCLOSURE

A copying machine for making multiple copies of an original in which the original is fed along a path from an entry location past an exposure window to a return location and wherein means located along the path is adapted to be actuated selectively to direct the original to the return location or back to the entry location. The actuable means is manually set by rotation of a cam in a given direction and is reset upon further rotation of the cam in the same direction.

This application is a division of my copending application Ser. No. 320,159, filed Oct. 30, 1963 for Electrostatic Copier now U.S. Patent No. 3,272,100, issued Sept. 13, 1966.

My invention relates to an electrostatic copier and more particularly to an improved electrostatic copier provided with improved means for exposing copy paper to an image and with means for carrying the exposed paper to the developing system without danger of crumpling the paper or jamming the machine.

Many types of copying machines are known in the prior art. One type of copy machine is the electrostatic copier in which a sheet of copy paper provided with a photoconductive coating receives an electrostatic charge and then is exposed to an image of the original to produce a latent electrostatic image on the paper. After it has received the latent electrostatic image, the copy paper is carried through a developing system in which it is subjected to the action of a toner so that particles of material adhere to the paper in areas to produce a visual image. This image is then set and the copy has been made.

In machines of the prior art a window of transparent material is employed to support the copy paper in the course of its travel as it is exposed to the image. Such a window formed, for example, from a glass plate tends to collect dust, paper lint and possibly stray particles of toner. After a period of time, the window becomes dirty and causes spots and streaks in the copy. This necessitates frequent cleaning of the glass window if clear copies are to be produced.

After the copy paper has received the latent electrostatic image, it must be carried to the developing system wherein it receives particles of toner to develop the image. In order that a compact machine be provided, the path of travel of the paper from the exposure window to the developing system is tortuous. The static charge which was placed on the paper causes the paper to adhere to almost any other surface it touches. In machines of the prior art this fact has caused great difficulty in that the charged paper has a tendency to become crumpled and to jam.

It is desirable that a copy machine be able to make as many copies of one original as are desired. In machines of the prior art this necessitates reinsertion of the original to make additional copies.

I have invented an electrostatic copier which overcomes the defects of copying machines of the prior art

2

pointed out hereinabove. My machine has an open window provided with means for supporting the copy paper as it travels past the window in the course of its exposure to an image of the original. My machine includes means for supporting the charged paper throughout its extent as it moves from the exposure window to the developing system to avoid crumpling of the paper or jamming of the machine. I provide my electrostatic copier with means for making any number of copies within a given maximum automatically in a rapid and expeditious manner.

One object of my invention is to provide an electrostatic copier with an exposure window which will not accumulate dirt.

Another object of my invention is to provide an electrostatic copier having means for supporting the charged sheet throughout its extent as it moves to the developer system to prevent crumpling the paper or jamming the machine.

A further object of my invention is to provide an electrostatic copier having means for automatically making a predetermined number of copies of the single original.

A still further object of my invention is to provide an electrostatic copier for selectively and automatically making a desired number of copies of a single original.

Yet another object of my invention is to provide an electrostatic copier with means for counting the number of copies made to stop the copying cycle of the machine automatically when the preselected number is reached.

Other and further objects of my invention will appear from the following description.

In general my invention contemplates the provision of an electrostatic copier comprising an open exposure window having means for supporting a sheet of copy paper as it is exposed to an image of the original. I provide a double belt transport system which supports the paper over its entire area and carries it to the developer system without danger of crumpling or jamming the machine. My machine is provided with a mechanism for automatically making a preselected number of copies of a single original and for stopping the machine when the number is reached.

In the accompanying drawings which form part of the instant specification and which are to be read in conjunction therewith and in which like reference numerals are used to indicate like parts in the various views:

FIGURE 1 is a perspective view of my electrostatic copier.

FIGURE 2 is a sectional view of my electrostatic copier illustrating the relationship between the various parts of the machine.

FIGURE 3 is a top plan of my electrostatic copier.

FIGURE 4 is a perspective view of the open transport window of my electrostatic copier.

FIGURE 5 is a fragmentary sectional view illustrating the copy paper transport system of my electrostatic copier.

FIGURE 6 is a fragmentary sectional view illustrating the original transport system of my electrostatic copier.

FIGURE 7 is a fragmentary plan view of the original transport system taken along the line 7—7 of FIGURE 6.

FIGURE 8 is a schematic view of the copy paper transport system driving arrangement.

FIGURE 9 is a schematic view of the original paper transport system driving arrangement.

FIGURE 10 is a schematic view of one form of control circuit which I may employ for my electrostatic copier.

Referring now to FIGURES 1 and 2 of the drawings, my electrostatic copy machine indicated generally by the reference character 10 comprises a bottom housing half 12 to which I secure a baseplate 14 by any suitable

3

means, such as by screws 16. The front of the bottom half 14 has a slot 18 adjacent the bottom thereof through which an original return tray 20 extends. The top half 22 of the housing has a large central opening 24 over a portion of which a window 26 extends. In a manner to be described hereinbelow, a copy delivery tray 28 is positioned to provide access to copies made on my machine. The top half 22 has respective openings adjacent the large opening 24 through which there extend a dial selector 30 and push button 32 for operation of the machine.

Referring now to FIGURES 2 and 3, baseplate 14 carries a pair of spaced main frame plates 34 and 36 which support the operating mechanism of the machine.

Any suitable means, such as brackets 38, carried by side panels 34 and 36, support a copy paper supply tray 40 between the plates. The leading edge 42 of the tray 40 is inclined so as to guide the sheets 44 of copy paper into the nip between a pair of copy paper feed rolls 46 and 48 rotatably supported in the side plates 34 and 36. The roll 48 loosely carries a pair of arms 50 adjacent the ends thereof swingably to support a roll 52 adapted to be driven to initiate movement of the top sheet 44 into the nip between the rolls 46 and 48. A pair of spaced rubber drive belts 54 pass through the nip between the rolls 46 and 48 and around roll 52 to drive roll 52 in a manner to be described.

Referring now to FIGURES 2 and 5, in a manner to be described hereinafter, when operation of the machine is initiated, roll 46 is driven in the direction of the arrow shown in FIGURE 5. This action causes the roll 48 to be driven and belts 54 drive roll 52 to slide the uppermost sheet 44 up into the nip between rolls 46 and 48. A bracket 56 carries a microswitch 58 having a feeler 60 which extends into the path of a sheet of copy paper being fed by the rolls 46 and 48. As will be described hereinbelow, when the leading edge of the sheet of copy paper being fed strikes the feeler 60, the drive to roll 46 is interrupted and the machine is ready for a copying operation in response to insertion of the original into the machine.

Assuming that a copying operation has been initiated, the drive to roll 46 is re-established and the sheet of copy paper is fed between guides 62 and 64 which lead into the charging wand chamber 66. A pair of spaced wires 68 extend across the upper half of the chamber 66 while spaced wires 70 extend across the lower half of the chamber 66. As will be described, a potential of, for example, +4000 volts D.C. is applied to the wires of the upper pair and a potential of -6000 volts D.C. is applied to the wires of the lower pair. The path of sheet of copy paper passing through the chamber is located so that it is 40 percent of the total distance between wires 68 and 70 from the wires 68 and consequently 60 percent of the total distance between wires 68 and 70 above the wires 70.

In practice, the sheets 44 are coated with a photoconductive material of a suitable type known to the art, such as zinc oxide. They are stacked in the tray 40, coated side down. When in a manner described they have passed through the chamber 66, they carry an electrostatic charge. As a sheet leaves the chamber it passes into the nip between a transport belt 72 and an idler roller 74. The belt 72 passes around a roller 76 and respective driven rollers 78 and 80. A pair of spaced plates 82 carried by the main frame support the sub-assembly of the belt transport system. After leaving the nip between the roller 74 and the belt 76, the sheet moves onto an open exposure window indicated generally by the reference character 84 comprising a generally rectangular frame 86.

Referring now to FIGURES 4 and 5, the longer sides of frame 86 carry flanges 88 and 90 having notches 92 in which I thread a fine filament 94 so as to form divergent strands of the filament extending generally outwardly from the center line of the path of movement of

4

the paper. Owing to this divergent strand arrangement, there is no danger that the paper might be caught in the filament. Filament 94 may be made of any suitable material. Preferably I employ monofilament nylon.

It is to be understood that in passing over the window 84 the paper having an electrostatic charge thereon is exposed to an image of the original. The charge leaks off over the relatively lighter portions of the image and is retained on the relatively darker portions so that it then carries a latent electrostatic image. It will be appreciated by those skilled in the art that this image may be either a positive or a negative of the original.

Adjusting mechanisms, one of which is indicated generally by the reference character 96 in FIGURE 5, mount a tension roller 98 on the plates 82 to permit adjustment of the tension in the belt 72. Plates 82 carry another pair of rollers 100 and 102 which are driven from rollers 80 and 78 in a manner to be described. Rollers 100 and 102 support a secondary transport belt 104; a portion of which registers with a length of the belt 72. A sheet of copy paper leaving the window 84 moves into the nip between belts 72 and 104 and is securely guided upwardly and around roller 78 as viewed in FIGURE 5 and into the toner system indicated generally by the reference character 106 of my machine. Any suitable insulating material may be used to form the belts 72 and 104. Preferably I employ a material such as "Mylar" which is the registered trade mark of E. I. du Pont de Nemours & Co. for a highly durable, transparent water repellent film of polyethylene terephthalate resin. It has outstanding strength, electrical properties and chemical inertness.

The double belt transport system of my copy machine has a distinct advantage over paper-guiding systems of the prior art. It is well known in the art that the electrostatic charge placed on the paper as it passes through the chamber 66 causes the paper to adhere to almost any surface. Owing to this fact in the prior art the paper has become crumpled and jammed in the course of its travel from the window 84 to the developing system 106. The cooperation of the belt 72 and the belt 104 ensures against such an occurrence as the paper is carried from the window 84 to the developer system 106. While the belt 72 is under tension, the belt 104 is a loose-fitting belt which requires no tensioning device and no centering device other than the side plates 82. Rollers 100 and 102 are driven from their mating rollers 80 and 78 in a manner to be described so that belt 104 is not required to transmit power and consequently has no slippage. It moves at the same speed as does the belt 72.

The developer system indicated generally by the reference character 106 includes a tank 108 which is cast from any suitable material and supported on the machine frame. The base of tank 108 is provided with ribs 110 which guide a sheet of copy paper passing into the tank. A sheet of copy paper carrying a latent image of the original passes out from between belts 72 and 104 and down into the tank 108. A suitable liquid toner carrying particles adapted to be picked up by the charged portions of the paper is pumped into the tank 108. Since this system per se forms no part of my invention, it will not be described in detail herein. The details of this system are shown in the copending application of Vernon L. Marquart, Marvin Teutsch and J. K. Swigert, Ser. No. 328,741, filed Dec. 6, 1963, now Patent No. 3,367,305, for "Developing System for Electrostatic Copier." Excess toner in the tank 108 flows over a weir 112 and back to the reservoir (not shown). As the paper moves into the tank 108, the image side of the copy is face up so that the image is not smeared as the paper slides along the ribs. The developing system of my machine comprises a pair of hold-down rolls 114 and 116 supported in slots 117 in the sides of the tank 108. These rolls are slightly spaced apart so that they do not squeeze the paper. They function to keep the copy below the level of the toner after the paper has been released from the belts 72 and 104.

The rolls 114 and 116 are driven through gearing from the main drive of the machine. The wet developed sheet of copy paper is fed by rolls 114 and 116 to a pair of squeeze rolls 118 and 120. Owing to the fact that toner particles tend to adhere to steel, rolls 114, 116 and 118 are rubber covered. Squeeze roll 120, which is formed of steel, is continuously wiped by a wiper 122 carried by a guide 124 supported on the machine frame.

Referring now to FIGURE 2, the squeezed developed copy paper is fed by squeeze rolls 118 and 120 to rubber transport belts 126 carried by rollers 128 and 130 comprising a part of the fixing system indicated generally by the reference character 132 of my machine. Since the fixing system per se does not form a part of my invention, it will not be described in detail herein. The fixing system is described more particularly in the copending application of Adalbert R. Vil, Ser. No. 320,862, filed Nov. 1, 1963, abandoned in favor of continuation application Ser. No. 577,088, filed Sept. 2, 1966 now Patent No. 3,330,189, for "Fixing System for Copy Machine." The transport belt system 126 carries the damp developed copy paper through the space between an upper duct 134 and a lower duct 136, the sides of which adjacent the belt system are perforated. These ducts blow heated air onto the surface of the paper to dry the same. Following the drying operation, the paper moves out onto the delivery tray 28 on which it is accessible to the operator of the machine.

Referring now to FIGURES 2, 6 and 7, a guide 138 on the underside of the tray 28 and a rearward extension 140 of the top 22 of the machine case form a slot 142 leading into the original-handling mechanism indicated generally by the reference character 144 of my machine. A sheet of original to be copied is guided by slot 142 to the nip between a pair of input feed rollers 146 and 148 supported between a pair of frame plates 150 of the unit 144. Feed rolls 146 and 148 advance the sheet to the space between guide plates 151 and 152 until the leading edge of the sheet strikes the feeler 154 of a microswitch 156. As will be described hereinafter, actuation of the feeler 154 initiates a copying operation. Assuming this has been done, the sheet is advanced to the nip between a control roller 158 and a belt 160 supported on rolls 162, 164 and 166. The belt 160 carries the sheet around past a guide 168 which leads the sheet past a window 170 through which light is focused on the original in a manner to be described. After leaving the window, the original passes between a retainer roller 172 and the belt 160 and is advanced along a guide 174 toward output feed rolls 176 and 178.

The original transport mechanism 144 of my machine includes a gate 180 carried by a shaft 182 for movement therewith. In a manner to be described hereinbelow, the gate 180 is adapted to be moved between the full line and broken line positions illustrated in FIGURE 6. Assuming the gate to be in the full line position shown in the figure, the leading edge of the original is guided by the gate to the nip between rolls 176 and 178 so that these rolls carry the sheet down onto the return tray 20.

If, as will be described hereinbelow, multiple or repeat copies are to be made, the gate 180 is moved to the broken line position. When this is done, the leading edge of the sheet, rather than being directed to the nip between rolls 176 and 178, is directed to the space between guides 184 and 186 which lead the sheet back into the input feed rolls 146 and 148 so that the sheet recirculates through the original transport system.

Referring now to FIGURES 6 and 7, the multiple copy select knob 30 is carried by a shaft 188 supported in frame members 190 and 192 disposed outboard of the right-hand plate 150 as viewed from the front of the machine. Shaft 188 carries for movement therewith a copy number-determining cam 194 provided with a flat 196. A follower 198 is adjustably mounted on an arm 200 pivotally carried on a pin 201. Nuts 204 permit adjustment

of the follower. The other end of arm 200 receives a link 202. A pin 206 connects link 202 to a lever 208 mounted on shaft 182 for movement therewith by any suitable means, such as a setscrew 210. A spring 212 bears between the plate 150 and the arm 208 normally to urge follower 198 into engagement with the periphery of the cam 194. A lug 214 on link 202 normally engages the movable element 216 of a switch 218 to hold the switch open.

When it is desired to make repeat copies, knob 30 is rotated through a distance corresponding to the maximum number of possible copies less the desired number. As soon as follower 198 is thus moved out of engagement with the flat 196, the gate 180 is moved to the broken line position. This action also permits switch 218 to close. A uni-directional clutch 220 couples the shaft 188 to an arm 222 connected by a pin 224 to the armature 226 of a solenoid 228. As will be described hereinbelow, each time a copy is made and so long as switch 218 is closed, a pulse of current is fed to solenoid 228 to step shaft 188 through a step of movement. This action continues until the follower 198 again engages the flat 196. When this occurs, the pulsing circuit is disabled and gate 180 returns to the position at which the original is delivered back to the operator on the return tray 20.

Referring again to FIGURE 2, as has been explained hereinabove, in the course of movement of a sheet of copy paper through its transport system, it moves past window 84. The original passing through the original transport system moves by the window 170. As will be explained hereinbelow, these movements are synchronized so that the original and the copy paper pass by their windows at the same time. My copy machine has an optical system including a housing 230 into which the window 170 opens. A support 232 within the housing has a parabolic mirror 234 which focuses light from a lamp 236 through the window 170 onto the surface of the original. I provide support 232 with cooling fins 238. The light from the original is reflected outwardly through a housing opening 240 in housing 230 and through an opening 242 in a second housing 244 supported by the base 14. Housing 244 supports a lens 246 and a reflective surface 248 which reflects the image coming through opening 242 to a mirror 250. Mirror 250 directs the image onto a reflecting surface 252 which translates the image upwardly through an opening 254 and onto the copy paper through window 84. As is known in the art, the charge which paper 44 received in passing through the corona leaks off in the relatively lighter areas of the image. Thus the charged paper is caused to carry a latent electrostatic image of the original.

I so arrange the operating parts of my machine as to be driven in synchronism. Referring now to FIGURE 8, I have shown the active rolls of a part of my system schematically in the figure by dot-dash lines. The drive motor 256 supported on the base 14 is adapted to be energized to drive a shaft 258 carrying a sprocket wheel 260. Wheel 260 drives a pitch chain 262 in engagement with a sprocket wheel 264. Chain 262 also extends around an idler sprocket wheel 266, a sprocket wheel 268 and a sprocket wheel 270. All of the wheels 260, 264, 266, 268 and 270 are rotatably supported on side panel 36 and are disposed outboard thereof.

The shaft 272 carrying sprocket wheel 264 extends through the panel 36 and carries a gear 274 inboard of the panel. Gear 274 is in driving engagement with respective gears 276 and 278 carried by rolls 78 and 80 for movement therewith. Pinions 280 and 282 on the rollers 102 and 100 drive the rollers in synchronism with their associated rolls. Shaft 284 which carries pinion 268 extends through the wall 36 and carries a pinion 286 for movement therewith. Pinion 286 engages and drives gears 288 and 290 carried respectively by the outlet squeeze roller 118 and by the roller 128 of the belt transport of the fixing system 132. A train of gears, 292, 294 and 296,

translates the movement of gear 288 to a gear 298 carried by the lower feed roll 116 of the developer tank rolls. A gear 300 on the upper developer tank feed roll 114 is coupled to the gear 298. The shaft 302 which supports wheel 270 extends through wall 36 and carries a gear 304 in driving engagement with a gear 306 carried by the input shaft 308 of a clutch 310 adapted to be energized to connect shaft 308 to roll 46 which drives the copy paper supply feed.

Referring now to FIGURE 9, I have shown the driving arrangement for the original transport system of my copy machine. Chain 262 extends from sprocket wheel 270 and from sprocket wheel 266 around a sprocket wheel 312 carried by a shaft 314 on the side panel 36. Shaft 314 extends through the panel and carries for rotation therewith a gear 316 in engagement with a gear 318 supported on a shaft 320 in panel 36. Gear 318 is in driving engagement with a gear 322 on roll 162 and with a gear 324 on roller 148. A pinion 326 on roller 158 is driven by gear 322. A pinion 328 on roller 146 is driven by gear 324. A gear 330 on the end of roll 164 remote from panel 36 drives a pinion 332 on roller 172. A gear 334 on the end of roll 166 remote from wall 36 drives a pinion 336 on the upper original output feed roller 176. A pinion 338 in engagement with pinion 336 drives the lower output feed roller 178.

In FIGURES 8 and 9 the arrows alongside chain 262 and the arrows adjacent the various gears and shafts indicate the directions of movement for proper feeding action.

Referring now to FIGURE 10 I have shown one form of control circuit which may be employed to operate my copy machine. One line 340 of the control circuit is connected to a first terminal 342 of a source including a second terminal 344 by a power switch PS and a fuse 346. The other control circuit conductor 348 is connected directly to the terminal 344. I connect the main drive motor 350, two blower motors 352 and 354 and pump motor 356 across lines 340 and 348 so that all motors are energized when switch PS is closed. I also connect a toner supply sensing switch 358, a signal light 360 and a current-limiting resistor 362 in series across the lines. A paper supply sensing switch 364, a signal lamp 366 and a current-limiting resistor 368 also are connected across the line. An air-heating element 370 and a normally closed thermal-responsive switch 372 are in series across the line.

The first control relay 1R of my system has switches 1R1, 1R2 and 1R3 associated therewith. These switches normally occupy the positions shown in FIGURE 10. In response to energization of winding 1R, a linkage 374 moves all the switches to the other position. A first rectifier circuit comprising a fuse 376, a rectifier 378, a resistor 380, switch 1R, a resistor 382 and a capacitor 384 all connected in series between the lines provide solenoid pulses in a manner to be described. I connect the winding S of solenoid 228 in series with switch 218 between the normally disengaged contact of switch 1R and line 348.

A second rectifier circuit comprising a fuse 388, rectifier 390, resistor 392 and capacitor 394 is connected across the lines 340 and 348 to provide a direct current potential at point 396 for the operation of the relays. I connect the microswitch 58 indicated as MS1 in FIGURE 10 between point 396 and one terminal of the winding C of clutch 310, the other terminal of which is connected to line 348. 1R2 is connected across MS1 to bypass this switch when winding 1R is energized. A thermal switch 398, a signal lamp L, a resistor 400 and the normally engaged contact of switch 1R3 are connected across the lines in the position of the parts shown in FIGURE 10. I connect the other or disengaged contact of 1R3 to one terminal of winding 2R, the other terminal of which is connected to the switch 398 by the timer switch T. I connect the normally disengaged terminal of microswitch 156, indicated as MS2 in FIGURE 10, the winding 1R so that when the original moves MS2 to the position other than that shown

in FIGURE 10, winding 1R will be energized. Switch 2R1 when connected in response to energization of winding 2R completes the circuit for the lamp 236. Switch 2R2 completes the circuit of the timer motor TM when winding 2R is energized and after microswitch MS2 is permitted to return to its initial position as the trailing edge of the original passes the switch. Switch 2R3 provides a holding circuit for winding 2R through switch T after winding 1R drops out. This switch also completes the circuit for the charging wand energizing circuit, indicated generally by the reference character 402.

In operation of my electrostatic copier, I first close power switch PS, for example, in response to the operation of a push button 32. If only a single copy is to be made, knob 30 is positioned at a location corresponding to a single copy. When PS closes, the main drive motor 350, blower motors 352 and 354 and pump motor 356 all are energized. Moreover, signal light 360 is lit to indicate that the machine is low on toner. Lamp 366 lights to indicate the depletion of the supply of paper and the air heater 375 is energized.

Closing of switch PS also energizes the winding C of clutch 310 from rectifier terminal 396, through MS1 and through winding C to line 348. When the clutch is energized, roller 46 is driven to drive roller 48, belts 54 and roller 52 to slide the top sheet 44 of copy paper from tray 40 to the nip between rollers 46 and 48. The paper moves between guides 52 and 54 and actuates the element 60 of microswitch 56. Microswitch 58 indicated as MS1 in FIGURE 10 opens and clutch 210 is de-energized. The machine is now ready to make a copy.

When the machine has thus been readied to make a copy, the original is inserted through slot 42 to the nip between rollers 146 and 148 which feed the original into the system 144 to bring the leading edge of the original into engagement with the actuating element 154 of microswitch 156. This causes the switch indicated as MS2 in FIGURE 10 to move from the position shown in the figure to its other position to complete the circuit of relay winding 1R through MS2, through winding 1R and through switch 398 to line 348. In response to its energization, winding 1R operates linkage 374 to actuate all of its switches 1R1, 1R2 and 1R3. When switch 1R1 is actuated, it normally applies a pulse from capacitor C1 through switch 218 to winding S of solenoid 228. Owing to the fact that only a single copy is being made however, switch 218 is open so that the pulse never reaches solenoid S. Closing of the switch 1R2 re-establishes the circuit to the clutch winding C since it bypasses MS1. At the same time, switch 1R3 closes to disable the ready lamp L and to energize winding 2R through the timer switch T. Moreover, it energizes the corona discharge voltage supply system 402.

Energization of winding 2R closes switches 2R1, 2R2 and 2R3. Switch 2R1 lights the lamp 236. Switch 2R2 readies the timer motor TM, the circuit of which is completed when MS2 returns to its initial position in a manner to be described. Switch 2R3 provides a holding circuit for the corona discharge supply and for winding 2R.

Now the original and the sheet of copy paper 44 move in synchronism respectively through the original transport system 144 and through the copy paper transport system. As the copy paper passes through the housing 66, it receives an electrostatic charge. The copy paper and the original move in synchronism past windows 84 and 170. A reflected image of the original is transported to the copy paper to cause the charge to leak off over the exposed areas. Thus, the copy paper carries a latent image of the original. The copy paper then is transported between belts 104 and 72 to the developer system 106. The double belt arrangement supports the copy paper over its entire extent in the course of this movement to prevent any crumpling or jamming. After leaving the belt system the copy paper moves down into tank 108 and through the liquid therein so that particles of toner are picked up by the charged areas on the paper. The copy

paper is guided between rollers 114 and 116 upwardly to the nip between rollers 118 and 120 which squeeze most of the liquid out of the paper. The damp copy passes through the fixing system 132 and down onto the tray 28. After passing between window 170, the original moves along guide 174 toward roller 176. It will be remembered that only one copy is being made so that gate 180 is in the full line position shown in FIGURE 6. In this position of the gate, it guides the leading edge of the original to the nip between rollers 176 and 178 which feed the original to the return tray 20.

The trailing edges of the original and of the copy paper leave switches MS2 and MS1 at about the same time. When the original leaves MS2, this switch returns to the position shown in FIGURE 10 and timer motor TM is energized. At the same time, winding 1R drop out of the circuit. Motor TM opens switch T when the copying operation is complete to de-energize winding 2R. The return of switch MS1 to its initial position causes a new sheet of copy paper 44 to be fed to the ready position so that the machine is ready to make another copy.

If it is desired to make a number of copies of a single original before the original is fed into the slot 142 knob 30 is set to the desired number of copies. This positions cam 194 at a predetermined location. It permits switch 218 to close. Now, on each copy operation, a pulse is applied to the winding S of solenoid 228 to step cam 194 through a step of movement. Automatically, when the desired number of copies is reached, follower 198 falls back onto the flat 196 so that switch 218 is open and the machine will recycle.

It will readily be apparent that when follower 198 is out of engagement with flat 196, gate 180 is in the broken line position shown in FIGURE 6. In this position of the gate, the leading edge of the original, rather than being guided to the nip between rollers 176 and 178, will be carried upwardly to the space between guides 184 and 186 which direct the original back into the system 144.

It will be seen that I have accomplished the objects of my invention. I have provided an electrostatic copier with an open window through which the copy paper can be exposed to an image of the original without danger of becoming dirty or streaked. My machine positively carries the charged sheet of copy paper around a tortuous path to the developing system without the danger of becoming crumpled or jammed. I can selectively set my machine to make any desired number of copies. It automatically shuts off when the number of copies to be made it reached.

It will be understood that certain features and subcombinations are of utility and may be employed without reference to other features and subcombinations. This is contemplated by and is within the scope of my claims. It is further obvious that various changes may be made in details within the scope of my claims without departing from the spirit of my invention. It is, therefore, to be un-

derstood that my invention is not to be limited to the specific details shown and described.

Having thus described my invention, what I claim is:

1. In a copying machine, an exposure window, means for conveying and guiding an original along a path from an entry location past said window and toward an exit location spaced from said entry location, actuable means disposed in said path for selectively directing an original either to said exit location or back to said entry location, a cam, means responsive to a predetermined rotation of said cam in a given direction for setting said actuable means to direct said original back to said entry location to make a plurality of copies thereof and means responsive to further rotation of said cam in the same direction for resetting said actuable means to direct said original to said exit location.

2. A copying machine as in claim 1 including means for sensing entry of an original into said conveying and guiding means, and means responsive to said sensing means for stepping said cam.

3. In a copying machine, an exposure window, means for conveying and guiding an original along a path from an entry location past said window and toward an exit location spaced from said entry location, actuable means disposed in said path for selectively directing an original either to said exit location or back to said entry location, said actuable means normally directing said original to said exit location, a cam, and means responsive to a predetermined rotation of said cam for setting said actuable means to direct said original back toward said entry location to make a plurality of copies thereof.

4. In a copying machine into which an original is fed and which has an exposure station past which said original is to be carried in the course of making a copy thereof, a transport system for carrying an original along a path from an input station past said exposure station to a return station spaced from said input station, means disposed in said path adapted to be actuated selectively either to guide said original to said return station or to guide said original past said return station and back to said input station, means for setting said actuable means to guide said original past said return station and back to said input station, means for counting the number of passages of said original through said transport system and means responsive to said counting means for resetting said actuable means to guide said original back to said return station.

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