Jan. 1, 1963 L. C. LOT 3,070,900

XEROGRAPHIC FIXING APPARATUS

Filed Feb. 28, 1958 4 Sheets-Sheet 1

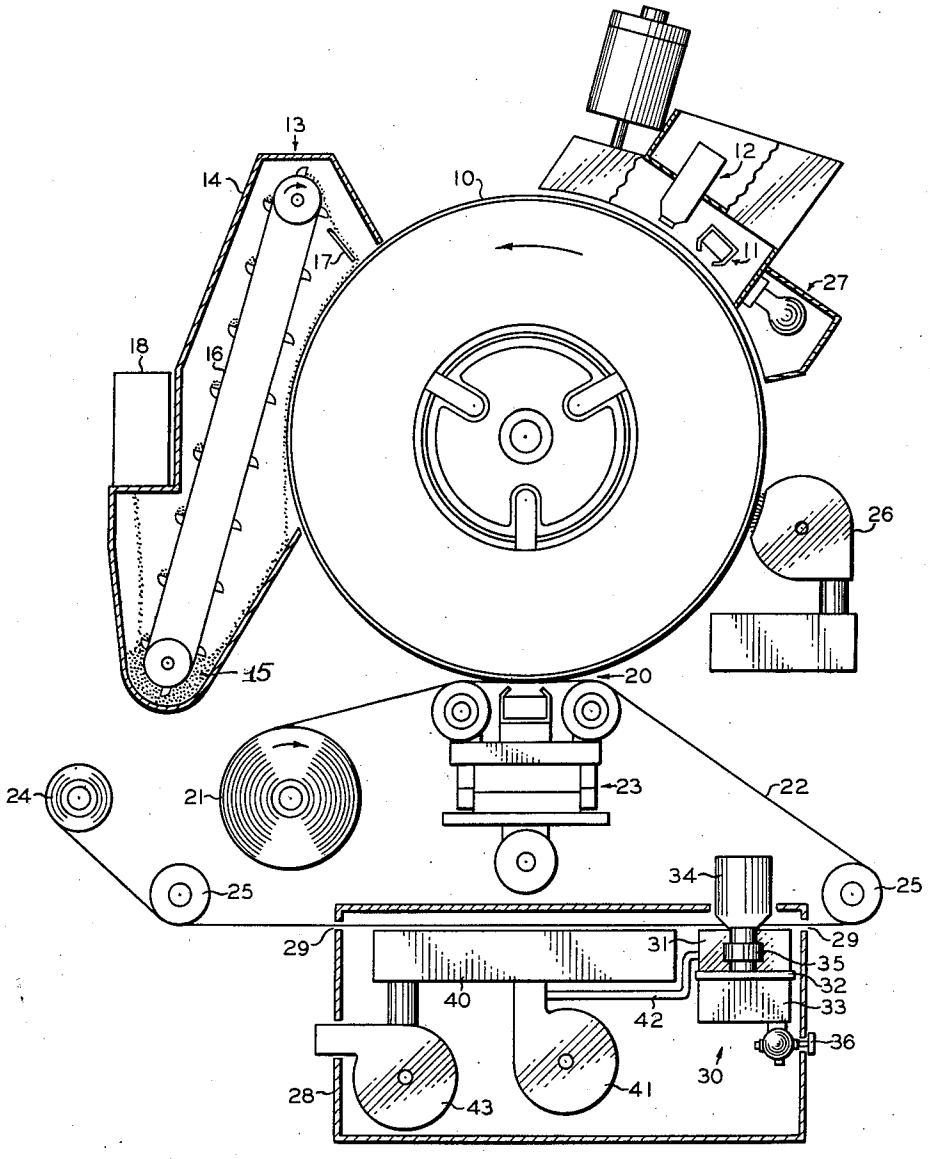


FIG. 1

INVENTOR.
Leon C. Lot

BY

ATTORNEY

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XEROGRAPHIC FIXING APPARATUS

Filed Feb. 28, 1958 4 Sheets-Sheet 2

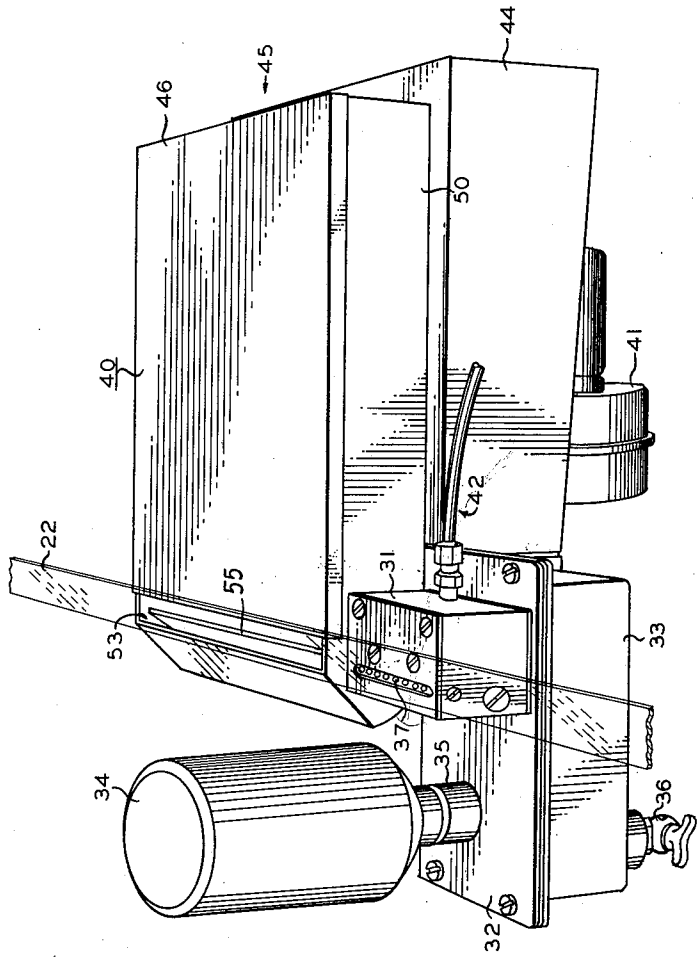


FIG. 2

INVENTOR.
Leon C. Lot

BY

ATTORNEY

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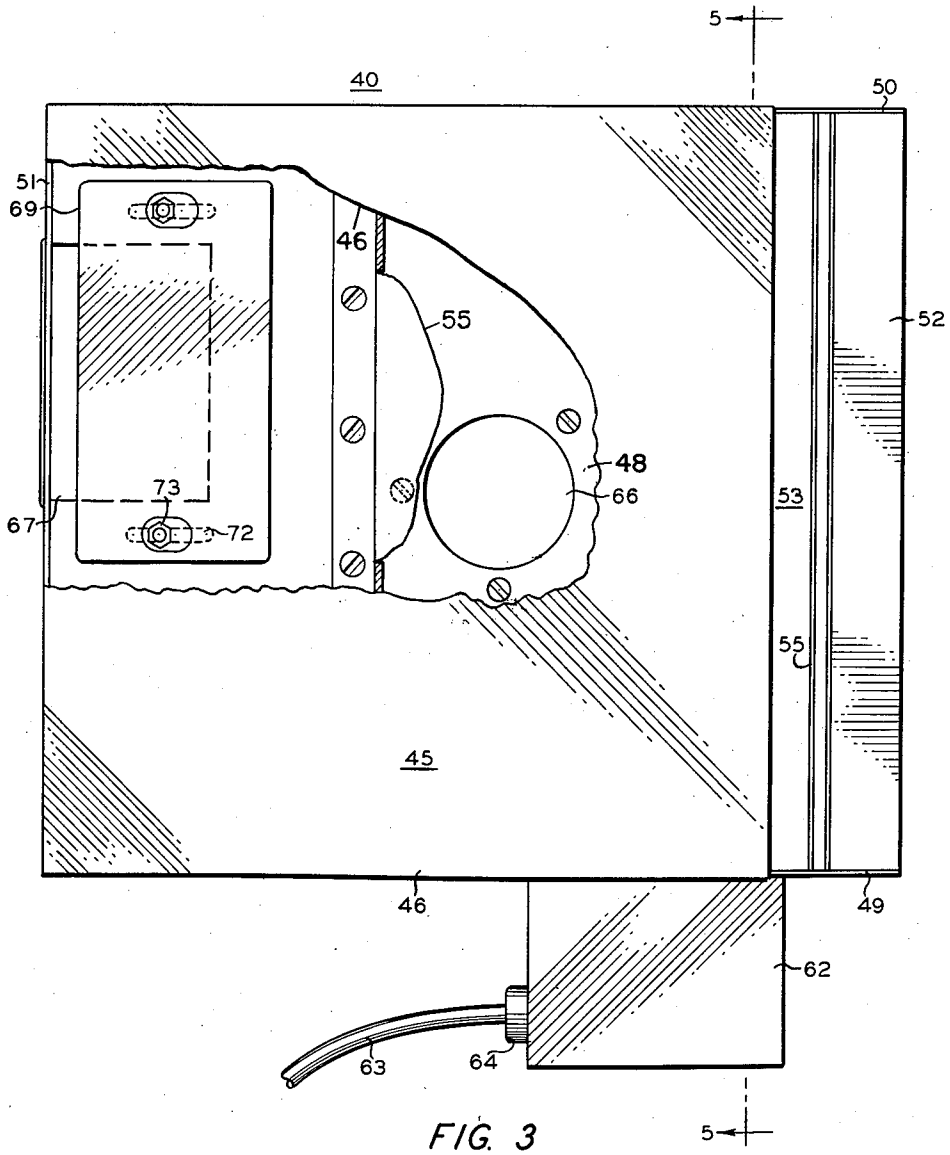


FIG. 3

INVENTOR.
Leon C. Lot

BY

ATTORNEY

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XEROGRAPHIC FIXING APPARATUS

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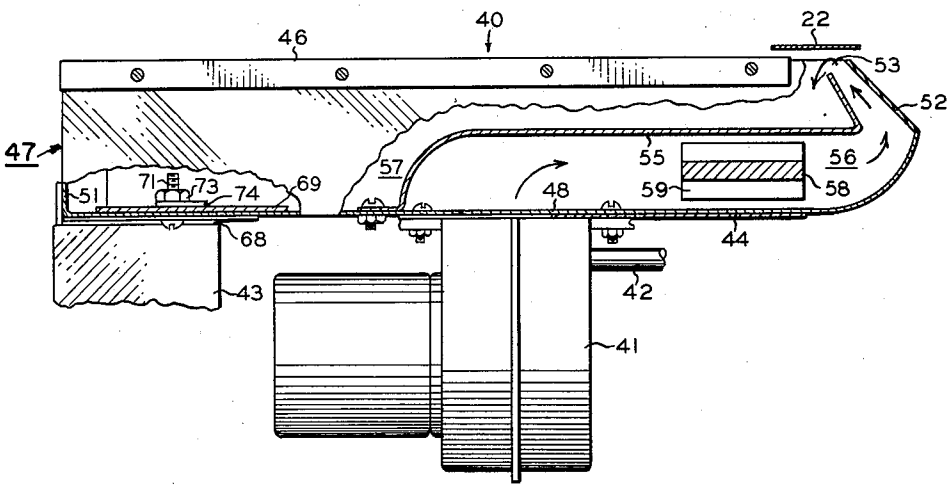


FIG. 4

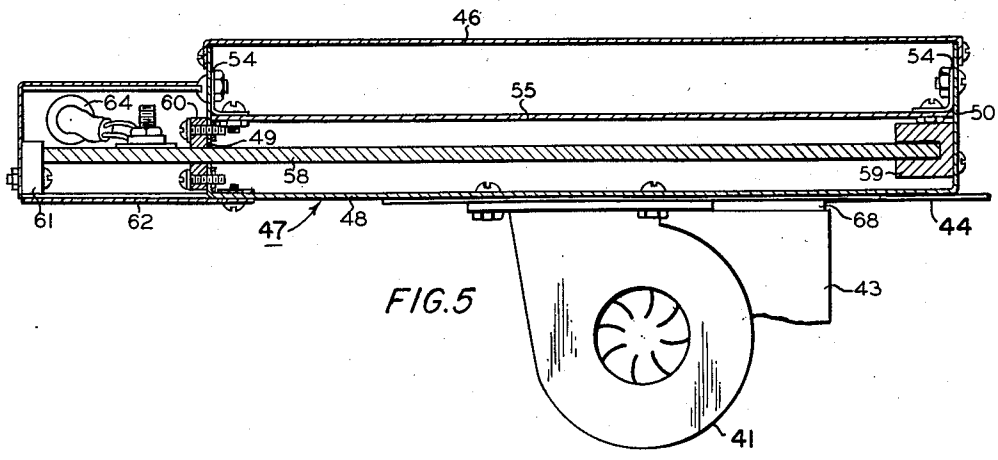


FIG. 5

INVENTOR.
Leon C. Lot

BY

United States Patent Office 3,070,900
Patented Jan. 1, 1963

3,070,900

XEROGRAPHIC FIXING APPARATUS

Leon C. Lot, Webster, N.Y., assignor to Xerox Corporation, a corporation of New York

Filed Feb. 28, 1958, Ser. No. 718,179
3 Claims. (Cl. 34—156)

This invention relates to xerographic powder image fixing devices and, particularly, to an improved apparatus for drying vapor fused xerographic powder images.

In the process of xerography, for example, as disclosed in Carlson Patent 2,297,691, issued October 6, 1942, a xerographic plate comprising a layer of photoconductive insulating material on a conductive backing is given a uniform electric charge over its surface and is then exposed to the subject matter to be reproduced, usually by conventional projection techniques. This exposure discharges the plate areas in accordance with the light intensity that reaches them, and thereby creates an electrostatic latent image on or in the photoconductive layer. Development of the latent image is effected with an electrostatically charged, finely divided material, such as an electroscopic powder, which is brought into surface contact with the photoconductive layer and is held thereon electrostatically in a pattern corresponding to the electrostatic latent image. Thereafter, the developed xerographic powder image is usually transferred to a support surface to which it may be fixed by any suitable means.

In the Carlson patent it is noted that a variety of types of finely divided electroscopic powders may be employed for developing electrostatic latent images. However, as the art of xerography has progressed, it has been found preferable to develop line copy images with a powder formed of any of a variety of pigmented thermoplastic resins that have been specifically developed for the purpose. A number of such developing materials are manufactured and marketed by The Haloid Company of Rochester, New York, and are specifically compounded for producing dense images of high resolution and to have characteristics to permit convenient storage and handling.

Such developing materials are specifically designed to permit them to be fixed to support surfaces either by conventional heat fixing or vapor fixing techniques, in accordance with the particular application in which they are employed. However, in order to provide the characteristics mentioned above, such materials are inherently limited in latitude in the operating conditions under which they may be used. For example, in automatic xerographic machines embodying heat fixing apparatus, the support surface web on which xerographic powder images are formed is passed through an oven-like structure that is maintained at a constant temperature that is determined by the fusing temperature of the resin component of the xerographic developing material and the web speed of the support surface. Should the web speed by increased or the oven temperature decreased, the powder images are not properly fixed and are subject to smearing. In the event web speed is decreased or oven temperature increased, the support surface itself is subjected to increased heat that is liable to deform, discolor, or even char it, depending upon the type of material of which the support surface is composed.

In the fixing of powder images on a support material, such as photographic film which will not tolerate even a relatively nominal temperature increase without distorting or damaging the film, the process of solvent vapor fusing is preferred. In this process, as described, for example, in Carlson Patent 2,624,652, the powder images are fixed by condensing a liquid solvent onto the image surface from a solvent vapor.

In automatic xerographic machines embodying vapor fixing apparatus, the support material with the powder

images thereon is usually passed through a vapor chamber containing a saturated atmosphere of developing material solvent. In such machines it is also essential that the web speed of the support surface be carefully correlated to the solvent vapor concentration in the vapor chamber to minimize the possibility of under-fixing or over-fixing the powder images, or of excessively wetting the support surface with condensed solvent. In addition, since substantially all solvents suitable for fixing xerographic powder images are either inflammable or noxious, the vapor drag-out caused by the support surface web moving through the vapor chamber tends to produce undesirable ambient conditions.

The principal object of the present invention is to provide an improved xerographic powder image fixing apparatus for use in automatic xerographic machines.

A further object of the invention is to improve vapor fusing apparatus for xerographic powder images whereby solvent vapor is applied to the surface on which the powder images are supported to fuse the powder images and whereby the resultant fused images are further fixed by forced air drying.

A further object of the invention is to minimize solvent loss in vapor fixing devices.

A further object of the invention is to improve a dryer for drying solvent wetted images on a strip or web of support material.

These and other objects of the invention are attained by means of a fixing apparatus including a vapor fuser and a dryer in combination. In the particular arrangement disclosed herein, the dryer is comprised of a sheet metal box having a narrow opening on the top and at one end of the box over which the support material, having tackified images thereon to be dried, passes. Fastened to the bottom wall of the box and extending up to and dividing the opening is a divider plate which divides the box into first and second compartments. A small compressor supplies air at a slight positive pressure to the first compartment wherein the air is heated by a heater element before passing out the opening into contact with the tackified images carried by the support material. The second compartment is connected to a source of slight negative pressure so that the heated air from the first compartment, after contacting the images, is exhausted. Since the compressor supplying air to the first compartment of the dryer is located below the vapor fuser, the surplus vapor, if any, from the vapor fuser, being heavier than air, will settle and be picked up by the compressor, and effectively exhausted.

The term "tackified" and the several variant forms thereof used throughout this specification are employed to define the condition of the powder particles of the xerographic powder image when heated or plasticized by a solvent in a manner such that the individual particles soften and coalesce and in which state they become sticky and readily adhere to other surfaces. Although this condition necessarily requires a flowing together of the particles to effect a thorough fusion thereof, it is to be understood that the extent of such flowing is not sufficient to extend beyond the boundary of the pattern in which the particles are formed.

A preferred form of the invention is shown in the accompanying drawings, in which:

FIG. 1 illustrates schematically a preferred embodiment of an electrophotographic apparatus adapted for continuous and automatic operation, and incorporating a fixing apparatus in accordance with the invention.

FIG. 2 is a perspective view of a preferred embodiment of the fixing apparatus in accordance with the invention.

FIG. 3 is a plan view of the dryer element of the fixing apparatus, partially broken away to illustrate the various elements of the device.

FIG. 4 is a view in side elevation of the dryer, partially broken away to illustrate the various elements of the device, and

FIG. 5 is a sectional view taken along line 5—5 of FIG. 3.

Referring now to the drawings, the continuously operating xerographic apparatus shown in FIG. 1 comprises a xerographic plate including a photoconductive layer on a conductive backing and formed in the shape of a drum, generally designated by numeral **10**, which is mounted to rotate through a plurality of xerographic processing stations. Positioned at a desired point adjacent to the path of rotation of drum **10** is a charging station **11** which may desirably be a corona discharge electrode or the like. Next subsequent thereto in the path of motion of the xerographic drum is an exposure station **12**. This exposure station may be one of a number of types of mechanisms or members such as desirably an optical projection system or the like whereby an optical image is projected onto the surface of the photosensitive xerographic drum. This is desirably done by a slit projection lens arrangement designed to project a line copy image onto the surface of the photoconductive xerographic drum.

Adjacent to the exposure station **12** is a development station generally designated **13**. The development station comprises generally a housing or enclosure **14** containing a source of development material **15** and a suitable conveyor **16** to carry the development material to the upper part of the development station from where the material is cascaded down a hopper chute **17** and then over the drum **10** to develop the electrostatic latent image formed thereon.

An automatic toner dispenser, generally designated by numeral **18** is used to supply additional toner powder to the development material **15**.

At the area generally designated by numeral **20**, electrostatic transfer of the developed image from the drum **10** occurs. A roller **21** supplies a continuously fed web of film **22** or other support material over the rollers of transfer mechanism **23** and into surface contact with drum **10**. Immediately below the web and drum contacting area is a corona discharge electrode that is suitably energized to attract the xerographic powder image from the drum surface and cause it to adhere electrostatically to the web surface, whereby transfer of the powder image is effected. The web is then fed, carrying the transferred image, over an image fixing apparatus **30** whereby the copy is permanently affixed to the web and finally on to take-up roller **24**.

Rollers **25** act as guide rolls for the web. The movement of web **22** is synchronized with the turning of drum **10**, which in this embodiment is rotated in a counterclockwise direction, as indicated by the arrow in FIG. 1. The drum **10** and the take-up roller **24** may be driven by a suitable motor (not shown) or by other conventional means.

Positioned next adjacent to the transfer area **20** is a cleaning device **26** to clean the drum surface of any residual powder.

The next and final station in the device described in FIG. 1 is a floodlight station **27** where the xerographic drum **10** is flooded with light to cause dissipation of any residual electrical charge on the drum **10**.

Normally, the various movable mechanisms of the xerographic device are enclosed in a suitable housing or housings similar to the enclosure **28** around the fixing apparatus **30**, the enclosure **28** having suitable slots **29** through which the support material may pass. The fixing apparatus **30** includes a vapor fuser **31** mounted on the cover plate **32** of a solvent reservoir tank **33** supplied with solvent from a solvent supply bottle **34** attached to the tank by a bottle adapter **35**. A drain cock **36** is mounted to the bottom of reservoir tank **33** for draining liquid from the tank. Although any one of a number of different types of vapor fusers may be used, the vapor fuser shown is of the type described in more detail in copending Huber et al. application Serial No. 718,178 filed February 28, 1958, now Patent 3,013,342 in which a compressed aeriform fluid is used to carry resin solvent vapors through outlet conduits **37** into contact with the powder images on a support material to thereby liquefy or tackify the powder images.

The support material with the tackified images thereon is then passed over an opening in the dryer **40** to permit the resin solvent to evaporate therefrom, thereby leaving the pigmented resin of the xerographic powder image permanently bonded to the support material. Air is supplied to the dryer **40** from air compressor **41** which in the embodiment disclosed also supplies air through conduit **42** to the vapor fuser **31**. Air is exhausted from the dryer by means of exhaust blower **43** which, in a permanent installation of the xerographic machine in a building, would perferably be connected to the building's exhaust facilities (not shown).

FIG. 2 shows the fixing apparatus mounted to a frame member **44** of the xerographic machine, the dryer **40** being fastened directly to the frame member **45** while the vapor fuser **31** is supported by the reservoir tank **33** fastened to the frame member, the outlet conduits **37** of the vapor fuser being positioned in line with the opening **53** in the dryer **40**.

Essentially, a vapor fuser is a device to create a zone of relatively high solvent vapor pressure through which a support material bearing powder particles forming an image is passed. Since the powder particles forming the image have a great affinity for the solvent vapor, the solvent goes into solution and liquefies or tackifies the powder particles and causes the particles to flow into the interstices of the support material. Later, under reduced vapor pressure, the solvent evaporates leaving a dry pigmented resin image permanently bonded to the support material. A reduced vapor pressure zone around the tackified image can be brought about by heat or circulated air, either forced circulation of air or natural circulation of air.

Thus, referring again to FIG. 1, after the support material passes over the vapor fuser **31** the powder particles are tacky, but, if left exposed to air, the powder particles will dry normally. However, if the powder images are not completely dried, but are still tacky when the support material is wound on a take-up roller, image offsetting will occur. In an automatic xerograph machine similar to the unit shown in FIG. 1, space limitations plus the relatively high speed at which the machine is desirably operated precludes a sufficient run of support material before it is wound on the take-up roller **24** to permit complete normal drying of the fused images. To permit the use of the vapor fuser **31** in a compactly designed automatic xerographic machine, the dryer illustrated in FIGS. 2 through 5, inclusive, is used for rapidly drying the tackified images.

The dryer **40** consists of a casing or housing **45** formed in the shape of a box or box-like structure fabricated of sheet metal, the casing **45** including a cover **46** secured to the open, walled housing **47** having bottom wall **48**, side walls **49** and **50**, rear wall **51** and front wall **52** which is contiguous with bottom wall **48**. The cover **46** does not completely overlie the entire top of the walled housing **47**, so that a narrow opening **53** is formed across the top of the box.

Secured to the bottom wall **48** and supported by flanges **54** attached to the side walls **49** and **50**, is a divider plate **55** which terminates below the plane of the opening **53** but effectively dividing the opening, as will be explained in more detail. By means of the divider plate **55**, the interior of the box **45** is divided into first and second compartments or chambers **56** and **57**, respectively, the divider plate **55** forming the common wall of the two compartments.

A strip heater **58** extends through an aperture in side

wall 49 into the first compartment 56 and is supported by a heater support 59 and an intermediate heater support 60, secured to side walls 50 and 49, respectively. The portion of the strip heater 58 located outside of the first compartment 56, is supported by stop member 61, which is fastened to terminal box 62 secured to the housing 47. The heater element 58 is connected to the electrical conduit 63 of an electrical circuit (not shown), the electrical conduit emerging from the terminal box 62 through the bushing 64 in a wall thereof.

Air is supplied to the first compartment 56 by air compressor 41 through an orifice in frame member 44 and then through inlet opening or inlet conduit 66 in the bottom wall 48. Air is exhausted from the second compartment 57 by the exhaust blower 43 through exhaust outlet 67 in the bottom wall 48 communicating with flanged exhaust duct or outlet conduit 68 secured to the housing 47. The effective size of the exhaust outlet is controlled by damper slide 69 adjustably secured by the bolts 71 extending through the elongated apertures 72, and threaded into the nuts 73 secured to the plates 74 on the damper slide 69.

As illustrated in FIG. 1, after the powder images on the support material have been fused by solvent from the vapor fuser 31, the support material 22 with the tackified images thereon is passed in closely spaced relationship over the length of the opening 53 in the dryer 40. The spacing between the support material 22 and the top of dryer 40 is generally between 1/32 inch and 1/4 inch, preferably 1/8 inch, when using a relatively narrow strip of support material, such as film, since the support material acts as a baffle to deflect the air over the opening 53. Air from the air compressor 41 flows into the first compartment 56 where it is heated by strip heater 58, the heated air flowing through the passage between the divider plate 55 and front wall 52 out through opening 53 into contact with the support material 22 effecting rapid drying of the tackified images on the support material. After the solvent from the tackified images is evaporated by the heated air, the mixture of air and vaporized solvent is exhausted through opening 53 into the second compartment 57 via the passage between the divider plate 55 and cover 46 by the exhaust blower 43.

As can be readily seen by the direction arrows in FIG. 4, indicating the flow of air, the opening 53 serves as both an inlet and an outlet opening from the dryer, the divider plate 55 effectively dividing the opening and forming with the front wall 52, portions of side walls 49 and 50, and the edge of cover 46, two passages for the egress and ingress of fluid from and to the first and second compartments 56 and 57, respectively.

The drying apparatus disclosed is primarily intended for use in a xerographic machine wherein images are formed on photographic film as the support material 22, and wherein the image characters extend to the edge of the film. Unlike common motion picture film which can be supported and transported through a device by means of sprockets engaging perforations along the edge of the film, the film used in the above-described machine cannot be supported in this manner, but is instead supported in the fashion schematically illustrated in FIG. 1. Thus, until the tackified images on the film are completely dried, the film is suspended across the dryer as illustrated in FIG. 1.

Since the film is not substantially rigidly supported as it passes over the opening 53 in the dryer 40, the film will flutter if too much air is blown on the film or if the exhaust pressure is too great, that is, the film will be forced away from the dryer if too much air is applied against the film, whereas, if the vacuum is too great the film will be drawn against the dryer. To prevent the film from fluttering either toward or away from the dryer, the flow of fluid from the first compartment 56 and into the second compartment 57 must be balanced to permit circulation of the fluid over the images on the film without any undue pressure differential occurring across the surface of the film to cause fluttering. This is accomplished in the disclosed embodiment by the use of a low capacity, low pressure air compressor 41 to supply air to the first compartment 56, and by controlling the exhaust pressure by means of the damper plate 69 which is movable to regulate the effective size of the exhaust outlet 67. It is obvious that if a substantially rigid support material is used, or if the support material is of a type which may be adequately supported, the problem of balancing the flow of fluid would not be as critical and may be completely eliminated.

The disclosed apparatus also prevents the occurrence of undesirable ambient conditions around the xerographic machine as a result of solvent vapor fumes. Since both the vapor fuser 31 and the dryer 40 are enclosed in a common enclosure 28, excess solvent vapor, if any, from the vapor fuser, being heavier than air, will settle to the bottom of the enclosure where it is picked up in the intake of the air compressor 41 supplying air to the first compartment 56, effectively exhausting vapor fumes from the enclosure 28 and preventing vapor drag-out as the support material 22 moves from the enclosure. Both the air from the first compartment 56 and the solvent, evaporated by it from the tackified images, is exhausted through the second compartment 57 by the exhaust blower 43.

While there have been shown and described the fundamental novel features of the invention as applied to a preferred embodiment, it will be understood that various omissions and substitutions and changes in the form and details of the device illustrated and in its operation may be made by those skilled in the art, without departing from the spirit of the invention. It is the intention, therefore, to be limited only as indicated by the scope of the following claims.

What is claimed is:

1. A device for fixing xerographic powder images on support material including an enclosure having slots therein for the passage of a support material, a box having a relatively narrow opening extending along the top of and at one end of the box mounted in said enclosure, a divider plate fastened to a bottom wall of said box and extending up to the opening and dividing the interior of said box into first and second compartments, said divider plate dividing said opening into two parallel openings both coextensive with the original opening and each communicating with a respective compartment, a heater element mounted in heat exchange relationship to said first compartment, an air compressor having an inlet conduit and an outlet conduit mounted in said enclosure, said outlet conduit of said air compressor being connected to said first compartment, exhaust means in communication with said second compartment and the exterior of said enclosure, and a vapor fuser secured in said enclosure, said vapor fuser having solvent vapor outlet conduits in line with the opening in the top of said box so that a support material with powder images thereon may first pass lengthwise over the aligned vapor outlet conduits of said vapor fuser whereby the powder images are fused to the support material and then lengthwise over the opening in said box where the images are dried, and whereby the solvent vapor fumes in said enclosure are sucked up by the inlet of said air compressor and discharged through said first and second compartment into said exhaust means.

2. A device for fixing xerographic powder images on support material including an enclosure having an ingress slot and an egress slot therein for the passage of a support material, a box having a relatively narrow opening extending along the top of the box mounted in said enclosure, said opening being aligned with said ingress slot and said egress slot, a divider plate fastened to a wall of said box and extending up to said opening in the box dividing the interior of said box into a first compartment and a second compartment, said divider plate dividing said opening into two parallel openings both coextensive

with the original opening and each communicating with a respective compartment, a heater element mounted in heat exchange relationship to said first compartment, an air compressor having its inlet opening positioned within said enclosure and its discharge opening connected to said first compartment, exhaust means having its inlet end connected to said second compartment and its discharge end extending through a wall of said enclosure, and a vapor fuser having aligned multiple solvent vapor outlet conduits, positioned with the solvent vapor outlet conduits of said vapor fuser positioned within said enclosure in line with said opening in the top of said box whereby a support material with powder images thereon may first pass lengthwise over the solvent vapor outlet conduits and then lengthwise over said opening.

3. A device for fixing xerographic powder images on support material including an enclosure having slots therein for the passage of a support material, a box having a relatively narrow opening extending along the top of and at one end of the box mounted in said enclosure, a divider plate fastened to the bottom wall of said box and extending up to the opening, dividing the interior of said box into first and second compartments, said divider plate dividing said opening into two parallel openings both coextensive with the relatively narrow opening and each communicating with a respective compartment, a heater element mounted in said first compartment, an air inlet conduit connected to said first compartment, an air compressor mounted in said enclosure and connected to said air inlet conduit to force low pressure air over said heater element, exhaust means connected to said second compartment and the exterior of said enclosure for exhausting air from said second compartment, and a vapor fuser, secured to said box, said vapor fuser having solvent vapor outlet orifices in line with the opening in the top of said box so that a support material with powder images thereon may first pass lengthwise over the aligned vapor outlet orifices of said vapor fuser whereby the powder images are fused to the support material and then lengthwise over the opening in said box where the images are dried, and whereby the solvent vapor fumes generated in said enclosure are exhausted from said enclosure by said exhaust means through said second compartment.

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