Enlarged Negatives by Reversal Processing

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Reversal processing is a convenient way to create enlarged negatives for contact printing processes where the negative must be the same size as the intended print. This is the case for many of the so-called alternative processes such as platinum/palladium, gum bichromate, kallitype, carbon, etc.. The following is a discussion on how to reversal process inexpensive Lithographic film for the purpose of creating enlarged negatives.

1 Introduction

Reversal processing is mostly used to yield positive images on camera film, but the same method can be used in the darkroom to make enlarged negatives for contact printing. Not only does this method work, it offers several advantages in speed, cost, and precision. Using this process, Lithographic (lith) film does not exhibit its usual extreme contrast, but rather gives excellent continuous tones and pinholes do not occur.

If one makes negatives via the usual method of enlarging the small negative onto a sheet of film to create an interpositive, developing this, and then contact printing this onto another sheet of film which is subsequently developed to make a negative, there is a significant cost in both materials and time. With continuous tone film becoming increasingly rare in large sizes, more here in the UK than in the U.S. apparently, the fact that reversal processing works best on inexpensive lith films which are still easily available is very attractive. Also, by going directly from negative to negative, or positive to positive, reversal processing uses half the usual amount of film and roughly half the time. An added advantage of this is that it also means less opportunity for dust, etc. to interfere.

Making enlarged negatives by reversal allows greater precision in attaining a given density range than the more usual method of contacting an interpositive because the main variables have been calibrated for the reversal process, whereas the interpositive method relies on judgement by eye. But several factors may combine to reduce accuracy (variation in temperature and condition of developer, fluctuations in mains voltage, etc.), and these need to be controlled as tightly as possible.

And there are some other negative aspects. One, is that the method has a couple of extra processing steps (bleaching and clearing) that involve potentially hazardous chemicals - potassium dichromate and sulphuric acid. (But potassium permanganate can be substituted for the dichromate, and there is no reason why 10% sulphuric should not be used instead of concentrated sulphuric). Another disadvantage is that budget lith films tend to be very thin and are easily buckled or scratched, so great care must be exercised in handling and using negatives made on them. In any case, reversal processing is a convenient way to produce high quality enlarged negatives at reasonably low cost.

2 Principle of Reversal

In a film or print material that has been exposed under a negative and developed to form a positive but not yet fixed, the silver salts that have not been turned to metallic silver - and which would normally be removed by fixing - are complementary to the developed positive and represent an unexposed, undeveloped negative image. After removal of the positive silver image by means of a suitable bleach, this negative may be fogged and developed. The main stages of the process are thus:

1. Exposure and development of a positive image
2. Bleaching the positive
3. Fogging
4. Re-development to a negative

Subsequent fixing is not necessary because the redevelopment stage changes all of the silver halides left in the emulsion at that point to black silver, so there is no work for a fixer to do.

3 Choice of Film for Enlarged Negatives

Film emulsions contain a great deal more silver halide than is actually needed to obtain the kinds of densities required in ordinary work; it has been estimated that less than 25% of the available silver is actually used in making a negative of normal density range (see, for example, "Recovery of Silver from Exhausted Fixing Solutions" in Clerc), the rest being discarded by fixing. What this means is that if we expose and develop a positive of normal density range, then remove it and develop up the negative, it will be much too dense with heavily veiled shadows.

To get round this problem, the initial positive image must be heavily overexposed and very fully developed. Then after this positive image is bleached away, the correct amount of silver halide remains to form a negative of the desired maximum density. Black silver must be developed right down to the film base in the deep shadow areas. Otherwise the resulting negative will not possess any clear areas, and will give the appearance of high base plus fog.

However, reducing the amount of silver in the negative image in this way lowers the contrast that can be achieved. For this reason a contrasty emulsion is needed. Lith film is ideal, and capable of excellent continuous tones with the reversal method. Even if a very low maximum density is required, full detail is preserved throughout the tonal range. Pinholes, which in other kinds of work can be such a problem on lith films, do not occur with the reversal method unless caused by dust or a dirty easel.

Of the available lith films, my recommendation is Freestyle APH, or its slightly more expensive sibling, APHS. This choice is on the basis of price, though both perform as well as anything else I have tried. There was no noticeable difference between APH and APHS in my tests. But (in common with other budget lith films), APH and APHS are very fragile and easily scratched, especially when wet. They therefore demand special care, both in processing and afterwards when handling/using the enlarged negative. Hardening is consequently recommended after processing. Though even then films remain considerably more delicate than Kodalith for example.

Freestyle Camera is located at 5124 Sunset Bl., Los Angeles, CA 90027, USA, and can be contacted on-line at http://www.freestylesalesco.com/ by phone at (800) 292-6137 or (323) 660-3460. To give some idea of prices, 100 sheets of 8X10 currently list at $36.99 for APH, or 42.95$ for APHS.

4 Exposure

4.1 Initial Exposure

Because this is a reversal (negative-to-negative) process, the normal rules of exposure and development do not apply: the final negative becomes THINNER with greater exposure or longer development times, or DENSER if either is reduced. This important point is easy to overlook! Exposure is the main variable in the process. Development time can also be a "control", but once established for a particular emulsion is best not altered.

In fact, two exposures are given, the first through the negative with the enlarger, and the second to white light (the "flash" exposure). The first, through-the-negative, exposure determines the shadow densities and

so plays a part in controlling the contrast of the copy. However, without a flash exposure the highlights would be extremely dense. The flash exposure brings the highlight densities down to the desired level, depending on the use for which the enlarged copy negative is intended.

More silver is produced by the first development as a result of the additional "flash" and, since more developed silver means less silver halide available for redeveloping, yields a thinner result on redevelopment than would be the case without a flash. The flash exposure covers the whole image area, but primarily affects the highlights. It therefore provides the main control over the maximum density achieved in the copy negative. The explanation is that in the first (through-the-negative) exposure, the shadows and midtones get more exposure than the highlights. The extra exposure delivered by the flash, while equal in all areas, is proportionally greater in the highlights. The extra developed silver due to flashing is therefore proportionally greater in the highlights, which as a result lose a greater proportion of silver in the bleaching stage.

The film must be exposed emulsion-up. This is the lighter side of the film and can be clearly seen under safelighting. Film is considerably faster than bromide papers so safelighting may need to be reduced. If the copy negative is intended to be used emulsion-down, the original negative must be reversed in the carrier so as to give a back-to-front image. However since APH and APHS are so thin, using the copy negative emulsion-up causes no significant loss of sharpness.

4.2 The Base Exposure

The first step is to find the correct exposure for a normal positive image. This is a positive of good density and tonal range such as we'd look for in a paper print. Test strips can be judged in the stop bath, by reflected light from the emulsion side (which now, after development, appears darker than the base side). The image is somewhat darker than a paper print would be since its highlights are represented by greyish silver halide, but contrast should be normal. It is of course important to use an acid stop bath, and to keep it in good condition. Note that judging a fixed film would give misleading results unless the whole system were recalibrated, but fixing is unnecessary extra work. Test strips serve no further purpose and can be discarded once the "normal" exposure time has been ascertained.

The "base" exposure actually given to a film to be reversed is found by applying a multiplication factor to the normal time. The contrast of the copy negative rises with increasing base exposure, so a large factor (about 6X) is chosen when your orignal is flat or slightly on the thin side, while a smaller factor (3X or 4X) generally suits originals that are of normal density range or slightly dense. Very dense originals can give good results with suitable exposure, but very thin originals are best avoided.

If we have an original negative that gives a good print on normal grade bromide paper, and have found that an exposure of 8 seconds gives a decent positive image on lith (unfixed) at the chosen magnification and lens aperture, the base exposure would be 24 seconds with the 3X factor applied. Contrast of the copy would be a fraction higher with the 4X factor (i.e. 32 seconds.), giving it a little more "punch", but the difference is small. In other words, the base exposure is not particularly critical.

A sheet of thin black card under the film during exposure minimizes halation and avoids recording any marks or scratches on the easel.

4.3 The Flash Exposure

Without the white light exposure, any original with reasonably normal contrast will produce a copy with excessively dense highlights. The enlarger, with an empty negative carrier, can be used for flashing, and if the maximum density of the original is known, the time required to obtain a desired maximum density in the copy can be worked out (in conjunction with preliminary tests).

The density range of a negative (the difference between its thinnest and densest areas) must suit the process for which it is intended. The required range may be 1.0 or less for gum, up to 1.8 or more for platinum, palladium, etc., but base-plus-fog (B+F) density, or the thinnest part of a negative tends to be fairly constant. So it is primarily the maximum density that needs to be controlled in order to obtain a given range. Note that I say "maximum density" rather than the more usual "D-max". D-max is the maximum density that

an emulsion is capable of producing, not necessarily the same thing as the highest density an image contains.

Highlight densities are therefore the main consideration in achieving a negative with the desired range, and these are represented by the thinnest areas of the positive (i.e. the film after its first development, and before reversing). But, we can assume, the majority of "good" positives will contain fairly similar highlight densities (the brightest non-specular highlight typically being a very light grey), in which case the flash exposure required to bring the maximum density in the final negative down to a given value will be similar. Or in other words, we'll assume that as long as the highlights are printed to the same depth in the positive, the same flash time always yields the same density range in the final negative regardless of differences between original negatives, magnification, actual printing exposures, etc.. But only as long as development time, temperature and similar factors are constant! There are, as might be expected, exceptions to the rule, and so we should expect the occasional failure. However, in practice the system works very well. It therefore makes sense, instead of messing about with the enlarger, to set up a dedicated, repeatable light source that does not continually need to be altered and reset for making the flash exposure.

I use a ceiling-mounted, clear, 15W bulb which is wired through a dimmer switch and the enlarger timer. The dimmer is useful because the longer flash exposures needed from a dimmer light source permit greater precision. The same light can also be used for other purposes such as pseudo-solarisation. Using an enlarging exposure meter, the light intensity can be adjusted to the right level for a particular need. Having it attached to a timer is convenient, but not essential. An on-off switch and wall clock with sweep second hand is almost as good.

If you want enlarged copy negatives with a maximum density of 1.8, for example, take a good, average negative that is fairly representative (in terms of density range) of all your negatives, find its normal exposure as above, apply the desired multiplication factor (3X recommended if its density range is more or less normal), and expose. Now put the film under the light used for the flash exposure, and give a stepped series of white-light exposures. Go from the ceiling to the floor for the lowest intensity if you do not have a dimmer or split-second timer, and/or move away from directly under the light if necessary to reduce it further. It is impossible to be precise, but with my set-up (15W on 240V), the range of useful times for APH/APHS is between about 1 and 6 seconds. If you use an opaque card over the film to time the flash exposure, remember to place it directly on top of the film rather than holding it above the film. A lot of light bounces off the walls with a ceiling light and will fog the film otherwise. (It doesn't matter if the film moves between flashes.)

After processing and drying the film, measure the maximum densities achieved, or make a print if you do not have access to a densitometer. If any one strip shows a density of 1.8 or very close to it, then it represents the flash time needed for all future copy negatives requiring the same maximum density. In the finished negative, remember that the lighter strips represent the longer flash times. For critical work, or when working with an original that has a very different distribution of densities to your calibration negative, repeat the test and "bracket" around the standard flash time.

4.4 A Simpler Way to Determine the Flash Exposure

The film receives more light from the flash than the through-the-negative exposure, so the flash exposure has the greater influence on the density range achieved. The through-the-negative exposure actually makes very little difference, so the flash exposure time that is found to deliver a particular density range with one exposure factor is a good approximation for all others. In other words, the "correct" flash time with a 3X factor will also work quite well with 4X, 5X or 6X.

In fact, the base exposure plays such a small part in determining a negative's density range that we can do without it for the purpose of calibrating the flashing light (equals applying a factor of 0X!) Accuracy is compromised to a small extent, but to make a quick, rough determination, just flash the film and don't bother exposing it in the enlarger.

5 Processing

Processing consists of developing the film, placing in an acid stop bath, bleaching out the positive image, placing the film in a clearing bath, and finally redeveloping. Washing is only necessary between the bleach and clearing stages, and at the end of the process. No fixing step is needed as long as the redevelopment is taken to completion. However, a hardening fix may be given to toughen the emulsion layer. Otherwise, a separate hardening bath is advised, as well as a little wetting agent being added to the final rinse.

After bleaching, the film needs to be fogged to expose the silver halide remaining in the film (i.e. the halide that was not affected by the first, through-the-negative exposure) so that it can be reduced to silver during the redevelopment step. This is however, nothing more elaborate than turning on the room lights after the film has been bleached and washed. In fact, it is perfectly safe to turn on the white light as soon as the film is in the stop bath after its first development, as long as the stop bath is in good condition.

5.1 Developing

As stated earlier, silver must develop right down to the film base in the deep shadows, so as well as extra exposure, a long development is needed. Print developers are generally more energetic than film developers, and most should be suitable. Some examples of reasonable choices would be Ilford PQ Universal, Kodak Dektol, etc.. However, the use of Warm-tone developers is not recommended.

Develop at the ordinary working dilution for five or six minutes. Shorter times are possible with most films, but you will need to experiment to establish the times appropriate for your developer and emulsion combination.

Six minutes should suffice for just about any lith film, and is a good place to start. Insufficient development manifests itself as high fog (i.e. veiled clear areas), while excessive development tends to eat away delicate shadow detail. It can be confusing whether such defects are due to errors in development or exposure, which is one good reason why development should be a constant in the process. The only reason I can think of for times longer than six minutes would be if your film has a very thick emulsion.

5.2 Stop Bath

There is nothing special about the stop bath. Any stop bath, commercial or home-made, with or without indicator should be fine. Time is not important if the solution is fresh, but allow 15 or 20 seconds before transferring to the bleach. Turn on the white light when the film has been in the stop bath for a few seconds, or if that makes you nervous wait until it is in the bleach. However, once the film is in the bleach continue processing with the lights on since it is essential that the film gets enough exposure to fully fog it before redeveloping. The sensitivity of the emulsion at this stage is a mere fraction of what it was originally and it cannot be overexposed.

5.3 Reversal Bleach

A reversal bleach differs from ordinary bleaches such as might be used for sepia toning. The reversal bleach physically removes the silver image by changing it to a compound of silver that is soluble in the bleaching solution, whereas sepia-type ("halogenising") bleaches change it into an insoluble compound that can be acted upon by other solutions (toners, etc.).

Two bleaches are suggested here, containing either potassium dichromate and sulphuric acid, or potassium permanganate and sulphuric. The final negative seems to be a little more contrasty when the permanganate bleach has been used. Both oxidize the silver image to silver sulphate, which is soluble in water and passes into the solution.

Dichromate Reversal Bleach (dil. 1+9 for use):

Water	750 ml
Potassium dichromate	50 g
Sulphuric acid (concentrated)	50 ml
Water to make	1000 ml

Permanganate Reversal Bleach (dil. 1+9 for use):

Water	750 ml
Potassium permanganate	50 g
Sulphuric acid (concentrated)	50 ml
Water to make	1000 ml

Water must NEVER be added to concentrated sulphuric acid in order to avoid a violent, potentially dangerous, reaction. Always add the acid TO THE WATER a little at a time. Or use 500 ml of 10% sulphuric and adjust the water content in the above formulae.

It is not essential, but I suggest that distilled or deionised water be used for making up (and diluting) either of these bleaches. Tap water contains chlorides that cause the precipitation of silver chloride particles during bleaching. This does not happen when the bleach is fresh, but begins after a certain amount of film has been through it. The silver chloride settles on films, and may cause trouble if it is not wiped off before the redevelopment stage. A bleach made with pure water avoids the problem altogether.

Bleaching takes a minute or so in fresh bleach, increasing to around 2 1/2 minutes as it approaches exhaustion.

5.4 Washing

If a number of sheets of film are being treated, it is suggested that they all be taken this far in the process (i.e. through the bleaching stage) before continuing with washing, clearing and redevelopment. Simply leave the films in clean water after bleaching. To take a sheet of film through the whole process in one go requires another two or three dishes, and space for them!

Film needs to be washed for a few minutes before clearing. The orange stain left by a dichromate bleach clears quite quickly, but washing should ideally be for longer, say 10-15 minutes. Permanganate bleach leaves a heavy brown stain of manganese dioxide that does not wash out (it is removed by clearing), and a similar wash time is given.

If making more than one enlarged negative, remember that wet films tend to be very delicate and may easily scratch each other if there is too much turbulence in the washing vessel.

5.5 Clearing

Each bleach has its own clearing solution, as follows:

Clearing Solution for Dichromate Bleach:

Sodium sulphite	50 g
Water to make	1000 ml

Clearing Solution for Permanganate Bleach:

Sodium bisulphite	50 g
Water to make	1000 ml

Both are used full-strength, for about 3 minutes. The permanganate stain disappears almost instantly.

Sodium sulphite is a mild solvent of silver halides, so to some extent the longer a film spends in the clearing solution, the thinner the negative will be after redeveloping. Its other effect is to reduce or remove veiling of the shadows. It also acts on any silver chloride that may have been precipitated from the use of tap water in the bleach, though it may not succeed in removing it completely.

The permanganate clearing solution acts similarly. In solution, bisulphite is decomposed into sulphite and sulphurous acid. To avoid the complication of yet another variable in the reversal process, clearing time should be standardized - 3 minutes is suggested. The temperature of the solution should also be standardized at around 20° C.

To further increase consistency, it is worthwhile to use the clearing solution only once, with 100 ml of solution per 8X10 film, or equivalent area. Since this is not enough to cover the film, it is necessary to keep it moving by agitating vigorously throughout clearing, with the film emulsion-up in the dish for clearing.

5.6 Redevelopment

The developer used for the first development may be re-used, and films may go straight into it from the clearing solution. Since the permanganate clearing solution is acidic, however, a quick rinse is recommended. Redevelopment is generally fairly quick, but depending on the condition of the developer may take several minutes. To be on the safe side allow 5 minutes. The object of redevelopment is to blacken all of the silver halide in the film, so there is no danger of overdevelopment.

The developer quickly exhausts when redeveloping, and may need replacing if a number of films are being treated. Incomplete redevelopment can be seen not only as low density, but also as a milkiness of the image when viewed from the base side of the film. This is due to the whiteness of silver halide still undeveloped in the depths of the emulsion.

5.7 Washing

Since all of the silver halide has been reduced to black silver, or at least it should have been, there is no need to fix. Therefore only a short wash is necessary: 10-15 minutes in running water. Once again, guard against the possibility of films scratching each other in the wash.

Permanganate is less toxic and more environmentally friendly than dichromate, but blistering or frilling of the emulsion can occur. You'd see this either in the clearing solution or the redeveloper if the wash following a permanganate bleach is less than thorough. A shorter wash than specified above is unlikely to cause any problems with the dichromate bleach, but 15 minutes should be given when using the permanganate bleach.

5.8 Hardening

Hardening is recommended, though not compulsory, and may be by any of several methods - formaldehyde, glyoxal, alum, etc.. A hardening fixer is another possibility, and if this reduces image densities you know you have not redeveloped completely. This, however, is not very likely if you look at the film before deciding redevelopment is complete. After hardening, wash another 2-3 minutes (or 20 mins. if hardening by fixer) and give a final rinse in water containing a small amount of wetting agent.

5.9 Summary of Process

The "traditional" method of making an enlarged negative would be to make an enlarged, continuous tone interpositive. This would then be contact printed onto another sheet of continuous tone film to arrive at an enlarged negative.

While this is a "tried and true" method, there are six basic steps needed for each piece of film used: exposure, development, immersion in the stop bath, fixing, washing, and drying. From start to finish we'd end up

using two sheets of fairly expensive continuous tone film, and would work our way through 12 processing steps.

In contrast, reversal processing requires just one sheet of relatively inexpensive lith film and the following 13 steps:

1. Find "normal" exposure for a good positive image (judged without fixing).
2. Decide on exposure factor: from 3X to 6X according to contrast required.
3. Give "base exposure", equals normal exposure time multiplied by exposure factor.
4. Give "flash" exposure according to maximum density/density range required in enlarged copy.
5. Develop in print developer at normal working dilution, for 6 minutes (or your own time).
6. Place film in acid stop bath. After a few seconds, turn on white light.
7. Place film in bleach, and transfer to clean water when all black silver has been removed.
8. Wash in running water for 10-15 minutes.
9. Treat film in the appropriate clearing bath for 3 minutes (or your own time) with constant agitation.
10. Place in print developer, normal working strength, for about 5 minutes.
11. Wash 10-15 minutes.
12. Harden (optional, but recommended).
13. Give a brief final wash in running water, then a short soak in still water with a little wetting agent added. Hang up to dry.

You end up trading roughly one extra processing step for using one less sheet of film.