United States Patent

Lala

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[54] METHOD OF MAKING SCREEN PRINTING ARTICLES

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[52] **U.S. Cl.** **101/128.3**, 96/36.4, 96/45
[51] **Int. Cl.** **B41n 1/24**, G03c 5/00
[58] **Field of Search** 96/36.4, 36.8, 45; 101/128.3

[56] **References Cited**

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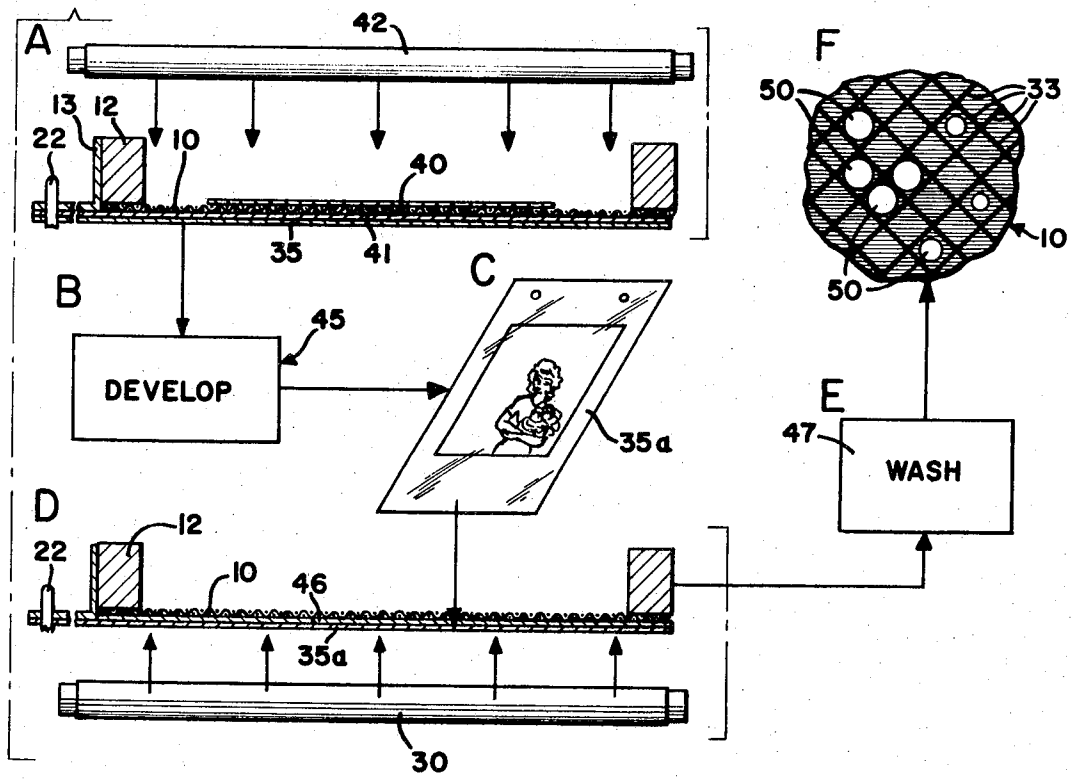
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Attorney—Marechal, Biebel, French & Bugg

[57] **ABSTRACT**

A screen printing article and method of making the article includes using the fibers of the screen to divide the image to be printed into a plurality of dots, the size of each representing the density of the light passing through the screen. Since the fibers of the screen themselves are used to break up the image, each dot being thus created falls substantially centrally in the openings between the fibers. A photographic film is placed adjacent the screen, exposed to the image to be printed and developed. The screen is then coated with a sensitized emulsion, and exposed to light projected through the developed photographic film. The film and the unexposed emulsion are then removed to leave a plurality of openings in the screen, each centrally positioned between the fibers of the screen, through which ink may pass.

10 Claims, 23 Drawing Figures



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SHEET 1 OF 2

FIG-1

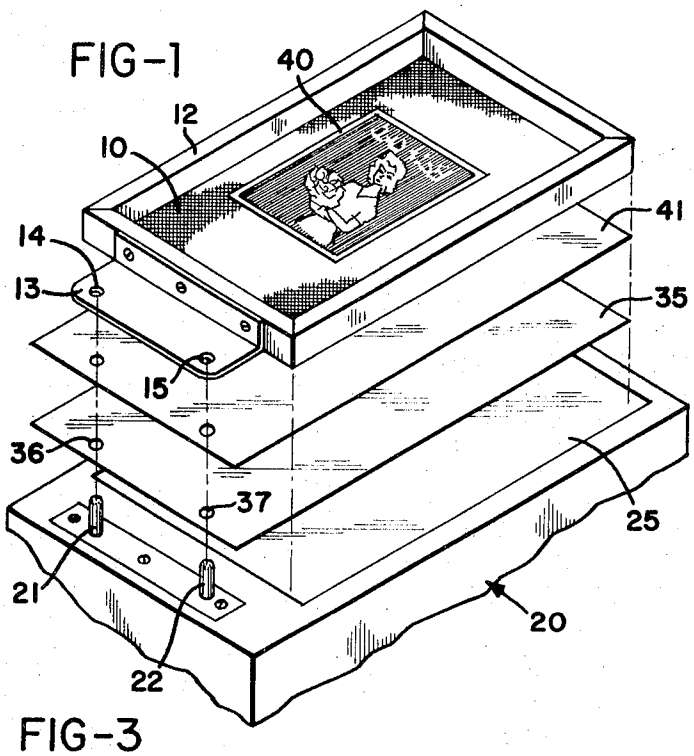


FIG-2

PRIOR ART

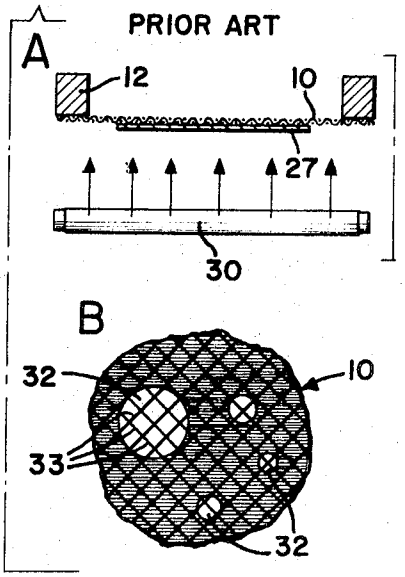
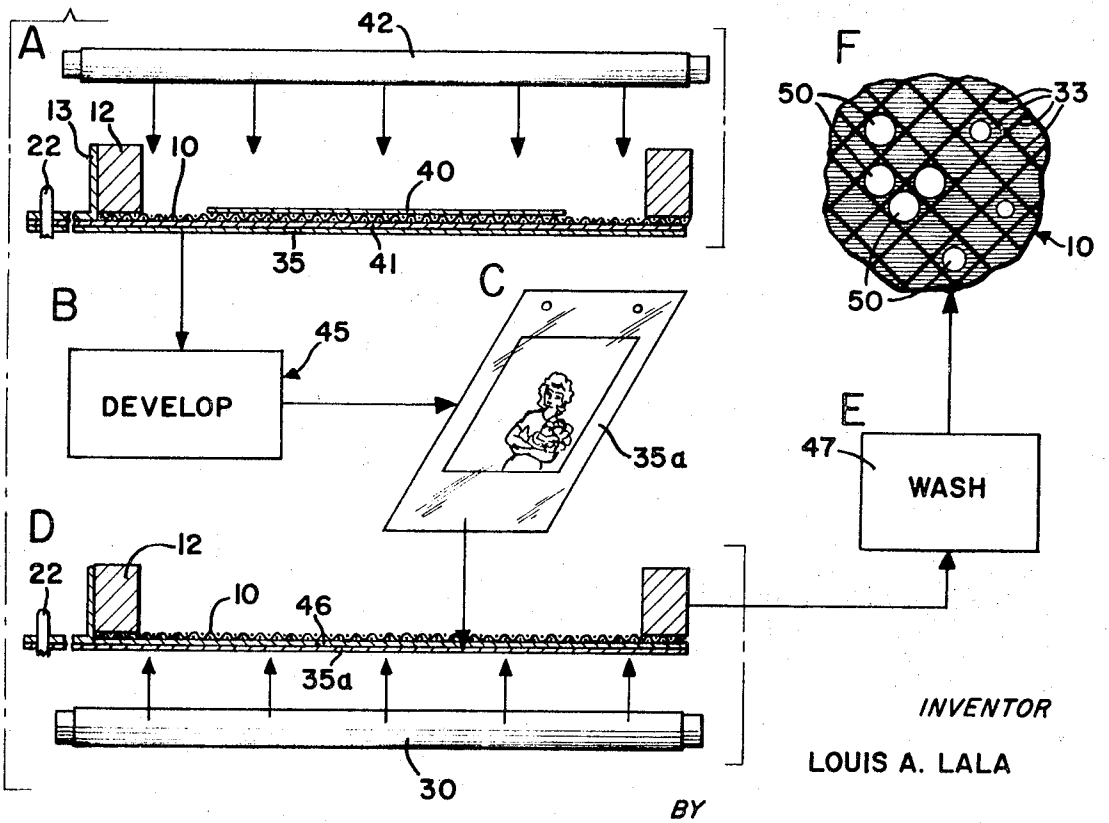


FIG-3



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FIG-4

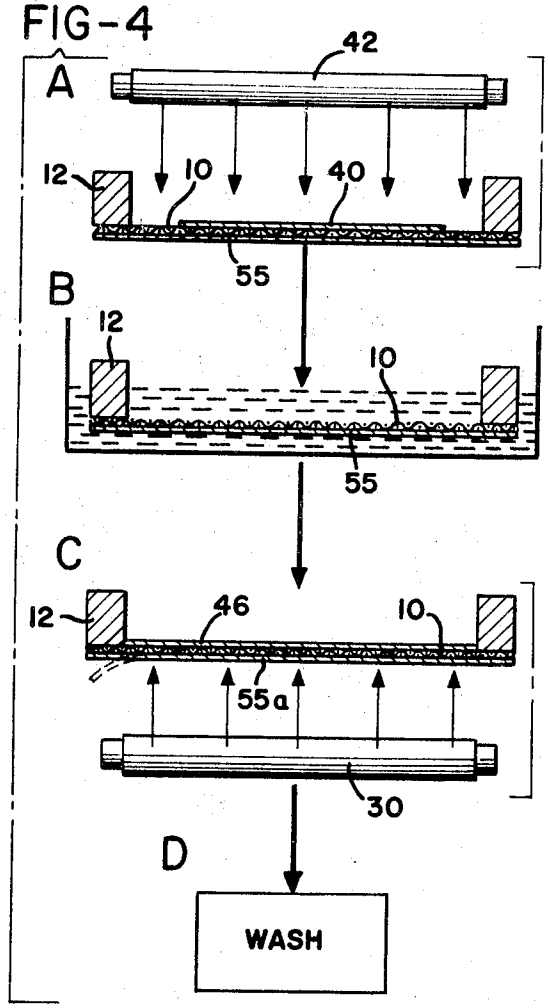


FIG-6

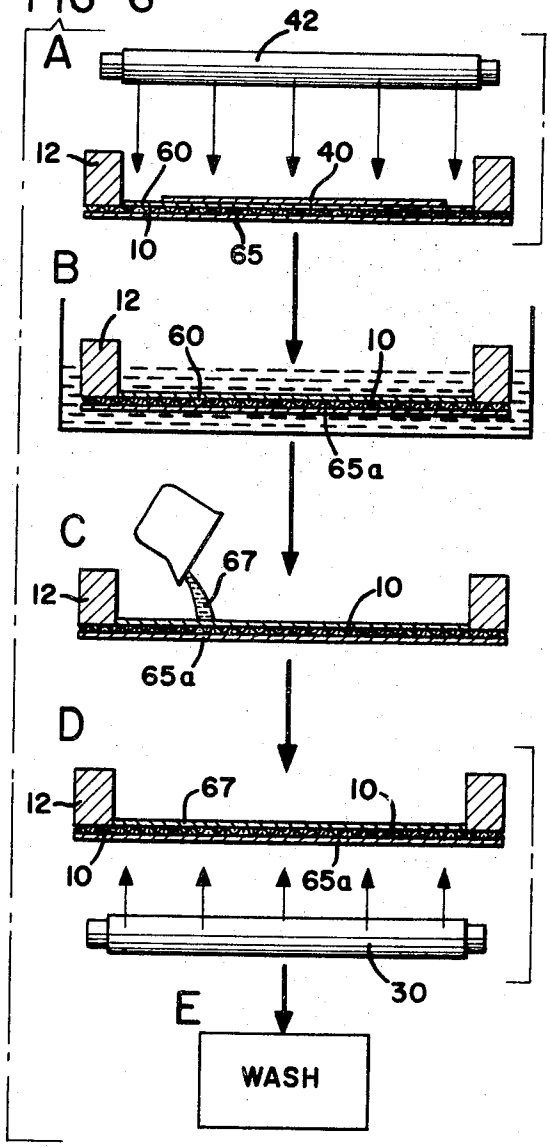


FIG-5

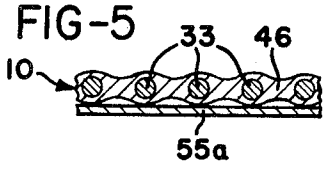
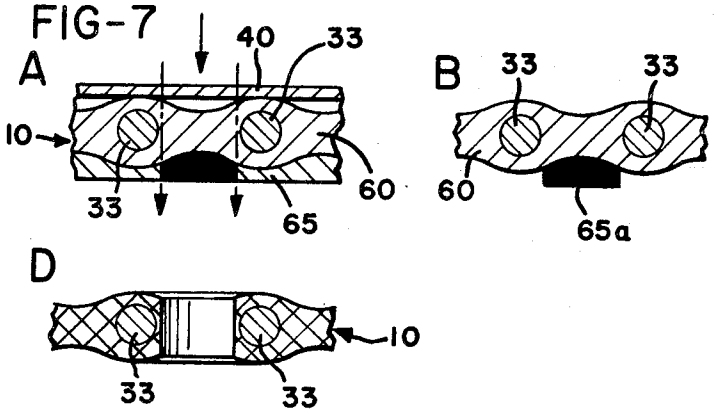


FIG-7



METHOD OF MAKING SCREEN PRINTING ARTICLES

BACKGROUND OF THE INVENTION

In the prior art screen printing process, a sensitized emulsion on the screen is exposed to light from a halftone transparency, usually a positive, and thereafter the emulsion is washed to remove all unexposed portions, thus leaving openings in the screen through which ink may pass.

The halftone transparency is usually formed by dividing a continuous tone original picture into a plurality of dots or lines. This is done photographically by positioning a screen having the desired dot or line number between the original picture and a photographic film. This method of making halftones is common to many printing processes.

In making screen printing plates, however, a moire pattern is formed when such a halftone transparency is used, this moire pattern being particularly noticeable when the number of dots or lines of the halftone transparency and the mesh of the screen are in close approximation, that is, in any ratio less than 1:1. It is common practice, therefore, to use the ratio 1:4 or 1:5 between the number of dots or lines in the transparency to the mesh openings. Accordingly, a limitation is inherently placed on the number of dots or lines on the halftone transparency to about 85–100 dots or lines per inch. With a 100 dot or line transparency, for example, the screen would have a mesh density of 400–500 openings per inch.

After the halftone transparency is created, it it then oriented relative to the screen to minimize the moire pattern, although in most cases this pattern is usually not eliminated.

Some of the dots representing highlights in the picture are of small diameter, and some of these dots are actually smaller than the diameter of the fibers forming the screen. These small dots, if positioned over a fiber, are therefore ineffective in passing ink, thus creating the moire pattern. Also, since some of the dots or openings in the screen may include one or more of the screen fibers, these openings may clog or fill with ink, and some of the smaller openings may clog or fill up completely upon the first application of ink to the screen.

Thus, the present screen printing process includes several basic problems as outlined above, including, for example, the moire pattern between the halftone transparency and the screen, the limitation on the size of the screen due to the number of fibers extending across the openings in the screen, and the inability of the process to reproduce fine detail, especially in large production runs or where inks including large metallic particles are used.

A more complete description of the prior art silk screen process, along with its advantages and limitations, may be found in the book "Photographic Screen Process Printing" by Albert Kosloff, 3rd Edition, published by the Signs of the Times Publishing Company, Cincinnati, Ohio.

SUMMARY OF THE INVENTION

This invention relates to an improved screen printing article and method for making the article wherein each opening in the screen is free of obstructions and moire patterns and which is therefore capable of printing pictures of higher quality than heretofore possible.

The screen printing article of this invention is a screen wherein each opening in the screen through which ink may flow is substantially centered between the fibers forming the screen. The method for preparing the screen includes the steps of projecting an image from a continuous tone negative through the screen onto a photographically sensitized surface. The fibers of the screen will cause the image to be divided into a plurality of dots on the surface, each centrally positioned between the fibers of the screen. The size of each dot will depend upon the intensity of the light passing through the fibers at that location. The photographically sensitized surface is then developed and the screen prepared with a sensitized emulsion. Light is then directed through the developed photographic surface onto the screen emulsion, and the emulsion is then washed to clear those areas which have not been exposed to light. Thus, each dot or opening will be located centrally between the fibers since these same fibers were used to create the dots on the photographic surface.

In one method of practicing the invention, the photographically sensitized surface is a photographic film which is first placed adjacent the screen, exposed to the image from a continuous tone picture, removed, developed, and then replaced and aligned in its original position, with each dot on the film thus positioned centrally between the fibers of the screen.

In another method of practicing the invention, a photographic film is secured to the screen by a suitable adhesive, exposed to the image-forming continuous tone picture through the screen and developed while it remains adhered to the screen. Thereafter, the screen is coated with a sensitized emulsion which is then exposed to light through the developed film. The film is then physically removed and the screen washed to remove the unexposed emulsion.

A third method of practicing the invention includes the steps of first coating a screen with a clear emulsion and thereafter coating one side of the screen with a photographically sensitized emulsion, projecting the image from a continuous tone picture through the screen onto the photographic emulsion, developing the photographic emulsion while it is in place on the screen, thereafter coating the clear emulsion with a sensitizing solution, and then exposing the now sensitized emulsion to light through the developed photographic emulsion. The screen is then washed to remove both the photographically sensitized emulsion and the unexposed portions of the screen emulsion.

In each of the methods described above, a photographic halftone positive film is formed utilizing the fibers of the screen to break up the image from a continuous tone picture into a plurality of dots, the size of each dot being a function of the intensity of the light through the fibers.

Since each opening in the screen is formed between fibers, no moire pattern is created, and since no fiber extends through any opening, the openings can be made smaller than heretofore possible, thus permitting the resultant printed article to be of higher quality. Also, since no fibers extend through the openings, these openings will not tend to clog as quickly as in other processes, thus permitting longer production runs from a single screen and the use of such a screen with inks containing relatively large metallic particles. The improved screen and method for making this screen can be used either in making single as well as multicolor prints.

It is therefore an object of this invention to provide an improved screen printing article wherein each opening in the article through the ink may pass is free of obstructions and is centrally positioned between the fibers forming the article; to provide a method for forming an improved screen printing article of the type described above wherein a continuous tone picture is projected through the screen onto a photographically sensitized surface, where the fibers forming the screen break up the image into a plurality of dots, the diameter of each dot being a function of the intensity of the light through the fibers at that location, to thereafter expose a sensitized emulsion on the screen to light through the developed photographically sensitized surface, and where the screen is thereafter washed to remove all unexposed emulsion, thus forming a plurality of openings in the screen, each centrally positioned between the fibers of the screen.

Other objects and advantages of the invention will be apparent from the following description, the accompanying drawings and the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an exploded pictorial view showing the relationship among the original art work, a screen printing plate, a photographically sensitive film, and a table for supporting these items;

FIGS. 2A and 2B are views illustrating the prior art method of making screen printing plates; FIG. 2A showing the relation

among the screen printing plate, the original art work on an image producing transparency, and the light source; and FIG. 2B showing the openings formed in a portion of the screen printing plate through which ink may pass;

FIGS. 3A—3F are views showing the steps of one method of practicing the invention;

FIGS. 4A—4D are views showing the steps of practicing another method of making screen printing plates according to this invention;

FIG. 5 is an enlarged view of a portion of the screen with a positive transparency attached;

FIGS. 6A–6E are views showing the steps of a third method for making screen plates according to this invention; and

FIGS. 7A–7D are enlarged cross-sectional views showing a portion of the screen plate and photographic film, illustrating more clearly the steps of the method shown in FIG. 5.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

In Fig. 1, a screen plate **10** is stretched on a frame **12** which includes an alignment bracket **13** having two holes **14** and **15** formed therein. While the term silk screen is often used in describing this screen printing plate, it will be understood that the screen **10** may be formed from many materials including, but not limited to, silk, nylon, cotton, monofilament synthetic materials, and metallic fibers.

A vacuum table **20** has mounted thereon a pair of upwardly extending pins **21** and **22** each having an outer diameter which matches the inside diameter of the holes **14** and **15**, respectively. Thus, when the frame **12** is placed on the table **20**, the pins **21** and **22** extend through the openings **14** and **15** to hold the frame precisely in place. The table **20** includes a translucent window **25**, and a light source, not shown, is positioned beneath the window to direct light upwardly through the window onto the screen printing plate **10** The window **25** may be made from ground glass, polarized glass, or other similar material.

The items which have been described thus far are conventional in the prior art method of making screen printing plates. Typically in prior art processes, the screen has four to five times the mesh relative to the number of dots or lines used on the halftone positive transparency. The halftone transparency **27** is first oriented relative to the screen **10** to minimize the moire pattern created between these two items, and the position of the transparency is marked. The transparency is then temporarily removed and the screen coated with a light sensitive emulsion, such as a synthetic adhesive resin mixed with ammonium bichromate, such as that sold under the trade name Screen Star, by Bond Adhesive Co. Jersey City, N.J. Also, a solution of polyvinyl alcohol, polyvinyl acetate and dibutyl phthalate, and potassium or ammonium bichromate may be used to coat the screen.

The transparency **27** is then replaced in its previously marked position. As shown in FIG. 2A, the screen is then exposed to light from a light source **30** through the transparency. The screen is washed to remove the unexposed areas of emulsion and then dried.

FIG. 2B shows a portion of the screen wherein one unexposed area is a relatively large circular opening **32** which has extending therethrough a plurality of fibers **33** from which the screen **10** is formed. Since the dot size of the halftone transparency is larger than the mesh of the screen **10**, one or more of the screen fibers will usually extend across the opening thus formed in the emulsion. In some cases, the size of the dot may be smaller than the diameter of one of the fibers **33**, and if this opening were positioned above a fiber, then no ink will be permitted to pass through the screen at that location.

Returning to FIG. 1, a photographic film has two alignment holes **36** and **37** punched therein which are aligned with and which fit precisely over the alignment pins **21** and **22**. This permits the film to be removed and subsequently replaced in exactly the same position relative to the screen **10**.

The fibers **33** from which the screen **10** is formed should be opaque to those wavelengths of which the film **35** is sensitive. Thus, metal or black fibers are opaque to all wavelength of light. When orthochromatic film is employed, red fibers may be used to form the screen **10**. The screen is formed from a plurality of generally equally spaced fibers in orthogonal relationship.

With the film **35** in place on the alignment pins **21** and **22**, the screen **10** is placed thereover, and a continuous tone negative picture **40** is placed directly on the screen **10**. It will be understood, however, that it is not essential that the art work **40** be placed directly on the screen, but only that the image from a continuous tone picture be directed through the screen **10** onto the photographic film **35**. Thus, a smaller negative in an enlarger could be employed with the image being projected through the screen **10** onto the film **35**.

In some cases, a spacer **41** is used to insure proper dot formation. Control over light intensity and exposure duration may also be exercised for proper dot formation. The spacer **41** may be either acetate or glass, and will have a thickness depending on the spacing between the fibers **33**, or in other words, the mesh of the screen **10**. For a screen having a **220** openings per inch, a spacer 0.016 inch thick has been found satisfactory. For screens having wider spaces between fibers, a thicker spacer **41** would be used, and conversely, for screens having a high mesh count, thinner spacers may be used. For very high mesh counts, no spacer would be needed.

Referring now to FIG. **3**, which illustrates clearly one method of practicing the invention, the continuous tone negative **40** is placed directly on the screen **10**, and light from a light source **42** is directed downwardly through both the negative **40** and the screen **10** onto the photographic film **35**. Preferably, the light from the source **42** is collamated. Since the fibers **33** from which the screen **10** is formed tend to break up the light into circular dots due to the optical phenomenon of interference, the film **35** will be, when developed, a halftone positive, with the size of each dot on the film representing the intensity of the light through the fibers at that location. The process for forming a halftone positive as described above is thus similar to the conventional practice of forming halftone transparencies by using a screen between a continuous tone picture and the photographic film.

After exposure, the film **35** is removed from the alignment pins **21** and **22** and developed, as shown generally at **45** in FIG. 3B. While the film is being developed, the screen **10** is coated with a light sensitive emulsion **46**. The developed film (FIG. 3C), now designated by reference numeral **35***a*, is replaced on the alignment pins **21** and **22** (FIG. 3D) and positioned so that each dot on the transparency is centered between the fibers forming the screen. The light source **30** within the table **20** then directs light through the halftone positive transparency **35***a* onto the coated screen **10**.

The screen is washed, as designated by reference numeral **47** (FIG. 3E), to clear or remove all unexposed areas. The screen thus formed is dried and each dot or opening in the screen will be found to be positioned centrally between the fibers forming the screen since it was these same fibers that were used to form the halftone transparency **35***a* through which the screen was exposed. Thus, each dot **50** in the screen, as shown in FIG. 3F, is located centrally between the fibers **33** forming the screen. The size of each dot **50** will be a function of the intensity of the image at that location.

The method of forming the improved screen printing article described above requires that the photographic film be replaced and realigned prior to exposure of the sensitized emulsion on the screen to light. While the alignment pins **21** and **22** assist in this realignment step, care must always be taken to insure that the dots on the halftone transparency are each centrally aligned between the fibers.

Another method for making an improved screen printing article is shown in FIG. **4**. In this method, a photographic film **55** is temporarily adhered to the screen **10** by a suitable adhesive with the emulsion side in direct contact with the screen. A

continuous tone negative **40** is placed on the opposite side of the screen **10**, as illustrated in FIG. **4A**. The film **55** is exposed to light from light source **42** through both the negative **40** and the screen **10**. The negative **40** is then removed and the film **55** is photographically developed (FIG. **4B**) while remaining attached to the screen **10**. The film is then separated from the screen either by inserting a thin sheet of acetate between film and screen, or by lifting one edge of the film. The screen **10** is coated with a sensitized emulsion **46** (FIG. **4C**) which is then allowed to dry, and the film is then returned to its original position. The sensitized emulsion is then exposed to light from a light source **30** through the now developed film **55***a*.

FIG. **5** is an enlarged view of the screen **10** with the film **55***a* attached and after the screen has been coated with light sensitive emulsion. Since the film **55** has not been removed from the screen **10**, no realignment was necessary after the film is photographically developed into a halftone positive transparence **55***a*.

After the emulsion **46** is exposed, the film **55***a* is removed, and the screen washed, as shown in FIG. **4D**. After it has dried, the silk screen may be used for printing.

A third method for forming an improved screen printing article according to this invention is shown in FIGS. **6** and **7**. Here, the screen **10** is coated with a clear emulsion **60**, and after this emulsion has dried, this emulsion is lightly coated with a waterproof clear, transparent plastic shield, such as that sold under the trade name Krylon, manufactured by Krylon Products, Norristown, Pennsylvania. This clear or transparent emulsion **60** is not photosensitive.

A photographic emulsion **65** is coated on the underneath side of the screen over the plastic shield. One such photographic emulsion is sold under the trade name Print-E-Mulsion CB–101, and is manufactured by Rockland Associates, 333 East 46th Street, New York, N.Y. A continuous tone negative **40** is then placed on the screen and the photographic emulsion **65** exposed to light from source **42** through both the negative **40** and the screen **10**. The clear emulsion **60** is water soluble and is preferably a polyvinyl alcohol, polyvinyl acetate emulsion. The photographic emulsion **65** is also water soluble.

After the photographic emulsion **65** is exposed to light, it is developed as shown in FIG. **6B**. This developing step removes all but the exposed portions of the photographic emulsion, such as portion **65***a* in FIG. **7B**. The developer used to develop the photographic emulsion **65** should be a slow acting type, such as Selectol, manufactured by Kodak. The type of developer used will depend, of course, on the type of photographic emulsion employed. During developing, the clear emulsion **60** is left unaffected due to the protective action of the thin plastic shield. It would be desirable, although it is not essential, to use a screen emulsion which is nonsoluble in the solution used to develop the photographic emulsion.

Again, the photographic emulsion **65**, after exposure to light through the screen **10**, will be a halftone positive transparency, with each dot of the transparency being centrally located between the fibers of the screen **10**, and the size of each dot will represent the intensity of light which passes through the fibers of the screen **10**.

As shown in FIG. **6C** and **7C**, the clear emulsion **60** on the screen **10** is then coated with a sensitizing compound **67** which, in the preferred embodiment is a solution of potassium or ammonium bichromate. This photosensitive compound **67** is not intended to form a separate layer, but is to impregnate and mix with the emulsion **60** to render it photosensitive. This newly sensitized emulsion is then exposed to light from lamp **30** through the halftone positive transparency **65***a*. The screen **10** is washed (FIG. **6E**), and all unexposed portions of the emulsion **60** and the remainder of the photographic emulsion **65** are removed, as shown in FIG. **7E**.

In each of the above-described methods of forming the improved screen printing article of this invention, a halftone positive is formed by exposing a photographically sensitive emulsion to light through the screen which is thereafter coated with a light sensitive emulsion and which is then exposed to light, through the thus formed halftone positive. The screen is washed to remove all unexposed areas, thus creating a plurality of openings in the screen, each opening being positioned centrally between the fibers of the screen. Each opening being positioned centrally between the fibers of the screen. Each opening has a diameter proportional to the intensity of the light passing through the fibers forming the screen.

While the continuous tone picture has been described as being a negative laid adjacent the screen, it is understood that this image could also be projected through the screen from an enlarger, for example. It is also contemplated that reversal type photographic emulsions could be employed so that the art work to be printed could be from a positive continuous tone transparency, rather than from a negative. It is also understood that this invention can be used in multi as well as single colored prints.

A screen printing article wherein each opening in the screen is formed by the fibers is therefore more efficient than prior art screen printing devices since no fiber extends through the opening. This permits the passage of large particles, such as metallic particles or crystals used in coating television picture tubes. Also, the openings do not tend to fill as quickly due to the drying of the ink around the edges of the opening. No moire pattern is created at any dot density thereby permitting the screen to be formed with smaller dot sizes, e.g., up to 600–800 dots per inch, depending on the availability of screens having this mesh number.

While the screen printing article and the methods for making the article described above constitutes the preferred embodiments of the invention, it is to be understood that the invention is not limited to this precise article and methods, and the changes may be made therein without departing from the scope of the invention.

What is claimed is:

1. A method of making a screen printing plate wherein each opening in said screen is centered between the fibers forming the screen, including the steps of

projecting an image through said screen onto a photographically sensitized layer, the fiber of said screen dividing said image into a plurality of dots on said layer;

developing said photographically sensitized layer;

coating said screen with a photosensitive emulsion; projecting light through said developed photographically sensitized layer onto said screen coated with emulsion;

removing said photographically sensitized layer; and

washing said emulsion to provide openings in said screen with each of said openings being centered between the fibers forming the screen.

2. The method of claim **1** wherein said photographically sensitized layer is a photographic film, the method including the steps of

adhering said film to said screen with an adhesive;

wherein the step of developing said photographically sensitized layer includes developing said film while it is adhered to said screen.

3. The method of claim **1** including the steps of coating said screen with a clear transparent emulsion, and coating one surface of said screen with a photographic emulsion prior to projecting said image through said screen;

wherein said step of developing said photographic sensitized layer includes developing said photographic emulsion while in place on said screen;

thereafter applying to said clear transparent emulsion a sensitizing compound to photosensitize said emulsion;

exposing said sensitized emulsion through said developed photographic emulsion; and

wherein the step of removing said photographically sensitized layer occurs simultaneously with the washing of said sensitized emulsion.

4. The method of claim **1** wherein said projected image is a negative image and wherein a positive is formed on said photographically sensitized layer.

5. A method of making a screen printing plate wherein each opening in the screen is centered between fibers forming the screen, including the steps of

attaching a photographic film to said screen;

projecting the image to be printed through said screen onto a photographic film, the fibers of said screen dividing said image into a plurality of dots on said film;

developing said photographic film while it remains attached to said screen;

coating said screen with a sensitized emulsion;

projecting light through said developed photographic film onto said emulsion; and

washing said emulsion to providing openings in said screen with each of said openings being centered between the fibers forming the screen.

6. The screen printing method of claim 5 wherein the size of each dot is a function of the intensity of the image at that location.

7. The method of claim 5, further including the step of separating said photographic film from said screen by a predetermined distance to control the formulation of the dots on said film when said image is projected through said screen.

8. The method of claim 5 further including the step of controlling the intensity of said image when projecting onto said photographic film to control the formation of dots on said film.

9. The method of making a screen printing plate wherein each opening in said screen is centered between the fibers forming the screen, including the steps of

coating said screen with a clear transparent emulsion;

coating one surface of said screen with a photographic emulsion;

projecting the image to be printed through said screen onto said photographic emulsion, the fibers of said screen dividing said image into a plurality of dots on said emulsion;

developing said photographic emulsion;

applying a photosensitizing substance to said clear emulsion to render it photosensitive;

directing light through said developed photographic emulsion onto said sensitized emulsion; and

washing said sensitized emulsion to provide openings in said screen with each of said openings centrally positioned between the fibers of the screen.

10. A method of making a screen printing plate wherein each opening in said screen is centered between the fibers forming the screen, including the steps of

projecting an image through said screen, onto a photographic film placed adjacent said screen, the fibers of said screen dividing said image into a plurality of dots on said film;

identifying the original relationship between said film and said screen;

removing said film, developing said film, and replacing said film in its original relation to said screen with the dots thus formed thereon aligned centrally between the fibers of said screen;

coating said screen with a photosensitive emulsion;

projecting light through said developed film onto said emulsion;

removing said film; and

washing said emulsion coated screen to provide openings in said screen with each of said openings being centered between the fibers forming the screen.

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