

Dec. 19, 1961

C. L. HUBER ET AL

3,013,342

XEROGRAPHIC FIXING APPARATUS

Filed Feb. 28, 1958

3 Sheets-Sheet 1

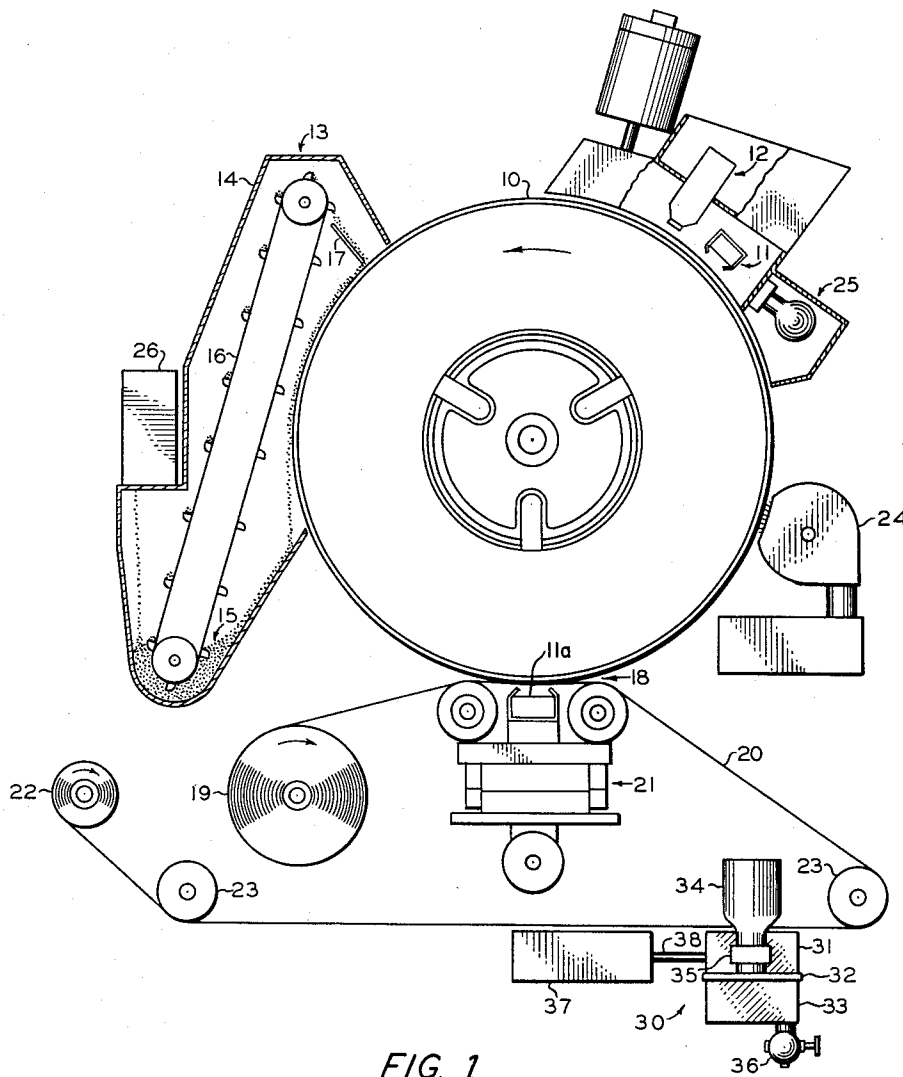


FIG. 1

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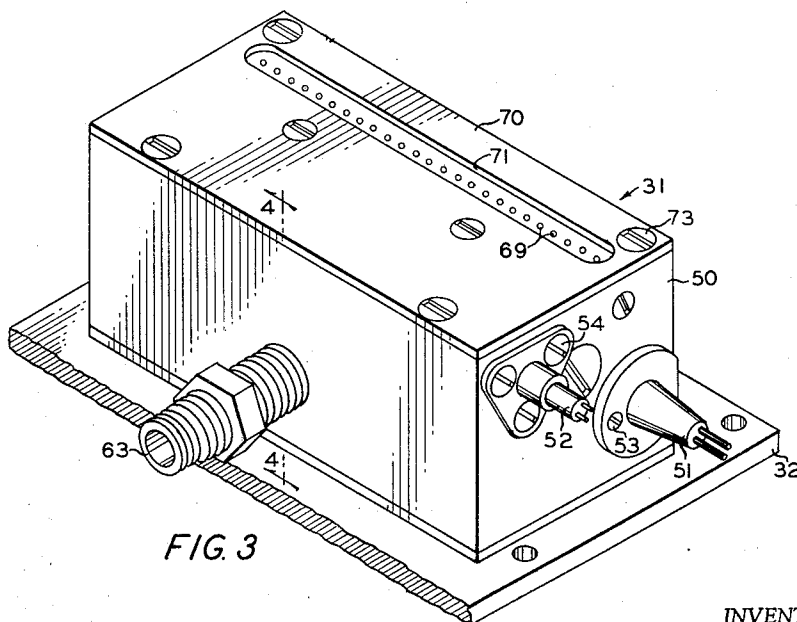
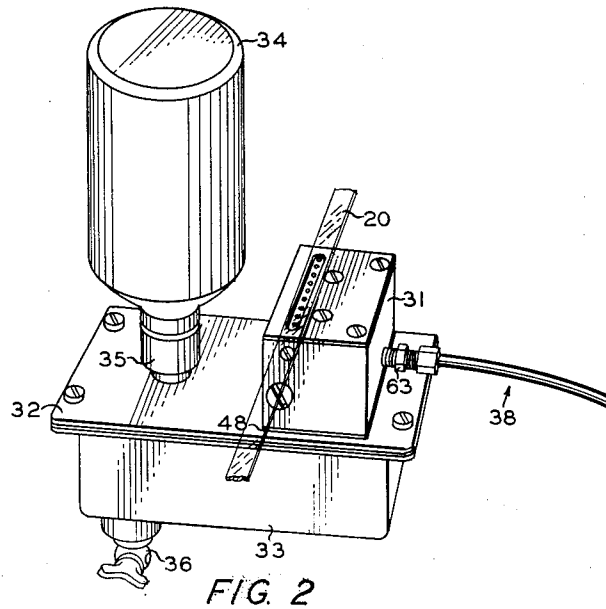
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XEROGRAPHIC FIXING APPARATUS

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3 Sheets-Sheet 2



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XEROGRAPHIC FIXING APPARATUS

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3 Sheets-Sheet 3

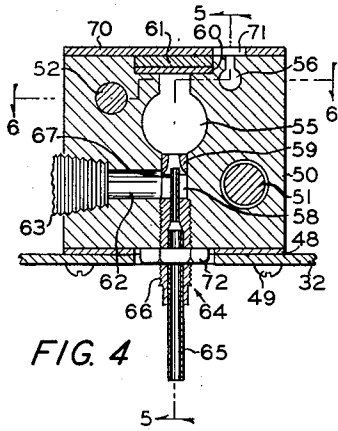


FIG. 4

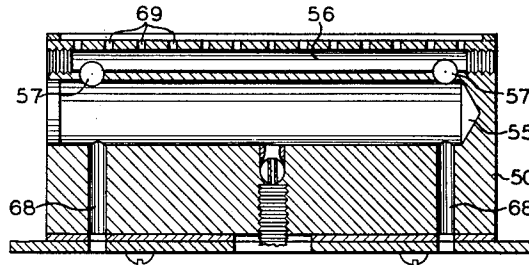


FIG. 5

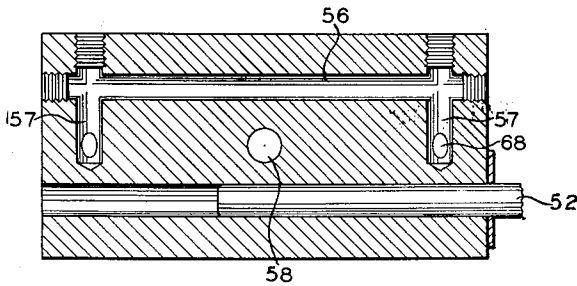


FIG. 6

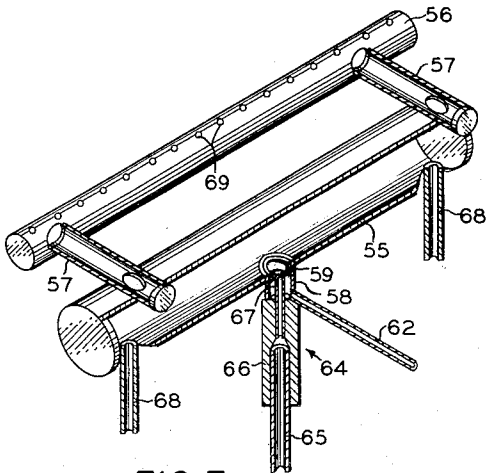


FIG. 7

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XEROGRAPHIC FIXING APPARATUS

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4 Claims. (Cl. 34—156)

This invention relates to the field of xerography and, particularly, to an improved apparatus for fixing xerographic powder images.

More specifically, the invention relates to an improved apparatus for vapor fixing xerographic powder images wherein a controlled quantity of the vapor of a solvent for the resin component of a xerographic developing material is brought into surface contact with a xerographic powder image on a support surface, whereby the solvent vapor goes into solution with the powder particles of the powder image and plasticizes them to fix them to the support surface. In addition, the invention includes apparatus for withdrawing solvent vapor from a source of supply in a predetermined quantity, and applying such solvent vapor to the powder images on a support surface such as film.

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 be increased or the oven temperature decreased, the powder images are not properly fixed and are subject to smear-

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ing. 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 transfer 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 transfer 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 solvent.

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 metered amounts of solvent vapor are applied to the surface on which the powder images are supported to attain optimum vapor fusing conditions.

A further object of the invention is to improve vapor fusing apparatus to effect precise quantitative control of the solvent vapor applied to a powder image formed in a xerographic machine. A further object of the invention is to minimize solvent loss in vapor fixing devices.

These and other objects of the invention are attained by means of an improved vapor fuser in which a stream of compressed aeriform fluid at low pressure pumps liquid solvent through a nozzle into a vaporizing chamber wherein the liquid is vaporized by a thermostatically controlled heater; the aeriform fluid containing vaporized solvent then passes into a second chamber from which it is forced through a number of small diameter outlet conduits into contact with powder images carried on a support material.

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 vapor fuser in accordance with the invention.

FIG. 2 is a perspective view of the vapor fuser in accordance with the invention secured to a solvent supply reservoir.

FIG. 3 is a perspective view of the vapor fuser element. FIG. 4 is a detail sectional view taken along line 4—4 of FIG. 3.

FIG. 5 is a sectional view taken along line 5—5 of FIG. 4.

FIG. 6 is a sectional view taken along line 7—7 of FIG. 5.

FIG. 7 illustrates schematically the various elements of the vapor fuser, the elements being depicted as tubular elements.

Referring now to the drawing, 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 designed 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 system, generally designated by numeral 26 is used to supply additional toner powder to the development material 15.

At the area generally designated by numeral 18, electrostatic transfer of the developed image from the drum 10 occurs. A roller 19 supplies a continuously fed web of film 20 or other transfer material over the rollers of transfer mechanism 21 and into surface contact with drum 10. Immediately below the web and drum contacting area is a corona discharge electrode 11a 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, described below, whereby the copy is permanently affixed to the web, and finally on to take-up roller 22. Idler rollers 23 act as guide rolls for the web. The movement of web 20 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 22 may be driven by a suitable motor (not shown) or by other conventional means. Positioned next adjacent to the transfer area 18 is a cleaning device 24 to clean the drum surface of any residual powder. The next and final station of the apparatus is a floodlight station 25 where the xerographic drum 10 is flooded with light to cause dissipation of any residual electrical charge on the drum 10.

The fixing apparatus 30, in general, includes a vapor fuser 31 mounted on the cover plate 32 of a solvent reservoir tank 33 normally secured to a frame member (not shown) of the xerographic machine. The reservoir tank 33 is supplied with a suitable 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. An aeriform fluid, preferably atmospheric air, although it may be any suitable inert gas, is supplied to the vapor fuser 31 through tube 38 by compressor 37 or similar source of compressed aeriform fluid.

As the web of support material advances over the vapor fuser 31, solvent vapor is forced into contact with the support material, as described below. Since the powder particles forming the xerographic powder image have a great affinity for the solvent vapor, the solvent goes into solution with and liquefies or tackifies the powder particles and causes them to flow into the interstices of the support material. By the time an individual increment of the support material has passed completely over the vapor fuser, the powder particles thereon are tackified to an extent sufficient to fuse the powder particles to 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. Thus, once the support material, bearing the tackified image thereon, is removed beyond the zone of influence of the vapor fuser, the image, if left exposed to air, will dry due to the natural circulation of air over the image.

FIGS. 2 through 7, inclusive, show the vapor fuser 31, which consists of a fuser block or casing 50 fastened to the cover plate 32 of the reservoir tank 33 by screws 49, the cover gasket 48 being positioned between the fuser block 50 and the cover plate 32. The fuser block 50 is longitudinally bored to receive a cartridge type heater element 51 and a thermoswitch control element 52 fastened to the block by machine screws 53 and 54, respectively, the elements being connected in series to an electrical circuit (not shown) in a conventional manner whereby the thermoswitch control element 52 controls the heat output of the cartridge type heater element 51.

Formed in the fuser block 50 and extending longitudinally therein is a heating or vaporizing chamber 55 and an outlet chamber 56 connected by a pair of passages 57. A vertical bore, forming a conduit 58, as shown in FIG. 4, extends through the fuser block 50 and intersects the heating or vaporizing chamber 55, the upper part of the conduit forming an access hole closed by a gasket 60 and cap 61. A venturi or venturi tube 59 is positioned in the conduit 58 adjacent the heating or vaporizing chamber 55. An inlet conduit 62 intersects the conduit 58 at substantially a right angle thereto and below the venturi 59, and the inlet conduit is threaded to receive the coupling 63 attached to the tube 38 from the compressor 37.

Adjustably secured in the bottom of the conduit 58 and locked in position by locking nut 72, is an aspirator tube 64 which is of sufficient length to extend through apertures in the cover gasket 48 and cover plate 32 into the reservoir tank 33 where the lower end of the aspirator tube is immersed in liquid solvent. The aspirator tube 64 consists of an induction tube 65 soldered to one end of a threaded coupling 66 and an eduction tube 67 made of hypodermic stock material soldered to the other end of the threaded coupling 66.

Also formed in the fuser block 50 are a pair of drain passages 68 communicating at one end with the heating or vaporizing chamber 55, and at the other end, via apertures in the cover gasket 48 and cover plate 32, with the reservoir tank 33 so that condensed solvent liquid may drain from the vaporizing chamber 55 back to the reservoir tank when the fuser is not in operation. Vapor is discharged from the fuser block through multiple outlet orifices 69 extending from the outlet chamber 56 to the exterior of the fuser block. The passages 57, outlet chamber 56 and outlet orifices 69 form, in effect, a multiple outlet manifold. The various elements just described are schematically illustrated apart from the fuser block in FIG. 7, each chamber, passage and conduit being depicted as tubular elements. A Teflon gasket 70 having an elongated slot 71 therein is fastened to the top

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of the fuser block 50 by screws 73, so that the slot 71 in the gasket 70 is positioned over the outlet conduits 69.

In the operation of the vapor fuser 31, air at a relatively low pressure of approximately $1\frac{1}{2}$ inches of mercury gage flows to the venturi 59, from the compressor 37 via the tube 38, coupling 63 and inlet conduit 62 and aspirates a fine mist of liquid solvent from the reservoir tank 33 through aspirator tube 64 into the heating chamber 55 wherein the liquid solvent is further atomized or nebulized since this chamber due to its size acts as an expansion chamber. In the heating chamber 55, the mixture of air and solvent is heated by means of the heater element 51, thereby vaporizing the solvent. The air containing the vaporized solvent flows from the heating chamber 55 through passages 57 into outlet chamber 56 and is discharged through outlet orifices 69 against a web of support material 20 carrying powder images thereon, the web of support material passing over the vapor fuser in closely spaced relationship to the top of the vapor fuser so that the jets of air containing the vaporized solvent from the outlet orifices 69 impinge upon the support material. Using low pressure air as indicated above, the support material should be spaced about $\frac{1}{32}$ to $\frac{1}{4}$ inch, preferably $\frac{1}{8}$ inch, above the top of the vapor fuser. The solvent vapor contacting the support material goes into solution with the powder particles of the xerographic powder image thereby tackifying these powder particles. Due to the efficient design of the vapor fuser 31, whereby low pressure air is used to aspirate a limited amount of solvent (3 to 4 ounces per hour) to effectively fuse the powder images, the pressure of the mixture of air and vapor solvent passing through outlet orifices 69 into contact with the powder images is not great enough to cause the powder images to be blown off or distorted on the support material.

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 due to the natural circulation of air over the image, or the tackified image may be dried by the application of controlled heat from a suitable source.

In a known type of vapor fuser, which usually consists of a solvent reservoir tank having an immersion heater therein to vaporize the solvent, if the xerographic machine is stopped so that the support material is held stationary over the vapor fuser, the support material and the image thereon will be subjected to the solvent vapor for a relatively long period of time, even if the immersion heater is turned off. In fact, in the typical type of fuser described above wherein the support material is passed over an open reservoir of solvent liquid, solvent vapors are released continuously to the atmosphere surrounding the support material. Such a condition is undesirable, because the support material and the image thereon may be damaged if exposed to solvent vapor for a continuous period of time. In the case of the image on the support material, the powder particles formed on the image will be overfused to the extent that the powder particles will run, destroying the sharp lines or boundaries of the image. In the case of the support material, overexposure to solvent vapors may warp the support material, and in the case wherein the support material is photographic film, the film may soften and swell thereby effectively destroying that portion of the film which has been overexposed to the solvent vapor.

In the disclosed vapor fuser, overexposure to solvent vapors is virtually eliminated, because the generation of solvent vapor can be effectively stopped, whenever the movement of support material over the vapor fuser is stopped, by merely stopping the air compressor 37 or other source of compressed aeriform fluid in a conventional manner as by valves or by merely stopping the air compressor. In the subject vapor fuser, since solvent is drawn into the vaporizing chamber by the compressed aeriform fluid, stopping the flow of aeriform fluid will

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stop the flow of solvent into the vaporizing chamber. Although there will be a short time lag between the stoppage of the support material over the vapor fuser and the time when solvent vapors are no longer generated, this period of time will be insufficient to be detrimental to the support material or the image thereon.

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. An image fixing device for use in a xerographic machine wherein a xerographic powder image formed on a support material is passed in closely spaced relationship over the image fixing device, said image fixing device including a means forming a reservoir for liquid solvent, a fuser block secured to said reservoir means, an outlet chamber, a vaporizing chamber and a pair of ducts formed in said fuser block, said outlet chamber being connected to opposite ends of said vaporizing chamber by said ducts, a substantially vertical conduit in said fuser block intersecting said vaporizing chamber between said ducts, a venturi positioned in said substantially vertical conduit adjacent said vaporizing chamber, an inlet conduit in said fuser block intersecting said substantially vertical conduit at substantially right angles thereto, an aspirator tube positioned in said substantially vertical conduit with one end of said aspirator tube positioned adjacent said venturi, the other end of said aspirator tube being positioned in said reservoir means, multiple outlet orifices formed in the top of said fuser block communicating with said outlet chamber and heating means mounted in said fuser block in heat transfer contact with said vaporizing chamber, whereby a liquid solvent in said reservoir means may be aspirated into said vaporizing chamber by the flow of low pressure aeriform fluid through said inlet conduit, the liquid solvent being vaporized in said vaporizing chamber and discharged into said outlet chamber from where it is discharged through said multiple outlet orifices against a web of support material passing in closely spaced relation over the top of said fuser block.

2. A vapor fuser for use in a xerographic machine wherein a powder image formed on a support material is fused in place by solvent vapors, the vapor fuser including a fuser block having an elongated outlet chamber and an elongated vaporizing chamber connected in communication with each other by duct means, a series of outlet orifices connected to said outlet chamber remote from said duct means, a first inlet conduit connected to said vaporizing chamber and a second inlet conduit connectable at one end to a source of pressurized aeriform fluid and at its other end connected to said first inlet conduit; a venturi tube positioned in said first inlet conduit between the intersection of said first inlet conduit with said vaporizing chamber and the intersection of said first inlet conduit with said second inlet conduit, an aspirator tube mounted in said first inlet conduit, one end of said aspirator tube being positioned adjacent to said venturi tube and the other end of said aspirator tube being connectable to a source of liquid solvent, and heating means mounted in heat transfer contact with said vaporizing chamber whereby liquid solvent drawn through said aspirator tube by action of reduced pressure resulting from low pressure aeriform fluid flowing through said venturi from said second inlet conduit is vaporized in said vaporizing chamber and is discharged through said outlet orifices via said vaporizing chamber, duct means and said outlet chamber against support material passing in closely spaced relation to said outlet orifices.

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3. A vapor fuser for use in a xerographic machine including a casing having a heating chamber and an outlet chamber formed therein, at least one duct in said casing connecting said heating chamber with said outlet chamber, a first inlet conduit extending from the exterior of said casing to said heating chamber at a point remote from said duct, a venturi tube mounted in said first inlet conduit near the junction of said conduit and said heating chamber, an aspirator tube means mounted in said first inlet conduit adjacent said venturi tube, said aspirator tube being of sufficient length to be submerged in a source of liquid solvent, a second inlet conduit connected to said first inlet conduit between said venturi tube and said aspirator tube, said second conduit being connectable to a source of low pressure aeriform fluid whereby liquid solvent drawn through said aspirator tube by the action of reduced pressure resulting from low pressure aeriform fluid flowing through said venturi tube from said second conduit is discharged into said heating chamber, multiple outlet orifices extending from said outlet chamber to the exterior of the casing and a heater element mounted in heat transfer contact with said casing.

4. An image fixing device for use in a xerographic machine wherein a xerographic powder image formed on a support material is fused in place by solvent vapors generated by the image fixing device, the image fixing device including a reservoir means for a liquid solvent, a fuser block mounted on said reservoir means, said fuser block having an outlet chamber and a vaporizing chamber in communication with each other through a pair of ducts, the terminals of said ducts being located at opposite ends of said outlet chamber and said vaporizing chamber, a series of outlet orifices connected to said outlet chamber for discharging a vapor from said outlet chamber against

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a support material passing in closely spaced relation to said outlet orifices, a first inlet conduit connected to said vaporizing chamber intermediate said ducts, a second inlet conduit connectable at one end to a source of pressurized aeriform fluid, and connected at its other end with said first inlet conduit; a venturi tube positioned in said first inlet conduit between said vaporizing chamber and said second inlet conduit, an aspirator tube mounted in said first inlet conduit, one end of said aspirator tube being positioned adjacent to said venturi tube in said first inlet conduit and the other end of said tube extending into said reservoir means for submergence in liquid solvent, and heating means mounted in heat transfer contact with said vaporizing chamber whereby liquid solvent drawn through said aspirator tube by the action of reduced pressure resulting from pressurized aeriform fluid flowing through said venturi tube from said second inlet conduit is discharged into said vaporizing chamber at a position remote from said ducts to prevent liquid solvent from entering said outlet chamber.

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