

April 21, 1970

R. F. WRENCH

3,507,654

STENCIL SCREEN AND METHOD

Filed Dec. 29, 1966

3 Sheets-Sheet 1

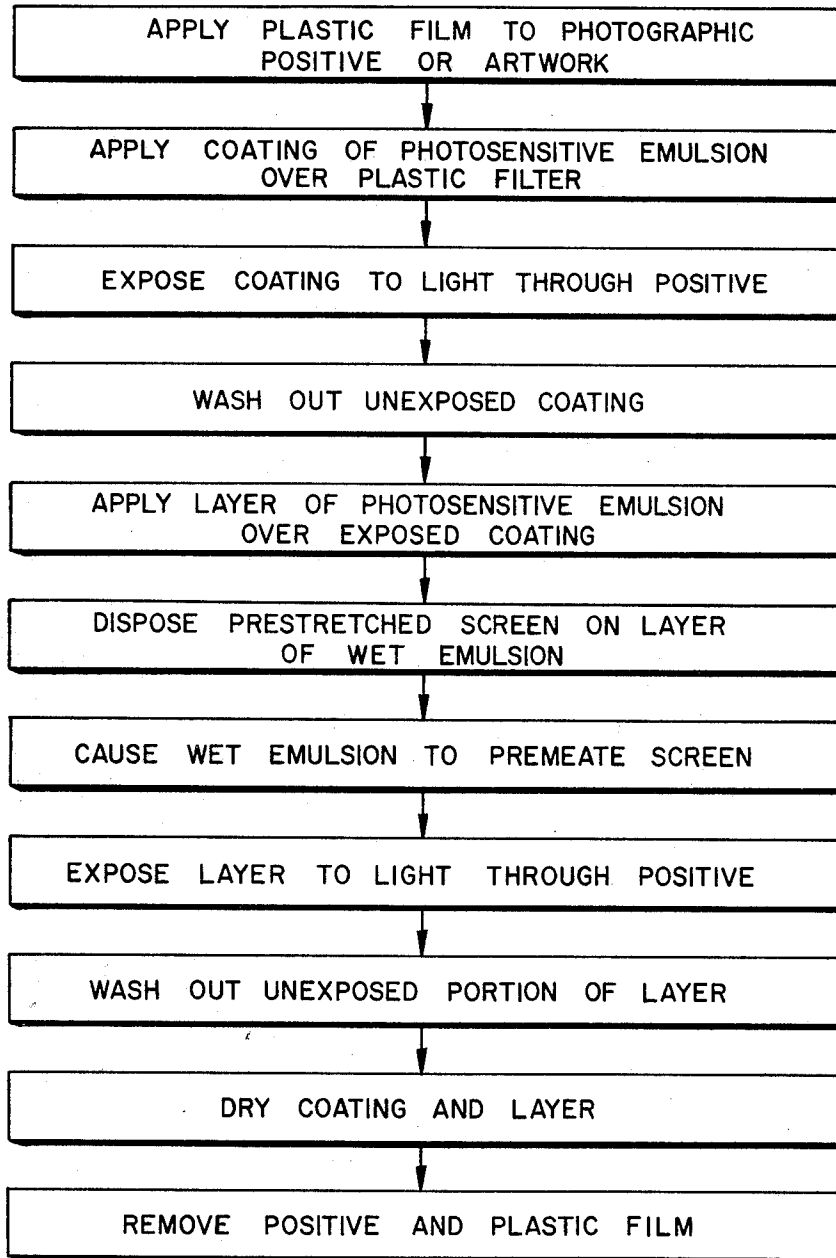


Fig. 1

INVENTOR.

ROBERT F. WRENCH

BY

Walter S. Zebrowski

ATTORNEY

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R. F. WRENCH
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3 Sheets-Sheet 2

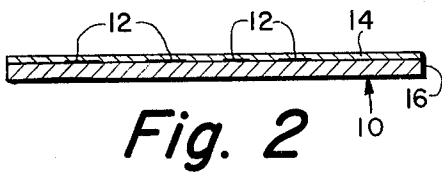


Fig. 2

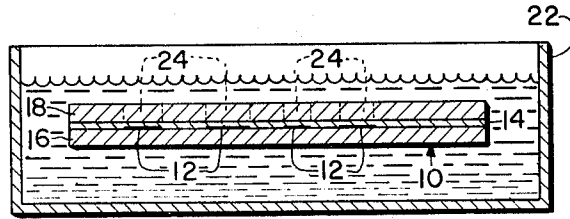


Fig. 5

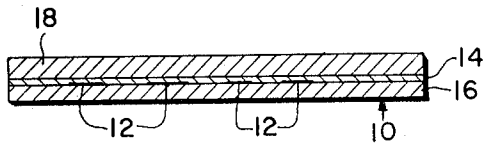


Fig. 3

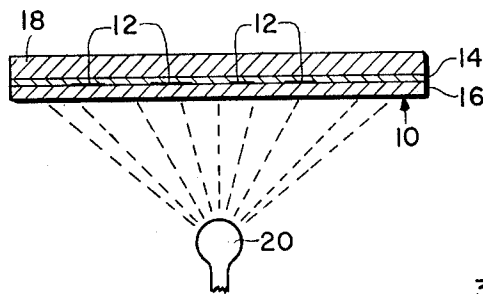


Fig. 4

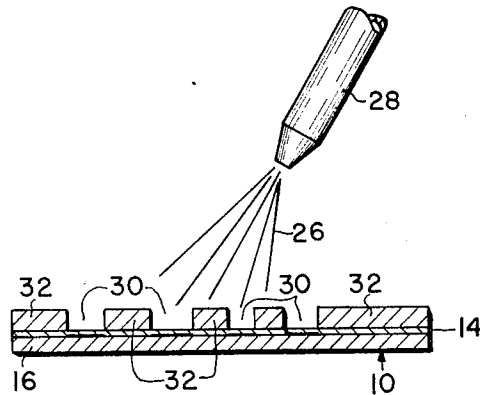


Fig. 6

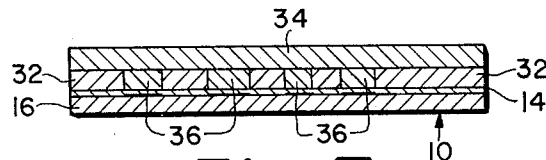


Fig. 7

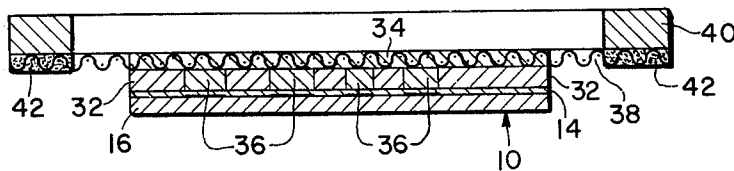


Fig. 8

INVENTOR.
ROBERT F. WRENCH
BY *Walter S. Zebrowski*
ATTORNEY

R. F. WRENCH

STENCIL SCREEN AND METHOD

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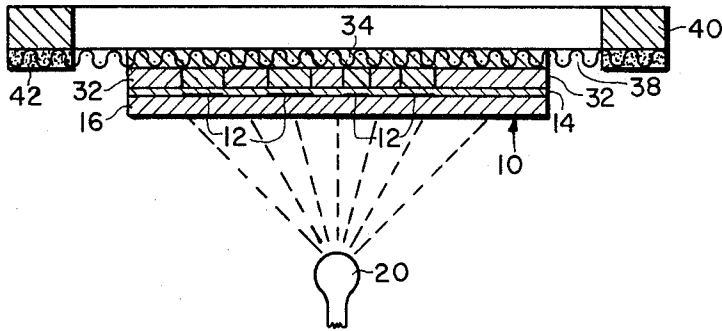


Fig. 9

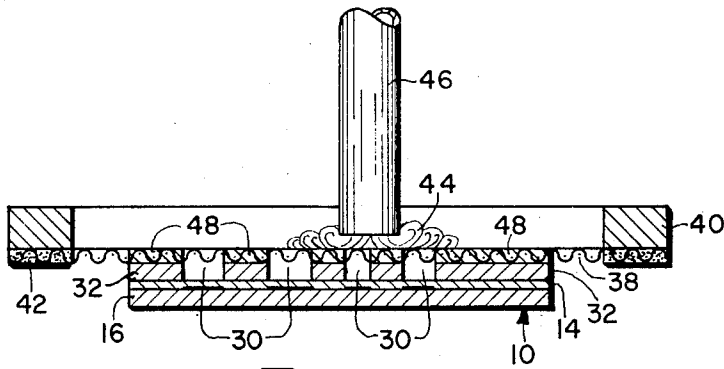


Fig. 10

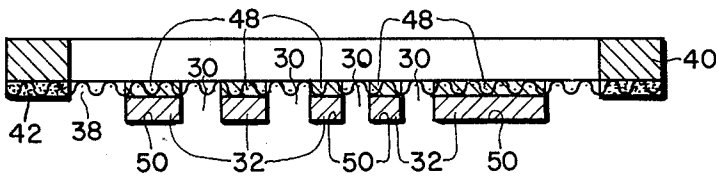


Fig. 11

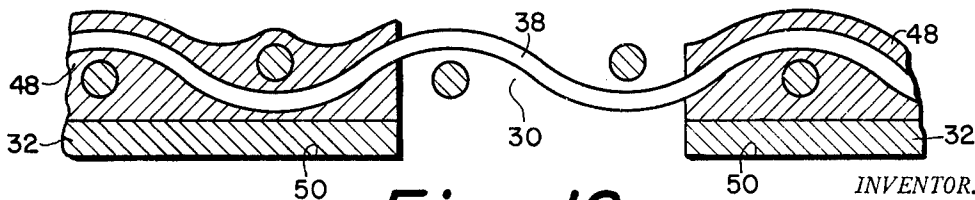


Fig. 12

50 INVENTOR.
ROBERT F. WRENCH
BY *Walter S. Zebrowski*
ATTORNEY

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3,507,654

STENCIL SCREEN AND METHOD

Robert F. Wrench, Corning, N.Y., assignor to Corning Glass Works, Corning, N.Y., a corporation of New York

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13 Claims

ABSTRACT OF THE DISCLOSURE

Stencil screens used for printing and an indirect, double 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 and developed directly on a photographic positive, and thereafter is transferred and bonded to a prestretched screen by means of a layer of such emulsion which is itself exposed and developed.

BACKGROUND OF THE INVENTION

Stencil screens, commonly referred to as silk screens, have heretofore been fabricated by a direct method. Such a method of forming a stencil screen 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 photo-sensitive 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 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 an article, having an opaque first area corresponding to that of the desired print surrounded by a light transmitting second area, applying a coating of a photosensitive emulsion over one surface of the member, 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 unexposed portion of the emulsion, applying a layer

of a photosensitive emulsion over the remaining coating, disposing a prestretched screen on the layer of wet emulsion and causing the emulsion to permeate the screen, illuminating the assembly so formed through the member with a suitable light thereby exposing an area of the emulsion layer corresponding to the opaque first area substantially unexposed, removing the unexposed portion of the emulsion layer, drying the coating and layer, and thereafter removing said 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 2–11 are diagrammatic views illustrating the various steps of one embodiment of this invention.

FIGURE 12 is a fragmentary cross sectional view of a completed screen.

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 the like having an opaque area 12 of substantially the same configuration as that which is desired to be printed is covered with a thin plastic film or sheet 14 of a synthetic resinous material such as, for example, Mylar or the like. Mylar is a polyester material. Opaque areas 12 of photographic positive 10 may be formed of a common photographic emulsion applied to an ordinary plastic backing 16. The thin plastic film acts as a release agent for the subsequently applied photosensitive emulsion and is adhered to positive 10 by any suitable means such as an acrylic cement, or the like, or by taping it down with a waterproof tape. Such a film must be clear, smooth, transparent or translucent, wettable by a photosensitive emulsion, and be capable of being formed in very thin films. Care should be taken to avoid entrapment of air between film 14 and positive 10. After film 14 is suitably adhered to positive 10 as illustrated in FIGURE 2, a coating 18 of a photosensitive emulsion is applied over film 14 as illustrated in FIGURE 3. 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 18 may be applied by any suitable means known in the art, such as by placing the photographic positive on a rigid support and thereafter knife coating the emulsion over the surface.

After coating 18 has been suitably dried, the assembly so formed is exposed to a suitable light 20 to expose that portion of coating 18 which surrounds opaque areas 12 as shown in FIGURE 4. Light 20 is schematically illustrated. While any carbon arc lamp or an ultraviolet light source may be used for this purpose, a collimated light is

preferred. The length of time for the exposure of coating 18 will depend on the thickness of the coating as well as the composition thereof.

Referring now to FIGURE 5, the exposed emulsion coated assembly is then placed in a suitable water bath 22 or simply flooded with water by placing the assembly under a gentle stream of water as the first step in washing out the unexposed portion 24 of coating 18. To facilitate washing out unexposed portions 24, bath 22 may be subjected to the action of an ultrasonic agitator.

Thereafter, as illustrated in FIGURE 6, the assembly is subjected to a water spray 26 supplied by any suitable means such as nozzle 28 as a final step of washing out the unexposed portions of the coating. After the unexposed portions of the coating are washed out leaving channels 30 in between remaining portions 32 of the photosensitive coating, the assembly is again dried.

Referring now to FIGURE 7, after the assembly is dried, a layer 34 of photosensitive emulsion is applied over the remaining exposed portions 32 by any suitable means such as a squeegee. To prevent the emulsion of layer 34 from entering channels 30, these channels may be filled with a light insensitive material 36 prior to the application of layer 34. Such a light insensitive material may be unsensitized polyvinyl alcohol, unsensitized polyvinyl acetate or the like. While the emulsion of layer 34 is still wet, a prestretched screen 38 is disposed on layer 34 and the wet emulsion is caused to permeate the screen as illustrated in FIGURE 8. Screen 38 is prestretched and maintained in place by bonding it to a suitable frame 40 by any suitable cement 42 such for example as epoxy cement, as is well known to one familiar with the art. The photosensitive emulsion of layer 34 may be of the same type as was used to form coating 18 or may be of any other suitable type as long as it forms a suitable bond between the exposed portions 32 and screen 38.

Referring now to FIGURE 9, after layer 34 is dried, the assembly is again illuminated through positive 10 with a suitable light 20, as heretofore described, to expose an area of layer 34 corresponding to the transparent area of positive 10 and exposed portions 32 of coating 18. The unexposed portions of layer 34 will correspond to opaque area 12 of positive 10. Thereafter the unexposed portions of layer 34 are washed out by means of a water stream 44 emitted from a suitable nozzle or hose 46 which is held close to the back side of screen 38. Such a stream also washes out any light insensitive material that may have been placed in channels 30, or that portion of layer 34 which may have flowed into channels 34 if no insensitive material was used. After such washing out, exposed portions 48 of layer 34 remain behind and correspond to exposed portions 32 of coating 18, and channels 30 extend through screen 38 separating both portions 32 and 48.

The exposed portions 32 and 48 of coating 18 and layer 34 respectively are then dried with positive 10 and film 14 in place. Thereafter, positive 10 and film 14 are stripped from the assembly leaving a finished stencil screen suitable for printing as illustrated in FIGURE 11. Since positive 10 and film 14 are adhered to the outer surfaces 50 of portions 32 while they are drying, 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 30. 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.

FIGURE 12 illustrates a greatly enlarged view of a screen where the printing surfaces 50 of portions 32 are flat and form sharp corners with channel 30. 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 positive 10 and film 14 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 causing relatively poor quality of the resulting printed matter.

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 film or sheet of Mylar having a thickness of $\frac{1}{2}$ mil was adhered to the emulsion side of the photographic positive to form a transparent release film. The photographic positive was then placed upon a smooth, flat, rigid surface with the film surface exposed. Then a coating of polyvinyl alcohol, a photosensitive emulsion, having a wet thickness of about 3 mils was applied over the Mylar film by means of knife coating. The assembly so formed was allowed to remain at room temperature for about $\frac{1}{2}$ hour to permit the coating of polyvinyl alcohol to dry.

The coating of emulsion was then exposed to a carbon arc lamp providing collimated light for about 40 seconds through the positive. In this manner the light passed through the positive and exposed only that portion of the polyvinyl alcohol which surrounded the opaque areas of the positive. This assembly was then flooded with water by subjecting it to a gentle stream of water at 110° F. for about 30 seconds. The washing out process was concluded by spraying the coated positive with water for several minutes to remove all of the unexposed portion of the polyvinyl alcohol. The excess water was then removed by a gentle stream of air and the assembly was permitted to dry at room temperature for about 3 hours.

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 again placed on the smooth, flat, rigid surface with the exposed emulsion side up and a layer of polyvinyl alcohol emulsion was formed thereon. While the emulsion was wet, the prestretched screen was disposed thereon and the emulsion was caused to permeate the screen. The assembly was then permitted to dry at room temperature for about 2 hours. In this manner the exposed and developed emulsion on the photographic positive was caused to bond to the prestretched screen.

The assembly was again exposed to a collimated carbon arc light through the positive for approximately 60 seconds. In this manner an area of the layer 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.

The screen assembly was then soaked in water having a temperature of about 110° F. for approximately 30 seconds and the unexposed portion of the emulsion layer was washed out by means of a water stream or spray. A $\frac{1}{4}$ " hose having water under about 10 p.s.i. pressure was held very close to the back side of the screen so that sufficient force was developed to wash out all of the unexposed portion of the emulsion layer. After all of the unexposed emulsion was removed, the surface water was thoroughly blotted with a chamois. This assembly was then permitted to dry for about sixteen hours at room temperature. After the assembly was thoroughly dried, the photographic positive and the Mylar film were removed by stripping them 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.

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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,
 - applying a coating of photosensitive emulsion over said film of release agent,
 - illuminating said emulsion through said article with a suitable light thereby exposing an area of said emulsion corresponding to said transparent area while leaving the area thereof corresponding to said opaque area substantially unexposed,
 - removing the unexposed portion of said coating of emulsion,
 - applying a layer of photosensitive emulsion over the exposed portion of said coating of emulsion, providing a prestretched screen,
 - disposing said prestretched screen on said layer of emulsion and causing it to permeate said screen,
 - illuminating the assembly so formed through said article with a suitable light thereby exposing an area of said layer of emulsion corresponding to said transparent area while leaving the area thereof corresponding to said opaque area substantially unexposed,
 - removing the unexposed portion of said layer of emulsion,
 - drying said coating and layer of emulsion, and thereafter removing said article.
2. The method of claim 1 wherein said coating and layer of photosensitive emulsion is polyvinyl alcohol.

3. The method of claim 2 wherein said coating and layer of photosensitive emulsion is illuminated with ultra-violet light.

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

5. The method of claim 4 wherein said release agent is a thin sheet of polyester material.

6. The method of claim 5 wherein said coating of photosensitive emulsion is polyvinyl alcohol.

7. The method of claim 6 wherein said layer of photosensitive emulsion is polyvinyl alcohol.

8. The method of claim 7 wherein said coating and layer of photosensitive emulsion is illuminated by ultra-violet light.

9. The method of claim 8 wherein said unexposed portion of the coating and layer of emulsion is removed by washing with water.

10. The method of claim 1 further comprising the step of filling the channels, remaining after the unexposed portion of said coating of photosensitive emulsion is washed out, with a light insensitive material prior to applying said layer of photosensitive emulsion over said exposed portion of said coating.

11. The method of claim 10 wherein said light insensitive material is unsensitized polyvinyl alcohol.

12. The method of claim 11 wherein said coating and layer of photosensitive emulsion is polyvinyl alcohol.

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

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DONALD LEVY, Primary Examiner

J. P. BRAMMER, Assistant Examiner

U.S. Cl. X.R.

101—128.3

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,507,654 Dated April 21, 1970

Inventor(s) Robert F. Wrench

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

Column 1, line 63, after "providing" insert --a member or--

Column 1, line 63, delete "an" (first occurrence)

Column 3, line 46, "inensitive" should read --insensitive--

SIGNED AND
SEALED
AUG 4 - 1970

(SEAL)

Attest:

Edward M. Fletcher, Jr.
Attesting Officer

WILLIAM E. SCHUYLER, JR.
Commissioner of Patents