

May 30, 1967

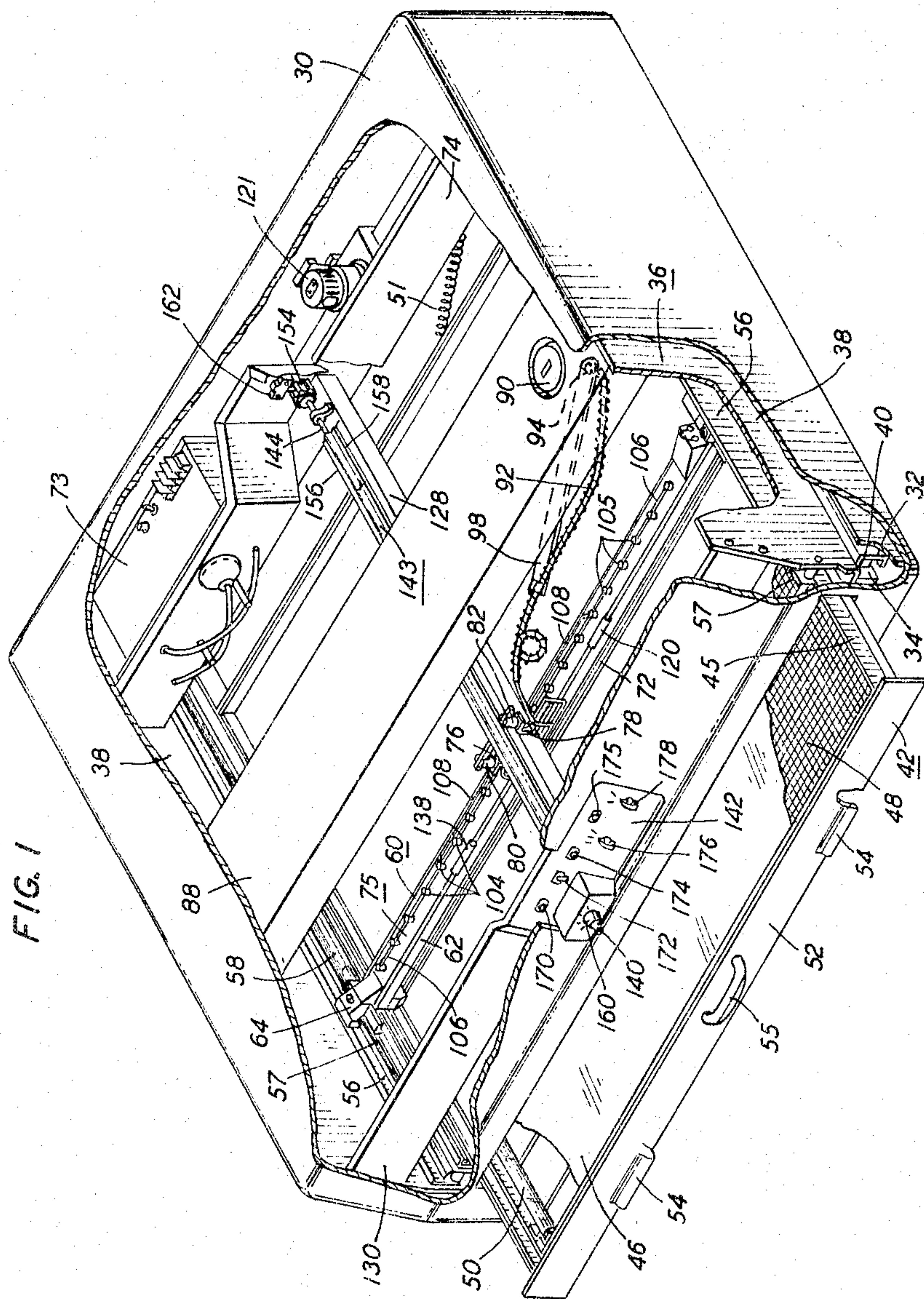
D. W. PEGRAM, JR

3,322,098

ELECTROSTATIC APPARATUS

Original Filed Nov. 6, 1964

6 Sheets--Sheet 1



INVENTOR
D. W. PEGRAM, JR.

BY

Henry L Newman

ATTORNEY

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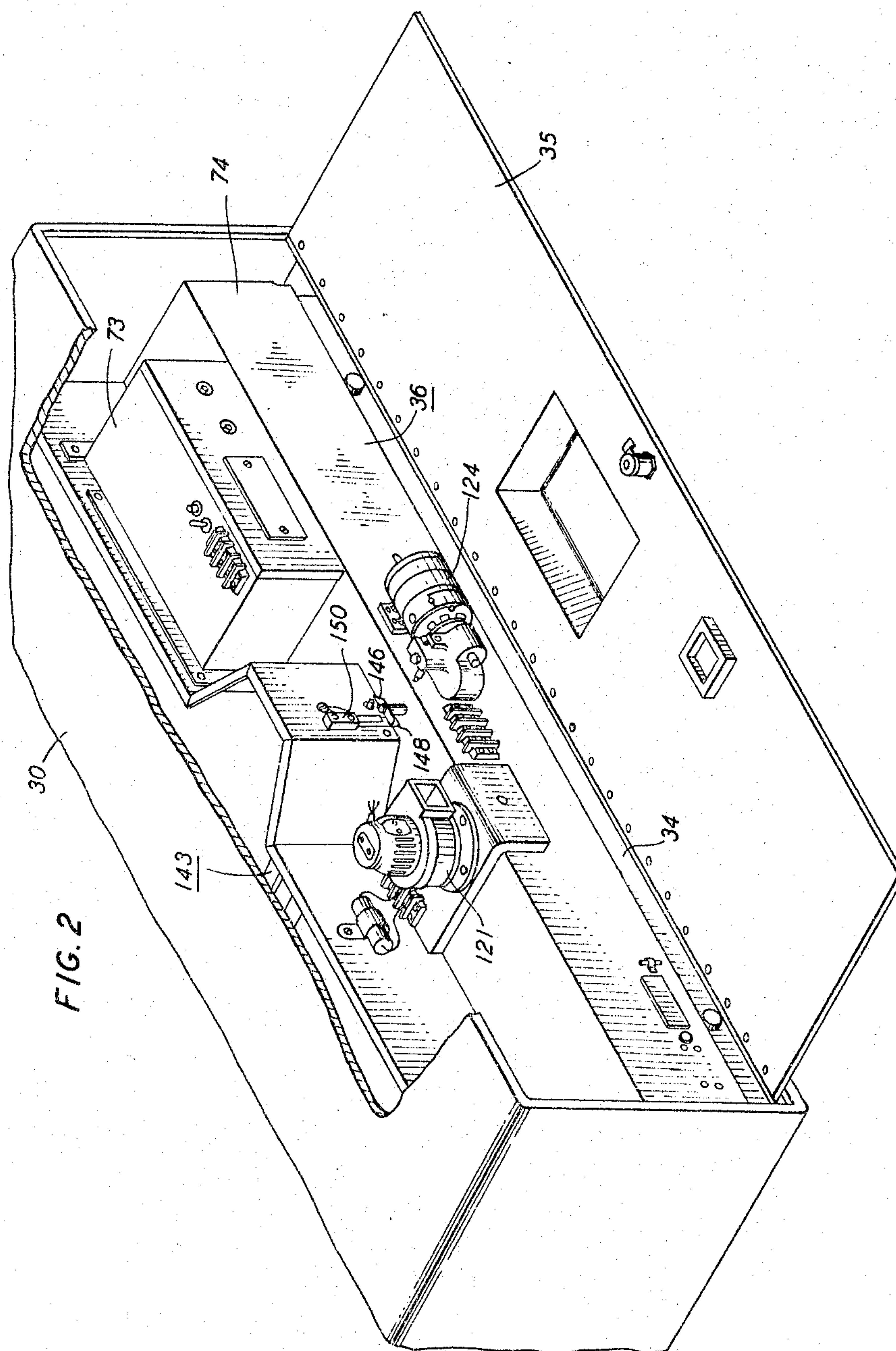
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ELECTROSTATIC APPARATUS

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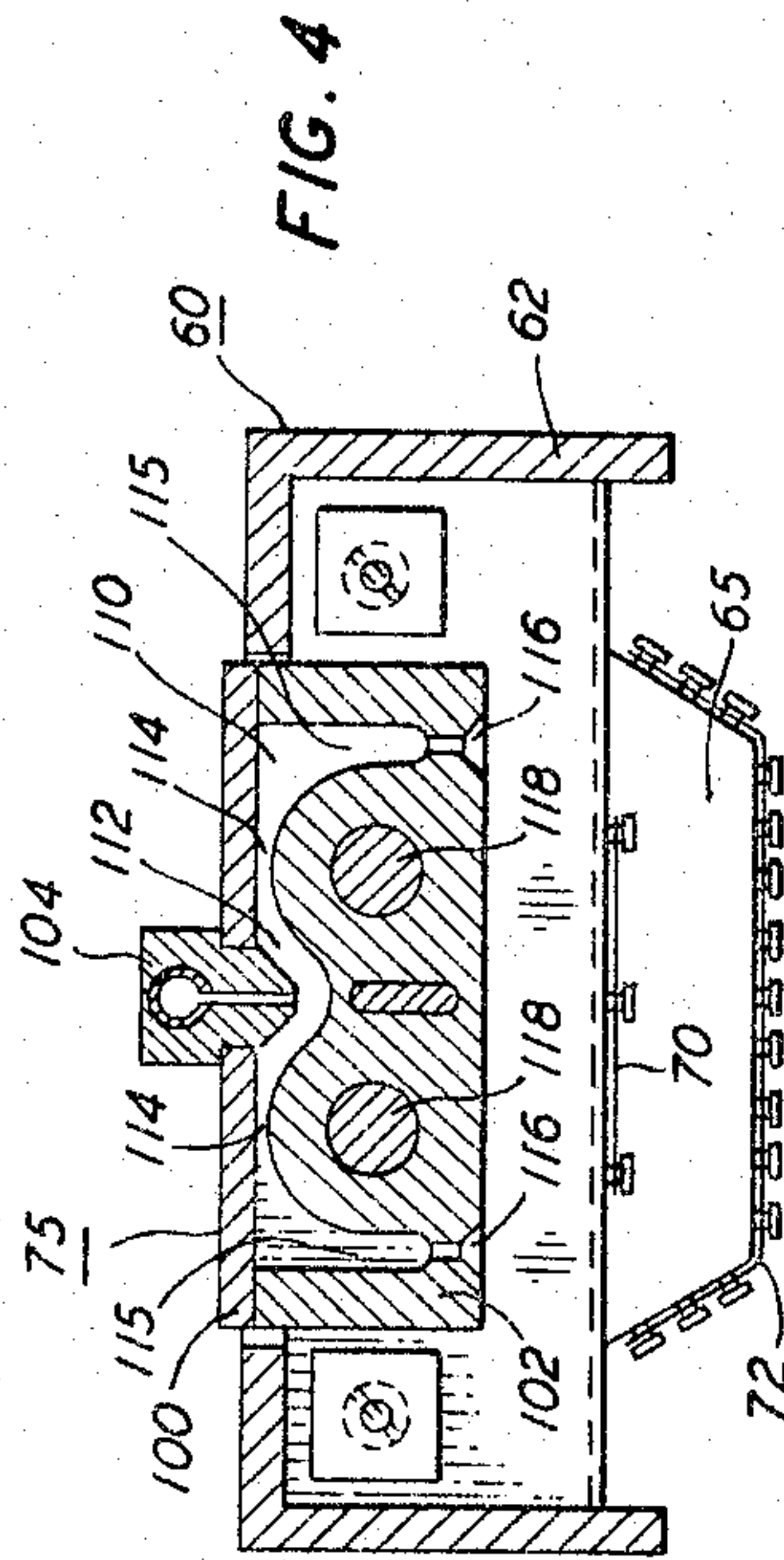
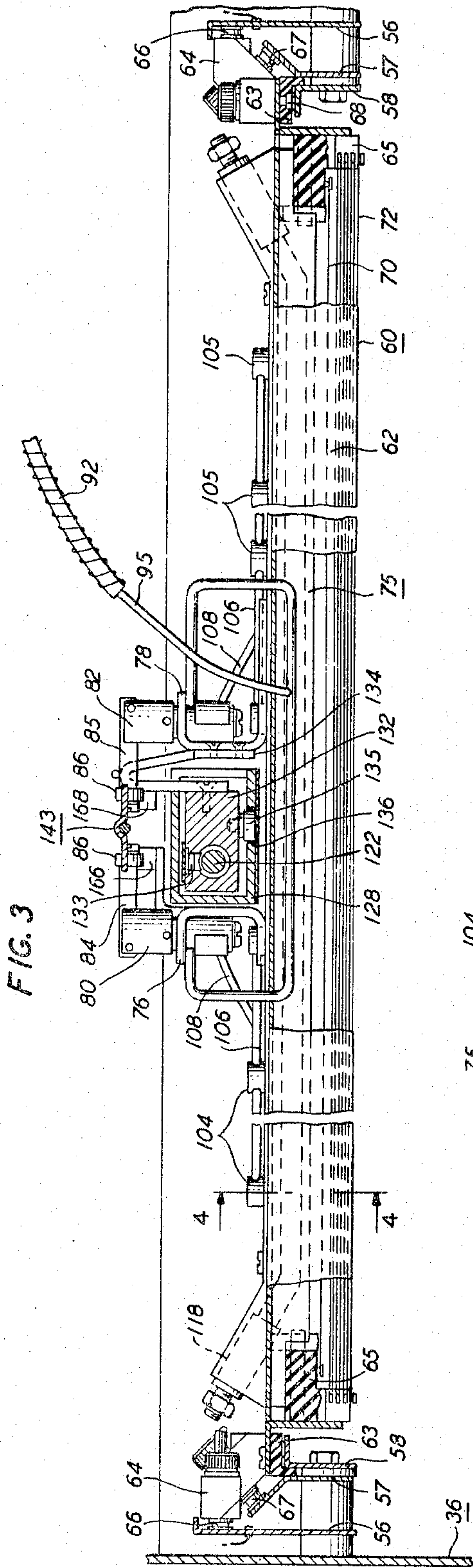
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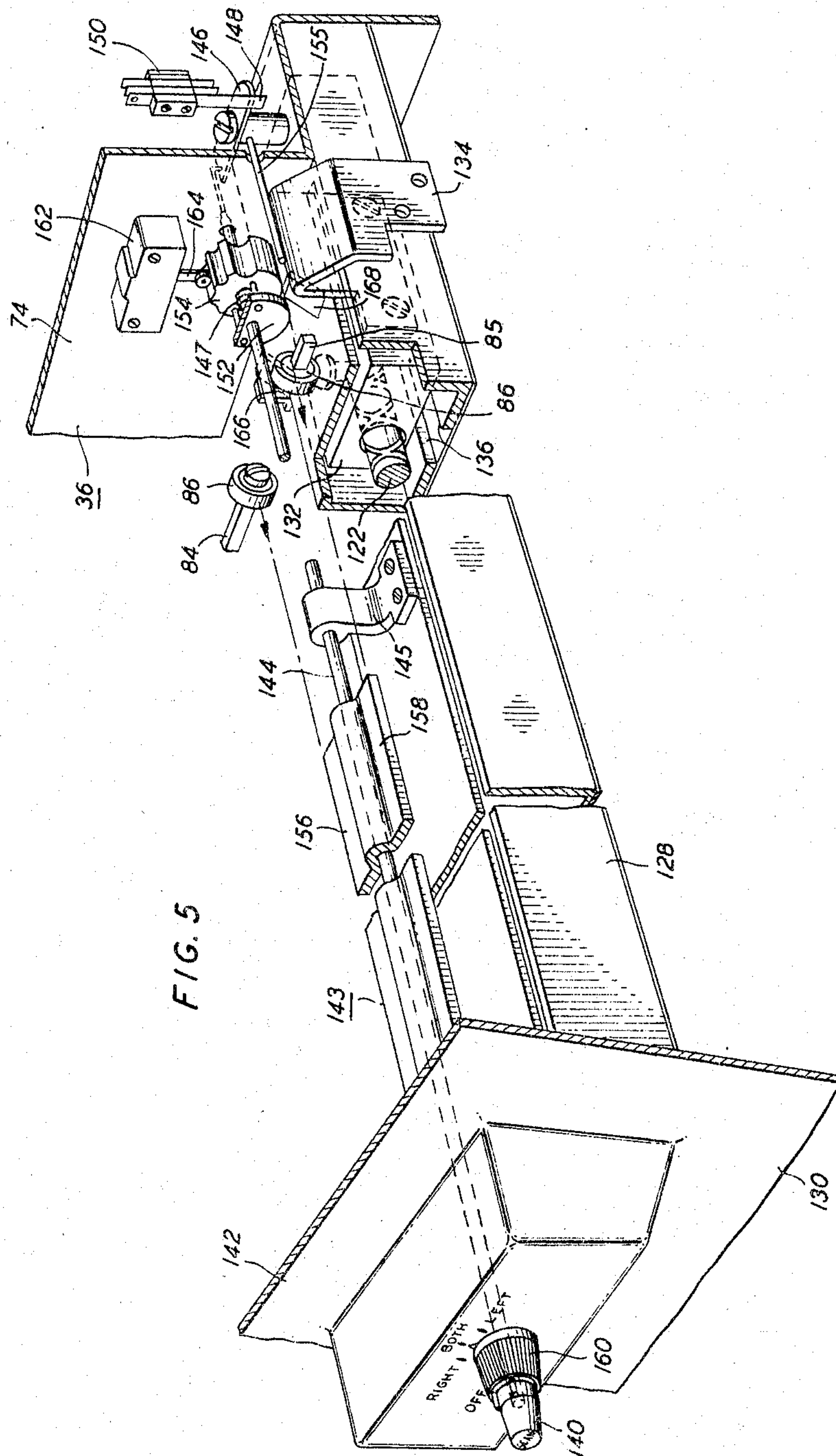
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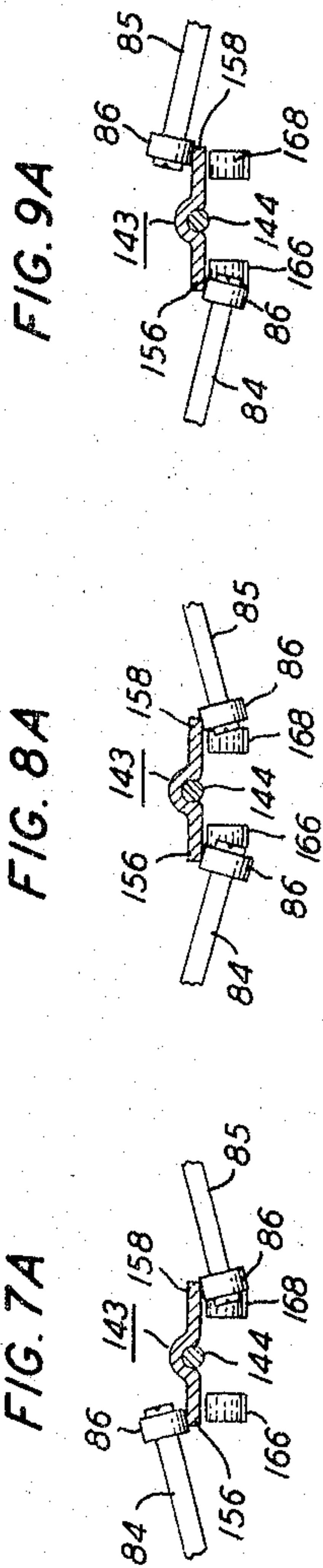
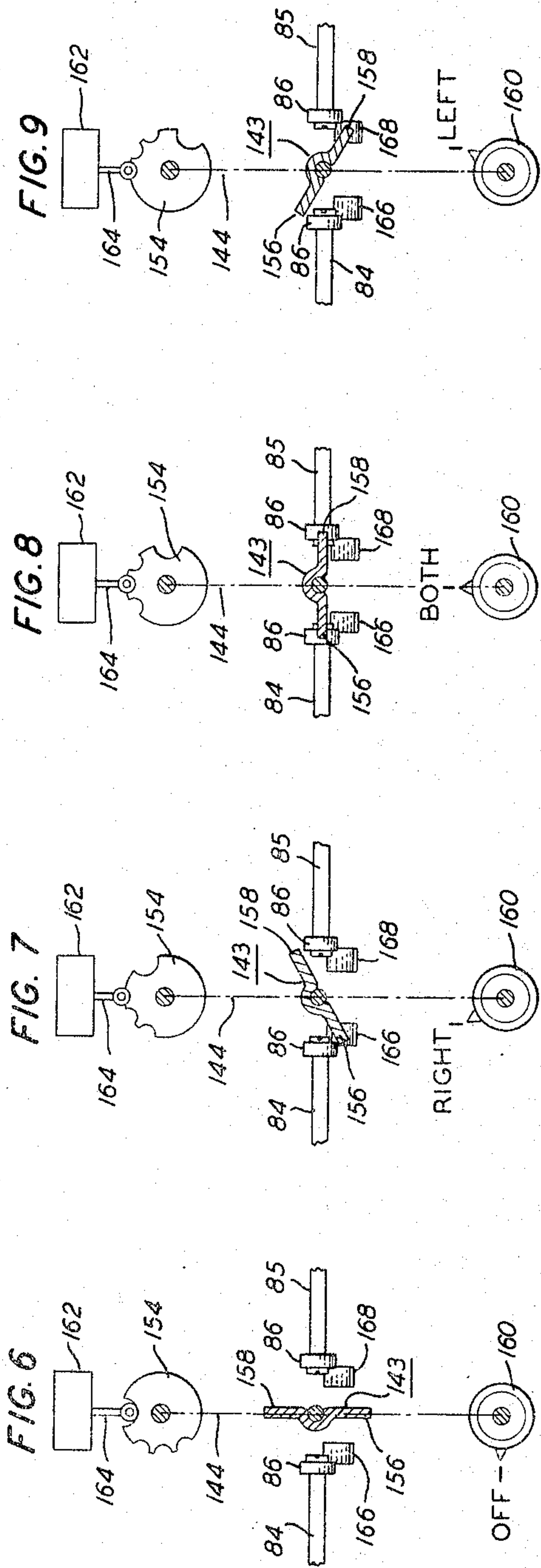
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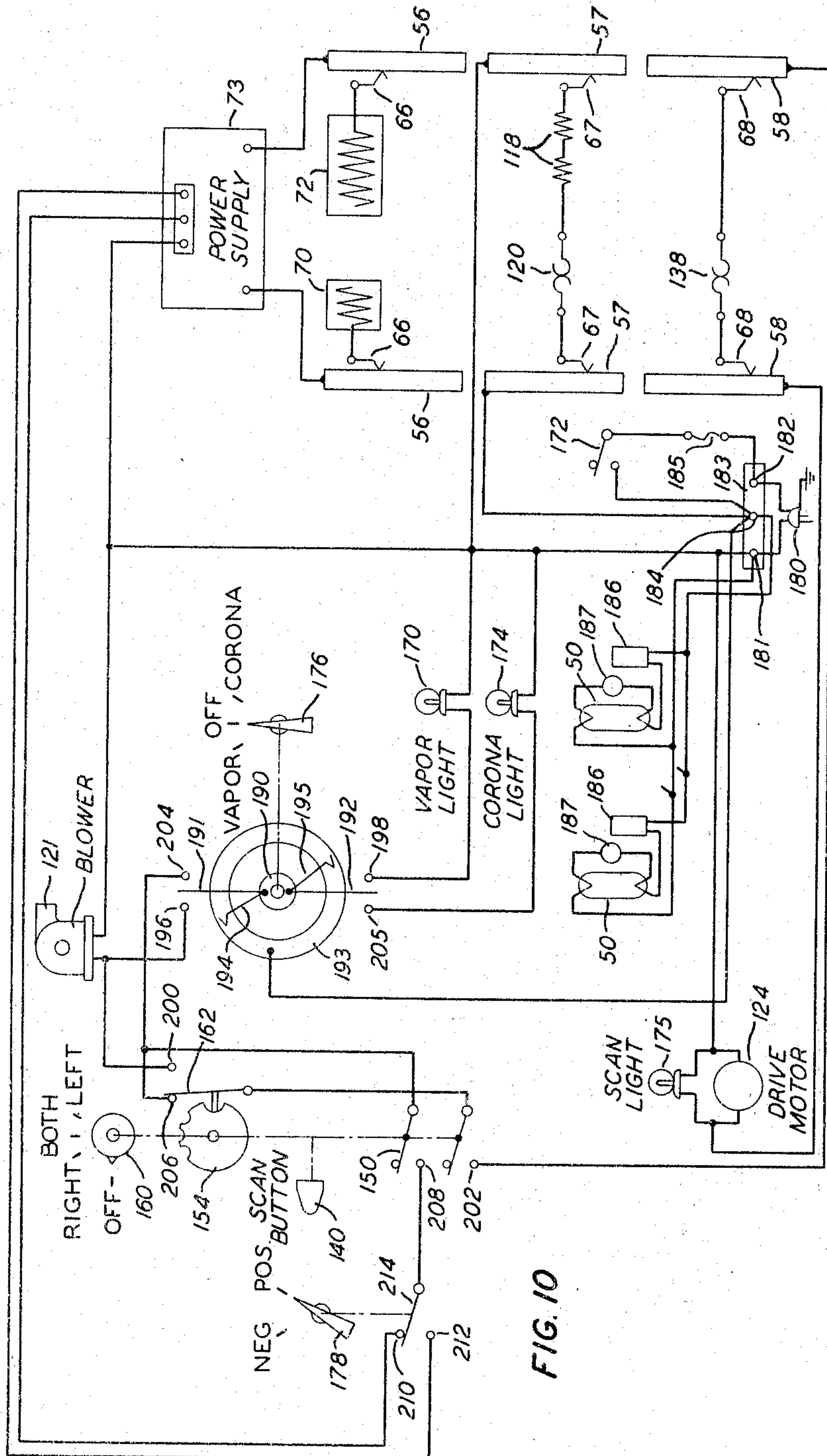


FIG. 10

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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

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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

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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

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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

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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 individual 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

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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 forth 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 and 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 position 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 drawings 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 apparatus, 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 brushes 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 electrostatic 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 carriers, 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 electrostatic 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. 5

What is claimed is:

1. An electrostatic powder image transfer and fixing apparatus comprising:

an electrically conducting work surface; and 10
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. 20

3. An electrostatic powder image fixing apparatus comprising:

a work surface adapted to receive a powder image bearing member; and 25
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. 30

4. An electrostatic powder image fixing apparatus comprising:

a work surface adapted to receive a powder image bearing member; and 35
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. 40

5. An electrostatic powder image fixing apparatus comprising:

a work surface adapted to receive a powder image bearing member; and 45
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. 50

6. An electrostatic powder image fixing apparatus comprising:

a work surface adapted to receive a powder image bearing member; and 55
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 60
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 adapted 65

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. 65

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 75

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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*.