

Dec. 23, 1969

G. E. SIEMER

3,485,486

SAFETY ARRANGEMENT FOR XEROGRAPHIC FUSING APPARATUS

Filed April 18, 1968

5 Sheets-Sheet 1

FIG. 1

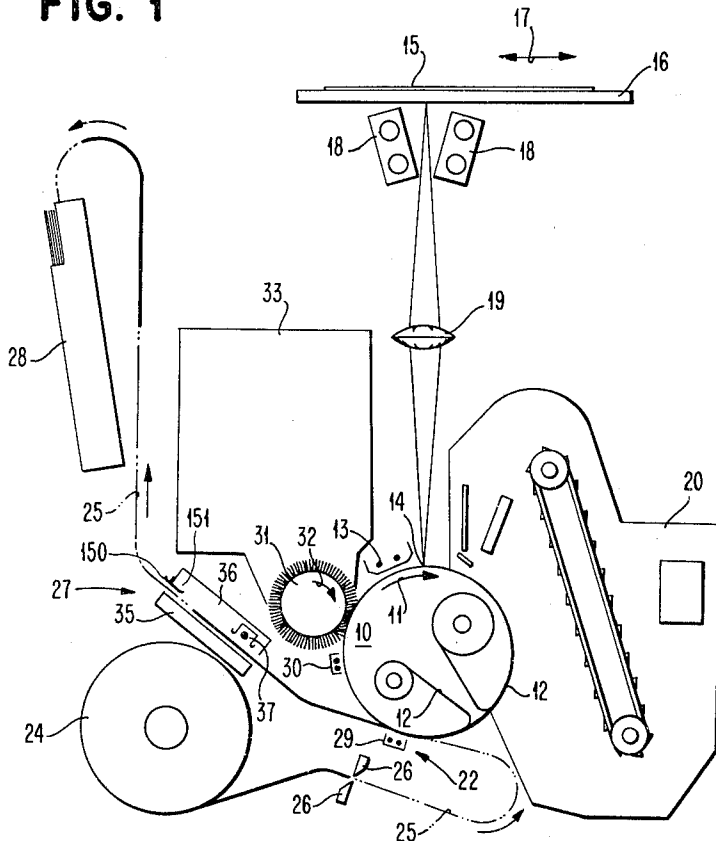
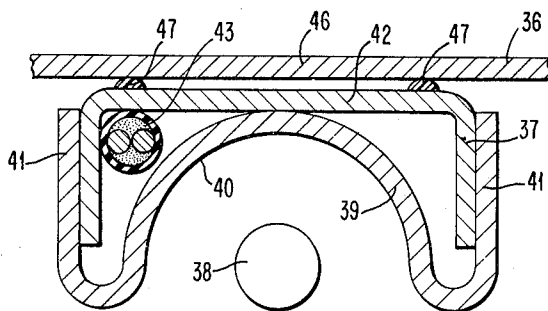


FIG. 3



INVENTOR

GLENN E. SIEMER

BY

Paul Marmichev

ATTORNEY.

Dec. 23, 1969

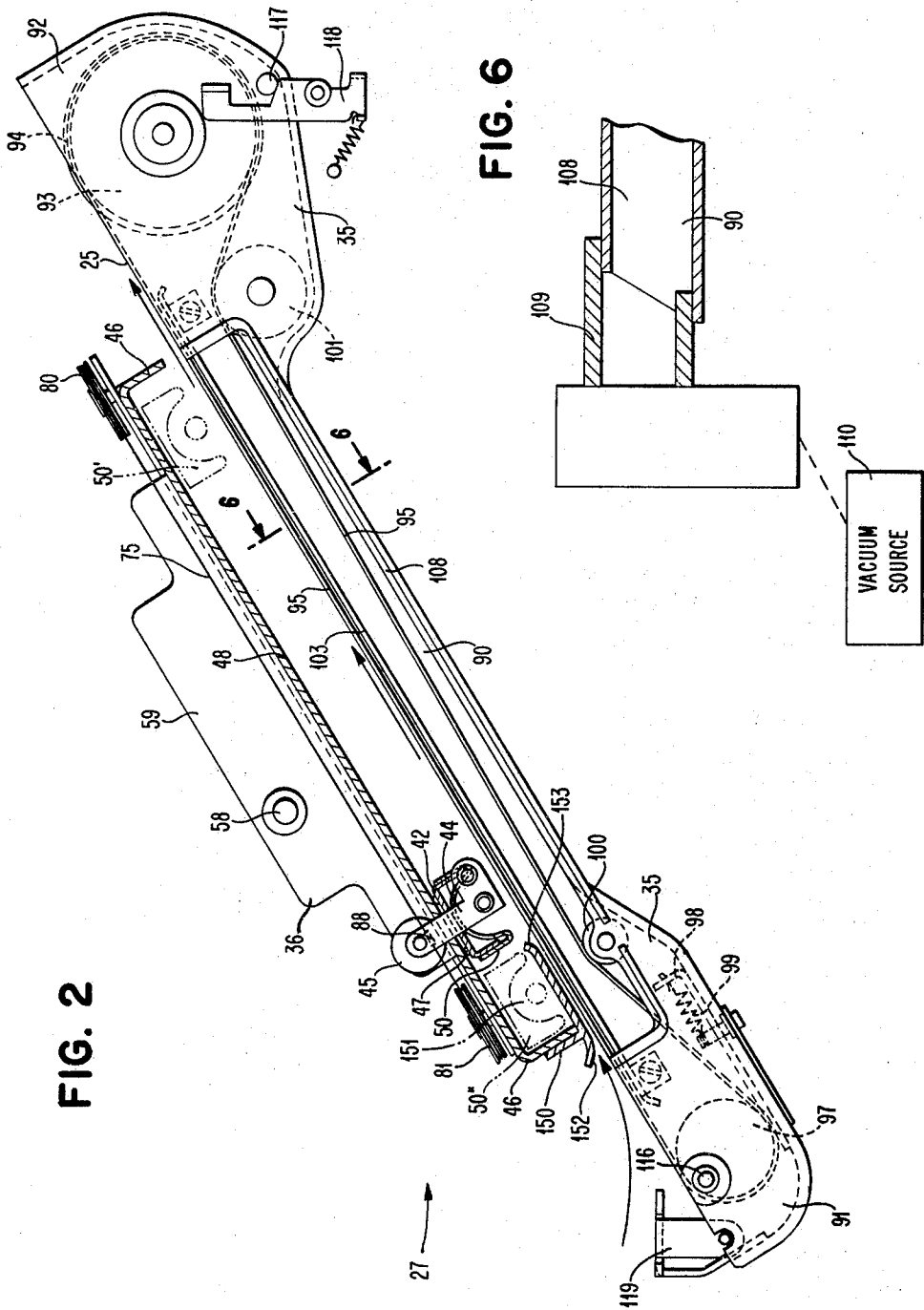
G. E. SIEMER

3,485,486

SAFETY ARRANGEMENT FOR XEROGRAPHIC FUSING APPARATUS

Filed April 18, 1968

5 Sheets-Sheet 2



Dec. 23, 1969

G. E. SIEMER

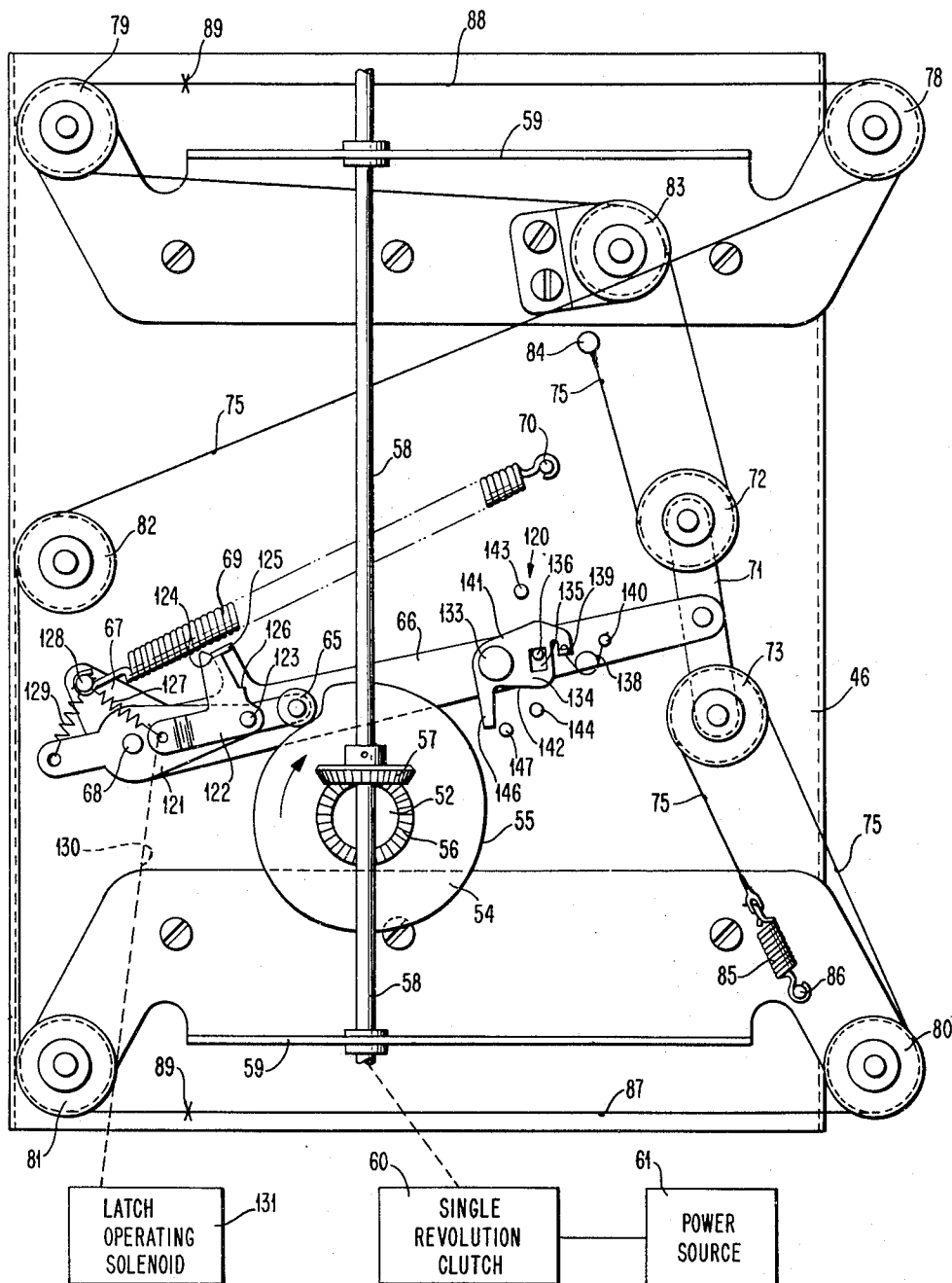
3,485,486

SAFETY ARRANGEMENT FOR XEROGRAPHIC FUSING APPARATUS

Filed April 18, 1968

5 Sheets-Sheet 3

FIG. 4



Dec. 23, 1969

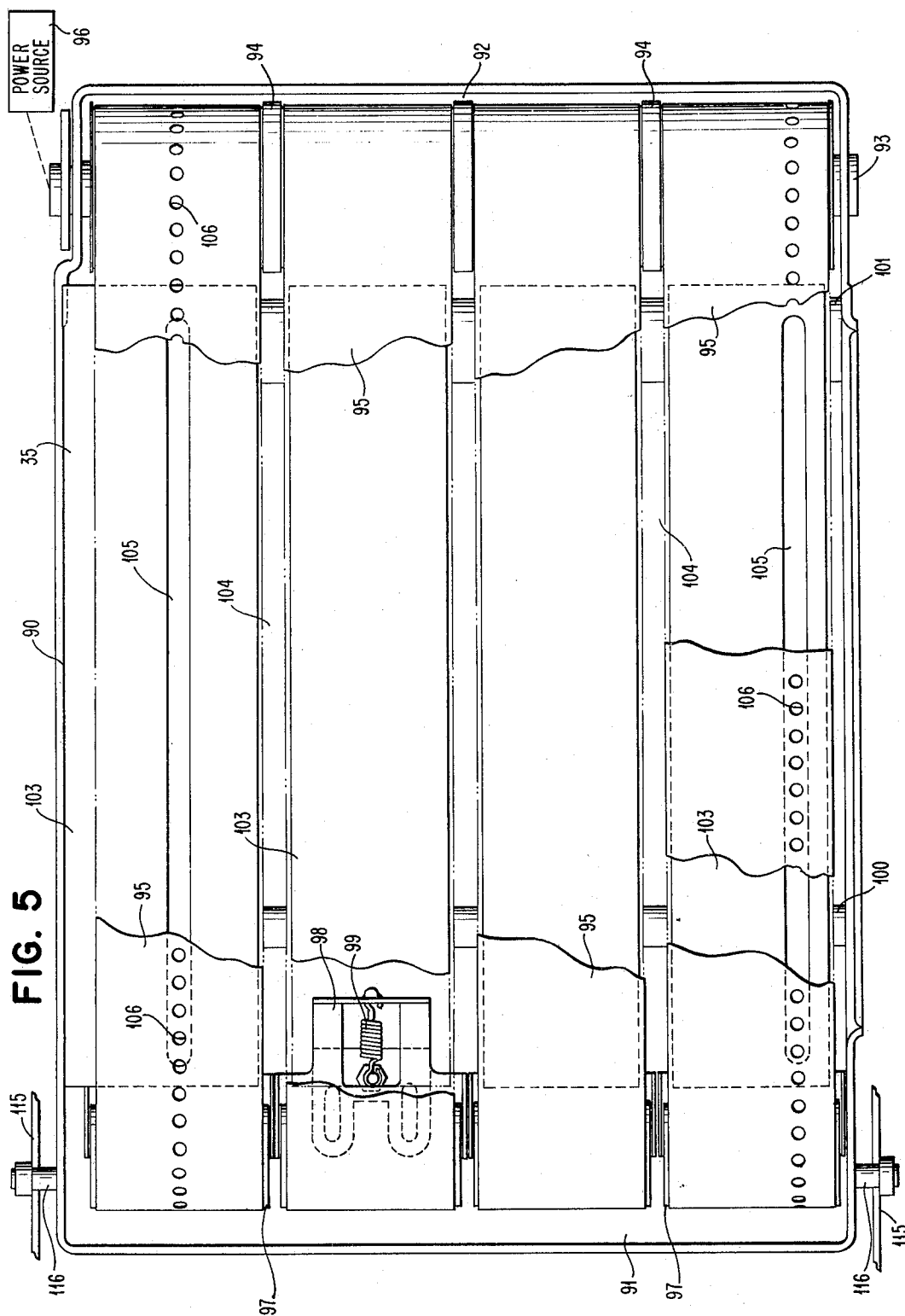
G. E. SIEMER

3,485,486

SAFETY ARRANGEMENT FOR XEROGRAPHIC FUSING APPARATUS

Filed April 18, 1968

5 Sheets-Sheet 4



Dec. 23, 1969

G. E. SIEMER

3,485,486

SAFETY ARRANGEMENT FOR XEROGRAPHIC FUSING APPARATUS

Filed April 18, 1968

5 Sheets-Sheet 5

FIG. 7

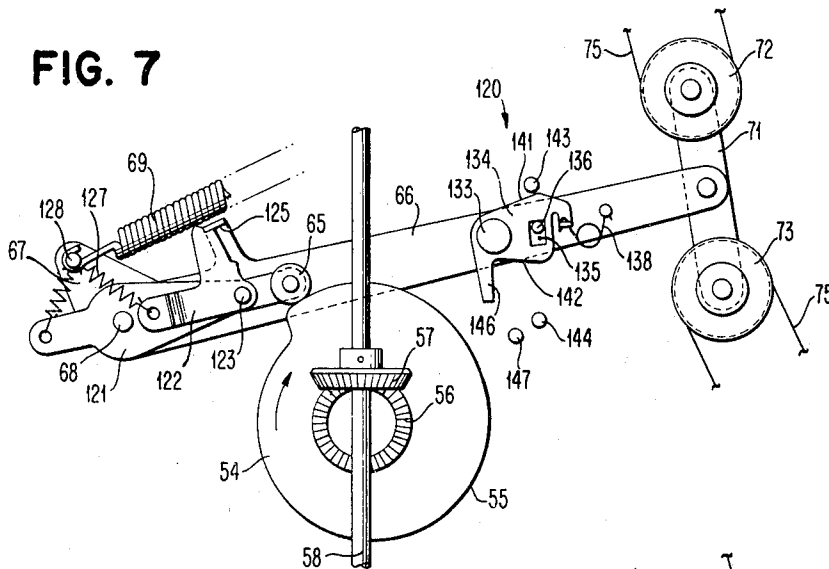


FIG. 8

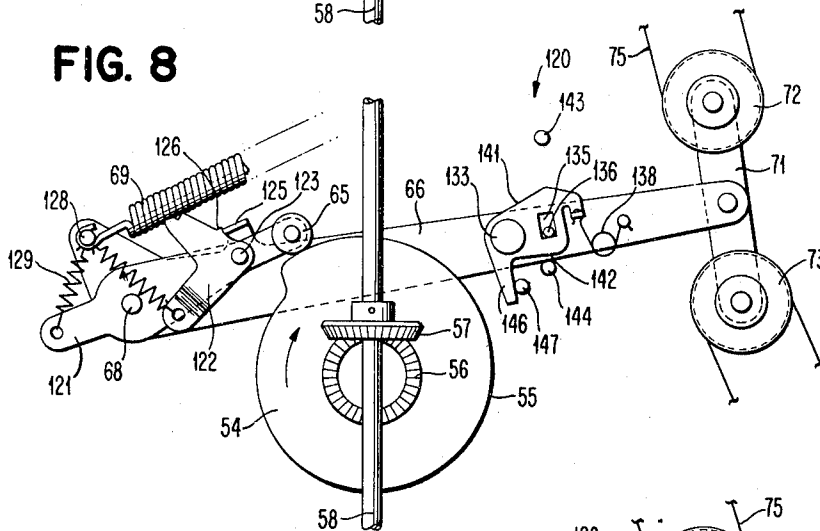
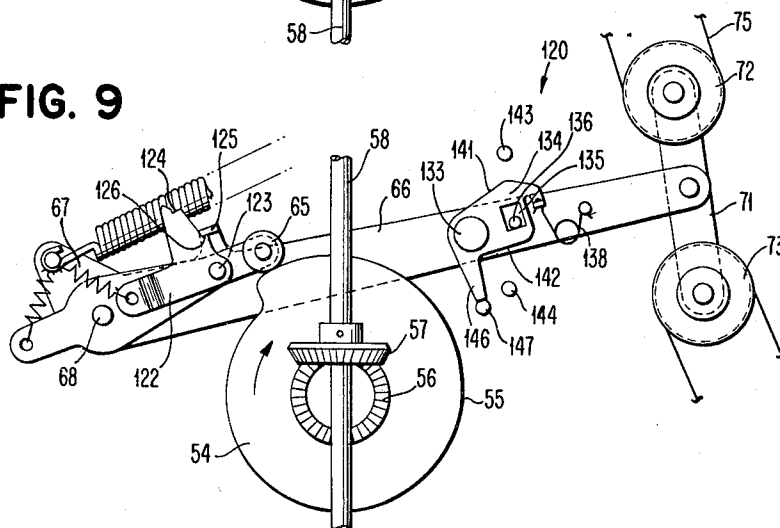


FIG. 9



1

3,485,486

SAFETY ARRANGEMENT FOR XEROGRAPHIC FUSING APPARATUS

Glenn E. Siemer, Lexington, Ky., assignor to International Business Machines Corporation, Armonk, N.Y., a corporation of New York

Filed Apr. 18, 1968, Ser. No. 722,284

Int. Cl. F27d 11/00, 21/00; F27b 9/06

U.S. Cl. 263—6

19 Claims

ABSTRACT OF THE DISCLOSURE

A safety arrangement for apparatus employed to fuse fixable marking material to a supporting surface, such as a copy sheet, in a xerographic copying machine is disclosed. This arrangement prevents charring of a copy sheet or a fire from occurring when the copy sheet becomes stopped or jammed in the fusing apparatus. The fusing apparatus comprises a heating unit which is mounted in heat exchange relation with and for movement along the path of travel of the moving copy sheet. The heating unit moves from an initial to a final position in the same direction as and with the moving copy sheet. Under fault conditions, the heating unit is moved to a safety position out of heat exchange relation with the copy sheet so that the possibility of fire due to overheating or charring of a copy sheet in the fusing apparatus is completely eliminated.

The present invention relates generally to the heating and copying arts. More particularly, the invention is directed to providing a safety arrangement for apparatus used to fuse fixable marking material to a supporting surface in a xerographic or similar copying machine.

The xerographic copying process is well known in the art and employs a photosensitive element comprising a layer of photoconductive material supported on a conductive backing substrate. The process normally includes the steps of depositing a uniform electrical charge on the surface of the photosensitive element while maintaining the element in the dark, exposing the charged element to a light image of the original being copied, and then developing the latent electrostatic image with fixable marking material or toner. If the photosensitive element is to be reused, the toner image is transferred to a sheet of plain paper defining a copy sheet, usually with the assistance of an external electrical field and/or pressure. The fusing apparatus heats and fixes the toner image on the copy sheet. The finished copy is then transported to an output hopper where it is accessible to the operator.

The fusing apparatus usually comprises a heating unit which generates sufficient heat to melt or fuse the toner on the copy sheet. The amount of heat which the heating unit must produce to cause fusing of the toner is largely a function of the time available to heat the toner. This in turn is dependent on the relative speed of movement between the heating unit and the copy sheet. The copy sheet becomes rapidly overheated if it is stopped or becomes jammed within the fusing apparatus. Further, when a jam occurs, portions of the copy sheet may be close to or in actual contact with the heating lamp or other hot elements of the fusing apparatus. A serious safety hazard is presented since a fire can be started in the fuser apparatus under these conditions.

The problems of charring of the copy sheets and fires in the fusing apparatus of xerographic copying machines have been previously recognized in the art and various solutions have been proposed. For example, it is known to employ shutters between the heating unit and the copy sheet. The shutters automatically close to protect the copy

2

sheet under fault conditions. Further, it has been suggested to automatically pivot the heating units or move the copy sheet supporting means to in operative positions when a fault condition occurs. While these arrangements are satisfactory under many operating condition, they require relatively expensive apparatus which and have increased the overall costs of xerographic copying machines.

It is the primary or ultimate object of the invention to provide an improved safety arrangement for xerographic fusing apparatus. The fusing apparatus comprises a heating unit which is moved from an initial to a final position along the path of travel of the copy sheet when a copy sheet is transported through the fusing apparatus. This arrangement substantially increases the time interval during which the copy sheet is in heat exchange relation with the heating unit. Means are provided to move the heating unit to a safety position under various fault conditions. When in the safety position, the heating unit is out of heat exchange relation with the copy sheet and the possibility of a fire starting in the fusing apparatus is completely eliminated.

Another object of the invention is the provision of a safety arrangement for xerographic fusing apparatus which incorporates means for moving the heating unit to a safety position whenever a fault condition is detected. The drive for moving the heating unit between initial and final position during normal fusing operations comprises a cam and cam follower mechanism. Under fault conditions the cam follower mechanism is collapsed from operative cam following relation with the cam and automatically moved to a predetermined safety stop position. The heating unit immediately moves to its safety position as the cam follower mechanism goes to its retracted safety stop position.

A further object of the invention is to provide a safety arrangement for xerographic fusing apparatus which includes structure for automatically returning the heating unit from the safety to an operative heat fusing position when it is desired to resume normal heat fusing operations. The operator is not required to take any action other than to remedy or clear the fault condition which caused the heating unit to move to its safety position. The cam follower mechanism is automatically returned to operative cam following relation with the drive cam and the heating unit moves back to an operative fusing position when the drive for the fusing apparatus is reenergized.

A still further object of the invention is to provide a safety arrangement for xerographic fusing apparatus having the characteristics set forth above which is extremely simple in construction and operation. The safety arrangement involves the addition of only a minor number of inexpensive parts to the basic fusing apparatus.

The foregoing and other objects and advantages of the invention will be apparent from the following more particular description of a preferred embodiment of the invention as illustrated in the accompanying drawings.

In the drawings:

FIGURE 1 is a schematic side view of a xerographic copying machine employing fusing apparatus having a traversing heating unit embodying the safety arrangement of this invention.

FIGURE 2 is a side sectional view from the opposite side of the xerographic copying machine in relation to the view of FIGURE 1 showing in more detail the construction of the fusing apparatus;

FIGURE 3 is an enlarged and fragmentary side sectional view of the traversing heating unit showing particularly the quartz heating lamp and the reflector therefor;

3

FIGURE 4 is a plan view of the fusing apparatus which particularly illustrates the cam controlled drive mechanism for moving the traversing heating unit between safety, initial and final positions;

FIGURE 5 is a plan view of the vacuum plenum;

FIGURE 6 is a fragmentary end sectional view taken generally along the section line 6—6 of FIGURE 2;

FIGURE 7 is a fragmentary plan view similar to the view of FIGURE 3 showing the positions of the various parts of the cam follower mechanism when the heating unit is in its final position;

FIGURE 8 is a fragmentary plan view indicating the positions of the parts of the cam follower mechanism when the heating unit is located in the protected or safety position; and

FIGURE 9 is a fragmentary plan view showing the positions of the different parts of the cam follower mechanism when the heating unit is moved from the protected or safety position to the initial position preparatory to resuming normal fusing operations.

XEROGRAPHIC COPYING MACHINE

Referring now to the drawings, and initially to FIGURE 1 thereof, there is shown a schematic representation of a xerographic copying machine embodying the safety arrangement for the fusing apparatus of the present invention. The electrophotographic member of the copying machine comprises a drum 10 which is mounted for rotation in the direction indicated by arrow 11. Disposed on the outer periphery of the drum is a thin layer of photosensitive material 12 which is supported on a conductive substrate. The photosensitive material is preferably an organic photoconductor comprising a one-to-one molar ratio of polymerized vinylcarbazole and 2, 4, 7-trinitro-9-fluorenone which is disclosed and claimed in an application of Meredith D. Shattuck and Ulo Vahtra entitled "Organic Photoconductive Compositions and Their Use in Electrophotographic Processes," Ser. No. 556,982, filed June 13, 1966, and assigned to the assignee of this invention. The photoconductor is coated on a flexible conductive backing material and stored on reels within the interior of the drum to permit replacement or changing of the operative photoconductor surface without removing the drum from the machine as is disclosed and claimed in an application of Clifford E. Herrick, Jr. entitled "Electrophotographic Process," Ser. No. 649,162, filed June 27, 1967 and assigned to the assignee of the present invention. While the disclosed photoconductor and drum construction are preferred, the present invention is concerned with fusing apparatus and is not dependent on the use of any particular electrophotographic member.

Disposed about the periphery of the drum 10 are a number of processing stations which carry out the conventional steps of the xerographic copying process. An initial charging station is provided by a corona unit 13 which deposits a uniform charge on the surface of the photosensitive material while the same is maintained in the dark. The next station is exposure station 14 where a line image of the original document is projected onto the uniformly charged surface of the photosensitive material 12 as the drum rotates. A document 15 to be copied is supported face down on a movable and transparent copy bed 16 which moves back and forth past a scanning slit as indicated by the arrow 17. The document 15 passing the scanning slit is illuminated by lights 18 and a line image of light and shadow is projected by stationary lens 19 onto the photosensitive material 12 carried by the drum.

The next station in the direction of rotation of the drum 10 is a cascade developer unit 20 where a two component developer composition is caused to move across the surface of the drum. The developer composition comprises heat fixable marking particles or toner which is attracted to and deposited on the surface of the photosensitive member in accordance with the latent electrostatic image

4

corresponding to the original. The result of the cascade development operation is the formation of a toner image on the surface of the drum. It is now necessary to transfer the toner image to a copy sheet and this is accomplished at the toner transfer station 22.

The plain copy paper is stored within the copying machine in roll form as indicated by roll 24 and is fed along a path of travel 25 in the direction indicated by the arrows leading past knives 26, toner image transfer station 22, fusing apparatus generally indicated by reference numeral 27 and then to an output copy hopper 28. The copy paper is cut to the length selected by the operator and the cut copy sheet moves into contact with the drum. A transfer corona unit 29 assists in the transfer of the toner image to the copy sheet. The copy sheet is then separated from the drum, the toner image fused by heat and the final copy transported to the output hopper 28.

Not all of the toner image is transferred to the copy sheet and it is necessary to remove the residual toner from the surface of the drum. This is accomplished by employing a preclean corona unit 30 whose corona discharge tends to loosen the remaining toner particles and a cleaning brush 31 which is rotated at high speed in the direction indicated by arrow 32. The toner particles which are brushed from the surface of the photosensitive material are drawn by vacuum into a filter bag mounted within a housing 33.

The above description of a representative xerographic copying machine is not intended to limit in any manner the teachings or claims of this invention. The principles of the safety arrangement disclosed in this specification can be employed with any of a wide variety of copying machines or systems.

FUSING APPARATUS

The fusing apparatus 27, as shown in FIGURES 1 and 2 of the drawings, is located along the upwardly inclined path of travel 25 of the copy sheets between the toner image transfer station 22 and the output hopper 28. It should be understood at the outset that the claims of the present application are limited to the safety arrangement for the fuser apparatus. The fuser apparatus itself is claimed in the co-pending application of James V. Cely and Robert T. Ritchie, Ser. No. 697,734, filed Jan. 15, 1968 entitled "Xerographic Fusing Apparatus" and which is assigned to the assignee of this invention.

The fusing apparatus comprises an elongated and stationary vacuum plenum 35 located below the path of travel which provides a means for supporting and transporting copy sheets through the fusing apparatus and a heating assembly 36. The heating assembly 36 is positioned above the path of travel 25 of the copy sheets in opposed overlying relation with respect to the vacuum plenum 35. The operative element of the heating assembly 36 is a heating unit 37 provided by a quartz heating lamp 38 and a reflector 39. The lamp 38 and the reflector 39 are elongated and extend transversely across the path of travel 25 of the copy sheets. The inner surface 40 of the reflector 39 is generally elliptical and highly specular. The heating lamp 38 is connected to a source of electrical energy which is preferably a standard and conventional electrical outlet found in any room since special wiring for supplying the necessary electrical power is not required. The heating lamp 38 and the reflector 39 cooperate to produce a transversely extending and relatively narrow band of infrared radiation on the surface of a copy sheet which, because of the unique mounting and movement of these members, is sufficient to fuse the toner image to the copy sheet.

The heating lamp 38 is preferably clip or spring mounted at its ends within the reflector 39 to permit easy removal and replacement. The reflector is formed from good heat conducting material and has a pair of upturned and vertically extending end walls 41 which nestingly receive and are joined to the depending legs of an elongated

and transversely extending channel shaped carriage member 42. Wires 43 for supplying electrical power to the heating lamp 38 run the length of the heating unit 37 in the space between the reflector 39 and the carriage member 42.

Connected to each end of the reflector 39 and the carriage member 42 is a mounting bracket 44 which carries a roller 45. The rollers 45 at the opposite end of the heating unit 37 engage and ride on the outer upper edges of a large and generally U-shaped heating assembly housing member 46. The upper surface of the carriage member 42 as provided with a pair of buttons 47 at each end thereof. The buttons are formed from a material having a low coefficient of friction and engage the outer lower edges of the housing member 46 in opposed relation to the rollers 45.

The heating assembly housing member 46 generally overlies the vacuum plenum 35 and its outer edges define a pair of transversely spaced and longitudinally extending side rails 48 which are engaged on the top and bottom by the rollers 45 and the pairs of buttons 47 at opposite ends of the transversely extending heating unit 37. The arrangement is such that the heating unit 37 comprising the heating lamp 38 and the reflector 39 is mounted in a highly simplified but rugged manner for traversing movement back and forth along the path of travel 25 of the copy sheets. In operation, the heating unit 37 moves from an initial position 50 to a final position 50' indicated by the broken line representation of the heating unit as a copy sheet moves along the path of travel 25 through the fusing apparatus. After the fusing operation, the heating unit 37 is returned to its initial position.

Attached to the forward end wall of the heating assembly housing member 46 is a generally T-shaped heat shield 150. The heat shield is formed from highly heat absorbing material and has a relatively thick cross section. The shield 150 provides an open ended heating unit receiving pocket 151 at the forward end of the fusing apparatus. Under fault conditions the heating unit 37 is automatically moved to a safety position 50'' within the pocket. The heat shield 150 serves not only as a heat isolating barrier between the copy sheet and the hot elements of the heating unit, but also as a means for quickly absorbing radiated heat from the hot elements of the heating unit to cool the latter below the temperature where they might cause a fire in the fusing apparatus. The forward end of the shield 150 is turned upwardly to provide a transversely extending guide 152 which assists in guiding the leading end of a copy sheet into the fusing apparatus. The rear end 153 of the heat shield 150 is curved upwardly to prevent accidental curling of the end of a copy sheet within the pocket 151 under fault conditions. However, sufficient clearance is maintained between the heat shield 150 and the top wall of the heating assembly housing member 46 to permit the heating unit 37 to freely move to its safety position 50''. It is important to note that during normal fusing operations the heating unit does not enter the pocket 151 and the heat shield 150 is maintained in a relatively cool and unheated state so that it can absorb the heat from the hot elements of the heating unit. The heating unit 37 is moved to its safety position 50'' anytime a fault condition is detected and from any point along its normal path of travel. The drive means for moving the heating unit between initial, final and safety positions will be described in detail in a following portion of the specification.

The heat required to fuse the toner image to a copy sheet can be expressed in terms of the following generalized time dependent equation:

$$\frac{\Delta Q}{\Delta t} = mCp \frac{\Delta T}{\Delta t}$$

where:

ΔQ =heat required to fuse the toner

m =mass of the toner

Cp =constant pressure specific heat of the toner

ΔT =temperature rise of the toner required to fuse the same

Δt =time required to fuse the toner to the copy sheet

5 The use of a traversing heating unit 37 permits the effective time (Δt) during which heating and fusing of the toner occurs to be appreciably extended so that the overall efficiency of the fusing operation is improved. In general, less energy is required using this fusing apparatus than is necessary in prior art apparatus of the same general type where the heating unit is stationary during the fusing operation.

10 For example, in a constructed embodiment of the invention, the copy sheets move through the fusing apparatus at a speed of four inches per second while the traversing heating unit moves with a copy sheet at a speed of one and two-tenths inches per second. The result of moving the heating unit in this manner is that the copy sheet moves two and eight-tenths inches per second relative to the heating unit. The approximately thirty percent reduction in the relative speed of travel between the heating unit and the copy sheet compared to similar apparatus employing a stationary heating unit substantially increases the time available to accomplish fusing of the fixable marking material. The heating lamp employed in this constructed embodiment was of the quartz infrared halogen atmosphere type available from Sylvania Electric Products, Inc. and was rated for operation at 1350 watts, 115 volts. The power requirements were supplied from a conventional 115 volt-15 ampere electrical wall outlet employing a standard wiring and the toner images were satisfactorily fused to the copy sheets under all conditions.

35 A very important aspect of the xerographic fusing apparatus is that no warm-up time is required to properly fuse the toner. The fusing unit is available for immediate use whereby the first copy is delivered to the output hopper as quickly as the other steps of the xerographic process can be completed and the sheet of copy paper moved through the machine. The time required to produce the first copy is not dependent on the fusing area reaching a predetermined temperature which in turn is dependent on how recently the xerographic copying machine has been used. Further, in the constructed embodiment of the invention, it was not necessary to partially energize the heating lamp during standby conditions. This reduces the overall power requirements for the xerographic copying machine and is particularly important in an installation where the machine is used rather infrequently and partial energization of the heating lamp is inefficient.

50 The drive mechanism for moving heating unit 37 between initial and final position 50 and 50' and, under fault conditions, quickly moving the heating unit to the safety position 50'' is best shown in FIGURES 4 and 7-9 of the drawings since its primary components are mounted on the top surface of the heating assembly housing member 46. A vertically extending shaft 52 is rotatably supported by a collar in the center of the housing member 46. Attached to the shaft 52 are a relatively large cam 54 having a profiled camming surface 55 and an upwardly facing bevel gear 56. Meshing with the teeth of the bevel gear 56 are the teeth of another and normally related bevel gear 57 which is pinned to the transversely extending drive shaft 58. The bevel gears 56 and 57 provide a right angle drive connection between the drive shaft 58 and the vertical mounting shaft 52. The drive shaft 58 is supported for rotation in the upstanding walls of a pair of brackets 59 attached to opposite sides of the heating assembly housing member 46 and is connected by clutch 60 to a source of mechanical power 61. The clutch 60 is preferably of the single revolution type and is actuated by timing circuits, not shown. The arrangement is such that as the leading edge of a copy enters the fusing apparatus, the clutch 60 is energized and the cam 54

rotates clockwise through a complete revolution. During this time the heating unit 37 moves from its initial position 50 to its final position 50' as the copy sheet moves through the fusing apparatus and then the heating unit returns very quickly to its initial position 50. The activation of the single revolution clutch 60 is, of course, synchronized with the cutting and feeding of the copy sheets, the rotation of the xerographic drum 10 and the movement of the transparent copy bed 16.

A cam follower mechanism is generally designated by the reference numeral 120 and comprises a cam follower roll 65 which engages the periphery or camming surface 55 of the cam 54. The cam follower roll 65 is rotatably mounted on the forward end of a carrier member 121. The carrier member 121 is pivoted on a vertically extending pin 68 and overlies one arm 66 of bell crank 67 which is also mounted for pivotal movement about the pin 68. A latch member 122 overlies the carrier member 121 and is pivoted to the latter by the pivot pin 123. The latch member 122 has a stepped latch surface 124 at its outer end which is adapted to engage an upturned tab 125 extending from arm 66 of the bell crank 67. The latch member is provided with a second stepped latch surface 126 whose function will be hereinafter more fully explained. A spring 127 interconnects the lower end of the latch member 122 with spring mounting post 128 on the other arm of the bellcrank 67 and biases the latch member clockwise. Another spring 129 extends between the mounting post 128 and the lower end of the carrier member 120.

The lower end of the latch member 122 is connected by a flexible drive connection schematically represented by reference numeral 130 to a solenoid 131. This solenoid 131 is energized to rotate latch member 122 counterclockwise against the action of spring 127 by suitable electrical control circuits, not shown, whenever a fault condition is detected. Any desired fault condition or conditions can be employed to actuate the solenoid, such as the energization of the emergency off control circuits for the xerographic copying machine and/or the absence of a copy sheet at the output of the fusing apparatus within a predetermined time interval of its introduction into the fuser apparatus as indicated by a plurality of copy sheet presence detector switches located along the path of travel of the copy sheets.

When the cam follower mechanism is latched in its operative position as shown in FIGURE 4 of the drawings, the cam follower roll 65 is biased into following engagement with the camming surface 55 of the cam 54 by a strong spring 69 which extends from the spring mounting post 128 and shorter arm of the bellcrank 67 to a stationary anchor pin 70 on the heating assembly housing member 46. Pivoted on pin 133 and located intermediate the ends of the arm 66 of bellcrank 67 is an overcenter resetting member 134. This member has an enlarged opening 133 therein whose edges cooperate with a stop pin 136 carried on the bellcrank arm to limit the pivotal movements thereof. The resetting member 134 is biased in either of its stable overcenter positions by a hairpin type spring 138 that extends from an upstanding tab 139 on this member to a spring mounting post 140 adjacent the end of the bellcrank arm 66. The resetting member 134 has a pair of surfaces 141 and 142 on opposite sides thereof which are adapted at certain times to engage and cooperate with a reset pin 143 and a stop pin 144, respectively, mounted on the heating assembly housing member 46. The resetting member 134 also has an integral projecting arm 146 which, under certain operating conditions, engages a stationary stop pin 147 mounted on the heating assembly housing member 46 to hold the bellcrank in an intermediate position. The use of the resetting member 134 and the various reset and stop pins which cause automatic relatching of the cam follower mechanism 120 when normal fusing operations are resumed and the heating unit is returned from the safety to an operative fusing position will be hereinafter more fully explained.

Attached to the outer end of the arm 66 of the bellcrank 67 is a link 71 which carries at its ends a pair of pulleys 72 and 73. Entrained about these pulleys are the opposite ends of a non-extensible and fixed length cord 75. As the pulleys 72 and 73 move back and forth in an arc defined by the length of the bellcrank arm 66 and the shape of the camming surface 55 when the cam follower mechanism is latched in operative relation, the cord 75 is pulled back and forth along a defined path.

Mounted from the brackets 59 attached to opposite sides of the heating assembly housing member 46 are pulleys 78-81. These pulleys are located at the corners of the heating assembly housing member and, in combination with additional pulleys 82 and 83 on the housing member 46 and the movable pulleys 72 and 73 carried by link 71, define the path of travel for the cord 75. The cord 75 extends from a stationary mounting point 84 for one end thereof, around movable pulley 72, then about stationary pulleys 83, 79, 78, 82, 81 and 80 in the order indicated, and about movable pulley 73 to one end of a relatively strong spring 85. The other end of the spring 85 is anchored at 86 to the heating assembly housing member 46. The spring 85 is provided to take up any slack in the cord 75 and maintain it tight in its path. The path of the cord 75 is such that the portions 87 and 88 thereof extending between the stationary pulleys 80-81 and 78-79 located on opposite sides of the heating assembly housing member will move in the same direction and by the same distance in response to movements of the movable pulleys 72 and 73 under control of the rotating cam 54 and cam follower roll 65. The mounting brackets 44 located at the opposite ends of the transversely extending heating unit 37 are attached to the cord 75 at the points indicated by the marks 89. The drive mechanism moves the heating unit 37 back and forth between its initial and final positions 50 and 50' over the path of travel 25 of the copy sheets in accordance with the profile of camming surface 55 of cam 54 to substantially lengthen the time that a copy sheet remains in operative relation with the heating unit.

The vacuum plenum 3 is shown in detail in FIGURES 2, 5 and 6 of the drawings and comprises a generally elongated and flat housing 90 formed from sheet metal or similar material and having a pair of enlarged pockets 91 and 92 at the ends thereof. Rotatably supported within the pocket 92 is a relatively large diametered drive roll 93. The drive roll 93 has a pair of side flanges and a plurality of transversely spaced ridges 94 which define guiding means for a plurality of transversely spaced endless copy sheet carrying belts 95. The belts are preferably fabricated from heat resistant fabric material having a high coefficient of friction and may be rubber coated or impregnated to better engage and hold the copy sheets. A power source 96 (see FIGURE 5) is drivingly connected to and continuously rotates the drive roll 93 when the vacuum plenum is latched in its operative position.

Disposed within the housing pocket 91 are a plurality of transversely aligned belt tensioning rolls 97. One of these rolls is associated with each of the endless copy sheet carrying belts 95. Each of the tensioning rolls 97 is rotatably supported in its individual slidable carrier 98 that is biased by a spring 99 toward the entrance end of the fusing apparatus. Rollers 100 and 101 are journaled in the housing 90 adjacent its ends and further guide the belts 95 along the lower portions of their paths of travel. The arrangement is such that the endless belts 95 are properly guided, tensioned and driven to transport copy sheets through the fusing apparatus.

Supported within and adjacent the top surface of the housing 90 of the vacuum plenum and between the drive roll 93 and the tensioning rolls 97 are a plurality of longitudinally extending sheet metal plates or slats 103. The plates 103 provide the top surface of the vacuum plenum and support the endless belts 95 along the upper portions of their paths of travel. These plates are transversely spaced from each other to define longitudinally ex-

tending openings or slits 104 between the transversely spaced endless copy sheet carrying belts 95. In addition, a pair of slots 105 are formed in the outermost pair of plates 103 and underlie the two rows of apertures 106 provided in the outermost of the endless belts 95.

The slits 104 between the plates, the spaces between the adjacent edges of the endless belts, the slots 105 and the rows of apertures 106 define a plurality of longitudinally extending and transversely spaced ports for applying vacuum pressure to the back of a copy sheet as it is transported through the fusing apparatus. The copy sheet is firmly held to the driven endless belts without disturbing the toner image on the face of the copy sheet or interfering in any way with the fusing operation. It is noted that the transverse spacing between the two rows of apertures 106 in the outermost belts is approximately equal to the width of the copy sheets. This has been found particularly effective in preventing curling of the side edges of the copy sheet due to thermal shock caused by the very rapid evaporation of moisture from the copy sheet.

One side of the vacuum plenum housing 90 is formed with an elongated and vertically tapered vacuum port 108 that is best shown in FIGURE 6 of the drawings. The port 108 cooperates with the complementary tapered end of a passageway 109 which extends from the stationary frame of xerographic copying machine. The passageway 109 is in communication with a vacuum source 110. The various adjacent edges of the vacuum port 108 and passageway 109 are overlapped to reduce the loss of vacuum pressure. This arrangement, while being sufficiently fluid tight to prevent undue losses in vacuum pressure, permits the vacuum plenum to be pivoted down to an open position without requiring disconnection of vacuum lines or any other special operations on the part of the operator. Also, the use of flexible vacuum lines or conduits which require relative frequent replacement has been avoided.

The end of the vacuum plenum 35 at the entrance to the fusing apparatus is pivoted to the stationary frame 115 of the xerographic copying machine by a pair of laterally projecting pivot pins 116. The other end of the vacuum plenum 35 carries a pair of transversely extending locking pins 117 which cooperate with a pair of spring biased latches 118 that are pivotally mounted from the frame of the xerographic copying machine. This mounting arrangement for the vacuum plenum is highly advantageous since the operator need only release the latches 118 and the vacuum plenum is pivoted down to about pivot pins 116 to completely expose the interior of the fusing apparatus. Any jams of copy sheets within the fuser apparatus can be quickly cleared and routine maintenance, such as periodic replacement of the quartz heating lamp 38, is greatly facilitated. The latches 118 are of the self latching type and are designed to automatically engage and latch the locking pins 117 in the position shown in FIGURE 2 of the drawings when the vacuum plenum is pivoted upwardly to its closed position.

OPERATION

Considering now the operation of the xerographic fusing apparatus of this invention, it will be assumed that the heating unit 37 is in its initial position 50 and the endless belts 95 are being driven in a direction to advance copy sheets upwardly through the fusing apparatus along the path of travel 25. As a copy sheet having a toner image thereon is stripped from the drum, it is transported into the fuser apparatus over a guide 119 located at the entrance end of the vacuum plenum (see FIGURE 2). The guide 152 formed by the forward end of the shield 150 assists in guiding the copy sheet into the fusing apparatus. When the leading edge of the copy sheet enters the fusing apparatus, the synchronizing timing circuits actuate the single revolution clutch 60 so that cam 54 is rotated clockwise through a complete revolution. The rise

of the cam surface 55 is such that the heating unit 37 advances in the same direction as the copy sheet at a substantially constant velocity. As previously explained, the velocity of the heating unit 37 is less than that of the copy sheet but it is sufficient to substantially increase the time that the heating unit is in operative fusing relation with the copy sheet. During its movement through the fusing apparatus, the copy sheet is held in a flat condition by the vacuum pressure applied to the back of the sheet.

As the trailing edge of the copy sheet with the fused image thereon leaves the fusing apparatus, the heating unit 37 has reached its final position 50', and the position of the cam follower mechanism 120 at this time is shown in FIGURE 7 of the drawings. The cam follower roll 65 moves from the highest rise portion to the dwell of the cam 54 and the heating unit returns quickly to its initial position under the action of spring 69. The length of time required to return the heating unit to its initial position is very short so that it is ready to fuse the toner image to the next copy sheet when the latter is introduced into the fusing apparatus. The above described fusing operation is repeated in an uninterrupted manner as copy sheets are successively introduced into the fusing apparatus and as long as no fault conditions are detected.

When a fault condition is detected, such as when the operator actuates the emergency off control circuits for the xerographic copying machine or a copy sheet has not passed from the fusing apparatus in a predetermined time period after its introduction into the fusing apparatus, the solenoid 131 is immediately energized to rotate the latch member 122 counterclockwise against the action of spring 127. The effect of the counterclockwise rotation of the latch member 122 is to decouple and permit relative pivotal movement between the carrier 121 mounting the cam follower roll 65 and the bellcrank 67 carrying the pulleys 72 and 73 which control the movement of cord 75 in its path of travel. The cam follower roll 65 remains in contact with the camming surface 55 of the cam 54 while the bellcrank is immediately pivoted clockwise to an extreme safety position where arm 66 engages the stop pin 144 mounted on the top of the heating assembly housing member 46. The positions of the parts of the cam follower mechanism 120 at this time are shown in FIGURE 8 of the drawings.

The bellcrank 67 has been effectively disconnected from its driving relation with the cam 54 and moved to a safety position which is below or more clockwise than the extreme clockwise position provided by the lowest or dwell portion of the camming surface 55 during normal fusing operations. The movement of the pulleys 72 and 73 to the positions illustrated in FIGURE 8 moves the cord 75 in its path of travel to the extent necessary to move the heating unit 37 to its safety position 50'' within the pocket 151 provided by the heat shield 150. This movement of the heating unit 37 occurs very quickly due to the action of the relatively strong spring 69. It is noted that the heating unit may be moved to the safety position 50'' in response to detection of a fault condition at any time during a fusing operation and without reference to the position of the cam follower roll 65 on the camming surface 55 of the cam 54.

The fault condition detection control circuits are operative to cut off energizing power from the heating lamp 38 simultaneously with the energization of the latch member actuating solenoid 131. The safety pocket 151 and the heat shield 150 are relatively cool when a fault condition is detected since the heating unit is not received in the pocket 151 at any time during normal fusing operations. The shield 150 acts as a barrier which prevent a copy sheet within the fusing apparatus from being overheated or coming in contact with the hot elements of the heating unit. Further, the radiated heat from the hot elements of the heating unit is absorbed by the relatively cool parts surrounding the pocket 151 to quickly lower the temperatures of these elements. The use of this safety

11

arrangement is effective in preventing fires in the fusing apparatus and damage to the copy sheets.

After the operator has cleared the fault condition, it is necessary to return the heating unit 37 to an operative fusing position where it is again in heat exchange relation with a copy sheet moving along the path of travel 25. This function is accomplished by the resetting member 134 and the reset and stop pins 143, 144 and 147. Under normal operating conditions of the fusing apparatus, the resetting member 134 is pivoted to its lower stable position (see FIGURE 2) so that its arm 146 clears the stop pin 147 as the bellcrank arm pivots back and forth in an arc about pivot pin 68 under the control of the camming surface 55 of cam 54. However, when a fault condition is detected, the bellcrank arm 66 quickly moves to a position against stop pin 144. As the bellcrank arm approaches this stop pin, the latter engages surface 142 of the resetting member 134 and moves the same sufficiently so that overcenter spring 138 forces the resetting member to its other stable position. The disposition of the various parts of the cam follower mechanism at this time is shown in FIGURE 8 of the drawings.

When the drive mechanism is re-energized the cam 54 begins to rotate and eventually the cam follower roll 65 will reach the dwell or lowest point on the surface of the cam 54. During this movement of the cam follower roll 65 and the carrier 121, the latch member 122, which is pivoted to the carrier 121 by pivot pin 123, moves clockwise sufficiently to position its stepped latch surface 126 behind and in engaging relation with the tab 125 extending from the bellcrank arm 66.

Continued rotation of the cam 54 causes the entire cam follower mechanism 120 to be pivoted counterclockwise about pivot pin 68 with the latch surface 126 engaging the tab 125. During this movement of the cam follower mechanism, the arm 146 of resetting member 134 rides past the stop pin 147 without switching the position of the resetting member 134 and then drops behind the stop pin 147. The positions of the various parts when the cam follower roll 65 is adjacent the high rise portion of the cam 54 is shown in FIGURE 9 of the drawings. At this time the heating unit 37 is located adjacent its initial position 50.

The cam 54 continues to rotate and the cam follower roll 65 moves down the sharp drop on the camming surface to the dwell point of the cam. The carrier member 121 and the latch member 122 pivot clockwise about pivot pin 68, but the arm 66 of bellcrank 67 is held in an intermediate position and prevented from moving clockwise by the arm 146 of resetting member 134 which is now positioned behind and engages the stop pin 147. As the cam follower roll 65 reaches the dwell of the cam, the stepped latch surface 124 of latch member 122 drops behind the tab 125 of bellcrank arm 67 and the heating unit 37 is located adjacent its initial position 50. The fusing apparatus is now ready to resume fusing operations. During the first fusing operation, the surface 141 of the resetting member 134 engages reset pin 143 located on the top of the housing member 46 to flip the resetting member to its other stable position. This removes the arm 146 of resetting member 134 from engaging relation with the stop pin 147. The cam follower mechanism 120 is now in its initial latched condition or state. Subsequent energization of the solenoid 131 in response to the detection of a fault condition will automatically result in the heating unit again being moved to its safety position 50'' in pocket 151 provided by heat shield 150.

It should now be apparent that the objects initially set forth have been accomplished and that various changes can be made in the disclosed embodiment without departing from the teachings of the invention. For example, the solenoid for actuating the latch member can be arranged so that the latch member is maintained in its latched state only as long as the solenoid is energized so that if power is lost for any reason the heating unit is moved to the safety position. Also, if the heating unit

12

moves too quickly to the safety position when a fault condition is detected, a damping means can be included either within the pocket or on top of the heating assembly housing member to prevent shock damage to the heating lamp. The heating unit may comprise more than one heating lamp or other types of heating elements. The fusing apparatus has application in a wide variety of copying systems other than those employing dry toner particles. It may be used to evaporate the solvent from and/or dry copy sheets in a copying system employing liquid development techniques and the term "fusing" as employed in this specification and the claims is intended to include and cover the use of disclosed method and apparatus for these purposes.

While the invention has been particularly shown and described with reference to a preferred embodiment thereof, it will be understood by those skilled in the art that the foregoing and other changes in form and details may be made therein without departing from the spirit and scope of the invention.

What is claimed is:

1. Apparatus for fusing an image on a copy sheet in a copying system or the like comprising:

means to move a copy sheet in one direction along a path of travel;

a fusing unit located in fusing relation with a copy sheet moving along said path of travel;

means mounting said fusing unit for movement along said path of travel in said one direction from an initial position to a final position and for movement to a retracted safety position out of fusing relation with a copy sheet moving along said path of travel;

means to move said fusing unit from said initial position to said final position when a copy sheet is moving along said path of travel adjacent said fusing unit to extend the time the copy sheet is in fusing relation with said fusing unit;

means to move said fusing unit to said retracted safety position out of fusing relation with a copy sheet;

said fusing unit comprises a heating unit disposed in heat exchange relation with a copy sheet moving along said path of travel; and

a heat shield at said retracted safety position which is disposed between said heating unit and said path of travel when said fusing unit is located in said retracted safety position.

2. Apparatus for fusing an image on a copy sheet in a copying system or the like comprising:

means to move a copy sheet in one direction along a path of travel;

a fusing unit located in fusing relation with a copy sheet moving along said path of travel;

means mounting said fusing unit for movement along said path of travel in said one direction from an initial position to a final position and for movement to a retracted safety position out of fusing relation with a copy sheet moving along said path of travel;

means to move said fusing unit from said initial position to said final position when a copy sheet is moving along said path of travel adjacent said fusing unit to extend the time the copy sheet is in fusing relation with said fusing unit;

means to move said fusing unit to said retracted safety position out of fusing relation with a copy sheet;

said means to move said fusing unit comprises means to return said fusing unit from said final position to said initial position after a copy sheet has moved from fusing relation with said fusing unit; and

means to move said fusing unit from said retracted safety position to a position in fusing relation with a copy sheet moving along said path of travel.

3. Apparatus for fusing an image on a copy sheet in a copying system or the like comprising:

means to move a copy sheet in one direction along a path of travel;

13

a fusing unit located in fusing relation with a copy sheet moving along said path of travel;
 means mounting said fusing unit for movement along said path of travel in said one direction from an initial position to a final position and for movement to a retracted safety position out of fusing relation with a copy sheet moving along said path of travel;
 means to move said fusing unit from said initial position to said final position when a copy sheet is moving along said path of travel adjacent said fusing unit to extend the time the copy sheet is in fusing relation with said fusing unit;
 means to move said fusing unit to said retracted safety position out of fusing relation with a copy sheet;
 said means to move said fusing unit from said initial position to said final position comprises a cam;
 cam follower means drivingly interconnecting said cam and said fusing unit;
 means to effect relative movement between said cam and said cam follower means; and
 said means to move said fusing unit to said retracted safety position comprises means to disengage at least a portion of said cam follower means from driven relation with said cam.

4. Apparatus according to claim 3 further characterized by:

said cam follower means comprises a cam follower element engaging said cam;
 a plurality of relatively stationarily mounted rotatable pulleys and at least one rotatable pulley which is mounted for translational movement;
 a linkage means rigidly interconnecting said cam follower element and said pulley which is mounted for translational movement;
 a flexible member extending in a path of travel about said pulleys; and
 said fusing unit being connected to said flexible member so that said fusing unit moves along said path of copy sheet travel upon actuation of said means to effect relative movement between said cam and said cam follower means.

5. Apparatus according to claim 4 further characterized by:

said linkage means comprising a pair of levers;
 one of said levers mounting said rotatable pulley which is mounted for translational movement;
 the other of said levers mounting said cam follower element;
 a latch member normally maintaining said pair of levers in rigid coupled relation with respect to each other;
 biasing means connected to said one of said levers for maintaining said cam follower element in engagement with said cam; and
 means to actuate said latch member to cause movement of said one of said levers relative to said other of said levers, said cam follower element and said cam to move said fusing unit to said retracted safety position.

6. Apparatus for fusing an image on a copy sheet in a copying system or the like comprising:

means to move a copy sheet in one direction along a path of travel;
 a fusing unit located in fusing relation with a copy sheet moving along said path of travel;
 means mounting said fusing unit for movement along said path of travel in said one direction from an initial position to a final position and for movement to a retracted safety position out of fusing relation with a copy sheet moving along said path of travel;
 means to move said fusing unit from said initial position to said final position when a copy sheet is moving along said path of travel adjacent said fusing unit to extend the time the copy sheet is in fusing relation with said fusing unit;

14

means to move said fusing unit to said retracted safety position out of fusing relation with a copy sheet when a fault condition is detected;
 said means to move said fusing unit from said initial position to said final position comprising a driven element;
 means to couple said driven element with said fusing unit so that said driven element moves said fusing unit; and
 said means to move said fusing unit to said retracted safety position comprising means to disengage said means to couple said driven element with said fusing unit.

7. Apparatus according to claim 6 further characterized by:

said driven element comprises a cam;
 said means to couple said driven element with said fusing unit comprises cam follower means; and
 said means to move said fusing unit to said retracted safety position comprises biasing means urging said cam follower means into engagement with said cam.

8. Apparatus according to claim 6 further characterized by:

means to re-engage said means to couple said driven element with said fusing unit to move said fusing unit into fusing relation with a copy sheet moving along said path of travel.

9. Apparatus for fusing an image on a copy sheet in a copying system or the like comprising:

means to move a copy sheet in one direction along a path of travel;
 a fusing unit located in fusing relation with a copy sheet moving along said path of travel;
 means mounting said fusing unit for movement along said path of travel in said one direction from an initial position to a final position and for movement to a retracted safety position out of fusing relation with a copy sheet moving along said path of travel;
 means to move said fusing unit from said initial position to said final position when a copy sheet is moving along said path of travel adjacent said fusing unit to extend the time the copy sheet is in fusing relation with said fusing unit;
 means to move said fusing unit to said retracted safety position out of fusing relation with a copy sheet when a fault condition is detected;
 said means to move said fusing unit from said initial position to said final position comprising a cam;
 cam follower means for coupling said cam with said fusing unit;
 said cam follower means comprising a cam follower element and a linkage means;
 said linkage means comprising a pair of levers;
 one of said levers mounting said cam follower element;
 a latch member normally latching said levers in rigid coupled relation with respect to each other;
 biasing means connected to said one of said levers for maintaining said cam follower element in engagement with said cam; and
 means to actuate said latch member to cause movement of said one of said levers relative to said other of said levers, said cam follower element and said cam to move said fusing unit to said retracted safety position.

10. Apparatus according to claim 9 further characterized by:

means to relatch said latch member in response to movement of said cam to move said fusing unit from said retracted safety position to said initial position.

11. Apparatus according to claim 10 further characterized by:

said means to relatch comprises a plurality of stationary stops and a resetting member; and
 said resetting member being carried by one of said pair of levers.

15

12. Apparatus for fusing an image on a copy sheet in a copying system or the like comprising:
 means to move a copy sheet in one direction along a path of travel;
 a fusing unit located in fusing relation with a copy sheet moving along said path of travel;
 means mounting said fusing unit for movement along said path of travel from a fusing position in fusing relation with a copy sheet moving along said path of travel to a retracted safety position out of fusing relation with a copy sheet moving along said path of travel;
 means to move said fusing unit to said retracted safety position out of fusing relation with a copy sheet when a fault condition is detected;
 a fusing unit receiving assembly located at said retracted safety position; and
 said fusing unit receiving assembly comprising a shield located between said fusing unit and said path of travel when said fusing unit is in said retracted safety position.
13. Apparatus for fusing an image on a copy sheet in a copying system or the like comprising:
 means to move a copy sheet in one direction along a path of travel;
 a fusing unit located in fusing relation with a copy sheet moving along said path of travel;
 means mounting said fusing unit for movement along said path of travel from a fusing position in fusing relation with a copy sheet moving along said path of travel to a retracted safety position out of fusing relation with a copy sheet moving along said path of travel;
 means to move said fusing unit to said retracted safety position out of fusing relation with a copy sheet when a fault condition is detected;
 a fusing unit receiving assembly mounted adjacent and to one side of said fusing unit when said fusing unit is located in fusing relation with a copy sheet moving along said path of travel;
 said fusing unit receiving assembly being pocket-shaped with an opening facing said fusing unit to permit the movement of said fusing unit into said assembly; and
 said fusing unit receiving assembly comprising a shield located between said fusing unit and said path of travel when said fusing unit is located in said retracted position.
14. Apparatus according to claim 13 further characterized by:
 means mounting said fusing unit for movement along said path of travel in said one direction from an initial position to a final position while in fusing relation with a copy sheet moving along said path of travel; and
 means to move said fusing unit from said initial position to said final position when a copy sheet is moving along said path of travel adjacent said fusing unit to extend the time the copy sheet is in fusing relation with said fusing unit.
15. The method of fusing marking material to a copy sheet which comprises the steps of:
 moving the copy sheet bearing the marking material in one direction along a path of travel;
 moving a fusing unit located adjacent said path of travel in said one direction when the copy sheet is moving along said path of travel adjacent said fusing

16

- unit to extend the time the copy sheet is in fusing relation with said fusing unit; and
 moving said fusing unit along said path of travel to a retracted safety position disposed along said path of travel out of fusing relation with a copy sheet moving along said path of travel when a predetermined condition is detected.
16. Apparatus for fusing an image on a copy sheet in a copying system or the like comprising:
 means to move a copy sheet in one direction along a path of travel;
 a fusing unit located in fusing relation with a copy sheet moving along said path of travel;
 means mounting said fusing unit for movement along said path of travel in said one direction from an initial position to a final position and for movement along said path of travel to a retracted safety position disposed along said path of travel;
 means to move said fusing unit along said path of travel in said one direction from said initial position to said final position when a copy sheet is moving along said path of travel adjacent said fusing unit to extend the time the copy sheet is in fusing relation with said fusing unit; and
 means to move said fusing unit along said path of travel to said retracted safety position.
17. Apparatus according to claim 16 further characterized by:
 a fusing unit receiving assembly located at said retracted safety position; and
 said fusing unit receiving assembly comprising a shield located between said fusing unit and said path of travel.
18. Apparatus according to claim 16 further characterized by:
 a fusing unit receiving assembly located at said retracted safety position and mounted adjacent said fusing unit when said fusing unit is positioned in fusing relation with a copy sheet moving along said path of travel; and
 said fusing unit receiving assembly being pocket-shaped with an opening facing said fusing unit to permit the movement of said fusing unit into said assembly.
19. Apparatus according to claim 16 further characterized by:
 said means to move said fusing unit from said initial position to said final position comprises a cam;
 cam follower means drivingly interconnecting said cam and said fusing unit;
 means to effect relative movement between said cam and said cam follower means; and
 said means to move said fusing unit along said path of travel to said retracted safety position comprises means to disengage cam follower means and said cam.

References Cited

UNITED STATES PATENTS

3,053,962	9/1962	Cerasani et al.	219—388
3,197,614	7/1965	Engelstad et al.	219—388
3,219,326	11/1965	Hunt.	

JOHN J. CAMBY, Primary Examiner

U.S. Cl. X.R.

219—388