May 30, 1967 D. W. PEGRAM, JR 3,322,098

ELECTROSTATIC APPARATUS

Original Filed Nov. 6, 1964

6 Sheets-Sheet 1

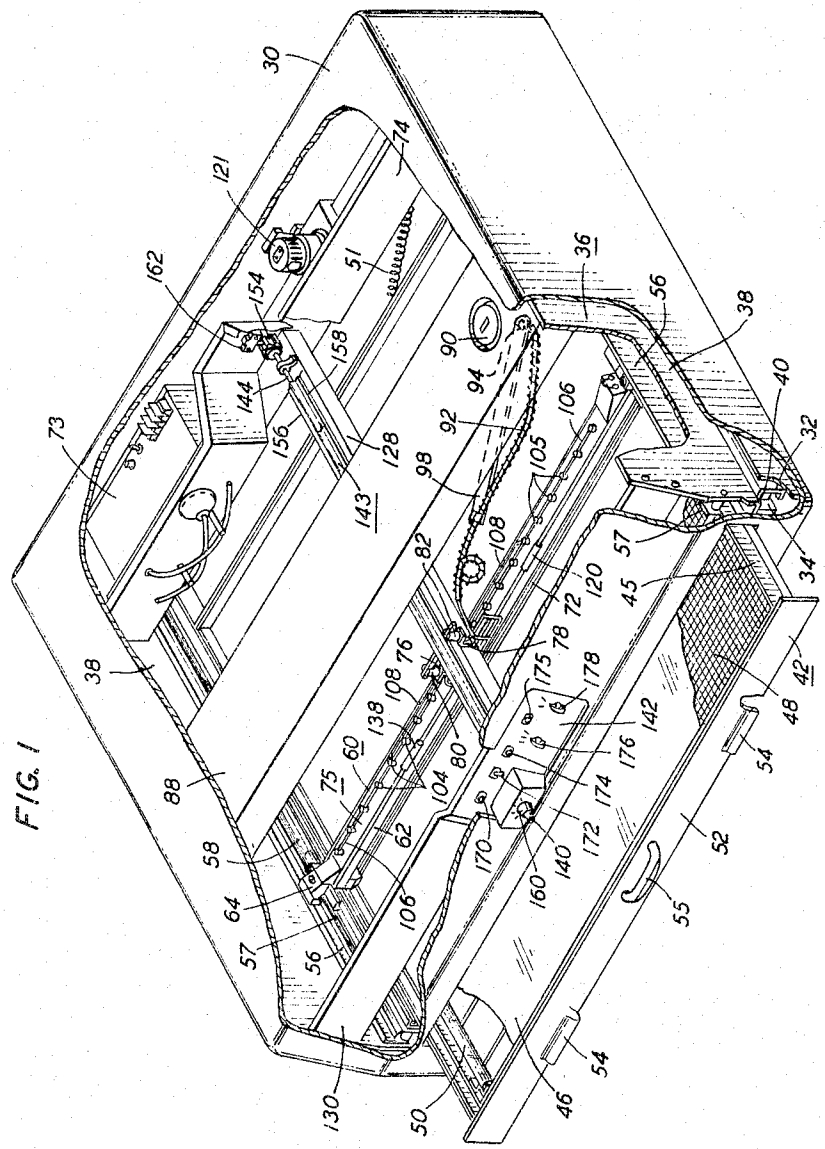


FIG. 1

INVENTOR
D. W. PEGRAM, JR.
BY
Harry L. Newman
ATTORNEY

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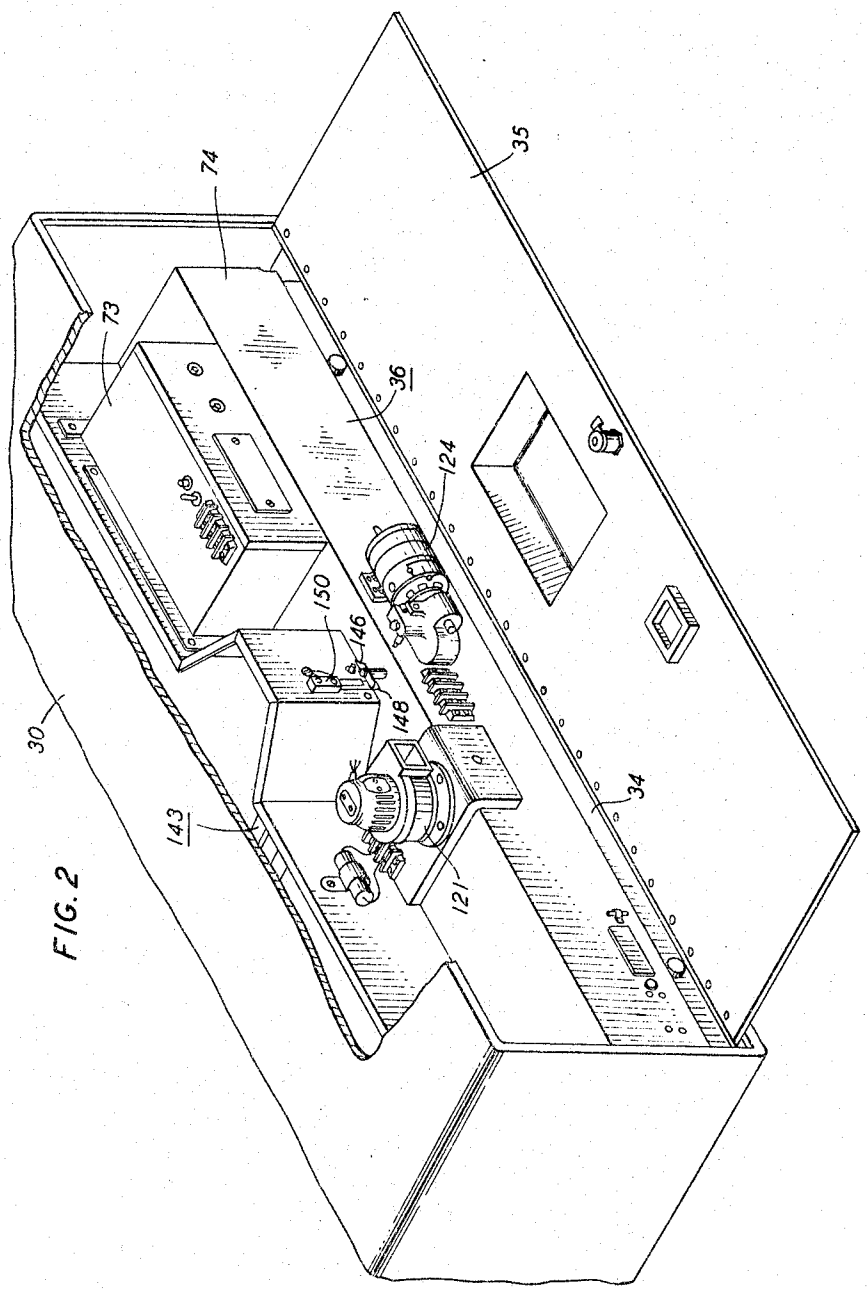


FIG. 2

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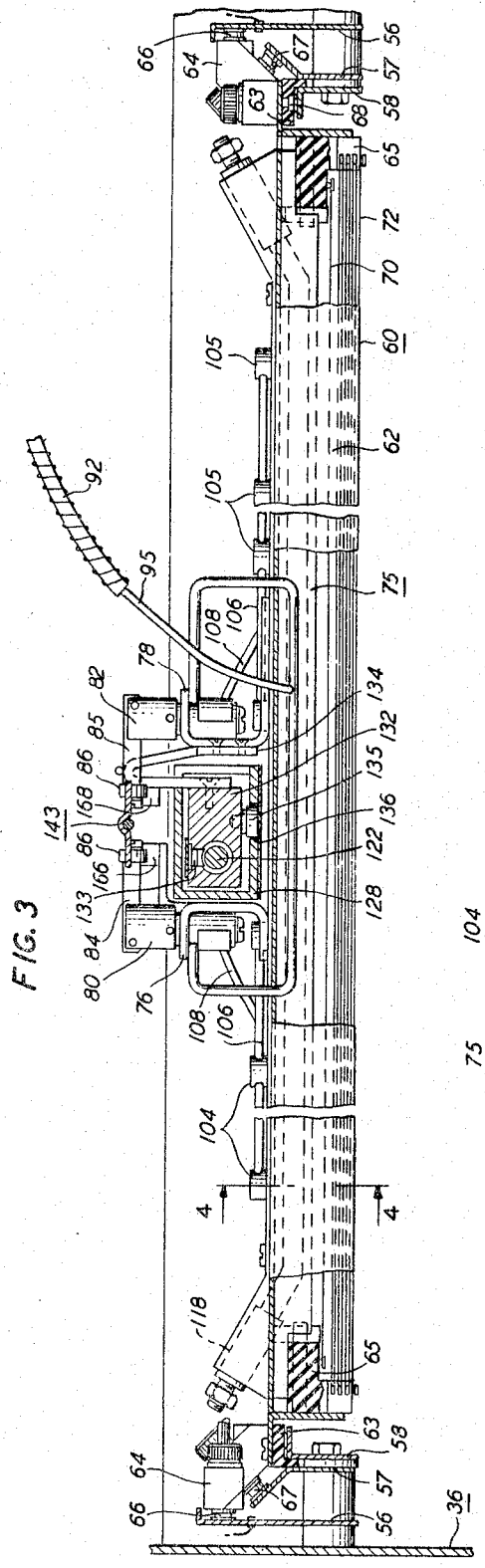
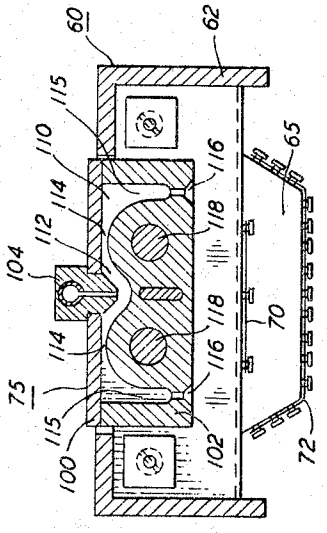


FIG. 3

FIG. 4



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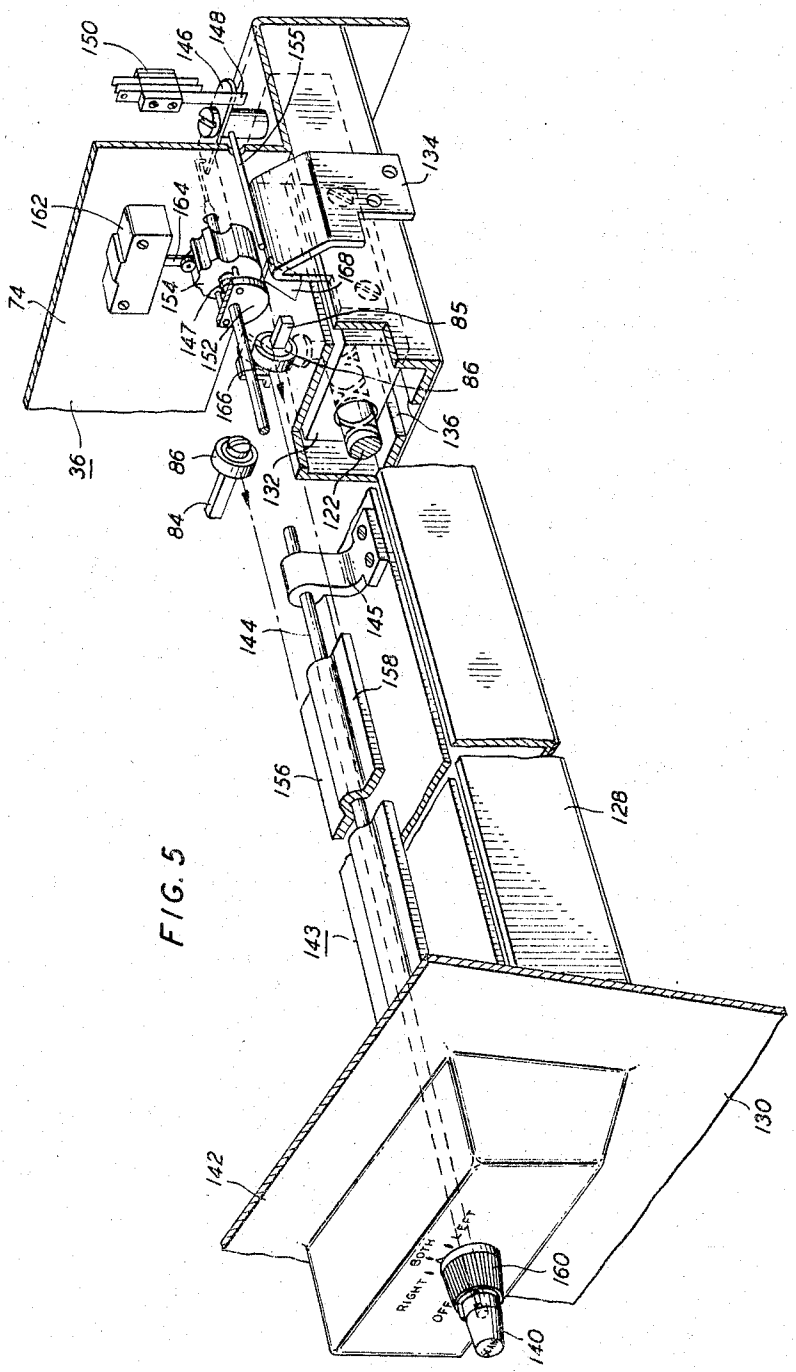


FIG. 5

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FIG. 9

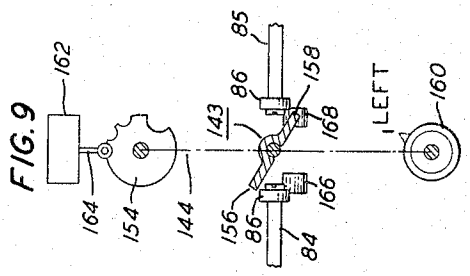


FIG. 9A

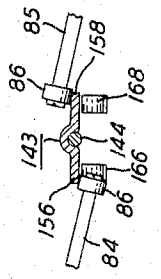


FIG. 8

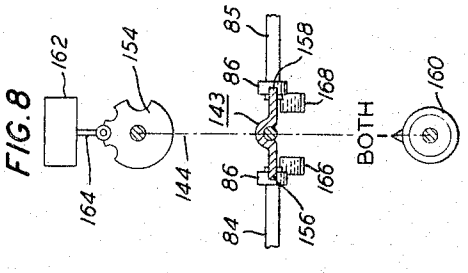


FIG. 8A

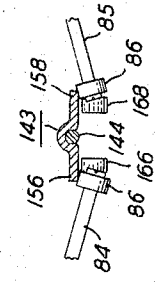


FIG. 7

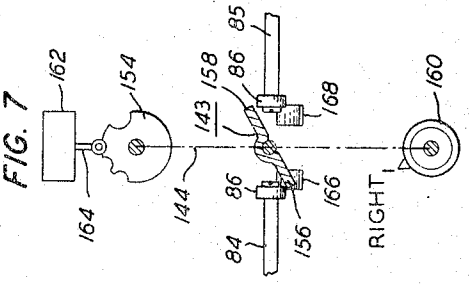


FIG. 7A

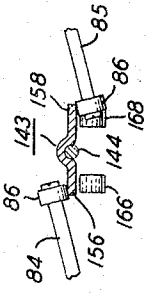
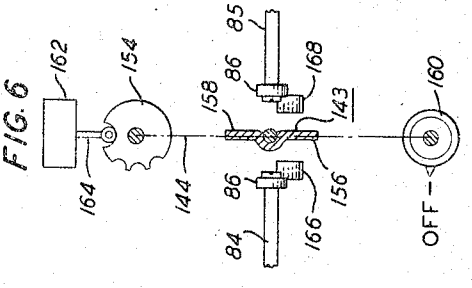


FIG. 6



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Original Filed Nov. 6, 1964 6 Sheets-Sheet 6

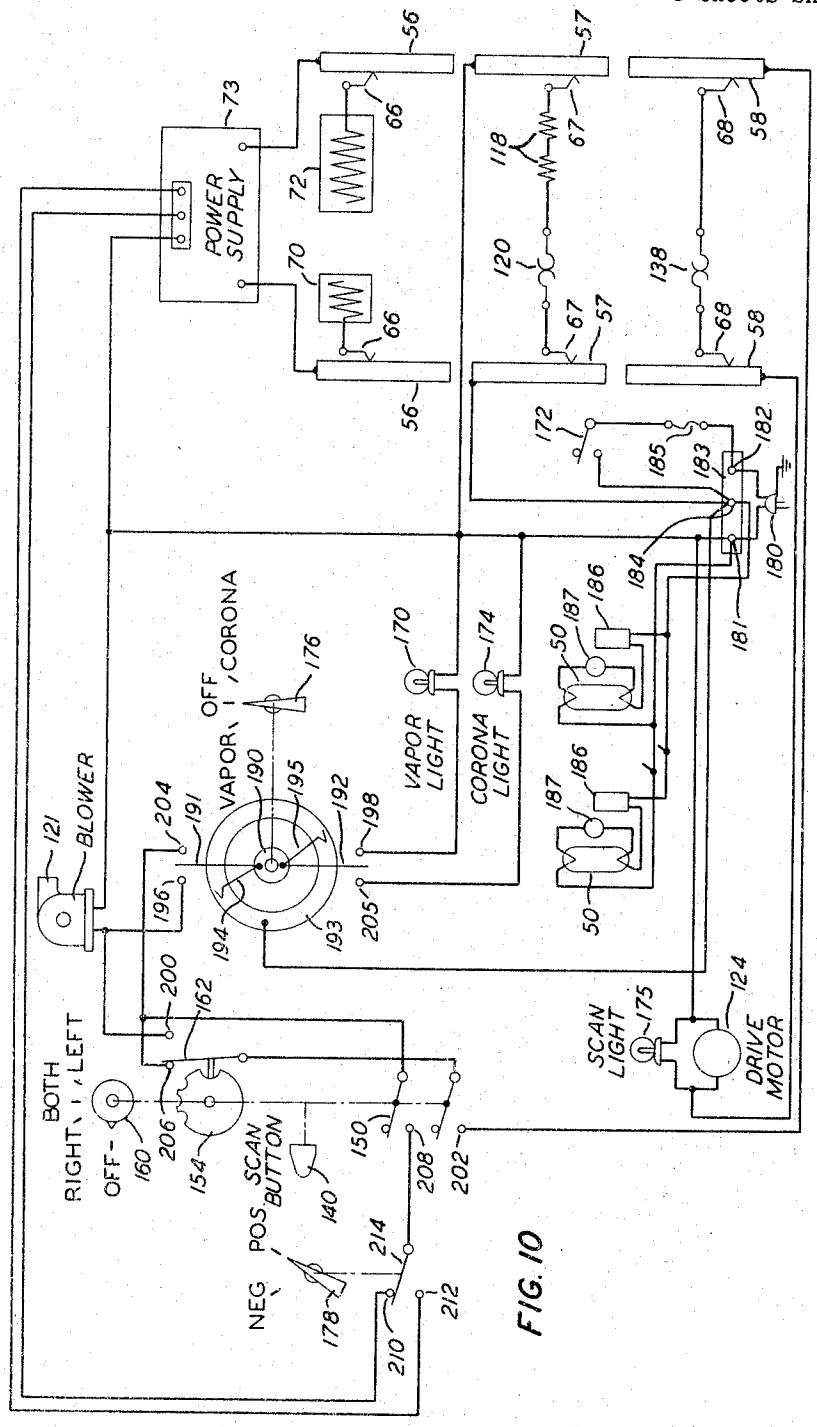


FIG. 10

United States Patent Office 3,322,098
Patented May 30, 1967

3,322,098

ELECTROSTATIC APPARATUS

Dewey W. Pegram, Jr., Burlington, N.C., assignor to Bell Telephone Laboratories, Incorporated, New York, N.Y., a corporation of New York

Original application Nov. 6, 1964, Ser. No. 411,177. Divided and this application Apr. 13, 1965, Ser. No. 447,738

14 Claims. (Cl. 118—637)

This application is a division of a copending application, Ser. No. 411,177, filed Nov. 6, 1964, now abandoned, which application is a continuation-in-part of an earlier copending application, Ser. No. 218,677, filed Aug. 22, 1962, now abandoned.

This invention relates to electrostatic printing apparatus and particularly to an apparatus for transferring and fixing an electrostatic powder image.

For many years the drafting departments of manufacturing concerns have been seeking ways of reducing the time spent by draftsmen in preparing manufacturing drawings. The principal area of concern has been the time required to apply notes, tables, and repetitive details to the drawings. Such work is tedious and time consuming, yet does not require real skill and so is wasteful of the draftsmen's talents.

Some progress has been realized through the use of templates and lettering machines. More recently, pressure sensitive tapes and dry transfer sheets on which letters and symbols are printed have been employed. However, templates still require the draftmen's time. Lettering machines cannot be used to apply schematic details. Pressure sensitive tapes appear as darkened strips on reproductions, and dry transfer details are easily abraded.

An object of this invention is to provide an apparatus for printing notes, tables, and repetitive details on drawings, thereby removing these tasks from the work load of the draftsmen and enabling them to use their time for more creative work.

Specifically, an object of this invention is to provide an apparatus for employing electrostatic powder images in the execution of documents such as drawings.

Electrostatic powder images may be formed by any one of several processes, one of which is xerography. In the art of xerography an electrophotographic plate comprising a photoconductive insulating layer overlying a conductive backing is sensitized by applying an electrostatic charge to the photoconductive layer. The sensitized plate is then exposed to a light image by reflecting or projecting thereon the image to be reproduced. Under the influence of the light of the photoconductive insulating layer becomes electrically conductive in proportion to the amount of light falling on each particular area, permitting the electrostatic charge to be selectively dissipated in the portions that are illuminated. In this manner an electrostatic latent image is formed corresponding to the shaded portions of the light image.

The latent image is developed by depositing thereon an electrostatic powder that carries charges opposite to that of the electrostatic latent image. The charged powder particles adhere to areas of the charge on the photoconductive insulating area in conformity with the density of the charge, thereby providing a powder image.

The powder image is transferred from the electrophotographic plate to a sheet of transfer material, such as paper, by placing the transfer sheet in contact with the plate and charging the transfer sheet opposite to the charge on the powder image. The powder image is attracted from the plate to the transfer sheet and adheres to the sheet when it is removed from the plate.

The apparatus of the present invention is employed to

transfer the powder image from the transfer sheet to a document such as a drawing and fix the powder image thereto. An illustrative embodiment of the apparatus comprises a cabinet including a drawer that can be pulled out to a position wherein the major portion of the drawer is outside the cabinet. The drawer has a horizontal work surface and lamps for illuminating the work surface, the work surface being light transmitting and overlying the lamps. The work surface is also electrically conducting and is connected to ground.

A movable carriage is housed within the cabinet, and with the drawer positioned within the cabinet, the carriage overlies the work surface. The carriage spans the width of the work surface, and a motor is provided for driving the carriage back and forth along the length of the work surface. The carriage includes a group of corona discharge wires and a vapor discharge tank.

The corona discharge wires are connected to a high voltage power supply, the power supply being selectively energizable to provide either a positive or a negative potential. Upon energization of the power supply, a high field strength is developed between the wires and the grounded work surface that ionizes the air and places an electrostatic charge on the work surface and any object in engagement therewith.

The vapor discharge tank is connected by a conduit to a reservoir containing a liquid solvent, and valves in the conduit path permit the solvent to flow to selected portions of the tank. The tank includes a vapor generating chamber and nozzles for controlling the rate of flow of the solvent into the chamber. Heating elements embedded in the tank raise the temperature above the vapor generating chamber to the point that the solvent is vaporized upon contact therewith, and ports distributed along the bottom of the tank direct the solvent vapor toward the work surface.

A complete understanding of the invention and of these and other features and advantages thereof may be gained from consideration of the following detailed description taken in conjunction with the accompanying drawing wherein one embodiment of the apparatus of the invention is illustrated. It is to be expressly understood, however, that the drawing is for the purpose of illustration and description and is not to be construed as defining the limits of the invention.

In the drawing:

FIG. 1 is a front perspective view, partly broken away, of the electrostatic powder image transfer and fixing apparatus of this invention, showing the movable carriage intermediate the ends of the cabinet as when fixing a powder image to a sheet of transfer material;

FIG. 2 is a rear perspective view, partly broken away, of a portion of the apparatus showing an access door thereof in an open position;

FIG. 3 is a front view, partly in section, of the carriage and the means by which it is driven, the carriage being shown in its rest position;

FIG. 4 is a sectional view taken along line 4—4 of FIG. 3;

FIG. 5 is a perspective view, partly broken away, showing the interacting elements of the means for controlling the operation of the carriage;

FIG. 6 is a schematic view showing the position of a control member with respect to valve operating levers and the position of an interlock cam with respect to an interlock switch when a vapor control knob is placed in its off position;

FIG. 7 is a schematic view showing the position of the control member with respect to the valve operating levers and the position of the interlock cam with respect to the interlock switch when the vapor control knob is placed

in the right position, the carriage being located in its rest position;

FIG. 7A is a schematic view showing the change in the position of the control member and the valve operating levers of FIG. 7 as a result of the carriage moving forward from the rest position;

FIG. 8 is a schematic view showing the position of the control member with respect to the valve operating levers and the position of the interlock cam with respect to the interlock switch when the vapor control knob is placed in the both position, the carriage being located in the rest position;

FIG. 8A is a schematic view showing the change in the position of the control member and the valve operating levers of FIG. 8 as a result of the carriage moving forward from the rest position;

FIG. 9 is a schematic view showing the position of the control member with respect to the valve operating levers and the position of the interlock cam with respect to the interlock switch when the vapor control knob is placed in the left position, the carriage being located in the rest position;

FIG. 9A is a schematic view showing the change in the position of the control member and the valve operating levers of FIG. 9 as a result of the carriage moving forward from the rest position; and

FIG. 10 is a schematic circuit diagram.

Referring now to the drawing and FIGS. 1 and 2 in particular, the electrostatic powder image transfer and fixing apparatus of this invention includes a cabinet **30**. A pair of drawer slides **32**, only one of which is visible, are respectively mounted adjacent the sides of the cabinet **30**, and a rectangular base **34** is secured to the drawer slides. All components of this invention other than the cabinet **30** are mounted on the base **34**, and the drawer slides **32** permit the base and the components mounted thereon to be moved out from the cabinet through an access door **35** at the rear of the cabinet when servicing of the components is required.

A tray **36** is mounted on the base **34**, the tray including a pair of side walls **38** that essentially extend the length of the cabinet **30**. A pair of drawer slides **40**, only one of which is visible, are respectively mounted along the bottom edge of the side walls **38**, and a drawer **42** is secured to the drawer slides so as to be movable through an opening in the front surface of the cabinet **30**.

The drawer **42** comprises a rectangular frame **45** on which a light transmitting and electrically conducting work surface **46** is supported, the work surface being electrically connected to ground. Typically, the work surface **46** is clear glass to which a thin coating of platinum is applied. A grid overlay **48** is provided for the work surface **46** and this is employed to assist in properly locating a powder image on a sheet of transparent transfer material, the transfer sheet having been positioned on the grid. A plurality of electric light sources, such as the fluorescent lights **50**, is mounted on the frame **45** beneath the work surface **46**, and means for diffusing the light (not shown) are situated intermediate the light sources and the work surface to provide even illumination of the work surface. A coiled cord **51** connects the light sources to a source of electric power.

A panel **52** a little larger in size than the cabinet opening **44** is secured to the front of the frame **45**, and the panel is provided with air passageways **54** to allow air to flow into the front of the cabinet **30** when the drawer **42** is closed. A handle **55** fastened to the front of the frame **45** is used to pull the drawer **42** out from the cabinet **30** when access to the work surface **46** is desired.

Turning to FIGS. 1 and 3, three pairs of current carrying rails **56**, **57**, and **58** are respectively secured to the tray side walls **38** just above the drawer slides **40**, the rails being secured so as to be electrically insulated from each other and from the side walls. The rails are spanned by a carriage **60** that comprises a rigid frame **62** having a

dielectric shoe **63** mounted to the underside of each end thereof. The carriage **60** is supported by the pair of rails **58**, and the shoes **63** ride on these rails and electrically insulate the carriage therefrom. The shoes **63** permit the carriage to move along the length of the rails **58**, and each shoe includes a lip that extends between the rails **57** and **58** and prevents any cocking of the carriage as it moves along the rails.

A dielectric brush block **64** and a corona wire mounting block **65** are also secured to each end of the frame **62**. Each brush block **64** has brushes **66**, **67**, and **68** mounted therein in an electrically insulated fashion, and the brushes respectively make electrical contact with the current carrying rails **56**, **57**, and **58**. The corona wire mounting blocks **65** have corona generating wires **70** and screen wires **72** strung therebetween below the frame **62**, and the corona generating and screen wires are respectively mounted on the blocks **65** so as to be spaced and electrically insulated one from the other, the screen wires generally underlying and arcuately encompassing the corona generating wires. One of the brushes **66** is electrically connected to the corona generating wires **70** while the other brush **66** is electrically connected to the screen wires **72**, and the rails **56**, which the brushes **66** engage, are electrically connected to a high voltage power supply **73** mounted on a stepped rear wall **74** of the tray **36**.

A vapor discharge tank **75** rests on the corona wire mounting blocks **65** within the rigid frame **62** but is not secured thereto. The vapor discharge tank **75** is heated during the operation thereof, and as it is able to expand relative to the rigid frame **62** and the elements mounted thereon, it does not create any stresses on these elements.

The vapor discharge tank **75** has a pair of brackets **76** and **78** secured to the upper surface thereof and extending upwardly therefrom. For reasons that become clear hereinafter, the bracket **78** is secured with the upright portion thereof approximately midway between the ends of the vapor discharge tank **75**, while the bracket **76** is mounted to one side of the bracket **78**. Valves **80** and **82** are respectively mounted on the brackets **76** and **78**, and the valves respectively include operating levers **84** and **85** that extend toward each other and have rollers **86** disposed about the ends thereof. The levers **84** and **85** are normally respectively biased by the valves **80** and **82** to a horizontal position and in this position of the levers the valves are closed. Movement of the levers **84** and **85** to a position below the horizontal respectively opens the valves **80** and **82**.

The valves **80** and **82** control the flow of a solvent liquid, such as trichloroethylene, from a stationary reservoir **88** to the vapor discharge tank **75**. The reservoir **88** extends between and is secured to the side walls **38** of the tray **36** and has an opening in the upper surface thereof through which the solvent liquid is added thereto, the opening being normally covered by a cap **90**. The liquid flows from the reservoir **88** to the vapor discharge tank **75** by gravity feed through a flexible tubing **92**. One end of the flexible tubing **92** is connected to a rotatable outlet **94** on the underside of the reservoir **88**, while the other end of the tubing is connected to rigid tubing **95** mounted on the vapor discharge tank **75**, the rigid tubing distributing the solvent liquid to the valves **80** and **82**. The flexible tubing **92** is looped to provide slack since the distance between the reservoir **88** and tank **75** changes as the carriage **60** moves along the rails **58**, and a wire spring is advantageously disposed about the entire length of the flexible tubing to prevent it from crimping. A support **98** mounted on the rotatable outlet **94** rotates with the outlet and holds the flexible tubing **92** above the path of movement of the carriage **60**.

Referring also to FIG. 4, the vapor discharge tank **75** comprises a cover **100** fastened to a base **102**. Two groups of nozzles **104** and **105** are mounted in the cover **100**, the nozzles in each group being in line and spaced one from the other. Each group of nozzles has a distribution

tube **106** interconnecting each nozzle within the group, and each group is connected to the outlet of one of the valves by a supply tube **108**, the group of nozzles **104** being connected to the valve **80** and the group of nozzles **105** being connected to the valve **82**. The nozzles **104** control the rate of flow of the solvent liquid into one portion of the vapor discharge tank **75** when the valve **80** is actuated to an open condition, and the nozzles **105** control the rate of flow of the solvent liquid into another portion of the vapor discharge tank **75** when the valve **82** is actuated to an open condition.

The nozzles **104** and **105** overlie indivual partitioned portions of a vapor generating chamber **110** in the vapor discharge tank **75**. The chamber comprises an inlet cavity **112** having a concave floor beneath the nozzles. The inlet cavity **112** is in communication with a pair of constricted passageways **114**, each of which leads to an outlet duct **115** on each side of the nozzles, and each outlet duct **115** communicates with a plurality of spaced ports **116** in the underside of the vapor discharge tank **75**. The ports **116** have conical terminations, and the ports at the front of the vapor discharge tank **75** are offset with respect to the ports at the rear of the tank.

A pair of electric heating elements **118** are mounted in the base **102** underneath vapor generating chamber **110**, the heating elements being connected to the current carrying rails **57** by the brushes **67**. A thermostat **120** mounted on the side of the vapor discharge tank **75** is connected in series with the heating elements **118**, and it maintains the tank **75** at the temperature necessary to vaporize the solvent liquid. For the solvent trichloroethylene, a temperature between **205** degrees and **215** degrees Fahrenheit has been found desirable. The solvent liquid drips from the nozzles **104** and **105** and is vaporized upon contact with the floor in the inlet cavity **112**. The expansion that occurs upon the vaporization of the liquid causes the vapor to move through the constricted passageways **114** into the outlet ducts **115**, the vapor being heated above ambient temperature as it passes thereto. The constricted passageways **114** accelerate the movement of the vapor, and the outlet ducts **115** direct the vapor through the spaced ports **116** toward the work surface **46** of the drawer **42**. Due to the conical termination of each port **116**, the vapor discharge therefrom is generally conical in shape, the discharges overlapping one another due to the offset between the front and rear ports. Exhaust means such as a blower **121** mounted on the stepped rear wall **74** of the tray **36** exhausts the vapor fumes out through the rear of the cabinet **30**.

Turning now to FIGS. 1, 2, 3, and 5, the carriage **60** is moved back and forth over the work surface **46** by means of a reversing lead screw **122** driven by a motor **124** mounted on the stepped rear wall **74**. The lead screw **122** is enclosed within a housing **128** and journaled in bearings (not shown) mounted in the ends of the housing, the housing being suspended between the rear wall **74** and a front wall **130** of the tray **36**.

A drive block **132** is disposed about the lead screw **122** and encased within the housing **128**. The drive block **132** has a pin **133** mounted therein that engages the groove in the lead screw **122**, and a drive bracket **134** secured to the drive block projects through a slot in the housing and is fastened to the bracket **78** mounted on the vapor discharge tank **75**. Thus when the lead screw **122** is rotated by the motor **124**, the drive block **132** is moved along the length of the lead screw **122**, and the block, acting through the bracket **78** and the vapor discharge tank **75**, moves the carriage **60**, the block automatically reversing its direction of movement when it reaches either end of the screw. As mentioned above, the bracket **78** is mounted approximately midway between the ends of the vapor discharge tank **75** and consequently the driving force acts on the carriage **60** approximately midway between its ends, thereby stabilizing the movement of the carriage along the rails **58**. In addition, roller bearings **135** are mounted on the underside of the drive block **132** and ride in a channel **136** in the bottom surface of the housing **128** to also stabilize the movement of the carriage **60**.

A thermostat **138** mounted on the vapor discharge tank **75** is electrically connected in series with the motor **124** by the brushes **68** engaging the current carrying rails **58**. The thermostat **138** remains open until the vapor discharge tank **75** reaches its operating temperature, and thus it prevents the motor **124** from being energized prior to that time.

Once the thermostat **138** closes, the motor **124** may be energized by depressing a scan button **140** on a control panel **142** that is part of the front wall **130** of the tray **36**, the controls on the control panel extending through an opening in the front of the cabinet **30**. The depression of the scan button **140** longitudinally displaces a control member **143** that comprises a shaft **144** journaled in bearings **145** mounted on the top of the housing **128**. The rear end of the control member **143** is coupled with one end of a scan lever **146** that is pivotally mounted on the back side of the stepped rear wall **74** of the tray **36**. The other end of the lever **146** is situated in juxtaposition with an actuator **148** of a bistable snap action scan switch **150**. Rearward movement of the control member **143** pivots the latter end of the scan lever **146** against the actuator **148** of the scan switch **150**, moving the actuator in a forward direction whereby the scan switch is closed. When the scan button **140** is released, the control member **143** is returned to a forward position and the scan lever **146** counterrotated by a compression spring **147**. The spring **147** is disposed intermediate a disc **152**, which is affixed to the shaft **144** and the interlock cam **154**, through which the shaft extends and is longitudinally movable.

A pin **155** mounted on the drive bracket **134** opens the scan switch **150** after the carriage **60** has scanned the work surface **46** of the drawer **42**, the carriage moving from a rest position at the rear of the tray **36** to the forward end of the tray and back to the rear end of the tray. The pin **155** projects rearwardly from the drive bracket **134** and is in direct line with the actuator **148** of the scan switch **150**. As the drive block **132** reaches its rearmost position on the lead screw **122**, the pin **155** moves through an opening in the rear wall **74** and deflects the actuator **148** rearwardly, opening the scan switch **150**. The momentum of the system causes the carriage **60** to coast to its rest position, which is a small distance from this rearmost position, and therefore the pin **155** is moved forward from the actuator **148**.

The control member **143** besides actuating the scan switch **150** also controls the operation of the valves **80** and **82** mounted on the carriage **60**. The control member **143** includes a pair of vanes **156** and **158** mounted on the shaft **144**, and by rotating a vapor control knob **160** disposed about the scan button **140** the shaft is rotated to change the attitude of the vanes. The interlock cam **154** through which the shaft **144** passes is keyed to rotate with the shaft, and the cam includes four grooves spaced around the periphery thereof. An interlock transfer switch **162** mounted to the rear wall **125** above the cam **154** has a plunger type actuator **164** that is biased against the periphery of the cam, and the actuator cooperates with the grooves in the cam to locate the vanes **156** and **158** in one of the following four positions: (1) the vanes extending vertically; (2) the vane **156** extending below the horizontal and the vane **158** extending above the horizontal; (3) the vanes extending horizontally; and (4) the vane **156** extending above the horizontal and the vane **158** extending below the horizontal. The groove associated with the first of the above positions is deep, and it permits the actuator **164** to move downward a sufficient distance to transfer the interlock switch from a first to a second position. The grooves associated with the last three positions are shallow, and in these positions of the cam **154**, the actuator **164** maintains the interlock switch **162** in the first position.

Referring to FIGS. 3 and 5, the vanes **156** and **158** extend laterally from the shaft **144** and lie in a common plane, and when the vanes are in a horizontal position this plane lies in the path of travel of the rollers **86** mounted on the ends of the operating levers **84** and **85** of the valves **80** and **82**, respectively, the plane of the vanes being slightly above the axis of rotation of the rollers when the valves are in a closed condition. The vanes **156** and **158** extend longitudinally along the length of the shaft for a major portion of the length thereof, but the vanes terminate a distance forward from the rear wall **74** of the tray **36** such that when the carriage **60** is in its rest position, the rear ends of the vanes are forward of operating levers **84** and **85**.

As a result of the above relationships, the operating levers **84** and **85** of the valves **80** and **82**, respectively, do not engage the vanes **156** and **158** when the carriage **60** is in its rest position, and the valves are therefore in their normally closed condition. But with the vanes **156** and **158** in a horizontal position, as illustrated in FIG. 8, movement of the carriage forward from its rest position brings the rollers **86** mounted on the operating levers **84** and **85** into engagement with the rear ends of the vanes. The rollers **86** are forced to move beneath the vanes **156** and **158**, as shown in FIG. 8A, and the levers **84** and **85** are thereby deflected downward opening the valves **80** and **82**. The valves **80** and **82** remain open until the carriage returns to the rear of the tray **36** at which time the rollers **86** move from beneath the vanes and the levers are again free to move upward, closing the valves.

When the vapor control knob **160** is rotated to place the vanes **156** and **158** in their second position, illustrated in FIG. 7, wherein the vane **156** extends below the horizontal and the vane **158** extends above the horizontal, the vane **156** is positioned below the path of travel of the operating lever **84** and the vane **158** is positioned above the path of travel of the operating lever **85**. Thus when the carriage is caused to traverse back and forth along the lead screw **122** there is no engagement between the operating levers **84** and **85** and the vanes **156** and **158** during the initial forward movement of the carriage. However, shortly after the operating levers **84** and **85** respectively move over and under the vanes **156** and **158**, the vane **156** is engaged by an inclined leveling member **166** mounted on the valve bracket **76** to the rear of the lever **84**. The inclined leveling member **166** deflects the vane **156** upwardly to a horizontal position, as shown in FIG. 7A, thereby rotating the shaft **144** to also move the vane **158** to a horizontal position. As the operating lever **84** is situated above the vane **156**, it is deflected upwardly and the valve **80** remains closed. The operating lever **85**, on the other hand, is located below the vane **158** and the movement of the vane to a horizontal position deflects the lever downwardly. The valve **80** is thereby opened and remains open until the carriage returns to its rest position.

When the vapor control knob **160** is rotated to place the vanes **156** and **158** in their fourth position, illustrated in FIG. 9, wherein the vane **156** extends above the horizontal and the vane **158** extends below the horizontal, the vane **156** is positioned above the path of travel of the operating lever **84** and the vane **158** is positioned below the path of travel of the operating lever **85**. Thus, when the carriage is caused to traverse back and fourth along lead screw **122** there is again no engagement between the operating levers **84** and **85** and the vanes **156** and **158** during the initial movement of the carriage. However, shortly after the operating levers **84** and **85** respectively move under and over the vanes **156** and **158**, the vane **158** is engaged by an inclined leveling member **168** mounted on the drive bracket **134** to the rear of the operating lever **85**. The inclined leveling member **168** deflects the vane **158** upwardly to a horizontal position, as shown in FIG. 9A, thereby rotating the shaft **144** to also move the vane **156** to a horizontal position. As the operating lever **85** is situated above the vane **158** it is deflected upwardly and the valve **82** remains closed. The operating lever **84**, on the other hand, is located below the vane **156**, and therefore the movement of the vane **156** to a horizontal position deflects the lever downwardly. The valve **80** is thereby opened and remains open until the carriage returns to its rest position.

Finally, when the vapor control knob **160** is rotated to place the vanes **156** and **158** in their first position, illustrated in FIG. 6, wherein the vanes extend vertically, the vanes are neither positioned in the path of travel of the operating levers **84** and **85** nor in the path of travel of the inclined leveling members **166** and **168**. As a result, neither of the operating levers **84** and **85** is deflected downwardly during the traversal of the carriage **60** and both valves **80** and **82** remain closed.

Turning again to FIG. 1, besides the scan button **140** and the vapor control knob **160**, the control panel **142** also includes a vapor light **170**, an "On-Off" switch **172**, a corona light **174**, a scan light **175**, a three position operation select knob **176**, and a two position polarity knob **178**. These elements will be elaborated upon in the description of the electric circuitry that follows.

Referring now to FIG. 10, the electrostatic powder image transfer and fixing apparatus of this invention is connected to an external source of **115** volts alternating current power by means of a plug **180**. The plug **180** is connected across terminals **181** and **182** of a terminal board **183** that also includes an intermediate terminal **184**. A fuse **185** an the "On-Off" switch **172** are connected across the terminals **182** and **184**, and when the "On-Off" switch is closed, current flows between the terminal **184** and the terminal **181** along three parallel paths. A first path includes the plurality of parallel connecting fluorescent lights **50** each of which is connected in series with a ballast **186** and a starter **187**. A second path includes the left hand rail **57**, the left hand brush **67**, the thermostat **120**, the heating elements **118**, the right hand brush **67**, and the right hand rail **57**.

A third path between the terminals **184** and **181** of the terminal board **183** includes an operation select switch **190**. The operation select switch **190** is operated by the operation select knob **176** and comprises contacts **191** and **192** respectively connected to a circular bus bar **193** by wipers **194** and **195**. When the knob **176** is placed in the "Off" position the contacts **191** and **192** are open and no current flows through the switch **190**. When the knob **176** is placed in the vapor position, the contacts **191** and **192** are respectively connected to contacts **196** and **198** to provide several parallel paths to the terminal **181**. The contact **198** is connected to the terminal **181** through the vapor light **170**. The contact **196** is connected to the terminal **181** both through the blower **121** and through a contact **200** of the interlock switch **162**, a contact **202** of the scan switch **150**, the right hand rail **58**, the right hand brush **68**, the thermostat **138**, the left hand brush **68**, and left hand rail **58**, and the drive motor **124** and scan light **175** which are connected in parallel. It is seen that in order for the drive motor **124** to be energized when the operation select knob **176** is placed in the vapor position, the vapor control knob **160** must be placed in either the left, both, or right positon so that the cam **154** places the interlock switch **162** in engagement with the contact **200**, and the scan button **140** must be depressed to place the scan switch **150** in engagement with the contact **202**. In addition, the vapor discharge tank **75** (FIG. 1) must be at its operating temperature or else the thermostat **138** will be open and interrupt the path through the drive motor **124**.

When the operation select knob **176** is placed in the corona position, the contacts **191** and **192** are respectively connected to contacts **204** and **205**. The contact **205** is connected to the terminal **181** through the corona light **174**. The contact **204** is connected to the terminal **181** through a contact **206** of the interlock switch **162**, the contact **202** of the scan switch **150**, the right hand rail

58, the right hand brush 68, the thermostat 138, the left hand brush 68, the left hand rail 58, and the drive motor 124 and scan light 175. Thus for the drive motor 124 to be energized when the operation select knob 176 is placed in the corona position, the vapor control knob 160 must be placed in the "Off" position so that the cam 154 places the interlock switch 162 in engagement with the contact 206, and the scan button 140 must be depressed to place the scan switch 150 in engagement with the contact 202.

The contact 204 of the operation select switch 190 is also connected to the terminal 181 through a contact 208 of the scan switch 150, either contact 210 or 212 of a polarity switch 214, and the high voltage power supply 73. The polarity switch 214 is operated by the polarity knob 178, and depending upon whether the knob is in the positive or negative position, the switch engages the contact 210 or 212, respectively, the particular input path employed to the power supply 73 determining the polarity of the high voltage output. The power supply 73 provides a potential of around six to eight thousand volts to the corona generating wires 70 through the left hand rail 56 and left hand brush 66 and a potential of about one-tenth that amount to the screen wires 72 through the right hand rail 56 and right hand brush 66.

Referring to FIGS. 1 and 10, in the operation of the apparatus, the plug 180 is inserted into an electrical outlet and the "On-Off" switch 172 is placed in the "On" position. A circuit is thereby completed from one side of the plug 180 through the terminal 182 of the terminal board 183, the fuse 185, the "On-Off" switch 172, the terminal 184, the left hand rail 57, the left hand brush 67, the thermostat 120, the heating elements 118, the right hand brush 67, the right hand rail 57, and the terminal 181 to the other side of the plug 180. The heating elements 118 heat the vapor discharge tank 75 to its operating temperature, and when the tank reaches its operating temperature the thermostat 138 closes while the thermostat 120 opens and closes as necessary to maintain the tank at this temperature.

The closure of the "On-Off" switch 172 also results in a circuit being completed from one side of the plug 180 through the terminal 182, the fuse 185, the "On-Off" switch 172, the terminal 184, the ballasts 186, the starters 187, the fluorescent lights 50, and the terminal 181 to the other side of the plug 180. The fluorescent lights 50 are thereby lit, illuminating the work surface 46 of the drawer 42.

The drawer 42 is pulled out from the cabinet 30, and a format sheet on which a drawing is being executed and to which one or more elements are to be added, is oriented on the work surface 46 with the assistance of the grid overlay 48. The elements to be added to the drawing are individually prepared separate from the drawing. The elements may be notes, or tables, or repetitive details, that is, details of the drawing that have appeared in previous drawingss or are likely to appear in future drawings. In the case of a note or a table, the information is advantageously written out by the draftsman and then typed on a standard form by a typist. In the case of a repetitive detail, the configuration, which may be traced from a previous drawing, is advantageously drawn by the draftsman on a standard form which may itself then be kept for future use or may be microfilmed and stored on programmed cards. In all cases, when an element is completed, it is checked for accuracy and if an error is found, it can be re-done in significantly less time than would be necessary if the element had been done directly on the drawing and the entire drawing had to be re-done.

When the elements to be added to the drawing have been prepared or selected from those previously prepared, they are then each employed as an original from which an electrostatic powder image copy is made using a standard electrostatic process such as xerography. However, instead of the electrostatic powder images being generated on or transferred to bond paper, as is the usual case, they are each generated on or transferred to a transparent carrier, that is, a sheet material through which a configuration is visible when the sheet material is placed in the proximity of the configuration. Furthermore, each of the electrostatic powder images on the transparent carriers is reversed so that when the images are transferred to the format sheet, they are positive. Finally each electrostatic powder image inherently has a particular polarity and potential, and when the powder images on the transparent carriers are prepared by means of a common appartus, the polarities of the powder images will be the same and they will have the same general potential.

After the powder images on the transparent carriers have been prepared, the drawer 42 is returned to its position within the cabinet 30, and the polarity knob 178 is operated to indicate a polarity opposite to that of the powder images. Thus, assuming that the powder images are positively charged, the polarity knob 178 is placed in the negative position whereby the polarity switch 214 closes on the contact 212, and then the operation select knob 176 is moved to the corona position, placing the contacts 191 and 192 of the operation select switch 190 in engagement with contacts 204 and 205 respectively. Since the contacts 191 and 192 of the operation select switch 190 are respectively connected to one side of the plug 180 by wipers 194 and 195, the bus bar 193, the terminal 184, the "On-Off" switch 172, the fuse 185, and the terminal 182, the engagement of the contact 192 with the contact 205 illuminates the corona light 174 by completing a path through the corona light and the terminal 181 to the other side of the plug 180. The engagement of the contact 191 with the contact 204, on the other hand, only provides a path from the one side of the plug 180 through the closed contact 206 of the interlock switch 162 to the open scan switch 150.

Referring also to FIG. 5, the scan button 140 is thereafter depressed to displace the control member 143 rearwardly, pivoting the lever 146 to deflect the actuator 148 of the scan switch 150 in a forward direction and thereby causing the switch to close on contacts 208 and 202. The closed contact 202 energizes the drive motor 124 and the scan light 175 by completing a circuit through the right hand rail 58, the right hand brush 68, the thermostat 138, the left hand brush 68, the left hand rail 58, the drive motor and scan light, and the terminal 181 to the other side of the plug 180. The energized motor 124 rotates the lead screw 122 causing the drive block 132 to move the carriage 60 over the work surface 46. At the same time, the closed contact 208 energizes the power supply 73 by completing a circuit through the negative contact 212 of the polarity switch 214, the power supply, and the terminal 181 to the other side of the plug 180. As the carriage 60 moves over the work surface 46, the power supply 73 provides direct current negative voltage through the rails 56 and the bruses 66 to the corona generating wires 70 and the screen wires 72. The large potential difference between the corona generating wires 70 and the grounded work surface 46 ionizes the air therebetween and directs a cascade of negative ions towards the work surface. The screen wires 72, which are at a lower potential than the corona generating wires 70, limit the electrosatic charge placed on the work surface 46 by decelerating the ions when the work surface approaches the same potential as that of the screen wires.

The potential of the screen wires 72 and the rate of movement of the carriage 60 are selected so that the electrostatic charge generated on the work surface 46 and thereby the format sheet thereon has a higher potential than that of the powder image. This electrostatic charge, being generated on the format sheet as the carriage 60 moves thereover, sequentially presses the sheet tightly against the work surface 46 and thereby acts to smooth out any wrinkles that may be present in the sheet. In addition, this charge, being of opposite polarity to and of

greater potential than that of the powder image, presses the format sheet in condition to attract the powder image from the carrier to the format sheet.

When the carriage **60** returns to the rear of the cabinet **30**, the pin **155** mounted on the drive bracket **134** passes through the hole in the rear wall **74** and deflects the actuator **148** of the scan switch **150** rearwardly, thereby opening the switch. Both the motor **124** and the power supply **73** are de-energized and the carriage coasts to its rest position.

The drawer **42** is pulled out from the cabinet **30**, and one or more transparent carries, each having an electrostatic powder image of a selected element thereon, are placed powder image side down on the format sheet. To prevent smudging of the powder image and to assure that each image is placed in the proper position on the format sheet, each carrier is placed on the format sheet by first arcuately flexing the carrier so that the powder image is on the convex surface thereof. A first end of the convex surface is then placed in juxtaposition with the format sheet, the other end of the convex surface being spaced a greater distance from the format sheet than the first end, and the carrier is moved to position preselected points on the first end of the convex surface or on the portion of the powder image in the vicinity thereof in alignment with preselected points on the format sheet. The preselected points on the carrier are advantageously index markings thereon, while the preselected points on the powder image are advantageously points of intersection of particular lines of the image. The preselected points on the format sheet are advantageously points temporarily placed thereon or intersection points on the grid **48** underlying the format sheet that are made visible by the lights **50** therebeneath. With the preselected points on the carrier or powder image in alignment with the preselected points on the format sheet, the first end of the convex surface is placed in contact with the format sheet and then the carrier is moved so as to sequentially place the remainder of the convex surface in contact with the format sheet. Because the carrier, like the powder image thereon, has an electrostatic charge of opposite polarity to that of the format sheet, the carrier is pulled down flat across the format sheet and held in the position in which it is placed. The number of carriers placed on the format sheet at one time is only limited by the fact that the carriers cannot overlap one another.

The drawer **42** is moved back into the cabinet **30** and the polarity knob **178** is placed to indicate the same polarity as that of the powder images, which in this instance are assumed to be positive. The scan button **140** is then depressed to again energize the drive motor **124** and the power supply **73** in the manner described above. The corona generating wires **70** and the screen wires **72** sequentially apply a positive electrostatic charge to the transparent carriers of a higher potential than that of the powder images. This application of the positive charge to the carriers, besides pressing the carriers against the format sheet, acts to repel the electrostatic powder images from the carriers while the negative charge on the format sheet acts to attract the powder images thereto. As a result, the powder images are sequentially transferred from the carriers to the format sheet.

When the carriage **60** has completed its traversal of the work surface **46** and the motor **124** and power supply **73** are once again de-energized, the drawer **42** is pulled out and the transparent carriers are removed from the drawing. In order to prevent movement of the carriers along the surface of the format sheet, which would result in smudging the electrostatic powder images, each carrier is removed by pulling one end thereof both away from the format sheet and toward the other end of the carrier while the other end of the carrier is held fixed, as by holding it down with a finger. When all but the other end of the carrier has been lifted from the format sheet, the other end is released, and the entire carrier is removed.

The drawer **42** is then returned to its position within the cabinet **30**, and the vapor control knob **160** is rotated to the right, both, or left position depending upon the location of the powder images with respect to the vapor discharge tank **75**. Assuming that the powder images are located to the right of the lead screw **122**, the vapor control knob **160** is placed in the right position, shown in FIG. 7, whereby the vane **158** extends above the path of travel of the operating lever **85** and the vane **156** extends below the path of travel of the operating lever **84**. In addition, in this position of the vapor control knob **160**, the interlock cam **154** closes the interlock switch **162** on the contact **200**.

The operation select knob **176** is thereafter moved to the vapor position, placing the contacts **191** and **192** of the operation select switch **190** in engagement with the contacts **196** and **198** respectively. Since the contacts **191** and **192** are connected to one side of the plug **180** in the manner set forth above, the engagement of the contact **192** with the contact **198** illuminates the vapor light **170** by completing a path through the vapor light and the terminal **181** to the other side of the plug **180**. Furthermore, the engagement of the contact **191** with the contact **196** energizes the blower **121** by completing a path through the blower and the terminal **181** to the other side of the plug **180**. The blower creates a flow of air from the front to the back of the cabinet **30**, pulling in air through passageways **54** in the front of the drawer **42** and exhausting out through an opening in the access door **35** (FIG. 2).

With the depression of the scan button **140**, the scan switch **150** is closed and the drive motor **124** and scan light **175** energized by completing a path from the contact **196** of the operation select switch **190** through the contact **200** of the interlock switch **162**, the contact **202** of the scan switch **150**, the right hand rail **58**, the right hand brush **68**, the thermostat **138**, the left hand brush **68**, the left hand rail **58**, the drive motor and scan light, and the terminal **181** to the other side of the plug **180**. The energized motor **124** rotates the lead screw **122** and thereby advances the carriage **60** from its rest position.

Referring also to FIGS. 3, 4, and 7, as the carriage **60** moves forward, the operating lever **84** of the valve **80** moves over the vane **156** and the operating lever **85** of the valve **82** moves under the vane **158**. Immediately thereafter the inclined leveling member **166** engages the rear end of the vane **156** and rotates the control member **143** to a horizontal position as shown in FIG. 7A. The operating lever **84** is thereby deflected upwardly by the vane **156** while the operating lever **85** is deflected downwardly by the vane **158**. The valve **82** is consequently opened permitting solvent liquid to flow from the reservoir **88** through the flexible tubing **92**, rigid tubing **95**, valve **82**, supply tube **108** and distribution tube **106** to the nozzles **105**. The solvent liquid drips from the nozzles **105** into the vapor generating chamber **110** wherein it is vaporized and discharged through the ports **116** toward the work surface **46**, the solvent vapor being added above ambient temperature as it passes through the outlet ducts **115**. The conical terminations of the ports **116** provide a generally conical shape to the discharge, and as a consequence as the carriage **60** moves over the format sheet, the electrolstatic powder images receive a fringe discharge before they receive the full discharge. The fringe discharge provides the powder images with an initial set that prevents feathering of the images when they are engaged by the full discharge. The powder images being at ambient temperature, a controlled amount of vapor condenses on the powder images, fusing the powder particles on the images and fixing the images to the format sheet.

When the carriage **60** completes its traversal of the work surface **46**, the motor **124** is de-energized, and after a brief delay during which the blower **121** exhausts the excess solvent vapor from the cabinet **30**, the drawer **42**

is pulled out to remove the format sheet, or the process is repeated to add additional elements of the drawing to the format sheet. When all of the elements have been added, the draftsman inks in the lines and characters needed to integrate the various elements and to complete the drawing.

What is claimed is:

1. An electrostatic powder image transfer and fixing apparatus comprising:
an electrically conducting work surface; and
a carriage movable over the work surface, the carriage including means for generating a corona discharge as the carriage moves over the work surface whereby a powder image may be transferred from a powder image carrier to a sheet of transfer material and the carriage including means for generating a solvent vapor discharge as the carriage moves over the work surface whereby the powder image may be fixed to the sheet of transfer material.

2. An electrostatic powder image transfer and fixing apparatus as in claim 1 further including means for preventing the simultaneous operation of the corona discharge means and the vapor discharge means.

3. An electrostatic powder image fixing apparatus comprising:
a work surface adapted to receive a powder image bearing member; and
a vapor discharge tank movable over the work surface, the vapor discharge tank including a vapor generating chamber, means for controlling the flow of a solvent liquid into selected portions of the chamber, means for vaporizing the solvent liquid in the chamber, and means for directing the solvent vapor generated in the chamber toward the work surface as the tank moves over the work surface.

4. An electrostatic powder image fixing apparatus comprising:
a work surface adapted to receive a powder image bearing member; and
a vapor discharge tank movable over the work surface, the vapor discharge tank including a vapor generating chamber, means for directing the flow of a solvent liquid into the chamber only during the movement of the tank over the work surface, means for heating the chamber to the vaporizing temperature of the solvent liquid, and means for directing the solvent vapor generated in the chamber toward the work surface as the tank moves over the work surface.

5. An electrostatic powder image fixing apparatus comprising:
a work surface adapted to receive a powder image bearing member; and
a vapor discharge tank movable over the work surface, the vapor discharge tank including a vapor generating chamber, means for controlling the flow of solvent liquid into the chamber, means for heating the chamber to the vaporizing temperature of the solvent liquid, and means in communication with the chamber for directing the solvent vapor generated in the chamber toward the work surface in a plurality of overlapping conical shaped discharges as the tank moves over the work surface.

6. An electrostatic powder image fixing apparatus comprising:
a work surface adapted to receive a powder image bearing member; and
a vapor discharge tank movable over the work surface, the tank including a vapor generating chamber, the chamber comprising an inlet cavity joined to an outlet duct by a constricted passageway, a plurality of spaced nozzles extending into the chamber in juxtaposition with the inlet cavity, the nozzles controlling the rate of flow of a solvent liquid into the cavity, a heating element mounted in the tank, the heating element being adapted to heat the tank to the vaporizing temperature of the solvent liquid, and a plurality of spaced ports in communication with the outlet duct.

7. An electrostatic powder image fixing apparatus as in claim 6 further including valve means adapted to control the flow of the solvent to selected nozzles.

8. An electrostatic powder image fixing apparatus as in claim 7 further including a stationary solvent liquid reservoir, and flexible tubing connecting the reservoir to the vapor discharge tank.

9. An electrostatic powder image fixing apparatus comprising:
a work surface adapted to receive a powder image bearing transfer sheet;
a vapor discharge tank movable over the work surface, the vapor discharge tank including a vapor generating chamber, means for controlling the flow of a solvent liquid into selected portions of the chamber, means for heating the chamber to the vaporizing temperature of the solvent liquid, and means for directing the solvent vapor generated in the chamber toward the work surface;
means for driving the vapor discharge tank back and forth over the work surface; and
means for preventing the operation of the driving means prior to the vapor discharge tank reaching the vaporizing temperature of the solvent liquid.

10. An electrostatic powder image transfer and fixing apparatus comprising:
an electrically conducting work surface; and
a carriage movable over the work surface, the carriage comprising rigid frame means, corona wires insulatedly supported on the frame means and extending along the length thereof, and a vapor discharge tank resting on the frame means, the vapor discharge tank including a vapor generating chamber, means for controlling the flow of a solvent liquid into selected portions of the chamber, means for heating the chamber to the vaporizing temperature of the solvent liquid, and means for directing the solvent vapor generated in the chamber toward the work surface.

11. An electrostatic powder image transfer and fixing apparatus as in claim 10 further including:
means for energizing the corona wires; and
means for preventing the simultaneous operation of the flow control means and the energizing means.

12. An electrostatic powder image transfer and fixing apparatus comprising:
an electrically conducting and light transmitting work surface connected to ground;
means for illuminating the work surface; and
a carriage movable over the work surface, the carriage comprising rigid frame means, dielectric mounting members secured to the frame means adjacent to the ends thereof, corona wires insulatedly supported on the mounting members and extending along the length of the frame means, a vapor discharge tank resting on the frame means, the vapor discharge tank including a vapor generating chamber, the chamber comprising an inlet cavity joined at an outlet duct by a constricted passageway, a plurality of spaced nozzles extending into the chamber in juxtaposition with the inlet cavity, the nozzles controlling the rate of flow of a solvent liquid into the cavity, a plurality of valve means adapted to control the flow of the solvent to selected nozzles, a heating element adapted to heat the tank to the vaporizing temperature of the solvent liquid, and a plurality of spaced ports in communication with the outlet duct adapted

to direct the solvent vapor generated in the chamber toward the work surface.

13. An electrostatic powder image transfer and fixing apparatus as in claim **12** further including:

means for moving the carriage; and

means for enabling the moving means only after the heating element has heated the tank to the vaporizing temperature of solvent liquid.

14. An electrostatic powder image transfer and fixing apparatus as in claim **12** further including:

a cabinet in which the carriage is housed; and

a drawer movably mounted in the cabinet, the drawer including the light transmitting and electrically conductive work surface and the means for illuminating the work surface.

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CHARLES A. WILLMUTH, *Primary Examiner.*

PETER FELDMAN, *Assistant Examiner.*