DECO 2003

Nashville, Tennessee.

SCREEN PRINTING INNOVATIONS FOR FLAT GLASS APPLICATIONS.

The screen printing process is a very simple but extremely versatile printing method.

Unlike other established printing systems it uses a stencil which is attached to or embedded in a mesh that is stretched over a printing frame.

In screen printing the ink or paste to be printed passes thru the mesh and stencil and its consistency or viscosity is not limited by any intermediate transfer via a printing plate or roller.

The thickness of the mesh and stencil together determines the actual printed ink deposit.
Small as well as very large areas, up to 6x18 feet or larger, can easily be printed with high definition and with controlled even thickness.

Since the ink is passed thru the stencil almost any ink or paste can be printed onto any type of flat material or surface.

Screen printing was early used for art reproduction and sign making where the heavy ink deposit resulted in vibrant colors and long lasting images on paper board, metal and glass panels and on fabrics.

The screen printing process is since long well established in the graphic market but it has also been adopted for industrial applications such as printed circuits and printing on glass. Printing on flat glass is used for various segments:

Automotive: Wind shields, back and side lites, sun roofs.

Gaming: Arcade games, one armed bandits, flipper games

Appliance: Stove tops, owen doors

Furniture: Mirrors, tables, doors.

Architectural: External decorative glazing of buildings.

Industrial: Touch panels, plasma displays, solar panels.

Although the printing process itself is simple, the screen printing lines themselves can be quite complex due to the degree of automation required for industrial production.

The need for fully automated production lines with one or more colors being printed in line puts a special focus on the screen printing machine with its relative time consuming set up and change over times. More about this problem later on.

"PRINTING OVER THE EDGE"

First I would like to focus on a problem which occurs when printing the black band or boarder on automotive glass such as windshields, back and side lites and sun roofs.

There is often the need to print the black band or obscuring print all the way out to the edge of the glass for design purposes.
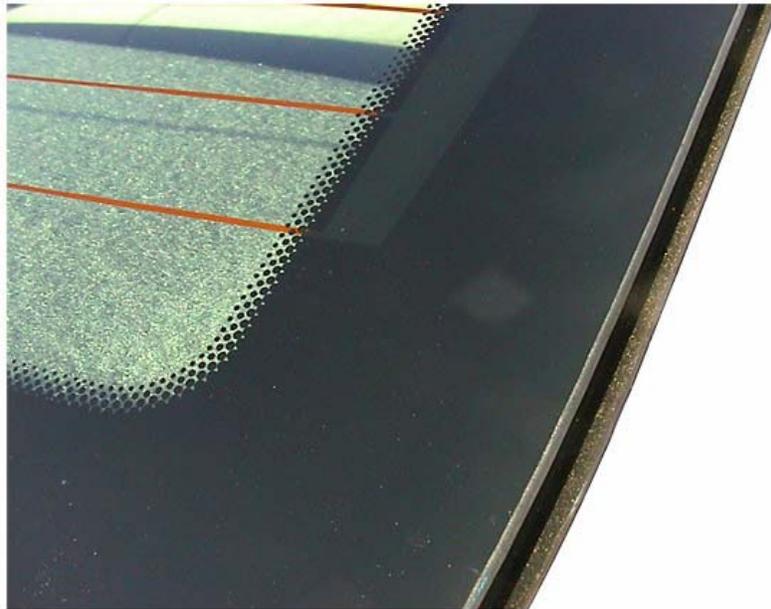
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This is normally not a problem since the printing machine can position the printed image and the glass with highest accuracy.

The problem is that the glass itself varies in size due to the previous cutting and edge grinding process with larger variations in the glass size than allowed for the printing accuracy.

To ensure that the black band is printed all the way to the glass edge, the stencil and printing image has to be made to fit the maximum glass size within its tolerance, which is ok.

The problem now occurs when printing on a glass with minimum size within its tolerance.

The result of this can be seen in this figure:

PRINTING OVER THE EDGE
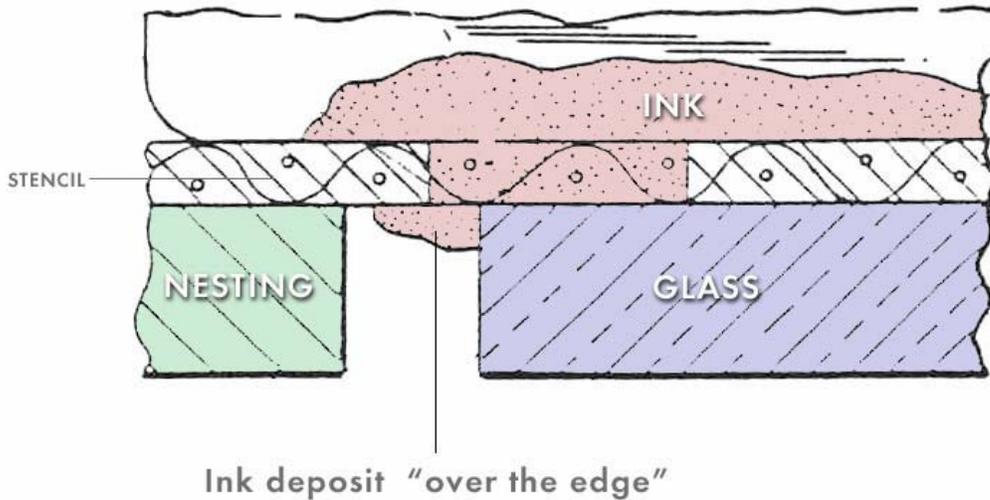PRINTING

WINDSHIELD

PRINTING FRAME

STENCIL
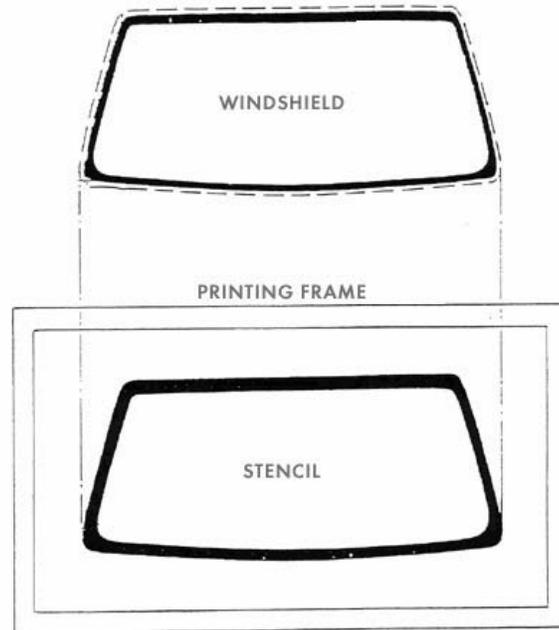
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The printing frame has an over sized print image compared to the glass.

This will allow the glass to be printed all the way to the edge but the print also extends "over the edge".

In this figure we can see what actually happens during the printing.

Ink deposit "over the edge"

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The ink will flow thru the open part of the stencil outside the glass periphery and after a couple of prints excessive amounts of ink will start to drop out of the stencil. The printing has to be halted and screen and stencil properly washed out and cleaned before printing can be resumed.

This is not only labor intensive but also time consuming which makes it unsuitable for high volume production.

However there are solutions for this problem, recently introduced in screen printing machines with printing "over the edge" capacities.

I will show you two innovations that can be employed.

AUTOMATIC CLEANING FROM UNDERSIDE OF THE SCREEN

The first solution is to use a special cleaning carriage which moves under the printing stencil and cleans the screen from residual ink around the border of the stencil.

In this figure we can see the design of the cleaning carriage and how it works.

PRINTING OVER THE EDGE
CLEANING

SCRAPER

VACUUM AREA

PAPER ROLL

PAPER ROLL
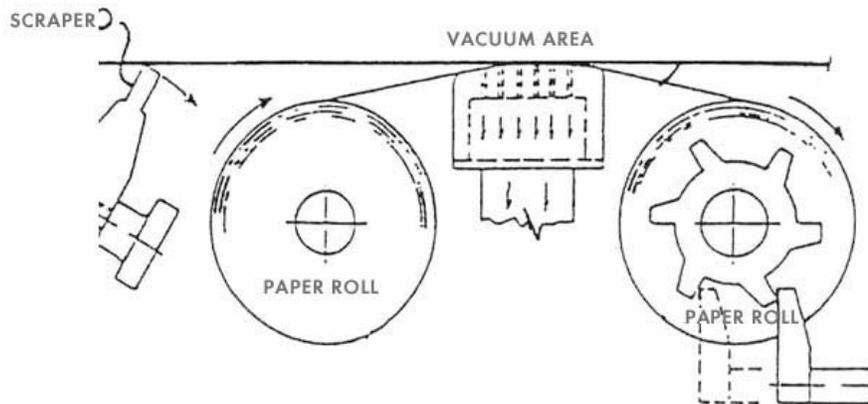
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The cleaning carriage works in two steps. First one pair of scrapers that scrapes off ink from the under side of the screen. Each of the scrapers engages for each direction of travel.

In between the scrapers there is a paper roll holder where a porous paper is passed over a vacuum chamber.

The ink still left in the stencil after the scraper is now effectively absorbed and removed by the vacuum and the wiping action of the paper.

The paper is advanced after each cycle so a new fresh portion of the paper is used for each pass.

This type of "over the edge printing" system with automatic cleaning gives good result but is very, very slow and it is not suitable where large runs and high productivity is needed.

AUTOMATIC CLEANING FROM ABOVE THE SCREEN.

The second innovation for printing "over the edge" is solving the problem from above instead form below.

In this figure we can see the system in detail.

PRINTING OVER THE EDGE
VACUUM

VACUUM NOZZLE

FLOOD COATER

STENCIL
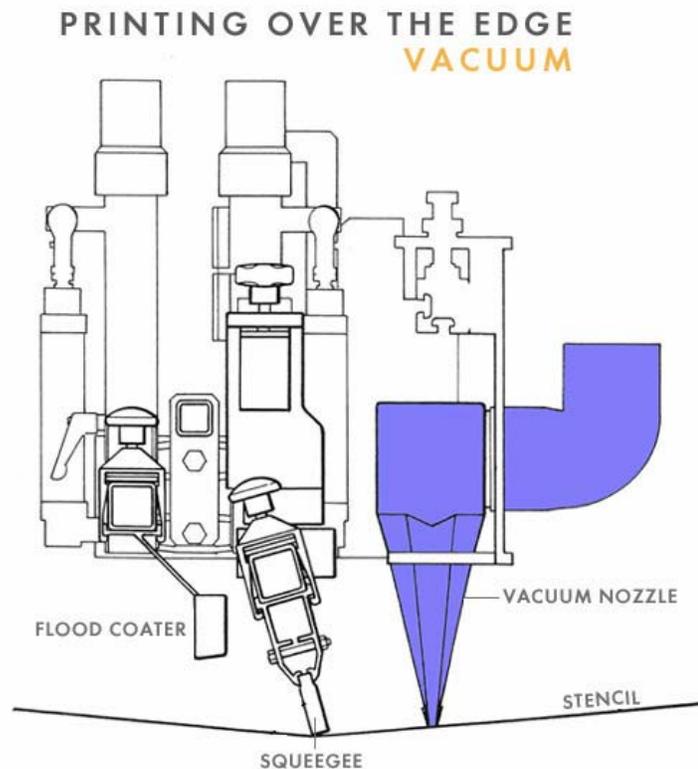
SQUEEGEE

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The operative part is a vacuum nozzle that stretches across the print area and it is attached to the squeegee carriage behind the squeegee.

As the squeegee prints the vacuum nozzle will effectively draw out and remove any excessive ink left in the stencil after printing.

This system is by its nature much faster and allows for printing "over the edge" with little time loss and can be used where high productivity is needed.
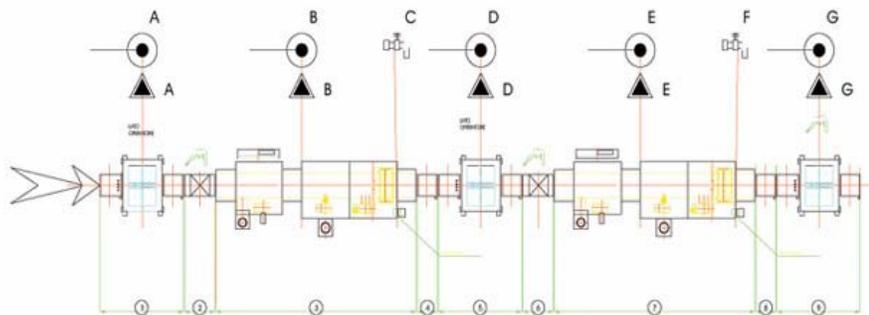
SCREEN ALIGNMENT IN AUTOMATIC PRINTING LINES

Automatic screen printing systems for in line production can be quite complex including printing stations, dryers, accumulators, conveying and synchronization stations, specially if two or more colors or images are printed after each other.

Here we can see one example of a 3-color printing line for appliances:

SCREEN ALIGNMENT - SETUP
APPLIANCE

| Pos.	N° Dis.	Denominazione	Dim.	Mat.	Q.tà
9		SCREEN PRINTER AG-HM 700X700			
8		SYNCROTRANSFER			
7		IR 2000-DRYER-CD			
6		TILTING ISPECTION STATION			
5		SCREEN PRINTER AG-HM 700X700			
4		SYNCROTRANSFER			
3		IR 2000-DRYER-CD			
2		TILTING ISPECTION STATION			
1		SCREEN PRINTER AG-HM 700X700			
POS.	Q.TA'	DESCRIZIONE	LUNGH.	MAT. UNI	CODICE DISEGNO

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And this is an example of a 2-color line for back lites for the automotive industry:

SCREEN ALIGNMENT - SETUP
AUTOMOTIVE GLASS PRINTING LINE

TRANSFER CONVEYOR			16
LIFTING CONVEYOR WITH REGISTRATION			15
TRANSFER CONVEYOR			14
TRANSFER CONVEYOR			13
TRANSFER CONVEYOR			12
50 PART TRANSFER			11
90°TRANSFER			10
SYNCROTRANSFER			9
I.R. DRYER 1200			8
SYNCROTRANSFER			7
SCREEN PRINTER AG-SEL			6
SYNCROTRANSFER			5
I.R. DRYER 1200 WITH CHILLER			4
TILTING ISPECTION STATION			3
SCREEN PRINTER AG-SEL			2
SYNCROTRANSFER			1
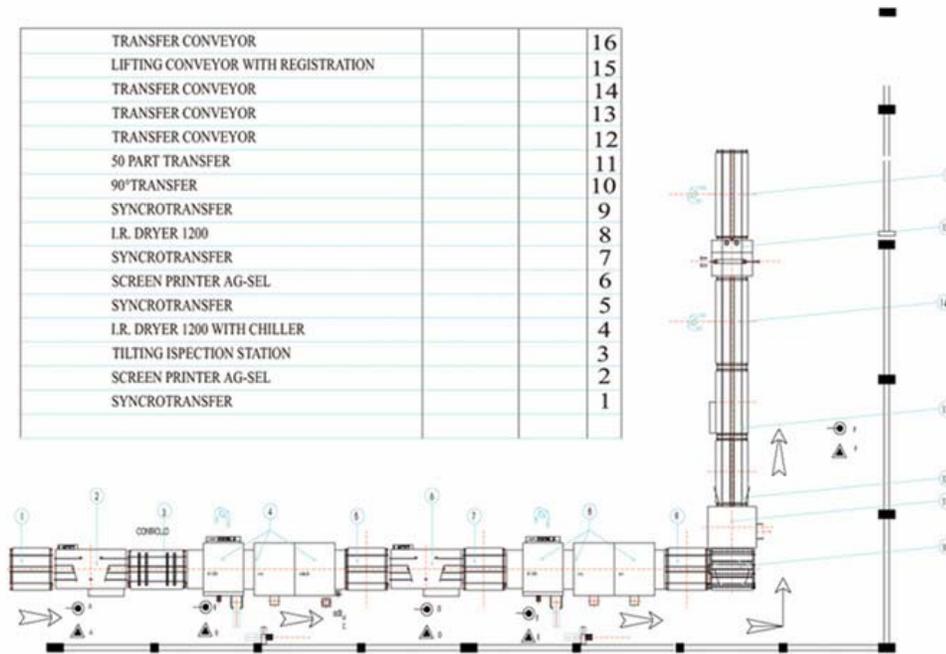
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One of the biggest problems in these lines is the set up and change over times needed for the screen printing presses.

Screen alignment is the most time consuming operation when setting up the machine for a new printing job.

Not only valuable production time is lost due to the long set up times but there is also a substantial loss of material and ink during test printing before a good and accepted print result has been achieved.

SCREEN ALIGNMENT.

The precise alignment of the screen image in precise register with the glass to be printed is far more difficult than the actual glass registration in the printing press.

There are several reasons for this.

Size of the screen:

The very large size of the printing frame itself makes it difficult to handle and align.

Frame sizes of 70"x 120" are common in printing of automotive glass and really large frames are used for printing of architectural glass with printing sizes of up to 10 x 13 feet and where the printing frames with a length of 16 feet or larger are used.

Frame profile and screen tension:
 To keep the weight of the printing frames as low as possible to facilitate handling, there is often a compromise between screen rigidity and handling capability.

If a frame profile is not rigid enough it can easily be out of square which can distort the image of the stencil to such extent that precise alignment is not at all possible.

Position of the stencil image in the frame:
The stencil making process is often outsourced or carried out in another pre-press department where the need and importance of precise positioning of the stencil image in relation to the frame is not realized or understood.

This can result in time consuming major adjustment of the frame holding system in the printing machine to finally get an acceptable alignment of the print with the glass.

ALIGNMENT WITH MASTER FOIL FRAME.

A very simple and effective system to facilitate the screen alignment is the use of a master frame with a transparent foil.

It is preferably used on small to medium sized semi automatic printing machines.

The printing table is made of two parts, one support table and one print table on top.

The print table can be adjusted in x, y and z direction on top of the support table by fine adjustment knobs.

The support table has register pins for locating of the foil frame.

The registration and alignment is made in 3 steps:

1. **The glass to be printed is placed in its nesting position on the print table and the foil frame is positioned over the glass and locked to the register pins from the support table.**
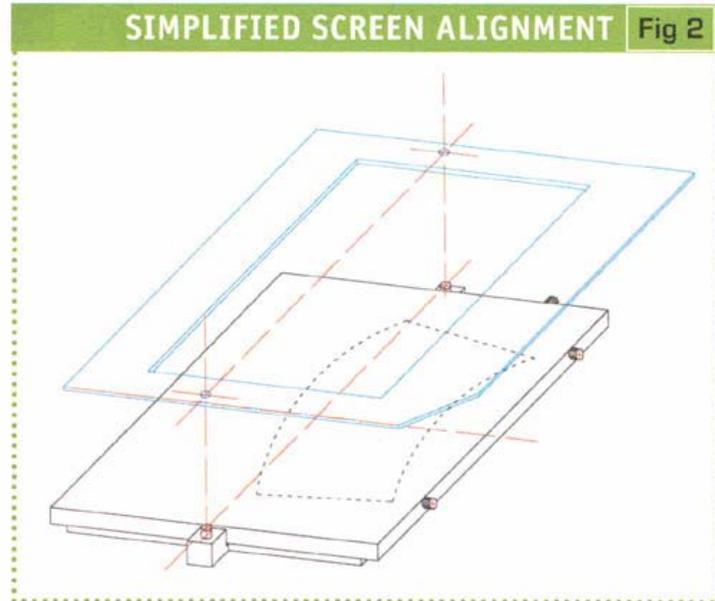
SCREEN ALIGNMENT - SETUP
TRANSPARENT FOIL FRAME

SIMPLIFIED SCREEN ALIGNMENT   Fig 1

STEP 1

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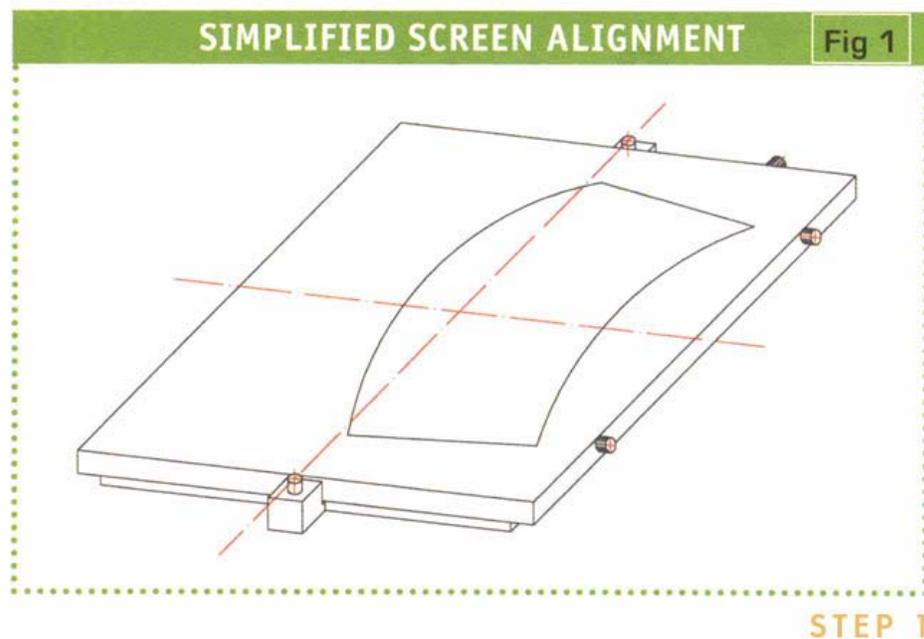
2. Move the table into print position and make a print.

SCREEN ALIGNMENT - SETUP
TRANSPARENT FOIL FRAME

SIMPLIFIED SCREEN ALIGNMENT | Fig 2

STEP 2

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3. Return the print table. A printed image is now on the transparent foil with exact location and size. Adjust the print table with the adjustment knobs so that the glass aligns with the printed image. Clean off the transparent foil for next set up.

SIMPLIFIED SCREEN ALIGNMENT | Fig 3

STEP 3

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4.
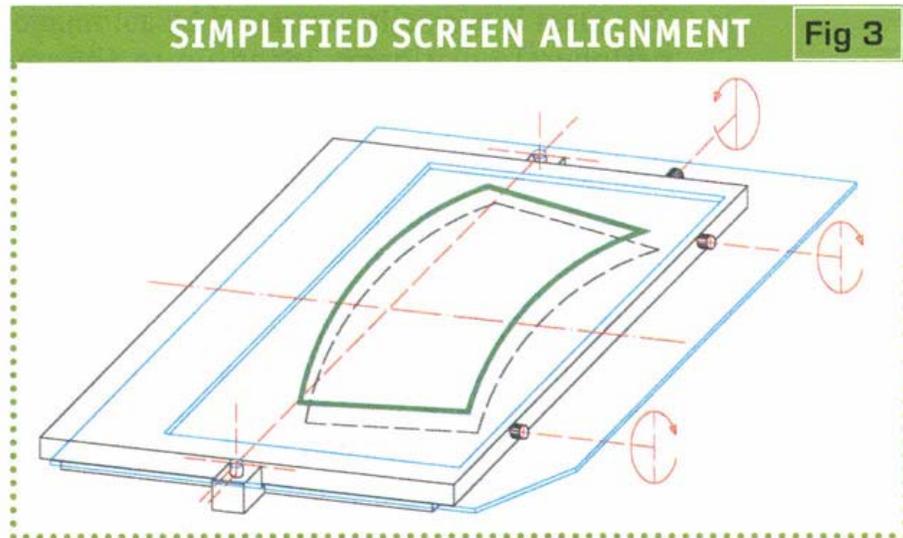
This is a quite simple way of alignment but it is unfortunately restricted to relative small printing sizes and can not be used for automatic in-line machines.

CCD CAMERA ALIGNMENT.

This system referrers to a printing machine with automatic locators of the glass in the printing table. Vertical positioning rollers move in from all sides to register the glass. The positioning rollers can be adjusted to the actual glass shape and size, either manually or automatic thru coordinates to the servo motors.

SCREEN ALIGNMENT - SETUP
SCREEN PRINTING MACHINE
WITH CCD CAMERA ALIGNMENT

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The vertical positioning rollers are mounted on a small shuttle together with a CCD camera pointing upward. There are three monitors, one for each camera.

SCREEN ALIGNMENT - SETUP
ALIGNMENT CAMERAS

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The camera lens has an engraved circle with the same diameter as the positioning roller. The shuttle can move the exact distance so that the camera can take the position of the roller and vice versa.

SCREEN ALIGNMENT - SETUP
CCD CAMERA WITH MONITORS

Camera

Register Stop

CCD Camera
with lens

Shuttle Movment
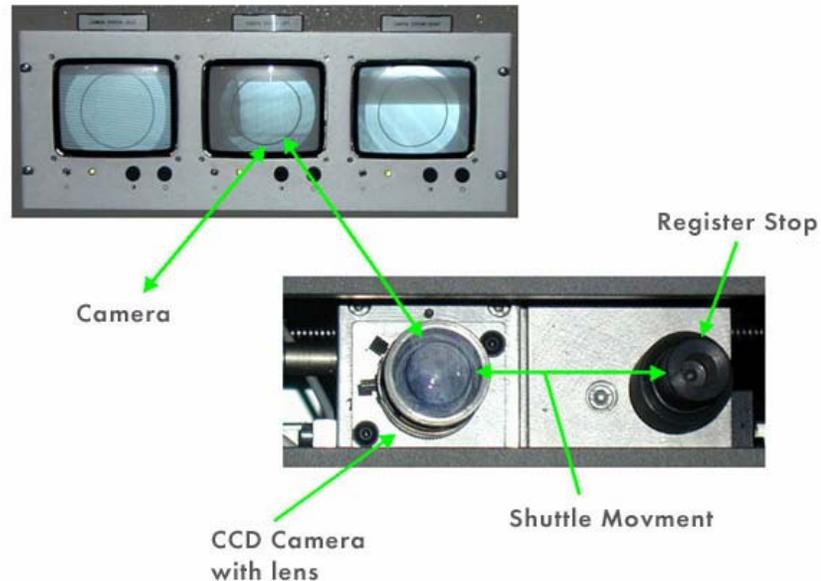
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There are three "register shuttles" with CCD cameras, two along the longest side of the glass and one on the short side. The opposite sides have only the vertical positioning rollers.
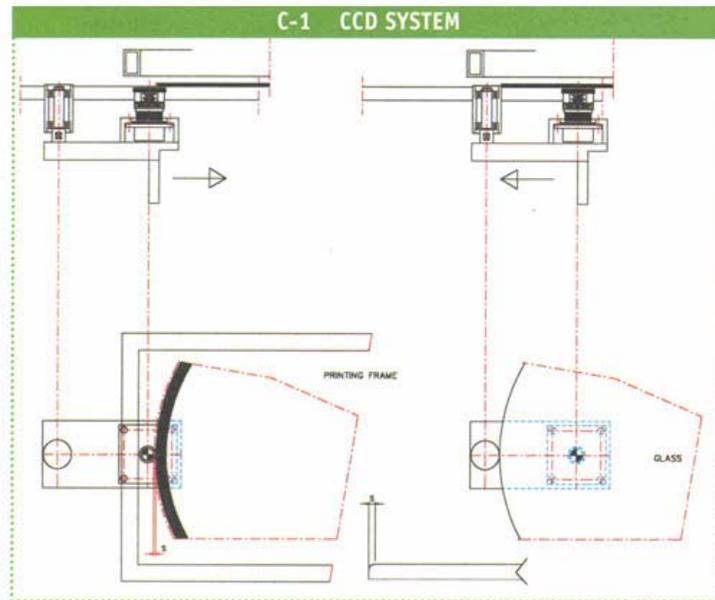
The set up is very fast, easy and accurate:

Mount the printing frame with its stencil in the printing machine.

Switch on the register camera shuttles to set up mode.

Each shuttle with its CCD camera now moves the camera to take the position instead of the positioning roller.

SCREEN ALIGNMENT - SETUP
CAMERA SHUTTLE REGISTER

Move each camera until the edge of the stencil in the screen becomes visible and adjust the position so that the circle "touches" the outer edge of the stencil image.
If the glass has rounded edges or if the print should be at a certain distance from the edge make corresponding offset adjustment of the camera position.

When all three CCD cameras have been aligned with the stencil image, switch over from set up to registration mode. The shuttles will now move the exact distance so that the positioning rollers switch places with the CCD cameras.

Screen alignment is finished. The operator can at any time during production switch over to set up mode for checking of screen position or make fine adjustments to the alignment.

The described system reduces the set up and alignment time to five to seven minutes, the advantage being that the screen alignment is carried out in direct relation to the stencil image without any need for registration marks, off line fixtures or any high demands for stencil positioning in the printing frame.

This is a smart innovation using modern, affordable technology to solve the time robbing problem of material registration and alignment and results in drastically shortened set up times, is easy to use and gives overall improvement in both printing quality and productivity.

Thank you for your attention.

Sylve J.D. Ericsson
Member of the Academy of Screen Printing Technology