MASK ETCHING
(Vertical Method)

General Description:

The mask etching operation consists of processing raw flat cold rolled steel through a series of six stages of processing. Procedures and equipment highlights follow. As the rolls of steel, plastic, and paper move from stage to stage, they are stapled or taped to the preceding rolls to allow for continuous feeding and to avoid the necessity of reloading each stage since this requires considerable work and disassembly of the equipment. (NOTE: the steel is stapled and the paper and plastic interleaving is taped.)

I. First Stage (General) Sensitizing

Raw steel stock received from mill (currently using J & L and Feran in .005" and .006" thickness furnished in rolls wound with paper interleaving). Visual quality checks are made on each roll. Occasionally, a roll will not "track" properly due to improper cold rolling techniques. Such material is not usable and is returned to the supplier.

First stage machine - steel preparation and coating - consists of six sections. (See Sketch I - VI)

(1) Payout Rolls (See Sketch I)

Vendor supplied rolls are manually loaded. The alternate reel is used for switching to new roll. The paper take-up roll is driven with a torque limited drive and the steel roll is controlled (tension control) by an adjustable electric brake (Warner).

(2) Caustic Wash Tank (See Sketch II)

Caustic wash tank consists of tank with steam heated caustic mixture and pumps for recirculating mixture through nozzles against both sides of the steel sheet.

(3) Rinse Chamber (See Sketch III)

Washes caustic residue from steel sheet and dries prior to glue application.

(4) Glue Flow Coating (See Sketch IV)

Glue flow coating is accomplished by gravity flow from a glue reservoir pot at a 30 inch height above nozzle outlet. Flow rate is controlled by adjustable hose clamps in each of two coating lines which are guided along the top edge of the steel sheet by a counter balanced pivot assembly. Flow rate is critical as established by pressure, viscosity, and rate valve adjustment. These variables are selected so as to provide two edge flow wave patterns, the secondary of which to form a visable intersection with the primary wave between 1/3 and 1/2 of the sheet width (from the bottom edge). Flow from the second nozzle is adjusted to obtain a single wave pattern. Moyno pump and filte

assembly is located about five feet below reservoir fluid level and pressure in the supply line to the reservoir with a clean filter is 3-5 PSI. A ~~float level valve~~ Contact SENSING Switch controls the Moyno pump motor.

Glue Mix Details (One Batch - 16 Gallons)

21,750 cc - demineralized water
1,563 grams - ammonium dichromate
8.7 grams - Wetsall
11,600 cc - glue *Norland photoengraving glue

Mix

Add ≈26,000 cc DeI water to adjust to S.G. 1.045 ± .0005

(5) Drying Oven (See Sketch IV)

Drying oven is a steam heated recirculating air oven with a damper controlled filtered make-up air inlet. Coated sheet leaving oven is basically dry although does have a slight tacky feeling while it is warm. A moistened sponge is in contact with the bottom edge to preclude any glue bead build-up which could prevent intimate contact with the master plate in the exposure stage.

(6) Take-up Reels (See Sketch V)

The rewind or take-up reels consist of a U. S. Motors variable speed drive with associated paper supply and tracking adjustment rolls.

II. Second Stage (General) Printing

The chase operation sensitizes the steel coating (emulsion) to provide a pattern of acid resisting areas which result in the desired hole pattern.

Second stage machine is basically a large contact print machine with two arc lamps, sheet transfer and vacuum clamp mechanism, and master plate mounting frames. Since this is a critical operation from the standpoint of accuracy and alignment the plate mounting system is rigidly constructed and the moveable "R" plate mount is bushing guided on sturdy shaft slides with a mechanical toggle clamping mechanism. Details of general considerations are outlined in the series of Sketches VI through VIII.

The hole pattern is photographically printed on the steel contact side surface. Since it is desirable to etch a tapered hole, the "R" side pattern is larger than the "O" side. The etching process is accomplished from both sides and is controlled to break through about .002 from the "O" side. Since the etched mask is torn from the steel sheet, it is necessary to provide for smooth "burr" free sections at the locating tabs of the mask. These areas are etched through since the pattern is printed on the "O" side. (See Sketch VII) These are also notch patterns provided for manually cutting the continuous strip at the mask removal station. The temperature in the "chase room" is maintained at 72°to provide for mechanical size stability and the master plates are cooled by a continuous low velocity air blast. The exposure procedure consists of seven steps as outlined:

*Has high protein content made from fish oil.

(1) Manually index coated steel web to position in exposure area.

(2) Clamp, plate frame ("R" frame moves on shaft by toggle assembly) and apply vacuum (electric timer controlled). (NOTE: vacuum pump down time is 45 seconds and reaches 28".)

(3) Check alignment marks/target and visually inspect clamped assembly.

(4) Change sequence number on "R" side (See Sketch VIII)

(5) Light exposure. Timer controlled arc lamps turn on for 60 seconds (adjustable) upon completion of vacuum pump down in Step 2. (Light source consists of two Xenon arc lamps. See Sketch VI)

(6) Visually inspect exposed mask. This inspection is accomplished with the aid of a white sheet of cardboard that is held at various positions and angles to reflect light showing visual patterns of the exposed mask. Defects appear as circular or line reflections on the glass surface of the master plate.

(7) Release vacuum. This must be done with care to insure smooth separation of plates and sheet without pulling off exposed pattern. Repeat procedure at Step 1.

III. Third Stage (Emulsion Develop General Description) Developing

The opaque pattern on the master plates in the preceding stage prevented the light from reacting on the ammonium dichromate and thus it is water soluble in these areas. This stage basically washes away the soluble emulsion and exposes the steel surface to the etchant. The baking section solidifies the acid "resist" pattern in those areas where steel remains. (Refer to Sketch IX for general third stage machine configuration.)

The brake assembly at the front end of this stage provides for web tension and plastic rewind. As the web moves into Section A (Sketch IX), the deionized water washes away the soluble portion of the emulsion coating. This section uses temperature controlled water in two stages (to save water). The temperature is controlled by thermostatic controlled mixing valves which blends heated deionized (170°F) and room temperature deionized water to maintain 100°F water at the final washing portion in Section A. This run-off water is collected and pumped back to the first portion of Section A after which it is discarded. In all these are 7 rows of 7 spray nozzles on each side of the web. By controlling the pressure, volume, and position of the spray pattern, all of the soluble emulsion is washed away.

As the web moves into Section B, it is rinsed with a surfactant (mixture of water and Kodak photo-flo 600 with ethylene glycol) which insures that the web will dry evenly with no water marks or streaks.

The next operation is the drying and curing oven followed by the take-up and plastic interleave rolls. (See Sketch IX)

IV. Fourth Stage (Etching-General) (Refer to Sketch X) Etching

This stage chemically etches away all of the steel that is not coated with the acid resist. The etching solution (ferric chloride) is sprayed against both sides of the web by a series of oscillating nozzles in such a manner as to etch from both sides to break through about 2/3 of the way from the "R" side. (See Sketch XI) Control of this operation requires careful adjustment of many variables such as spray nozzle pressure (about 25 PSI ranging to 7 PSI near etch finish end), web speed, etchant temperature and concentration, direction of nozzle sweep, and flow volume. The etching process is visually monitored through viewing windows in the etching tank. Lights on the "O" side enable the operator to watch the "break thru" pattern which gives good indication of etching quality.

From the etch section, the steel is rinsed with water to remove acid residue. This is accomplished by spray flooding both sides with tap water which is processed for disposal.

Following the rinse, the water insoluble "resist" is washed off with a caustic solution. It is then rinsed and dried in the next 2 sections. The drying is accomplished by means of three radiant heaters on each side (chromolox) and rewound on the web take-up reel. (No interleaving used here.)

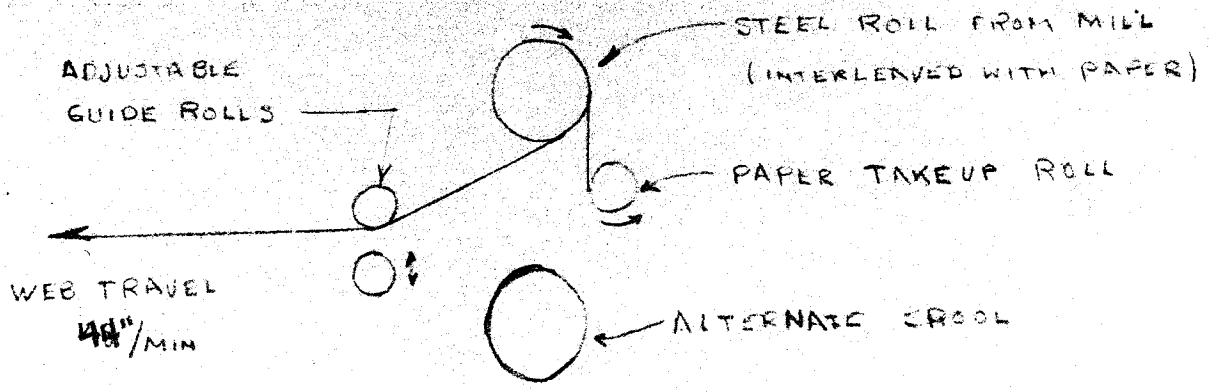
V. Fifth Stage (Quality Control and Inspection) Patrol check

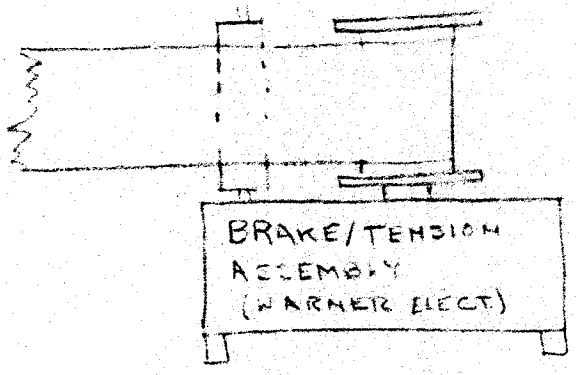
Each 10th mask is removed from the web and inspected for light pass characteristics in the center and on four corners on optically calibrated light source standards. Data from this inspection is used to adjust variables in the etching operation.

VI. Sixth Stage Strip Out

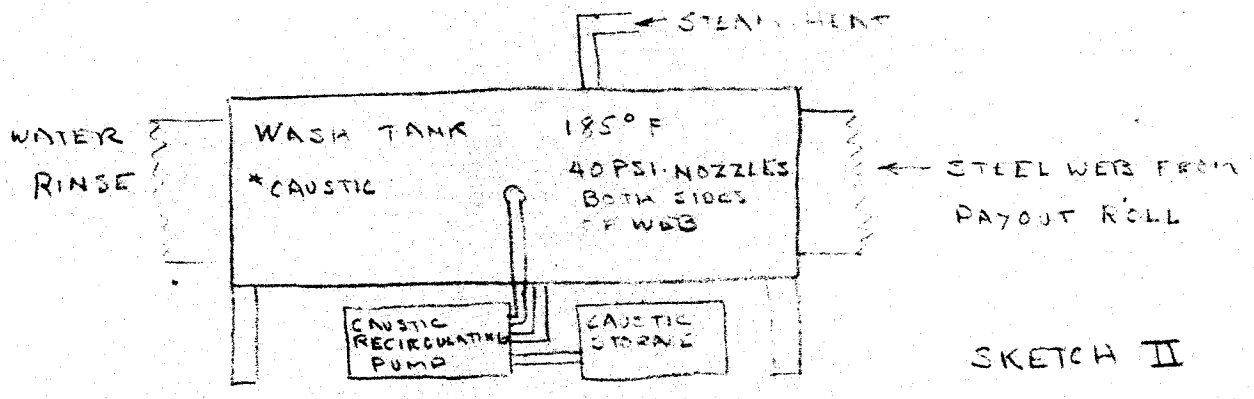
The mask web roll is then positioned in a horizontal plane over a work table and unrolled for manual removal of each mask. The removal is accomplished by tearing away the web section which holds the mask flat with a suitably shaped mask holding form.

J. R. Restle



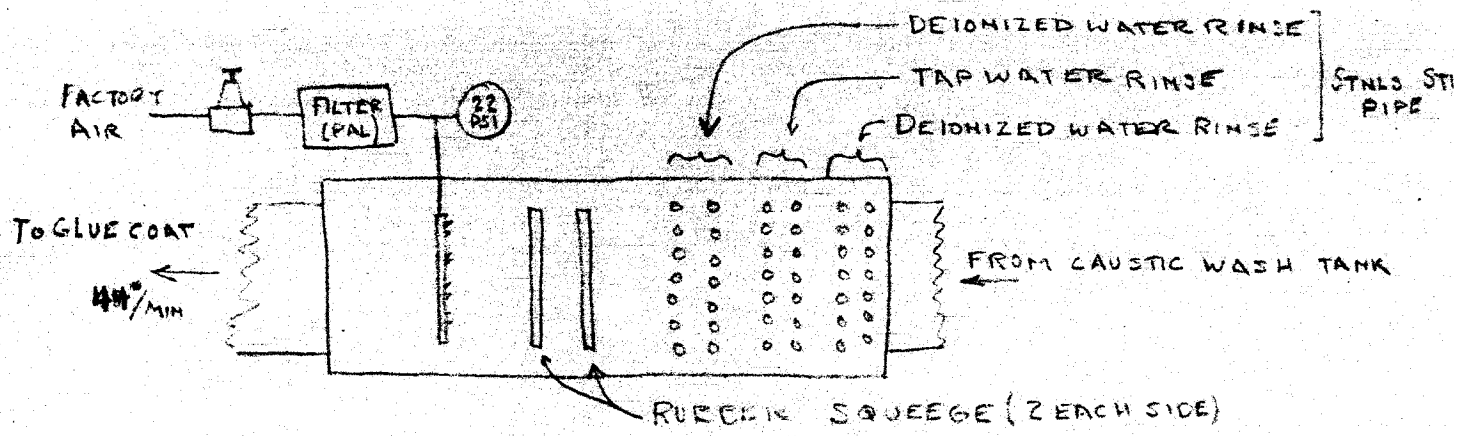


SKETCH I - PAYOUT END



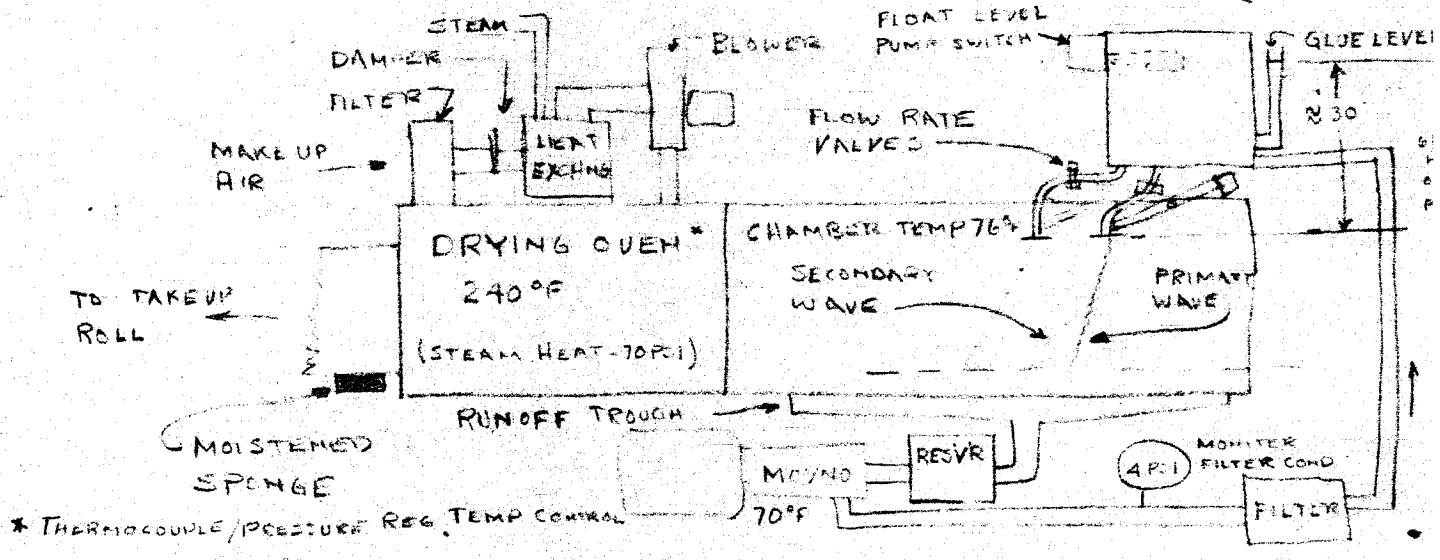
SKETCH II

* CAUSTIC - 1 QUART ENDOX L-76 / # SW 68
MAINTAIN BALANCE BY LAB ANALYSIS

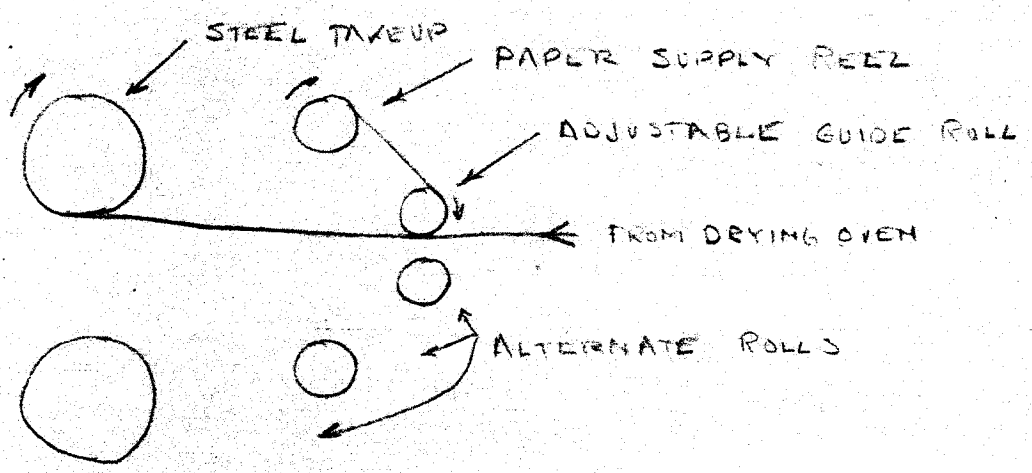


WATER SPRAY, AIR - SQUEEGE FROM BOTH SIDES OF WEB

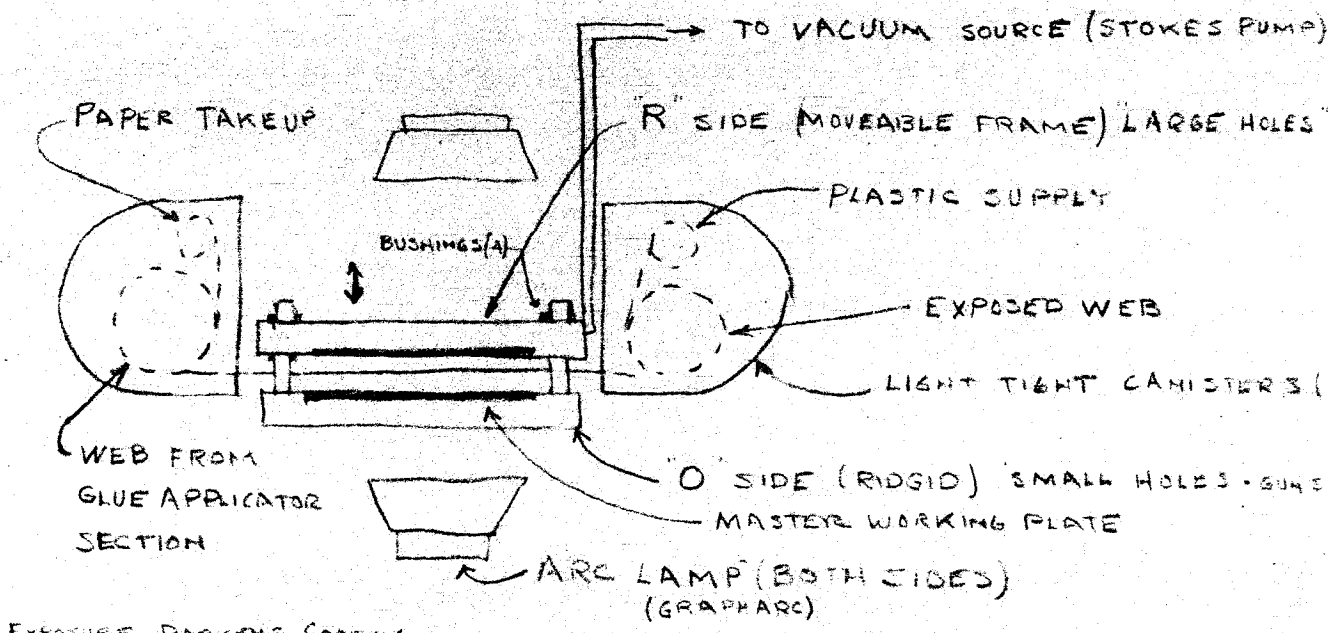
SKETCH III RINSE



SKETCH IV GLUE FLOW COATING & DRYING OVEN

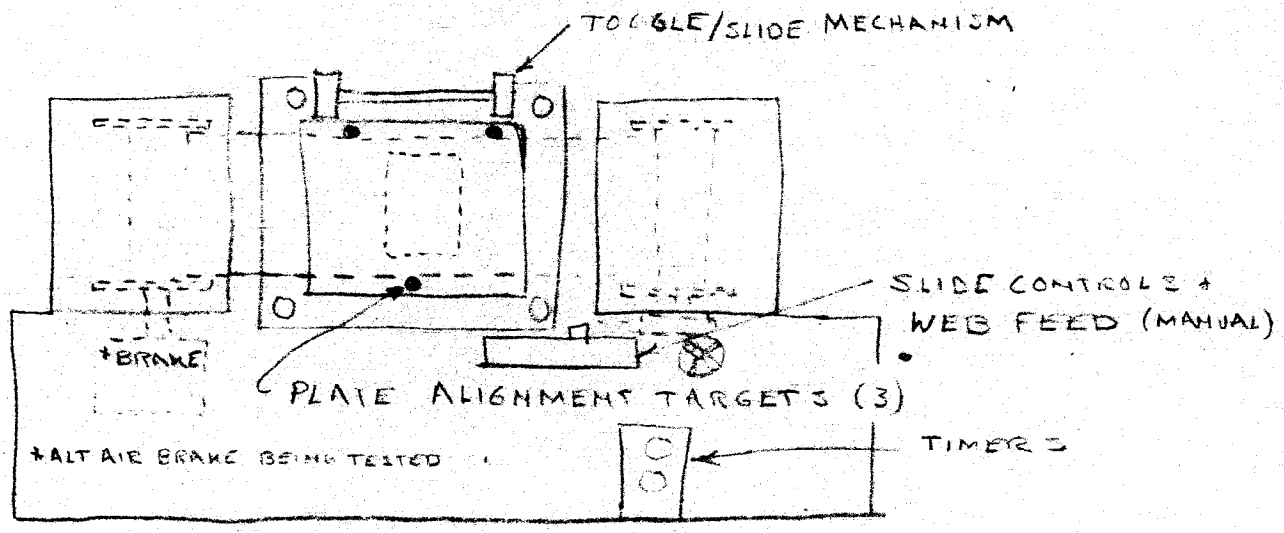


SKETCH V TAKE UP END



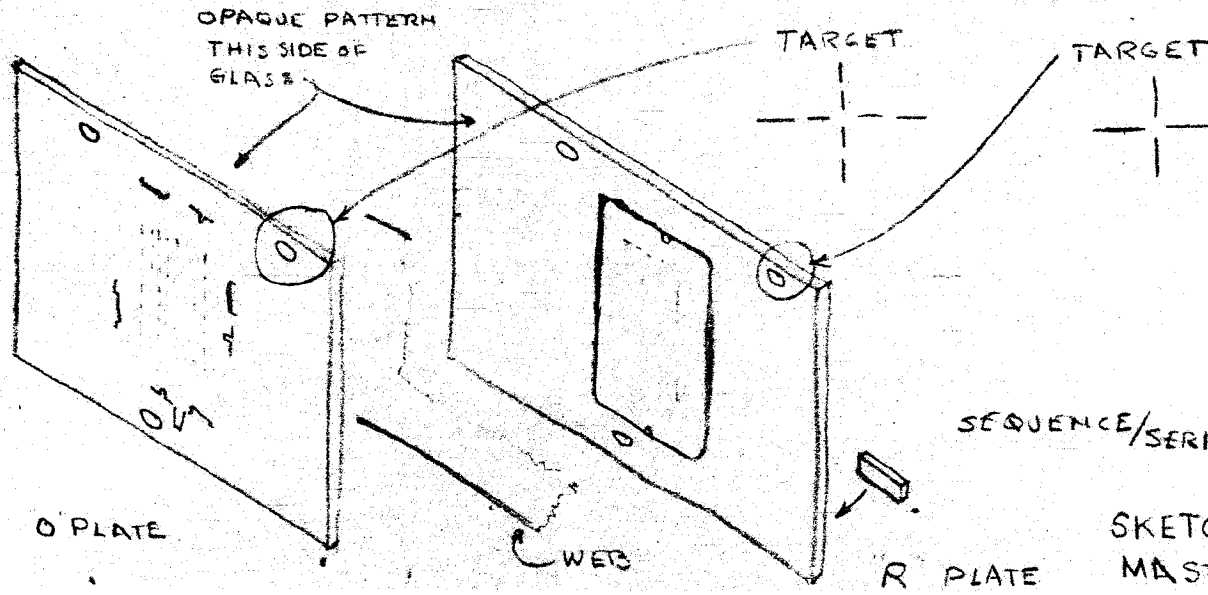
EXPOSURE DARKENS COATING

SKETCH VI EXPOSURE (CHASE)

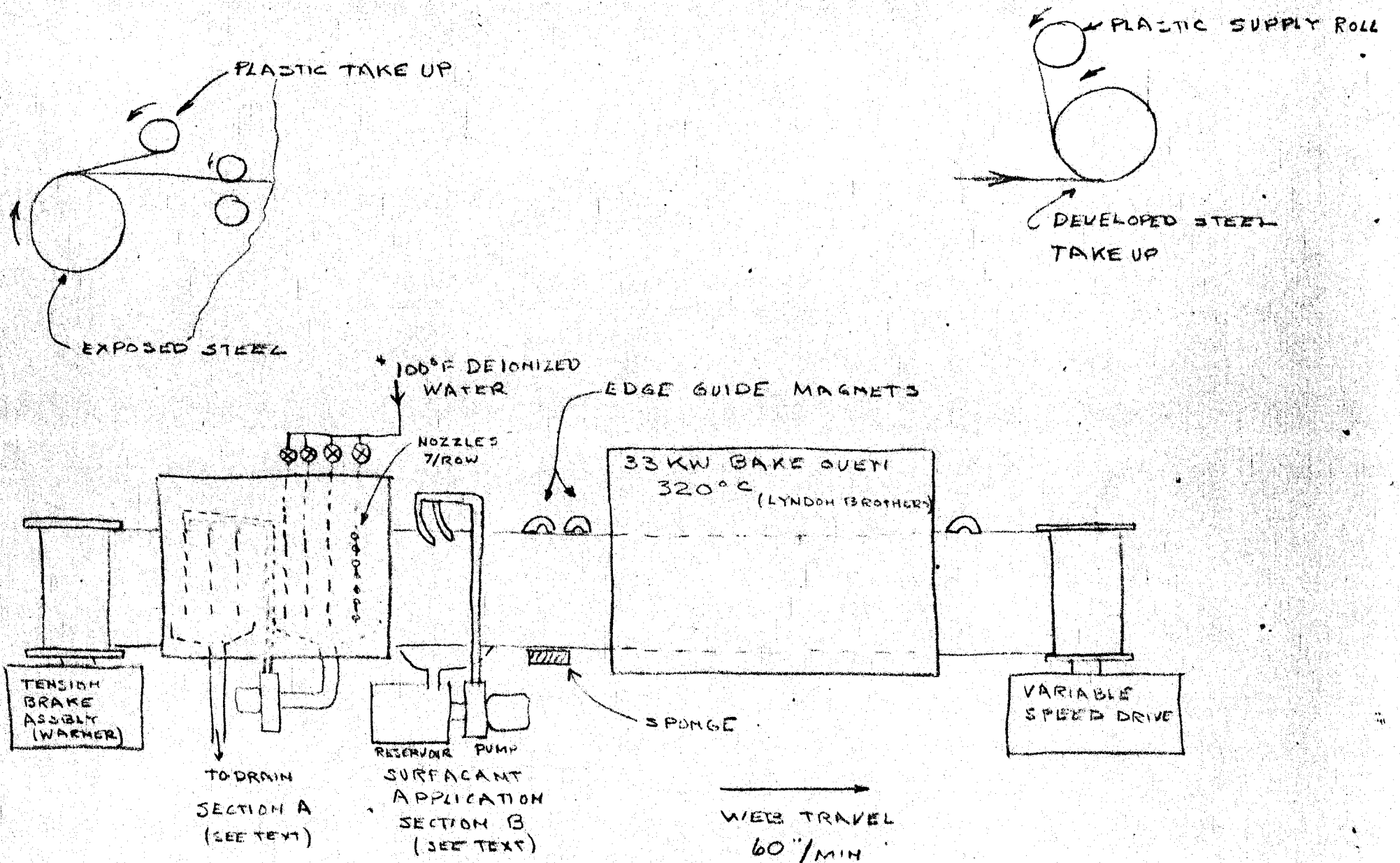


FACING "CHASE" MACHINE FROM ARC LAMP POSITION

SKETCH VII "O" SIDE (CHASE

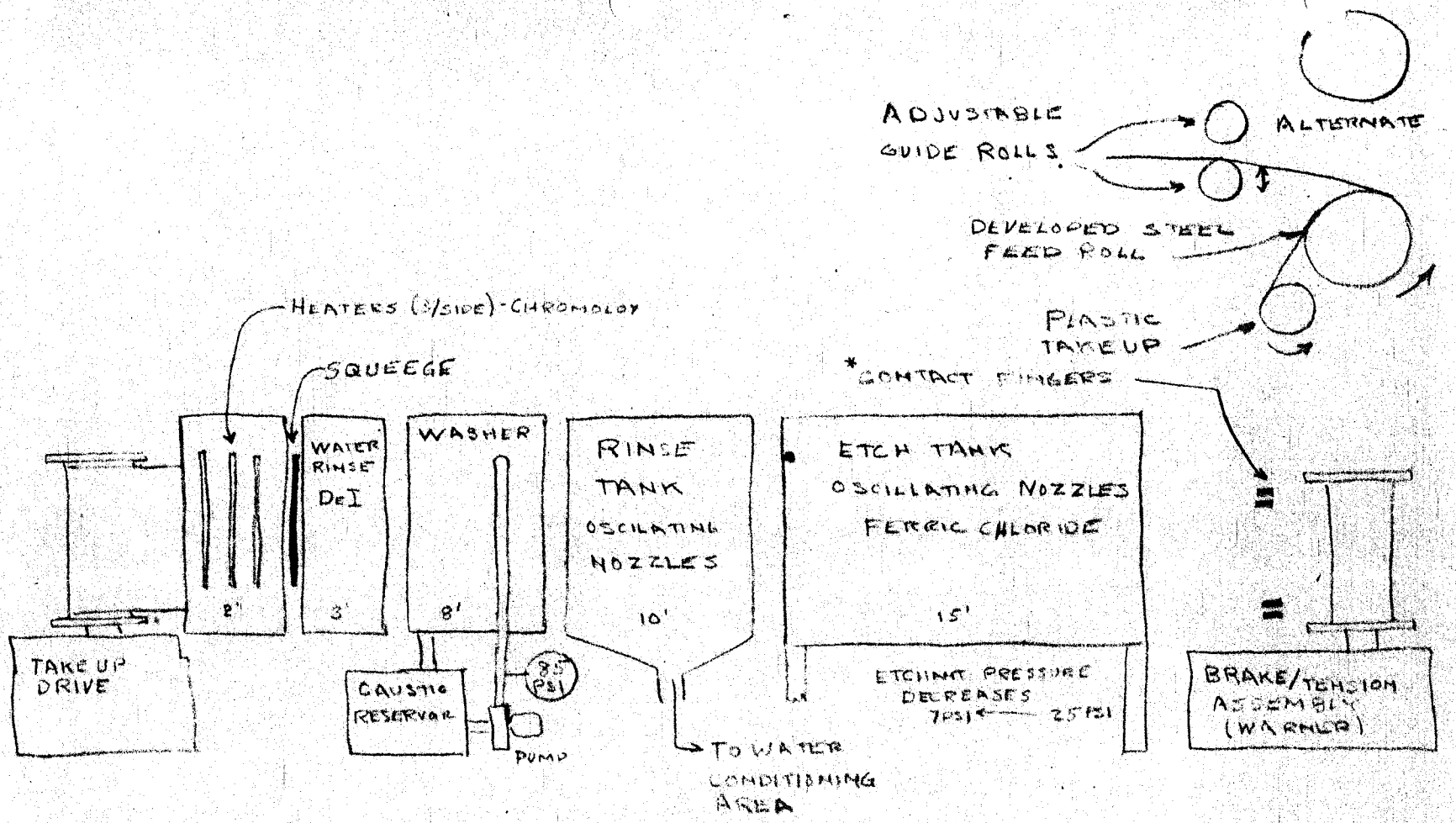


SKETCH VIII MASTER PLAT



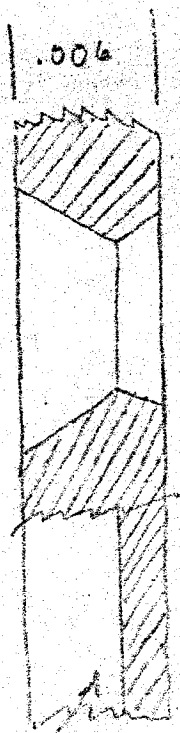
* WATER TEMP ESTABLISHED BY MIXING HEATED DEI (170-180°F) WITH AMBIENT TEMP WATER

SKETCH IX (THIRD STAGE) DEVELOPING



* CONTACT FINGERS - CHECK FOR RESIST PRESENCE
(EG CLOSED CIRCUIT = NO RESIST

SKETCH XI (4TH STAGE) ETCHING



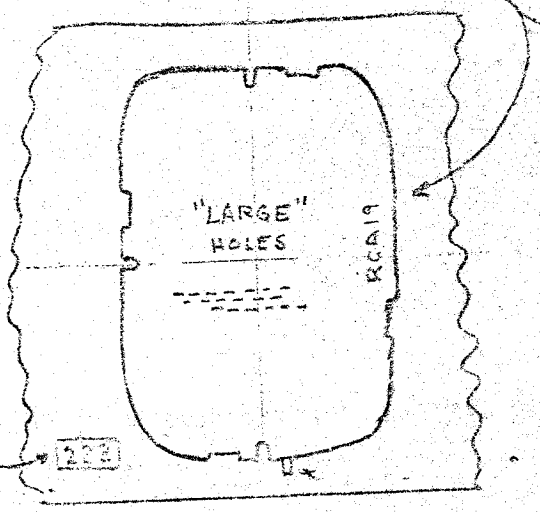
"R" SIDE
(PHOSPHUR SIDE)
LARGER OPENINGS

"O" SIDE - FRONT / GUN SIDE
SMALL "HOLES"

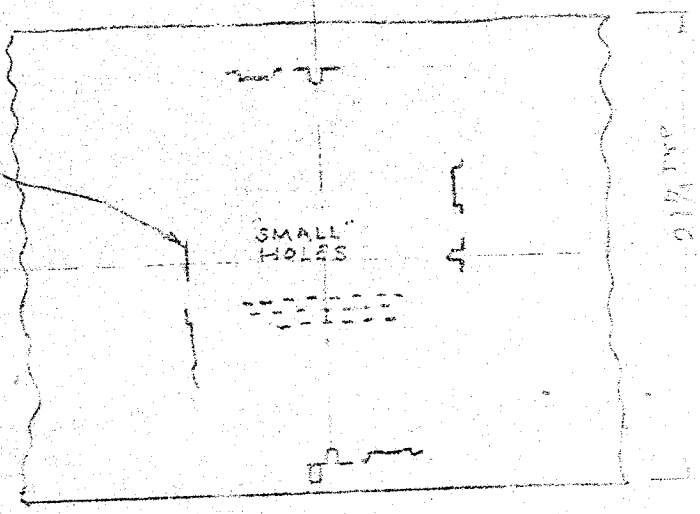
APPROXIMATE HOLE/SLOT
CONFIGURATION (CROSS SECTION)

ETCHED "TEARAWAY"
PERIPHERY - EXCEPT
AT LOCATING NOTCHES
AND THRU ETCH
SECTIONS

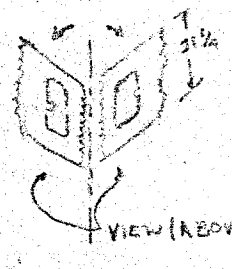
TOP EDGE OF MASK (TUBE)
NOTE LOCATING "NOTCH" AT BOTTOM (6 OCL



"R" SIDE TYPICAL PERIPHERY
ETCH THRU PATTERN



"O" SIDE TYPICAL PERIPHERY
ETCH PATTERN



* NOTCH FOR CUTTING WEB

SKETCH XI ETCH DETAILS