Dye Transfer Materials

James Browning

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By James Browning

This paper outlines how to make all materials necessary to make a Dye Transfer, or Dye Imbibition print. This printing process was developed in the 1930s and later marketed by the Eastman Kodak Company. The materials were available until 1993, when Kodak discontinued manufacturing them. I realized that in order to continue making dye prints, I would have to make the basic materials myself. From 1995 through 1998, I developed the formulations, and digital techniques to produce fine dye prints. I am passing this information into the public domain as an effort to ensure the continued existence of this wonderful process.

Dye Transfer works by creating a relief image in gelatin. The thickness of the gelatin on the matrix is proportional to the amount of exposure the area receives. This is accomplished by exposing the matrix through the base. A yellow dye is incorporated in the emulsion, which absorbs the blue light to which the film is sensitive. The exposure proceeds to a greater depth into the emulsion with greater exposure. The film is developed in a pyro tanning developer that cross-links the polymers of the gelatin in exposed areas, and 'hardens' it, or makes it insoluble in water. The film is then washed in very hot water, and the unexposed gelatin washes off. The matrices are then soaked in dye baths, and the dyes migrate into the gelatin relief image on the matrix. The matrix is rinsed, and then rolled into contact with the receiver sheet. The dye transfers from the matrix to the receiver. This is repeated three times. Cyan, Magenta, and Yellow transfers create a print, with a very strong and neutral black D-Max, and a D-Min (highlight) at the paper white. Many controls can be applied during the transfer process by varying the chemistry of the solutions - color balance and contrast are fine-tuned at this time. You can even paint dye onto the matrix (mat) by hand, and transfer again to beef up the color in a specific area. The prints are easily bleached, and retouched - an important aspect of a dye print.

James Browning is an software engineer by training. Since 1990 he has been engaged as a professional color printer and a consultant in the digital color printing equipment field. After leaving Silicon Valley in 1990, he came back to his native New Hampshire to start Digital Mask, a high end digital printing lab. He built a high quality laser based scanner / film recorder, which he used to correct transparencies for printing onto Cibachrome. After this, he used the laser recorder to record on color negative materials, for printing onto type C papers. Now, he prints directly to type C papers using a Chromira digital paper writer. He was a consultant at ZBE Inc, working on the Chromira. He developed many aspects of the new technology, as well as much of the calibration software. During this time, he developed the matrix film emulsion, dye formulations, coating techniques, and digital techniques for creating laser separations for the new Dye Transfer process. Jim makes Dye Transfer prints of his own work as well as for others.

Emulsion Mixing Apparatus

The emulsion is formed from two parts, by slowly adding a silver nitrate solution into a potassium bromide solution. The rate of addition must be controlled, as well as the temperature. A means for stirring the solution is provided by a paddle stirrer. A burette is suspended over the reaction vessel on a rigid framework. The vessel is placed on a hot plate, whose temperature is controlled by a temperature controller. The emulsion is filtered using a vacuum filtering apparatus.

Description	Mfr.	Ref. Number	Qty
Lab Frame 2	VWR	60075-009	1
Swivel Clamp	VWR	21571-305	1
6” Rod	VWR	60079-348	1
Rod Connector	VWR	60079-010	2
Burette 1000ml	VWR	17475-308	1
SS. Beaker 6 qt.	VWR	13975-105	1
SS. Beaker 4 qt.	VWR	13975-080	1
SS. Beaker 1 ¼ qt.	VWR	13975-025	8
SS. Beaker Cover	VWR	13975-026	8
SS. Beaker Cover	VWR	13975-081	1
SS. Beaker Cover	VWR	13975-106	1
Stirrer Model 102	VWR	58950-286	1
Paddle 12”	VWR	58950-738	1
Hot Plate Cimarec 2	VWR	33921-889	1
Filter Paper 40 um	VWR	28313-068	10
Filter Paper 5 um	VWR	28310-081	5
Filter Flask 4L	VWR	29415-165	1
Buchner Funnel	VWR	30305-109	1

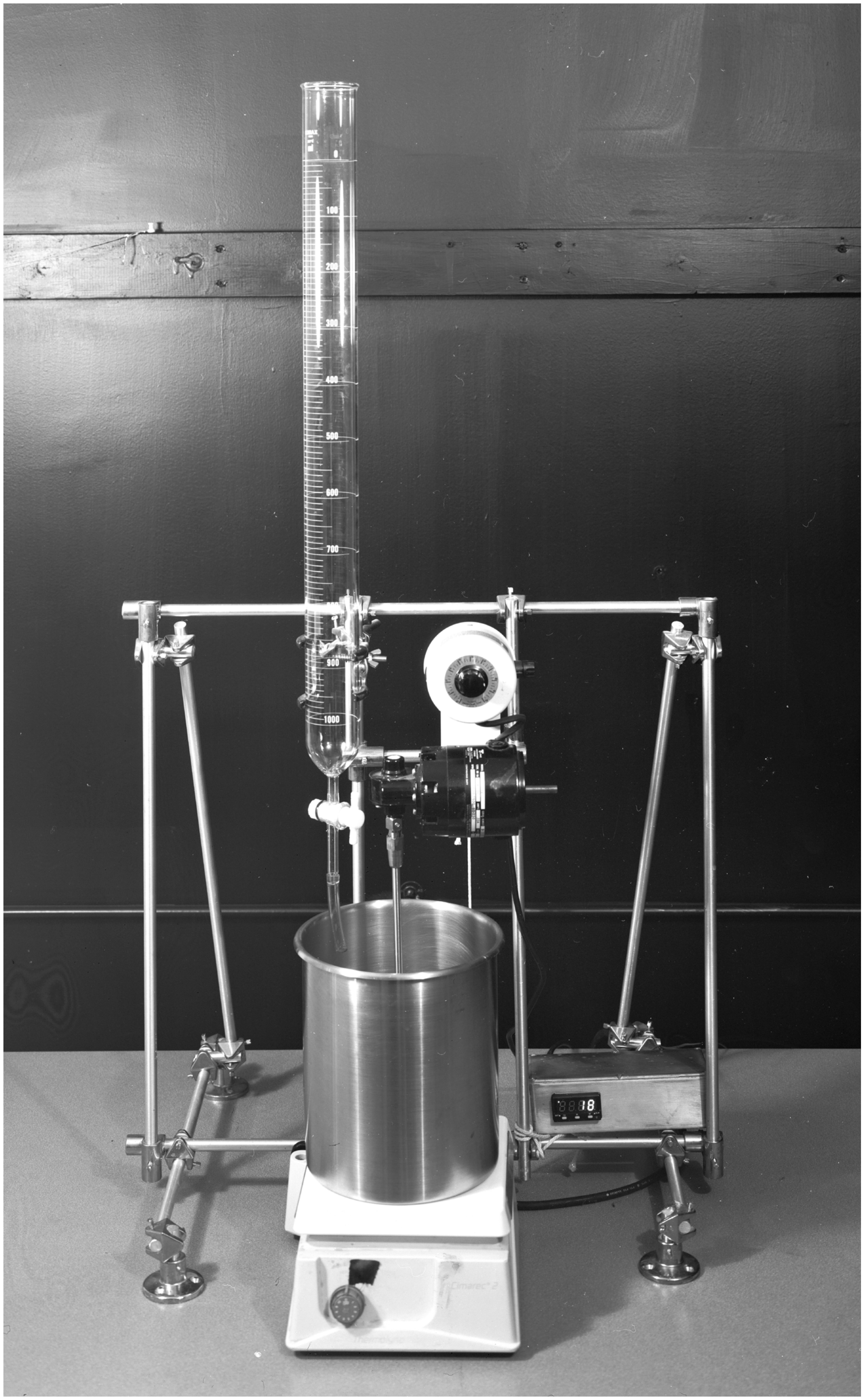
In addition, you will need a vacuum pump for filtering, as well as holding the film when coating. You will need to provide a trap before the pump to catch any water, etc. Use the following:

Filtering Flask 1L	VWR	29417-047	1

Flasks should be fitted with cork stoppers, which are drilled to the correct hole size, and coated with Silicone caulking to stop air leaks.

You will need an accurate temperature controller. I recommend the following (with additional components listed) Wire components as shown in controller manual. Program the PID Loop with the following parameters: Input Sensor: Type K Thermocouple, ASP1 dwell time: 10, Ramp Rate: 0.0, Offset: 2.7, Shift Process Value: 0, Proportional Band: 11, Integral Time: 0. The controller has Fuzzy Logic, which will fine tune the parameters for you. The controller will hold to within 1°C.

Acculex Temp-1000	Acculex	Temp10-10(SSR output)	1
Gentron SS Relay	Allied	SSR600240R55	1
Fuse Holder	Allied	798-0558	1
Fuse 3A Slow Blow	Allied	845-4059	1
Thermocouple Type K	Allied	544-0130	1
Bud Econobox	Allied	736-3604	1
Line Filter	Allied	851-0472	1



Emulsion Mixing Apparatus

Matrix Film Formulation

(updated 8/15/2020)

I developed the following matrix film with the generous help of Rae Adams. This is a conventional Iodobromide emulsion, which has been adjusted for a straight curve on the final print. It has been proven to work using conventional darkroom techniques as well as in a calibrated hybrid workflow using calibrated seps. Direct laser exposure of this film may require finishing additions to minimize reciprocity effects. The following is the version of this emulsion which was run at Fotokemika and sold as Efke Matrix Film.

Making the emulsion requires a system for heating a five-liter container (Stainless), and maintaining the temperature accurately. A burette suspended over the container is used to slowly drip solution B into solution A over long periods of time. A paddle stirrer is also mounted over the reaction vessel, and run at slow speed.

The following formulation (Trial # 20) is for four Liters of emulsion:

Solution A:

Potassium Bromide	168 g
Potassium Iodide (5% solution)	62.4 ml
Inert Gelatin	160 g
Distilled Water	3500 ml

Solution B:

Silver Nitrate	160 g
Distilled Water	500ml

Solution C: (for 500 ml of emulsion)

Sodium Thiosulfate (0.1% solution)	1 ml
Gelatin	30 g
(Gelatin added directly to the heated emulsion)	

Solution D: (for 500 ml of emulsion)

Potassium Bromide (1% solution)	10 ml
Manganous Sulfate (1% solution)	10 ml
7-Hydroxy-5-Methyl-1, 3,4-triazaindolizine (1 % solution pH 7.2)	7.5 ml
Acid Yellow Dye # 23 (Tartrazene)	1.5 g
Triton X-200 (1% by volume)	3 ml
Sorbitol	3.75 g

Note: Adj. pH of triazaindolizine solution to 7.20 by adding Sodium Hydroxide.

Solution E: (for 500 ml of emulsion)

1-Phenyl-5-Mercapto Tetrazol 0.1% in Ethanol	4 ml
Sodium Azide 6.5% water solution	20 ml

- ***Emulsification / Physical Ripening***

Add B (at 55° C) to A (at 55° C). Use a burette over a heated beaker holding solution A at 55° C. Stir the solution using a paddle mixer. (Approx. 200 rpm). Temperature must be controlled to 1° C using a temperature controller and hot plate.

Addition as follows:

Add 10 ml of B to A in 5 seconds.
Wait 1 minute
Add 245 ml of B to A over 4 minutes.
Wait 10 minutes
Add 245 ml of B to A over 5 minutes.

Ripen additional 15 minutes

Immediately chill the emulsion using an ice bath. Chill until the emulsion is very solid, whack the side of the container, there should be a distinct 'jiggle' feeling.

- ***Washing***

Cut the emulsion into 'noodles' 1/4" crossection. Wash using cold distilled water for 4 hours. Change water frequently. Keep the emulsion cold until ready to proceed with the finishing steps.

The following steps prepare 500 ml of emulsion for coating one sheet.

Note: To prepare a batch of film having matched speed, do the following steps on the full quantity needed. Multiply the quantities by as many sheets as you are going to coat. Sensitize the emulsion, and add the final prep. Filter the entire batch in two stages, first with 40 um filter paper, followed by 5 um filter paper. Use a vacuum filtration system. Pour the emulsion into 1L stainless containers with lids, 500 ml per container. Refrigerate until fully gelled. Remelt the emulsion in one of these containers, and immediately coat. Use the same procedure for each coating.

- ***Sensitization***

Remelt the emulsion, heat to 55° C. Add the 30-g gelatin to the mix, and stir until fully dissolved. Add Solution C, mix thoroughly. Stir for 70 minutes while maintaining temp at 55° C. Control temp to 1° C. Cover the emulsion with aluminum foil while stirring to prevent fogging from the safelight.

- ***Final Prep***

Add solution D, mix. Add solution E, mix. The Tartrazene dye is used to absorb blue light to cause the depth penetration exposure effect and to minimize scattering. The Triazaindolizine is a stabilizer, and is available in bulk from Allied Signal Corp. 937-455-3005. A wetting agent Triton X-200 is added to promote even coating. Triton X-200 is an an-ionic surfactant. The Sorbitol is a plasticizer used to minimize reticulation, drying marks, and minimize curl. Mix a full batch of emulsion, and pour into separate containers. Solution E contains PMT - a stabilizer which minimizes fogging in long term storage, and the Sodium Azide acts to preserve the emulsion when stored. Store chilled. Note, Sodium Azide was used by Fotokemika. It is hazardous, you may want to substitute Thymol as a preservative.

- ***Coating***

Coat sufficient emulsion to obtain at least a 7um (dry) thickness. You optionally can coat an unhardened gelatin overcoat. An overcoat may slow down surface fogging and protect from abrasion, but I have not found it necessary in practice.

- **Setting**

Set at 50° F for 10 minutes to gel emulsion.

- **Drying**

Dry in a dust free enclosure for 12 hours at room temperature.

Use care when making the emulsion. Completely scrub the mixing vessel, beakers, stirring paddle, stirring rods, etc. Use soap, and an abrasive scrubber. Rinse thoroughly, final rinse with distilled water. Filter the emulsion with 5um filter paper using a vacuum filter before coating. A filter must be installed in the coater, placed in a position before the emulsion passes through the slot. Thoroughly clean all mixing vessels and other utensils as you go, and carefully clean the coater after a coating run to prevent buildup of gelatin, which would re-melt into subsequent emulsions. The coater must be rinsed with hot water between uses. All coating is best carried out using the light of a sodium safelight, which provides adequate light for working for long periods of time.

It is helpful to construct a ‘noodler’ which is used to cut the emulsion into long strips of ¼” crossection prior to washing. I used half of a Besler 4x5 negative carrier. I drilled holes along the opening perimeter, and threaded fishing line in both directions to form a grid. I force the emulsion through this grid into a container.

About Gelatins:

The gelatin greatly affects the sensitization of the emulsion. In the past, less refined gelatins, which contained sulfur compounds were used. These are termed ‘fast’ gelatins, and they sensitize the emulsion without the need to add a sulfur sensitizer. The problem with this is that each batch of gelatin will have a different effect. In modern emulsions, a highly refined inert gelatin is used. This allows a controlled sensitization by addition of sulfur and gold compounds to the mix. I find that the lot controlled Kind and Knox photographic gelatins work very well. They harden well in the tanning developer, withstand vigorous wash-off, have low fog characteristics, and absorb and transfer the dyes readily. Use of other gelatins will probably yield very different results! I use a low viscosity gelatin, the Kind and Knox T8042 Bloom 267, Viscosity 41.8. This gelatin coats well at the concentration specified.

Dye Formulation

The following dye formulations will replace the Kodak dyes fairly accurately. The dyes have been tested for fade, and perform very well.

Mix a 28% solution of Acetic Acid for pH adjustment.
Mix a 28% solution of Triethanolamine for pH adjustment.

- Add the specified amount of dye in 500 ml of distilled water. Heat to near boil while stirring until dye is dissolved. Add 1.3 L of distilled water to bring volume to 1.8 liters.
- Add 1 ml of Formalin 10% to protect the dye from biological growth
- Add 0.5 grams EDTA.
- Adjust pH of the solutions by first adding 10 ml of undiluted Triethanolamine to the dye solution. Add 10 ml of undiluted Glacial Acetic Acid. Titrate the solution to the proper pH using the 28% solutions. Add acid to lower pH, add trieth. To raise pH.
- Top off with distilled water to bring total quantity to two liters.
- Filter.

	Acid Blue 45	*Acid Red 80*	*Acid Yellow 11*	
Dye pH:	4.17	4.67	4.33	*pH*
Dye Concentration:	2.4	3.0	5.0	*g / 2L*

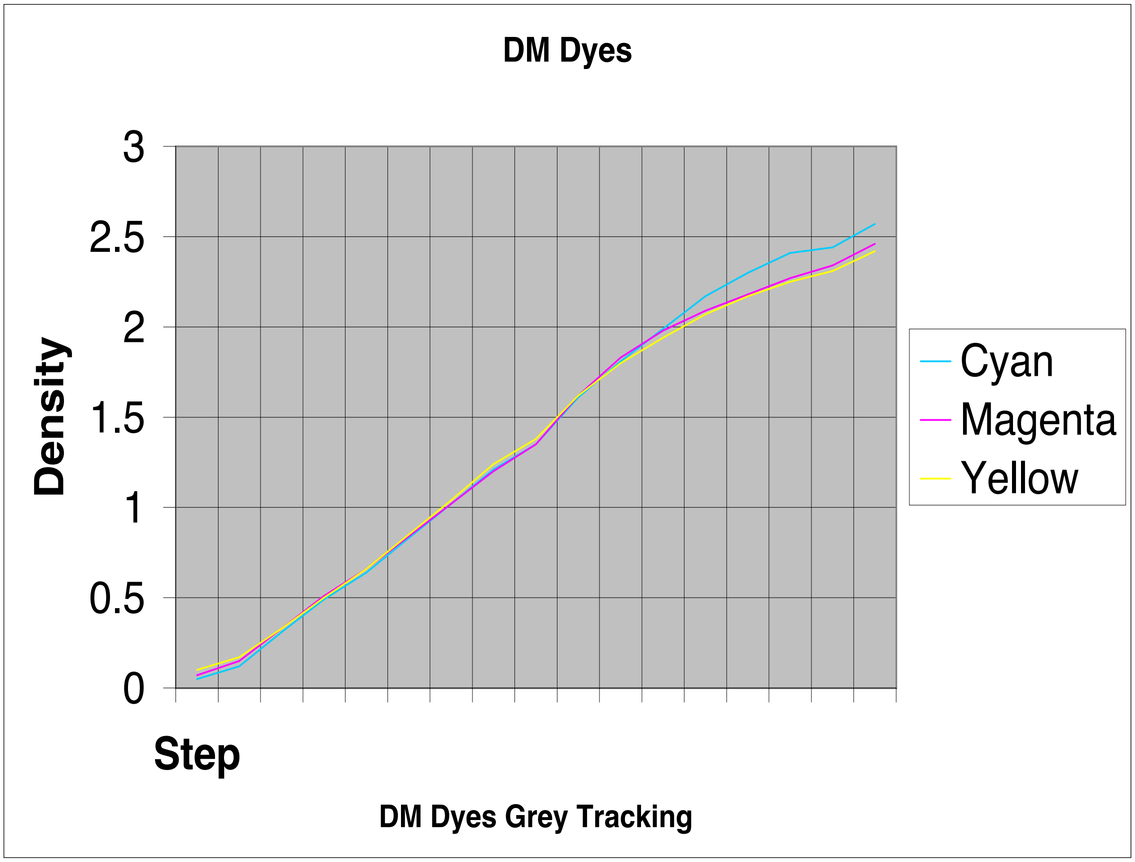
Notes:

Since there is no toe-cutter added to the magenta, you will need to use Highlight reducer in the first rinse to color balance the highlights. Try using no HL reducer for the Cyan and Yellow transfers, and for the magenta transfer use 12 ml 1% Sodium Hexametaphosphate added to 1 liter of rinse for one minute. This acts as a toe-cutter. You may also add the HL reducer directly to the dye bath. Try adding 50 ml of 1% solution of Sodium Hexametaphosphate added to 1950 ml of dye solution.

An alternate cyan dye is Acid Blue 25. This dye is bluer than the Blue 45 and transfers more slowly. It is more light fast than the Blue 45. A less stable magenta and yellow, which will produce the brightest color, are Acid Red 289, and Acid Yellow 23. These dyes will produce brighter images, at the expense of light-fastness.

Check the pH of the dyes frequently, and adjust as necessary. Make sure you calibrate your pH meter before taking a reading, and use fresh buffer solutions. Allow plenty of time for readings to stabilize, particularly with the cyan dye. Filter the dyes frequently to remove particulate matter.

Replenish the dyes with a solution consisting of the same formulation, but at four times the concentration; mix the replenisher solution to 500 ml total. The replenisher should be adjusted to the correct pH. You will have to experiment to determine the proper replenishment rate. A good starting point would be to add five times the amount Kodak recommends, this replenisher is five times less concentrated than the Kodak dye concentrates.



1	0.05	0.07	0.1
2	0.12	0.15	0.17
3	0.31	0.33	0.33
4	0.49	0.51	0.5
5	0.64	0.66	0.66
6	0.83	0.84	0.85
7	1.02	1.02	1.04
8	1.21	1.2	1.24
9	1.35	1.35	1.38
10	1.61	1.62	1.62
11	1.81	1.83	1.8
12	1.99	1.98	1.94
13	2.17	2.09	2.07
14	2.3	2.18	2.17
15	2.41	2.27	2.25
16	2.44	2.34	2.31
17	2.57	2.46	2.42

Developing the Matrix Film, and Making a Print

Expose the film through the base (Emulsion down), and develop in the following tanning developer:

Matrix Film Tanning Developer

Solution A:

Benzoatriazole	5.0 g
Oxalic Acid	40.0 g
Metol	140.0 g
Pyrogallic Acid	150.0 g
Water to make:	20 L

Solution B:

10 lbs. Sodium Carbonate Monohydrate dissolved in 20L of 120° F water.

Mix 1 part A to 2 Parts B for normal contrast. Develop for 3 minutes @ 68° F. Rinse film in 68° water for 30 sec, and fix in a non-hardening fixer for 3-min. Rinse in 68° F water for one minute. Wash off unhardened Gelatin using four of five vigorous rinses at 120°. Rinse the matrix in cold water for one minute. Harden the matrix for 3 minutes in the following hardener:

Hardener

Glyoxal	40 ml
Distilled Water to make	2 L

Harden for 5 minutes, followed by a Photo-Flo bath for 1 minute.
Dry the matrices before use.

If you don't have Kodak Dye Transfer paper, you will need to prepare your own paper. I have used Ilford MG FB F paper successfully. Fix and wash the paper completely. Mordant by soaking for 10 minutes in a 1% solution of Thorium Nitrate. You can use the M-1 mordant if you don't want to work with Thorium.

Kodak M-1 Mordanting Solution

Part A

Aluminum Sulfate	200 g
Water to	1 L

Part B

Sodium Carbonate	80 g
Water to	1 L

Mix one part B to one part A. Add B to A. Filter out any undissolved precipitate. Soak paper in mixture for 5 minutes. Wash 5 minutes. Then immerse in a 5% sodium acetate solution for 5 minutes. Dry paper or immerse in paper conditioner.

Condition the paper in paper conditioner for about 15 minutes before transferring the image. This is Bob Pace's formulation:

Paper Conditioner

Triethanolamine	60 ml
Glacial Acetic Acid	19.4 ml
Ethylene Glycol	100ml
Water to make	4 L

Check pH and adjust to 6.0.

Soak the paper in hot water for 5 minutes. Drain, and transfer to the conditioner. Condition for at least 15 minutes. Drain, and then roll the conditioned paper onto the transfer board with the emulsion face up.

To transfer a matrix, first soak it in 120° F. Water for one minute. Then place it in the appropriate dye bath for five minutes. Agitate the dye bath using a tray rocker. Drain the matrix, and transfer to the first rinse (1-% acetic acid). Rinse for one minute, drain, and then transfer to the second rinse (1-% acetic acid). Rinse, drain, rinse again, and move the matrix to the transfer board along with some of the rinse. Roll the matrix into contact with the paper. Transfer for 5 minutes.

The dyes transfer very well, but as with all matrix film transfers, you need to maintain the temperature at least at 70° F, with higher temperatures working better. Soaking a towel in hot water, and placing it over the matrix will facilitate the transfer. Highlight clarity may be controlled by using a small amount of the highlight reducer (Sodium Hexametaphosphate) to get the clearest highlights, near paper white. Use a good quality fiber based paper - I have used fixed out Ilford Multigrade FB.

Paper Preparation

Paper can be prepared from a diffuse surface up to a high gloss surface. For a very diffuse surface, coat a single layer of hardened gelatin onto Lana Lanaqurille 140 lb. paper. Use the following gelatin preparation:

• Water	1 L
• Gelatin	100 g
• Formalin 10%	40 ml
• Resorcinol	0.5 g
• Triton X-200	6 ml
• Mordant	

Use this solution once, it will harden upon cooling, and cannot be reused. Different mordants may be used. The M1 mordant can be added in small quantity. A better mordant is Thorium Nitrate. I would recommend post-mordanting the paper in a 1% bath of Thorium Nitrate dissolved in water. I recommend a 10-minute soak in a 1% solution of Thorium Nitrate in water.

For a bright, gloss paper, coat onto Baryta paper which has been prepared with a barium sulfate coating and calandared.

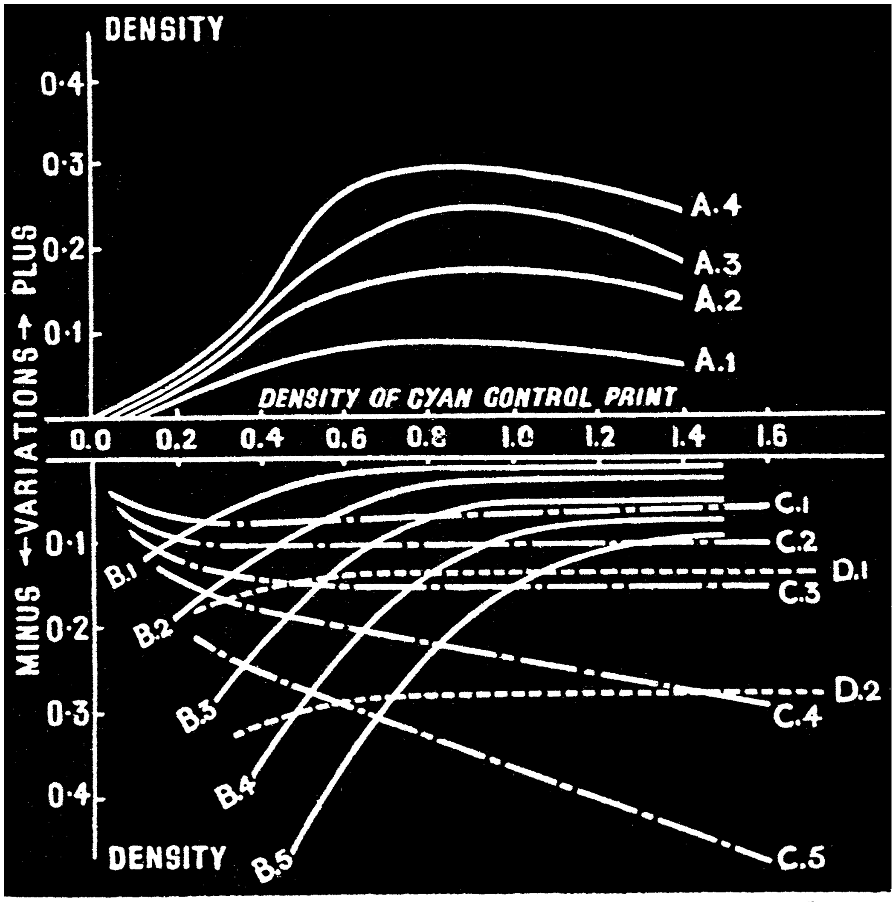
Be very careful with the Formaldehyde and Resorcinol, as they are very toxic. If you decide to use Thorium Nitrate as a mordant, be careful to avoid breathing the dust, as it is mildly radioactive, and inhaling the powder is to be avoided at all costs. Read the MSDS for further safety procedures. Use a full-face respirator with a 99.997 % efficient particle filter, and a fume hood at all times when handling either the powder or dilute aqueous solution. The unmordanted paper will bleed the dyes, particularly the magenta dye.

Color Adjustments

Several additives can be used with the first rinse to control the color balance and highlight cast. These include adding acid for increased density, adding Sodium Acetate for decreased density, and adding Sodium Hexametaphosphate to reduce dye only in the highlights (highlight reducer).

You can increase or decrease the pH of the dye baths for large changes in contrast. Some people actually paint the dyes onto the matrices, and re-transfer to increase saturation in a local area. The opposite of this is to squirt the Sodium Acetate solution at the matrix to leach out some dye to remove unwanted color. The print is easily retouched, one of the best features of a dye print.

For a complete discussion making separations, exposing and developing the matrix film, and rolling the prints and retouching, please refer to the books mentioned. This area is where dye printing really shines and printers develop their own unique methods for controlling the print during the rolling process.



Control solutions. The graph shows the approximate effect of making various additions to the first acid rinse. The differences caused are given as plus and minus variations in the reflection densities of a cyan step wedge when compared with a normal control print. The amount of rinse used was 150 c.cm. and the area of matrix surface 80 square inches. The rinsing time was 5 minutes except for Calgon (1 minute).

The curves A represent extra 28 per cent acetic acid in the rinse: A1, 5 c.cm. acid added, matrix not drained before transferring from dye bath; A2, 10 c.cm. acid; A3, 5 c.cm. acid and 5 c.cm. of dye bath; A4, 10 c.cm. of acid and 5 c.cm. of dye bath.

The curves B show the effect of 1 per cent Calgon added: B1, ¼ c.cm.; B2, ½ c.cm.; B3, 1 c.cm.; B4, 2 c.cm.; B5, 4 c.cm.

Curves C are the result of using an extra weak first rinse of acetic acid. The strengths are: C1, 0.2 per cent; C2, 0.1 per cent; C3, 0.05 per cent; C4, 0.025 per cent; C5, 0.01 per cent.

Curves D illustrate the effect of adding 5 per cent sodium acetate solution: D1, 5 c.cm.; D2, 10 c.cm.

Effect of Rinse Controls

Kodak Formulations

Here are some formulations from Kodak's Formulas for Dye Transfer Chemicals CIS-15. These are the ones that I use since they work well.

Tanning Developer

To prepare a working solution of A, mix 14.1 g of Part 1 and 6.0 g of Part 2 with enough water to make 1 Liter. Mix 1 part solution A to 2 parts solution B just prior to development for normal contrast.

Solution A

Part 1 (two-part formula)

Kodak *ELON* Developing Agent, fine	6.00 g	
Ascorbic acid	2.00 g	
Methyl paraben, purified	1.00 g	
Potassium bromide	5.00 g	
5-Methylbenzotriazole	0.1 g	- note: works far better than plain Benzo
Part 2		
Pyrogallic acid	6.00 g	

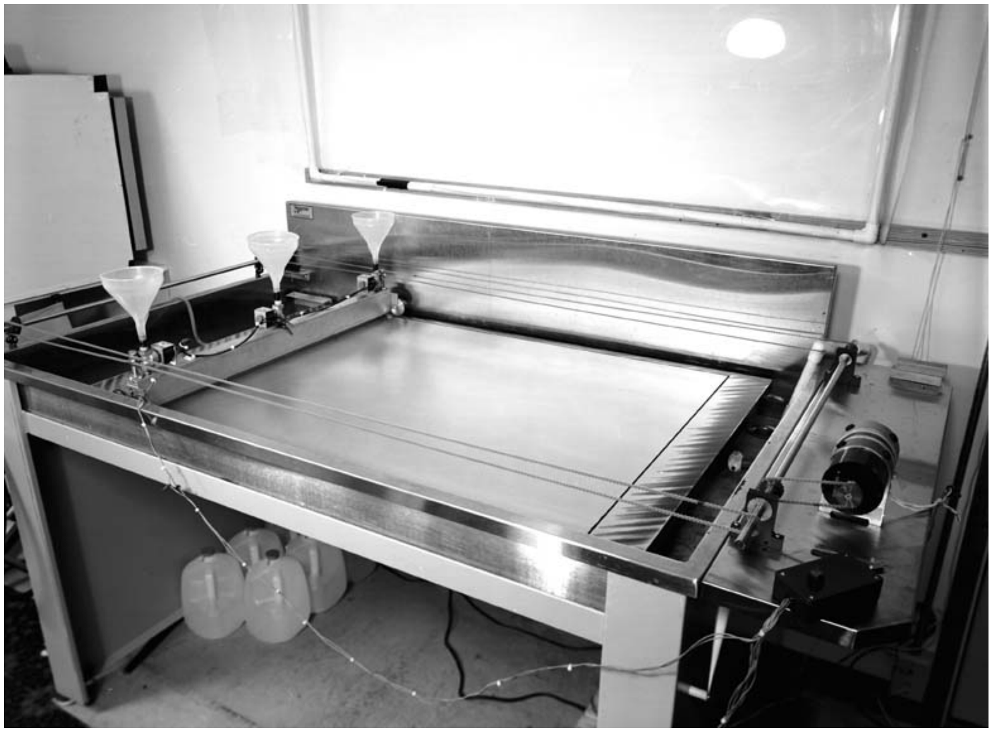
Solution B

Sodium Carbonate Monohydrate	215.9 g
Kodak Anti-Calcium, No 1	10.0 g
Water (120° F)	1 L

Dye Transfer Paper Conditioner

Water, demineralized	579.0 g
Glacial Acetic Acid	35.5 g
Formaldehyde, 37% solution (12% Methanol)	90.1 g
Ammonia, 28% solution	77.7 g
Ethylene Glycol	264.0 g

Allow the mixture to stand for at least 12 hours before testing to allow the reaction between the ammonia and formaldehyde to go to completion. To prepare a working solution, use 250ml of concentrate and enough water to make 1 liter of conditioner. The pH of the working solution should be set to 6.0 (by adding ammonia if necessary) at 80° F (26.7° C).



Slot Coater

Trough Coater

Polyester Stock

Coating

I have built a sheet coater, which is very simple in operation. I had a large piece of aluminum precision ground jig plate (50” x 34” x 1”) machined with vacuum channels, and anodized for corrosion resistance. This plate is VERY flat. This is called the platen, and it holds the film flat for coating horizontally. The platen is mounted on screw leveling feet, placed in a Stainless Steel 36 x 60” sink. I use a machinist’s level to get the plate very level. The slot coater consists of an aluminum piece which has a slot milled out of the center, which forms a chamber to hold gelatin. On the bottom of this body two triangular ‘jaws’ are mounted, which are adjusted using a feeler gauge to set a 0.008” (8 mil) gap running a full 32”. On the top of the coater I have mounted three solenoid valves, and three funnels. The coater is mounted on four precision wheels, and the assembly is driven across the platen by timing belts, sprockets on shafts, and a DC motor which pulls on both sides, for a very smooth motion.

In operation, first cut a 50” x 34” piece of 0.007” Melenex 583 (ICI polyester film with a special coating which accepts aqueous coatings), place it on the platen, turn on the vacuum, and use the DT roller to roll out any air pockets. I use a sprayer system placed in the sink beneath the platen to spray hot water (130° F). This raises the temperature of the platen so that the emulsion will spread evenly. It is also necessary to temper the coater itself. Heat the coater with hot water to about 100° F. Make sure you blow out all the water before using the coater. Position the coater at the edge of the platen. Heat 500 ml of emulsion first in a hot water bath, and then using a hot plate to 70° C, and then load the funnels with equal amounts of emulsion. Three funnels are used to feed the emulsion evenly into the coater chamber. Push the feed button for one cycle of the timer circuit, and watch the bead form. When the bead is fully formed, open the solenoids for one cycle, and then start the coater moving at about 1” per second. An electronic timer circuit controls the solenoids, and lets small amounts of emulsion into the coater body at regular intervals (clicks). When the coater reaches one end, reverse the coating direction, and ‘doctor’ the emulsion with the coater blade formed by the slot jaws coming to a point 0.010” above the film. Drive the coater off the edge of the platen to the cleaning position. Close the dust cover, and turn on cold water to the sprayer (50° F) for about 10 minutes, which chills the platen, and causes the gel to set. Turn off the vacuum pump, open the dust cover (make sure you use full body Tyvek overalls to limit dust), lift the sheet out of the sink, and carefully tack it onto a drying frame, and place it horizontally inside a laminar flow HEPA filtered dryer. I use a

Clestra Cleanroom Super II 2' x 4' HEPA filter blower module, which feeds an enclosed area 2' x 4' x 4'. A light tight door is on the front of the dryer cabinet, which is made from light baffle panels, which allow the laminar flow air to move out of the cabinet without restriction. Drying takes a long time, usually 6 to 8 hours, and I dry 8 sheets at a time.

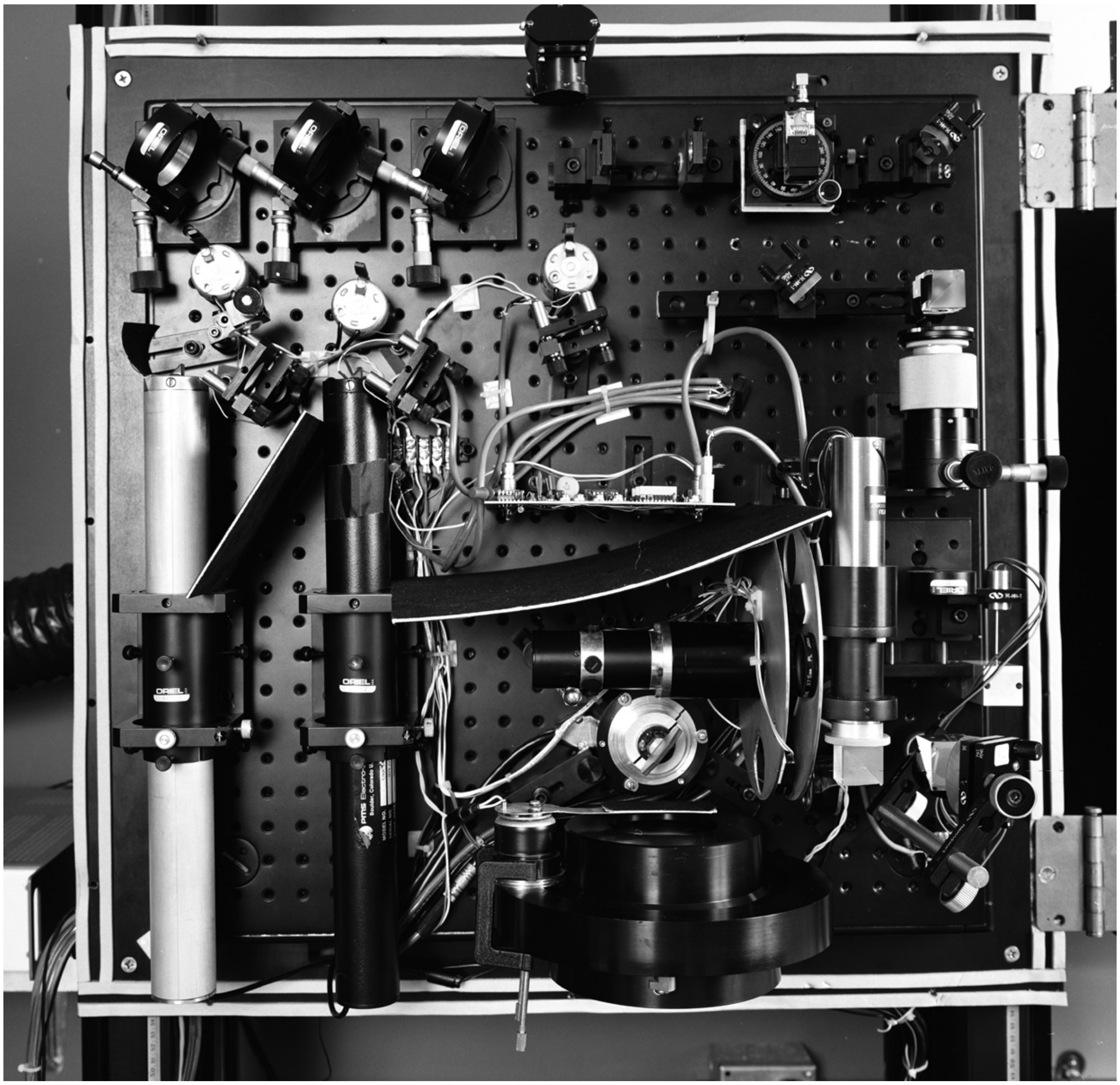
While I am heating another batch of emulsion for coating, I flush the coater with hot water several times to remove any remaining emulsion. I position the coater beyond the edge of the platen, so that the rinse water doesn't get onto the platen. I have mounted two aluminum L channels in the sink, which provide an extension for the coater to rest on while cleaning. Be careful to wipe the bottom of the slot jaws completely, to prevent any emulsion from remaining, which will cause streaks. Attach a small air compressor to the hose barb on the coater, and blow the coater dry before the next coating. Before coating, temper the coater with hot water on the outside.

The HEPA filtered Dryer

A simpler method of coating should work well with smaller sheet sizes. Wrap a wire tightly around a stainless steel rod over the full length. By adjusting the gauge of the wire, you can control the amount of emulsion passing through the gaps between the wraps, thus controlling the emulsion thickness. The emulsion and film should be hot enough to allow the emulsion to flow after doctoring it with the blade. Pour a supply of emulsion in front of the blade, and draw it through the emulsion, and over the full length of the film. The ideal thickness of the emulsion will be enough so that when exposed normally, the image will appear only faintly during development. A too thick emulsion will reticulate when chilled or during drying, which will pattern into the image. A too thin emulsion will 'print through', and the rough surface of the film will texture the image, as well as limiting the DMAX of the print. Try 100 ml of emulsion for a 16x20" sheet.

Materials Cost:

The cost of materials is about $8 per sheet of 30x40" film, most of the expense is in the silver, I buy the inert photographic gelatin from Kind and Knox in minimum 25 lb. lots costing $ 10 / lb., and the polyester film cost about $ 0.50 / foot of the 50" wide rolls. The Silver Nitrate is from First Reaction at $ 277.00 / Kg.



Laser Head of the Film Recorder

Making Separation Negatives

I am creating my separations digitally using a laser based film scanner / film recorder I designed and built a few years ago. I typically use 230 mb files, which make 26 x 33" prints, which are completely sharp, and show no digital artifacts. The recorder both scans the originals (Up to 150 l/mm) and records onto 8x10" film (EPN, VPS, and TMX). The film is held on registration pins, which allows exposing three seps in perfect register.

Alternately, seps can be made by exposing TMX (Tmax-100) film using red, green, and blue filters. Red and Green exposed color correction masks should be used when making the seps. Use HL masks to counteract the toe of the matrix film.

Coater Construction

The slot coater is constructed from aluminum. It consists of four custom-machined parts, and several small off the shelf mechanical parts. The parts are grouped into three areas, the slot coater, the transport system, and the platen with sprayer assembly. Stainless, aluminum and PVC are used throughout in order to prevent corrosion.

The platen is machined from 1" thick aluminum jig plate. This is a cast aluminum material which is machined flat. The material I used exhibited a slight machining ripple, and had to be sanded flat to get an extremely smooth surface. The platen should hold flat to +/- 0.002 over the entire surface. Vacuum channels are machined into the top of the platen, which are used to hold the film down. Not shown in the drawing is a set of six adjustable feet, which screw into the bottom of the platen, and have knurled adjustable feet for leveling. Also underneath the platen is a sprayer system which is constructed from ¾" PVC pipe to form a closed H pattern in a size which fits under the platen. 1/16" holes are drilled into the sprayer assembly pipes, which spray water up at the bottom of the platen, in order to heat or cool the platen. The entire platen assembly is placed into a stainless steel sink of sturdy construction (I have a California Stainless sink). A machinist's level is used to adjust the feet until the platen is extremely level.

The Slot Coater assembly consists of the top, bottom, body, and two triangular jaws. The jaws form the slot. The parts are bolted together with stainless steel bolts. Two types are used, cap head # 6-32, and # 6-32 slotted flat head. The top has four ¼" NPT threaded holes. Three of these holes accept the solenoid valves, and the remaining hole (second in from right) is fitted with a ¼" NPT barbed fitting. This fitting attaches to an air pump, and is used to blow out the coater after cleaning. The fourth hole also provides an air relief hole. Two side plates are attached which are used for mounting the four precision wheels. The wheels are built up using Berg Cam Followers, which are pressed into precision Berg wheels. The wheels are bolted into the wheel mounting plates. The two triangular slot applicator blades are bolted to the underside of the coater and the vertical face of each blade face each other. This forms a slot the full width of the coater. The gap is adjusted using a feeler gauge to 0.008". Accuracy of the slot should be held to 0.0008" over the full slot, both parallel and perpendicular to the base. Finally, a 0.015 gauge is placed under the slot blades, the wheel assemblies are loosened, the wheel assembly is forced downward with slight pressure, and the assembly bolts are tightened. This operation sets the height of the coater blades 0.010" to 0.015" above the surface of the film.

The three solenoid valves are fitted with ¼" NPT brass nipples, and screwed into the top of the coater. A ¼" NPT hose barb is screwed into the remaining hole (2nd from right). Three plastic funnels are mounted on top of the solenoid valves. I used Patterson # 306 funnels. I screwed a nylon hose barb into the solenoid ¼" NPT top hole, and placed the funnel over the barb. I secured the funnel by forcing a small piece of plastic tubing over the barb inside the funnel, and forcing it downwards. Finally, I lifted the funnel up as far as it would go, and secured it in place with heat shrink tubing which is shrunk over the bottom of the funnel, and the exposed part of the hose barb.

The transport assembly consists of a low rpm gear motor, coupled via Berg belts to a drive shaft. The shaft holds two Berg sprockets, which drive two full lengths Berg belts. The belts extend the full length of the coater, and beyond. On the opposite side of the drive motor, another shaft is mounted, which also has two sprockets attached. The belt is stretched between the two shafts, and a spring-loaded tensioner holds the belts taut. The motor is connected to a variable voltage power supply, and a hand paddle which has a three position switch, with move left, stop, and move right positions. The two belts attach to the top of the coater body using two clamps (not shown). The electrical system includes the motor power supply, hand paddle, and a button, which enables the emulsion, feed system.

Emulsion Feed System

The emulsion feed system consists of a circuit, which contains a timer, and a relay. The 555 timer is set up as an oscillator. On the front of the control box, there is a knob, which attaches to a pot, which sets the delay between solenoid activation. This allows a controlled slow addition of the emulsion into the coater chamber over the period of the coating. There is a switch, which is closed to open the solenoids for cleaning.

A smaller hand-sized box contains a switch for controlling the motor direction, and a push button for enabling the Emulsion Feed System to work.

Parts List for Coater

Description	Mfg.	Ref Number	Qty
Vacuum Pump	Gast	523-101Q-G582DX	1 Grainger 4F740
Timing Belt	Berg	20TB-640	2
Timing Belt	Berg	20TB-58	1
Timing Belt Pulley	Berg	20TP6-20	1
Timing Belt Pulley	Berg	20TP8-20	1
Timing Belt Pulley	Berg	20TP8-16	4
Threaded Stud	Berg	PV-35	6
Thumb Nut	Berg	PD1-25	6
Shafting	Berg	S1-21	2
Bearings	Berg	B4-12	4
Shaft Hangers	Berg	BC25-1C	4
Drive Roller	Berg	G1-27	4
Cam Follower	Berg	JE-B-4	4
#8-32 Nut SS.	Berg	Y5-8	4
#6 Plain Washer SS	Berg	Z4-6	4
#8 Lock Washer SS	Berg	Z3-8	4
#6-32 Flat Head SS	Berg	Y6-S6-A10	20
#6-32 Cap Head SS	Berg	Y9-S6-A8	14
Sink 36 x 60”	Cal Stainless	CAL SS. 868T2	1

Other Items (Hardware Store): ¼” NPT Hose Barbs Qty 4. Funnels Patterson # 306- available at a photo store. Shelf and hardware for mounting the Shaft Hangers to the sink. I had this made by a sheet metal worker out of Stainless Steel. If you look at the photo, you will see a shelf on the right side of the sink. You will need clamps for clamping the coater to the Berg Belts. My system is not that great, it consists of a Thumb Nut glued upside down on the top of the coater, with a Threaded Stud threaded into it, and some nuts and washers which form a pincher to clamp the belts at the right height. A better system would be a clamp, which bolts onto the belt, with a hole, which engages a pin, mounted on the coater. This would be a convenient quick-disconnect method. The ThumbNuts should be bored and tapped to fit the Threaded Stud’s 3/8-16 thread.

Electronic Parts

U2 LM555 Timer	DigiKey	LM555CN	1
U1 LM7812	DigiKey	NJM7812FA-ND	1
Q1 ZTX603	DigiKey	ZTX603-ND	1 (replaces TIP-120)
Power Supply 24V	C&H Sales	PS8902	1
Power Supply 12V Var.	Radio Shack	MW122A (LKG Ind.)	1
Sol1-3 Solenoid Valves	C&H Sales	SV9252	3
D1 1N4002 Rectifier	DigiKey	1N4002MSCT-ND	1
C3 330uf Electrolytic	DigiKey	P5531-ND	1
C1 0.10 Multi-layer	DigiKey	P4525-ND	1
C2 1.0uf Polyester	DigiKey	EF2105-ND	1
R1 1 MΩ Pot	DigiKey	CT2211-ND	1
R2 1.5 MΩ	DigiKey	1.5MQBK-ND	1
R3 2.2 KΩ	DigiKey	2.2KQBK-ND	1
S1 DPDT 12V Relay	DigiKey	Z790-ND	1
S2 SPDT Switch	DigiKey	CKN1020-ND	1
S3 DPDT Switch	DigiKey	CKN1150-ND	1
S4 SPST Button	DigiKey	EG2005-ND	1
Motor	C&H Sales	DCMTG9900	1

Electronic Hardware

Pot Knob	DigiKey	8554K	1
Plastic Enclosure	DigiKey	SR111G-ND	1 (Hand Paddle S3, S4)
Plastic Enclosure	DigiKey	SR152G-ND	1 (Timer Circuit)
Vector Board	DigiKey	V1045-ND	1 (Timer Circuit)
Hole Grommets	DigiKey	RP455-ND	10 (Package of 10)
Relay Socket	DigiKey	Z793-ND	

You will also need stranded hookup wire, and tie wraps. Use 14-G wire to connect the solenoids to the relay, and back to the 24V power supply. Use 18-G wire elsewhere.

Trough Coater Construction

Material: Clear Acrylic ½”
Interior of box is 31” (W) x 10” (H) x 8” (D)

The Trough coater is made from plexiglass. A box is constructed which measures:
31” x 10” x 8” from ½” clear Acrylic (inside dimensions).

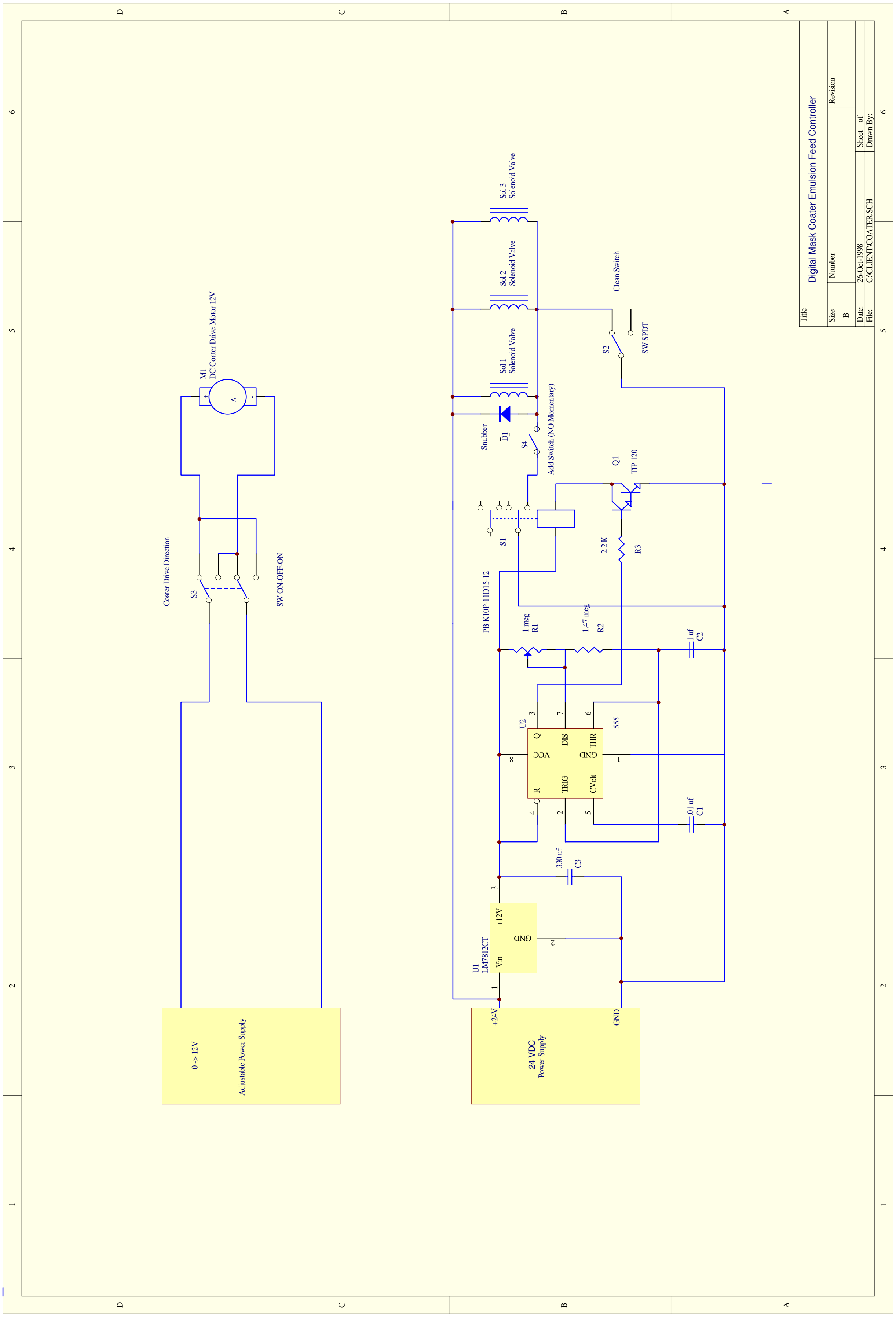
Inside dimensions shown, adjust outside dimensions as needed. Adjust joints as needed.
The front has a 5” x 31” opening on top.
Additional piece (½” Acrylic) measuring 2” x 31” is glued inside box as shown.
Three holes bored through: 0.5” diameter as shown on both side pieces. These holes must be accurately perpendicular to piece. Tolerance is – 0.000 / +0.002 for bored holes.

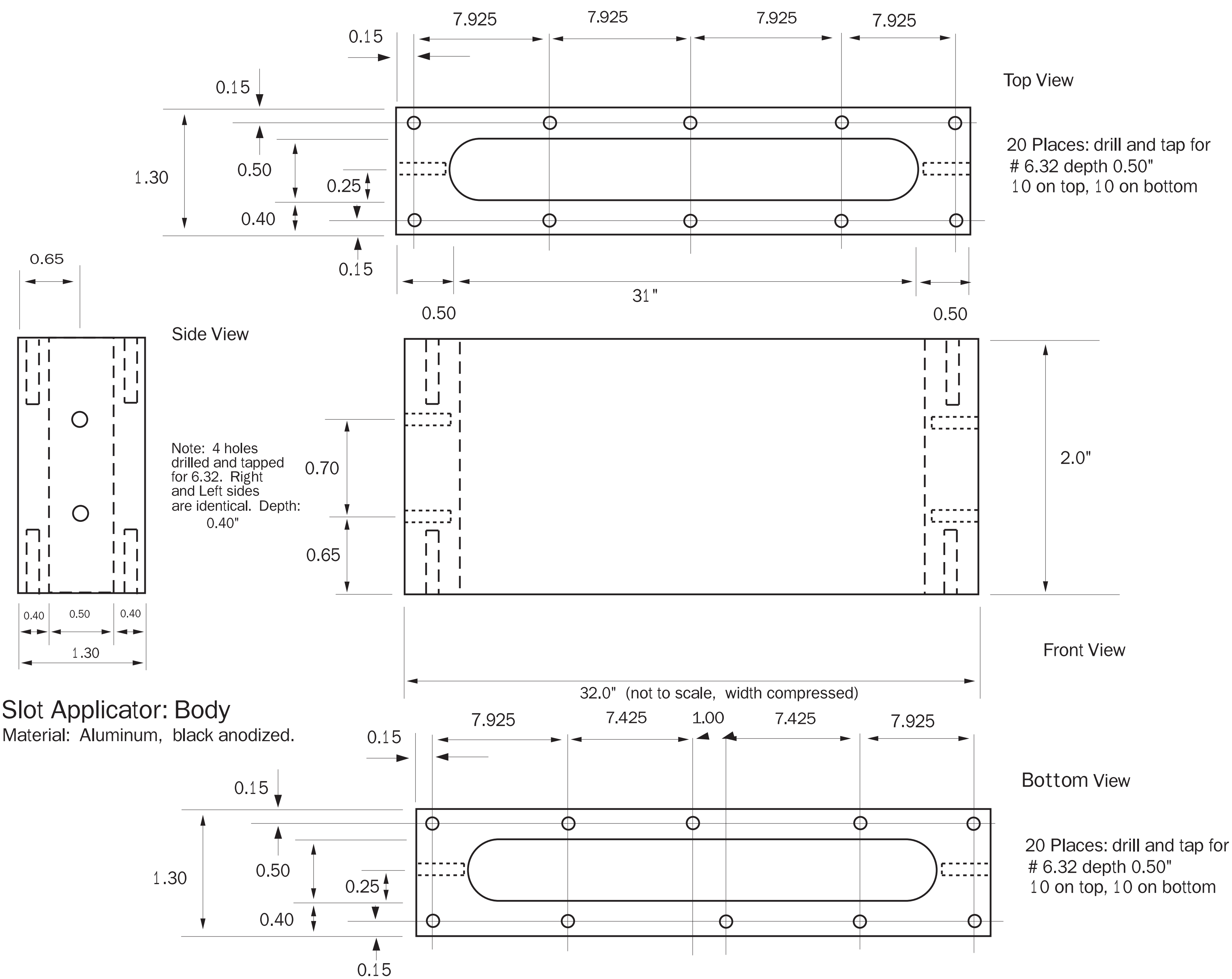
The left side piece (as viewed from the front) has a 0.87” diameter X 0.40” deep cut concentric with the 0.50” bored hole as shown below. Right Side piece does not have the 0.87 X 0.20 circular cut, just the 0.50 hole bored through.

Not Shown: Bore four additional holes in the two side pieces to insert two copper tubes into the trough at the bottom edges of the trough. I did this after the box was finished. Seal the copper tubes with Silicone caulk. Circulate hot water through these tubes to keep the gelatin up to temperature. Bore one hole at the bottom center of the trough (on one of the side plates), and epoxy glue in a ¼” NPT threaded insert. Screw in a pipe nipple and a 90 degree elbow. Attach a funnel to the elbow for use as a fill spout.

Parts for Trough Coater (Berg)

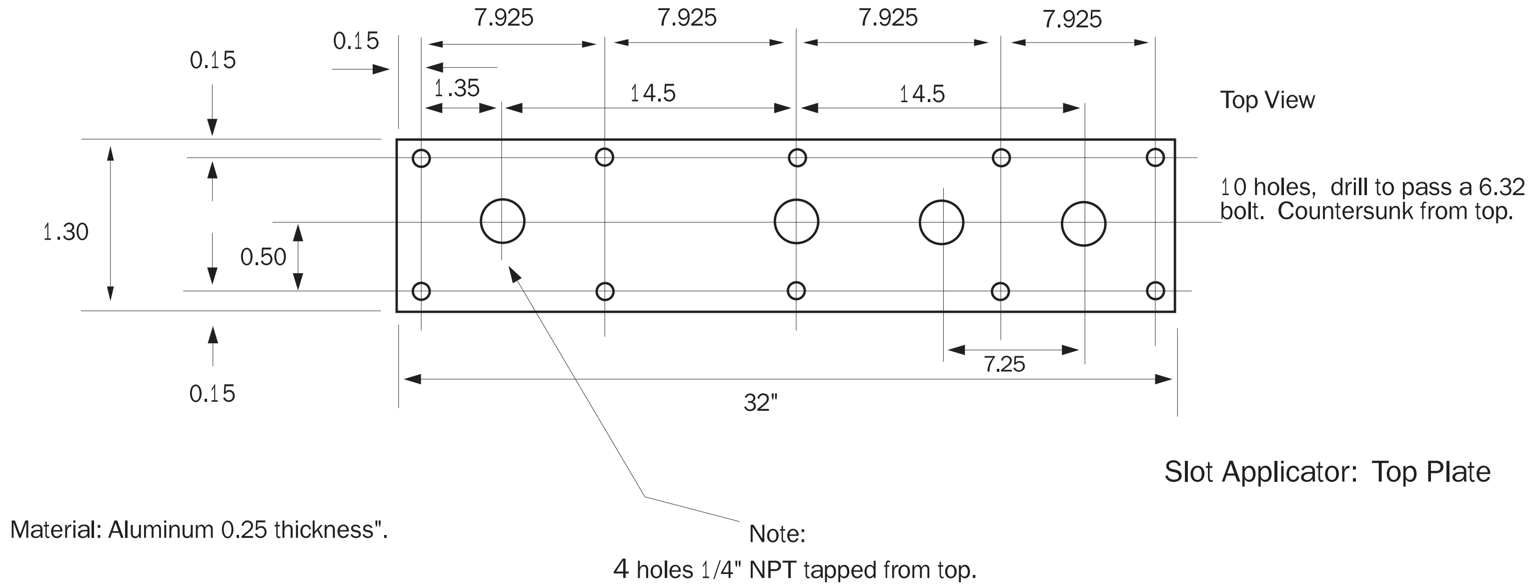
Description	***Quantity***	***Catalog Number***
Slip Clutch	Qty 1	JH-14
Hand Crank	Qty 1	CN2-15
Ground Shaft 3/8”x 32”	Qty 2	S6-320
Ground Shaft 3/8” x 36”	Qty 1	S6-360* (machined, see below)
Teflon Bearings 3/8”	Qty 5	B9-17
Hub 3/8”	Qty 6	PH2-7
Collar 3/8”	Qty 5	CS-38•


Digital Mask Coater Emulsion Feed Controller
Title
Size
B
Number
Revision
Date: 26-Oct-1998
File: C:\CLIENT\COATER.SCH
Sheet of
Drawn By:
M1
DC Coater Drive Motor 12V
Coater Drive Direction
S3
SW ON-OFF-ON
0 -> 12V
Adjustable Power Supply
24 VDC
Power Supply
+24V
GND
U1
LM7812CT
Vin
GND
+12V
330 uf
C3
U2
555
VCC
Q
DIS
THR
GND
CVolt
TRIG
R
.01 uf
C1
1 uf
C2
1 meg
R1
1.47 meg
R2
2.2 K
R3
Q1
TIP 120
PB K10P-11D15-12
S1
S4
Add Switch (NO Momentary)
Snubber
D1
Sol 1
Solenoid Valve
Sol 2
Solenoid Valve
Sol 3
Solenoid Valve
S2
SW SPDT
Clean Switch

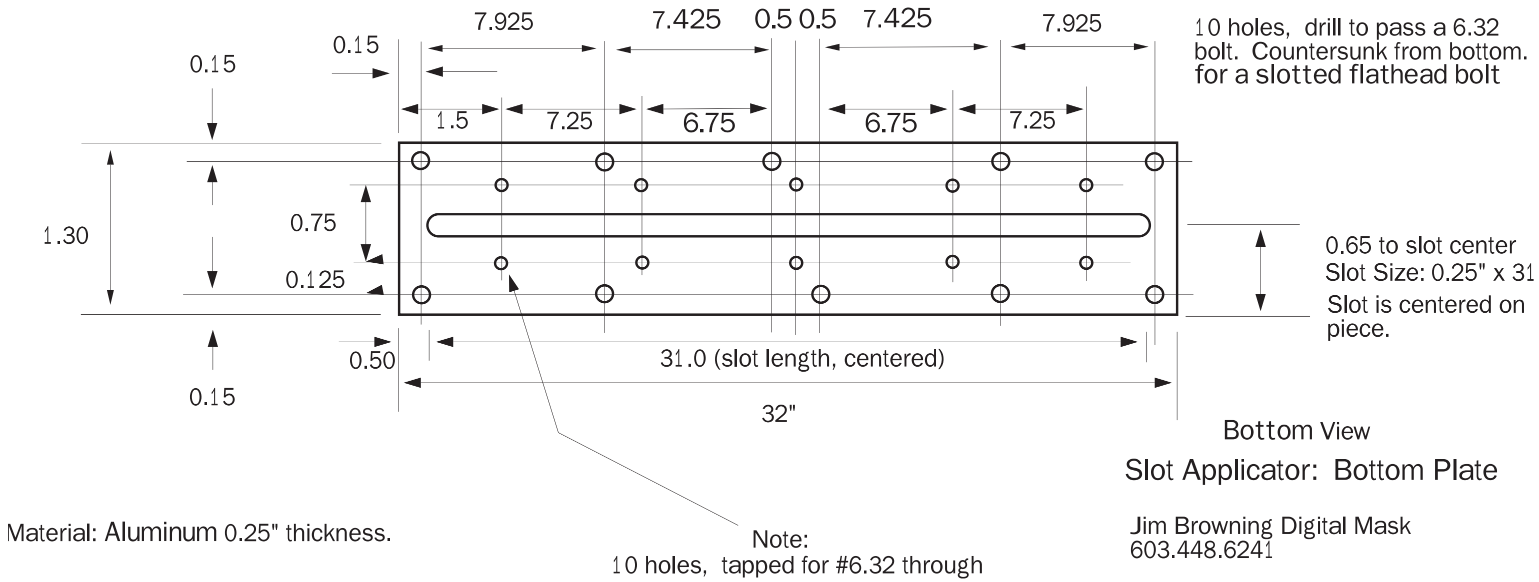


Slot Applicator: Body

Material: Aluminum, black anodized.

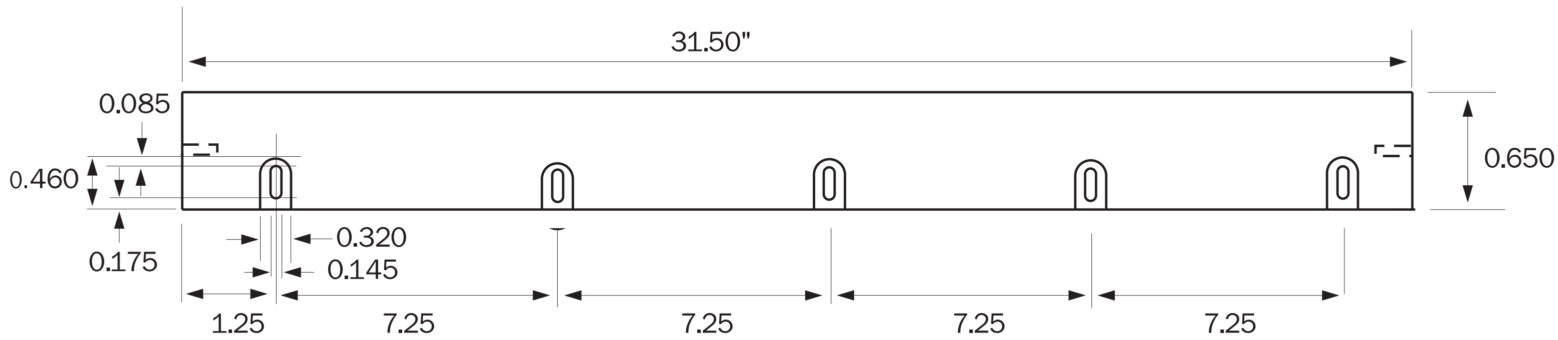


Slot Applicator: Top Plate



Slot Applicator: Bottom Plate

Jim Browning Digital Mask
603.448.6241

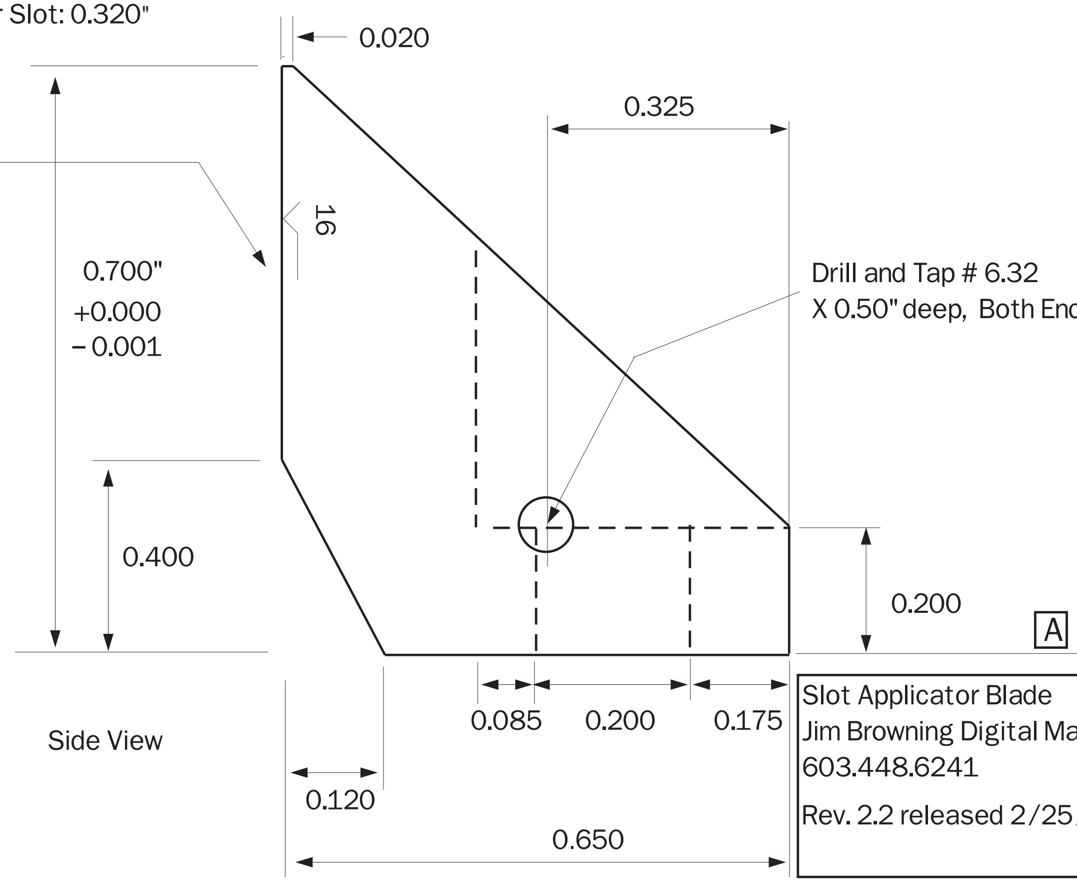


Top View

Note: Slotted to accept #6.32 Button Head
Bolts: Inner Slot: 0.145" Outer Slot: 0.320"

This surface should mirror
the twin piece to form a slot
accurate to 0.001" or better.

⊥	0.0005	A
▱	0.0005	

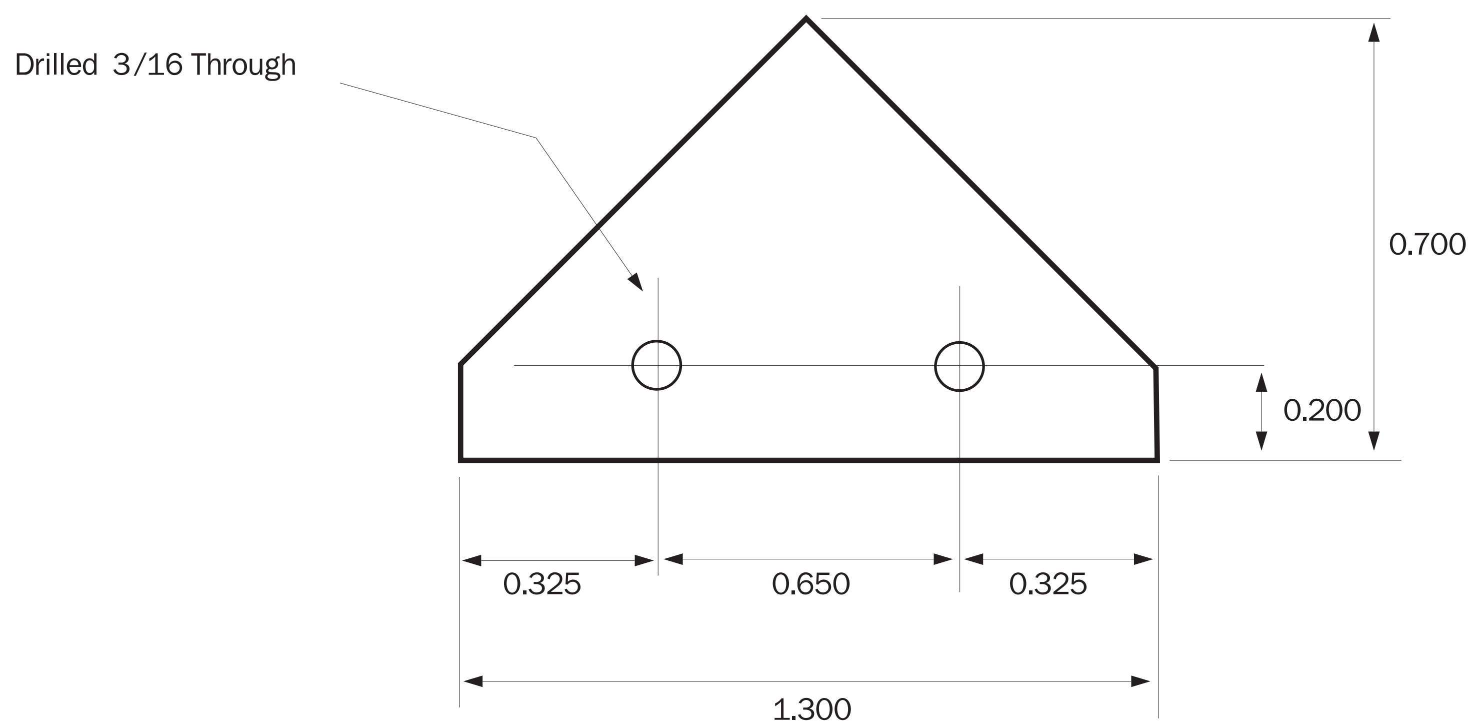


Side View

Slot Applicator Blade
Jim Browning Digital Mask
603.448.6241

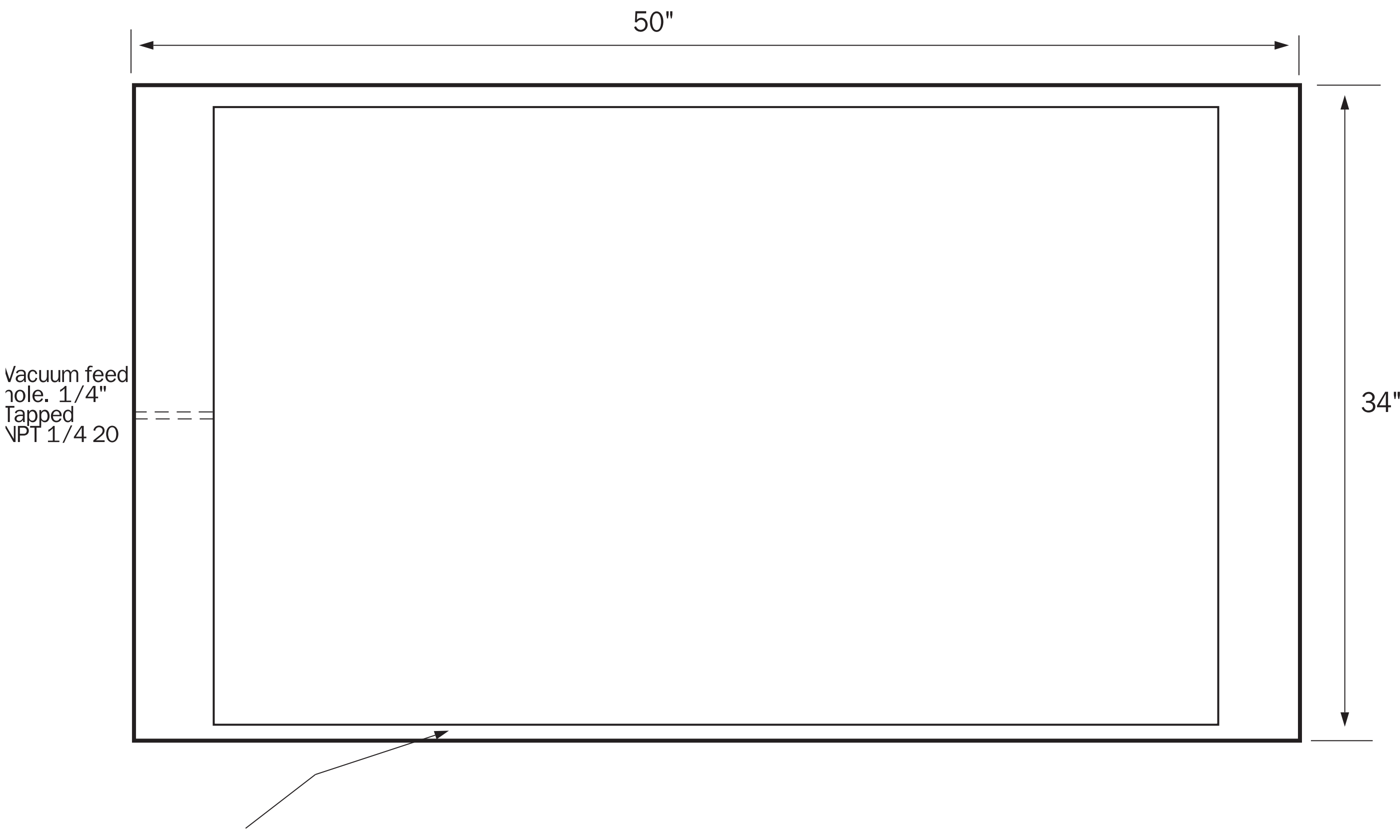
Rev. 2.2 released 2/25/99

Material: Tool Steel, Stress Relief
Nickel Plated
Quantity: 2 Pieces



Material: Aluminum 1/8" Thickness
Quantity: 2

Slot Applicator End Cap
Jim Browning Digital Mask
603.448.6241

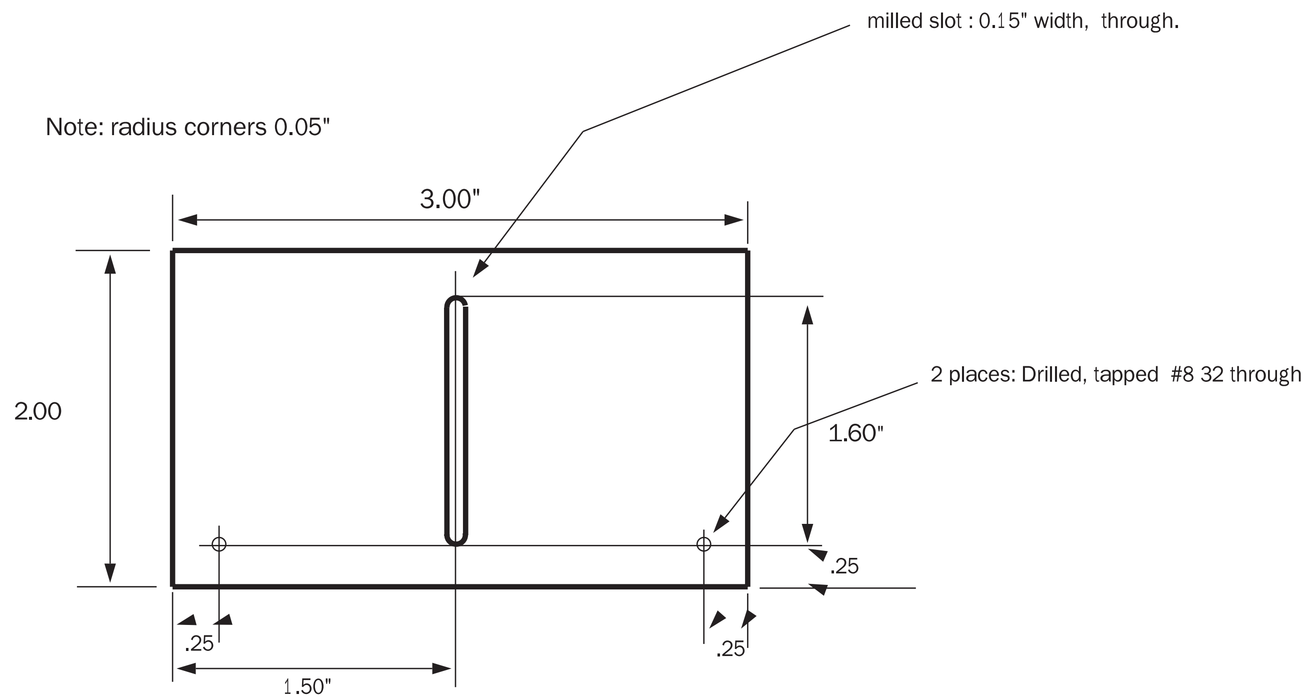


Vacuum Channel, 1/8" slot, 1/4" deep,
Dimensions: 32 x 43" centered.

Note: Vacuum feed hole is centered on the end of the piece. Deeper channel milled on vacuum slot to connect vacuum channel to feed hole.

Coating Platen
Jim Browning
Digital Mask
603.448.6241

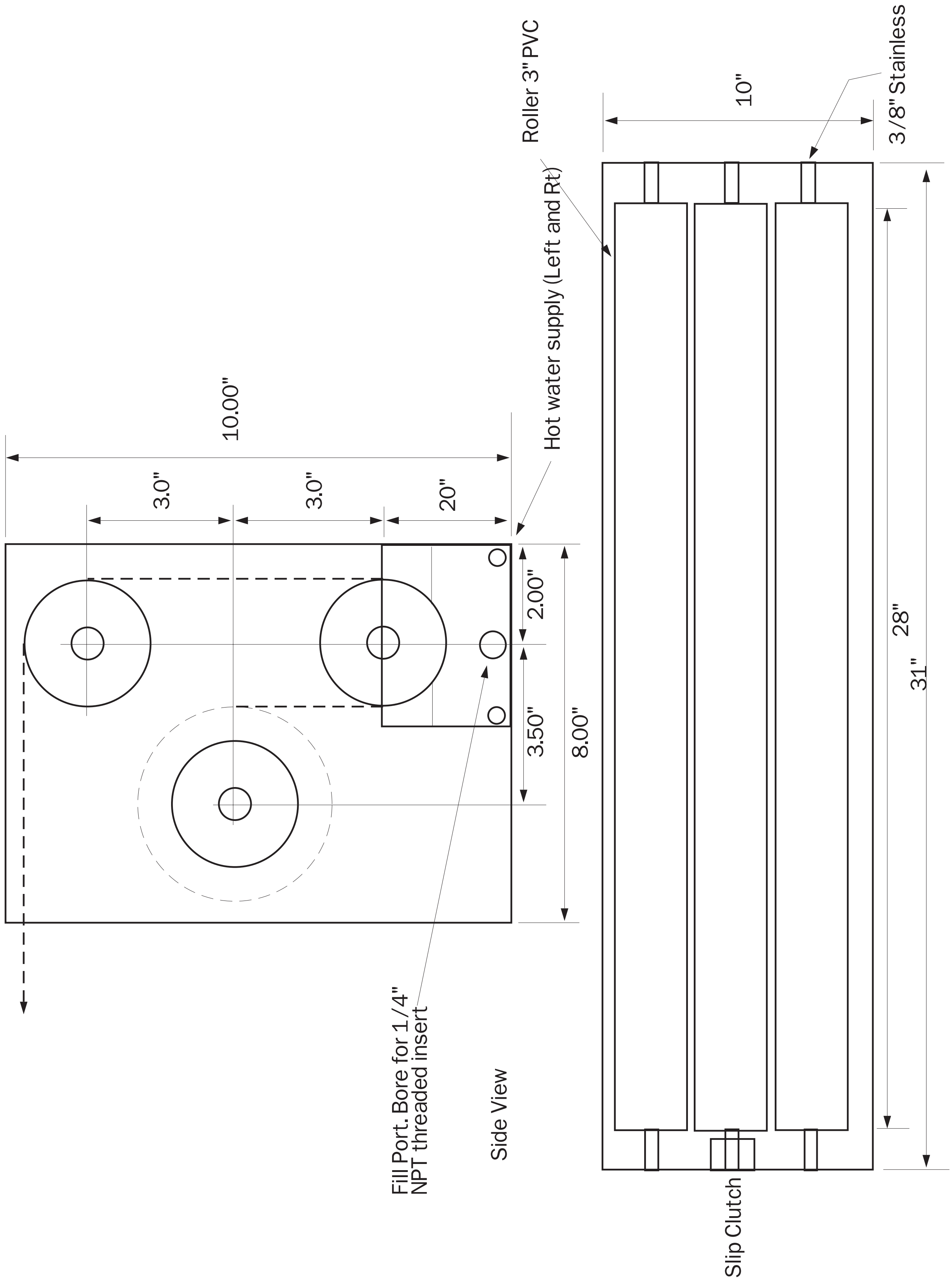
Material 3/4" aluminum jig plate.
34 x 50"



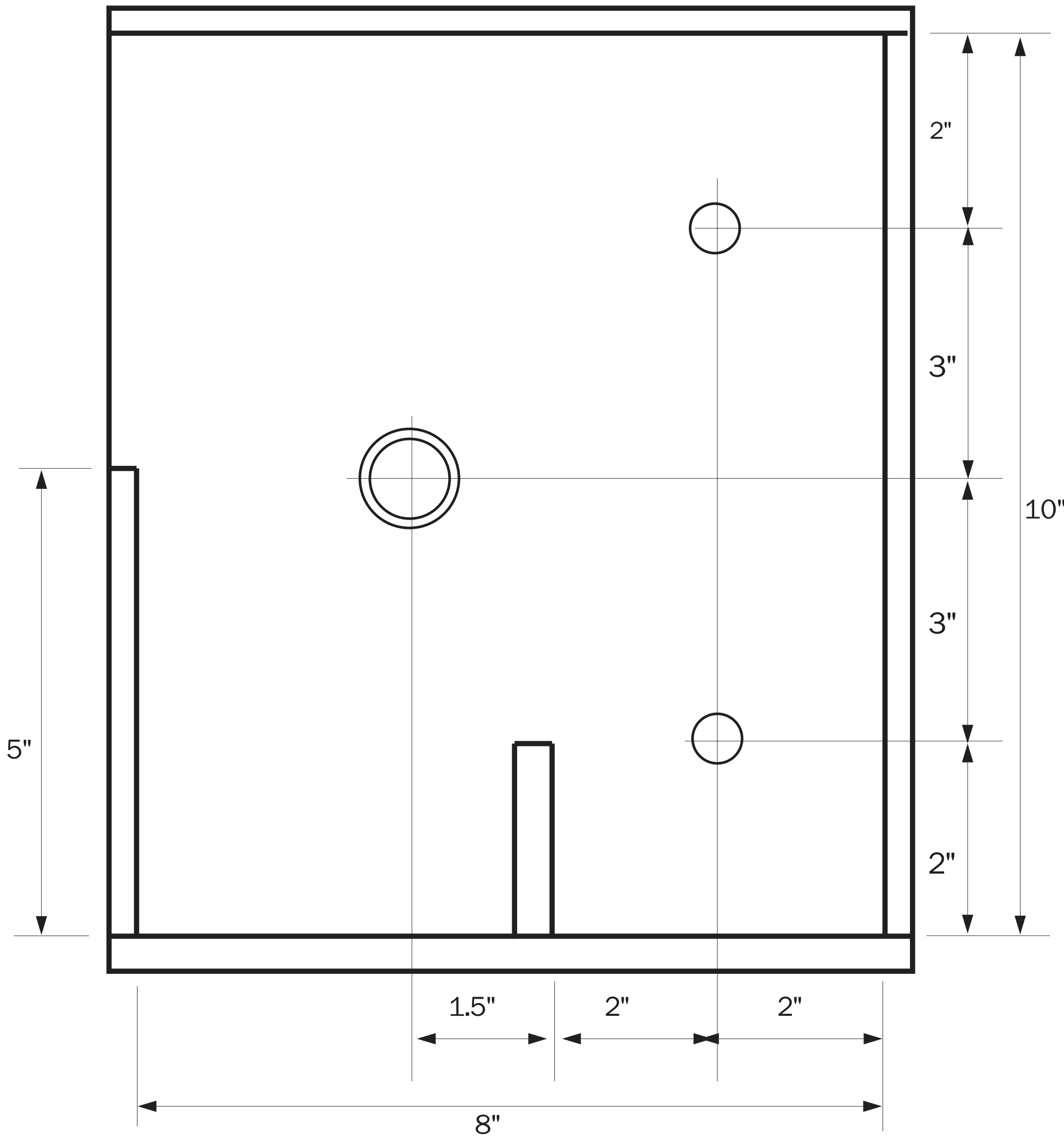
Quantity 2. Material: Stainless, 0.125" thickness. 3.00" x 2.00"

Wheel Mount

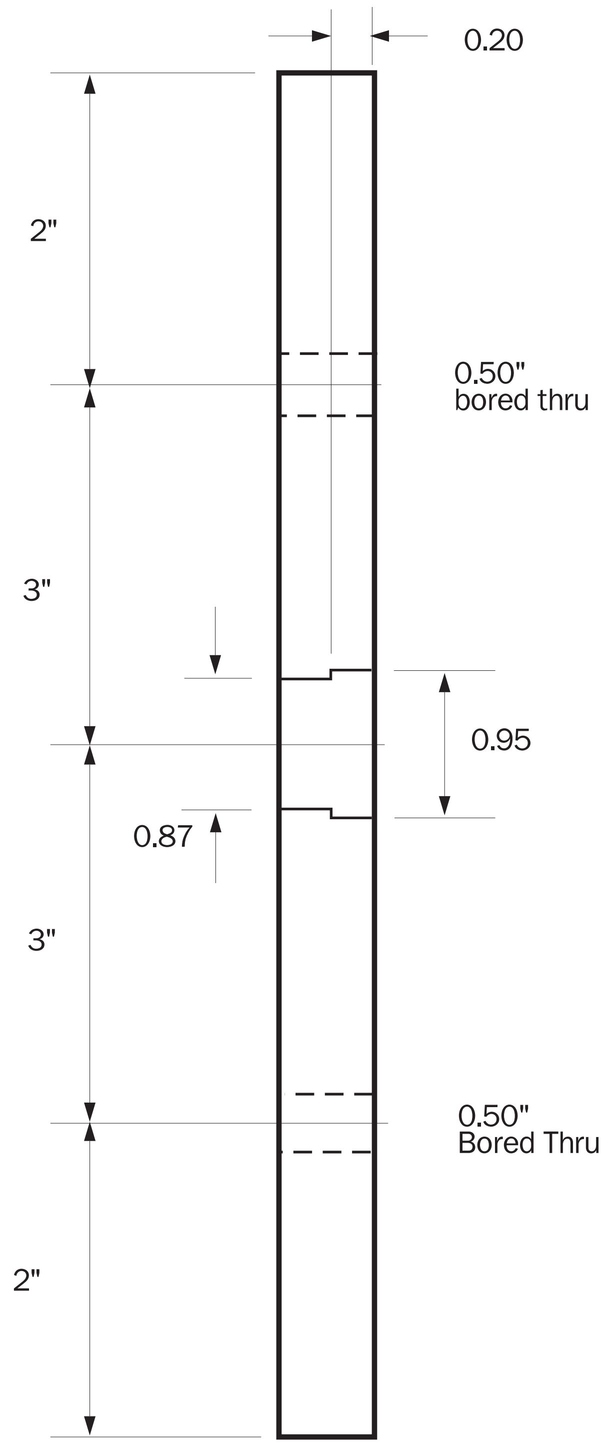
Jim Browning
Digital Mask
187 Stevens Rd
Lebanon, NH 03766



10.00"
3.0"
3.0"
20"
2.00"
3.50"
8.00"
Hot water supply (Left and Rt)
Roller 3" PVC
10"
3/8" Stainless
28"
31"
Fill Port. Bore for 1/4"
NPT threaded insert
Side View
Slip Clutch

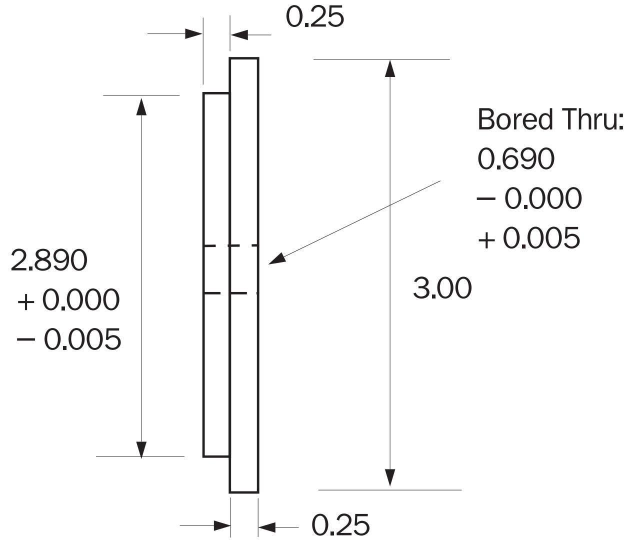


Trough Coater Box. Made from 1/2” Clear Acrylic. Interior of box is 31” (W) x 10” (H) x 8” (D).



Trough Coater Side. 1/2” Clear Acrylic. Left side only. Right side does not have the step in the center hole. This is replaced with a single 0.50” hole bored through. Otherwise the same.

Trough Coater Roller
Material Aluminum Thick walled Tubing
Turned on outside to 3.00" diameter
Black Anodized
Quantity: 3



Roller End Cap
Material: Aluminum
Black Anodized
Qty: 6

James Browning
Digital Mask
603.448.6241

Dye Transfer Dye Fade Tests

All samples faded 50 hours in direct sunlight.

Acid Blue 25

Notes: Dye is quite blue. Transfers slowly. Good Light-fastness.

	Not faded	Faded	Delta
R	0.95	0.84	- 0.11
G	0.60	0.58	- 0.02
B	0.31	0.31	- 0.00
R	0.35	0.29	- 0.06
G	0.26	0.22	- 0.04
B	0.20	0.16	- 0.04

Acid Blue 45

Notes: Dye is a good match for Kodak in Hue. Somewhat on Blue side. Clean transfer, clean highlights. Fading in mid-tones – shifts hue. Greater fading in highlights than Blue 25.

	Not faded	Faded	Delta
R	1.08	0.88	- 0.20
G	0.51	0.55	+0.04
B	0.25	0.36	+0.11
R	0.34	0.24	- 0.10
G	0.18	0.15	- 0.03
B	0.13	0.12	- 0.01

Kodak Cyan

Notes: Somewhat on blue side. Clean Transfer, clean highlights. Fading in mid-tones, shifts hue. Greater fading in highlights than Blue 25.

	Not faded	Faded	Delta
R	1.08	0.90	- 0.18
G	0.54	0.56	+0.02
B	0.30	0.39	+0.09
R	0.31	0.24	- 0.07
G	0.19	0.17	- 0.02
B	0.15	0.14	- 0.01

Acid Red 80

Notes - Slightly duller and more yellow than Kodak, transfers well. Clean highlights. Very light fast. Similar dye to Kodak Magenta, except not quite as bright or as blue.

	Not faded	Faded	Delta
R	0.24	0.23	- 0.01
G	0.96	0.90	- 0.06
B	0.61	0.60	- 0.01
R	0.10	0.08	- 0.02
G	0.32	0.26	- 0.06
B	0.26	0.22	- 0.04

Kodak Magenta

Notes: Very good magenta, good purity, Very light fast. Transfers well, with clean highlights. Slightly more blue than Acid Red 80.

	Not faded	Faded	Delta
R	0.25	0.23	- 0.02
G	0.99	0.92	- 0.07
B	0.54	0.55	+0.01
R	0.10	0.08	- 0.02
G	0.33	0.27	- 0.06
B	0.23	0.20	- 0.03

Acid Yellow 11

Notes: Excellent yellow, Better purity than Kodak yellow. Good Light-fastness. Good Transfer, clean highlights.

	Not faded	Faded	Delta
R	0.09	0.07	- 0.02
G	0.16	0.14	- 0.02
B	1.02	0.96	- 0.06
R	0.08	0.06	- 0.02
G	0.11	0.08	- 0.03
B	0.31	0.23	- 0.08

Kodak Yellow

Notes: Excellent yellow. Moderate Light-fastness. Good Transfer, clean highlights. Skin tone in fade test loses noticeably more yellow than with Acid Yellow 11.

	Not faded	Faded	Delta
R	0.07	0.07	- 0.03
G	0.19	0.16	- 0.03
B	1.14	1.03	- 0.11

R	0.09	0.06	- 0.03
G	0.11	0.08	- 0.03
B	0.33	0.23	- 0.10

Grey – New Dye Set

Notes: The new dye set (Acid Blue 25, Acid Red 80, and Acid Yellow 11) shows improvement over the Kodak dye set. This is doing in large part to the increased stability of the Acid Blue 25.

	Not faded	Faded	Delta
R	1.00	0.96	- 0.04
G	1.07	1.05	- 0.02
B	1.01	0.92	- 0.09
R	0.34	0.31	- 0.03
G	0.33	0.30	- 0.03
B	0.30	0.25	- 0.05

Grey – Kodak Dye Set

Notes: The Kodak dye set shows more fading than the above dye set. Particularly a shift to red in the midtones.

	Not faded	Faded	Delta
R	0.99	0.83	- 0.16
G	0.97	0.92	- 0.05
B	0.95	0.85	- 0.10
R	0.31	0.23	- 0.08
G	0.28	0.22	- 0.06
B	0.26	0.20	- 0.06

Dye Densitometer Readings

From single transfers

Kodak Yellow:

Cyan:	0.03
Magenta:	0.12
Yellow:	1.00

Acid Yellow 11:

Cyan:	0.01
Magenta:	0.09
Yellow:	1.00

Kodak Magenta:

Cyan:	0.22
Magenta:	1.00
Yellow:	0.53

Acid Red 80:

Cyan:	0.23
Magenta:	1.00
Yellow:	0.59

Kodak Cyan:

Cyan:	1.00
Magenta:	0.49
Yellow:	0.23

Acid Blue 45:

Cyan:	1.00
Magenta:	0.50
Yellow:	0.24

Phone Numbers

note - these are circa 2000 and may no longer be valid, but I'm including them anyway.

Alfa Aesar Organics 800-343-0660 Chemical Distributor.

Allied Electronics 1-800-433-5700 General Electronics Supplies, Temp Controllers.

Allied Signal Chemicals 973-455-3005

C & H Sales Co. 1-800-325-9465 Surplus motors and Electronics.

Carolina Color and Chemical 704-333-5101 Supplier of Dyes.

Clestra Cleanroom, Inc. 315-452-5200 Suppliers of the HEPA blower.

Condit Mfg. 203-426-4110 (Warren Condit) Makers of pin registration equip.

David Doubley 313-235-8956, doubleyd@detroitedison.com. Comprehensive DT Manual.

DigiKey 1-800-344-4539 General Electronics Supplies.

Dr. Jay Paterson, Dye Transfer Co. 713-768-4581. Suppliers of DT materials.

First Reaction 603-929-3583 Best price on Silver Nitrate.

ICI 800-648-1926 Supplier Melenex polyester film.

Kind and Knox - 800-223-9244 Supplier of photographic gelatin.

Photographer's Formulary 800-922-5255 General Photographic chemical supplies.

Pylam Products Co. Inc. 602-929-0070 Suppliers of Dyes

Unique Photo 800-631-0300 Film and Photo Chemistry

VWR Scientific 800-932-5000 General chemical supplier

W. H. Berg Inc. 1-800-232-BERG. Makers of precision Mech. Parts.

Acknowledgements

I would like to thank the following individuals for their invaluable help with this project. Rae Adams was instrumental with the development of the matrix film emulsion. I also got invaluable help from Doug Gates with emulsion additives. Greg Wendholdt has generously shared his research and testing of the dye formulations. Harold Boechenstein has generously shared his research on the Dye Transfer process. Andy Cross has provided valuable help in dye calibration, and made many valuable suggestions. Dr. Jay Paterson has kindly offered several suggestions and encouragement along the way. Guy Stricherz of CVI Laboratory has generously given me several suggestions concerning the process. David Doubley has an excellent book on Dye Transfer, from which I have borrowed a few formulas. I would like to thank Frank McLaughlin for his support and encouragement. Finally, I would like to thank my Aunt Helen and Uncle Don Browning for getting me interested in the process in the first place, and showing me how its done. And I would like to thank my cousin Tom Browning for his help with setting up my dye lab.

	11		80		25		45	
CHEMICAL CLASS	Monoazo		Anthraquinone		Anthraquinone		Anthraquinone	
C.I. CONSTITUTION NUMBER	18820		68215		62055		63010	
HUE								
Daylight	Bright yellow		Bright bluish red		Blue		Blue	
Artificial light (tungsten)	Slightly redder		Yellower		Little change		Slightly greener	
DYEING: WOOL								
Method	3		3		3		3	
Levelling	Good; can be salted at boil		Good. May be salted at boil		Good		—	
S.D.C. migration test method/grade	—		—		—		I/2–3	
Staining other fibres	Silk—*hs*, nylon—*d*, acetate—*ss*, cellulose—*u*		Acetate and cellulose—*u*		Acetate—*s*, cellulose—*u*		Acetate and cellulose—*u*, nylon—*d*	
DYEING: OTHER FIBRES	Silk: sulphuric or acetic acid (levelling: good) Nylon: formic acid		Nylon: formic acid Silk: acetic, formic or sulphuric acid, or broken degumming liquor		Nylon: neutral; formic acid for exhaustion if necessary. Good barré coverage Silk: acetic, formic or sulphuric acid		Silk: formic acid	
PRINTING	Direct on wool and silk		Direct on nylon, silk and wool		Wool, silk and acetate: direct			
FASTNESS PROPERTIES								
Method	AATCC	ISO	AATCC	ISO	AATCC	ISO	AATCC	ISO
Alkali	5	4	4*	4	4	4	2	2–3
Carbonising	4–5	4–5	4–5	4	4	4–5	3	4
Chlorination — alteration	—	4	1	3	—	3	—	2–3
staining wool	—	—	—	4–5	—	—	—	3–4
Decatising	5	4–5	5	4–5	4	4–5	5	4–5
Light, ⅓–½ normal	—	5	4	5	4	5	4	5
normal	6–7	5–6	5	5–6	4–5	5–6	4	5–6
2 × normal	—	6	6	6–7	5	6	5	6
Milling, alkaline — alteration	2	1–2	2–3	2	1–2	2	1	1
staining wool	—	—	2–3	2	—	—	1	1
Milling, acid — alteration	—	2	—	3	—	4	—	2
staining wool	—	—	—	1	—	—	—	1–2
Peroxide bleaching — alteration	1	2	1–2	1	1–2	—	1	1–2
staining wool	—	—	1	1	—	—	1	1–2
Perspiration	1	2–3	3–4	3–4	4	3	2	2–3
Potting — alteration	—	2	—	2	—	—	—	1
staining wool	—	—	—	1	—	—	—	1
Sea water — alteration	3–4	2	3	4	2	3	2–3	2
staining wool	—	—	3	2	—	—	2–3	1–2
Stoving	4–5	4	4–5	4	3	4–5	4	3–4
Washing — alteration	2	1–2	2–3	3	1–2	3–4	1–2	2
staining wool	2	2	2–3	1	1–2	4	1–2	3–4
OTHER PROPERTIES								
Dischargeability	Good		Poor		Poor		Poor	
Effect of metals — copper	Redder		Slightly bluer and duller		Little duller		Slightly duller	
chromium	—		Little change		—		—	
iron	Duller		Duller		Little duller		Slightly redder and duller	
NON-TEXTILE USAGE	See Leather Dyes section Paper: coating and surface colouring Heavy metal salts struck on alumina are used in lacquers, paints and enamels, also for textile printing. Resins, cellulose esters amd spirit varnishes. Drugs and cosmetics See C.I. Solvent Yellow 15		Anodised aluminium, paper, plastics, soap, writing inks See Leather Dyes section		See Leather Dyes section Anodised aluminium Soap Bath salts		Heavy metal salts as pigments for printing inks, book cloths and wallpaper Paper: beater dyeing and coating Anodised aluminium Urea, melamine and nitrocellulose plastics Soap and cosmetics See Leather Dyes section	
			*Fastness properties on nylon (AATCC): Light 3; Washing 4		Fastness on nylon (ISO): Light 5–6, 6, 6; Perspiration 4–5;* Washing 4* *Syntanned dyeings			

Color Index Listings for Dyes

Disclaimer

The processes, formulations and equipment outlined in this manual are suggestions only. They have worked for the author, but may need to be modified to suit a particular need. Making the matrix film is a very difficult art to master. It requires extreme attention to detail and cleanliness. Do not expect this to be accomplished easily. I cannot predict your level of success in this. I have produced prints using these procedures with success. Differences in dye lot, and manufactures may affect your results, so always test samples of the lot you intend to buy.

Although I have carefully checked the manual for mistakes, I cannot be 100% sure that no mistakes exist, and I cannot be responsible for any losses due to mistakes or omissions in the information contained in this manual. If you find a mistake or omission, please bring it to my attention. To make sure that you have the latest information before undertaking any of the procedures contained in this manual, you should contact me before proceeding.

Use great caution when handling dangerous chemical. Obtain the MSDS sheets, and read them. Use industry standard practices when handling chemicals: rubber gloves, eye protection, waterproof clothing, and for some of the more toxic chemicals, use a full-face respirator, and a fume hood. I do not encourage you to work with any chemicals which are potentially hazardous to your health. If you decide to work with these chemicals, it is entirely your own decision. If you do decide to use hazardous chemicals, I advise that you research and use industry standard practices for safety. I would also advise that you research the laws concerning handling and disposal of toxic wastes, and observe them fully.

If you need some advice about DT printing, or matrix film coating, please feel free to contact me:

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