Jan. 14, 1969 R. C. ROBERTSON ET AL 3,421,816

SAFETY ARRANGEMENT FOR COPYING MACHINE

Filed April 6, 1966 Sheet 1 of 6

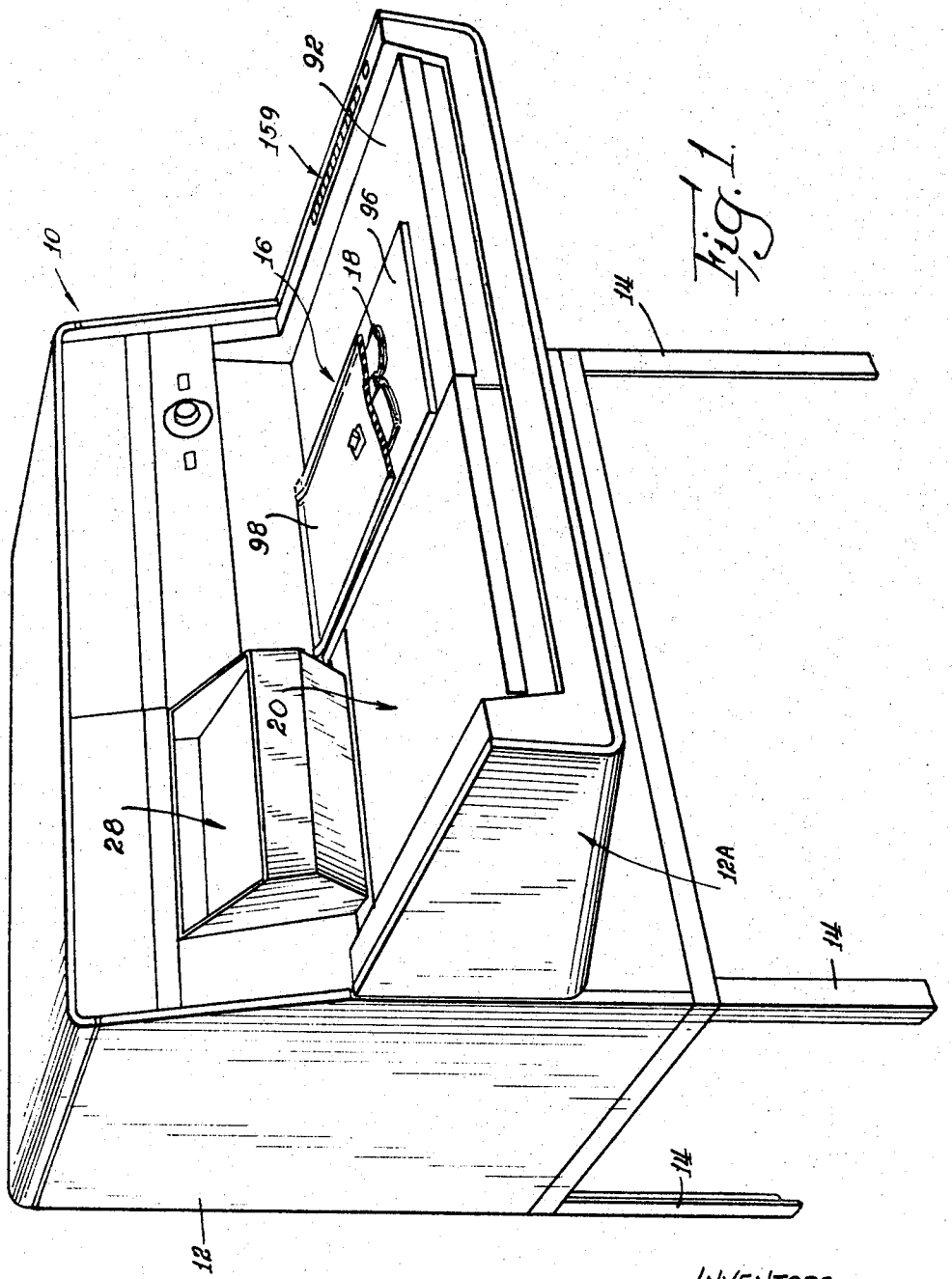


Fig. 1

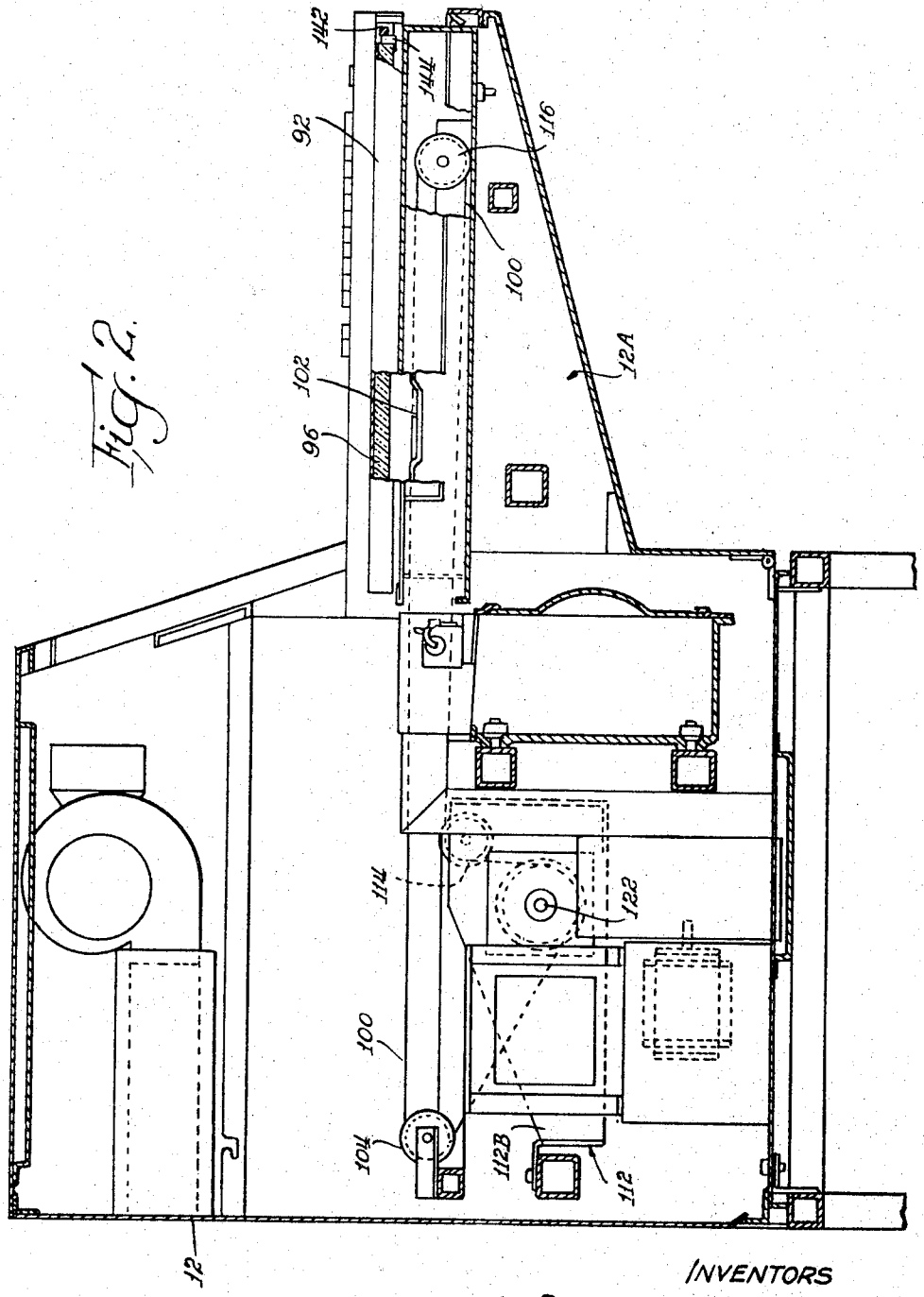
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SAFETY ARRANGEMENT FOR COPYING MACHINE

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Fig. 2.



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SAFETY ARRANGEMENT FOR COPYING MACHINE

Filed April 6, 1966 Sheet 3 of 6

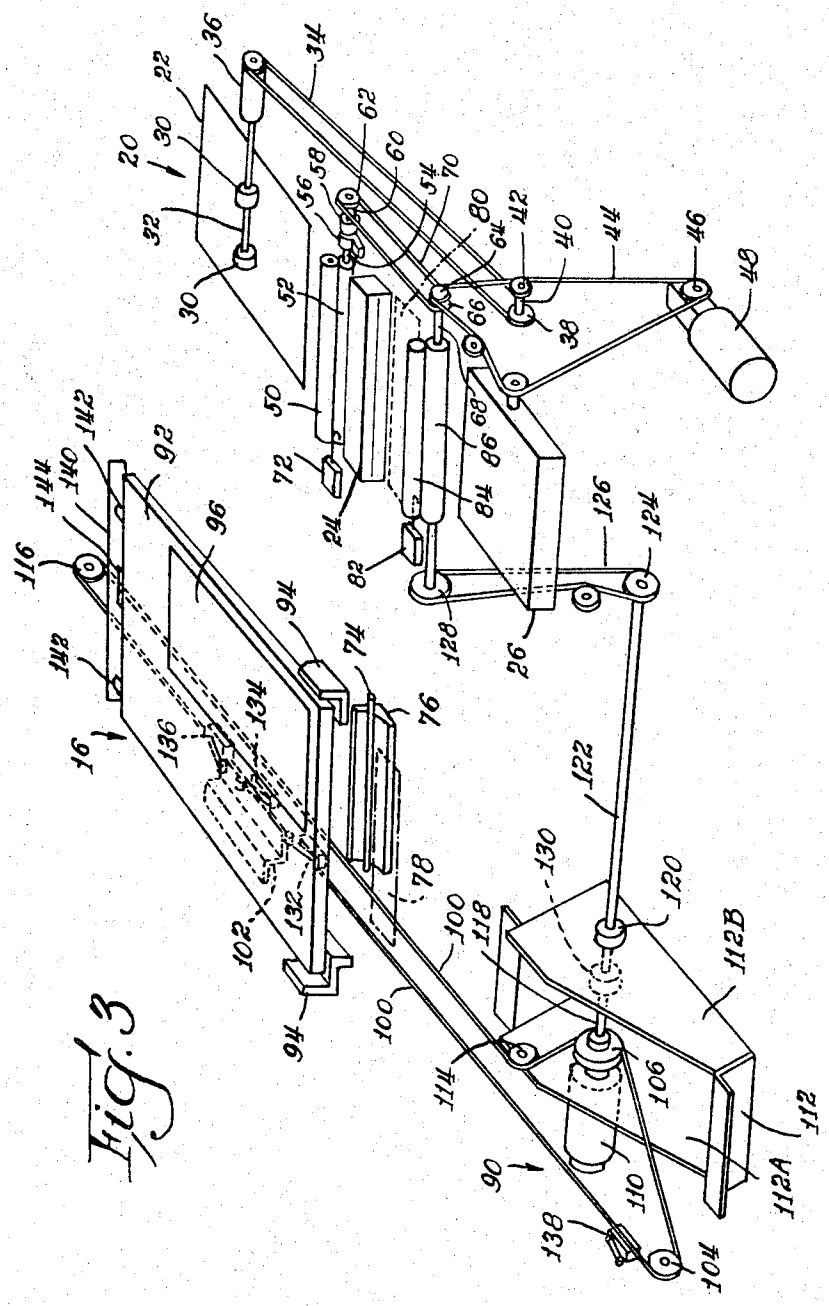


Fig. 3

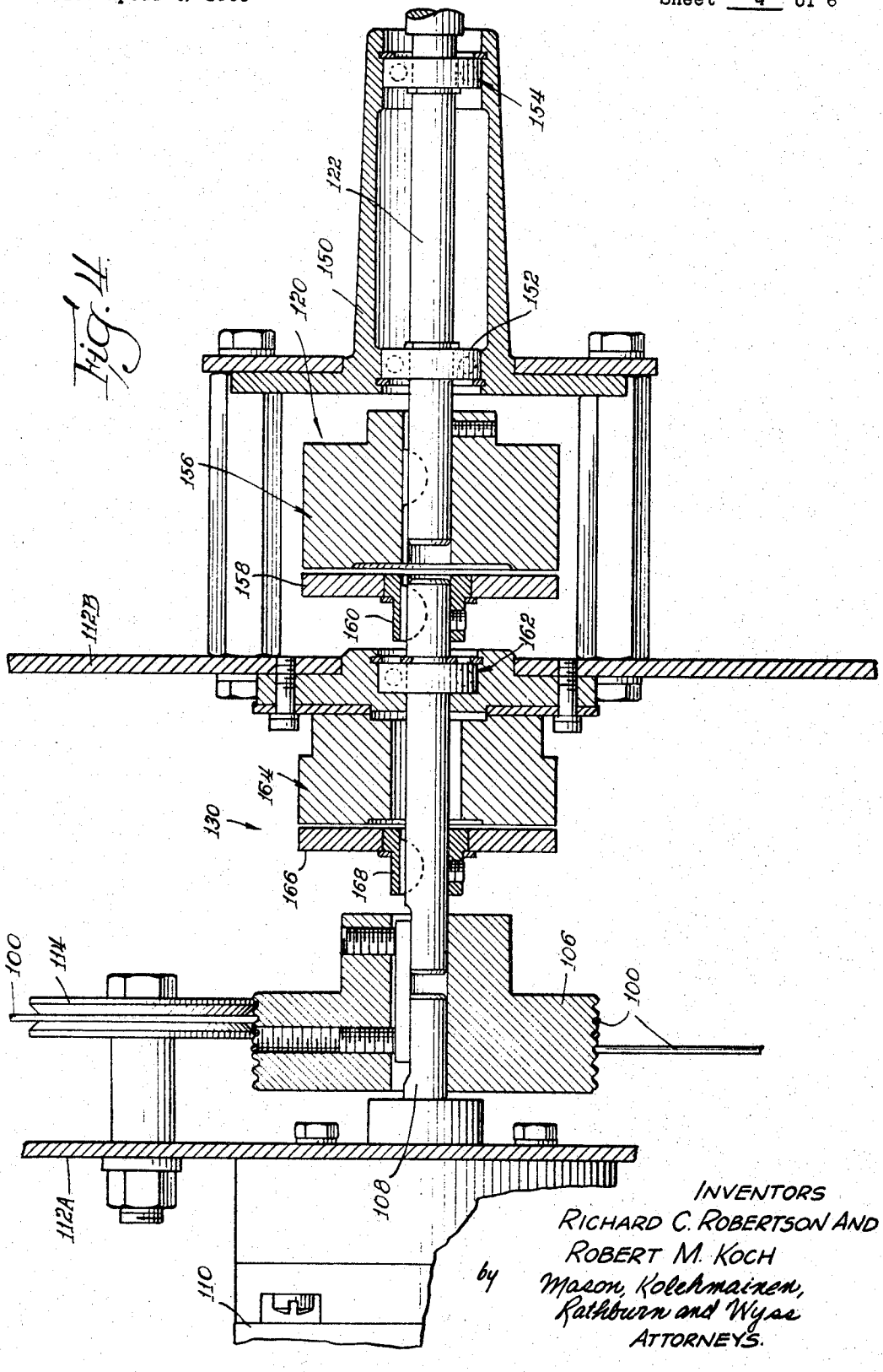
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SAFETY ARRANGEMENT FOR COPYING MACHINE

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Fig. 11



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SAFETY ARRANGEMENT FOR COPYING MACHINE

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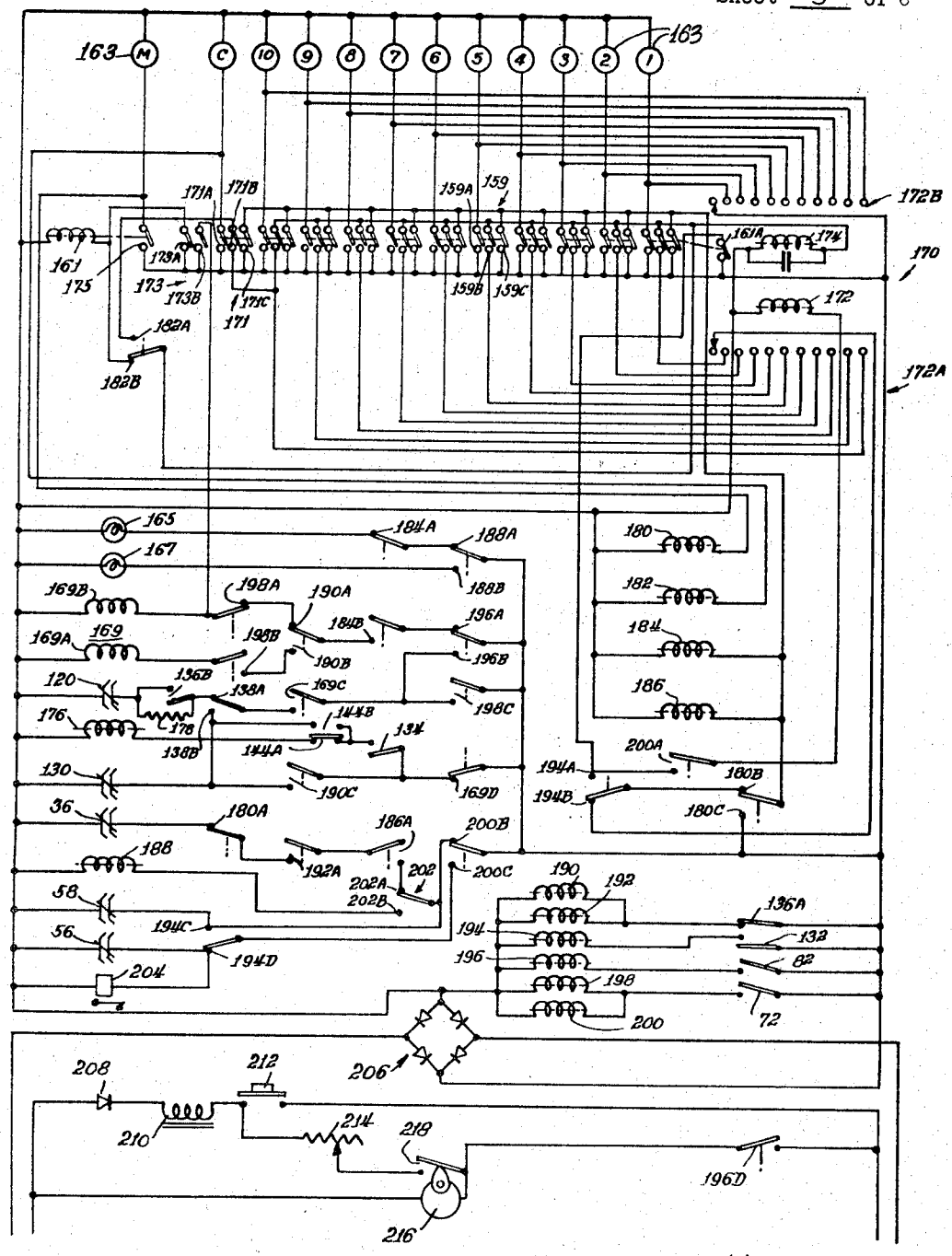


Fig. 5a.

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SAFETY ARRANGEMENT FOR COPYING MACHINE

Filed April 6, 1966 Sheet 6 of 6

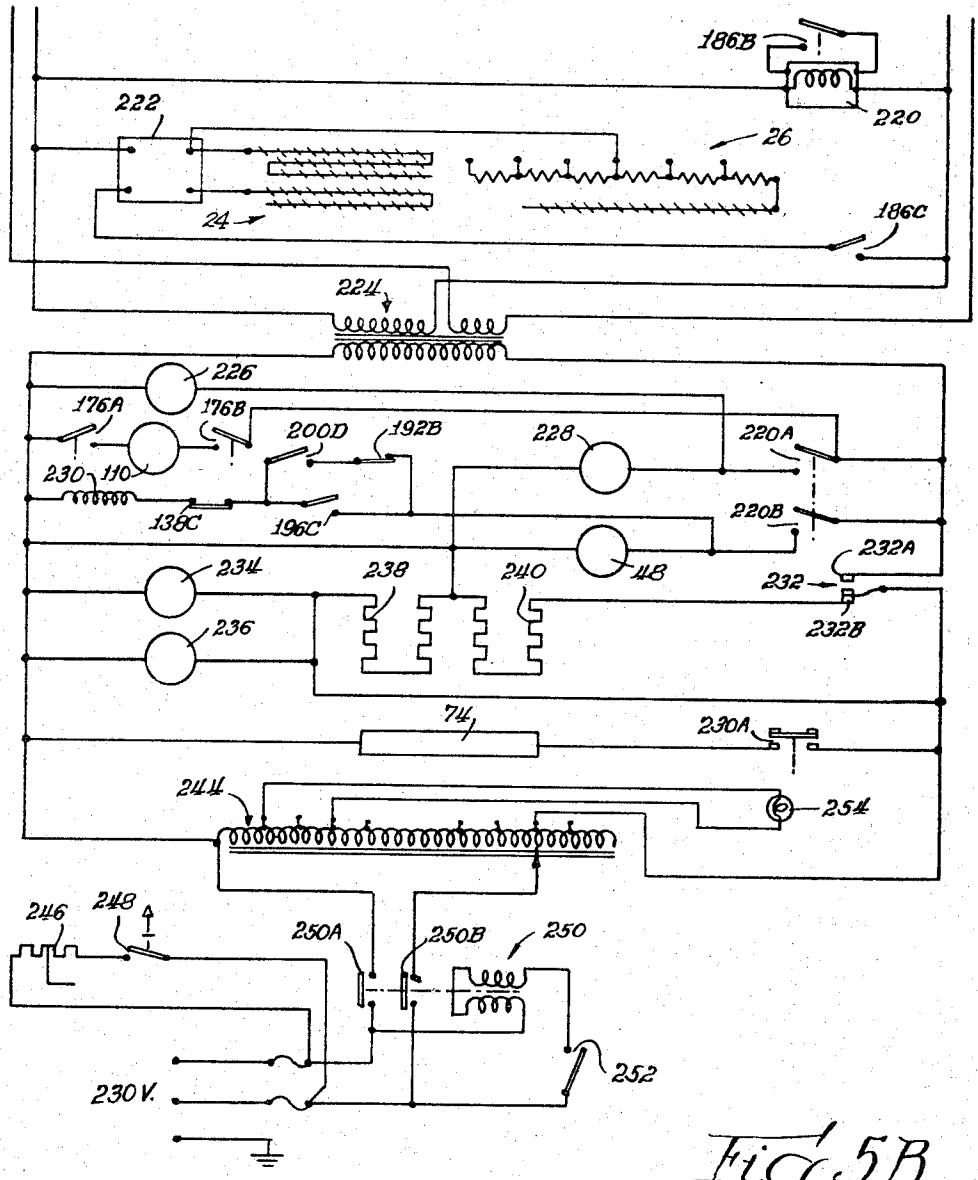


Fig. 5B.

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3,421,816

SAFETY ARRANGEMENT FOR COPYING MACHINE

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Filed Apr. 6, 1966, Ser. No. 540,716
U.S. Cl. 355—8 4 Claims
Int. Cl. G03g

ABSTRACT OF THE DISCLOSURE

The application discloses a photoelectrostatic copying machine in which a table carrying an original to be copied is reciprocated past a scanning station to provide a reflected light image that selectively exposes a charged photoelectrostatic element. The table moves relative to an exposed portion of the machine housing and carries a safety switch that arrests movement of the table when the table strikes an impediment to its movement.

This invention relates to a photoelectrostatic copying machine and, more particularly, to such a machine including new and improved means for selectively exposing a sensitized member in accordance with a graphic original.

One type of known xerographic or photoelectrostatic copying machine selectively exposes a charged member by moving the original through the machine in synchronism with movement of the charged member. This type of machine can be used only with a flexible original, such as sheet material, which can be flexed to permit its feeding through the machine over a path frequently including curved sections. In other known machines adapted for use with inflexible or bulky graphic originals, the original is maintained in a fixed position on an exposure table, and the light image for selectively exposing the charged member is developed either by full frame exposure or by scanning the original with a movable light source. The use of full frame exposure and movable scanning light sources tends to increase the size of the machine or to require optical compensations which are disadvantages in certain applications.

Accordingly, one object of the present invention is to provide a new and improved photoelectrostatic copying machine.

Another object is to provide a photoelectrostatic copying machine in which a light image of even bulky or inflexible graphic originals can be developed by moving the original relative to the scanning or optical system.

Another object is to provide a photoelectrostatic copying machine in which a charged member is moved in a synchronized relation with the reciprocation of an original supporting frame past an illuminating or scanning area.

A further object is to provide a photoelectrostatic copying machine including new and improved means for effectively controlling the reciprocating movement of an original supporting frame.

A further object is to provide a photoelectrostatic copying machine having an exposure system spaced generally parallel to the illuminating and exposing areas, an original supporting frame horizontally reciprocable adjacent the illuminating area, and drive means for feeding the charged image receiving surface past the exposing area in synchronism with the reciprocation of the frame.

Another object is to provide a new and improved method of making copies in which the original is reciprocated over a fixed path.

In accordance with these and many other objects, an

embodiment of the invention comprises a photoelectrostatic copying machine having a housing containing an exposing system with an illuminating area at which a graphic original is illuminated to provide a reflected light image that is directed to impinge on a charged photoelectrostatic member at an exposing area. The member, which can comprise a sheet of copy paper, is fed from a supply thereof through a charging station at which a uniform electrostatic charge is imparted to one or both of its surfaces. This sheet is then fed in synchronism with the movement of the graphic original to be copied past the exposure area at which the light image selectively discharges the charged surface to define a latent electrostatic image. The sheet is then transported through a developer station in which the electrostatic image is converted to a loose powder image and is then forwarded through a fuser unit in which the powder image is placed in a permanent form. The copy sheet is then discharged from the machine.

In accordance with the present invention, the assembly for scanning and selectively illuminating the graphic original comprises a supporting frame, platen, or table normally disposed outside the machine housing. The table is mounted for reciprocating and generally horizontal movement on the housing in a direction generally parallel to the illuminating area. The original supporting frame or table is coupled to drive means for the copy sheet during movement in a scanning direction and is driven in a reverse direction for return to its normal position by a separate drive means independent of the drive means for the copy sheet. A plurality of switches disposed along the path of movement are actuated in accordance with the position of the supporting frame to synchronize the movement of the frame with the operation of the copying machine. A control circuit actuated at least in part by these switches controls the various drive means to insure movement of the copy sheet and the frame to aligned positions relative to the illuminating and exposing areas to thereafter insure synchronized movement of the frame and the copy sheet during the selective exposure of the copy sheet.

Many other objects and advantages of the present invention will become apparent from considering the following detailed description in conjunction with the drawings in which:

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

FIG. 2 is a sectional view through the copying machine illustrating a shiftable original supporting frame and drive means therefor;

FIG. 3 is a schematic drawing illustrating the drive system for moving the original supporting frame and a copy sheet in a synchronized relation with each other;

FIG. 4 is an enlarged sectional view of a drive assembly for the original supporting frame or table; and

FIGS. 5A and 5B, when positioned one above the other, form a schematic circuit diagram of a control circuit for controlling the operation of the copying machine.

Referring now more specifically to FIGS. 1–3 of the drawings, therein is illustrated a copy making machine **10** which embodies the present invention and which includes a housing **12** supported on a plurality of floor engaging legs **14**. The housing **12** includes a forwardly extending table or shelf portion **12A** having on its right side (FIG. 1) a slidably mounted assembly **16** for receiving a graphic original **18** such as a book from which a copy is to be made. The assembly **16** is reciprocated into and out of the housing **12** to permit the graphic original **18** to be scanned to develop a corresponding light image. The left side of the table or shelf portion **12A** of the housing **12** and the aligned portion of the housing **12**

include a copy sheet feeding assembly 20 which feeds a photoelectrostatic copy sheet 22 (FIG. 3) in synchronism with the moving original 18 through a charging station 24 to receive a uniform electrostatic charge. This sheet is then moved past an exposing area in synchronism with the movement of the original 18 so that the charged surface is selectively discharged in accordance with the light image developed by scanning the original, thereby producing a latent electrostatic image. The copy sheet 22 is then fed through a developer station 26 in which the latent image is developed into a powder image, and subsequent movement of the copy sheet 22 carries this sheet into a fixing or fusing station in which the loose powder image is placed in permanent form. A completed copy is discharged into a copy receiving tray or receptacle 28 (FIG. 1) disposed at the front of the housing 12 above the sheet feeding assembly 20.

The units including the sheet feeding assembly 20, the corona charging assembly 24, the developer station or assembly 26, the fixing station (not shown), as well as the various means for transporting the copy sheet 22 are substantially identical to the similar components shown and described in detail in the copending application of John L. Tregay et al., Ser. No. 389,037, filed Aug. 12, 1964, which application is assigned to the same assignee as the present application. Accordingly, these portions of the copying machine 10 are shown in schematic form, and their construction and operation is described only to the extent necessary to an understanding of the present invention. More specifically, the assembly 20 includes a receptacle or tray containing a stack of photoelectrostatic copy sheets 22 (FIG. 3). A pair of drive rollers 30 secured to a shaft 32 rest on the uppermost copy sheet 22 to provide means for feeding a single copy sheet 22 from the assembly 20 into the copying machine 10. One end of the shaft 32 is coupled to a drive belt 34 through an electrically controlled clutch 36. The drive belt or chain 34 passes around a drive pulley or sprocket 38 connected by a shaft 40 to a pulley or sprocket 42 which is rotated by a drive chain or belt 44 passing around a drive pulley or sprocket 46 which is driven by a main drive motor 48 for the machine 10.

Accordingly, whenever the clutch 36 is rendered effective to couple the shaft 32 to the drive belt 34, the sheet engaging rollers 30 advance the uppermost copy sheet 22 toward the nip between a pair of feed rollers 50 and 52. The roller 50 is biased against the roller 52 which is secured to a shaft 54. A combined clutch-brake unit including an electrically controllable brake 56 and electrically controlled clutch 58 selectively controls rotation of the shaft 54. Energization of the brake unit 56 arrests rotation of the shaft 54. Energization of the clutch unit 58 couples the shaft 54 to a shaft 60 conneced to a gear or pulley 62 that is continuously rotated by the main drive motor 48 through the belt or chain 44, a pair of pulleys 64 and 66 secured to one end of a shaft 68, and a drive belt or chain 70. The brake 56 is released, and the clutch 58 is energized when the rollers 30 feed the leading edge of the copy sheet 22 into the nip between the rollers 50 and 52. The rotating rollers 50 and 52 advance the leading edge of the copy sheet 22 through the nip toward the charging station 24 so that the leading edge of the copy sheet 22 engages and actuates a control switch 72. The operation of the switch 72 releases the clutch 36 to terminate rotation of the feed rollers 30, energizes the brake 56 to stop movement of the shaft 54, and releases the clutch 58 to interrupt the driving connection between the shafts 54 and 60. The copy sheet remains in this position until the assembly 16 moves the original 18 to a proper position relative to an exposing assembly or system.

The exposing assembly or system is substantially identical to that shown in the above-identified disclosure and includes a line light source 74 disposed adjacent a reflector 76 to focus light on an illuminating area 78 disposed in the path of movement of the original 18 on the assembly 16. The light reflected from the original 18 is transmitted by an optical system including, for instance, reflective surfaces and lenses, to an exposing area 80. The areas 78 and 80 preferably are spaced apart and disposed in substantially parallel and horizontal planes. When movement of the assembly 16 places the original 18 at a predetermined position relative to the illuminating area 78, the brake 56 is released, and the clutch 58 is energized so that the rollers 50 and 52 feed the copy sheet 22 through the charging station 24 in which it receives a uniform electrostatic charge. As the leading edge of the sheet 22 leaves the charging station 24, an additional control switch 82 is actuated.

The copy sheet 22 now moves over the exposing area 80 in synchronized relation with movement of the original 18 past the illuminating area 78 so that the uniform electrostatic charge on the copy sheet 22 is dissipated in accordance with the received light image to provide an electrostatic image. The leading edge of the copy sheet 22 then passes into the nip between a pair of rollers 84 and 86 to be advanced to the developer station 26. The roller 86 is secured to the shaft 68 and is continuously rotated by the motor 48 through the belt 44 and the pulley 64. The rollers 84 and 86 advance the copy sheet 22 through the developer station 26 in which the electrostatic image is converted to the powder image. The sheet 22 is then conveyed to a fixing station (not shown) such as a heating means disclosed in the above-identified disclosure in which the loose powder image is placed in a permanent form. As the trailing edge of the copy sheet 22 passes beyond the switches 72 and 82, these switches are released. When the original 18 has been completely scanned, the assembly 16 is returned to its normal position.

Referring now more specifically to the original supporting and moving assembly 16, this assembly is moved by a drive means indicated generally as 90 (FIG. 3) to a position in which the original 18 is disposed adjacent the illuminating area 78, and the assembly is thereafter moved in synchronism with the movement of the copy sheet 22 past the exposing area 80 to develop a light image for selectively discharging the charged surface of the copy sheet 22. The assembly 16 includes a supporting table or frame 92 (FIGS. 1–3) which is slidably mounted on the housing 12 and the shelf portion 12A for generally horizontal reciprocating movement in a plane generally parallel to the illuminating area 78 and the exposing area 80. The table 92 is slidably supported by any suitable means such as a pair of guideways 94 (FIG. 3) carried on the housing 12. The frame 92 is apertured to receive a transparent member 96, commonly glass, normally covered by a flexible opaque cover member 98 (FIG. 1) that is pivotally mounted to the frame 92 along one edge or at one end of the glass pane 96. When an original 18 is to be copied, it is placed with the material to be copied facing downwardly toward the glass pane 96, and the flexible cover 98 is then placed over the original 18 as illustrated in FIG. 1.

The drive means 90 provides for shifting the table or frame 92 relative to the illuminating area 78 and more particularly between a normal position illustrated in FIG. 3 and a displaced position disposed downwardly and to the left from the illustrated position. The drive means 90 includes a flexible connecting element, such as a wire 100, secured at one end to a bracket 102 that is secured to and depends from the lower surface of the frame 92. The wire 100 passes around a pulley 104 (FIGS. 2 and 3) secured to the housing 12, and several convolutions of the wire 100 pass around a pulley 106 which is provided with a helical groove and which is secured to one end of a shaft 108 (FIG. 4) of a return motor 110. The motor 110 is secured to a wall 112A of a supporting frame 112 carried on the housing 12. The wire 100 then passes around a pulley 114 carried on the wall 112A and an ad-

ditional pulley **116** rotatably mounted on the projecting portion **12A** of the housing **12** so that the other end of the wire **100** can be secured to a forward portion of the bracket **102**. The direction of rotation of the motor **110** is such that the grooved pulley **106** rotates in a clockwise direction to move the table **92** from left to right in FIG. 3. This movement returns the table **92** from a displaced position, which can be different for different lengths of copy sheets **22**, at a speed greater than the speed at which the table **92** is moved from right to left (FIG. 3) during scanning to reduce the cycle time necessary for each copy.

To provide means for moving the table **92** from right to left in FIG. 3 in synchronism with and preferably at the same speed as the copy sheet **22**, the wire **100** is driven by the motor **48** which also actuates the drive system for the copy sheet **22**. More specifically, a shaft **118** which is rigidly secured to the pulley **106** extends into an electrically controlled clutch assembly **120** in which terminates one end of a shaft **122**. The other end of the shaft **122** carries a drive pulley **124** which is coupled by a belt **126** to a pulley **128** that is secured to one end of the shaft **68**. As set forth above, the shaft **68** is driven by the motor **48** in synchronism with the rotation of the rollers **50**, **52**, **84**, and **86**. Thus, the shaft **122** is rotated in a counterclockwise direction in synchronism with the rotation of the feeding means for the copy sheet **22**. When the clutch **120** is energized to couple the shaft **122** to the shaft **118**, the pulley **106** is rotated in a counterclockwise direction, and the upper length of the wire **100** is moved from left to right to move the frame **92** in the same direction. The assembly **90** also includes an electrically controlled brake **130** which, when energized, arrests movement of the shaft **118** and thus stops rotation of the pulley **106** to stop the frame **92** in a predetermined position. The brake **130** is normally applied to lock the table **96** against movement. This is desirable because the positioning of articles to be copied, such as heavy books, on the table **96** might displace this table from its normal position.

To control the synchronized movement of the table **92** and the copy sheet **22**, the machine **10** includes a plurality of switches actuated in dependence on the position of the table **92**. More specifically, three switches **132**, **134**, and **136** are normally maintained in a closed or operated condition by engagement with the depending bracket **102** when the table **92** is in its normal position. The switches **136**, **134**, and **132** are released in this sequence as the table **92** moves from right to left and are operated in the reverse order when the table returns to a normal position moving from left to right. A normally open switch **138** is actuated if the table **92** moves too far to the left and provides a limit switch.

To prevent any possibility of injury to the operator during return movement of the table **92** to its normal position, the edge of this table positioned most closely to the operator, i.e., the forward edge of the table **92** (FIG. 1) is provided with a bumper of resilient material within which is disposed a bar or plate **140** (FIG. 3) slidably mounted on the table **92** by a pair of rods **142**. The bar or operator **140** is resiliently biased to its outer position. If an obstruction is encountered during movement of the table **92**, the bar **140** is depressed against the resilient bias and actuates a switch **144**. This actuation of the switch **144** immediately arrests movement of the table **92**.

FIG. 4 of the drawings illustrates the details of the drive assembly or drive means **90**. The shaft **122** which is continuously rotated through the drive system actuated by the motor **48** is rotatably mounted on a wall **112B** on the frame of the wall **112** by supporting structure **150** carrying a plurality of sets of bearings **152** and **154**. The inner end of the shaft **122** is keyed to a combined winding and field structure **156** in the clutch assembly **120**. The clutch assembly **120** also includes a generally circular magnetic plate **158** which is mounted on a sleeve **160** that is keyed to one end of the shaft **118**. The shaft **118** is rotatably mounted on the wall **112B** by a bearing assembly **162**. When the winding in the assembly **156** is energized, the magnetic plate **158** is coupled to the field structure of the assembly **156**, and the shafts **122** and **118** are coupled for rotation.

The brake assembly **130** includes a combined field structure and winding assembly **164** which is rigidly secured to the supporting wall **112B**. This assembly also includes a generally circular and magnetic member **166** carried by a sleeve **168** that is keyed or otherwise secured to the shaft **118**. The shaft **118**, as set forth above, is rigidly secured to the pulley **106**. Whenever the winding in the assembly **164** is energized, the field attracts the member **166** toward the field structure of the assembly **164** and thus couples the shaft **118** to the frame **112** and arrests rotation of the pulley **106**.

FIGS 5A and 5B of the drawings illustrate a control circuit for controlling the operation of the machine **10**. In the normal or off condition of the machine, a heater **246** (FIG. 5B) is intermittently connected across an alternating current input line by a humidity controlled switch **248**. The heater **246** and the humidity switch **248** are disposed within the enclosure for the paper feeding assembly **20** and serve to maintain the copy sheets **22** at uniform humidity. The heater **246** and the switch **248** are effective to control the humidity within the enclosure for the copy sheets **22** independent of the on or off condition of the machine **10**.

When the machine is to be placed in operation, a start switch **252** is closed so that the windings of a start relay **250** are energized to close two pairs of contacts **250A** and **250B**. The closure of these contacts energizes an input power transformer **244** to supply power to the machine **10**. The energization of the input transformer or autotransformer causes the illumination of a lamp **254** to provide a visible indication of the on condition of the machine.

The application of power to the input transformer **244** energizes a pair of motors **234** and **236**. The motor **234** drives a conveying mechanism (not shown) for conveying the copy sheets containing the powder image through the fixing or fuser station. The motor **236** operates a blower for the fuser station. The application of power to the machine **10** also directly energizes a heater **238** and energizes an additional heater **240** through a temperature responsive switch **232** including a pair of normally closed contacts **232B**. When the temperature at the fusing station reaches a predetermined level, the temperature responsive switch **232** opens the contacts **232B** and closes a pair of normally open contacts **232A**. The opening of the contacts **232B** terminates the energization of the heater **240** so that only the heater **238** remains effective. The closure of the contacts **232A** forwards alternating current power to a transformer **224** for supplying power to other parts of the control circuit.

One output of the transformer **224** is connected across a fullwave rectifier bridge **206** (FIG. 5A) so that direct current power is made available to an additional portion of the control circuit. As set forth above, the switches **132**, **134**, and **136** are normally maintained in an operated conditioin by the table **92** in its normal position, and these switches are shown in their operated condition. The switches **132** and **134** each includes a pair of contacts normally held in open condition, and the switch **136** includes a pair of normally open contacts **136B** and a pair of normally closed contacts **136A**. The closed contacts **136A** complete an energizing circuit for the windings of two relays **190** and **192**. When the relay **190** is operated, a pair of contacts **190A** are opened to interrupt one part of an energizing circuit for one winding **169B** of a mechanical latching relay **169**, and a pair of contacts **190B** are closed to prepare a portion of an operating circuit for a second winding **169A** on the relay **169**. The closure of a pair of contacts **190C** when the relay **190**

is operated energizes the winding of the brake assembly **130** so that the rotation of the pulley **106** is arrested. Thus, the frame or table **92** for the original **18** is braked or held in its normal home position. The closure of a pair of contacts **192A** when the relay **192** is operated prepares an operating circuit for the clutch **36** which controls the feeding of copy sheets **22** into the machine **10** from the assembly **20**, and the opening of a pair of contacts **192B** interrupts a portion of one operating circuit for a lamp relay **230** that controls the energization of the lamp **74**. The connection of power to the bridge **206** also illuminates a lamp **165** over a circuit including two pairs of normally closed contacts **184A** and **188A** to provide a visible indication that the machine **10** is prepared for selection of the number of copies to be produced.

The machine **10** includes a switch **202** which is operated to a position closing a pair of contacts **202A** when an adequate supply of copy sheets **22** are in the assembly **20**. Alternatively, when an insufficient supply of copy sheets is provided, the switch **202** is operated to a condition in which the contacts **202A** are opened, and a pair of contacts **202B** are closed. The closure of the contacts **202B** completes an energizing circuit for the winding of a relay **188** over a circuit including a pair of normally closed contacts **200B** to operate the relay **188**. When this relay is operated, the contacts **188A** are opened, and a pair of contacts **188B** are closed. This terminates the illumination of the lamp **165** to provide a visible indication that the machine **10** is not ready for reproduction and completes a circuit for energizing a lamp **167** which provides a visible indication that the supply of copy sheets **22** has been depleted.

To prepare the machine for producing copies, the graphic original **18** is placed on the table **92** beneath the flexible cover **98** and overlying the transparent pane **96**. The machine can then be conditioned for automatic reproduction of a desired number of copies by manually actuating one of a plurality of mechanically interlocked push buttons **159** (FIGS. 1 and 5A) carried on the right-hand portion of the projection **12A** from the housing **12**. Each of these push buttons contains an individual illuminating lamp **163** (FIG. 5A) and three normally open contacts **159A**, **159B**, and **159C**. Assuming that the switch **159** representing five copies is depressed to prepare the machine **10** for automatically producing five copies of the original **18**, the three pairs of contacts designated as **159A**, **159B**, and **159C** in FIG. 5A of the drawings are closed. The closure of the contacts **159B** connects a reset coil or solenoid **174** in a stepping switch **170** which counts the number of copies produced by the machine **10** to the fifth contact in a contact bank **172A** in this counting switch, thereby preparing a circuit for restoring the switch **170** to a normal position. The closure of the contacts **159B** also connects the fifth contact in the bank **172A** to the winding of a push button reset solenoid **161** over a circuit including a pair of normally closed contacts **182B**. When the solenoid **161** is energized, a detent mechanism for holding an operated one of the push buttons in an operated condition is released to restore all of the push buttons to a normal state. The closure of the contacts **159A** completes an obvious circuit for illuminating the lamp **163** associated with the "5" push button to provide a visible indication of the number of copies selected. The closure of the contacts **159C** completes an energizing circuit for a pair of relays **184** and **186** as well as connecting one terminal of the bridge **206** over a circuit including a plurality of normally closed contacts **180B** and **194B** to the wiper of the contact bank **172A**.

The operation of the relay **184** opens the contacts **184A** to terminate the illumination of the lamp **165** and provide a visible indication that the copy selection has been made. The operation of the relay **184** also closes a pair of contacts **184B** to prepare a portion of an operating circuit for the windings **169A** and **169B** on the latching relay **169**. The operation of the relay **186** closes a pair of contacts **186B** (FIG. 5B) in a time delay circuit associated with a relay **220** to operate this relay and to provide the time delay interval described in detail in the above-identified disclosure. The operation of the relay **220** closes a plurality of contacts **220A** and **220B** (FIG. 5B). The closure of these contacts completes an obvious energizing circuit for the main drive motor **48** and for two additional motors **226** and **228**. The motor **226** operates a blower used in feeding copy sheets from a developer station **224** to the fusing station. The blower **228** provides a blower for cooling the lamp **74**. The energization of the main drive motor **48** places the drive system and drive means operated by this motor in operation.

The operation of the relay **186** also closes a pair of contacts **186C** (FIG. 5B) so that a power supply **222** is rendered effective to energize corona discharge wires at the charging station **24** and an additional corona discharge wire providing developer bias in the developer station **26**. The closure of the contacts **186A** upon operation of the relay **186** completes an energizing circuit for the feeder clutch **36** extending through the closed contacts **180A**, **192A**, **186A**, **202A**, and **200B**. Since this circuit includes the contacts **192A** closed by the relay **192** when the table **92** is in its normal position, the operation of the machine **10** cannot be initiated when the table **92** is away from its normal position. The energization of the clutch **36** renders the feeder wheels **30** (FIG. 3) effective to advance a copy sheet **22** into the nip between the rollers **50** and **52**. The clutch **58** for driving the rollers **50**, **52** is now energized over a circuit including the closed contacts **200B** so that these rollers receive the leading edge of the copy sheet fed by the rollers **30** and advances it to a position disposed adjacent the corona discharge unit **24** to actuate the switch **72**. The actuation of the switch **72** indicates that a copy sheet **22** is in position for a copying operation.

The closure of the switch **72** completes an energizing circuit for the windings of two relays **198** and **200**. When the relay **200** operates, two pairs of contacts **200A** and **200C** are closed, and the contacts **200B** are opened. The closure of the contacts **200A** prepares a circuit for energizing the motor magnet **172** for the stepping switch **170**. The opening of the contacts **200B** interrupts the above-described circuits for the clutch windings **36** and **58** so that the feeder wheels **30** no longer advance the copy sheet and the rollers **50** and **52** are no longer rotated. This stops the copy sheet **22** in a predetermined position approaching the entry to the corona charging unit **24**. The closure of the contacts **200C** completes a circuit over a pair of normally closed contacts **194D** for energizing the brake **56** to arrest rotation of the shaft **54** and that of the rollers **50** and **52** with the copy sheet **22** in the desired position. The closure of the contacts **200C** also operates a solenoid in a mechanical counter **204** which provides a running total of the number of copies produced by the machine **10**. The closure of the contacts **200D** prepares a circuit including the closed contacts **220B** and a pair of contacts **138C** on the limit switch **138** for operating a lamp relay **230**, which circuit is interrupted at the open contacts **192B**.

The operation of the relay **198** opens the contacts **198A** and closes a plurality of contacts **198B** and **198C**. The opening of the contacts **198A** interrupts another point in the circuit for the winding **169B** of the latching relay **169**, and the closure of the contacts **198B** completes an energizing circuit including the closed contacts **196A**, **184B**, **190B**, and **198B** for energizing the winding **169A** of the latching relay **169**. This operation of the relay **169** closes a pair of contacts **169C** and opens a pair of contacts **169D**. The opening of the contacts **169D** interrupts a circuit for energizing the brake **130** for the pulley **106** so that this pulley is now freed for rotation. The closure of the contacts **169C** completes a circuit includ-

ing the closed contacts 198C, 138A, and a series connected resistance element 178 for energizing the clutch 120. The low level energization of the clutch 120 resulting from the series resistor 178 provides a slipping coupling between the shaft 122 and the shaft 118 so that the pulley 106 is slowly rotated in a counterclockwise direction to slowly advance the table 92 to bring the leading edge of the original 18 to a position adjacent the illuminating area 78.

As the table 92 moves away from its normal position, the switch 136 is restored to its normal condition. In doing so, the contacts 136A are opened to interrupt the operating circuit for the relays 190 and 192, and the contacts 136B are closed to provide a shunt around the series resistance 178. This provides full energization of the winding in the clutch 120 and increases the speed at which the table 92 is driven. The full or complete clutching of the shaft 122 to the shaft 118 insures that the table 92 moves the original 18 past the illuminating area 78 in a synchronized relation with the movement of the copy sheet 22 past the exposing area 80 under the control of the drive system actuated by the motor 48.

The release of the relay 190 closes the contacts 190A and opens the contacts 190B and 190C. The opening of the contacts 190B interrupts the above-described energizing circuit for the winding 169A of the latching relay 169. Since this relay is latched in either of its two alternate conditions, the contacts 169C remain closed, and the contacts 169B remain opened. The closure of the contacts 190A prepares a circuit for energizing the winding 169B of the relay 169, but this energizing circuit is interrupted at the open contacts 198A. The opening of the contacts 190C interrupts an additional point in the energizing circuit for the winding of the brake 130.

When the relay 192 is released, the contacts 192A are opened, and the contacts 192B are closed. The opening of the contacts 192A interrupts an additional point in the circuit for energizing the winding of the feeder clutch 36. The closure of the contacts 192B coupled with the prior closure of the contacts 200D when the copy sheet is advanced to its ready position completes a circuit including the closed contacts 220B, 192B, 200D, and 138C for energizing the winding of a lamp relay 230. When the relay 230 is operated, a pair of contacts 230A are opened to energize the lamp 74. Thus, the lamp 74 is now illuminated to prepare the exposure system for operation.

As the table or frame 92 moves through its next increment of movement, the switch 134 is released to close the contacts 134. The closure of the contacts 134 prepares an operating circuit for a control relay 176 which controls the energization of the return drive motor 110. However, this circuit is interrupted at the open contacts 169B.

As the table or original supporting frame 92 approaches the illuminating area 78, the switch 132 is released to close a pair of normally open contacts which energize the winding of a relay 194. When the relay 194 is operated the contacts 194B are opened to interrupt the connection to the wiper for the switch bank 172A and a pair of contacts 194A are closed to provide an energizing circuit for the motor magnet 172. The switch 170 is an indirect drive switch and is spring advanced when the motor magnet 172 is released. A pair of contacts 161A are momentarily closed by operating any of the push buttons 159 and serve to hold the magnet 172 energized if the push buttons are operated to change the number of copies in an order after the machine 10 has been started. The operation of the relay 194 also opens the contacts 194D and closes a pair of contacts 194C. The opening of the contacts 194D releases the counter 204 and the brake 56 and the closure of the contacts 194C energizes the clutch 58 so that movement of the copy sheet 22 is initiated.

The rotation of the drive rolls 50 and 52 now advances the leading portion of the copy sheet through the charging station 24 in which one or both surfaces receive a uniform electrostatic charge. When the charged sheet leaves the charging station 24 and passes over the exposure area 80 the switch 82 is operated to complete an energizing circuit for a winding of a relay 196. When the relay 196 is operated the contacts 196A are opened to interrupt an additional point in the energizing circuit for the winding 169A of the relay 169. The closure of a pair of contacts 196B when the relay 196 operates completes an alternative circuit for maintaining the energization of the clutch 120. The closure of the contacts 196C (FIG. 5B) completes an alternative circuit including the closed contacts 220B and 138C for maintaining the energization of the winding of the lamp relay 230. The closure of the contacts 196D energizes a motor 216 driving a cam which periodically closes a pair of contacts 218. This energizes a vibrator winding 210 through a potentiometer 214 and a rectifier 208. The vibrator winding 210 forms a portion of a toner dispenser and is periodically energized under the control of the timer motor 216 to dispense additional toner to the developer station 26 in dependence on the linear length of copy sheets 22 fed through the machine 10. A push button 212 provides an alternate means for manually controlling the dispensing of toner.

The graphic original 18 on the table 92 and the copy sheet 22 are now advanced past the illuminating area 78 and the exposing area 80 in synchronism with each other by means of the drive system actuated by the motor 48. As the trailing edge of the copy sheet 22 passes beyond the switch 72, this switch is released to release the relays 198 and 200. The release of the relays 198 and 200 restores the contacts controlled thereby to their normal condition, and, in doing so, prepares the control circuit for the next copying operation. When the relay 200 releases to open the contacts 200A, the energizing circuit for the motor magnet 172 is interrupted, and the switch 170 releases to advance the wipers in the contact banks 172A and 172B a single step from their normal home position to a first position representing the first copy produced by the machine 10. Since the push button switching assembly 159 representing five copies has been actuated, this movement of the wiper in the switch bank 172A does not produce any useful function. However, the wiper in the bank 172B completes an obvious circuit for energizing the lamp 163 representing a single copy. Thus, the push button "1" is illuminated to provide a visible indication that the first copy of the five copies requested has been produced.

As the trailing edge of the copy sheet 22 passes beyond the charging station 24, thus indicating that the original 18 has been moved past the illuminating area 78 and that the copy sheet 22 has been fully exposed at the exposing area 80, the switch 82 is released to interrupt the operating circuit for the relay 196. This releases the relay 196 and prepares the machine 10 for returning the table 92 to its normal position and for continuing the feeding of the exposed copy sheet 22 through the machine to be ejected into the copy receiving receptacle or tray 28. The switch 82 is released at different times in dependence on the length of the copy sheet 22. Thus, the return of the table 92 to its normal position is started at different points in its forward or scanning movement in dependence on the length of the copy sheet 22, or, indirectly, on the length of the original to be copied. The control exercised by the release of the switch 82 could also be exerted by switches actuated by movement of the table 92 to different positions corresponding to the different lengths of the copy sheets 22.

When the relay 196 is released, the opening of the contacts 196C (FIG. 5B) interrupts the operating circuit for the lamp relay 230 so that this relay releases to open the contacts 230A. This terminates the illumination of the lamp. The opening of the contacts 196B, the contacts 198C having been previously opened, interrupts the energizing circuit for the winding in the clutch assembly 120 so that the shaft 118 is no longer clutched to the shaft 122. Thus, the table 92 is no longer driven in its forward

direction by the drive system actuated by the motor **48**. The closure of the contacts **196A** completes a circuit for energizing the winding **169B** of the latching relay **169**, this circuit extending through the closed contacts **196A**, **184B**, **190A**, and **198A**.

When the winding **169B** of the latching relay **169** is actuated, the contacts **169C** are opened, and the contacts **169D** are closed. The opening of the contacts **169C** interrupts an additional point in the previously interrupted circuit for the winding in the clutch assembly **120**. The closure of the contacts **169D** completes a circuit extending through the closed switch **134**, and the closed contacts **144A** on the safety switch **144** for energizing the winding of the relay **176**. On operating, the relay **176** closes two pairs of normally open contacts **176A** and **176B** (FIG. 5B) to complete an energizing circuit for the return motor **110**. When the motor **110** is energized, the pulley **106** is rotated in a clockwise direction, and the table **92** moves from left to right (FIG. 3) to return the table toward its normal position. During this interval, the copy sheet **22** continues to move through the machine **10** to complete the development of the electrostatic image and the fixing of the powder image.

As the table **92** moves toward its normal home position, the switch **132** is first opened to interrupt the energizing circuit for the relay **194** so that this relay releases and restores its contacts to their normal positions and conditions the control circuit for another cycle of operation. The switch **134** is next opened to interrupt the above-described energizing circuit for the winding of the relay **176** and this relay is released to open the contacts **176A** and **176B** and to terminate operation of the return motor **110**.

When the table **92** reaches its home position, the switch **136** is operated to close the contacts **136A** and to open the contacts **136B**. The opening of the contacts **136B** removes the shunt around the resistance **178** in the interrupted circuit for energizing the winding in the cltuch **120**. The closure of the contacts **136A** again operates the relays **190** and **192** so that the contacts controlled thereby are moved to their actuated positions. The closure of the contacts **190C** energizes the winding in the brake assembly **130** so that rotation of the shaft **118** and of the drive pulley **106** is damped so that the table **92** comes to a stop. The opening of the contacts **190A** interrupts the energizing circuit for the winding **169B**. However, the contacts **169C** remain open and the contacts **169D** closed because of the mechanical latching arrangement embodied in the relay **169**. The closure of the contacts **192A** once again completes the circuit for the winding in the clutch **36** so that the rollers **30** feed the next copy **22** in the assembly **20** toward the nip between the rotating rollers **50** and **52**.

When the copy sheet **22** being fed by the roller **30** reaches the nip between the rollers **50**, **52** and is advanced to its ready position in which its leading edge engages and operates the switch **72**, the relays **198** and **200** are again operated. The control circuit controls the production of the second copy of the original **18** by reciprocating the platform **92** in synchronism with feeding the selected copy **22** in the manner described above during which the stepping switch **170** is advanced so that the wipers in the banks **172A** and **172B** are advanced to their second positions, thus terminating illumination of the "1" lamp **163** and illuminating the "2" lamp **163** to indicate the production of the second copy.

This operation continues until such time as, during the production of the fifth copy, the trailing edge of the fifth copy sheet **22** passes beyond the switch **72** so that this switch is released to release the relays **198** and **200**. In releasing the relay **200**, the contacts **200A** are again opened to release the motor magnet **172**. At this time, the wipers in the banks **172A** and **172B** advance to their fifth position. The wiper in the bank **172B** energizes the fifth lamp **163** which has been energized through the closed contacts **159A** on the "5" push button **159**. The lighting of only the fifth lamp **163** indicates the completion of the requested number of copies. The wiper in the bank **172A** prepares a circuit for resetting the push buttons and the stepping switch **170**.

More specifically, with the wiper in the bank **172A** in engagement with its fifth contact, the winding of the solenoid **161** and the winding of the reset magnet **174** are connected through the closed contacts **159B** in the fifth push button **159** over the wiper in the bank **172A** to the open contacts **194B** on the relay **194**. When the table **92** moves toward its normal position, the switch **132** is again operated to interrupt the operating circuit for the relay **194**, and this relay releases to close the contacts **194B**. This further connects the windings of the reset solenoid **161** and the reset magnet **174** over the closed contacts **180B** and the closed contacts **159C** on the operated push button **159** to the bridge **206**. When the solenoid **174** is energized, the wipers in the switch banks **172A** and **172B** are restored to their normal condition, which, in turn, interrupts the above-described circuit for energizing the solenoids **161** and **174**. The energization of the solenoid **161** releases the mechanical interlock for the copy selecting push buttons so that the contacts **159A**, **159B**, and **159C** for the selected push button **159** are all released to restore the copy selecting mechanism to its normal condition.

These operations terminate the illumination of the "5" lamp **163** and release the relays **184** and **186**. The release of the relay **186** opens the contacts **186A** to prevent the energization of the clutch **36** and the feeding of an additional copy sheet **22** into the machine **10**. The closure of the contacts **184A** illuminates the lamp **165** to provide a visible indication that the machine **10** is ready for the next copy order. The opening of the contacts **186B** starts the ninety second delay period of the delay circuit associated with the relay **220** so that this relay releases to open the contacts **220A** and **220B** in the event that a copy order is not placed by actuating one of the push buttons **159** within the ninety second time interval. The release of the relay **220** terminates the energization of the motors **48**, **228**, and **226** until such time as their operation is required for the production of additional copies. The opening of the contacts **186C** disables the power supply **222** (FIG. 5B) so that the corona bias and corona charging potentials are no longer supplied to the stations **24** and **26**. The machine **10** remains in this condition until the next copy order is placed by actuating one of the ten push buttons **159**.

As indicated above, the switch **144** provides a safety control to prevent return movement of the platform or table **92** if this return movement is, in any sense, obstructed. When the table **92** strikes an obstruction during return movement, the bar **140** actuates the switch **144** (FIG. 3) so that the normally closed contacts **144A** (FIG. 5A) are opened and a pair of contacts **144B** is closed. The opening of the contacts **144A** interrupts the operating circuit for the relay **176** so that the contacts **176A** and **176B** are opened to terminate energization of the return drive motor **110**. This stops the return drive for the table **92**. The closure of the contacts **144B** energizes the winding in the brake assembly **130** so that rotation of the shaft **118** and thus of the pulley **106** is immediately arrested. Whenever the obstruction to the return of the table or platform **92** is removed so that the switch **144** is released, the closure of the contacts **144A** immediately reoperates the relay **176** to start the return motor **110**, and the opening of the contacts **144B** releases the brake **130**. This emergency arresting of the table return drive does not affect the movement of the copy sheet **22** or the completion of the copy thereon.

As set forth above, the return movement of the frame **92** is normally initiated when the trailing edge of the copy sheet **22** passes the exposing area **80** so that the switch **82** is released to release the relay **196**. However, if the

paper becomes jammed in the machine or if a very long length of copy sheet **22** is fed into the machine, the switch **82** remains actuated beyond the time at which the table **92** reaches its displaced or left-hand (FIG. 3) position. If this occurs, the table **92** engages the operator for the limit switch **138** to operate this switch to open the contacts **138A** and **138C** and to close a pair of normally open contacts **138B**. The opening of the contacts **138A** terminates the energization of the winding in the clutch assembly **120** so that the shaft **118** and the drive pulley **106** are isolated from the rotating shaft **122**, thus stopping forward movement of the frame **92**. The closure of the contacts **138B** energizes the winding in the brake assembly **130** to arrest further forward movement of the table **92**. The opening of the contacts **138C** (FIG. 5B) releases the relay **230** to terminate the energization of the lamp **74** and prevents overheating. When the jam is closed or when the end of the copy sheet **22** passes beyond the switch **82** to release this switch, the table **92** is returned to its normal position in the manner described above, and the switch **138** is released to restore the contacts **138A**, **138B**, and **138C** to their normal positions.

The machine can also be conditioned for manually feeding individual copy sheets **22** into the nip between the rollers **50** and **52** without using the assembly **20**. More specifically, by manually actuating a switch or push button **175**, a circuit is completed for operating a manual control relay **180** which prepares the machine **10** for a manual operation. When the relay **180** is operated, the contacts **180A** are opened to disable the circuit for energizing the clutch **36** for the feeding assembly **20**. The operation of the relay **180** also opens the contacts **180B** and closes a pair of contacts **180C**. The closure of the contacts **180C** completes an operating circuit for the relays **184** and **186** which are normally operated under the control of one of the ten push buttons **159**. The opening of the contacts **180B** opens a point in the circuit described above for pulsing the motor magnet **172**. Thus, the stepping switch **170** is not actuated during manual operation. The machine **10** can now be operated by manually feeding the copy sheets **22** between the nip between the rollers **50** and **52** to control the actuation of the switch **72**. Thereafter, continued feeding of the copy sheet **22** and the operation of the machine **10** is similar to that described above for automatic operation. A lamp **163** also is energized by the closed contacts of the manual push button **175** to provide a visible indication that the machine **10** is conditioned for manual operation.

The machine **10** can be restored to normal automatic operation by actuating a momentary reset push button or switch **173** including two pairs of normally open contacts **173A** and **173B** which are not coupled to the release solenoid **161**. The closure of the contacts **173A** energizes the solenoid **161** to release the closed contacts **175**. The opening of the contacts **175** terminates the energization of the "manual" indicating lamp **163** and releases the relay **180**. The release of the relay **180** releases the relays **184** and **186** and returns control over the clutch **36** to the control circuit.

The closure of the contacts **173A** is also effective over a circuit including the normally closed contacts **182B** to energize the reset magnet **174** to insure that the counting switch **170** is in its normal position. The closure of the contacts **173B** energizes the winding **169B** of the latching relay **169** to insure that the contacts **169C** are opened and the contacts **169D** closed. The closure of the contacts **169D** insures that the brake assembly **130** is rendered effective whenever the platform or table **92** is in its normal position in which the contacts **190C** of the relay **190** are closed. Thus, the machine **10** can be restored to its normal condition by momentarily actuating the reset switch **173**.

To condition the machine **10** for continuous operation, a continuous operation push button **171** is actuated to close three pairs of contacts **171A**, **171B**, and **171C**, which contacts are latched in a closed condition. The closure of the contacts **171A** energizes a lamp **163** to provide a visible indication that the machine is in condition for continuous operation. The closure of the contacts **171A** also completes an operating circuit for a relay **182** which operates to open the contacts **182B** and to close a pair of contacts **182A**. The opening of the contacts **182B** interrupts the circuit for energizing the release solenoid **161** under the control of the setting of the stepping switch **170**.

The closure of the contacts **182A** connects the reset magnet **174** of the stepping switch **170** to the closed contacts **171B** in the continuous operation push button **171**. These contacts are connected to the tenth contact in the bank **172A** of the switch **170**. The closure of the contacts **171C** completes an operating circuit for the relays **184** and **186** to start the machine **10** as well as prepares a path over the contacts **180B** and **194B** for controlling the energization of the reset magnet **174** in dependence on the setting of the wiper in the contact bank **172A**. Thus, the machine **10** now continuously produces copies by automatically feeding sheets **22** from the assembly **20** into the machine **10**. Whenever the stepping switch **170** reaches its tenth setting, a circuit is completed from one side of the full-wave rectifier bridge **206** through the closed contacts **171C**, **180B**, **194B**, the wiper in the contact bank **172A**, and the closed contacts **171B** and **182A** for energizing the reset magnet **174**. Thus, the stepping switch **170** is reset to normal position after the production of each ten copies when the machine **10** is conditioned for continuous operation. The machine **10** is restored to a normal condition by momentarily operating the reset button **173** so that the solenoid **161** restores the contacts **171A**, **171B**, and **171C** to a normal condition. Incident to this restoration operation, the relay **182** is released to open the contacts **182A** and to close the contacts **182B**.

Although the present invention has been described with reference to a single illustrative embodiment thereof, it should be understood that numerous other modifications and embodiments can be devised by those skilled in the art that will fall within the spirit and scope of the principles of this invention.

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

1. In a photoelectrostatic copying machine for making a copy of a graphic original on a web or sheet material,

a housing,

an exposure means in the housing including an illuminating area and an exposing area disposed in spaced positions,

first drive means for moving the sheet material past the exposing area in a position generally parallel to the exposing area,

an original supporting frame for removably receiving a graphic original to be copied,

means mounting the frame on the housing for reciprocating movement in a generally horizontal plane parallel to and passing over the illuminating area,

second drive means for reciprocating the supporting frame between normal and displaced positions to move the original carried thereon past the illuminating area,

safety switch means mounted on the frame and exposed for manual actuation,

and circuit means controlled by the safety switch means and connected to the second drive means for arresting movement of the frame by the second drive means.

2. An apparatus for making copies of originals on copy material comprising:

copy material feeding means for feeding copy material through the apparatus along a predetermined path;

copy material charging means and copy material developing means disposed at spaced positions along

the path for charging the copy material and developing a charge image on the copy material,

an exposing system including an exposing area disposed adjacent the path between the charging means and the developing means for exposing the copy material, said exposing system also including an illuminating area spaced from the exposing area,

a table for receiving an original to be copied and mounted on the apparatus for reciprocating movement relative to the illuminating area,

drive means connected to the table for moving the table relative to the apparatus to move an original past the illuminating area,

a control circuit connected to the drive means for controlling the operation of the drive means,

and switch means carried on and movable with the table and connected to the control circuit for controlling the operation of the drive means,

3. The apparatus set forth in claim 2 in which the drive means moves the table in a first direction during which the original is scanned at the illuminating area and in a second direction opposite to the first direction,

and in which the control circuit includes means for disabling control of the drive means by the switch means during movement in the first direction.

4. An apparatus for making copies of originals on copy material comprising:

copy material feeding means for feeding copy material through the apparatus along a predetermined path;

copy material charging means and copy material developing means disposed at spaced positions along the path for charging the copy material and developing a charge image on the copy material,

an exposing system including an exposing area disposed adjacent the path between the charging means and the developing means for exposing the copy material to form the charge image, said exposing system also including an illuminating area spaced from the exposing area,

a table for receiving an original to be copied and mounted on the apparatus for reciprocating movement relative to the illuminating area,

drive means connected to the table for moving the table relative to the apparatus to move an original past the illuminating area,

a control circuit connected to the drive means for operating the drive means to reciprocate the table through a cycle of reciprocating movement for each copy of the original to be produced,

switch means carried on and movable with the table and operable by contact with an object disposed in the path of movement of the table,

and means connecting the switch means to the control circuit to arrest operation of the drive means when the switch means is operated.

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