THIS BOOK CONTAINS NUMEROUS PAGES WITH THE ORIGINAL PRINTING ON THE PAGE BEING CROOKED.

THIS IS THE BEST IMAGE AVAILABLE.

PHOTOENGRAVING

by

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B.F.A., Bethany College, 1970

A MASTER'S REPORT

submitted in partial fulfillment of the

requirements for the degree

MASTER OF ARTS

Department of Art

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1972

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Major Professor

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INTRODUCTION

INTRODUCTION

This Master's Report illustrates technical information as synthesized from technical manuals, information as gathered from photoengravers and information as researched and used by the author.

This research began as a "junkyard" idea. The author began trying new directions in printmaking by combining photoengraved plates that were sold to junkyards as scrapmetal with plates that were hand engraved. (Plate #I)

Satisfactory results could have been achieved from this method; however, it does not afford the opportunity to use imagery that has special meaning to the author. In this case, the source and imagery of commercially produced plates was limited.

The author's interest in photography, the reproduction of photographs commercially and a desire to combine these with hand altered plates brought forth an interest in trying to duplicate commercially photoengraved plates.

At first, with only a small amount of research, the possibility of duplicating a commercially produced plated seemed impossible. This, however, changed with the discovery of Kodak pamphlets pertaining to photoengraving commercially. With this information the author set forth on research that has completely changed the direction in printmaking which the author had been previously pursuing. This research has brought a new challenge in attempting to jutaposition commercial imagery with images the artist has produced.

Using and following the procedures as outlined in this report will not guarantee results that will be of a satisfactory nature to each individual. These are results of a short period of investigation resulting in many failures,

but through the failures a direction was given to continue the exploration. The author has by no means reached a foolproof method of producing a perfectly photoengraved plate with each new image. New tests have to be made with new discoveries.

The only "fail-safe" method available is to have the plate commercially made or invest in a tremendous amount of expensive commercial equipment. Working within the restrictions of equipment that was available, the author feels that satisfactory images can be produced by the Artist-Printmaker. Further research in this area by the author will continue to make available new directions, new ideas, and hopefully, less chance for error.

Outlined in the following report will be the author's actual experience using commercial photoengraving products. Hopefully this research will be helpful in eliminating errors that others might encounter.

The methods of achieving a final product as used by the author are methods that are not used commercially, but generally follow the basic commercial procedures. For instance, the positive or negative master transparency is done commercially with a process camera and an arc of neon lamps, whereas the author used an enlarger to produce a master transparency. (See illustration on page 5.) The results of using an enlarger is a transparency with the same overall characteristics as a transparency done with a process camera.

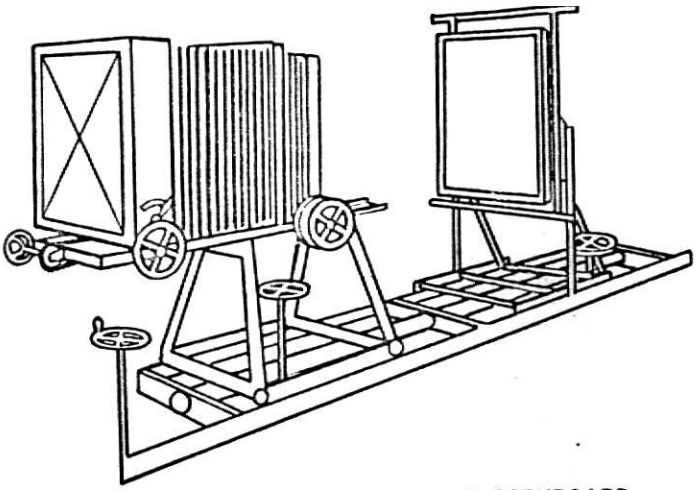
The author suggests that if more technical information is desired on commercial photoengraving, the reader may purchase from Kodak the various references indicated in the bibliography or visit a photoengraving company.

For the purpose of simplification, a glossary and a section on miscellaneous procedures is provided on pages 74 through 90.

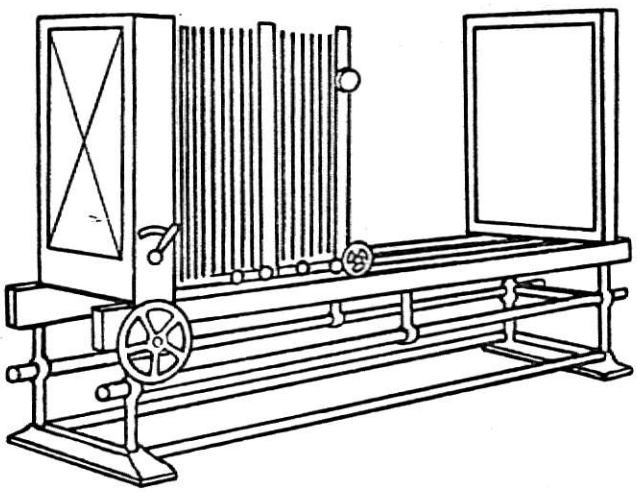
The author suggests the reader familiarize himself with the terms in the glossary. They will be used frequently throughout this report.

Under miscellaneous will be found applications that apply to specific procedures. For example, conversion acid needed for zinc or proper method for cleaning zinc.

As a final introduction to this report, the reader should become familiar with the procedures as outlined in an actual working situation. Thereby, the terminology and the procedures as used by the author will be more relevant and understandable.

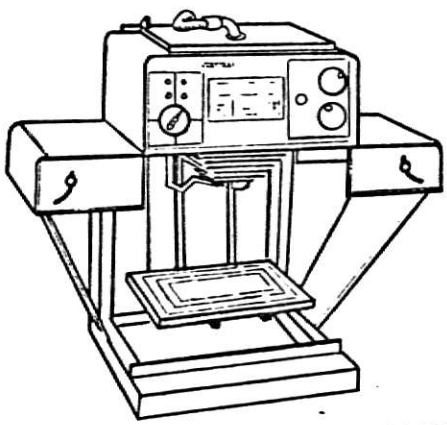


MOVABLE BACK, LENSBOARD AND COPYBOARD



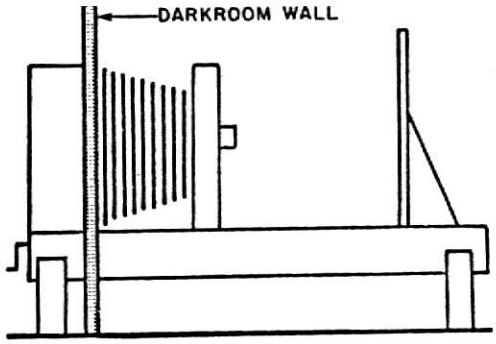
MOVABLE BACK AND LENSBOARD

GALLERY CAMERAS



MOVABLE LENSBOARD AND COPYBOARD

VERTICAL PROCESS CAMERA



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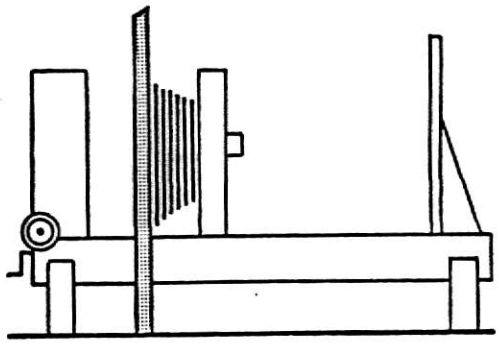

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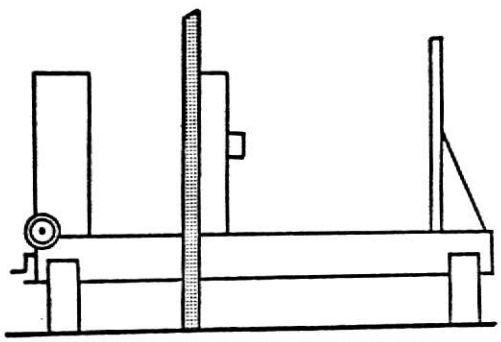

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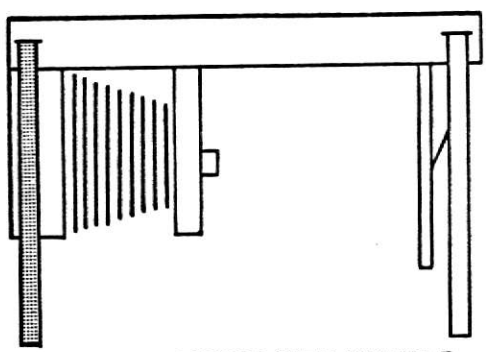
(NO BELLOWS)

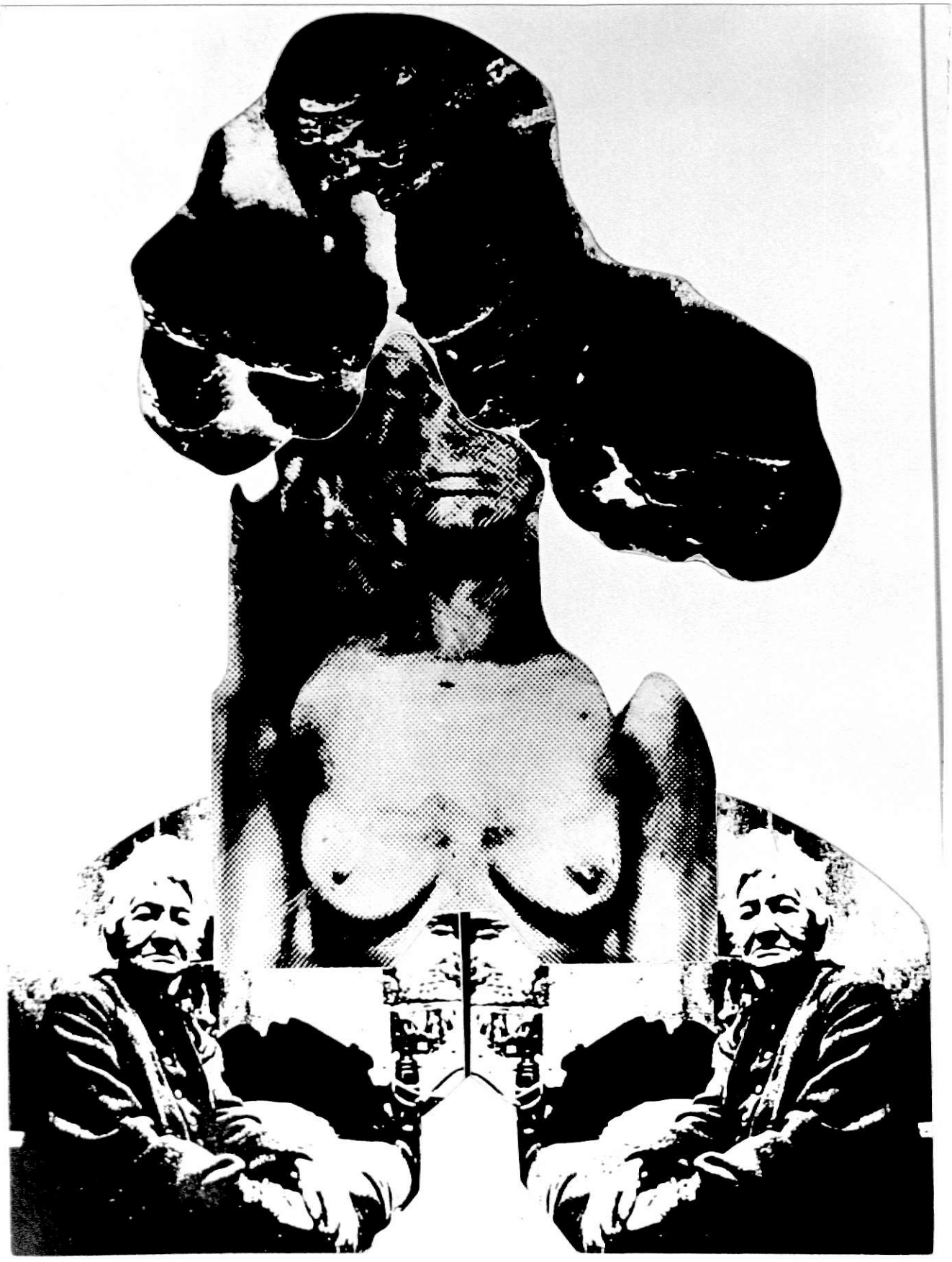


OVERHEAD CAMERA WITH MOVABLE
LENSBOARD AND COPYBOARD

DARKROOM CAMERAS

INFORMATION:

The illustration above will explain the different types of process cameras. These are the basic types found in most shops. A camera may be designed for some special type of work, but this is quite rare.



Photograph of a Plate Executed by Les Crook

EQUIPMENT AS USED BY THE AUTHOR

EQUIPMENT AS USED BY THE AUTHOR

The equipment as outlined in this part represents the basic and necessary equipment as used by the author, however, other types of equipment could be used for the development of a master transparency of equal quality.

1. A room that is at least 8' x 10' with a working table, running water, and one which can be sealed from light. (See illustration on page 10.)
2. 35mm single lens reflex camera.
3. Automatic close-up rings for detail work.
4. Tripod for copying.
5. 45 MCR enlarger that holds 35mm negatives up to 4" x 5" negatives. The enlarger has a 55mm lens and a 75mm lens. This enlarger with combinations of lenses makes possible all combinations of various enlargements.
6. Trays--size 11" x 14" and 16" x 20". This combination makes possible trays for small enlargements as well as large without the use of a great amount of chemicals.
7. Chemicals:
   - A. For processing 35mm negatives.
     1. D-76 Kodak Developer.
     2. Kodak Indicator Stop Bath.
     3. Kodak Fixer.
   - B. For processing Kodalith Film or other Graphic Art Films.
     1. Kodalith developer Parts A and B.
     2. Kodak Indicator Stop Bath.
     3. Kodak Fix Bath.

8. Films:

   A. For making negatives for positive master transparencies.

      1. Kodak Tri-X film.

   B. For making Positive Master Transparencies.

      1. Kodalith Ortho film 4556, Type 3, (Estar thick base) size 8 x 10.

      2. Kodalith Ortho film 2556, Type 3 (Estar base) size 16 x 20.

      3. Kodalith Autoscreen 2563 (Estar base) size 8 x 10.

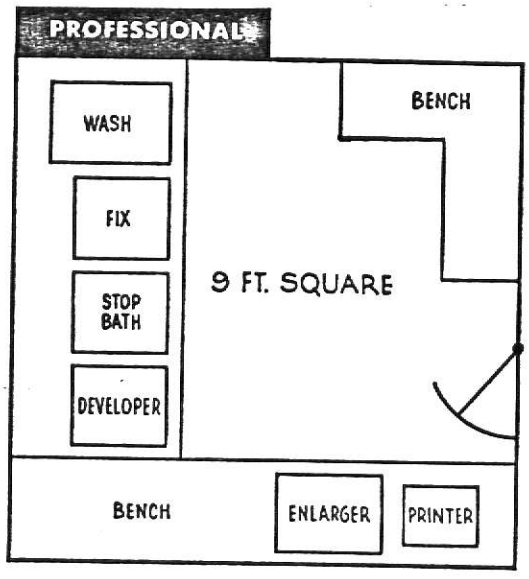
9. Gralok Timer.

10. Safelight--Kodak swivel base with combination of yellow, red, yellow-green filters.

11. Photofloods--Two photoflood bulbs were used for most exposures. The photofloods were of the type BCD.

12. Air Brush and Compressor.

13. Handmade Whirler.



Basic set-up for a Dark Room.

THE NEGATIVE

THE NEGATIVE

Before any of the following procedures can be performed a negative of the original work must be obtained. Normally this is done by photographing objects with a camera.

Most any camera can be used to achieve some kind of result; however, if detail work is desired, such as copying from books, magazines, or other sources, a camera mounted on a tripod with extension rings, macro-lenses or closeup lens is required. Close work requires a camera with adjustable and removable lens; therefore a 35mm SLR camera works best.

Copying a full page illustration layouts, drawings, etc. can be achieved by a copy camera which provides a sturdy means of focusing on the art work to be photographed.

The negative itself will depend upon the size camera used. The author always used a 35 SLR camera, so the negative was rather small. Other cameras produce negatives of larger size such as $2\frac{1}{2}$ x $2\frac{1}{2}$ or 8 x 10 inch negatives. Normally the largest negative used in this report was a 4 x 5 inch. The standard, however, for all master transparencies was from a 35mm negative for this report.

The production of the negatives as used by the author came from Kodak Tri-X film. Basically there is no reason for using this film, but it did produce large graininess which was desirable.

Once the roll of film is exposed in the camera it may be returned to a photography dealer for developing. Only the negatives are used as there is no need for the prints. In some cases the photographer may want a contact print to determine the quality of the negative. The photography dealer will gladly provide the photographer with the added print.

Once the negatives are returned to the photographer, they should be stored in such a manner as to prevent scratches and other damage to the emulsion.

Handle a negative only by its edges. Fingerprints, smudges, lint, dust, and scratches all will be transferred to the final master transparency.

Fingerprint smudges can be removed by a slightly moist photo sponge and film emulsion squeezed.

Dust and lint can be removed by blowing on the negative or using a photo lint brush.

Scratches on a negative require a procedure that does not make it a worthwhile process. Either re-photograph or accept the final imagery that will be transferred to the positive.

THE ENLARGER

THE ENLARGER

Enlargers come in all sizes and all prices. The enlarger used by the author provided for interchangeable lens and negative carriers from 35mm to 4 x 5 inch, adjustable bellows to correspond with the different sizes of negatives, and adjustable bellows for focusing. The enlarger provided for enlargements from 1 x 1 to 16 x 20 inches using the easel of the enlarger.

The purpose of an enlarger is to provide the photographer with an enlarged positive image either as a finished product or to be used in further reproduction. The finished product does not necessarily have to be a positive as this can be altered to provide a negative with different kinds of film.

Following will be the basic procedure for the use of the enlarger. (7)

1. The negative is inserted in the proper negative carrier with the emulsion side down towards the enlarging lens.
2. The enlarger is turned on.
3. The enlarger is moved to a height that will obtain the size image desired.
4. The enlarger is focused for clarity of image.
5. The lens is adjusted to proper F stop.
6. Turn off the enlarger.
7. Film is placed under the enlarger, on the easel, with the emulsion side facing up towards the lens of the enlarger.
8. The clock is adjusted for proper time of exposure.
9. The clock and the enlarger are turned on at the same time.
10. At the end of exposure turn off the enlarger, remove the film, reset the clock for length of time in developer and place film in the develope

ENLARGING LENS

ENLARGING LENS

Basic understanding of the enlarging lens is necessary to reproduce a workable transparency. The information as outlined here applies to any lens, however, the F-Stops may be entirely different, but the progressing of stops will fall somewhere in or outside these limits. (7)

The fastest lens provides the largest aperatures, since the larger openings let in more light and cut down on the exposure time. The largest aperatures always have the smallest F numbers. An F/8 opening, for example, is larger and faster than F/16.

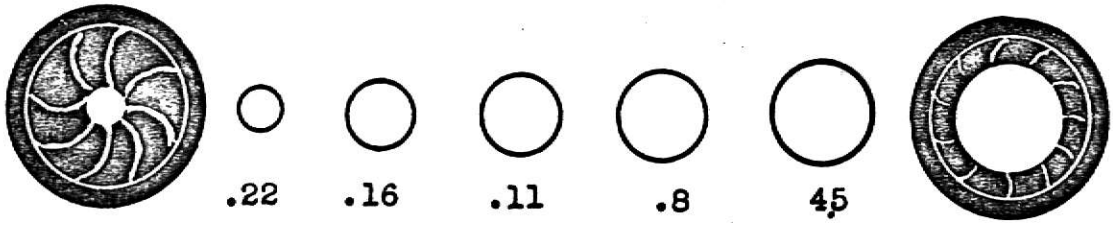
The larger aperature (smaller F/numbers) permit shorter exposures, but decrease the sharpness of the image. However, photoengravers are normally concerned with sharpness and accuracy rather than speed, so they rely on small aperatures (larger F numbers) and long exposures. For most purposes the F/8 or 11 aperature is suited for copying line work, but if the copy consists of very fine lines, the lens should be stopped down to F/16 for greater sharpness.

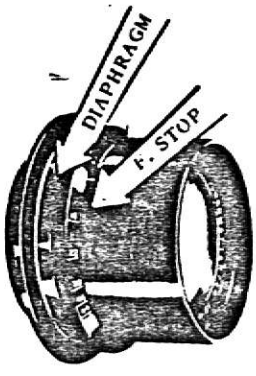
Since an F/16 opening is smaller than the F/8, the exposure time must be increased. Using the next smaller or larger lens opening either doubles or halves the exposure time. For example, a 10-second exposure at F/11 will require 20 seconds at F/16 or 5 seconds at F/8.

If the F/8 opening is used for the same size work at a basic exposure, either the opening or the exposure must be changed or the exposure must be changed if the copy is reduced or enlarged. (The distance from the lens to the film being exposed is changed.) In most cases, the photographer keeps the F opening constant and changes his exposure time.

Each lens barrel contains a device known as the "iris diaphragm". This disphragm consists of a series of thin metal blades which are so arranged as to

form a circular opening in the center. By turning a ring or collar on the outside of the lens barrel, these blades can be adjusted to increase and decrease the size of the opening. In this manner the amount of light reaching the film to be exposed is controlled. These blade openings are kept at a certain size in relation to the size of the lens. The opening that is formed is referred to as "F Stop". These numbers appear on the collar of the lens. (See example on page 19.)





The location of the Lens Diaphragm and the F. Stop Numbers.

F stops or numbers represent a fractional part of the focal length of the lens. When you set the F stop at F8, you are actually setting the opening to 1/8th the size of the lens focal length. (If the lens is 16 inches, the size of the opening would be 2".)

Illustration Showing F Stops in Relationship to Lens Opening

PROCEDURES FOR EXPOSING KODALITH AUTOSCREEN, LINE FILM, AND CONTACT PRINTING

PROCEDURES FOR EXPOSING KODALITH AUTOSCREEN, LINE FILM, AND CONTACT PRINTING

The following procedures will include contact printing, master reproduction, and use of autoscreen film.

Contact Positive From a Negative

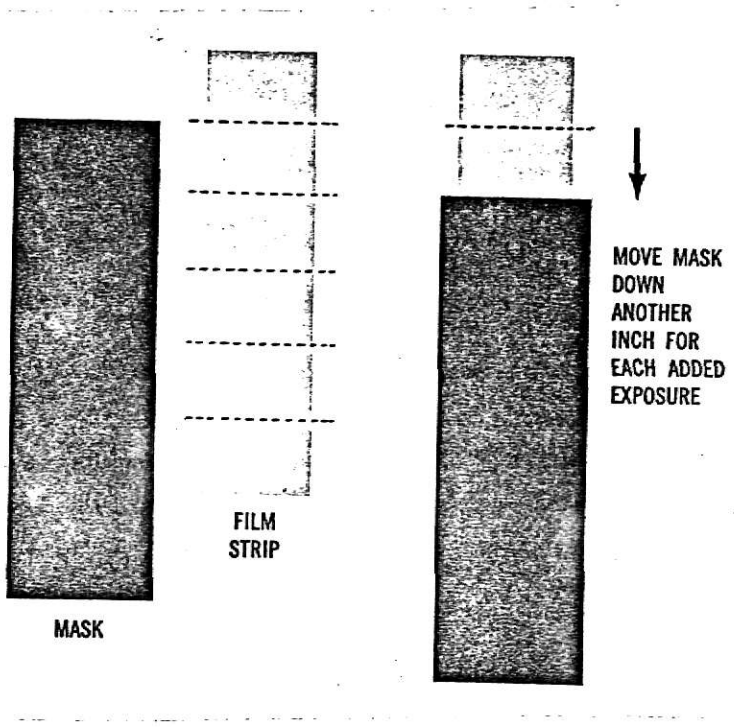
To expose the film image onto the plate, printmaking methods require a film positive. To obtain a positive, Kodalith film is contact printed with a negative. To obtain a good contact positive the two films have to be in as close contact as possible. This can be done by placing a sheet of plate glass over the film and exposing, then develop and a positive image is obtained. (See illustration on page 24.)

A test strip can be made to eliminate most of these variables. To determine exposure start with an F stop on the enlarging lens of 8 with a normal density negative and increase the time in a uniform progression; each time moving a mask across the emulsion side of the film. (See example on page 23.) A series of steps could be 4, 8, 16, 32, 64 seconds. Develop the strip and determine which exposure of the film gave the best results and repeat to the size of film desired. (7) The procedure indicated here is the basic order to follow in exposing a direct exposed Kodalith.

1. Place negative in negative carrier of enlarger with emulsion side down. Place in enlarger and (adjust for clarity of image) raise or lower enlarger to size desired.
2. Turn off enlarger, place Kodalith film on easel with the light dull side facing up towards the lens. The dark shiny side is the back

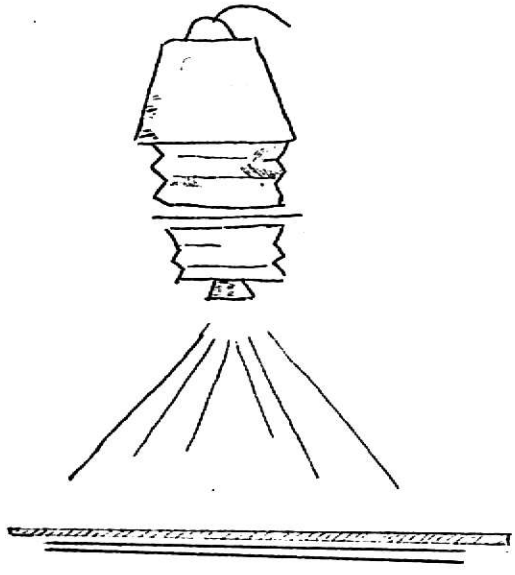
of the film. (7) Handle the film by the edge as much as possible. (7)

3. Set clock to desired length of exposure, turn on clock and enlarger at the same time.
4. Develop Graphic Art Film as recommended by the manufacturer.



Procedure To Use For Test Strip Exposing of Film

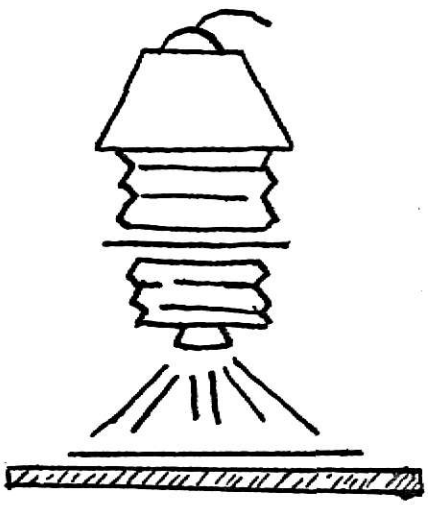
White Light Source - Bulb or Enlarger



1. Plate glass
2. Negative--
   emulsion side down
3. Kodalith--
   emulsion side up

Make the exposure to white light as recommended for the type of film being used.

Illustration for Exposing Contact Printed Film



Negative

1. Kodalith Film
2. Easel

Exposing Using Direct Method

Kodalith Transparency Positive Exposed in Direct Method
Without Halftones

Correctly Exposed Kodalith Transparency

Contact Exposing With the Use of Autoscreen and Contact Screen

Halftones become essential in intaglio work as a means of retaining the ink in the etched areas of the plates. Normally, when the image is printed with small halftones the dots and the paper fuse visually and trick the eye into seeing intermediate tones without actually seeing the halftone pattern. The halftones produced by the author were strictly from Kodak Auto Screen film.

Kodak Auto Screen is designed to render automatically a halftone image from a continuous tone original, without the use of a separate halftone screen.

To develop a full range of tones a detail exposure is required, followed by a flash exposure. (See illustration on page 30.)

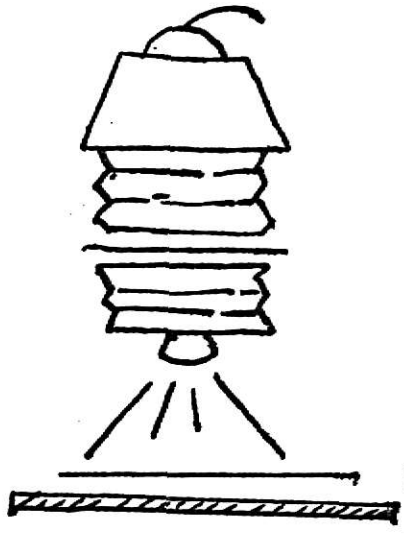
The author in all reproduction, contact printed the 35mm or a $2\frac{1}{2}$ x $2\frac{1}{2}$ negative to produce the master autoscreen transparency. The author's transparencies were based upon the reproduction of positive transparencies only, therefore an additional step is added to the reproduction of the master transparency.

Procedure For a Positive Transparency Using a Halftone Contact Printed Positive

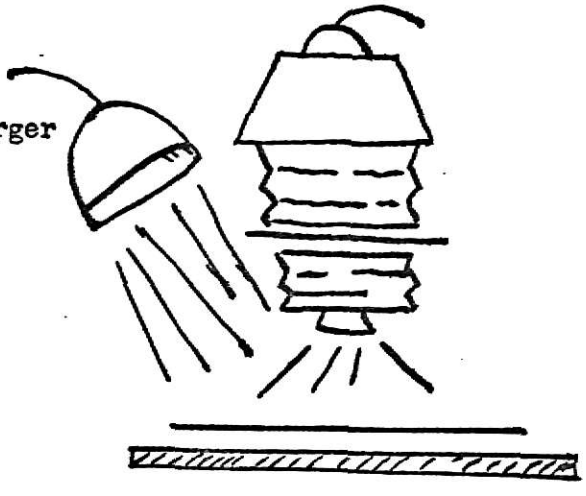
The Kodak Autoscreen is contact printed with a 35mm negative or a 2¼ x 2¼ negative, using the technique as explained on page 30. This produces a positive transparency or a positive negative of the same size as the original negative. Develop, stop, fix. The positive negative or transparency is contact printed with Kodalith film producing a negative transparency of the same size as the original. Develop, stop, and fix.

The detail exposure is made with the negative in the enlarger. In both detail and flash exposure the enlarger is in the ON position. (See example on page 30.)

Flash exposure--The flashing equipment consisted of a Kodak adjustable safelight with a light yellow filter. The safelight is hand held about three feet away from the Kodalith film as the film is being exposed by the enlarger. (See example on page 30.) The only problem with this method is there is no way of controlling the size of the halftone dots per square inch. For example, the larger the master transparency the larger will be the dot pattern. The only alternative to this method is the use of a halftone screen closer to the size of the master transparency or by using Kodak Contact Screens. Both of the latter require a sizeable amount of money investment.



Main Exposure of Kodalith Autoscreen Film



Flash Exposure of Kodalith Autoscreen Film

Test Strips of Autoscreen Showing Combinations of Exposures
Relating to Over and Under Exposure

Correctly Exposed Autoscreen For Photo Engraving

The Final Autoscreen Transparency

The dots can be examined for correctness of the detail and flash exposures. All tones of the transparency will be represented by dot sizes between these extremes: (7)

- If the highlights are solid black, with no tiny clear dots, the main exposure was too long.
- If the clear dots in the highlight area too large, the main exposure was too short.
- If the highlights are satisfactory but the shadows are clear, with no dots, more flash exposure is needed.
- If highlights are satisfactory but the shadow dots are too large, less flash exposure is needed.

The dots should range from a dense, small dot in the lightest tones to a small, clear opening in the shadows. Pale brown dots in the highlights usually will not produce properly. Experience revealed that the highlight dots should be larger pinpoints and that the clear dots in the shadows should be similarly large. (5) Make a test strip which has the correct dot size; make a print with the corresponding exposures. Slight errors can be compensated for by increasing or decreasing developing time.

Halftone From Magazines, Books, Paper, Etc.

Copying from materials that have already been mechanically reproduced will already have halftones. The problem, however, might arise from the scale of the original reproduction used by the photographer. The mimute scale may not reproduce as halftones. For example pictures in magazines contain 14,400 dots per square inch and many color illustrations contain 57,600 dots per square inch. However, most reproduction work in magazines is done with screens containing 150 lines per square inch. Copying these magazines with 150 line ruling will translate into halftones on the master transparency. Therefore a halftone screen, nor autoscreen is necessary on illustrations with lines less than 150 per square inch. (8)

Halftone Screens in General Use

133 LINE SCREEN
For printing on coated paper.

120 LINE SCREEN
For magazine and dull coated papers.

100 LINE SCREEN
For machine finish, super and bond papers.

85 LINE SCREEN
For blotters, colored bonds and high-grade newsprint.

65 LINE SCREEN
For average quality newsprint.

50 LINE SCREEN
For national newspaper advertising

Illustration Showing Examples of Screens at Different Lines Per Square Inch

PREBAKING OF SENSITIZED RESIST

PREBAKING OF SENSITIZED RESIST

Prebaking is not essential, however, it does remove moisture, dries out unevenous of application of resist. Over prebaking should be avoided for it destroys the resist, causes resist fogging and changes the character of some metals.

Zinc is particularly affected by temperature. At temperatures between 300 and 400 degrees farenheit the character of zinc begins to change and at temperatures of 400 degrees a complete change takes place in the structural quality of metal. Excessive heat not only effects changes of character of the metal, but destroys cohesion of the resist as well. (5)

Prebaking time as used by the author depended upon the thickness of the resist application. The prebake temperature was usually done at a temperature of 225°F. The prebake time varied from five to ten minutes.

MAXIMUM PREBAKING TEMPERATURES FOR KODAK PHOTOSENSITIVE RESISTS

Resist	Temperature/Time
KODAK Photo Resist	250 F (120 C) for 10 minutes
KODAK Photo Resist, Type 2	250 F (120 C) for 10 minutes Specifically recommended for thick images.
KODAK Photo Resist, Type 3	250 F (120 C) for 10 minutes
KODAK Metal-Etch Resist	250 F (120 C) for 10 minutes
KODAK Photosensitive Lacquer	250 F (120 C) for 10 minutes
KODAK Ortho Resist	*Do not* exceed 176 F (80 C) for more than 10 minutes maximum. Complete insolubilization will occur within 5 minutes at temperatures of 212 F (100 C) and above.
KODAK Thin Film Resist	180 F (82 C) for not more than 20 minutes. Lower temperatures for longer times can be used. Temperatures over 220 F (104 C) may adversely affect adhesion.

Prebaking temperatures for Kodak Photosensitive Resists

PROCEDURE WITH KODALITH FILM IN EACH CHEMICAL USED FOR PROCESSING

PROCEDURE WITH KODALITH FILM IN EACH CHEMICAL USED FOR PROCESSING

Before removing Kodak film from package, make sure the safelight is safe. Use a small strip to test in the presence of turned on safelight. Develop and look for any signs of fogging.

There should be four trays--three trays for chemicals, another larger tray for washing processed film. (5)

DEVELOPER Into one tray pour about ½ inch in depth Kodalith developer parts A and B. Add water to three times the total of A and B. Kodalith developer, parts A and B, should only be mixed immediately before usage as the mixture quickly exhausts itself within a twelve hour period. As with other photographic chemicals, Kodalith developer should be used at 68°F to 70°F.

STOP BATH Into a second tray pour about a one inch depth of acid stop bath, such as Kodak Indicator Stop Bath. Stop bath consists of a 28% mixture of acetic acid with indicator to determine point of exhaustion. Also, used with glacial acetic acid mixed in three parts acid to eight parts water. The exhaustion rate on stop bath is about 100 8" x 10" transparencies. Follow the instructions on the package for mixing since this varies with the amount of stop bath by weight.

FIXER Into a third tray pour an inch of Kodak Fixer or Kodak Rapid Fixer. Kodak Fixer and Rapid Fix have approximately the same rate of exhaustion as stop. These rates should be adhered to fairly closely or the Kodaliths will be streaky and yellow. (7) Follow the instructions on the package for proper mixing ratio as this varies with the amount of fixer by volume and weight.

WASH Fill a large tray with water, and keep the water running. Circulation and replenishment of water is a necessity.

TIME The developing time and the recommended developer are stated in the instruction sheet packaged with the film.

TEMPERATURE Temperature can be adjusted to the recommended 68°F by floating the trays of solution in a sink. Do not put water into the developer to adjust temperature.

ILLUMINATION The film, exposed or unexposed, must be handled only by the Illumination of the safelight recommended in the instruction sheet packaged with that particular film. The safelight provides light of a color and intensity that will not effect the film if darkroom work is carried out with reasonable care.

The Kodalith film, after exposure, is immersed quickly and completely in the kodalith developer with continuous agitation. The time on most film will vary between two and two minutes and forty-five seconds. (See illustration on page 43.)

STOP BATH Remove Kodalith film from developer with left hand and place face up in stop for at least thirty seconds.

FIX Remove Kodalith film with right hand, place in fix from three to five minutes.

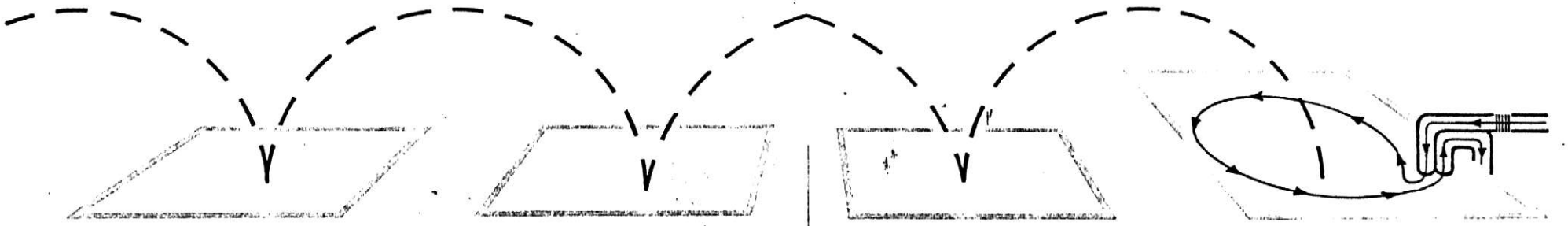
WASH Remove from fix, wash in running water from fifteen to twenty minutes.

Remove from wash and squeege with a regular window squeege on a smooth surface such as glass or plexiglass. Hang to dry. If after removal from the fix and after washing, the kodalith is slightly yellow, the fixer could be exhausted or kodalith removed too quickly from fixer. Replace fixer and put Kodalith film back in fixer for two minutes. Wash and dry.

Characteristics of a Correctly Developed Transparency: (7)

- Black areas so dense that light cannot, or can barely be seen through the image.
- Few pinholes in the solid black areas.
- Clear clean transparent areas.
- Image edges as sharp as the original.
- Correct size and shape transparency desired.

Store transparencies in dust-free containers until ready for use.



DEVELOP

Place the exposed film in the developer. Do this by dragging the film face-down through the developer and then quickly flipping it over, face-up. Agitate the developer continuously as follows: Raise the left side of the tray about ½ to ¾ inch; lower it smoothly, and then immediately raise and lower the far side similarly; next, raise and lower the right side, and then the near side. These four operations constitute an "agitation cycle," which requires a total time of about 8 seconds. Most operators form a habit of uniform agitation, so that they can more nearly repeat their results on successive negatives. Continue agitation until the recommended time has elapsed.

When a developer solution is used for a large number of negatives, it gradually becomes exhausted. A gallon of developer can develop a film area equal to about forty 8x10-inch sheets of film. You should increase gradually the developing time during the useful life of the solution. Discard the solution when you have reached a 50-percent increase in development time, necessary to produce a good negative, when exposure is normal, as shown on page 15.

STOP

Handle the wet film by a corner or edge to avoid damaging the image. Lift it up and let it drain for a few seconds, then quickly transfer it to the acid stop bath. This stops development more quickly than does a water bath and helps keep images uniform. It also prolongs the life of the fixing bath. After several seconds of vigorous agitation, transfer the film to the fixer.

IMPORTANT TIP

When your hands have been in solutions, always rinse them in clean water **before** wiping them on the darkroom towel or before touching **anything.** This will help prevent spots on films, caused by contamination from solutions and dry chemicals.

FIX

Agitate the film vigorously in the fixer for several seconds. Don't turn on the room lights until the film appears to be clear in the unexposed, light areas—usually after about a minute in a fresh fixer or 30 seconds in KODAK Rapid Fixer. Then, leave the film in the fixer for the recommended time, to remove the last traces of unexposed light-sensitive material.

WASH

To preserve the image, the film must be washed as recommended in the instruction sheet. After washing, wipe it gently with a soft rubber squeegee and hang it up to dry. The film dries more quickly and more uniformly if both of its sides are squeegeed onto a rigid surface, such as glass or plastic.

Development by Inspection

Line negatives are usually developed by inspection. When development is nearly complete, you lift the negative briefly from the developer and look through it at a safelight mounted above the sink. A magnifier will help you inspect fine detail. By observing the density of the black background, you can learn to judge when development should be stopped.

Assuming proper development, density is largely determined by exposure. You should, of course, estimate the camera exposure as accurately as possible. However, developing by inspection does permit you to compensate for some exposure error by stopping short of the recommended developing time or by developing a little longer, whichever is indicated by inspection.

Diagram Showing Procedures in Each Tray

CORRECT EXPOSURE

This segment was exposed correctly. The negative areas are either clearly transparent or densely opaque. Edges are sharp, and detail proportions are true to the original.

UNDEREXPOSURE

This segment was underexposed. Although transparent areas are clear, the dark areas have low density. A positive made from a negative of this type shows thickening of all detail.

OVEREXPOSURE

This segment was overexposed. Although dense areas are opaque, density appears in some areas which should be clear. A positive made from a negative of this type shows loss of fine detail.

Examples of Exposures of Graphic Art Films

PREPARATION OF PLATE SURFACE FOR PHOTOSENSITIVE RESISTS

PREPARATION OF PLATE SURFACE FOR PHOTOSENSITIVE RESISTS

The most common cause of a resist failure can be usually traced to improper preparation of a metal's surface. Each metal requires a different method of preparation or a combination of procedures. Under-cleaning a surface will often result in complete photo resist failure. Over cleaning will change the surface properties of the metal. (9) A sure test for proper surface cleanliness is that an unbroken film of water can be spread on the entire surface of the plate. (5)

Oil, grease, and oxidation have to be removed before a resist will properly adhere to a metal surface. Available are various methods of removal for each type of problem.

- Oil and Grease - Usually oil and grease can be removed by alcohol acetone, trichloroethylene, lacquer thinner, alkalines and some detergents.
- Oxides - Abrasive cleaning such as fine pumice, and a brush are effective in removing heavy oxide films, fingerprints, or heavy soil residue. Household scouring powder is not recommended as these materials contain agents harmful to resist adhesion. (5)
- Polished Surfaces - Several combinations of the former mentioned methods may be used to remove a polished surface. (9)
- Acid Cleaning - Acid cleaning is helpful in removing oxides, organic matter, and residues carried from alkaline cleaners. The acid must not be excessively strong, as this will destroy the surface of the plate. (9)
- Rinsing - After all chemical cleaning the plate must be rinsed thoroughly. A double water rinse or a spray rinse is a minimum. Do not wash for an extended period of time as the chemicals in water will start to adhere to the surface of the metal. Remove water with a squeege.

- Drying - Compressed air is effective but must be filtered. Drying is normally done at room temperature so that reoxidation of the surface is limited. Residual moisture may cause poor adhesion of the resist, so a final heat drying should be used just before applying resist. Set at temperature of not more than 120°F. (5) Store plate in a clear dust-free area until used. Reclean if oxidation occurs.

Pumice and the acid bite provide a slight tooth to the metal for better adhesion of the resist; however, this may not be sufficient as factors other than soil removal and surface finish often enter into photo resist processing. A conversion acid might be necessary to insure an absolutely proper adhesion. In many cases this is all that is needed for good adhesion of a resist. Normally a specific acid treatment will apply to a particular surface and process. (Refer to Miscellaneous on page 74.)

The author used, at one time or another, all combinations of the previously outlined procedures for cleaning. The metal to be photoengraved will have to be evaluated by the individual for the necessary procedures to be used as outlined previously in this section.

KODAK PHOTOSENSITIVE RESISTS

KODAK PHOTOSENSITIVE RESISTS

The number of resists available from various manufacturers are numerous. Finding a supplier, however, may be another story in each locality of the country. This research, because of lack of supplies is based mainly on Kodak products. Resists used are manufactured under the commercial titles of KPR, KPR-2, and KMER. (5)

KPR (Kodak Photo Resist) Designed with a low viscosity and low solid content. KPR is used whenever a thin resist coating is desired without a large amount of deep etching. KPR is normally used for circuit board design. It does not adhere well to zinc or other oliphilic metals and must be etched in a very diluted acid: 1 to 10.

KPR-2 A resist with higher solid content and higher viscosity than KPR. KPR-2 yields thicker application at the same dilution. More resistant to deep etching. Acid can be used at stronger dilution: 1 to 8. Adheres well to zinc when used on a whirler.

KMER KMER has a higher viscosity and solid content than KPR or KPR-2. KMER coatings of increased thickness requires more exposure and extremely resistant to deep etching. KMER exhibits excellent adhesion to zinc, steel, and aluminum. However, the long exposure time is detrimental to the use of photofloods. Not recommended for use unless the illumination source is arc lamps. All of these resists depend upon proper dilution. Improper dilution can cause too thick an application and the image would completely wash out in the developer, or over dilution could cause severe breakdown of the resist.

The author feels that all of these Kodak resists could be used to achieve a desired result. However, without the proper light source all of these resists cannot sufficiently adhere to the metal properly. Therefore, breakdown of the resist may occur in a matter of seconds in an acid. Photofloods, as used by the author, only achieved proper results with the use of KPR-2, at a time exposure of 8 to 12 minutes.

APPLICATION PROCEDURES FOR KODAK PHOTOSENSITIVE RESISTS

APPLICATION PROCEDURES FOR KODAK PHOTOSENSITIVE RESISTS

Photo resists can be applied in numerous ways with the two most convenient methods being the spray and whirler.

SPRAYING Spraying with an air brush and compress air. The obvious problem with this method is humidity and oil passing through the compressor mixing with the resist. This mixture causes poor adhesion and a definite cause of resist failures. (5) Spraying requires a room with ventilation for the fumes are very noxious. Also, without proper dilution cobwebs of the resist will coat the room as well as the plate. This is an indication of insufficient amount of thinner.

This method requires that a set procedure be followed closely in mixing and applying: (9)

1. Resist properly diluted.
2. Surface of the plate at room temperature.
3. Plate placed in a semi-vertical position.
4. Spray at a distance from 8 to 14 inches.
5. Spraying should be done in a consistent horizontal, evenly spaced spray pattern so as not to develop streaks in application. The same pattern is to be done in a vertical and a diagonal pattern until the plate is sufficiently coated. Amount of coating can be determined by a series of test plates with various thickness of application.

This method does provide excellent results if procedures are followed closely and equipment is in good condition.

WHIRLER The whirler method provides even coatings and greatly lessens the chance of failure due to improper application. This method provides for a coating of equal thickness from center to the edge of the surface. (6)

A whirler is an expensive item; especially one that can handle large plates. The author devised a method for a "hand-made" whirler that gives satisfactory results with a small investment and one which can handle plate sizes up to 24 inches by 40 inches. The whirler consists of a 1/3 horsepower motor driving a bicycle wheel and a 3/4 inch plywood bed. Approximate speed of the whirler made by the author was 110 RPM. This speed provided excellent coverage, medium thickness, and excellent durability in the acid.

The spraying and pouring onto the whirler should be done in a semi-dark room, but does not require that these procedures be done with a safe light. In the presence of a regular 100 watt light bulb, there is safety as long as the plate is removed to a dark area after spraying or whirling the resist.

The author used both of these methods and obtained satisfactory results. However, the whirler method did provide better adhesion on zinc and stronger resistance to nitric acid even on a less diluted acid. However, over-dilution becomes an important factor with whirling. In most cases, the dilution can be reduced to half the dilution ratio of spraying or no dilution may be necessary with the proper light source as indicated previously.

TYPICAL RESIST DILUTIONS FOR SPRAYING

Resist	Dilution
KODAK Metal-Etch Resist	4 parts resist 5 parts KODAK Metal-Etch Resist Thinner
KODAK Thin Film Resist	4 parts resist 5 parts KODAK Thin Film Resist Thinner
KODAK Ortho Resist	1 part resist 1 part KODAK Ortho Resist Thinner
KODAK Photo Resist, Type 2	1 part resist 1 part KOR Thinner
KODAK Photo Resist, Type 3	1 part resist 1 part KOR Thinner
KODAK Photo Resist	Full Strength
KODAK Photosensitive Lacquer	Rarely applied by spray-coating techniques. If applied by this method, dilute to viscosity of KPR with KPR Thinner (for Photoengraving).
KODAK AUTOPOSITIVE Resist, Type 3	Full strength

Typical Resist Dilutions for Spraying

EXPOSING OF THE SENSITIZED PLATE

EXPOSING OF THE SENSITIZED PLATE

Photo resists are sensitive to a particular range of light spectrum. The peak sensitivity is near the ultra-violet range.

Typical exposing sources include carbon arc lamps; high pressure mercury, vapor lamps; pulsed xenon lamps, ultraviolent fluorescent tubes; BL and photo-floods. (1)

Carbon arc lamps provide for a good source of light illumination for line and halftone reproduction. Carbon arc lamps provide a pin-point light source necessary for halftone use and relatively short exposure time.

Fluorescent tubes provide a broad source of light and uniform illumination and operate at a relatively low heat.

Photo floods--Blue photofloods provide a low source of constant ultra-violet light. Obvious drawbacks are long exposure, heat radiation and short life. However, this source is readily available to each individual. (3)

Numerous factors of resist failure can be traced to the exposure procedure: (5)

1. The light source not being intense in relationship to the length of time of exposure.
2. The light source being too intense for length of time of the exposure.
3. Improper distance between source of light and sensitized plate.
4. Plate not at room temperature.
5. Density of Kodalith.
6. Type of resist.

Optimum exposure level can be determined by making a series of exposures. This is done by exposing the resist coated plate at increments with an opaque

plate at increments with an opaque mask. When making the exposure series keep the unexposed portion of the plate covered completely. Inspect after developing. It should reveal one or more satisfactory areas. (See example on page 58.)

Commonly encountered results are as follows: (5)

The finished plate has several satisfactory areas. Select midpoint of these areas and proceed with exposure.

The finished plate has only one satisfactory area. Determine optimum exposure and expose strictly within that limitation.

The finished plate has no satisfactory areas. Possibly exposure was either above or below limitations. Re-expose using the two outer limits of previous exposures.

The second means of determining correct exposure is with a Kodak photographic step table Number 2. Step table is a piece of film that has been exposed to yield steps of increasing density, ranging from the clear film to complete opacity. Simply place the step table on the plate being exposed, remove after exposure, develop plate and etch as usual. Then determine at which density the plate was most correctly exposed by looking at the engraved step table. (5) (See illustration on page 58.)

The method used by the author was two photofloods suspended at a distance of 18 to 24 inches above a smooth working surface. Photoflood bulbs were of the type BCD.

Exposing of the emulsion depended upon the type of resist and the distance of photofloods from the surface of the emulsion. This method was probably among the most inefficient methods of exposure since arc lamp, pulse neon and neon tubes provide the best source of near ultra-violet rays of light which is necessary for proper exposure and adhesion of metal.

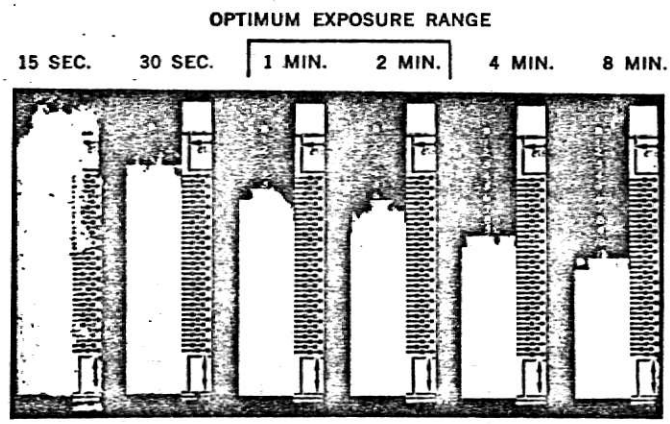


FIGURE 25: A series of test exposures such as this one will help you keep tabs on the quality and reliability of your exposure and processing system.

Exposure Time Using Kodak Photographic Step Table

The length of exposure is necessarily long in comparison to these other sources of light, but does, however, produce adequate results with most photo-sensitive resists. (See illustration on page 60 for procedure used by the author for exposing sensitized plates.)

Time exposures above thirty minutes at the distance indicated becomes destructive to the resist. The photofloods produce such an intense amount of heat at exposures longer than thirty minutes as to heat the plate, fog the resist, prevent removal in unexposed areas and in some cases cause complete removal of the resist when developed.

Kodalith

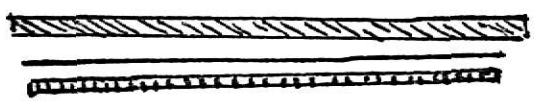


Plate Glass

Emulsion

Plate

Placement of Kodalith on Sensitized Plate

DEVELOPING SENSITIZED RESIST

DEVELOPING SENSITIZED RESIST

Kodak products used by the author have a developer used individually for each type of developer. (9) Other products also have individual types of developers. However, on some types it is necessary only to develop in water. Such products come under the tradename of Phico Red Dot and JGP available through numerous graphic product distributors. Distributors used by this author were Lou Wenzel Supply Company, Tulsa, Oklahoma and Lawrence Photo Company, Wichita, Kansas.

The developer is an extremely volatile mixture and should not be used in a confined area without ventilation. Developing can take place under any light source. The developer must not be placed in any type of plastic tray as the developer will attack and dissolve most plastics. The best container would be a stainless steel or glass tray.

Developing time will vary with thickness of resist and length of exposure. A resist can be over developed with the result being the emulsion swelling and eventually complete removal by the developer. The length of developing becomes extremely critical in the use of small halftone dots; over developing will result in the halftone dots combining as a mass, thereby a loss of the halftone quality.

Developing time will vary with each manufacturer's resist also. The time for Kodak resists, for example, varies from one to three minutes. (5) (See illustration.) In many developers a dye is added to show areas of development which help to determine correct length of development time. The more intense the area of the dye, the closer the time to completion of developing.

The developer can acquire adverse problems in the final development of a resist. Possible problems that might occur and their antidotes are: (5)

1. Image completely washed out or off -- Developing time too long or too short.
2. Image is streaky -- Too long or too short a time in the developer. Over development or under development results in image breakdown which begins a sequential pattern of exhausted developer, over prebaked and chemical streaks from water remaining resist.
3. Image swells -- Insufficient exposure, too thick an application, too long in the developer.
4. Resist on plate, no image -- Over prebaked or over exposed.

RECOMMENDED COMBINATIONS OF KODAK RESIST AND KODAK RESIST DEVELOPER

Resist Type	Recommended Developer	Time*	Remarks
KODAK Photo Resist	KODAK Photo Resist Developer	1-3 minutes	Adequate development within this range. If it is not performing satisfactorily, discard developer or check for heat fog or light fog.
KODAK Photo Resist, Type 2	KODAK Ortho Resist Developer	1-3 minutes	Cleanest development obtained by soaking in, and spraying with, KOR Developer.†
KODAK Photo Resist, Type 3	KODAK Ortho Resist Developer	1-3 minutes	Same as above.
KODAK Photo Resist, Type 4	KODAK Ortho Resist Developer	1-3 minutes	Same as above.
KODAK Ortho Resist	KODAK Ortho Resist Developer	1-3 minutes	Same as KPR.

Kodak Resist With Time and Kodak Resist Developer

POSTBAKING SENSITIZED RESIST

POSTBAKING SENSITIZED RESIST

Postbaking will vary in time and temperature with each resist. Postbaking is a necessity in most cases involving a long time in an acid bath. Postbaking provides good durability of the image and less chance of premature failure of the resist after developing. (5)

Kodak provides for a minimum time/temperature cycle of twenty minutes at 250°F for good adhesive qualities. Temperatures and times above this will cause a reversal of its adhesive quality and cause premature breakdown of the resist. (9) (See illustration on page 67.)

The author adhered to these time/temperature ratios as much as possible. Postbaking can be done under normal daylight conditions.

POSTBAKING TIME-TEMPERATURE CYCLES

KODAK Photo Resist	Postbake for 10 minutes at 250 F (120 C). Thin coatings may not require a postbake.
KODAK Photo Resist, Type 2	Postbake for 10 minutes at 250 F (120 C). Postbaking is needed with this resist; performance in electroplating solutions is directly affected by image dryness.
KODAK Photo Resist, Type 3	Postbake for 10 minutes at 250 F (120 C). As with KPR 2, postbaking is necessary to achieve the proper degree of image dryness for electroplating applications.
KODAK Photo Resist, Type 4	Postbake for 10 minutes at 250 F (120 C). Postbaking should be used to achieve the proper degree of image dryness for electroplating.
KODAK Ortho Resist	Postbake at 250 F (120 C) for 10 minutes. Do not exceed 250 F; resist performance may be seriously affected.

Postbaking Time-Temperature Cycles

ETCHING SENSITIZED PLATE

ETCHING SENSITIZED PLATE

The etching of a metal becomes the final test for all previous procedures. Each metal will have its own particular type of acid. The author adhered to a tray developing method with the acid at a ratio of one part acid to ten parts of water. Stronger acid must not be used in the case of small halftones as the etch factor becomes so great as to undercut the dots and destroy the dot pattern of the halftone.

As a rule all etching systems benefit by some form of agitation. The best etch factors are usually attained with equipment that uses bubble or spray etching methods. (5) The bubble and/or spray etching methods, because of cost, becomes prohibitive on a small scale. The tray developing method is simple, but developing will have to be watched closely as to determine approximately the length of time for getting the best etch factor. As in the case of halftone, dragon-blood can be used to increase the etch factor. However, the actual application of dragons blood is an art in itself and takes an extreme amount of practice.

APPLICATION OF DRAGON'S BLOOD

APPLICATION OF DRAGON'S BLOOD

A small amount of Dragon's Blood or etching powder should be allowed to remain in the open over night with the addition of a small amount of fresh etch powder before application. The plate should be dipped in Dragon's Blood in a scooping motion allowing it to slide from top to bottom; repeat. Then using a very fine camel hair brush, lightly brush the surface in a continuous sweep vertically, horizontally, then diagonally until there is only slight traces of the dust on the surface. Place over a hot plate and melt in the powder. (Etching powder melts at 248°F) (2) Etch lightly. Remove from acid, wash with running water and repeat until etched to desired depth.

REMOVAL OF RESIST FROM PLATE

REMOVAL OF RESIST FROM PLATE

The removal of the resist if it becomes necessary, can be difficult. Each product will suggest various methods of removal. Usually the suggestions follow these combinations: a high-grade solvent, pumice, and a bristle brush. If the resist is not removed the result will usually be a cold white, instead of a slight gray on the paper after printing an inked plate. Ink and print the plate in the usual manner of printing.

Possible Methods of Removal (5)

1. Proper stripper for the resist.
2. Scrub with a commercial pumice (not household) and a bristle brush.
3. Redevelop a resist in its own developer.
4. Fire at temperature in excess of 750°F for fifteen minutes.

As of the writing of this report the author has not found a method of removing a resist that can be applied universally to all resists nor any method that will remove a resist easily or adequately without altering the image or photoengraving.

However, if additional imagery is added to the plate, the resist must be removed.

MISCELLANEOUS

KODAK PHOTO SENSITIVE RESISTS AS THEY APPLY TO VARIOUS METALS (6)

Applications:

Surface-type and etched-and-filled nameplates, decorative designs, and photomilling.

Recommended Resists:

KPR, KPR 2, or KPR 3. Do not use KMER, KTFR, or KOR on clear, anodized aluminum where a yellowish cast would be objectionable.

Surface Treatment:

Generally, the surface is clean except for dust. If fingerprints or oils are on the surface, degrease but avoid alkaline materials which will etch the anodized layer. Polish with a polishing-grade buff powder, if necessary. Do not use harsh abrasives. Rinse in running water. Remove with oil-free compressed air. Heat may be used to complete drying.

Coating:

See "Resist Techniques" section, page 3.

Dry:

At temperatures over 176 F (80 C) for 10 minutes for KOR. The other resists may be dried at temperatures not over 250 F (120 C). Longer times at lower temperatures may also be used, if preferred.

Expose and Develop:

See "Resist Techniques" section, page 3.

Dye:

The image may be dyed, if needed.

Postbake:

Usually unnecessary; however, the image must be free from solvent.

Etching:

For applications in which only the anodized layer is to be etched, use Solution 1 or 2, which follow. For deep etching of aluminum, first remove the anodic layer, using Solution 1 or 2; then follow with a deep-etching solution, such as Solution 3 or 4.

1. Use a 20 percent solution of sodium hydroxide at room temperature. *Care must be exercised to prevent over-etching and attack upon the aluminum.*

2. Use proprietary anodizing strippers or deoxidizers — such as Turco 2897 (Turco Products, Inc., South Central Avenue, Los Angeles, California 94501) or Wyandotte 2487 (Wyandotte Chemicals Corp., Wyandotte, Michigan 48212).

3. When deep etching is required for chemical milling or nameplates, use an acid solution, such as:

1 gallon of photoengraver's grade ferric chloride (42-degrees Baumé) combined with 12 ounces of 38 percent (concentrated) hydrochloric acid. This bath is a very rapid etchant and evolves considerable heat. The bath should be kept below 110 F (43 C) by cooling. The rate of etching may be controlled by varying the amount of hydrochloric acid used.

ILLEGIBLE

THE FOLLOWING DOCUMENT IS ILLEGIBLE DUE TO THE PRINTING ON THE ORIGINAL BEING CUT OFF

ILLEGIBLE

4. A solution of hydrochloric acid alone may also be used. Such a solution can be made by combining 1 volume of 38 percent (concentrated) hydrochloric acid with 4 volumes of water. This bath evolves heat and may require cooling. Very high etch rates are obtained at about 150 F (66 C). Since the anodized layer is not etched by the HCl solution, deep etching may be accomplished with relatively thin resist coatings.

The deoxidizers mentioned in No. 2 can also be used to remove smut and impart adhesion to fillers when etched-and-filled nameplates are being made.

Resist Removal:

Generally not necessary, as the resist acts as a protective lacquer. If removal of the resist is desired, follow the recommendations in the "Resist Techniques" section, page 3.

Suggested Reading:

Jogarao, A., Shenoi, B., and Indria, K., "Multicolored Effects on Anodized Aluminum," *Metal Finishing* (July, 1961).

Procedure with Kodak Resist on Aluminum

Applications:

Nameplates, decorations, and electronic circuitry

Recommended Resists:

For electrolytically deposited chromium, use KMER. For vacuum-deposited chromium use RTFR.

Surface Treatment:

Electrolytically deposited chromium. Degrease in a vapor degreaser or by other suitable means. Clean by immersion in a 170 F(77 C) solution containing 1 volume of concentrated hydrochloric acid and 3 volumes of water for about 3 minutes. Rinse in running water.

Vacuum-deposited chromium. Generally, the surface should be clean, except for dust. Degrease, if necessary, in a vapor degreaser or by other suitable means. Clean the surface in a mild detergent if needed. Rinse in running water. Remove water with oil -=free compressed air. Heat may be used to complete drying.

Coating:

Electrolytically deposited chromium. See “Resist Techniques” section, page 3.

Vacuum-deposited chromium. Generally, a thin resist coating is needed. High-speed whirlers or spraying devices capable of depositing very thin coatings of photoresist should be used.

Dry:

At temperatures not over 250 F (120 C) for 10 minutes for KMER; with KTFR, do not exceed 180 F (82 C) for 10 minutes. Longer times at lower temperatures may be used, if preferred.

Expose and Develop:

See “Resist Techniques” section, page 3.

Dye:

Thick coatings of KMER or KTFR usually do not require dyeing, since the resist normally will have enough contrast to permit easy inspection. Thin coatings of these resists should not be dyed in order to maintain maximum image definition and etch resistance.

Postbake:

Generally not necessary for KMER. For KTFR, a postbake at 250 F (120 C) is usually helpful.

Etching:

Electrolytically deposited chromium. Use Solution 1 or 2.

1. Use a solution containing 3 volumes of concentrated nitric acid and 7 volumes on water at about 175 F (80C).

2. Use a solution containing 2 volumes of 42-degreee Baume ferric chloride and 1 volume of concentrated hydrochloric acid at about 175 F (80C).

Stock Solution A	*Metric*	*Avoirdupois*
Distilled water	1000 cc	34 fluid ounces
KODAK Sodium Hydroxide	500 grams	17½ ounces
Stock Solution B		
Distilled water	3000 cc	102 fluid ounces
KODAK Potassium Ferricyanide	1000 grams	35 ounces

Prepare a working solution of 1 part Stock Solution A, and 3 parts Stock Solution B. Use the working solution at room temperature.

Resist Removal:

See "Resist Techniques" section, page 3.

Procedure with Kodak Resist on Chromium

Printed circuits, photoetched parts, nameplates, embossing dies, and architectural decorations.

Recommended Resists:

KPR, KPR 2, KPR 3, and KOR

Surface Treatment:

Degrease in a vapor degreaser or by other suitable means. Pumice scrubbing may be needed for heavy oxides; otherwise, a chemical cleaning should be sufficient. Immerse the surface in a solution of 8 percent (by volume) hydrochloric acid or ammonium persulfate for about 30 seconds at room temperature. Rinse well in running water at room temperature. Remove the water with oil-free compressed air. Heat may be used to complete drying as long as it does not reoxidize the surface. As an alternate cleaning method, a dry buffing system can be used. Rotary-type bristle brushes are generally acceptable if they do not introduce other types of soil onto the surface.

Coating:

See "Resist Techniques" section, page 3.

Dry:

At temperatures not over 176 F (80 C) for KOR. For KPR, KPR 2, and KPR 3, do not exceed 250 F (120 C).

Expose and Develop:

See "Resist Techniques" section, page 3.

Dye:

The image should be dyed to facilitate inspection. See also "Resist Techniques" section, page 3.

Postbake:

Generally not necessary except for thick images. If the image is postbaked, do not exceed 250 F (120 C).

Etching:

For chemical etching, use any of the following solutions.

1. Solutions of ferric chloride. The PERI (Photo-Engravers Research, Inc.) Powderless Etch Process can be used when large etch factors are desired.

2. Solutions of ammonium persulfate and mercuric chloride. See *Bulletin 102,* Becco Chemical Division of Food Machinery and Chemical Corporation, Buffalo, New York.

3. Electrolytic etching can be done in solutions of ammonium chloride saturated with sodium chloride. See *Controlled Etching of Copper,* Photo-Engravers Research, Inc.

4. Solutions of cupric chloride.

Plating:

Thorough image development is most essential for quality plating. Standard plating solutions and techniques can be used, except that severe pre-cleaning cycles must be avoided. Instead, use one of the following methods:

1. Immerse the surface in a weak solution of ferric chloride for 10 to 15 seconds. Immediately follow this with a dip in a 10 percent (by volume) solution of hydrochloric acid and water. The acid dip will prevent hydrolysis of the ferric chloride to ferric hydroxide. Rinse well in running water.

2. Use a 10 percent solution of ammonium persulfate made by dissolving approximately 3/4 pound of ammonium persulfate in a gallon of water. A 10- to 15-second dip should be sufficient. Rinse well in running water.

Note: Use these dips just prior to the plating cycle.

Resist Removal:

See "Resist Techniques" section, page 3.

Suggested Reading:

1. Borth and Rogers, *Powderless Etching of Copper,* Technical Association of the Graphic Arts, Inc. (June, 1961).

2. Greer, W. N., "Measurement and Automatic Control of the Etching Strength of Ferric Chloride," *Plating* (October, 1961), 1096.

3. Sayer, J. R. Jr., and Smit, J., "Evaluation of Fine Line Etching Techniques for Printed Circuit Applications," *Plating* (July, 1961), 789-793.

4. Shaffert, Winkler, Vaaler, and Deubner, *The Ferric Chloride Etching for Photoengravings,* Photo-Engravers Research, Inc., 2447 Western Avenue, Park Forest, Illinois.

Procedure with Kodak Resist on Copper

Applications:

Working tools, dies, engravings, small parts, and photomilling.

Recommended Resists:

KMER or KTFR.

Surface Treatment:

Degrease in a vapor degreaser or by other suitable means. If necessary, pumice or otherwise mechanically clean the surface. Rinse with running water.

Conversion Coating:

Immerse the surface in a 170 F (77 C) bath made by adding 1 volume of concentrated phosphoric acid to 3 volumes of water until the surface is lightly phosphatized. Remove any non-adherent smut with a water rinse. (Note that proprietary conversion-coating materials should be evaluated on their performance with respect to photoresist adhesion and to etch factors for the particular process used.) Remove water with oil-free compressed air. Heat may be used to complete drying.

Coating:

See "Resist Techniques" section, page 3.

Dry:

At temperatures not over 180 F (82 C) for KTFR, 250 F (120 C) for KMER.

Expose and Develop:

See "Resist Techniques" section, page 3.

Dye:

KTFR and KMER images are normally not dyed.

Postbake:

Frequently helpful. Postbake at 250 F (120 C) for at least 10 minutes.

Etching:

Chemical etching may be done in one of the following solutions:

Solution 1 — A solution of ferric chloride 36- to 42-degree Baumé.*

Solution 2 — A solution of ferric chloride and nitric acid.*

Solutions 3 & 4. The approximate etch rates for tool steel (SAE O-1) with Solutions 3 and 4 are given below. Solution 4 has a tendency to stop etching below 175 F (80 C). Greater etch rates are obatined when spray- or splash-type etching machines are used. (This statement also applies to Solutions 1 and 2.)

Temperature	*Etch Rates (mil/min)*
77 F (25 C)	0.18
122 F (50 C)	1.7
175 F (80 C)	10.0

***Note:** When ferric-chloride etching systems are used, be sure that dissimilar ions, especially copper, are not present in the etching bath. Such ions will cause poor etch factors and generally unsatisfactory results.

Solution 3

300 ml concentrated nitric acid
700 ml water

Solution 4

300 ml concentrated nitric acid
35 grams silver nitrate
700 ml water

Solutions such as 5 and 6 are frequently used for making steel engravings and embossing dyes.

Solution 5
"Spencer's Acid"

Solution A		*Solution B*	
Concentrated Nitric Acid C. P.	5 parts	Concentrated Nitric Acid C. P.	5 parts
Silver Metal	1 part	Mercury	1 part
Distilled Water	5 parts	Distilled Water	5 parts

Dissolve metals as indicated. Combine Solutions A and B, and dilute 1:1 with distilled water.

Use as follows:

1. Pour on steel surface.

2. Start the etch by dipping a strip of zinc in the solution and touching the zinc to the steel. The reaction will continue when the zinc is removed.

Note: Solutions containing high concentrations of hydrochloric, nitric, or hydrofluoric acid promote resist failure when used for deep etching.

Solution 6 — Cronite Etching Acid for Steel

(Available from Cronite Company, Hudson Blvd. at 88th Street, North Bergen, New Jersey 07049.)

Resist Removal:

See "Resist Techniques" section, page 3.

Suggested Reading:

Cornish, J. M., "Steel Roll Embossing Operations," *The Gravure Technical Association Bulletin,* 12:3 (September, 1961), 90-98.

Rock, A. L., and Cooper, J. B., "Precision Photoengraving of Carbon Steel Machine Parts," *Industrial Photography* (May, 1958), 38-39.

Procedure with Kodak Resist on Steel

Applications:

Nameplates, dials, photoetching of small parts, and printing plates.

Recommended Resists:

KMER or KTFR (except for Dow Powderless Etch Process), KPR, KPR 2, KPR 3, KOR.

Surface Treatment:

Degrease in a vapor degreaser or by other suitable means. Pumice or otherwise mechanically clean the surface. Rinse in running water.

Conversion Coating:

Immerse the surface in a solution of 2 percent (by volume) concentrated phosphoric acid and water at room temperature for about 2 minutes. Agitation will improve the phosphatized surface. (Note that proprietary conversion coatings should be evaluated on their performance with respect to photoresist adhesion and to etch factors for the particular process used.) Rinse with running water. Remove the water with oil-free compressed air. Heat may be used to complete drying.

Coating:

See "Resist Techniques" section, page 3.

Dry:

At temperatures not over 176 F (80 C) for KOR; 180 F (82 C) for KTFR; and 250 F (120 C) for KMER, KPR 2, and KPR 3.

Expose and Develop:

See "Resist Techniques" section, page 3.

Dye:

KPR, KPR 2, KPR 3, and KOR images can be dyed if desired.

Postbake:

Generally helpful for all resists. Postbake at 250 F (120 C) for 10 minutes or more, as required.

Etching:

Use a nitric acid solution of the type used by photoengravers. Etching is usually done in a conventional etching machine of the spray or splash type. A modified nitric-acid etchant (formula given below) has been suggested for line and halftone work on engraver's magnesium. Since requirements and equipment in this work vary, the basic formula will probably need modification to fit a particular application.

Etchant Formula for Photoengraving Zinc

	Metric	*Avoirdupois*
Water	115 liters	30 1/3 gallons
Nitric Acid	15.5 liters	3 gallons
Dirats D116 Concentrate	1.0 liters	1 quart
Decaline	5.0 liters	5½ quarts

The 5:1 ratio of Decaline to the Dirats D116 Concentrate gives the optimum shape of the etched image and the smoothest bottom of the etched area.

The Dow Powderless Etch Process can be used when large etch factors are desired and KPR, KPR 2, KPR 3, or KOR is used as the photoresist.

Resist Removal:

See "Resist Techniques" section, page 3.

Procedure with Kodak Resist on Zinc

Degrees Fahrenheit	Degrees Centigrade	Degrees Fahrenheit	Degrees Centigrade
70	21	194	90
74	23	198	92
78	25	202	94
82	27	206	96
86	30	210	98
90	32	214	101
94	34	218	103
102	38	222	105
106	41	226	107
110	43	230	110
114	45	234	112
118	47	238	114
122	50	242	116
126	52	246	118
130	54	250	121
134	56	254	123
138	58	258	125
142	61	262	127
146	63	266	130
150	65	270	132
154	67	274	134
158	70	278	136
162	72	282	138
166	74	286	141
170	76	290	143
174	78	294	145
178	81	298	147
182	83	302	150
186	85	306	152
190	87	310	154

Finding Intermediate Temperature Conversions:

If, for example, the Centigrade value for 156 F is desired, simply add the Centigrade value for 154 F and the Centigrade value for 158 F and divide their sum by 2.

$$2\overline{)137}$$

67 C + 70 C

68.5 C (rounded off to 69 C)

While 68.5 C is an approximate value, rounding it off to the nearest whole number yields a figure that is within ±½ degree of the true value.

If odd-numbered values are desired, such as 157 F, or if values higher than those in the table are needed, application of the formula $C = \frac{5}{9}(F - 32)$ is recommended.

Professional, Commercial, and Industrial Markets Division

EASTMAN KODAK COMPANY • ROCHESTER, N.Y. 14650

4-67 Minor Revision

JONES GRAPHIC PRODUCTS OF OHIO, INC.

JGP Type II Resist

Processing Instructions - Brief Outline

1. METAL CLEANING BEFORE COATING:	Prepare metal surface by brushing with Pumice or detergent type plate cleaner. Treating the surface of magnesium metal with a dilute ammonium dichromate or chromic acid solution is advisable.
2. PLATE COATING:	Medium coatings are desired - (65-75 rpm). Heat the plate very well to insure thoroughly dried coatings.
3. EXPOSURE:	Three to four minutes under most conditions will be satisfactory. Twenty minutes under photofloods type BCD.
4. IMAGE DEVELOPMENT:	Develop under warm water spray for 30-45 seconds. Cottoning may be done if desired.
5. IMAGE HARDENING:	Treat the entire image area with Type II Resist hardening solution for 20-25 seconds. This solution may be used in a tank, tray, or simply flowed over the plate. Rinse moderately, and dry. Prolonged rinsing will remove absorbed hardener resulting in weak prints.
6. CHROMIC ACID REMOVAL:	Pour chromic streak remover over plate and rinse with water. Place on whirler.
7. BURN-IN:	Remove any water droplet stains with slightly dampened cotton before burning-in. Heat the plate evenly until image color changes from tan to dense black.
8. SCUMMING-OUT:	To insure clean etching, immerse the plate in the following solution for two minutes: Potassium Hydroxide - 12 oz. avoirdupois Potassium Permanganate - 2 oz. avoirdupois Add water to make - one gallon.

See Processing Manual for Additional Detailed Information.

PHICO RED DOT

Processing Instructions - Brief Outline

1. METAL CLEANING BEFORE COATING:	Prepare metal surface by brushing with Pumice or detergent type plate cleaner. Treating the surface of magnesium metal with a dilute ammonium dichromate or chromic acid solution is advisable.
2. PLATE COATING:	Medium coatings are desired - (65-75 rpm). Heat the plate very well to insure thoroughly dried coatings.
3. EXPOSURE:	Three to four minutes under most conditions will be satisfactory. Twenty minutes under photofloods type BCD.
4. IMAGE DEVELOPMENT:	Develop under warm water spray for 30-45 seconds. Cottoning may be done if desired.
5. IMAGE HARDENING:	Treat the entire image area with Phico Resist Fixer hardening solution for 20-25 seconds. This solution may be used in a tank, tray, or simply flowed over the plate. Rinse moderately, and dry. Prolonged rinsing will remove absorbed hardener resulting in weak prints.
6. CHROMIC ACID REMOVAL:	Pour chromic streak remover over plate and rinse with water. Place on whirler.
7. BURN-IN:	Remove any water droplet stains with slightly dampened cotton before burning-in. Heat the plate evenly until image color changes from tan to dense black.
8. SCUMMING-OUT:	To insure clean etching, immerse the plate in the following solution for two minutes: Potassium Hydroxide - 12 oz. avoirdupois Potassium Permanganate - 2 oz. avoirdupois Add water to make - one gallon.

See Processing Manual for Additional Detailed Information.

GLOSSARY

APERATURE The opening of a lens which admits light. Most cameras and enlargers adjust to control light by closing or opening to prevent over exposure (too much light) or under exposure (not enough light).

CAMERA, PROCESS A commercial method of reproducing a master transparency. Same as other cameras except it is restricted to photographing flat copy. Usually extremely large and nonportable.

CAMERA, COPY A camera used only for copying work of a limited size. A stationary unit with camera mounted on a vertical cylinder. The camera moves from a one to one copy, up to the limited height of the cylinder.

CAMERA, SLR Single lens reflex. Objects seen through the lens with optical mirrors. Adjustable lens for correct focusing on object. May be used for all kinds of reproduction, two dimensional as well as three dimensional.

CONTRAST A term used to describe the separation of tones in a negative or print. A picture which has only a slight increase in density from tone to tone for a given increase in exposure is termed "low in contrast". Large increase from tone to tone is "high in contrast."

CONVERSION COATING An acid applied to a metal to alter the surface and make more receptive to a photosensitive resist.

DENSITY A numerical measure of the degree of blackening, or light-stopping ability of a photographic image.

DIAPHRAGM CONTROL See aperature.

EASEL Device for holding print or film on the base of the enlarger.

ENLARGER Device for reproducing an image on a larger or smaller scale.

EXPOSURE The action of submitting any photosensitive surface to the action of light. The quantity of light allowed to act on a photographic material.

F-STOP See aperature.

FOCAL LENGTH Lens to camera film distance. Larger the lens such as 200mm, the less the focal length, but a larger image. The smaller the lens such as 28mm, the larger the focal length, but a smaller image.

FOCUS To adjust until the image reaches its clearest and most distinct quality.

FOG In film, a veil of silver of low density of photographic material. Non-image light source striking the material.

FOG Photoresist materials - A sum of insoluable resist in non-image areas. Non-image light striking the material.

GRAPHIC ART FILM In this report, a film used for the final reproduction of a master transparency. Positive or negative, to be used for photoengraving reproduction.

HALFTONE A tone pattern composed of various size dots of uniform density.

KODALITH Graphic Art Film brandname for Kodak product. See Graphic Art Film.

NEGATIVE Photographic image obtained from the original subject.

PHOTOENGRAVING Misnomer, actually should be photo-etching as the process takes place in acid etching the unexposed parts of the metal. Photoengraving is usually thought of as a mechanical process involving the use of hand engraving tools on metal.

PHOTORESIST An organic, resinous material which, when applied to a surface and allowed to dry becomes sensitive to ultraviolet radiation and visible light.

TRANSPARENCY A photographic image, either negative or positive, that is intended to be viewed or used by transmitted light.

TRANSPARENCY, MASTER See transparency.

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PHOTOENGRAVING

by

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AN ABSTRACT OF A MASTER'S REPORT

submitted in partial fulfillment of the

requirements for the degree

MASTER OF ARTS

Department of Art

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1972

The purpose of this master's report is to clarify the enigmatic jargon that glorifies photoengraving as some sort of religious mystique.

At the time of writing this report there was not available to the non-commercial engraver or artist-printmaker any readily available sources of information other than pamphlets published by Kodak which were as hard to find as dinosaurs' teeth.

Other sources were written in such an unintelligible manner as to make them almost worthless to anyone working on a non-commercial scale. Especially, when the sources speak of necessity of having sophisticated equipment and a preponderance of elaborate procedures to obtain any images of angelic quality.

This report is written to give a clear, unsophisticated, simplified, nontechnical approach to photoengraving. In other words this is a "How to" to be used as a guide for the non-commercial printmaker-artist. Technical information, when introduced will have the author's comments, rebuttals and alternate procedures as researched from February 1971 to April 1972.

Amateur and makeshift equipment was substituted mostly for commercial equipment in this research. The exceptions are dully noted throughout and sources for graphic supplies have been indicated.

The substitution of non-commercial equipment required that a trail and error procedure be followed in this research. Therefore, the information as outlined may not be exacting within the limits of reproducing a photoengraving image, 100 percent of the times attempted. Also, the information will vary with the equipment used by each individual artist-printmaker.

However, by using only slight variables within the limits of those indicated by the author, most any equipment used by any individual should obtain satisfactory or more satisfactory results than those obtained by the author.

In the author's application of the researched information, satisfactory imagery was reproduced and found to be most useful in enlarging on a more personal approach to printmaking.

The author continues to test new chemicals, equipment, and alternate methods and hopes to develop more exacting procedures to be used by the artist-printmaker in the future.