May 5, 1970 G. M. PREDDY ET AL 3,510,303

THIN EMULSION DEPOSITION STENCIL SCREEN AND METHOD

Filed Dec. 29, 1966 3 Sheets-Sheet 1

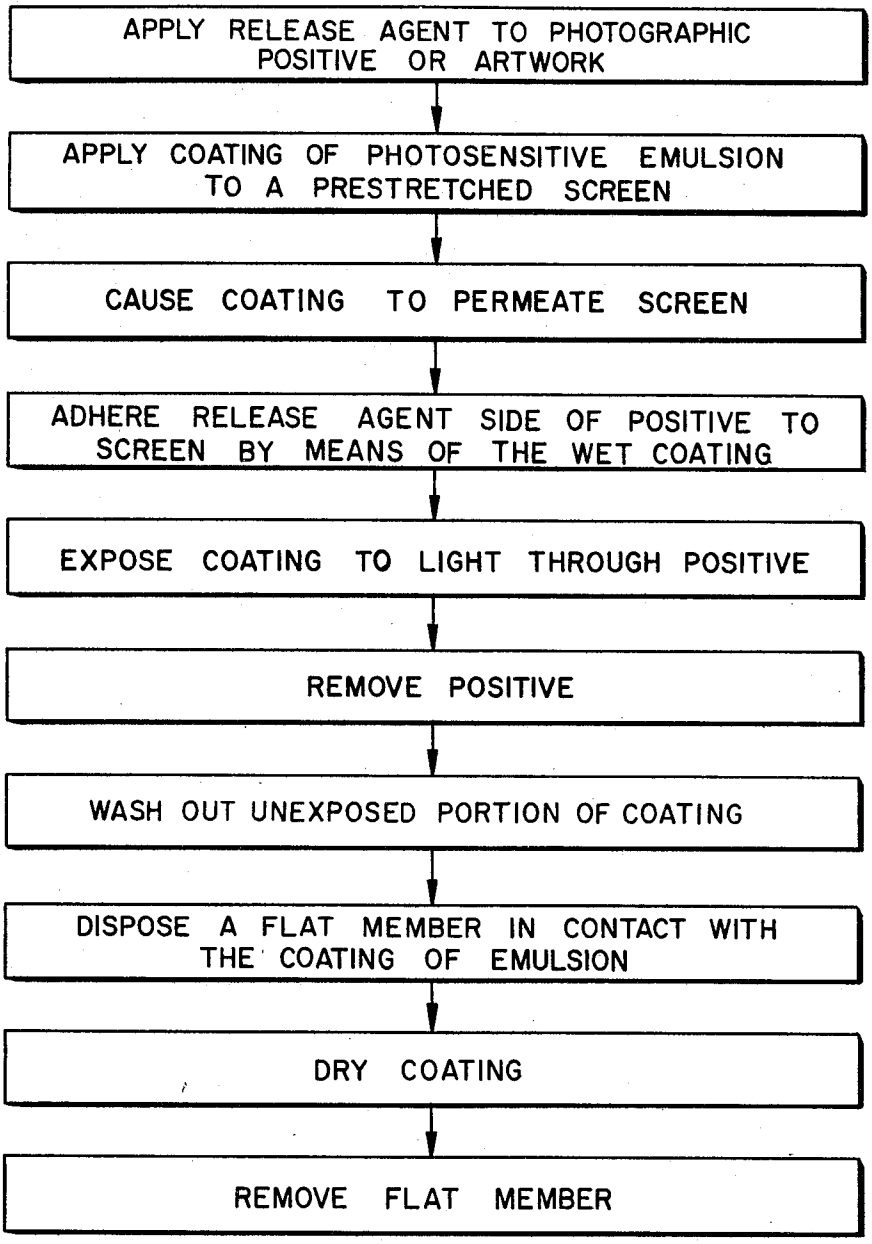


Fig. 1

INVENTORS.
GENADIUS M. PREDDY
WILLIAM B. UPCHURCH
BY Walter S. Zebrowski
ATTORNEY

May 5, 1970 G. M. PREDDY ET AL. 3,510,303

THIN EMULSION DEPOSITION STENCIL SCREEN AND METHOD

Filed Dec. 29, 1966 3 Sheets-Sheet 2

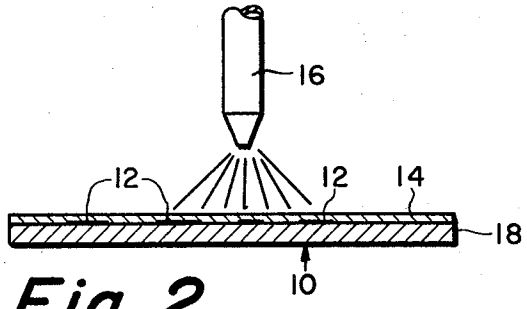


Fig. 2

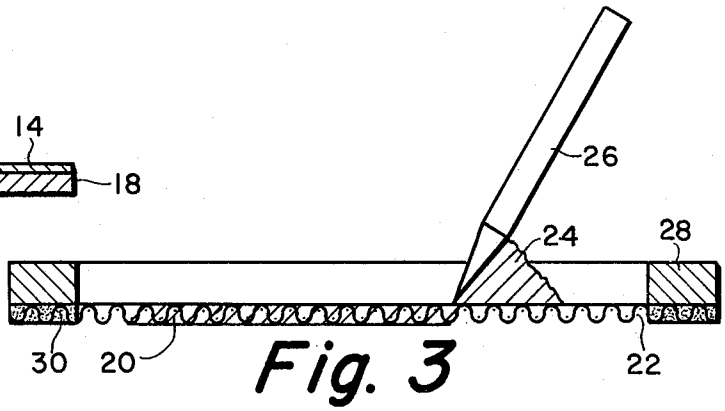


Fig. 3

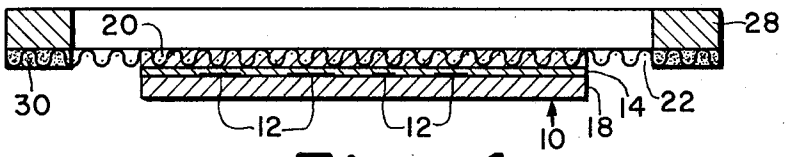


Fig. 4

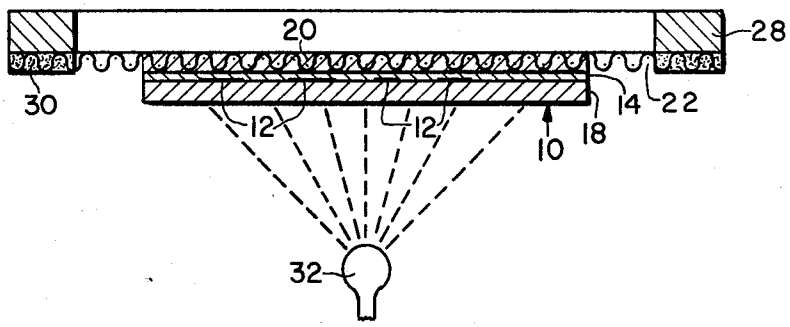


Fig. 5

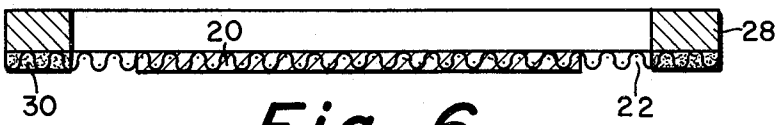


Fig. 6

INVENTORS.
GENADIUS M. PREDDY
WILLIAM B. UPCHURCH
BY
Walter S. Zebrowski
ATTORNEY

May 5, 1970 G. M. PREDDY ET AL 3,510,303

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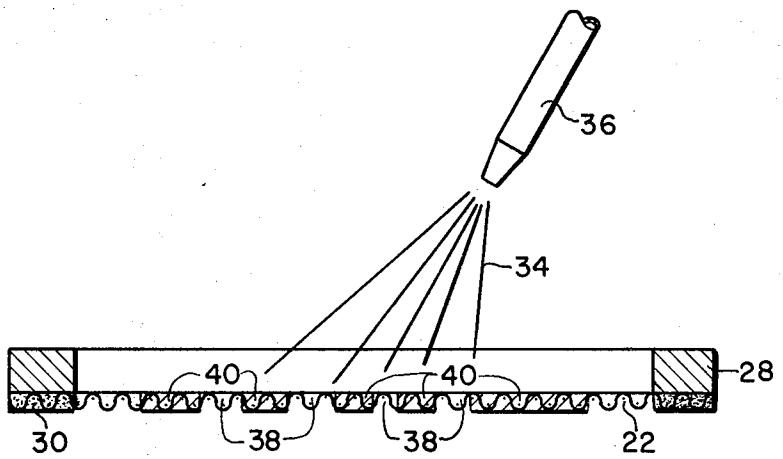


Fig. 7

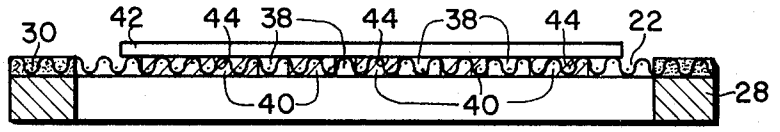


Fig. 8

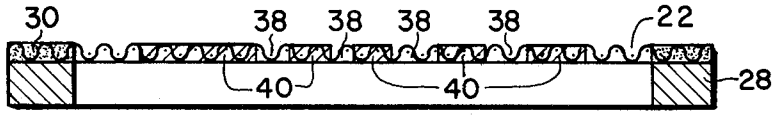


Fig. 9

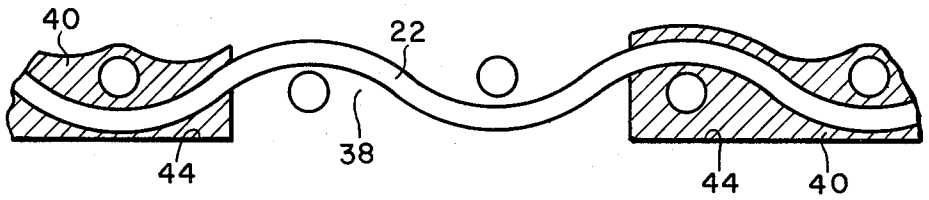


Fig. 10

INVENTORS.
GENADIUS M. PREDDY
WILLIAM B. UPCHURCH
BY
Walter S. Zebrowski
ATTORNEY

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3,510,303

THIN EMULSION DEPOSITION STENCIL SCREEN AND METHOD

Genadius M. Preddy, Durham, and William B. Upchurch, Castalia, N.C., assignors to Corning Glass Works, Corning, N.Y., a corporation of New York

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Int. Cl. G03c 5/00
U.S. Cl. 96—36.4 13 Claims

ABSTRACT OF THE DISCLOSURE

Stencil screens used for printing and to a direct, single exposure method of producing precision stencil screens which permit high print definition are described. The photosensitive emulsion which forms the stencil screen blockage is exposed directly on a prestretched screen after a photographic positive has been adhered to the emulsion in its wet state. The positive is then removed and the emulsion developed. Thereafter, the emulsion is dried while disposed in contact with a flat member.

Background of the invention

Stencil screens, commonly referred to as silk screens, have heretofore been fabricated by a method which requires the application of a coating of a photosensitive emulsion to a prestretched screen, which coating is thereafter dried. A photographic positive is formed having an opaque area, corresponding to the information to be printed by the screen, surrounded by a transparent area. The positive is then placed against the back side of the screen and the assembly is subjected to a suitable light which passes through the transparent portion of the positive and exposes the photosensitive emulsion applied to the screen. The positive is thereafter removed and the emulsion on the screen is developed so that the unexposed portion of the emulsion, corresponding to the information to be printed, is washed out leaving an open area in the screen through which the printing medium can thereafter pass.

Stencil screens formed by this method permit formation of line widths which are limited to about 5 mils, which lines can be fabricated to a tolerance of only about ±1.5 mils. In addition, such stencil screens often result in printed line edges having a saw tooth effect. Further, the emulsion contains craters and pits due to the slow drying of the photosensitive emulsion contributing to the relatively poor quality of the resulting printed matter. Lines having widths of 1 or 2 mils, such as are desired for microcircuit conductive path applications for example, cannot be printed by a screen formed by such a method.

Summary of the invention

The objects of the present invention are to provide an economic, thin emulsion deposition stencil screen having a crater and pit free emulsion and a method of fabricating such a screen that overcomes the heretofore noted disadvantages whereby smooth edged lines can be printed having small widths and spacing therebetween as well as having a very close dimensional tolerance.

According to the present invention, a stencil screen may be formed by providing a member, article, or device, having an opaque first area corresponding to that of the desired print surrounded by a light transmitting second area, providing a prestretched screen, applying a coating of a photosensitive emulsion over one surface of the screen, causing the emulsion to thoroughly permeate the screen, adhering the member to the screen by means of the emulsion while it is in a wet state, illuminating said emulsion through the member with a suitable light thereby exposing an area of the emulsion corresponding to the transparent second area while leaving an area of the emulsion corresponding to the opaque first area substantially unexposed, removing the member, removing the unexposed portion of the emulsion, and thereafter drying the emulsion while disposed in contact with a flat member.

Additional objects, features, and advantages of the present invention will become apparent, to those skilled in the art, from the following detailed description and the attached drawing, on which, by way of example, only the preferred embodiments of this invention are illustrated.

Brief description of the drawings

FIGURE 1 is a flow diagram illustrating the steps of the method of this invention.

FIGURES 2–9 are diagrammatic views illustrating the various steps of one embodiment of this invention.

FIGURE 10 is an enlarged fragmentary cross sectional view of a screen formed in accordance with this invention.

Detailed description

By the term stencil screen as used herein is meant a stretched screen, having a substantially impermeable emulsion applied to a portion thereof while the balance is uncoated permitting a printing medium to pass through, at least a portion of which balance corresponds in shape and configuration to that which is desired to be printed.

By the term printing as used herein is meant to form an impression or print of letters, characters, patterns, designs, artwork, and the like of any desired shape and configuration on any substrate.

By the term screen as used herein is meant a mesh, fabric, or cloth formed of any weavable material such as silk, nylon, Dacron, and the like fibers as well as metal wires such, for example, as stainless steel.

In accordance with this invention a photographic positive **10** or a like device having an opaque area **12** of substantially the same configuration as that which is desired to be printed is coated with a thin film **14** of a release agent, such as for example, acrylic lacquer, resinous material, or the like. A suitable release agent must be clear, smooth, transparent or translucent, wettable by a photosensitive emulsion, and be capable of being applied in very thin films. Such a release agent may be applied by means of a spray nozzle **16** as illustrated in FIGURE 2. Opaque areas **12** of photographic positive **10** may be formed of a common photographic emulsion applied to an ordinary plastic backing **18**.

A coating **20** of a photosensitive emulsion is applied over prestretched screen **22**, as illustrated in FIGURE 3, by placing a quantity of photosensitive emulsion **24** over screen **22** and spreading it out by means of squeegee **26**, or the like. By spreading the wet emulsion out by such means as a squeegee, the emulsion is caused to thoroughly permeate the screen. Screen **22** is prestretched and maintained in place by bonding it to a suitable frame **28** by any suitable cement **30**, such for example as epoxy cement, as is well known to one familiar with the art.

Suitable examples of photosensitive emulsions are sensitized polyvinyl acetate, sensitized polyvinyl alcohol, sensitized gelatin, or the like, which hereinafter will be simply referred to as polyvinyl acetate, polyvinyl alcohol, gelatin, and the like. Coating **20** may be applied by any suitable means known in the art as long as the emulsion is caused to permeate the screen.

After the release agent is suitably dried on photographic positive **10**, the positive is adhered to screen **22** by means of coating **20** while it is in a wet state as illustrated in FIG. 4. The release agent side of the positive is disposed adjacent to and in contact with coating **20** so that it becomes wetted by an emulsion. Coating **20** may be applied to screen **22** while positive **10** is disposed adja-

cent to it or underneath it. In such a case, care must be taken to prevent entrapment of air between the screen and positive.

The assembly so formed is then dried and exposed to a suitable light **32** to expose that portion of coating **20** which surrounds opaque areas **12** as shown in FIG. 5. Light **32** is schematically illustrated. Although a collimated light is preferred, any carbon arc lamp or an ultraviolet light source may be used for this purpose. The length of time for the exposure of coating **20** will depend on the thickness of the coating as well as the composition thereof. It has also been found that the assembly may be placed within a vacuum chase and exposed to a light while the assembly is maintained under a vacuum. Employing a vacuum chase is desirable in order to maintain the positive perpendicular to the light source and at a preselected distance therefrom. Thereafter, positive **10** together with release agent film **14** are stripped from the assembly leaving behind screen **22** with partly exposed coating **20** as shown in FIG. 6.

Referring now to FIG. 7, the unexposed portions of coating **20** are washed out by means of a jet of water **34** from a suitable source such as nozzle **36** leaving behind exposed portions **40** of coating **20** which correspond to opaque areas **12** of positive **10**. If desired, an ultrasonically agitated water bath may be used to aid in washing out the unexposed portions of the coating as is well understood by one familiar with the art. After the unexposed portions of coating **20** are thoroughly washed out, channels **38** extend through screen **22** separating exposed portions **40** of coating **20**.

Referring to FIG. 8, while exposed portions **40** are still moist and wet from the step of washing out of the unexposed portions of coating **20**, a flat member, such as sheet **42** of synthetic resinous material, such as for example, Mylar, polyester, or the like is disposed adjacent the exterior surfaces of portions **40** and mechanically adhered thereto as for example by rolling or the like. Exposed portions **40** are then suitably dried with sheet **42** in place, whereupon sheet **42** is removed leaving a finished stencil screen suitable for printing as illustrated in FIG. 9. Sheet **42** is adhered to the outer surfaces **44** of portions **40** while they are drying so that these surfaces dry flat and smooth to prevent craters and pits from forming therein and so that they form sharp corners with the sidewalls of channels **38**. Such flat surfaces and sharp corners permit the subsequent printed matter to have sharp edges and high definition by keeping the printing medium from flowing between these surfaces and the substrate being printed.

FIG. 10 illustrates a greatly enlarged view of a screen where the printing surfaces **44** of portions **40** are flat and form sharp corners with channel **38**. As is seen, the back side of the emulsion shrinks somewhat when it dries and tends to assume the contour of the screen fibers. If the emulsion was dried without a flat member such as sheet **42** adhered to the printing surface, the emulsion would dry and shrink from both sides whereby the emulsion on the printing surface would also tend to assume the contour of the screen fibers.

A typical example of one method of carrying out the present invention is illustrated by the following description. A photographic positive having an opaque first area corresponding to that of the desired print or impression surrounded by a light transmitting second area was provided. A coating of an acrylic lacquer was sprayed over the emulsion side of the photographic positive to form a transparent release film of approximately 0.2 mil in thickness. The coated positive was then dried at a temperature of about 72° F. for about 30 minutes.

A prestretched screen was formed by providing a metallic frame having at least one flat surface, adjacent to which a nylon screen was disposed. The screen was stretched in all directions and bonded to the frame by means of an epoxy cement, which cement was thereafter permitted to dry while tension was maintained on the screen.

The coated positive was placed on a smooth, flat, rigid surface with the lacquered side up and the prestretched screen was disposed adjacent to the lacquer. A quantity of wet emulsion was then placed on the other surface of the screen and was spread out over the screen with a squeegee so that the wet emulsion would permeate the screen and wet the surfaces of the lacquered positive. The assembly was then permitted to dry at room temperature for about 6 hours. In this manner the photographic positive was caused to adhere to the prestretched screen.

This assembly was then placed in a vacuum chase and a vacuum of 15 inches of mercury was drawn. The assembly was exposed to a carbon arc light through the positive for approximately 30 seconds. In this manner an area of the coating of emulsion corresponding to the transparent area on the photographic positive, that is the area surrounding the opaque area of the positive, was exposed to the light.

After the assembly was removed from the vacuum chase, the photographic positive and the film of acrylic lacquer release agent was removed from the assembly by stripping and the emulsion on the screen was uncovered. The screen assembly was then soaked in water having a temperature of about 110° F. for approximately 15 to 30 seconds and the unexposed portion of the emulsion film was washed out by means of an ultrasonic bath and a water spray for several minutes. After all of the unexposed emulsion was removed the surface water was blown off by an air stream. While the emulsion on the stencil screen was still wet, a transparent Mylar plastic film was placed adjacent the exterior surface of the exposed and developed emulsion and the film was adhered to the emulsion by means of pressure from a roller. This assembly was then permitted to dry for about sixteen hours at room temperature. After the assembly was thoroughly dried, the plastic film was removed by stripping it off producing a completed stencil screen.

A screen produced as described in the typical example is capable of printing lines of a slurry of electrically conductive material having a width of about 1 mil and very smooth edges. The printing surface of the exposed and developed emulsion on the screen is free of craters and pits.

It is obvious that a stencil screen formed by the method of this invention is suitable for printing microcircuit paths, decorative artwork, ordinary printing matter, or the like.

Although the present invention has been described with respect to the specific details of certain embodiments thereof, it is not intended that such details be limitations upon the scope of the invention except insofar as set forth in the following claims.

What is claimed is:

1. A method of forming a stencil screen comprising the steps of:

forming an article having an opaque first area corresponding to that of the print desired surrounded by a transparent second area,

applying a film of a release agent to one surface of said article,

providing a prestretched screen,

applying a coating of photosensitive emulsion to said prestretched screen so that it thoroughly permeates the screen,

adhering said article to said screen by means of said emulsion with the surface to which said release agent was applied being adjacent said emulsion,

illuminating said emulsion through said article with a suitable light thereby exposing and area of said emulsion corresponding to said transparent area while leaving the area thereof corresponding to said opaque area substantially unexposed,

removing said article,

removing the unexposed portion of said emulsion, disposing at flat member in contact with one surface of the exposed portion of said coating of photosensitive emulsion,

drying the remaining emulsion, and thereafter removing said flat member.

2. The method of claim **1** wherein said article is a photographic positive.

3. The method of claim **1** wherein said photosensitive emulsion is polyvinyl acetate.

4. The method of claim **3** wherein said light is ultraviolet light.

5. The method of claim **3** wherein said release agent is a film of an acrylic lacquer.

6. The method of claim **3** wherein the unexposed portion of said coating of emulsion is removed by washing with water.

7. The method of claim **1** wherein said article is disposed adjacent to said prestretched screen while the coating of photosensitive emulsion is being applied so that said article is adhered to said screen simultaneously with the application of said emulsion.

8. The method of claim **7** wherein said article is a photographic positive.

9. The method of claim **7** wherein said photosensitive emulsion is polyvinyl acetate.

10. The method of claim **9** wherein said release agent is a film of an acrylic lacquer.

11. The method of claim **9** wherein said light is ultraviolet light.

12. The method of claim **9** wherein the unexposed portion of said coating of emulsion is removed by washing with water.

13. The screen formed by the method of claim **1.**

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GEORGE F. LESMES, Primary Examiner

J. P. BRAMMER, Assistant Examiner

U.S. Cl. X.R.

101—128.3

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,510,303 Dated July 1, 1970

Inventor(s) Genadius M. Preddy - William B. Upchurch

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 2, line 71, "an" should be replaced by --the--.

Column 6, claim 9, line 1, the numeral 7 should be 8.

SIGNED AND
SEALED
SEP 22 1970

(SEAL)
Attest:

Edward M. Fletcher, Jr.
Attesting Officer

WILLIAM E. SCHUYLER, JR
Commissioner of Patents