Feb. 9, 1971 R. F. GALITZ 3,561,130

METHOD AND APPARATUS FOR FIXING DEPOSITED MEDIUM BY VAPOR APPLICATION

Filed Aug. 28, 1968 6 Sheets-Sheet 1

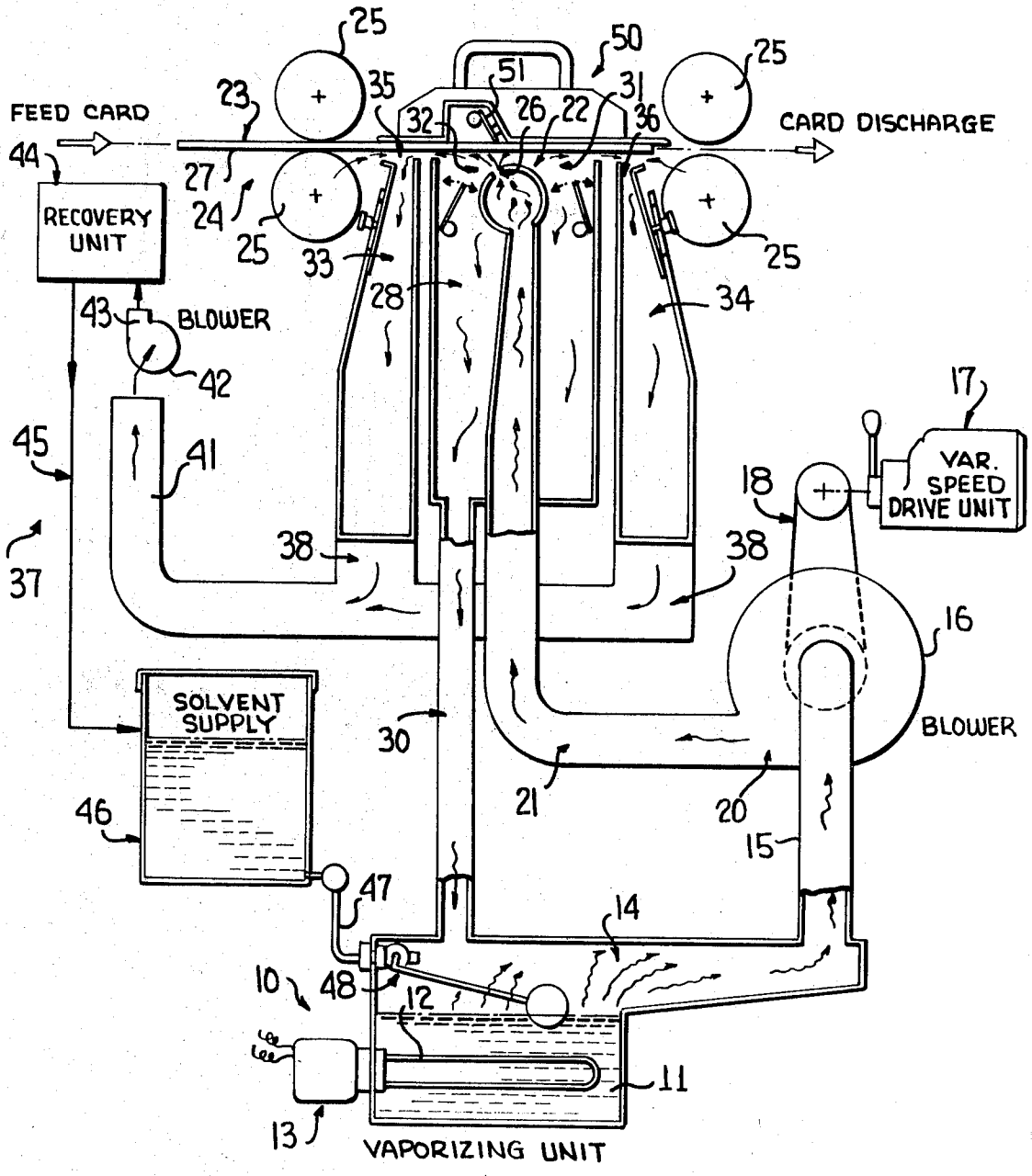


FIG. 1

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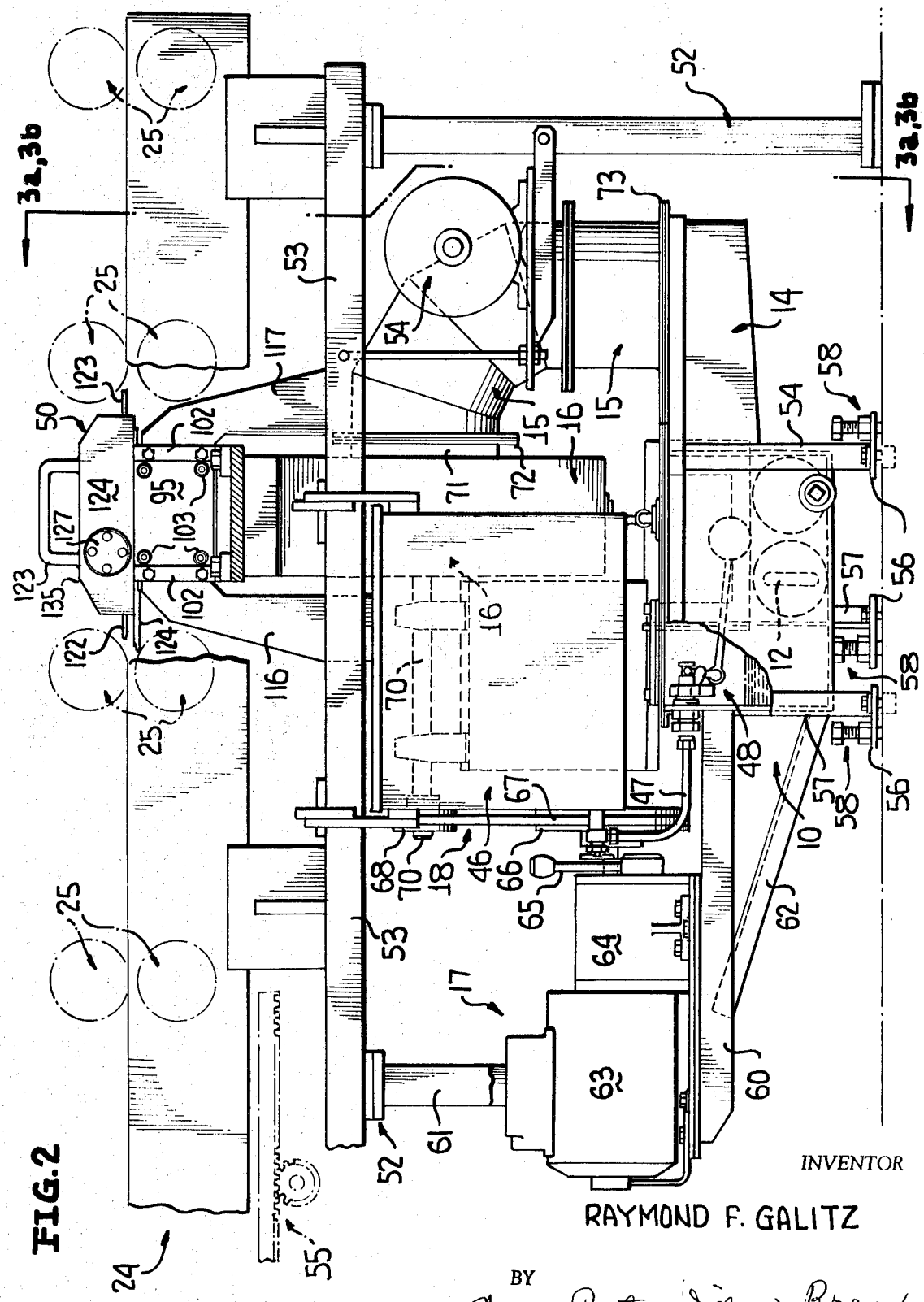


FIG.2

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METHOD AND APPARATUS FOR FIXING DEPOSITED MEDIUM BY VAPOR APPLICATION

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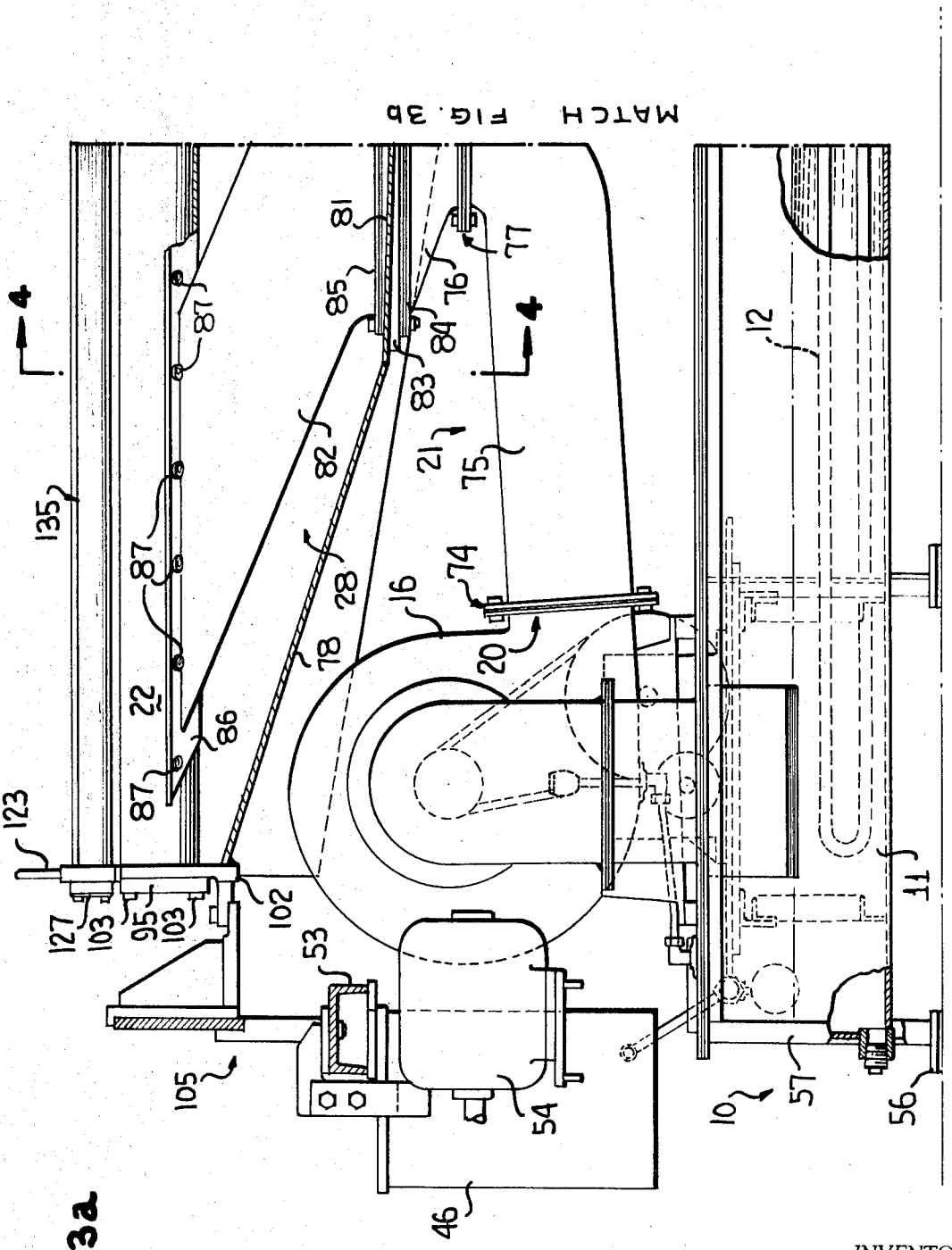


FIG. 3a

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METHOD AND APPARATUS FOR FIXING DEPOSITED MEDIUM BY VAPOR APPLICATION

Filed Aug. 28, 1968 6 Sheets-Sheet 4

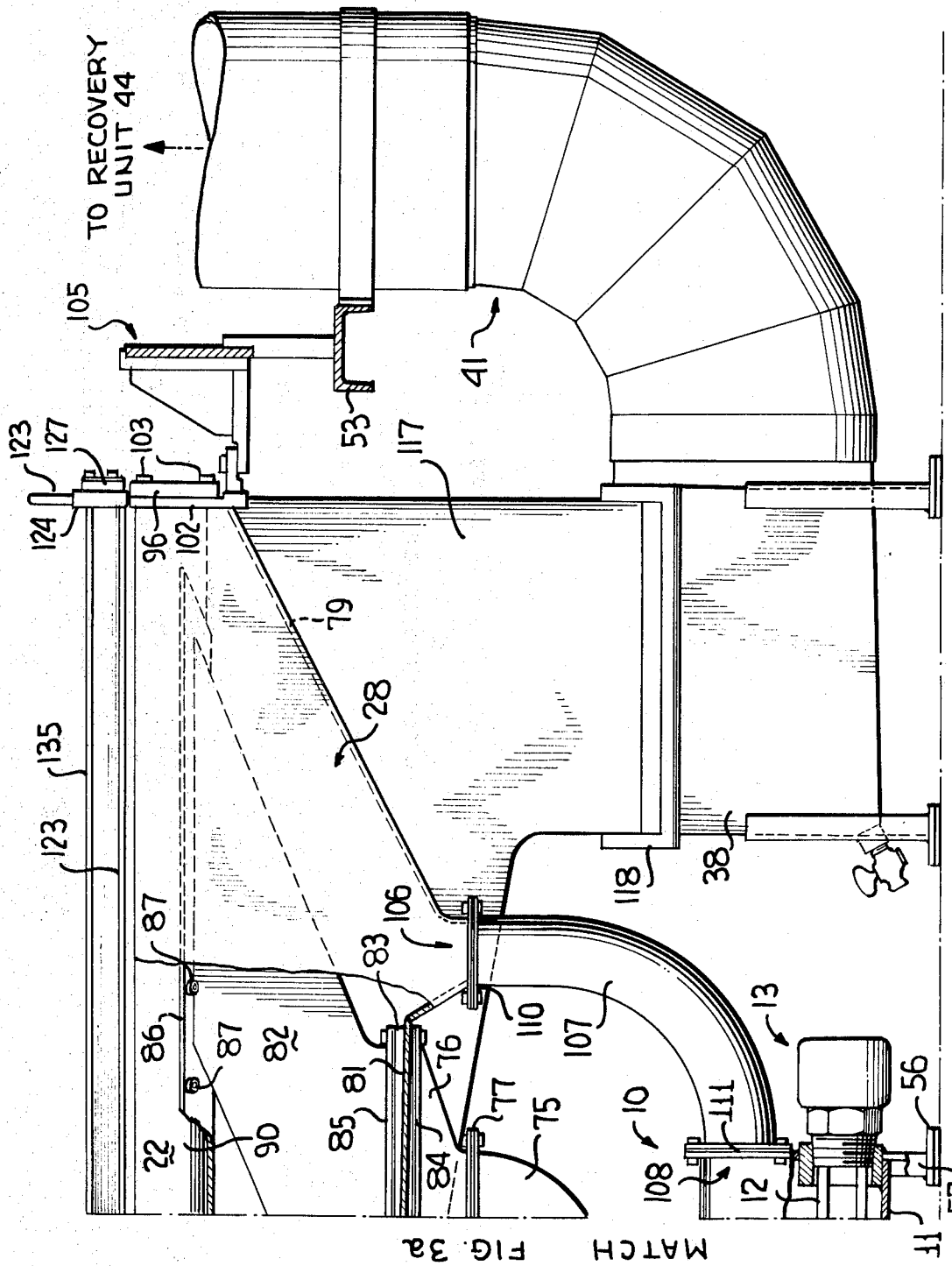


FIG. 3b

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METHOD AND APPARATUS FOR FIXING DEPOSITED MEDIUM BY VAPOR APPLICATION

Filed Aug. 28, 1968 6 Sheets-Sheet 5

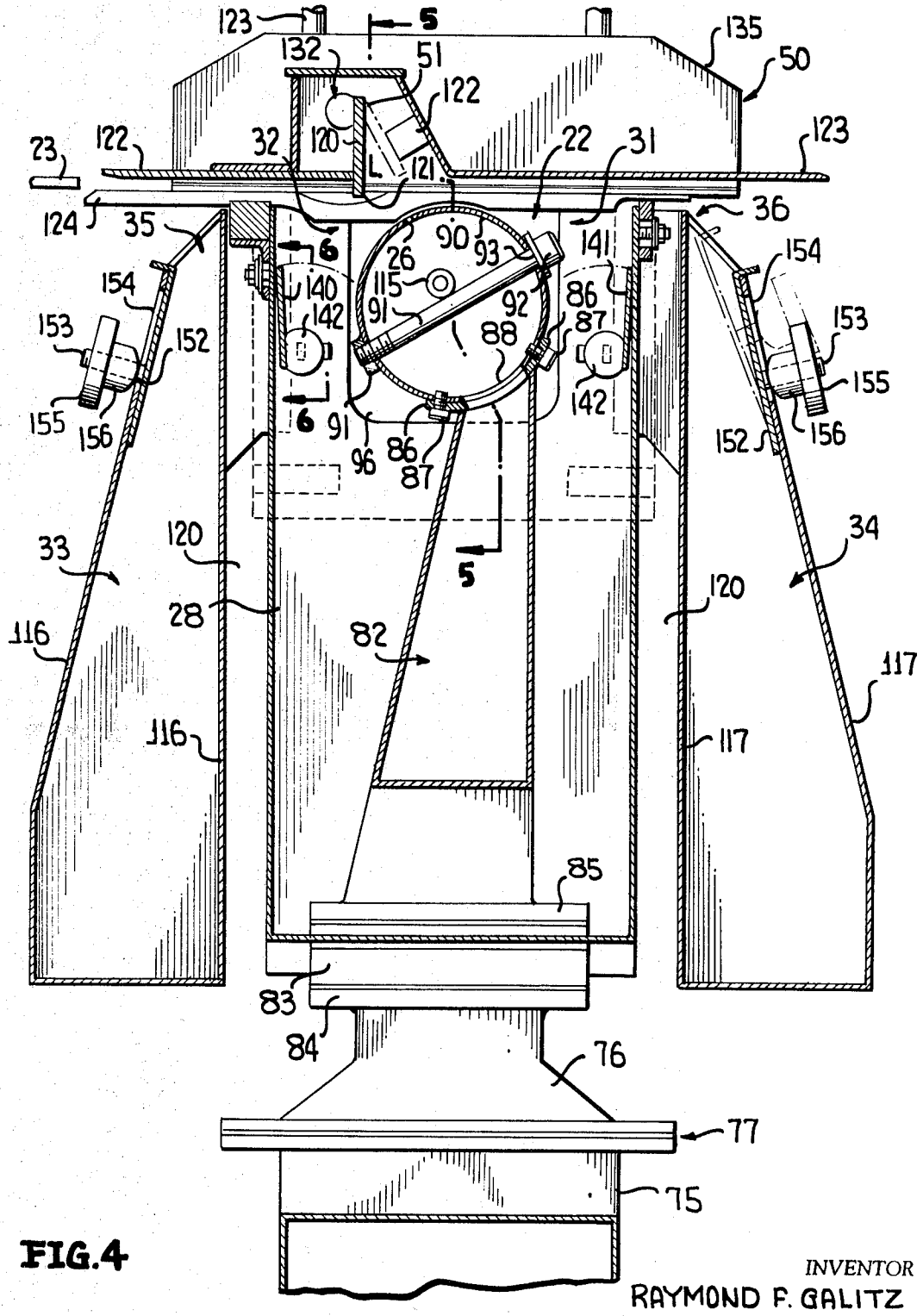


FIG.4

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METHOD AND APPARATUS FOR FIXING DEPOSITED MEDIUM BY VAPOR APPLICATION

Filed Aug. 28, 1968 6 Sheets-Sheet 6

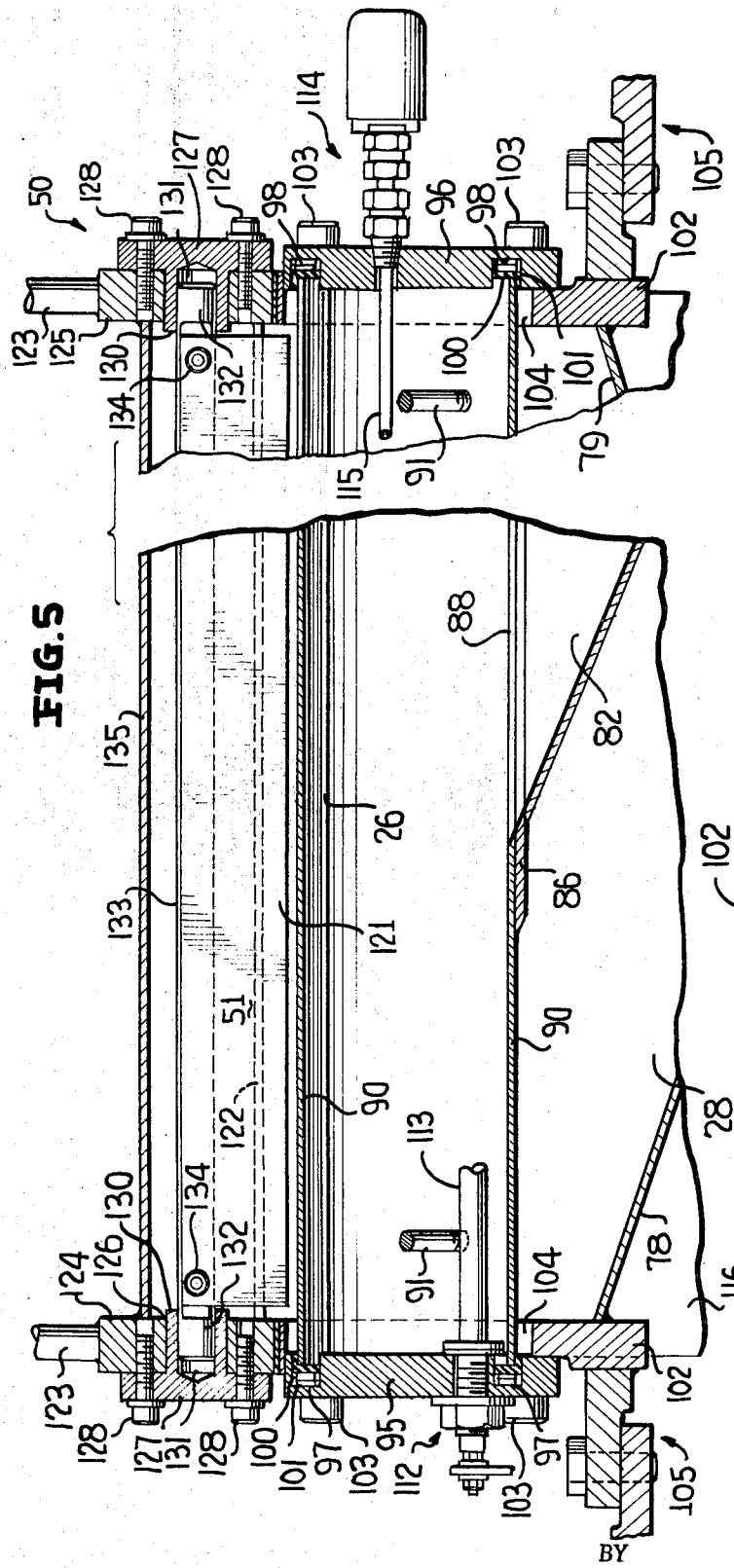


FIG.5

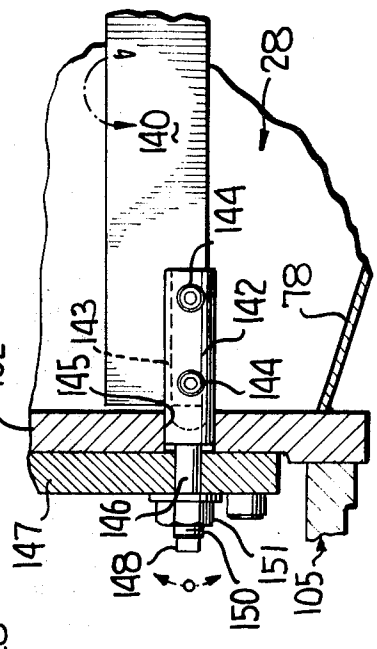


FIG.6

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United States Patent Office 3,561,130 Patented Feb. 9, 1971

3,561,130

METHOD AND APPARATUS FOR FIXING DEPOSITED MEDIUM BY VAPOR APPLICATION

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Int. Cl. F26b 13/00
U.S. Cl. 34—23 31 Claims

ABSTRACT OF THE DISCLOSURE

Method and apparatus for fuzing printing or coating material upon conveyed articles by the application of hot solvent vapors is disclosed herein. A vaporizing unit is connected for the supply of solvent vapor to a vapor knife including a hollow tubular resilient member having an elongate vapor emission slot and contractible toward its longitudinal axis for varying the slot width. Recirculation provisions withdraw vapor from adjacent the knife for subsequent reapplication and reclaiming provisions withdraw vapor bi-passing the recirculation provisions to return a portion of the vapor to its liquid state for subsequent vaporization. The reclaiming provisions also draw in air to prevent passage of air into the recirculation path and cover provisions overlie the knife and include a pivotal gate movable by articles in transit past the knife. The gate diverts emitted vapors to the recirculation provisions absent the presence of an article proximate the knife, masks the leading edge of articles conveyed into proximity with the knife and contacts a surface of the articles during transit past the knife to aid in the proper positioning of such articles.

This invention relates generally to methods and apparatus for fixing or fuzing medium deposited upon articles by the application of solvent vapor to the medium and more specifically to methods and apparatus for fuzing electrostatically deposited printing or coating medium by the application of hot solvent vapors.

The application of solvent vapors to a substrate or article having an image electrostatically produced thereon to effect fixing or fuzing of the toner medium forming such image is known in the art. Typical toner medium may include particles of approximately 41% n-butyl methacrylate and approximately 59% polystyrene or a combination of polyethylene and carbon black. The application of a solvent such as trichloroethylene in a vapor state to an image comprising particles of such toner results in a "fixing" or fuzing of the discrete toner particles such that the discrete toner particles are fuzed and fixed to the substrate.

In the fixing or fuzing of electrostatically printed images at production rates, the time required for each such fixing or fuzing operation must be substantially reduced if commercial production rates are to be economically attained. Further, the continual applications of solvent vapors to numerous articles in production line fashion requires special attention to the conservation of solvent which, without such special attention, would be substantially wasted in the escape of vapors from the fuzing or fixing station. Similarly, where the articles to be treated are of a card-like or panel-like nature, it is necessary to assure an even application of solvent vapors across the entirety of the printed area to effect a fuzing operation which is consistent throughout the image area of the cards or panels.

In view of the foregoing, it is a primary object of this invention to provide methods and apparatus for fuzing

deposited printing or coating medium at production rates and through the efficient employment of solvent vapor.

A further object of this invention is to provide methods and apparatus for applying hot solvent vapor to printed or coated articles to effect fuzing of deposited medium at production rates.

Another object of this invention is to provide methods and apparatus in accordance with the immediately foregoing object wherein recirculation of heated vapor is employed and reclaiming of excess vapor is effected by reduction of such excess vapor to a liquid state.

Additionally, it is an object of this invention to provide apparatus for directing solvent vapor against articles for the fuzing of deposited medium thereon and including provisions for recirculating the applied vapor in addition to provisions for reclaiming excess vapor by the reduction of such excess vapor to a liquid state for subsequent vaporization.

In accordance with the immediately foregoing object of this invention, it is a further object of this invention to provide in the provisions for reclaiming vapor, vapor withdrawal means which withdraws the excess vapor from adjacent the area of application and which further withdraws air or other atmospheric gases from such area, preventing the inclusion of such atmospheric gases in the provisions for recirculating vapor.

Yet another object of this invention is to provide an improved vapor knife apparatus for directing a wide, jet of vapor against a printed or coated article.

An additional object of this invention is to provide in the aforementioned vapor knife an elongate vapor emission opening formed in a hollow tubular member of resilient material, which hollow tubular member is contractible toward its longitudinal axis and expandable away from such axis to effect variation in the width of the emission opening.

Still another object of this invention is to provide in a vapor application system covering provisions including a pivotable gate contactible by articles in motion along a path of conveyance, wherein the gate normally intersects vapors to divert such vapors to recirculation provisions and wherein the gate masks the leading edge of articles so conveyed.

With the above and other objects in view that will hereinafter appear, the nature of the invention will be more clearly understood by reference to the following detailed description, the appended claims and the several views illustrated in the accompanying drawings.

In the drawings:

FIG. 1 is a simplified diagrammatic view of apparatus in accoradnce with this invention and illustrates a vaporizing unit, vapor applying knife provisions fed from the vaporizing unit, vapor recirculation provisions opening adjacent the knife and connected with the vaporizing unit for returning vapor thereto, and vapor reclaiming apparatus for withdrawing additional vapor from the area of application for reduction to a liquid state and reinsertion into a solvent supply.

FIG. 2 is a front elevational view of the apparatus diagrammatically illustrated in FIG. 1 with parts broken away for clarity and shows card or panel conveying provisions, covering means overlying the area of vapor application, vaporizing and pumping provisions for directing vapor into the application area and recirculating vapor to the vaporizer.

FIGS. 3*a* and 3*b*, in combination, provide a vertical cross-sectional view taken along the line 3*a*, 3*b*–3*a*, 3*b* of FIG. 2 illustrating the vapor knife including a transversely arranged elongate hollow tubular member, the vaporizer and vapor passage provisions communicating between the vapor knife and vaporizer and including a

vapor pumping blower for moving vapor from the vaporizer for application by the vapor knife to card or panel-like articles.

FIG. 4 is an enlarged fragmentary vertical cross sectional view taken along the line **4—4** of FIG. 3*a* and illustrates a vapor emission opening adjusting stud extending transversely across the hollow tubular member of the vapor knife, a pivotally mounted gate supported by the cover provisions for contacting the leading edges of articles fed therepast and recirculation and reclaiming openings proximate the paper knife for withdrawing vapor from the area of application.

FIG. 5 is a fragmentary vertical cross sectional view taken along the line **5—5** of FIG. 4 and shows the hollow tubular member of the vapor knife mounted in end plate provisions and further illustrates the mounting of the pivotable gate within the cover provisions.

FIG. 6 is an enlarged fragmentary cross sectional view taken along the line **6—6** of FIG. 4 and shows the mounting of a pivotable damper within a chamber forming a portion of the vapor recirculation provisions.

Referring to the drawings in detail, indicated generally at **10** in FIG. 1 is a vaporizing unit or vaporizer including a liquid solvent depository or solvent retaining portion **11** having mounted therein a heating element **12** of a suitably selected heater and control combination **13**. The vaporizer **10** further includes a vapor outlet **14** connected, via outlet duct provision **15**, with a blower **16** which draws vapor from the vaporizer **10** upon driving actuation from a variable speed drive unit and motor combination **17** and a drive train **18**.

Hot solvent vapor produced by the heating of a quantity of liquid solvent maintained within the depository **11** is passed through the blower **16** to an output **29** thereof and, via further duct provisions **21**, is passed to a vapor knife **22**, to be more fully described hereinafter.

Card-like or panel-like articles, one of which is indicated at **23** in FIG. 1, are passed along a predetermined path of conveyance directly above the vapor knife **22** as by the provision of suitably selected conveying means **24** which may include a plurality of conveying or position determining rollers **25** disposed immediately upstream and downstream from the area of vapor application adjacent the knife **22**.

Hot solvent vapors emitted in a jet from a vapor emission opening **26** in the vapor knife **22** are directed against an undersurface **27** of the card **23** during passage of the card along its predetermined path of conveyance. A chamber, generally indicated by the numeral **28** and housing the vapor knife **22**, is connected via the duct **30** with the upper portion of the vaporizer **10**. The blower **16**, in withdrawing vapor from the upper portion of the vaporizer **10**, applies a reduced pressure to the chamber **28** via the duct **30** and consequently hot vapor is withdrawn into the chamber **28** and recirculated across the level of liquid solvent within the vaporizer **10**.

The undersurface **27** of the cards **23** has deposited thereon, as by electrostatic printing, a predetermined image or coating of toner or printing medium soluble with respect to the solvent vaporized within the vaporizer **10**. The application of hot vapor from the vapor knife **22** to the undersurface **27** of the card **23**, then, fuzes or fixes the printed image or coating thereon. Such fuzing of the deposited printing or coating medium employs a limited quantity of the vapor emitted from the vapor knife **22**. However, a relatively large portion of the hot vapor so emitted will be withdrawn into the chamber **28** through the openings **31** and **32** defined therein on each side of the knife **22**. Thus, a relatively large portion of the vapor emitted from the knife **22** is recirculated to the vaporizer **10** for subsequent reapplication to cards in transit past the knife **22**.

On both the upstream and downstream sides of the chamber **28** are provided two further vapor withdrawal passages **33** and **34** respectively. The passage **33** terminates in an opening **35** closely proximate and upstream from the opening **32** of the chamber **28**. Similarly, the passage **34** terminates in an opening **36** closely proximate and downstream from the opening **31** of the chamber **28**. Solvent vapor spilled over from the openings **31** and **32** of the chamber **28** are withdrawn through the openings **35** and **36** which serve as intakes to a solvent vapor reclaiming system generally indicated by the numeral **37**. The solvent vapor reclaiming system **37** includes, in addition to the passages **33** and **34**, manifold duct provisions **38** combining vapor from the passages **33** and **34** and passing the combined vapor to a further duct **41**. Application of a reduced pressure to the duct **41** and correspondingly to the passages **33** and **34** may be provided by a blower **42** having an output **43** feeding the vapor passing therethrough to a recovery unit **44**.

The recovery unit **44** may be any of a number of commercially available, known or suitably selected assemblies capable of condensing hot vapor to its liquid state. Condensed solvent liquid is passed via a line **45** to a source of solvent or supply tank **46** for subsequent revaporization by the vaporizer **10**.

The supply tank **46** feeds the vaporizer **10** via a supply line **47** and a suitably selected float valve **48** responsive to the liquid solvent level within the vaporizer **10** to maintain a relatively constant predetermined liquid solvent level within the vaporizer.

It will be seen that hot solvent vapor escaping the recirculation provisions constituted by the chamber **28** and its associated duct **30** will pass into the passages **33** and **34**. It should further be noted that movement of a card **23** past the vapor knife **22** tends to carry therewith a quantity of the hot solvent vapor applied to the undersurface **27** and such quantity of vapor carried by the card **23** past the opening **31** of the chamber **28** is withdrawn from the undersurface **27** of the card upon approaching the opening **36** terminating the passage **34**.

It should be noted that air or other atmospheric gases proximate the area of application of hot solvent vapor to the card **23** is substantially prevented from entering the chamber **28**, with a resultant reduction in temperature in the recirculation path, inasmuch as such atmospheric gases are drawn into the passages **33** and **34** prior to their possible entrance into the chamber **28** via the openings **32** and **31**. Accordingly, reduction in vapor temperature by the inclusion of atmospheric gases occurs in the reclaiming provisions of the system wherein a subsequent reduction in temperature for the purposes of condensation is intended and wherein such reduction in temperature by the inclusion of atmospheric gases does not effect the temperature of the hot vapor applied via the vapor knife **22**.

Located atop the hot vapor application area is a cover **50** which aids in locating the cards **23** during their passage along the path of conveyance thereof and which substantially limits the escape of solvent vapor prior to and following the passage of a card past the vapor emission opening **26** of the knife **22**. Mounted within the cover **50** is a pivotable gate **51** having a lowermost portion which normally intersects the path of the conveyance of the card **23**, causing the gate **51** to be pivoted upon contact with a leading edge of a card in transit through the area of vapor application.

Turning now to FIG. 2, there is shown therein a mounting frame **52** including a base **53** supporting thereon the generally indicated conveying provisions **24**. Driving of the conveying provisions **24** may be effected through the employment of a suitably selected motor **54** and suitably selected driving positions **55** which are only diagrammatically illustrated in FIG. 2, the conveying provisions **24** and drive **55** forming, per se, no part of this invention.

A series of mounting feet **56** and upright support members **57** support the vaporizer **10**. The feet **56** are provided with threaded levelling means **58** adjustable to pro-

vide levelling of the vaporizer **10** with respect to the liquid solvent contained therein.

A frame **52** additionally includes a generally horizontally disposed mounting platform **60** connected via a generally vertically extending upright **61** with the base **53** and further supported by a diagonally extending support bar **62**. The platform **60** mounts the variable speed drive unit and motor combination **17** which drives the blower **16** to withdraw vapors from the vaporizer **10** and recirculate vapors through the varporizer. The combination **17** may be any of a number of suitably selected or commercially available combinations including a motor **63** and a variable speed output box **64** which, by actuation of a manually operable control **65**, varies the speed imparted to the blower **16**. The output from the variable speed drive unit and motor combination **17** is applied to the blower **16** via the drive **18** including an output pulley **66** over which is entrained a belt **67** in driving engagement with a further pulley **68** mounted upon a shaft **70**, which shaft **70** serves as the input to the blower **16**.

The blower **16** includes an input port **71** joined as at **72** with the duct provisions **15** which communicate with the vaporizer **10** as indicated at **73**. The output portion **20** of the blower **16** is, as best seen in FIG. 3*a*, connected at the flanges **74** with a first passage providing duct **75** constituting a portion of the duct provisions **21** leading to the vapor knife **22**. A second portion of the duct provisions **21** is provided by a short upwardly extending duct **76** which increases in cross sectional area in an upward direction and which is connected with the duct **75** at the flanges **77**. The chamber **28** forming a portion of the recirculation provisions described hereinabove with respect to FIG. 1 includes a pair of front and rear sloped side walls **78** and **79**, respectively, joined by a further connecting wall **81**, all of which is best illustrated in FIGS. 3*a* and 3*b*.

Within the chamber **28** a further generally upwardly opening duct **82** communicates with the vapor knife **22** to supply hot solvent vapor thereto for application to a conveyed article. The generally upwardly opening duct **82** within the chamber **28** communicates with the upwardly extending duct **76** located externally of the chamber **28** via a connector **83** which extends through the connecting wall **81** of the chamber **28**. The ducts **76** and **82** are flanged at **84** and **85**, respectively, and secured to the connector **83**.

The duct **82** within the chamber **28** supplies hot vapor through the chamber **28** to the vapor knife **22** and terminates at its uppermost portion in a partially cylindrical flange **86** which is secured to the knife **22** by a plurality of fasteners **87**. The vapor supplying duct **82** communicates with the interior of the vapor knife **22** through an opening **88**, best illustrated in FIG. 4, formed in a generally cylindrical, hollow tubular member **90** which constitutes the body of the vapor knife **22**. The hollow tubular member **90** is of steel or similarly resilient material and, as best seen in FIGS. 3*a* and 3*b* extends transverse to the path of conveyance in the articles to be treated. The vapor emission opening **26** through which hot solvent vapors are applied to the undersurface **27** or cards or panels **23** in transit past the knife **22** is provided by an elongate narrow slot extending axially the length of the tubular member **90**.

Adjustment of the width of the slot **26** in the circumferential direction with respect to the tubular member **90** is effected by the provision of a pair of studs **91** extending diametrically through the hollow tubular member **90** and having an enlarged head portion **92** and a washer **93** contacting the exterior of the hollow tubular member **90**. Threadedly received upon the studs **91** is a nut **94** which contacts the exterior of the tubular member **90** diametrically opposite the head **92** and which may be affixed to the exterior of the tubular member as indicated in FIG. 4. It will be seen that turning of the stud **91** in a tightening direction will effect reduction in the width of the vapor emission slot **26** through a contraction of the tubular member **90** inwardly toward its longitudinal axis whereas a loosening of the stud **91** effects a relaxation in the pressure applied to the tubular member **90** allowing the enlargement of the vapor emission slot **26** under the inherent bias provided by the resilient material of which the tubular member **90** is formed.

Mounting of the vapor knife **22** within the chamber **28** is provided by a pair of mounting plates **95**, **96** having generally annular grooves **97**, **98**, respectively, formed in the interior surfaces thereof and receiving respective ends of the hollow tubular member **90** therein. An annular bearing member **100** is received in each of the slots **97** and **98** and contacts the respective end of the tubular member **90** located therein. A suitably dimensioned wave washer **101** is located in each of the slots **97** and **98** between the bottoms thereof and the bearing members **100** biasing the bearing members **100** into firm engagement with the respective ends of the tubular member **90**. Each of the end or mounting plates **95** and **96** is supported upon an upright apertured plate **102** as by a bolt **103**. Each of these plates **102** includes a central aperture **104** through which extends the tubular member **90** for reception in the slots **97**, **98**. The apertured plates **102** terminate the cavity **28** in which the knife **22** is located on either side of the path of conveyance and are joined with the walls **78** and **79** adjacent opposite ends of the vapor knife **22**. The apertured plates **102** and mounting plates **95** and **96** are supported by mounting provisions generally indicated by the numeral **105** in FIGS. 3*a* and 3*b* which support the knife **22** upon the members of the supporting base **53**.

The chamber **28** into which hot vapor is drawn for recirculation terminates in a port **106** best seen in FIG. 3*b*, which port is connected, via a curved conduit **107**, with a recirculated vapor intake port **108** provided at one end of the vaporizer **10**. The conduit **107** constitutes the duct **30** of FIG. 1 and is flanged and connected at its ends **110** and **111** to the chamber **28** and vaporizer **10**, respectively.

Vapor recirculated through the chamber **28**, conduit **107**, across the level of the liquid within the vaporizer **10** and returned to the vapor knife **22** is maintained at an elevated temperature provided by both the heater **13** of the vaporizer **10** and an ancillary heater **112** mounted upon the mounting plate **95** and having an elongate heating element **113** extending into the interior of the hollow tubular member **90**. The ancillary heater **112** may be a suitable commercially available heater and serves to further elevate the temperature of solvent vapor prior to jet-like emission from the elongate vapor emission opening **26** of the knife **22**.

A suitable commercially available thermocouple temperature sensing device **114** may be mounted upon the mounting plate **96** with an elongate bi-metallic temperature responsive element **115** extending into the interior of the tubular member **90** to detect the temperature of the vapor just prior to emission from the opening **26**. The thermocouple **114** may be employed to control the ancillary heater **112** for automatic control of the temperature of the hot solvent vapor applied to articles in transit past the knife **22**.

The passages **33** and **34** which terminate in openings **35** and **36**, respectively, through which vapor spilled over from the chamber **28** is withdrawn, are provided by two large downwardly depending conduits **116** and **117**, best illustrated in FIG. 4. The conduits **116** and **117** are joined at a flanged end **118** thereof, best illustrated in FIG. 3*b*, with the manifold **38** for passage of vapor to the recovery unit **44** via the duct provisions **41**. The conduits **116** and **117** are spaced slightly from the chamber **28** and the space **120** so provided on each side of the chamber **28** may be employed for jacketing the chamber in insulating material to further help maintain the temperature of solvent vapor in the recirculation path.

It will be noted from FIG 4 that the vapor emission opening **26** of the vapor knife **22** is directed angularly toward the path of the conveyance of the treated articles in an upstream direction with respect to that path of conveyance. The angle at whjch hot solvent vapor leaves the tubular member **90** may be adjusted and pre-set by a rotation of the tubular member **90** about its axis and within the slots **97** and **98** of the mounting plates **95** and **96** prior to fastening of the tubular member **90** with the duct **82**. The gate **51** pivotally mounted within the cover **50** overlying the vapor application area is mounted slightly upstream with respect to the vapor emission opening **26** and defines a surface **120** thereon which, in the absence of a card or panel **23** within the vapor application area, intersects the path of vapor emission from the vapor emission opening **26** to maintain vapor so emitted in the area of the openings **31** and **32** of the chamber **28** to assure withdrawal of a substantial portion of the vapor through the chamber **28** for recirculation and to reduce substantially vapor losses along the conveyance path, absent the presence of a card or panel **23**. A lowermost portion **121** of the gate **51** intersects the path of conveyance of the cards or panels **23** as defined by a set of guiding provisions **122**, **123** and **124**. It will be seen from FIG. 4 that the lowermost portion **121** of the pivotally mounted gate **51** masks the leading edges of articles in transit along the path of conveyance from vapor emitted through the opening **26** of the vapor knife **22**. Such masking action is of particular benefit where the cards or panels **23** are of corrugated medium extending parallel to the path of conveyance defined openings in the leading edge of the paperboard panels susceptible to the entrance of vapor therein. The masking action provided by the portion **121** of the gate **51**, then, prevents entrance of vapor into the openings which ordinarily would be exposed to the jet or stream of hot solvent vapor from the vapor knife **22**. Additionally, it will be noted that the cover **50** has mounted therein a stop **122** for contacting the surface **120** of the gate **51** upon movement of the gate by the leading edge of a panel **23** in transit therepast. Once pivoted to the position shown in broken lines in FIG. 4, the lowermost portion **121** of the gate **51** contacts the upper surface of the panel to aid in maintenance of the panel in close proximity to the vapor emission opening **26** as vapor is applied to the undersurface of the panel.

As best seen in FIGS. 3*a*, 3*b* and 5, the cover **50** extends the full width of the path of conveyance and is provided with a pair of handles **123**, facilitating the manual placement and removal of the cover **50**. The cover **50** terminates in a pair of front and rear side walls **124** and **125**, respectively, each of which has an aperture **126** formed therein closed by cover plate **127**, fastened to the walls **124** and **125** as by the bolts **128**. Through the apertures **126** extend a pair of bearing projections **130** integrally formed upon the interior surface of the cover plates **127** and defining a centrally located bore **131** therein. Within the bores **131** are received closely fitting cylindrical ends **132** of a rotatable gate support bar **133**. The gate **51** is affixed, as at **134**, upon the gate support bar **133**, the cylindrical end **132** of the bar **133** being rotatably slidable within the bores **131**. The walls **124** and **125** of the cover **50** are spanned by a hood **135** to complete the enclosure of the vapor application area.

Adjustments of the flow of hot solvent vapor into the chamber **28** is provided by the inclusion of a pair of dampers **140** and **141** immediately below the openings **32** and **31**, respectively, and adjacent the exterior of the hollow tubular member **90** of the knife **22**. The dampers **140** and **141** are each supported upon a pair of damper support members **142**, one of which is best illustrated in FIG. 6. The damper support members **142** are of generally cylindrical configuration relieved along a portion of the surface thereof as at **143** for connection with the dampers as by the screws **144**. Each of the damper support members **142** extends into an aperture **145**, four of which are provided in the upright plate **102**. A shaft portion **146** extends through a further plate **147** affixed to the upright plate **102** and terminates in an end **148** of generally rectangular cross-section, exterior of the cavity **28** and allowing manual variation of the angle of inclination of the dampers **140** and **141**. The shaft **146** is threaded as at **150** to allow the provision of a lock nut **151** suitable for maintaining the associated damper at a desired angle of inclination.

Air intake into the passages **33** and **34** from adjacent the area of application of hot solvent vapor is adjustable by the provision of movable panel members **152** mounted upon the conduits **116** and **117** as by the provision of outwardly extending studs **153** slidably maintained within slots **154** formed in the outermost walls of the conduits **116** and **117**. Threadedly maintained upon the studs **153** are adjustable retaining members **155** having projections **156** formed thereon for engagement with the walls of the conduits **116** and **117** adjacent the slots **154**. Movement of the panel members **152** as indicated by broken line illustration in FIG. 4 allows reduction in the cross sectional area of the openings **35** and **36** into the passages **33** and **34**, respectively, and allows restriction of air flow into such passages by movement of the panel members **152** into closer proximity with the path of conveyance of the cards or panels **23**.

Varying the angle of inclination of the dampers **140** and **141** adjust the amount of hot solvent vapors spilled over from the chamber **28** to the passages **33** and **34**, while adjusting the position of the movable panel members **152** allows an adjustment in the amount of air or atmospheric gases entering the passages **33** and **34**, thus preventing the entrance of excess atmospheric gases such as would cause withdrawal of those gases into the chamber **28**.

As set forth hereinabove, a portion of the hot solvent vapor applied to articles in transit along the path of conveyance is carried with such articles and ultimately withdrawn into the passage **34**. The rate of vapor production, then, by the vaporizer **10** should be adjusted to provide vapor as required by the use thereof in fixing or fuzing the coating or printing medium on the undersurface of the panels **23**, by the withdrawal of vapor carried with the panels in their movement through the vapor application area, by the slight vapor losses occurring in the system and to provide an amount of vapor spilled over past the openings **31** and **32** into the chamber **28** to be withdrawn by the passages **33** and **34** for conversion to the liquid state.

It will be seen from the foregoing that adjustment of the vaporization of the vaporizer **10**, the driven rate of the blower **16** and the position of the dampers **140** and **141** and the panel members **154** allows employment of the system to maintain elevated vapor temperatures in the recirculation path, decreasing the time required in each fuzing operation, with minimum loss of solvent and with little or no entry of atmospheric gases into the recirculation path.

While the methods and apparatus described hereinabove represent preferred forms of the embodiment, it will be readily apparent that many variations may be made therein without departure from the spirit of the invention embodied therein.

I claim:

1. Fuzing apparatus for fixing deposited printing or coating medium to articles by the application of vapor thereto including means for vaporizing a liquid solvent to form a solvent vapor, vapor applying means for directing solvent vapor produced by said means for vaporizing against one of said articles, means for locating said articles for the application of vapor thereto, vapor recirculation means for removing vapor from adjacent said article for reapplication thereto and vapor reclaiming means in addition to said vapor recirculation means for collecting

a portion of the solvent vapor directed against said article and converting the collected solvent vapor to a liquid form for subsequent vaporization.

2. Apparatus according to claim 1 wherein said vapor recirculation means defines first vapor inlet means adjacent said vapor applying means for withdrawing vapor immediately adjacent the area of application of said vapor to said article, said vapor reclaiming means including second vapor inlet means adjacent said first vapor inlet means and on the opposite side of said first vapor inlet means from said vapor applying means for withdrawing vapor passing said first vapor inlet means and substantially preventing intake of atmospheric gases by said first vapor inlet means into said vapor recirculation means.

3. Apparatus according to claim 2 wherein said first and second inlet means are closely proximate the location of said article, said second inlet means including at least one adjustable panel mounted for movement toward and away from said article to adjust intake of atmospheric gases to said vapor reclaiming means and movable to vary the cross-sectional area of said first inlet means.

4. Apparatus according to claim 3 wherein said recirculation means includes adjustable damper means located therein for partially restricting vapor passage from said first vapor inlet means.

5. Apparatus according to claim 1 wherein said means for locating said article comprises means for directing movement of articles along a path of conveyance, said means for directing solvent vapor against one of said articles including outlet means proximate said path of conveyance for passing vapor therethrough to an trticle and first passage means connecting said outlet means with said means for vaporizing, said recirculation means including first inlet means opening proximate said path of conveyance and second passage means connecting said first inlet means and said means for vaporizing, said outlet means being located centrally within said first inlet means and said reclaiming means comprising second inlet means proximate said path of conveyance and including inlets on opposite sides of said first inlet means for withdrawing vapors passing said first inlet means and for substantially preventing the entrance of atmospheric gases into said first inlet means.

6. Apparatus according to claim 1 wherein said means for vaporizing includes liquid retaining means and heater means mounted within said liquid retaining means for heating liquid solvent therein to produce solvent vapor, said means for directing solvent vapor against one of said articles including outlet means for passing solvent vapor therethrough and pump means for moving solvent vapor from said means for vaporizing to said outlet means, said recirculation means comprising inlet means adjacent said outlet means and passage means interconnecting said inlet means and means for vaporizing for passing vapors from said inlet means and through said means for vaporizing for reapplication to an article.

7. Apparatus according to claim 1 wherein said means for directing solvent vapor against one of said articles includes a vapor knife, means communicating between said vapor knife and said means for vaporizing, said vapor knife including a hollow tubular member having an elongate opening formed axially along the surface thereof for passing vapors therethrough and into contact with said articles and an intake opening connected with said passage means for passing vapors from said vaporizing means to the interior of said knife.

8. Apparatus according to claim 7 further comprising heater means mounted within said hollow tubular member for heating vapor just prior to passage through said elongate opening.

9. Apparatus according to claim 7 wherein said hollow tubular member is of resilient material and includes means for contracting said tubular member to reduce the circumferential extent of said elongate opening.

10. Apparatus according to claim 8 wherein said means for contracting said tubular member includes at least one elongate stud extending laterally through said tubular member and bearing enlarged tubular member contacting members at opposite ends thereof and in contact with the exterior of said tubular member, one of said enlarged tubular member contacting members being adjustably received upon said stud for contracting said tubular member against the bias of said resilient material upon movement inwardly with respect to said tubular member and for allowing expansion of said tubular member under the bias of said resilient material upon movement outwardly with respect to said tubular member.

11. Apparatus according to claim 7 wherein said knife further includes two end plates closing and mounting said tubular member at opposite ends thereof, said plates including means for allowing angular movement of said tubular member about its longitudinal axis to pre-set the angle of emission of vapor from said elongate opening.

12. Apparatus according to claim 1 wherein said means for locating said article includes means for directing movement of the article along a predetermined path, said means for directing solvent vapor against one of said articles including vapor knife means located proximate said predetermined path for directing a stream of vapor toward said path, cover means adjacent said path and on the opposite side thereof from said vapor knife means and including a swingably mounted gate extending into said path for swinging under contact with leading edges of articles in transit on said path.

13. Apparatus according to claim 12 wherein said gate is located upstream along said path with respect to said vapor knife means and includes a surface lying in the flow path of the vapor stream from said vapor knife means to divert at least a portion of the vapor stream to said recirculation means prior to swinging movement of said gate by an article in transit on said predetermined path.

14. Apparatus for fixing deposited printing or coating medium to articles by the application of vapor including means for guiding articles along a predetermined path of conveyance, vapor application means for directing a stream of vapor onto said articles during their movement along said predetermined path, means for withdrawing vapor from the area of application, cover means located proximate said vapor application means and on the opposite side of said predetermined path from said vapor application means, said cover means including a pivotally mounted gate normally intersecting a stream of vapor from said vapor application means for substantially preventing escape of vapor from said means for withdrawing vapor and said gate extending into said predetermined path for pivotal movement by contact with articles in transit on said path for masking the leading edge of articles prior to movement into contact with said gate.

15. Apparatus for fixing deposited printing or coating medium to serially conveyed panels including means for guiding movement of the panels along a predetermined path, vapor application means for directing a stream of vapor against a surface of said panel during movement thereof along said path, cover means located proximate said vapor application means and on the opposite side of said path from said vapor application means, said cover means including a gate having a portion normally intersecting said path and lying in the stream of vapor from said vapor application means, said gate portion intersecting said predetermined path being located for contacting leading edges of panels in transit on said predetermined path and movable by said panels to contact the surface of said panels nearest said cover means during movement of said panels past said gate and to mask the leading edges of said panels from said stream of vapor prior to movement of said panels past said gate.

16. Apparatus according to claim 15 further including means for withdrawing vapor from the area adjacent said vapor application means, said gate substantially prevent-

ing the escape of vapor past said means for withdrawing during absence of a panel proximate said vapor application means.

17. Fuzing apparatus for fixing deposited printing or coating medium to serially conveyed panels including means for guiding movement of panels along a predetermined path, vapor knife means extending transversely of said path for directing a wide, thin solvent vapor stream against a surface of said panels during movement along said path, vaporizing means, means connecting said vaporizing means with said vapor knife means, vapor recirculation means including an open ended chamber adjacent said path and means connecting said chamber with said vaporizing means, said vapor knife means being located within said chamber adjacent the open end thereof and means for circulating vapor for emission from said vapor knife means and for returning vapor to said vaporizing means through said chamber.

18. Apparatus according to claim 17 wherein said vapor knife means includes a vapor emission opening, an interior chamber and vapor heating means within said interior chamber for heating vapor during passage through said chamber to said vapor emission opening.

19. Apparatus according to claim 17 further comprising vapor reclaiming means including channel means opening adjacent said open end of said open ended chamber for withdrawing vapor passing said chamber means and for substantially preventing atmospheric gases from entering said chamber by drawing said atmospheric gases into said channel means before passage thereof to said chamber.

20. Apparatus according to claim 19 wherein said vapor reclaiming means comprises means for converting vapor entering said channel means to a liquid state for revaporization, said channel means being located closely proximate at least one edge of the open end of said open ended chamber to withdraw vapors spilled over the open end of said open ended chamber.

21. Apparatus according to claim 17 further including liquid solvent supply means, said vaporizing means including means for maintaining a quantity of liquid solvent therein, heater means for heating said liquid solvent to produce solvent vapor, said means for maintaining a quantity of liquid solvent including level responsive means for controlling the addition of liquid solvent to said vaporizing means in dependence upon the liquid level within said vaporizing means.

22. Apparatus for fixing deposited printing or coating material on articles in transit along a predetermined path including vaporizing means for producing hot solvent vapor from liquid solvent, means for applying said hot solvent vapor to articles in transit along said predetermined path, recirculation means for withdrawing said hot solvent vapors from adjacent said predetermined path and vapor reclaiming means for converting hot vapor to liquid for revaporization including means for withdrawing vapor and atmospheric gases from adjacent said recirculation means to recapture vapor passing said recirculation means and to prevent cooling of vapor in said recirculation means by the drawing of atmospheric gases into said recirculation means.

23. Apparatus according to claim 22 wherein said means for applying said hot solvent vapor includes vapor knife means for directing a stream of vapor against articles in transit on said path, said vapor knife means including ancillary heating means for heating vapors during passage through said knife means.

24. The method of applying solvent vapor to articles having printing or coating medium deposited thereon including the steps of vaporizing a liquid solvent to produce solvent vapor, directing the solvent vapor into a predetermined area for application against the article, withdrawing a portion of the solvent vapor from the predetermined area, recirculating the portion of solvent vapor for reapplication to an article and reclaiming an additional portion of the solvent vapor including withdrawing the additional portion of solvent vapor from the predetermined area and converting the additional portion to liquid solvent.

25. The method according to claim 24 wherein said step of reclaiming includes withdrawing a quantity of atmospheric gases from adjacent said predetermined area to substantially preclude withdrawal of atmospheric gases in said step of withdrawing the first mentioned portion of solvent vapor.

26. The method according to claim 25 wherein said step of vaporizing includes heating the solvent liquid to produce hot solvent vapors, said method further including additionally heating the solvent vapor just prior to direction into the predetermined area.

27. The method according to claim 24 wherein said step of vaporizing includes heating a quantity of liquid solvent within a vaporizer to produce hot solvent vapor, said step of recirculating including directing the first mentioned portion of solvent vapor withdrawn from the predetermined area into the vaporizer for reapplication.

28. The method of applying solvent vapor to articles having printing or coating medium deposited thereon including the steps of serially conveying articles along a predetermined path of conveyance, generating solvent vapors, directing the solvent vapor against the articles in a wide, thin jet disposed transverse to the path of conveyance, withdrawing a first portion of vapor from adjacent the jet of vapor including sucking vapors from areas along the path of conveyance immediately upstream and downstream from the jet of vapor, recirculating the first portion of vapor for inclusion in the jet, withdrawing a second portion of vapor including sucking vapor from areas along the path of conveyance immediately upstream and downstream from the areas at which the first step of withdrawing occurs to reclaim vapor in addition to the first quantity of vapor and converting the second quantity of vapor to a liquid state for subsequent vaporization.

29. The method according to claim 28 wherein the step of withdrawing a second portion of vapor includes drawing atmospheric gases from adjacent the path of conveyance to substantially prevent inclusion thereof in the first step of withdrawing.

30. The method according to claim 29 wherein the step of vaporizing includes producing hot solvent vapor, said step of drawing atmospheric gases preventing lowering of the temperature of the recirculated vapor by the inclusion of atmospheric gases therein.

31. The method according to claim 28 wherein the step of vaporizing includes producing vapor at a rate at least equal to the sum of the rate at which the second portion of vapor is withdrawn, the rate at which vapor is employed in the fuzing of medium on the articles, and the rate at which vapor escapes the first and second steps of withdrawing.

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