Aug. 21, 1962 UB IWERKS 3,049,810

XEROGRAPHIC FUSING APPARATUS

Filed July 29, 1957 2 Sheets-Sheet 1

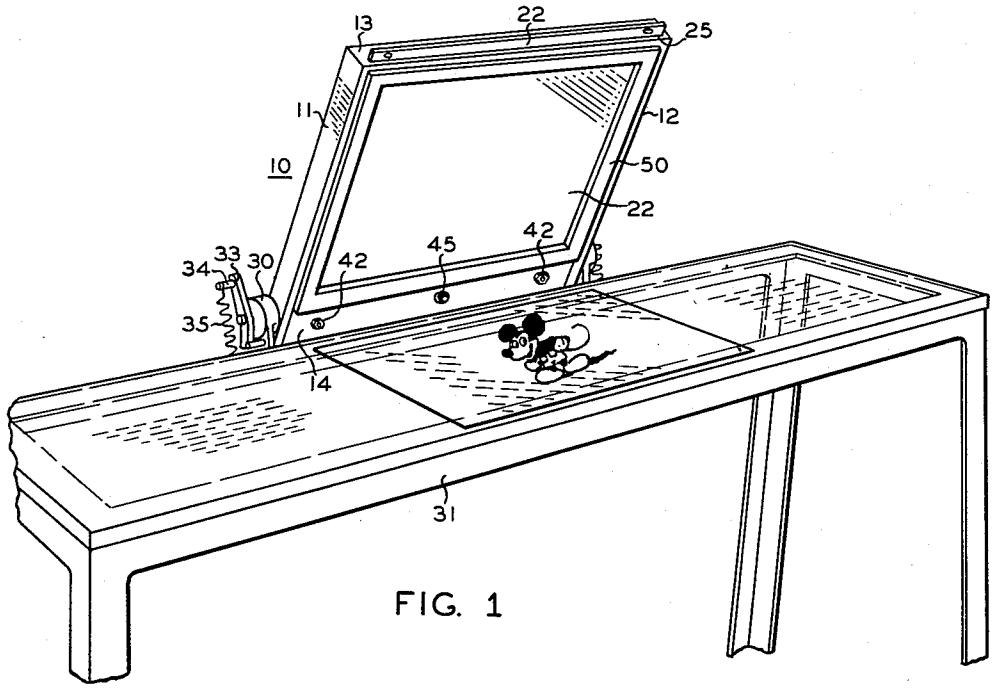


FIG. 1

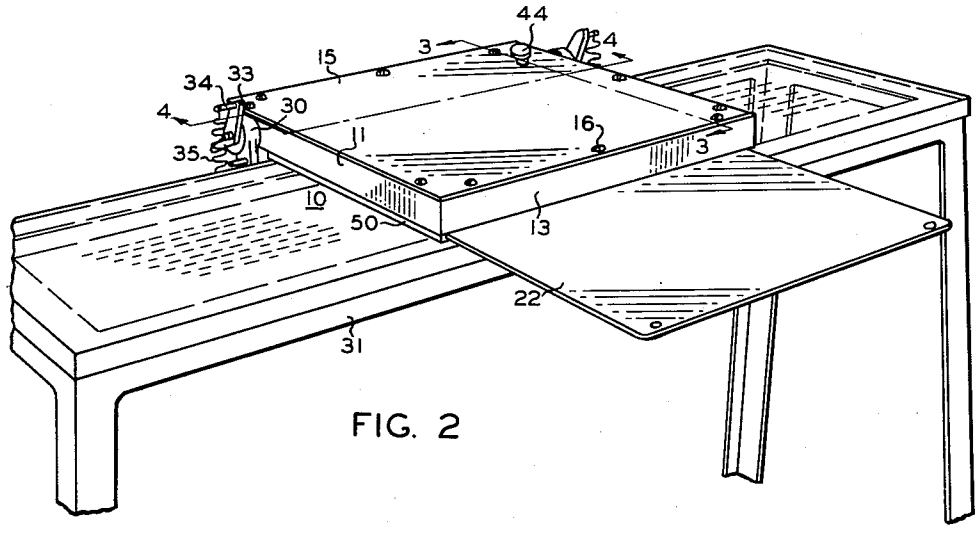


FIG. 2

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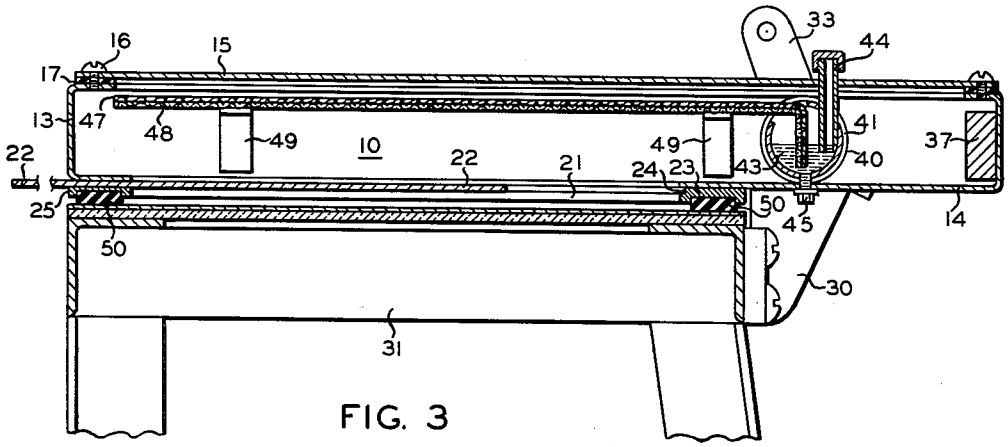


FIG. 3

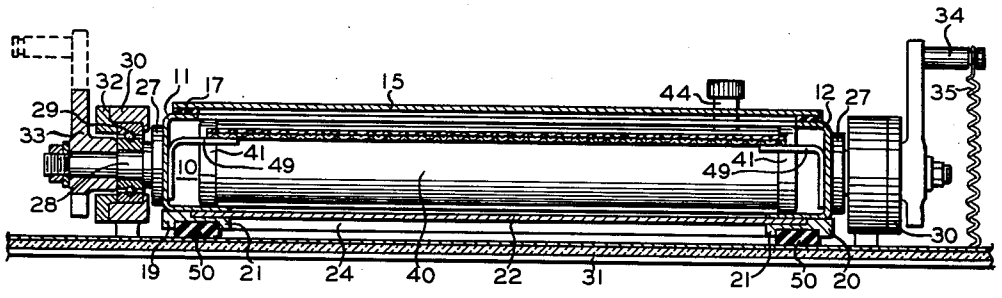


FIG. 4

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3,049,810
XEROGRAPHIC FUSING APPARATUS

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

The invention is particularly applicable in a method for vapor fixing xerographic powder images having a soluble resin component wherein a powder image on a support surface is exposed to a controlled quantity of the vapor of a solvent for the resin component of the developing material of which the image is formed, whereby the solvent vapor condenses on the powder particles of the powder image and tackifies or plasticizes them to fix them to the support surface. For this purpose, the invention includes apparatus for generating an atmosphere of solvent vapor, temporarily maintaining the vapor in a confined space, and applying the confined solvent vapor to the support surface on which the xerographic powder image is formed.

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 that is brought into surface contact with the photoconductive layer and is held thereon electrostatically in a pattern corresondping 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 resins that have been specifically developed for the purpose. A number of such developing materials are manufactured and marketed by Xerox Corporation, 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 xerographic systems embodying heat fixing apparatus, the support surface on which xerographic powder images are formed is placed in 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. Should the oven temperature be decreased, the powder images may not be properly fixed and are then subject to smearing. In the event the oven temperature is 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.

Similarly, in xerographic systems embodying vapor fixing apparatus, the support surface on which the xerographic images are formed is usually passed into a vapor chamber containing a saturated atmosphere of solvent for the resin component of the developing material. In such machines it is also essential that the time of exposure to the solvent vapor be controlled in order to minimize the possibility of underfixing or overfixing 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 dragout caused by the support surface moving out of the fixing apparatus tends to produce undesirable ambient conditions.

In certain applications of xerographic techniques, the matter of fixing the powder image to a support surface is a highly critical procedure and requires the employment of special methods and apparatus to effect its proper accomplishment. A typical example of such a situation occurs in the application of xerographic techniques to the production of animated cartoons.

In general, to make a cartoon movie, each frame of the finished film is exposed to a group of four or more cellulose acetate transparencies, upon which are drawn and painted the various figures in the cartoon. Usually, each transparency or "cel" is employed to depict a single character and a progression of cels are necessary to portray the successive movements required to simulate motion in the finished film. Sometimes a drawing may appear on only one of the cels that are being photographed, but in all cases in a given film sequence a uniform number of cels are stacked together before exposure in order to maintain consistency of light transmission and reflection. Background scenes are usually painted on one of several types of artist painting boards and may be painted in watercolor, tempera color, or an oil color, and are positioned in back of the cels being photographed.

Prior to the application of xerographic techniques to the production of cartoon movies, the preparation of the individual cels required that an artist draw a pencil sketch of the desired figure on heavy white bond paper in exact registration for the scene to be portrayed. The paper employed was specially prepared with a series of holes punched along one edge which were used for alignment and registration purposes. When the drawing was completed, it was passed on to a tracer who placed a cellulose acetate "cel" having similar registration holes over the original drawing and copied all of the pencil lines of the original sketch with pen and ink. The inked drawing was then passed to another artist who colored the ink outlines on the reverse side of the cel, according to a predetermined coloring sketch. After the painting was completed, the several cels required to form a particular scene were mounted on a board, using the holes to achieve proper registration, and were photographed to form a single frame of the movie.

Since normal motion picture projection speeds are twenty-four frames per second and at least four cels are required to be prepared for each frame, it is apparent that a full minute of projection requires the preparation of many thousands of cels and that the preparation of a two-reel "short" requires the expenditure of a tremendous amount of effort. In addition, since highly skilled artists are required for this work, it is obvious that the cost of making animated cartoons is quite high. In order to decrease these costs, it was found that xerographic techniques could be employed to eliminate a substantial portion of the skilled manual craftsmanship that was previously employed. Specifically, it was found that xerocopies of the original artist sketches could be transferred directly

to cels and fused thereon, thereby eliminating completely all of the manual tracing previously required. In addition, it was found that certain of the artist's shading effects, that were normally lost in the manual tracing operation, could be retained by the careful application of xerographic techniques to improve the quality of the finished cartoon.

In practice, this is effected by uniformly charging a photoconductive layer formed on a conductive backing, exposing the charged photoconductor to the sketch required to be reproduced, developing the latent electrostatic image of the sketch formed on the photoconductive layer with a xerographic developing material including a soluble resin component, transferring the xerographic powder image thus formed to the surface of a cellulose acetate cel and fixing the powder image on the cel surface. Obviously, heat fixing cannot be employed in such a technique since the heat of the fixing oven would distort, if not destroy the cel material. Since vapor fixing is commonly employed with cellulose acetate material in xerographic applications, vapor fixing is the obvious solution. However, since an overexposure of a cellulose acetate film to solvent vapor frequently results in fogging of the film as a result of the residual film of solvent left on the film after fixing, particular care must be exercised in the application of vapor fixing techniques in the preparation of animated cartoon cels.

The principal object of the present invention is to improve vapor fixing apparatus for xerographic powder images to effect precise quantitative control of the solvent vapor applied to a powder image. A further object of the invention is to minimize solvent loss in vapor fixing devices. A further object of the invention is to increase the efficiency and decrease the cost of vapor fixing apparatus.

These and other objects of the invention are attained by apparatus comprising the combination of a vapor chamber having integrally connected top and side walls and a removable bottom wall, a reservoir for resin solvent supported in the chamber, a wicklike element secured in spaced relation to the inner surface of the top wall of the chamber and extending into the solvent reservoir, and a peripheral gasket member secured to the bottom of the vapor chamber for forming a substantially vapor-tight seal between the vapor chamber and a support surface.

The term "tackified" and the several variant forms thereof used throughout this specification are employed to define the condition of the powder particles of a xerographic powder image when treated 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:

FIGS. 1 and 2 are isometric views of the xerographic powder image fixing apparatus of the invention shown in its inoperative and operative positions, respectively; and

FIGS. 3 and 4 are sectional views of the vapor fusing apparatus of the invention taken along the lines 3—3 and 4—4, respectively, of FIG. 2.

In the form of apparatus shown in the drawings, the invention includes a vapor chamber **10** that is formed of side rails **11** and **12**, front rail **13**, and a lateral rear compartment member **14** that are integrally connected at their ends to form a rectangular frame. Side rails **11** and **12** and front rail **13** are channel-shaped members having turned-over upper edge portions that cooperate with a similar turned-over portion on rear compartment member **14** to form a continuous support for a rectangular top wall member **15** that is secured thereto by screws **16**. A rectangular gasket **17** is placed between top wall **15** and the rectangular frame in order to form a vapor-tight seal therebetween. For providing a removable bottom wall for vapor chamber **10**, longitudinal, formed extrusion members **19** and **20** are secured to the under sides of rail members **11** and **12**, respectively. Each of the members **19** and **20** is provided with a shoulder portion **21** which, together with the lower edges of rails **11** and **12**, form longitudinal grooves to accommodate the side edges of a rectangular bottom plate **22**. A lateral, formed extrusion member **23** (see FIG. 3) is secured to the forward edge of the underside of rear compartment member **14** and is provided with a shoulder portion **24** to accommodate the leading edge of bottom plate **22** when it is moved to its extreme rearmost position. Another lateral, formed extrusion member **25** is secured at each end of the under side of front rail member **13**, and is spaced therefrom to form a slot-like opening to permit the insertion and withdrawal of bottom plate **22**. If desired, a resiliently urged felt seal (not shown) may be provided on the lower edge of front rail member **13**, in the manner commonly employed in the construction of photographic cassettes, to provide a seal between the lower edge of rail member **13** and lateral member **25** when bottom plate **22** is withdrawn.

For mounting vapor chamber **10** with respect to a work surface, side rails **11** and **12** are provided with trunnions **27**. Each trunnion is fixed on its respective side rail and is provided with a shouldered extension **28** that extends into a ball bearing **29** that is seated in a mounting bracket **30** that may be secured on a suitable work table or other support **31**. A lock nut **32** is provided to bear against the outer face of bearing **29** and retain it in position in bracket **30**. Fixed to the outer end of extension **28** is an arm **33** that extends upwardly and is provided with a horizontal pin **34** that is connected by a spring **35** to a corresponding pin (not shown) mounted on the lower end of bracket **30**. By this arrangement, vapor chamber **10** is pivotally mounted for rocking movement about the axis of trunnions **27**, whereby the chamber may be lowered to a substantially horizontal or operative position, as shown in FIG. 2, or raised to an inclined or inoperative position, as shown in FIG. 1. In either position, the vapor chamber is resiliently urged to its limit of movement by the toggle action exercised by spring **35**. A counterweight **37** secured at the rear of compartment member **14** serves to balance the weight of the forward portion of the vapor chamber to facilitate manual operation.

For forming an atmosphere of solvent vapor within chamber **10**, the apparatus includes a vapor generating mechanism comprising a slotted tubular reservoir **40** that is provided with end caps **41** to form a liquid-tight container, and is secured to the bottom portion of rear compartment member **14** by fasteners **42**. Preferably, reservoir **40** is positioned so that its longitudinal axis is aligned with the pivotal axis of the vapor chamber to minimize the movement of resin solvent **43** within the reservoir. An upwardly extending tubular connection **44** is provided for filling reservoir **40**, and a drainage hole is provided at the bottom of the reservoir whereby it may be emptied by removing a cap screw **45**.

For withdrawing resin solvent from reservoir **40**, the apparatus includes a wicklike member **47** that may be made of felt or similar porous material and is substantially rectangular in form and coterminous with the area of the opening formed by side rails **11** and **12**, front rail **13**, and the forward edge of rear compartment member **14**. Wick member **47** is supported by a relatively stiff screen or grid member **48** which, in turn, is supported on brackets **49** that are fixed on the inner faces of side rails **11** and **12**.

For forming a vapor-tight seal with a support surface placed on work table **31**, formed extrusion members **19**, **20**, **23** and **25** are provided with grooved portions on their lower faces for seating a rubber or similar resilient gasket

member 50. Gasket member 50 thus extends completely around the peripheral edge of the opening formed by side rails 11 and 12, front rail 13, and rear compartment member 14, and is so arranged that it seats squarely on work table 31 when vapor chamber 10 is moved to its lowermost position.

By the arrangement thus described it is apparent that resin solvent placed in reservoir 40 is drawn upwardly into wick member 47 and evaporates therefrom in the atmosphere of the chamber to form a saturated atmosphere of solvent vapor within the chamber. When bottom plate 22 is in closed position (as shown in FIG. 1), the solvent vapor reaches a saturated condition as determined by the ambient temperature, thereby providing a substantially fixed amount of available solvent vapor.

When a cel or other support surface having a xerographic powder image formed thereon is to be fixed, it is placed on the surface of work table 31 immediately beneath the frame of the vapor chamber. The vapor chamber is then manually lowered to press gasket member 50 into surface contact with the edge of the cel or support surface. Bottom plate 22 is then removed momentarily to expose the powder image to the vapor in the chamber. This relationship is maintained for a sufficient time period to effect complete tackification of the powder particles of the image. This time period may be determined empirically in accordance with the size of the work sheet, the ambient temperature, and the amount and type of xerographic developing material that may be employed, and is usually in the range of from two to ten seconds when trichloroethylene or a similar solvent is used. At the end of the required time period, bottom plate 22 is reinserted to close the vapor chamber, and the vapor chamber is then raised to its uppermost position. This action exposes the tackified powder image to ambient air to permit the solvent to evaporate from the powder image and leave a fixed xerographic powder image on the cel. The closing of the chamber by plate 22 retains all unused solvent vapor within the chamber. As the chamber is raised to its uppermost position, wick 47 is effective to disperse additional solvent vapor into the atmosphere of the chamber to replace that used in fixing the powder image. Thus, the only vapor that is lost to the atmosphere is that that actually condenses to tackify the powder image and that which is confined between the surface of the cel and the bottom of plate 22 when the plate is restored to its closed position.

Thus, there has been described a xerographic powder image vapor fixing apparatus whereby a metered quantity of vapor solvent may readily and conveniently be applied to a support surface on which a xerographic powder image is formed. In addition, there is provided a compact and efficient vapor fixing apparatus in which a minimum of solvent vapor is released to the atmosphere during operation.

Obviously, a number of different types of instrumentalities and techniques may be employed in carrying out the invention and widely differing applications of the invention may be made without departing from the scope thereof. Furthermore, many changes could be made in the above-described construction and a number of apparently different embodiments of the apparatus could be made within the scope of the invention. Therefore, it is intended that all matter contained in the above description shall be considered as illustrative, and that the invention be limited only as defined in the appended claims.

What is claimed is:

1. An apparatus for fixing resin base powder images on support surfaces including the combination of a vapor chamber having integrally connected top and side walls and a removable bottom wall, means for forming an atmosphere of vapor of a resin solvent within the chamber, and a peripheral gasket member secured to the bottom of the vapor chamber for forming a substantially vapor-tight seal between the vapor chamber and a support surface.

2. An apparatus for fixing resin base powder images on support surfaces including the combination of a vapor chamber having integrally connected top and side walls and a removable bottom wall, a reservoir for resin solvent supported in the chamber, means coacting with the solvent reservoir for forming an atmosphere of solvent vapor within the chamber, and a peripheral gasket member secured to the bottom of the vapor chamber for forming a substantially vapor-tight seal between the vapor chamber and a support surface.

3. An apparatus for fixing resin base powder images on support surfaces including the combination of a vapor chamber having integrally connected top and side walls and a removable bottom wall a, reservoir for resin solvent supported in the chamber, a wick-like element secured in spaced relation to the inner surface of the top wall of the chamber and extending into the solvent reservoir, and a peripheral gasket member secured to the bottom of the vapor chamber for forming a substantially vapor-tight seal between the vapor chamber and a support surface.

4. An apparatus for fixing resin base powder images on support surfaces including the combination of a vapor chamber having integrally connected top and side walls, slide supporting elements formed around the bottom edges of the side walls, a bottom wall slidably mounted in the slide supporting elements, a gasket member secured to the bottom of the vapor chamber for forming a substantially vapor-tight seal between the vapor chamber and a support surface, and means for forming an atmosphere of vapor of a resin solvent in the resin chamber.

5. An apparatus for fixing resin base powder images on support surfaces including the combination of a vapor chamber having integrally connected top and side walls, slide supporting elements formed around the bottom edges of the side walls, a bottom wall slidably mounted in the slide supporting elements, a peripheral gasket member secured to the lowermost surfaces of the slide supporting elements for forming a substantially vapor-tight seal between the vapor chamber and a support surface, and means for forming an atmosphere of vapor of a resin solvent in the resin chamber.

6. An apparatus for fixing resin base powder images on support surfaces including the combination of a vapor chamber having integrally connected top and side walls, slide supporting elements formed around the bottom edges of the side walls, a bottom wall slidably mounted in the slide supporting elements, a peripheral gasket member secured to the lowermost surfaces of the slide supporting elements for forming a substantially vapor-tight seal between the vapor chamber and a support surface, and means for forming an atmosphere of vapor of a resin solvent in the resin chamber, said last recited means including a reservoir for a resin solvent and a wick-like element supported in spaced relation to the inner surface of the top wall of the chamber and extending into the solvent reservoir.

7. An apparatus for fixing resin base powder images on support surfaces including the combination of a vapor chamber having integrally connected top and side walls, slide supporting elements formed around the bottom edges of the side walls, a bottom wall slidably mounted in the slide supporting elements, a peripheral gasket member secured to the lowermost surfaces of the slide supporting elements for forming a substantially vapor-tight seal between the vapor chamber and a support surface, and means for forming an atmosphere of vapor of a resin solvent in the resin chamber, said last recited means including a reservoir for a resin solvent, a grid-like structure secured in spaced relation to the inner surface of the top wall of the chamber, and a wick-like element supported on the grid structure and extending into the solvent reservoir.

8. An apparatus for fixing resin base powder images on support surfaces including the combination of a vapor chamber having integrally connected top and side walls, slide supporting elements formed around the bottom edges of the side walls, a bottom wall slidably mounted in the slide supporting elements, a peripheral gasket member secured to the lowermost surfaces of the slide supporting elements for forming a substantially vapor-tight seal between the vapor chamber and a support surface, means for forming an atmosphere of vapor of a resin solvent in the resin chamber, and mounting means for pivotally supporting the chamber for movement toward and away from a support surface.

9. An apparatus for fixing resin base powder images on support surfaces including the combination of a vapor chamber having integrally connected top and side walls, slide supporting elements formed around the bottom edges of the side walls, a bottom wall slidably mounted in the slide supporting elements, a peripheral gasket member secured to the lowermost surfaces of the slide supporting elements for forming a substantially vapor-tight seal between the vapor chamber and a support surface, means for forming an atmosphere of vapor of a resin solvent in the resin chamber, mounting means for pivotally supporting the chamber for movement toward and away from a support surface, and resilient toggle means coacting with the pivotal mounting means for maintaining the vapor chamber at either extreme of movement.

10. An apparatus for fixing resin base powder images on support surfaces includes the combination of a vapor chamber having integrally connected top and side walls, slide supporting elements formed around the bottom edges of the side walls, a bottom wall slidably mounted in the slide supporting elements, a peripheral gasket member secured to the lowermost surfaces of the slide supporting elements for forming a substantially vapor-tight seal between the vapor chamber and a support surface, mounting means for pivotally supporting the chamber for movement toward and away from a support surface, and means for forming an atmosphere of vapor of a resin solvent in the resin chamber, said last recited means including a tubular reservoir for resin solvent, said reservoir having its longitudinal axis aligned with the pivotal axis of the chamber, and a wick-like element supported in spaced relation to the inner surface of the top wall of the chamber and extending into the solvent reservoir.

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