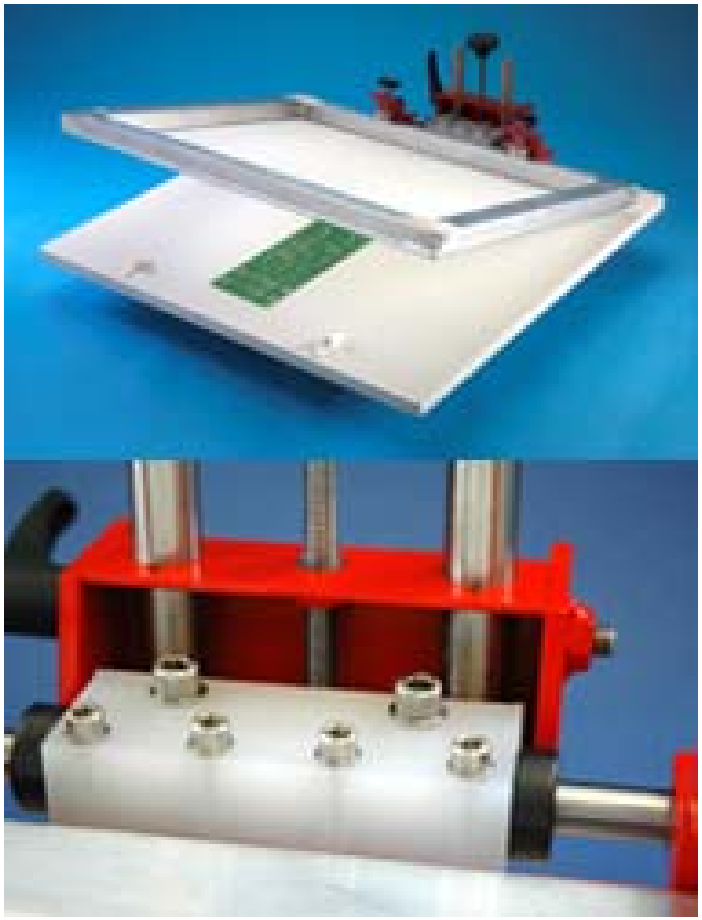
To Order Call: +44 (0) 1223 893900

MEGA ELECTRONIC LIMITED
Mega House, Grip Industrial Estate
Linton, Cambridge, England. CB21 4XN
Telephone: +44 (0) 1223 893900 Fax: +44 (0) 1223 893894
email: sales@megauk.com web: www.megauk.com

INTRODUCTION TO SCREEN PRINTING



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Introduction to Screen Printing

There are several different methods of printing and by far the most versatile is Screen Printing Suitable substrates (surfaces) for the process include plastics, paper, card, wood, textiles, ceramics, metals, leather, glass and many others. The process is not restricted to flat surfaces only Circular items such as plastic bottles and glassware can be screen printed on purpose made machines.

In this technological age precision screen printing has many varied applications and ink and material choices can become a process requiring engineering and chemical knowledge as well as skill in application techniques. Pressure sensitive lettering is screen printed with an edge quality that can be magnified 10 times without loss of definition along with the acid resist for electronic circuit boards (PCB's) where track width can be as little as 0.1mm (.004in) wide.

Basic printing, however, can be mastered with a little perseverance and application and the intention of the following notes is to enlighten the reader on the main elements involved.

The first essential is to generate a one to one positive of the exact image it is required to print. This should be in the form of a solid black image on clear or opaque light transmitting material such as tracing paper or plastic films purpose made for the process.

Various methods may be used and will be chosen dependent upon facilities available and the precision required.

Please note that this guide does not contain processing instructions for our Photo-Imageable solder-masks and idents. Separate instructions are available for these products.

HAND GENERATED ARTWORK

Using an artwork drafting film (Mega Parts: 100-027, 100-028) artwork of a reasonable detail can be produced at a 1:1 scale. The general layout should be first drawn on paper and then the artwork drafting film laid over. Detail can then be traced over using opaque Indian ink; Mega's Opaque Artwork Pens or rub down transfers such as the 'Seno' range

COMPUTER PRODUCED ARTWORK

Using CAD software and scanners is the most popular way of producing artworks. The design should consist of solid blacks with shading being avoided. The key to a good quality computer generated artwork is the out-put method used. Professional Image Setters or Photoplotters produce perfect artworks, but the hardware can be expensive (see Mega's Low Cost Raster Photoplotter). A popular method of printing artworks is therefore via Laser printers of InkJet printers. A high resolution out-put is chosen and a media such as Mega's LaserStar (for laser printers) or Premium JetStar (for inkjet printers) should be used.

Once the mesh is stretched the frame must be secured in such a way as to ensure that there will be no release of the desired tension. A very basic system for wooden frames is to use a staple gun but this has the disadvantage in that it will not retain high mesh tensions. Commercially, these days, both wood and metal frames have the mesh adhered using an adhesive and it is invariably a two pack compound which is painted on to the frame through the mesh.

Drying time is typically 10-15 minutes and because the bond is spread over a large area the mesh is less prone to tear.

The coarseness of the mesh is identified by the number of threads per centimetre of weft and warp and a typical general purpose mesh would be 90 t/cm which will produce excellent results with fine type style of, say, 6 pt using an indirect stencil.

The range of (meshes available can go from 6 t/cm to 183 t/cm but these are extremes and would not be found in general use. Textile printing generally requires a course mesh to provide heavy ink deposits | which tend to soak into the fabric to a much larger extent than if the substrate is non-porous. High mesh counts would normally be dictated if it is required to lay down a very light ink deposit such as very small and a fine lettering or 0.1mm thick lines etc. on a hard substrate.

INK TYPES AND SELECTIONS

There is a specialist ink type for almost every conceivable application, from those containing ground glass for ceramic and enamel work through fabric printing, glass, painted surfaces, plastics, paper, board and wood to etch resist coatings for PCB generation. In any specialist field, the printer must carry out his own research, starting with the manufacturers of the ink and their published data sheets. Generally, however, most users will be printing onto common materials and a number of options will be open, final choice being based on availability, cost, colour choice, etc. Printing onto paper and card presents few technical problems as the "user friendly" nature of such materials will accept many ink types without fear of adhesion problems etc.

Most inks will achieve a reliable bond in one of two ways, if you are printing onto fabric or the modestly absorbent surface of paper or card the ink will tend to penetrate the surface and "soak" into the material thus producing a mechanical key. If, however, printing onto non-absorbent surfaces such as epoxy powder coat finishes, stove enamel, glass or plastics it can be appreciated that a straight ink may well lift off such surfaces as there is little possibility of ink penetration and therefore any mechanical key. In the case of glass there is little possibility of incorporating an additive to the ink which will provide any form of etch effect to improve the key and a powerful bonding type ink will be selected which invariably means a 2 pack mixture. In the case of plastics and some paint finishes it is often possible to find an aggressive thinners which, if added to the ink will, until it evaporates, slightly dissolve the surface of the substrate and thus generate a powerful bonding interface.

MESH STRETCHING

The frame is typically made from wood or hollow section steel or aluminium tube with welded corners. It is essential that it is sufficiently strong to withstand the tension which will be applied when the mesh is stretched and fixed to the undersurface.

With regard to mesh types most applications will use either nylon or polyester. Nylon is monofilament thermoplastic fibre which is very flexible and durable and is ideal for printing onto irregular shaped objects. Generally it is used for direct stencils or those screens where emulsion is applied directly onto the mesh. Durability and long life are the benefits to be gained from using a nylon mesh in

Polyester is also a synthetic material but with greater stability than nylon which means that it will not tend to stretch or shrink and thus vary its tension and therefore image size as temperature, humidity and general moisture content in the mesh vary. This is particularly important when printing items such as PCB's or for colour work when the registration of the desired image must be a lot more precise than on a simple one colour logo etc. Both nylon and polyester should, ideally, be stretched when wet to the desired tension and secured to the frame by a suitable means. The mesh for small screens can be stretched or pre-tensioned using a bench top mesh stretcher where to tension is applied by using simple threaded hand-wheels and a simple jamming device secures the mesh in grippers which run the full width of the tensioning frame. Larger screens will require a considerable amount of mechanical forms and therefore a pneumatic system is normally employed.

INDIRECT STENCILS

Indirect stencils comprise of a clear carrier film on which is applied a UV sensitive (i.e. hardenable with the application of UV light) coat of. usually gelatinous based, emulsion (emulsion = water soluble). Such film is purchased in roll form and protected from premature exposure by being supplied and stored in a black light proof storage tube.

An example is Mega's Five Star Film.

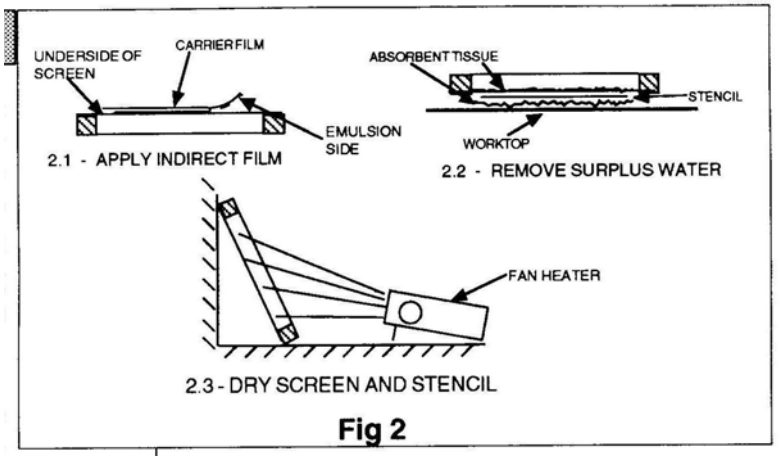


Fig 2

The emulsion side can be identified as the matt side and this will, finally, become the stencil through which the ink either flows or otherwise. If in doubt, the emulsion can be scraped and lifted with an art knife and this is worth doing to obtain the "feel" of the emulsion coat in its unhardened state.

To prepare a screen, first degrease and abrade the mesh using proprietary compounds and wash off with water ensuring that no residue remains and the mesh is thoroughly rinsed and dean. Put to one side in the wet state to await the stencil.

The stencil will now be exposed over the artwork in a UV exposure unit which results in the clear areas being hardened by UV light. The stencil becomes a negative of the original artwork. After exposure it is washed with warm water which, after an initial softening period of 1-2 minutes under the water wash, the unhardened areas will wash away to be completely clear down to the carrier film below.

Some indirect stencils may require 'fixing* in a peroxide based solution prior to washout. Note that the shiny side is the carrier film and the matt side is the UV sensitive coated side, apply the water spray to the coated side* (See Fig.1) The stencil can now be (aid onto the underside of the screen by placing the screen upside down and laying on the stencil, emulsion side down

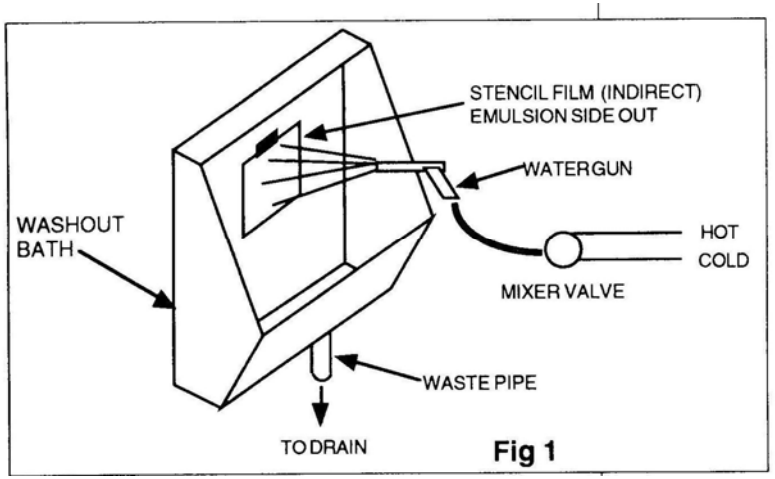


Fig 1

In the process of washing out unhardened areas of the stencil the hardened areas will also have been slightly dissolved by the water rendering the face that contacts the screen adopting a "slimy' and slightly "tacky* texture. In this state, the emulsion will embed into the mesh and once surplus water has been removed with absorbent paper and dried with a domestic fan heater, will key, or adhere to the screen. Ensure that the stencil does not "slide" on the screen during application as any contamination of clear areas by the softened emulsion will block the free passage of ink when printing and be almost impossible to remove once dry.

Once dry, a colour change in the emulsion will provide an indicator, the carrier film can be lifted at one corner and peeled away leaving the stencil firmly secured to the underside of the mesh and ready to be prepared for printing.

SCREEN RECOVERY

Once a particular stencil has served its purpose or useful life, it can be removed and the recovered screen reused. Indirect stencils are the easiest to strip and to soften the stencil a proprietary solution is available, although often a straight household bleach such as '"domestos" will suffice. The procedure is to apply the stripping solution, wait 5-10 minutes for it to react and simply wash off with a water spray. Indirect stencils can be more difficult and a high pressure water wash will save much elbow grease and if available may remove indirect stencils without need to apply a stripping solution. Once recovered there may be evidence of old ink stains which, if extensive, will reduce the performance of a recovered screen. These can be removed, again by the use of proprietary compounds, but be warned as such products tend to be very aggressive. Hand, eye and clothing protection should be worn. Before re-using the screen it should be thoroughly degreased to ensure reliable stencil adhesion. When applying these various compounds a washing-up type pan brush is used and it will be found that considerable effort should be put into the process to ensure that every part of the screen is treated thoroughly.

COLOUR SEPARATION

If it is required to print in more than one colour, separate stencils must be produced for each colour specified. Each colour must then be printed individually and generally allowed to dry before the next is printed. An exception is for fabric printing because of the absorbent nature of the substrate and on some occasions using water based inks the technique of printing wet on wet will allow the two inks to merge and produce a third colour.

For full colour printing as required for large sized poster displays, the original artwork is computer separated into small dots of four different colours in the same way as colour newspapers or magazines, but on a somewhat coarser scale. Four screens are then produced and the four colour print run carried out in much the same way. Registration is extremely critical for such work as the dot size is very small.

An alternative option for simple 2 or 3 colour work is to generate the appropriate number of stencils from the complete original artwork and blank out the relevant areas using screen filler. This ensures that registration within the image will always be correct as all screens were produced with the same artwork. It is also easier to envisage when blanking out than at the artwork generation stage.

PRINTING

Before actually pouring ink onto the stencil check that the necessary preparation has been done:-

- Unwanted areas of screen masked off.
- Register and register locations set correctly.
- Snap adjusted.
- Unwanted vacuum holes masked off.
- Frame lift stop adjusted. (Note:- too much lift and the ink runs to the back of the frame. Hand held squeegees also have a habit of falling from their resting place within the frame).
- A suitable squeegee has been selected.
- The ink has been selected and thoroughly mixed with up to 10 thinners if required.
- Working areas surrounding the printing bed are clear for receiving printed work.

Ink may then be poured onto the left hand side of the screen and with a work-piece in position the squeegee should be drawn firmly and at an angle of approximately 60° to the mesh, from left to right of front to back. Always pull towards the work location stops. (see Fig.8). Do not pull too quickly, a steady and smooth action is essential ensuring that downward pressure is even along the length of the squeegee and full contact is made between stencil and substrate over the whole image area. Generally, with the exception of fabric printing, a single pass is usual otherwise a "ghost" double print will be produced due to minor registration variations. With fabrics density of ink may be more important and two or three passes may be necessary. Immediately lift the frame and with light squeegee pressure, "flood" back the ink over the image area to provide a supply of ink for the next pass and also to prevent the small quantities of ink left in the mesh from drying out and blocking the image area prior to the next pass. This latter point is most important in respect of inks for plastic substrates which have highly volatile thinners which tend to evaporate or dry within minutes.

Remove the printed article to dry, load the next and proceed as before for the remainder of the print run.

SCREEN WASH-UP

Upon completion of printing, the unused ink may be returned to the tin using a round nosed spatula or plastic scraper. Surplus ink is then removed using rag or disposable paper towels and a suitable solvent or thinner. Concentrate on the top face of the screen first as this is where most ink will remain, once almost clean the masking can be removed and a final wash applied to both sides.

Do not apply water at any stage if the stencil is to be reused as it is water soluble and will be damaged beyond recovery.

Ink thinners can be straight Turpentine, used for oxidising inks, or a more volatile and aggressive solvent. In any event suitable safety protection should be worn for wash-up, comprising rubber gloves and if, applicable, eye protection.

DIRECT STENCILS

A direct stencil is so called because the emulsion is laid or coated directly onto the screen. It is supplied in liquid form with a sensitizer to activate the solution and make it respond to the UV light at the exposure stage. The insensitive emulsion is the consistency of a household enamel paint and the sensitizer is in liquid form, usually contained in a small separate bottle and may need to be mixed with water prior to mixing both components together thoroughly to produce an active and usable emulsion. Once mixed shelf life is. typically, limited to 6 months but its life will be extended if refrigerated.

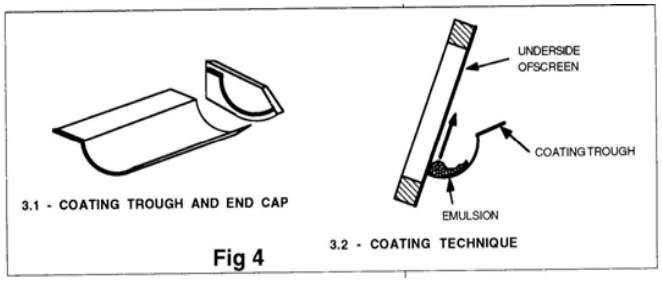
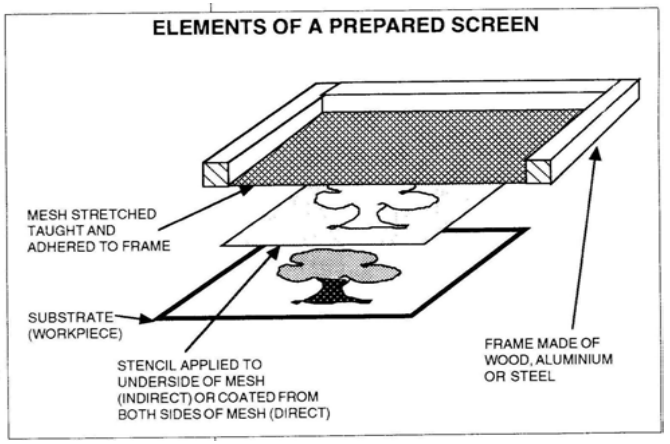


Fig 4



To prepare a screen, firstly degrease and dry the mesh. Mix ! the emulsion and sensitiser if not already mixed and allow air bubbles to disperse for 5 minutes. The coating is normally applied with a proprietary "coating trough* which is an extruded aluminum section which can be cut to the desired length and fitted with plastic end caps to contain the emulsion. (See Fig. 4)

The emulsion is usually applied as one coat to each side of the screen, wet on wet and an element of technique is necessary to obtain a uniform coat. Hold the trough against the mesh to start the coat and tilt to allow the ink to "flood" against the mesh. Draw upwards gently and with firm positive pressure

At the end of the coating adopt a side to side movement as the trough is rolled back to enable a clean lift off without depositing an undue thickness of emulsion.

Once coated, the emulsion should be dried with a fan heater in the same way as the indirect stencil. In both cases the drying should be carried out away from direct sunlight and preferably in subdued light or a shaded comer. Once dry, the indirect emulsion will become UV sensitive. If coated screens are not intended for immediate use, they should be stored in a light proof container or black plastic 'bin" bags and in a dark cupboard. The screen is now ready for exposure using a UV light source in the same way as an indirect stencil. Once exposed, wash out with warm water and the same principles apply, unhardened areas will wash away producing a negative stencil of the positive artwork.

The principals of stencil exposure are identical. Ultraviolet light (UV) is aimed at the stencil with the artwork between, and in close contact with. the stencil to prevent the possibility of "light creep" between stencil and artwork which will produce poorly defined edge quality.

MACHINE SET-UP PRIOR TO PRINTING

The prepared screen is mounted onto the lifting frame of the printing table. The substrate (or workpiece) is then positioned on the table and aligned in correct register with the screen. An easy way of establishing this register is to attach the original artwork in the desired position on the substrate and carefully match up the two images with the screen lowered in the printing position. A printing bed with fine register adjustment aids this setting, otherwise it must be done by careful manual adjustment of the substrate position on the table until the desired location is achieved. Once positioned, three registration stops should be stuck to the bed.

These stops can be 2-3 thicknesses of masking tape for paper and thin card substrates or, if printing thicker materials, heavier card or similar may be used to provide a more positive stop. (See Fig.7)

It is important to use only three stops, as more will cause possible inaccurate registration (a three legged stool will never rock, a four legged stool has two possible resting positions on an uneven floor -kinematic location principle).

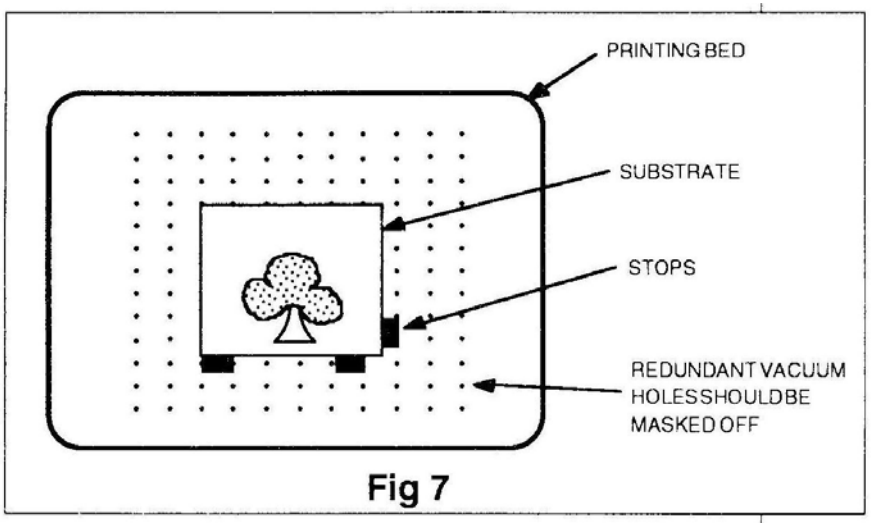


Fig 7

Light materials such as paper and light plastic (Vinyl) films will need a vacuum bed to hold them down during printing, otherwise they will lift with the screen as the ink is applied by the squeegee. Most printing tables have this facility and it is important to mask with tape or paper any holes in the vacuum bed which are outside the boundary of the substrate, otherwise valuable holding power will be lost. Heavier substrates such as PCB's. card and metal plates will not require the vacuum hold facility. If using the vacuum facility it will be noted that it is "on stream" only when the screen is lowered, when the screen is lifted the vacuum is shut off to allow release and easy removal of the printed substrate.

The gap between the screen and substrate is called the "snap" and should be set using the adjustable rear hinge pivots and the front adjustable stops to approximately 6mm (1/4in). This setting is important as during printing the mesh must lift clear of the substrate immediately the squeegee has passed, otherwise any slight movement of screen register will cause a smudge or imperfect printed image. (See Fig. 8.)

The principle of printing is that the squeegee forces the ink through the screen other than where blanked off by the stencil. For fine quality work the flexible rubber or plastic blade should have sharp comers to "cut off" the ink flood cleanly as it passes over the top surface of the mesh. When printing fabrics a heavy layer of ink is required because of the absorbent nature of the substrate and a round nosed squeegee is often used. Squeegee sharpeners are available and often comprise a long narrow sanding belt which is motor driven but for modest use are hardly worth the investment. A normal linisher can be used or careful sanding on a 180 grit wet and dry paper placed on a flat surface such as a sheet of glass. Squeegees may be purchased for any specified length, or a better option is to initially purchase, say, a 1.5M length and cut out several different lengths to suit specific jobs or screens.

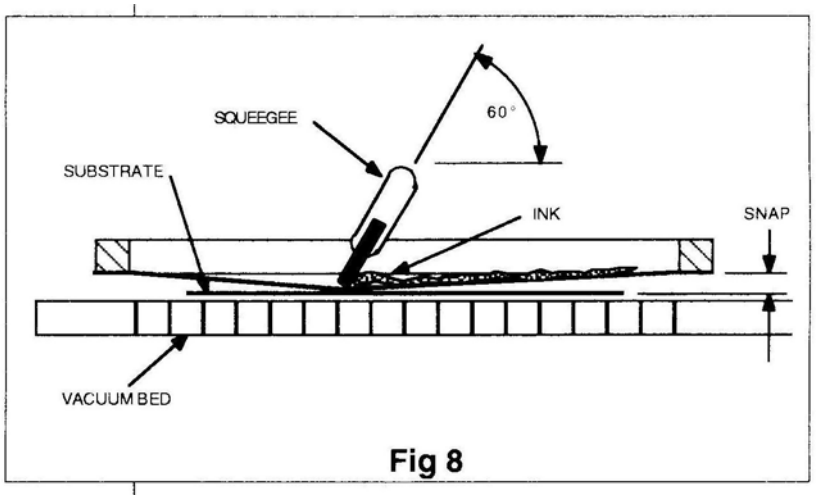


Fig 8