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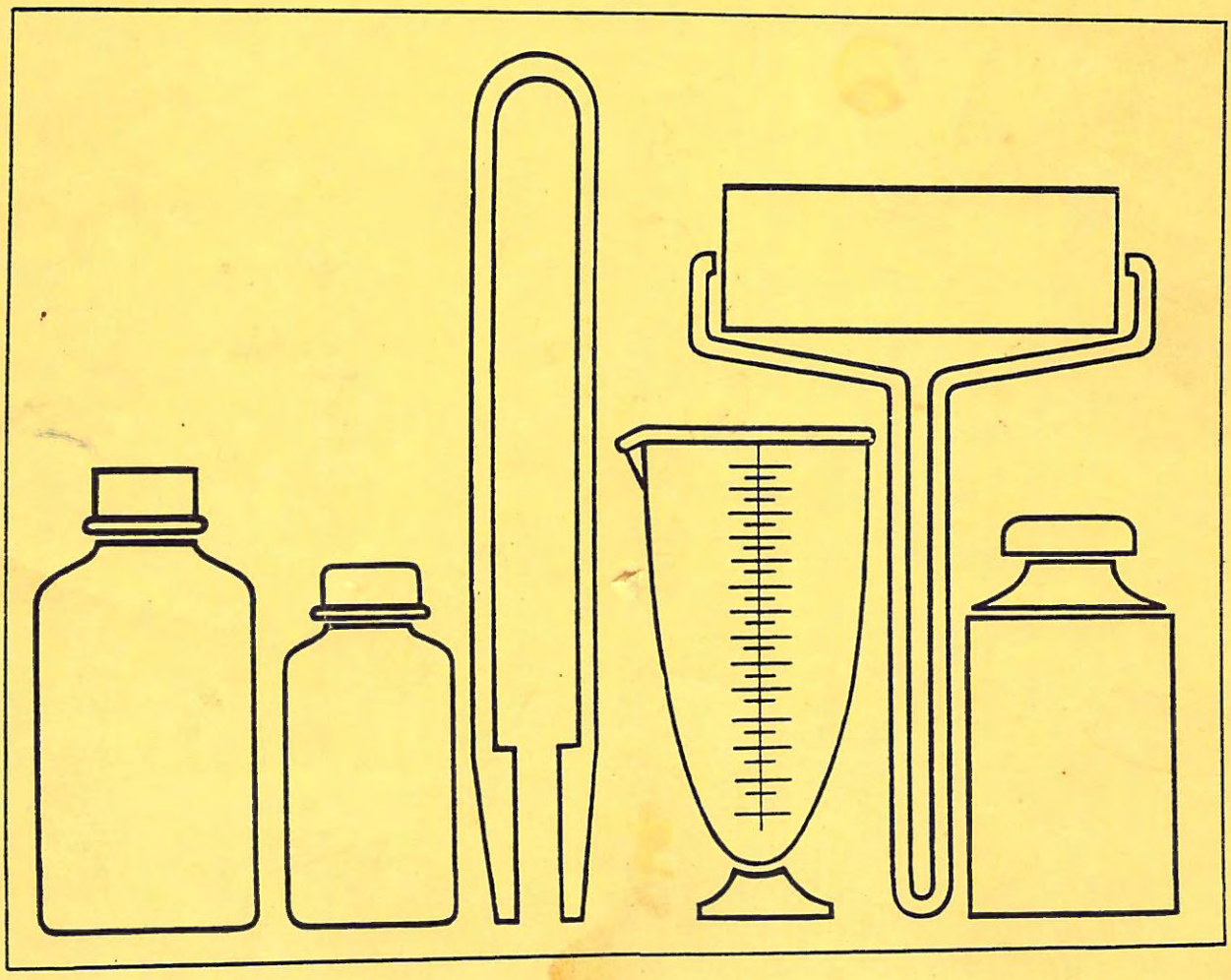
150

DO-IT-YOURSELF

BLACK AND WHITE

POPULAR PHOTOGRAPHIC FORMULAS



EDITED BY PATRICK D. DIGNAN

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POPULAR PHOTOGRAPHIC FORMULAS

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NO. HOLLYWOOD, CALIFORNIA 91606

150 POPULAR B/W NEWSLETTER FORMULAS

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150 POPULAR B/W NEWSLETTER FORMULAS

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SOME HELPFUL HINTS

Remember: Sloppy work produces sloppy results. If you are now producing prints with stains that you cannot account for, chances are you will fail at compounding your own solutions from your formulas.

PHOTOCHEMICALS ARE TOXIC

Remember: All photographic chemicals are toxic. A number are poisonous. Some chemicals, especially developing agents, can cause a severe case of dermatitis. A few people are allergic to these agents. A few become allergic after working with them. If you cannot keep your hands out of the solution, use rubber gloves. If you are prone to allergies, we would not recommend mixing photochemicals or, for that matter, working in a darkroom.

The labels on all photochemicals warn you: Keep out of reach of small children. If you have small children, lock up your chemicals - they can kill!

MEASURING GRADUATES

Photographic graduates should be calibrated in milliliters (ml) or cubic centimeters (cc). Either measurement can be used. Photographically, they are equivalent.

There are a number of plastic graduates available in photo stores which are suitable for most black and white solutions. It is a good idea to purchase a small one that will measure from 10 to 25 ml - also one that will measure 500 to 1,000 ml.

TIPS ON WEIGHING

When you set up a table to do your weighing and mixing, place the scales on newspaper. Make certain the table is level. Make certain your scale is zeroed.

CONTAMINATION

After lining up the chemicals you propose to use, make it a habit to only open one bottle at one time. We recommend throw-away plastic spoons to scoop out each chemical. DO NOT REUSE THE

SOME HELPFUL HINTS

SPOON IN THE NEXT BOTTLE. Replace the cap after weighing each chemical. Intermixing caps is a sure way to contaminate your chemical supply.

Either use weighing paper or wash and dry the weighing tray or pan after each measurement. If you spill a dry chemical, make it a habit to clean it up immediately. The same applies to liquids. The powders or liquids will not only stain your floors, but chemical dust in the air can also end up as unexplainable spots on your film or prints or both.

HOW TO SPEED WEIGHING

After you mix and try a formula and if you like the results, the next thing to do is sit down and calculate how many times a year you will want to use the same formula.

Purchase a supply of plastic lunch bags and then measure out each chemical needed and bag enough so that you can compound the solution for the coming year. Seal each bag and with a felt tip marker list the formula name and the chemical name on each bag. Place the individual plastic bags in a glass jar and cap. Next time you need the same solution, all you have to do is pour out each bag in order and dissolve. This system, of course, means that you will not have to clean the scale pan or change the weighing paper until you change to the next chemical.

PURCHASE A GOOD THERMOMETER

If you wish to produce repeatable results, a good photographic thermometer is mandatory. Get in the habit of using the temperature specified in the formula. If none is given, assume 68°f.

AGITATION

Always agitate the same way each time you develop a roll of film. Most formulas call for agitation the first 15 or 30 seconds, and then once or twice for 5 seconds each minute. If your negatives are constantly thin, check your method of exposure; also, the time and temperature used. The same applies if your results produce contrasty negatives. Reduce the amount of agitation or total time of development.

SOME HELPFUL HINTS

THE METRIC SYSTEM

All formula amounts in this booklet are in metric only. If you are still using ounces and quarts, now is your chance to see the value of grams and liters. A liter is 54 ml more than a quart. The liter is convenient because it is 1,000 milliliters, or ml for short. You will find cc listed in a number of the formulas. It stands for cubic centimeter. Cubic centimeter and milliliter are equivalent photographically.

SCALES - HOW TO PURCHASE

There are dozens of different measuring scales or balances on the market. You should purchase one calibrated in grams. The size that you purchase should be determined by the amount of mixing you plan to do. If your scale will only hold or measure 50 grams and a formula calls for 100 grams, you will, of course, have to measure 50 grams twice. Most small inexpensive scales will measure down to one gram accurately. Photo shops, toy stores, and health-food stores are three places to shop for an inexpensive scale. If you decide to purchase a more expensive unit, we recommend Ohaus. Their least expensive trip balance retails for about $60. However, it will last a lifetime.

WATER - THE CHEMICAL YOU USE THE MOST

Tap water usually contains a number of chemicals that are not used in photography. A hard water salt such as calcium carbonate produces sludge in your solutions and scum on your negatives. Gasses such as chlorine are also detrimental. The gasses and salts can be removed by boiling the water and letting it stand overnight. Some of the heavy salts, dust, dirt, etc., will settle to the bottom. You can decant or poor off the top section of water for use in developers.

A simpler system is to purchase distilled or deionized water from your grocery store. Use it only for developers. Stop baths and fixing solutions are more tolerant of contaminants, so unless your tap water is not palatable it can be used for these secondary solutions.

SOME HELPFUL HINTS

WASHING FILM

This will appear as a paradox, but do not use distilled water for washing your film. In this case the salts in the water help reduce the swelling of the emulsion. If the tap water in your area is soft, you can harden it be adding magnesium sulfate as a 1% or 2% solution. Magnesium sulfate is available in drug stores as Epsom Salts.

USE DISTILLED WATER AS A FINAL RINSE

If you process a roll of film and find water stains after drying, try a final rinse in distilled water. It may take two 1-minute rinses, but you'll be pleasantly surprised at how clean your negatives will look.

DIRT IN YOUR TAP WATER

Dirt can ruin your negatives or prints. Sand seems to be part of tap water at certain times of the year. A good filter on your tap water will eliminate this problem. Check your photo shop.

USING PAPER TOWELS

Never use a cloth towel when mixing or when processing. The cloth towel will gradually become a source of contamination. After you've had your hands in fixer, pay attention to what light switches you touch, door knobs, or faucet handles. These may be subconscious sources of contamination.

* * *

HOW TO MAKE A PERCENTAGE SOLUTION

A percentage solution increases the accuracy of compounding the smaller amounts of chemicals called for in some formulas. In fact, a number of photographers make percentage solutions of most of the chemicals that they use in formulas, because measuring out a liquid by volume requires less time.

Making a percentage solution is not practical with developing agents unless sulfite or bisulfite is also present. The amount must be compensated for in the formula.

The dictionary gives the following definition of percentage: "a given rate or proportion in every hundred."

When one gram of any chemical is added to water and the total volume is brought to 100 cc (or milliliters or ml), we say we have made a 1% solution. If we add 10 grams and bring the total volume to 1000 ml (or one liter), we still have a 1% solution. There is still only one gram to 100 ml of water.

First, let's review a few decimal points of interest:

1. gram = one gram (or 1000 milligrams)
0.1 gram = 1/10 of a gram (or 100 milligrams)
0.01 gram = 1/100 of a gram (or 10 milligrams)
0.001 gram = 1/1000 of a gram (or 1 milligram)

One milligram is about the smallest amount you will ever need to use in photography.

Now let's assume that we need 10 milligrams (or mg) of benzotriazole to a liter of developer. How do you make a percentage solution and how many cc (ml) should be used to add 10 mg into the developer?

If we add one gram (1000 mg) to 1000 ml of solution, 100 ml will contain 1/10 of a gram (or 100 milligrams). One ml will contain one milligram (or 0.001 gram). So, to get 10 milligrams you would use 10 ml of your 1/10 gram stock solution.

Ten grams, when made into a percentage solution of 100 ml, is a 10% solution. If the total water is increased to 1000 ml, it is now a 1% solution.

* * *

PHOTO CHEMICALS
WHAT THEY DO AND WHERE TO PURCHASE

The following is an alphabetical list of most of the chemicals used in this booklet. Additional notes will also be found in the various articles.

ACETIC ACID (Glacial) is pure 99% Acetic Acid. It is called Glacial because it freezes into glacial-like crystals at 62°F. Vinegar is a dilute of Acetic Acid.
Caution: Glacial Acetic Acid causes severe burns.
Photographic Uses: In photography a 2 to 3% solution is used as a stop bath. It is also used as a general acid to lower the pH of fixing solutions. It is also used in some toners and intensifier formulas, etc.

AMMONIUM HYDROXIDE (see Sodium Hydroxide)

AMMONIUM THIOSULFATE (see Sodium Thiosulfate)

ASCORBIC ACID is synonymous with Vitamin C. The tablet form is usually available in 500 milligram amounts. The tablet contains an inert binder of starch which can be filtered off. The binder is not part of the designated weight. In other words, a 500 milligram tablet weighs more than 500 milligrams. To secure 1 gram of Ascorbic Acid, use 2-500 milligram tablets.

BENZOTRIAZOLE is available as Kodak Anti-Fog No. 1 in photo stores. This is sold in a 50 tablet bottle. Lauder and other suppliers sell the powder form in gram or ounce amounts, which is less expensive than the tablets. Benzotriazole is extremely difficult to dissolve in cold water. It readily dissolves in hot water (125°-150°F). It is used as an anti-fog. It's action is similar to Bromide, although it is always used in small milligram amounts. It is added to paper developer to produce blue-black tones.

BORAX $10H_2O$ (or Decahydrate) is also available as Penahydrate ($5H_2O$). Formulas in this book all call for Borax $10H_2O$, which is the chemical supplied by Kodak and Lauder (see page 16). It is a mild alkali, developer, activator and buffer.

BORIC ACID CRYSTALS: Most drug stores sell a pure Boric Acid as a powder for medical use. The powder is very difficult to dissolve. For this reason all photographic formulas should stipulate Boric Acid Crystals. It is used in developers and fixers as a pH buffer.

CALGON (Photo Grade) is not exactly the same as Calgon available in grocery stores. Lauder supplies Calgon under the chemical name Sodium Hexametaphosphate. Sodium Hexametaphosphate is a water softener and detergent. It prevents calcium, carbonate, magnesium and iron salts from crystalizing out of processing solution. Also prevents calcium sulfate. It can usually be left out of a formula if distilled or de-ionized water is used.

CITRIC ACID is used to adjust pH of various formulas. It is also used as a sequestering agent to remove trace metals. It is non-toxic. It is incompatible with Carbonates, Bicarbonates (forms CO_2), Acetate or Sulfides.

DIETHYLENE GLYCOL is poisonous. Deaths have been reported from its uses as a solvent in an elixir. Used as a mutual solvent in some formulas. Available from Lauder Chemical and other suppliers.

ETHYLENE DIAMINE TETRA ACETIC ACID NA_4: There are dozens of compounds derived from E.D.T.A. A number are used in photography as sequestering, chelating, and complexing agents. In this booklet, E.D.T.A. NA_4 is stipulated primarily because of its greater solubility. Its action is complex and beyond the scope of this booklet. It's available from Lauder Chemical and other suppliers. It is also available under many trade names.

FORMALDEHYDE (or Formalin) is a gas and is sold as a water solution called Formalin. It is usually 37 to 40% Formaldehyde. It is available in some drug stores and some photo stores; also, graphic arts suppliers and general chemical houses. IT IS NOT MAILABLE.

GUM ARABIC is a natural inert gum available from Litho houses and also art supply stores.

KODAK BALANCE ALKALI (see Sodium Metaborate)

HYDROGEN PEROXIDE is available in drug stores. This is a gas in water solution used as an antiseptic and hair bleach. It is used in B/W bleach formulas.

KODAK PHOTO-FLO #200 is a liquid wetting agent available in photo stores. To commercial photo finishers, there is available Photo-Flo #600 and also #1200. These are highly concentrated solutions which are diluted differently than Photo-Flo #200.

POTASSIUM ALUM (decahydrated) is used in fixing baths to harden the emulsion. It is not as effective as Chrome Alum, but it does retain its hardening ability for a much longer time. This is sold by Kodak, Lauder, etc.

POTASSIUM BICHROMATE is available under the Kodak brand. Also available from Litho supply houses. It is unusual because it is one of the few chemicals that will dissolve metallic silver without affecting the undeveloped silver halides. It has a number of other interesting properties. However, in this booklet it is used to compound reversal bleach solutions. It is toxic.

POTASSIUM BROMIDE is mainly used as restrainers in developers. Bromides help prevent development of the silver halide that was NOT exposed. When this type of development does take place, the result is known as "fog". Bromide also retards development.
Bromide decreases the rate of density in the least exposed regions of the characteristic curve more than in the region that receives a higher exposure. Film developing solutions usually contain no Bromide or small amounts (0.5 grams). When processing paper prints "fog" cannot be tolerated, therefore the Bromide content is usually increased to around 2.0 grams per liter. An excess of Bromide in paper developers for black-tone papers will give a greenish tone. With warm tone paper, it increases the warmth of the tone. Bromide is also used in Ferricyanide bleaches to convert the metallic silver to silver bromide.

POTASSIUM CARBONATE is used in some developing solutions to form the alkali. It gives a higher pH than Sodium Carbonate. Developers compounded with Glycin usually use Potassium Carbonate.

POTASSIUM DICHROMATE (see Potassium Bichromate)

POTASSIUM FERRICYANIDE: Ruby-red crystals. Forms a corrosive solution and should be used in plastic or plastic-coated metal containers. It is decomposed by acids. Protect Ferricyanide solutions from light. Bleaching refers to the complete changing of the developed silver halide in an emulsion. Reducers are chemicals that have the same type of chemical action. Usually used in B/W photography to alter the density of an emulsion. The following solution has long been used as a subtractive reducer for negatives:

FARMER'S REDUCER

SOLUTION "A"		
Sodium Thiosulfate (anhy)	16.0	grams
Water to make	250.0	ml
SOLUTION "B"		
Potassium Ferricyanide	12.5	grams
Water to make	125.0	ml

Both of the stock solutions have good keeping properties. However, when mixed they have a very short life, approximately 5 minutes. This type of reducer removes the same amount of silver from all density at the same time. A weak solution favors reduction of the shadows. A strong solution increases the contrast. For use: mix ½A with ½B and use for about 30 seconds and then wash. The operation may be repeated if more reduction is required. Complete washing should follow. Color of solution should be lemon yellow. Discard when blue-green.

POTASSIUM HYDROXIDE (see Sodium Hydroxide)

POTASSIUM IODIDE: Extremely small amounts of Potassium Iodide are called for in some black & white developers. Note that it is iodide, not iodine. The 2 to 12 ml called for can be easily measured using a percentage solution. This chemical is available from Lauder and a number of other companies in small amounts. Pound amounts are available from chemical supply houses.

POTASSIUM THIOCYANATE (see Sodium Thiocyanate)

SILVER NITRATE is available from a number of sources. Kodak supplies it in 1 oz. and 16 oz. bottles. It's also listed in the Eastman Organic catalog as #491. It is used in combination with bromide, chloride, iodide, and gelatin to make what we call a photographic emulsion. This chemical is not mailable.

SODIUM ASCORBATE can be found in the canning goods department of some grocery stores. It is used to prevent the discoloration of peaches, cut potatoes, etc. When Ascorbic Acid is combined with Sodium Bicarbonate, a new chemical is formed called Sodium Ascorbate. It is a very weak developer if combined with alkali. However, when Phenidone is added a very excellent developer can be produced. The ascorbate in this case has two functions. It replaces the Sulfite and also functions as a developer. (See Article page 43).

SODIUM BICARBONATE: Unless you decide to use a re-agent grade of this chemical, which for most photographic purposes is not necessary, it is available from the grocery store as "baking soda".

SODIUM BISULFATE may be used to replace Sulfuric Acid. 2.82 parts replaces 1 part by weight of pure Sulfuric Acid. In solution, Sodium Bisulfate forms equal molecular parts of Sodium Sulfate and Sulfuric Acid. It is available as hydroscopic white crystals whose solutions are strongly acid. Keep the bottle tightly closed. Weigh rapidly. Poisonous. Note the spelling - Sodium Bisulfate is different from Bisulfite.

SODIUM BISULFITE can best be thought of as a chemical "container" for Sulfur Dioxide, easily opened with mild acidulation. Sodium Bisulfite acts as a mixture of Sulfurous Acid and Sodium Sulfite. Sodium Bisulfite finds some use in formulated "developer" solutions replacing part of the Sodium Sulfite. A more extensive use of Sodium Bisulfite is in the formulation of hypo fixing baths. Decomposition of the Sodium Thiosulfate in acid solution is markedly decreased by the addition of Sodium Bisulfite. Sodium Bisulfite solutions are also used after bleaching solutions to remove the brown deposits. The solution is called a "clearing bath". Sodium or Potassium Metabisulfite is stipulated in some formulas - Sodium Bisulfite can be substituted on a 1:1 basis in most formulas. Supplied by Kodak, Lauder, etc.

SODIUM HEXAMETAPHOSPHATE: The photo-grade is called unadjusted. We do not recommend the washing type of this. Sodium Hexametaphosphate is a water softener and detergent. It prevents calcium, carbonate, magnesium and iron salts from crystallizing out of processing solution. Also prevents calcium sulfate. The amount called for in most formulas is from 0.5 gram to 2.0 grams. If you use deionized water, calgon need not be included in the formula.

SODIUM HYDROXIDE (Caustic Poison): This caustic is available in photo stores and from chemical supply houses. It is not mailable. If unable to locate, try the household cleaning section of your grocery store. "Holly Lye" is one brand of toilet cleaner that we have found satisfactory. Check the labels carefully. If the caustic lye is recommended for making soap, it is probably pure enough for most photo uses. DO NOT HANDLE THIS CHEMICAL. IT CAUSES SEVERE BURNS. Sodium Hydroxide is supplied as flakes or pellets. WEIGH IT RAPIDLY -- IT WILL PICK UP MOISTURE FROM THE AIR and thereby changes in weight.

SODIUM METABISULFITE (see Sodium Bisulfite)

SODIUM METABORATE ($8H_2O$) is used to replace the alkali in a number of developers. It is a combination of Sodium Hydroxide and borax. Among its many advantages is the fact that it does not release CO_2 (carbon dioxide gas) as the carbonates and other alkalis will when an emulsion is placed in an acid stop bath. This is a chemical equivalent to Kodak's Balanced Alkali (or Kodalk). Keep this chemical tightly capped - it does absorb moisture from the air, which changes its chemical composition. Sodium Metaborate is available from Lauder, etc. Kodak Balanced Alkali is available in most photo stores.

SODIUM PHOSPHATE, TRIBASIC ($12H_2O$): The solution is strongly alkaline. A 1% solution has a pH of 11.9. Technical crystals are sometimes made with excess alkali to prevent caking and gives a more alkaline solution. It is used in developers as a source of alkali. When using Trisodium Phosphate, the solution should be made with distilled water or the formula should contain Calgon.

SODIUM SULFATE (anhydrous) is photographically inert. However, it is added to photographic solutions to help decrease the swelling of the emulsion. Because of the increased salt content of the solution, developing action is decreased. Tropical developers will usually contain approximately 45.0 grams per liter of Sodium Sulfate. Thus, processing can be carried out at a temperature of 90°F.

SODIUM SULFITE (anhydrous) plays many roles in photographic processing. It is used in developer solutions as a preservative. That is, it retards the oxidation of the developing agents. At the same time, it prevents the air oxidation of the solution. When Sodium Sulfite is used in large amounts in some black & white developing solutions, it has a solvent action on the silver halide. This system was used in some of the older formulas, but is not recommended with today's thinner emulsions. Sodium Sulfite acts as an accelerator of some developing agents while retarding the action of others. In formulas containing Metol (Elon) the majority of the sulfite must be dissolved after the Metol, or the Metol will refuse to go into solution. Because Sodium Sulfite produces a mild alkaline reaction it has been used not only as a preservative, but also as the alkali in some fine-grain developers. It is available from Kodak, Lauder, etc.

SODIUM THIOCYANATE (Liquid): Kodak only sells this chemical in one-gallon bottles. The solid is available from a number of chemical suppliers. Thiocyanate absorbs water from the air, which will change its weight. The liquid is a 51% solution and is more stable than the solid material. One ml is equivalent to 0.66 gram of powdered Sodium Thiocyanate. Potassium Thiocyanate can be substituted (see article on page 16). In large amounts it acts like Sodium Thiosulfate (hypo), however, it also softens the emulsion. It is added to FIRST developers, (reversal B&W processing), in very small amounts (1 to 2 grams) to clear or dissolve the fine silver in the highlights.

SODIUM THIOSULFATE PENTAHYDRATE (contains $5H_2O$): This is available in most photo stores and is labeled "HYPO". The Kodak brand is Pentahydrate. One of the personality traits of this form of hypo is that it will lower the temperature of the water used for mixing.

SODIUM THIOSULFATE (anhydrous): This form of hypo does not contain water of crystallization. 60.0 grams of the anhydrous is equivalent to 100.0 grams of the Pentahydrate. The anhydrous has the advantage that it does not change the temperature of the water used for mixing. Available from Lauder, etc.

SULFURIC ACID is a very corrosive acid. Poisonous. A week solution is used in your car battery. For most purposes, Sodium Bisulfate is a safe substitute. (See Sodium Bisulfate).

* * *

DEVELOPING AGENTS

All developing agents have a number of properties that make them the "prima donnas" of the darkroom. Their job is to work on the exposed silver halide. If that is their function, why must we add so many other chemicals? We said that they were the "prima donnas" and so they are. When mixed with water they immediately start to decompose. Without going into the involved chemistry of "why", we will explain that this is due in part to the dissolved oxygen in the water. We might add that this applies to all chemicals that act as reducing or developing agents. To prevent this rapid spoilage, Sulfite has been added to developing solutions for the last 100 years (see Sodium Sulfite).

METOL, ELON, PICTOL: When used with Sodium Sulfite, forms a very slow fine grain developer - (D-23). Metol is one chemical which refuses to dissolve if too much Sodium Sulfite is present in the solution. It is usually recommended to add a pinch of Sulfite to the solution first and then dissolve the Metol. The small amount of Sulfite will prevent oxidation, but will not prevent the Metol from dissolving. Metol can be used with the Carbonates, but caustic alkalies (Sodium Hydroxide, etc.) produce a developer which can give chemical fog.

Metol is invariably used in combination with Hydroquinone, and the two are said to be super additives. In other words, development is greater with the two in combination than either used alone.

Some people are allergic to Metol, the solution producing dermatitis similar to phenylenediamine poisoning. In fact, it is traces of phenylenediamine in the Metol which is actually the culprit. These impurities are difficult to eliminate in manufactuing. Phenidone can be substituted for Metol in most formulas. Metol, Elon, and Pictol are just three of the many trade names for the chemical p-METHYLAMINOPHENOL SULFATE. This is available from Kodak, Lauder, and a number of other suppliers.

PHENIDONE (1-phenyl-3-pyrazolidone): The activity of Phenidone is very similar to that of Metol, but has many properties which make it more advantageous to use. It is non-toxic and although more expensive than Metol, only one fifth to one tenth as much is needed to produce the same results. Phenidone is much more soluble than Metol so that a more concentrated developer can be produced. Today a Phenidone/Hydroquinone combination is used in most commercially-prepared developers, (instead of Metol/ Hydroquinone). Complete details on this developing agent are given elsewhere in this book. Available from Lauder Chemical in 4 oz. and 1 lb. bottles. We understand that Ilford and other chemical suppliers also stock it.

PYROCATECHOL (or Pyrocatechin): When used, solutions quickly turn reddish in color, even when freshly prepared. Used to produce fine grain developers. The following formula by Windisch is said to prevent halation and also retain high-light detail, even with contrasty subjects, and it is also claimed to compensate for over exposure. We have not personally verified this formula.

SOLUTION "A"	
Sodium Sulfite (anhy)	12.5 grams
Pyrocatechol	80.0 grams
Water to make	1.0 liter
SOLUTION "B"	
Sodium Hydroxide	100.0 grams
Water to make	1.0 liter

In preparing "A", dissolve a pinch of Sulfite, boil the water for ten minutes, then add the balance of Sulfite and Pyrocatechol. For normally exposed slow film (Plus X) use 12 parts "A" and 7 parts "B" and add to 500 ml water. Develop 15 to 20 minutes at 65°f. For contrasty subjects, use 20 parts "A", 5 parts "B", add to 500 ml of water. Develop 18 to 20 minutes.

Ansel Adams has some illustrations using the more dilute (20 parts A, 5 parts B) version of this formula and claims no other developing agent or technique retains high-lights so well; it is even compared favorably to the old water bath method. Mr. Adams suggests one full stop additional exposure.

AMIDOL - (chemically it is Diamino-Phenol Dihydrochloride): Amidol has long been a favorite in paper developers for the black tones that it produces. In solution Amidol is highly unstable. Amidol will develop in either an acid or alkaline solution. When used in an acid solution it produces what is known as a depth developer. Development instead of starting at the top of the emulsion, works from the bottom up. In the following formula this effect is attributed to the restraining action of the Sodium Bisulfite. The acid is literally strained by the gelatin so that little action takes place at the top of the emulsion.

Water	700.0	ml
Amidol	15.0	grams
Sodium Sulfite (anhy)	125.0	grams
Sodium Bisulfite	50.0	grams
Water to make	1.0	liter

Developers compounded with Amidol have a short working life, two to three hours. A number of chemicals have been recommended to stabilize Amidol in solution, among them small amounts of Metol or Hydroquinone, which are not very effective. We list a formula by Cyril Peckham which has proven effective (see page 31). Amidol is available from Lauder in 4 oz. amounts and from other suppliers, sometimes under the chemical name.

HYDROQUINONE: When used alone with alkali, forms a very high contrast of developer and is the basis of many Litho Type developing solutions. Its main use is in combination with Metol, which is the basis of all Universal M-Q Developers. Hydroquinone, when used with Phenidone, produces a developer which has a cleaner and longer life than M-Q Developers. Hydroquinone tends to produce fog so that it is necessary to include Bromide in the formula. It is available from Lauder, Kodak, etc.

GLYCIN is white to gray crystals or powder; is not easily oxidized by air. It is insoluble in cold water; readily soluble in alkaline solutions. At one time this developing agent was very popular for fine grain development. It is still used in some formulas - not as readily available as the other developing agents used in this booklet. Check chemical supply catalog under the chemical name. Do not confuse with Glycerin, which is not a developing agent.

chemical conversions almost made easy.

By: D. William Reichner

This article is intended to be incomplete. The conversions included in the chart are those I have found to be the most common and most useful in my compounding of formulas. Additional entries could be made. I invite correspondence that could further extend the usefulness of the chart. If there is a sufficient number of generally useable conversions received, another article summarizing these in chart form will be prepared.

A word of CAUTION. Some conversions can be made without any difficulty or change in the chemical action of a solution - while others simply MUST NOT be made. There are many factors that must be considered. Some compounds are more soluble than chemically-similar alternates. Others are more toxic, less stable, more expensive, difficult to obtain, contain undesirable impurities in its commercial form if not specifically prepared for photographic purposes, etc.

The chart entries have been limited to easy conversions - almost. Those that are NOT recommended for ALL applications are indicated by an asterisk next to the Specified Ingredient. The others are recommended under MOST conditions. There are very special applications where normally useable substitutions must not be used. For example, in preparing dry-packaging of fixer, the crystal form of Sodium Thiosulfate must not be used in place of the anhydrous form. This particular restriction applies to similar forms of other chemicals used in dry-packaging.

Producing the necessary alkalinity for photographic solutions can be perplexing. It is possible to produce the required alkalinity in some solutions by the use of a small amount of a highly caustic compound like Sodium Hydroxide, or by the use of a large amount of a milder caustic compound like Sodium Carbonate or Kodalk or Sodium Phosphate, Tribasic, or others. Does it really matter what is used as long as the degree of alkalinity reached is the same? It DOES matter!

Photographically speaking there are different families of Alkaline Agents. Within each family substitutions can be made with little fear of altering the characteristics of the solution. Some replacements between families may be possible but these are the rare exceptions and they are wholly dependent upon the actual use of the solution. Even within a family there may be limitations on substitutions. The only way to be absolutely certain as to the advisability of any substitution is to perform an experiment with the specified agent in one solution and its substitute in another, and examine the results obtained on identical film or paper exposed under the same conditions. If nothing drastic occurs and the results are identical, then you can substitute without any further hesitation. If the substitute produces better results than the original, then you've made a fortuitous discovery and should share it. Again, I invite correspondence on such discoveries.

The Alkaline families are separated from each other on the chart. The order of entries in the table is based on frequency of use by me. For all practical purposes, anhydrous and dessicated forms are considered to be the same.

YOU HAVE	AND THE FORMULA SPECIFIES	THEN MULTIPLY THE SPECIFIED AMOUNT BY
Borax ($5H_2O$) (Sodium Borate, Pentahydrated)	Borax ($10H_2O$) (Sodium Borate, Decahydrated)	0.76
Borax ($10H_2O$)	Borax ($5H_2O$)	1.31
Sodium Carbonate, Monohydrated	Sodium Carbonate, Anhy.	1.20
	Sodium Carbonate, Cryst.	2.33
	Potassium Carbonate, Anhydrous*	0.90
Potassium Carbonate, Anhydrous	Sodium Carbonate, Mono.*	1.12
Sodium Hydroxide	Potassium Hydroxide	1.40
Potassium Hydroxide	Sodium Hydroxide	0.72
Kodalk (Balanced Alkali) (Sodium Metaborate) --See Note A--	Sodium Carbonate, Mono.*	1.70
Sodium Carbonate, Monohydrated	Kodalk (Balanced Alkali) (Sodium Metaborate)	0.59

NOTE A - There are many forms of Sodium Metaborate - experimentation may be necessary.

YOU HAVE	AND THE FORMULA SPECIFIES	THEN MULTIPLY THE SPECIFIED AMOUNT BY
Acetic Acid, Glacial	Acetic Acid 28%	0.28
	Sodium Diacetate, Anhyd. (in grams)	0.43
Acetic Acid, 28%	Acetic Acid, Glacial	3.54
	Sodium Diacetate, Anhyd. (in grams)	1.52
Sodium Thiosulfate, Crystal ($5H_2O$)	Sodium Thiosulfate, Anhyd.	1.57
Sodium Thiosulfate, Anhydrous	Sodium Thiosulfate Crystal ($5H_2O$)	0.64
Potassium Bromide	Sodium Bromide	1.16
Sodium Bromide	Potassium Bromide	0.86
Sodium Acetate, Anhyd.	Sodium Acetate, Cryst.	0.60
Sodium Acetate, Cryst.	Sodium Acetate, Anhyd.	1.66
Sodium Sulfate, Anhyd.	Sodium Sulfate, Cryst.	0.44
Sodium Sulfate, Cryst.	Sodium Sulfate, Anhyd.	2.27
Sodium Sulfite, Anhyd.	Sodium Sulfite, Cryst.	0.50
Sodium Sulfite, Cryst.	Sodium Sulfite, Anhyd.	2.00
Potassium Thiocyanate	Sodium Thiocyanate	1.00
Sodium Thiocyanate	Potassium Thiocyanate	1.00
Benzotriazole (Anti-Fog #1)	6-Nitrobenzimidazole Nitrate (Anti-Fog #2)	1.00
6-Nitrobenzimidazole Nitrate (Anti-Fog #2)	Benzotriazole (Anti-Fog #1)* --See Note C--	1.00

* - NOT recommended for ALL applications.

CHEMICAL CHANGES YOU CAN MAKE TO CHANGE GAMMA & DENSITY

We are often told that there is not much sense in compounding your own processing solutions, manufacturers supply us with all we need in prepared chemical kits.

The only problem is that they do not. There are literally thousands of processing solutions that you can mix yourself that are not available. One of the biggest problems confronting the darkroom worker is that you cannot modify the solutions that are available unless you know what chemicals are in the can or kit. For those of you who own a balance and a stock of basic chemicals, we give you a set of general rules with which you can make some predictable changes in the type of negative you wish to produce. This information is from "Control Techniques in Film Processing" published by SMPTE* 1960.

"The control chemist is often faced with the problem of altering the composition of one of his metol-hydroquinone developers to suit changes in machine design, to meet the demands of the Production Department or to provide the proper development conditions for new types of emulsions. The information given in the foregoing paragraphs will be helpful in determining what changes in formulation will yield the desired result. Usually the problem at hand is one of modifying the existing formula to effect a change in gamma, density or both for a fixed development time. Manipulation of the various constituents along with changes in pH and/or temperature is not always straightforward since the effect of the variation in the amount of one ingredient is often dependent on the particular formula to be modified. However, as a guide it may be helpful to tabulate a few of the possible changes which might be made in a given situation."

Desired Change		Modification for Fixed Development Time
Gamma	Density	
Increase	Increase	Increase pH; increase temperature
Increase	None	Increase bromide; increase hydroquinone
Increase	Decrease	Increase bromide
Decrease	Increase	Decrease bromide, increase metol
Decrease	Decrease	Decrease pH; decrease hydroquinone; decrease temperature

*Society of Motion Picture and Television Engineers

IMPROVED D-76

By Milan Merhar

I and a few other people have been doing some experimentation on D-76/C-76 type developers. First of all, it appears that D-76, if mixed from the can or from the formula, is an unstable solution. Upon storage or use, the borax will tend to become more hydrolized and thus increase the pH. With straight D-76 and, say, Tri-X the user may notice increasing grain with older solutions. Due to the low activity of the developing agents used, however, there is rarely a major change in contrast or film speed.

The situation becomes worse when Crone Additive C is used*. Due to the increased activity of the C-76 over D-76, the solution is prone to increasing contrast, speed, and graininess with age. If development times are shortened to lower contrast, speed gain suffers leaving clear shadows on the negatives.

The obvious solution, we feel, is to replace the borax with a more stable buffered alkali. Due to ecological restrictions, we felt that the obvious phosphate substitutions were unsuitable. We then settled on a mixture of Sodium Carbonate and Sodium Bisulfite. Our suggested formula for what we call D-76X is as follows:

Metol	2.0	grams
Sodium Sulfite (anhy)	100.0	grams
Hydroquinone	5.0	grams
Sodium Bisulfite	3.0	grams
Sodium Carbonate (mono)	9.6	grams
Water to make	1.0	liter (pH 70° is 8.6)

Adding 1 oz. Crone Additive C converts this to what we call C-76X. Lifetime tests of this solution show that up to 20 rolls of 36 exposure 35 mm. film can be developed per liter without any variation in image quality. Over thirty rolls per liter can be developed with only a minor reduction in contrast in the last few rolls processed.

This formula thus solves the problems we found with D-76. It also must be mixed "from scratch", thus eliminating the convenience aspect of an additive for a packaged developer. We therefore propose the following "additive to the additive":

To one liter (quart) of D-76 as prepared from the can, add 8 grams of Sodium Carbonate (anhy) and 3.6 grams of Sodium Bisulfite. pH should be 8.6 at 70°. This has been called D-76Y. It (in limited tests) has the same characteristics as D-76X but without the inconvenience of "mixing it all from scratch." The corresponding C-76Y has the same characteristics as C-76X.

*Crone Additive C is distributed by Lauder Chemical.

KALOGEN - A CONCENTRATED MQ DEVELOPER

(For One-Shot, Throw-Away Applications with B/W Film & Paper)

By Walter C. Snyder

Photographic formularies which make any pretense to complete and thorough coverage invariably include a recipe for a universal black-and-white processing solution under the name of "Concentrated MQ Developer". The developing agent in these solutions (as in all metol/hydroquinone formulas) is metoquinone, a compound which is only slightly soluble in water, but extremely soluble in solutions of the caustic alkalies (i.e. sodium, potassium or lithium hydroxide).

Typical formulas for concentrated MQ developers indicate a metol/hydroquinone ratio of 1:2, a large quantity of preservative (sodium sulfite or potassium metabisulfite), and sufficient caustic alkali to just dissolve the metoquinone base which precipitates out when dissolution of the first three constituents is attempted. Some formulas specify preparation of a 50% caustic solution for precise dissolution of the metoquinone base. For making stock developer solutions of a liter or more, however, the need for a 50% caustic solution can usually be obviated by careful addition of the specified weight of solid hydroxide crystals or pellets.

The following formula for a concentrated MQ developer deviates from the 1:2 ratio cited above in that the metol constituent is one-fourth rather than one-half of the hydroquinone. The cost advantage is significant and there appears to be no apparent penalty in quality of results or useful working life. Credit for the original formula (marketed commercially in 1917 and 1918) must go to Paul L. Anderson, a prominent pictorialist from the 1910's through the 1930's and author of "The Technique of Pictorial Photography" (J.B. Lippincott, copyright 1939) in which said formula is published under the name of Kalogen. A slight modification of the original formula has been introduced here to produce colder print tones and to extend the life of the diluted working solution (i.e. the bromide has been reduced from 9 to 5 grams per liter of stock solution and liquid anti-fog has been added as shown).

Water (distilled & boiled at 125°F)	800.0 cc
Metol	13.5 grams
Sodium Sulfite (desiccated)	180.0 grams
Hydroquinone	53.0 grams
Potassium Bromide	5.0 grams

A heavy, white precipitate will form when the ingrediants above are mixed in the order shown (the metol and sulfite will dissolve, but the addition of hydroquinone results in precipitation). Cool

the solution to about 75°F and then slowly add the following while stirring gently:

Sodium Hydroxide	35.0 grams

Addition of the sodium hydroxide will clear (or almost clear) the solution. Now, add the following, still stirring gently:

EDWAL Liquid Orthazite-(anti-fog)	30.0 cc
Distilled water to make	1.0 liter

The final liter of solution should be completely clear. Pour the clear solution into a bottle full to the top (most quart bottles will hold a liter), stopper lightly and allow to stand for about 24 hours, then filter through cotton loosely packed in a funnel and store in tightly capped 60 cc (2 American fluid ounces) amber bottles. Such bottles are available by the case from medical supply houses, or alternatively (and more costly) in smaller quantities from the pharmacies of most drug stores.

FOR USE WITH PAPER: When used with fast bromide enlarging papers at a dilution of 1:15 with tap water, Kalogen gives brilliant, cool-black tones. A processing temperature of 72°F is recommended. Expose the paper sufficiently to produce a fully-developed print from a good negative with 2 to 2½ minutes developing time. As for working life, a diluted solution made by adding 60 cc of stock to 900 cc of water (2 fl. oz. of stock to 30 fl. oz. of water) will easily process 60 sheets of 5 x 7 DW enlarging paper without degradation of tonal quality or evidence of staining. The diluted solution should be used promptly, of course, and then discarded after use.

FOR USE WITH FILM: For processing of medium and slow speed 35 mm. black-and-white films, a dilution of 1:60 with tap water makes a good working-strength one-shot developer. EK Plus-X which has been exposed at an effective index of 125 to 160, for example, will give clean, unblocked negatives when developed for 4 to 5 minutes at 72°F in a Nikor or similar tank. Agitation should consist of one inversion cycle every 30 seconds (note: one inversion cycle is equal to turning the tank upside down and back in about four seconds). The exact formula for a convenient amount of 1:60 working solution is as follows:

Tap water at 72°F	480.0 cc
Kalogen Stock Solution	8.0 cc

For measuring small amounts of stock solution, a 10 cc plastic "throw-away" syringe and needle is recommended. Again, check with a local medical supply house or a drug store pharmacy.

STABILITY IN STORAGE: When stored in nearly full and tightly-capped small bottles, Kalogen stock solution will keep for months at normal room temperature.

HIGH ACUTANCE DEVELOPERS

BY GERALD KOCH

Any discussion of high acutance developers should begin with a definition of acutance. Unfortunately this term is not easily explained. However, for the purpose of this article we can think of acutance as the scientific name for what the eye perceives as sharpness. Some years ago, when emulsions were grainier than they are today, developers containing very active silver halide solvents such as thiocyanate and phenylenediamines were popular. Their popularity was not universal since it was found that the reduction in granularity was at the expense of sharpness. As far as the eye is concerned, as it is the final critic in any photographic process, a sharp print is obtained by favoring acutance over grain.

The acutance of an emulsion is related to many variables notably its thickness, grain size and contrast. Of these the first seems to be the most important. In order to understand this, let us consider a single ray of light from a point source striking two photographic emulsions, a thick one and a thin one. As the ray passes through each emulsion it is scattered by the halide grains. A simular scattering enables us to see the projectors beam of light in a smoky movie theater. If we developed the two films and looked at each image and its cross section they would appear as below.

THIN EMULSION THICK EMULSION

Fig. 1

The result of scattering in both cases is to make the image of the point source larger than it should be if the emulsion were infinitely thin. Obviously, the thicker the emulsion the more the image is spread and the fuzzier are its edges. This is why, all other things being equal, a print from a fast film cannot be as sharp as one from a slow film. In order for a fast emulsion to be fast it must contain more silver halide and therefore must be thicker.

Now we can improve on the already considerable sharpness of modern slow speed films by making them thinner. Physically we can't do this but chemically we can, by using a developer which works only on the surface of the emulsion. Such a developer must be very active to offset the loss in sensitivity resulting from using only a portion of the emulsion layer. But in order to prevent excessive contrast the developer must be compensating. That is, it must stop working in regions of high exposure once a certain density is reached while still continuing to work in regions of low exposure. A simple way to solve these two problems is to use a very dilute solution of a very active developer. Because of the high dilution of the developer will be exhausted at the sites of high exposure, keeping the contrast at

the proper level. Being very dilute it will have little effect on the silver halide in the interior of the emulsion. In addition high acutance developers usually contain no bromide; the bromide released during development being used to restrain the action in areas of high exposure, thus increasing the compensation.

Pioneer work on this technique was done by Willi Beutler working for Tetanal-Photowerk in Germany. His formula, originally published in the Leica News, together with some other high acutance formulas appearing in the British Journal of Photography and in Mason, Photographic Processing Chemistry are given in the table below.

TABLE I

STRENGTH OF WORKING SOLUTION	BEUTLER	FX-1	FX-13	MASON
Metol	1.0	0.5	0.5	0.5 g
Sodium Sulfite, anhydrous	5.0	5.0	40.0	5.0 g
Potassium Iodide, 0.001%	2.5	5.0	5.0	5.0 ml
Sodium Carbonate, monohydrate	5.85	2.925	2.925	5.85g
Water to make	1.0	1.0	1.0	1.0 l
	IN EACH CASE USE ONCE AND THEN DISCARD. Each liter sufficient for 4 - 35 mm or 2 - 120 size rolls.			
Develop at 68°f.				
Pan-X 35 mm EI = 80	9	13	8	
Plus-X 35 mm EI = 160	12			

The FX-13 developer is best made up as a triple strength concentrate, being diluted with two parts of water before using. Because of the high sulfite concentration it will keep even with the carbonate added. The other developers, however, must be made up as two solution concentrates since there is not enough sulfite present to prevent oxidation if the carbonate was also present. For the Beutler developer, these concentrates would be:

STOCK SOLUTION A:
Metol.....10.0 g
Sodium Sulfite, anhydrous.....50.0 g
Potassium Iodide, 0.001%.....25.0 ml
Water to make..... 1.0 l

STOCK SULTION B:
Sodium Carbonate, monohydrate...58.5 g
Water to make 1.0 l

For one roll of 36 exposure 35 mm film, just before using take 20 ml of Solution A, 20 ml of Solution B and add 200 ml of water. This results in a solution somewhat weaker than recommended which I find to give better results.

Successful use of high acutance developers requires the thinnest practical negative consistant with printing on normal contrast paper. Over-exposure will result in coarse grain and lower acutance.

Agitation is also important. When using a Nikor or similar tank, agitate continuously for the first 15 seconds and then for 5 seconds every minute. The use of an acid stop-bath is NOT recommended. Instead use a one minute rinse in water. All solutions including wash water should be at 68°f., do not use higher temperatures. If developer fog is experienced with old film add small amounts of benzotriazole 0.2%.

These developers do not reduce the grain inherent in an emulsion, but the increase in sharpness due to their use is amazing especially if you are accustomed to a solvent type developer such as Microdol or D-76 which mush up the grain. FX-13 containing a moderate amount of sulfite will produce somewhat finer grain than the other developers. Besides showing you detail you thought your camera never saw before, these developers have the added advantage of being the most economical to use. Commercial preparations based on the same considerations as previously given are Neofin Blue, Ethol TEC and FX-22, but may not be identical with any of the formulas given above.

The following developer is for papers and appeared some years ago under the name New Winchester. It produces rich, black tones, has good keeping qualities and a low staining tendency. Contrast is intermediate between D-52 and D-72. Below is my modification of the formula eliminating the wetting agent once called for and adding a small amount of boric acid as an antifoggant. (Hydroquinone developers containing some borate have been found to exhibit lower development and aerial oxidation fog. The culprit is thought to be an oxidation product of the hydroquinone, i.e. hydroxyhydroquinone. The borate ion forms a complex with ortho-dihydroxybenzenes such as hydroxyhydroquinone and prevents them from acting as fog producers. Luvalee, J.E. and Goldberg, G.M., J. Photogr. Sci., 6, 90 (1938).)

Metol	3.5 g
Sodium Sulfite, anhydrous	35.0 g
Hydroquinone	8.6 g
Sodium Carbonate, monohydrate	73.7 g
Boric Acid	1.0 g
Potassium Bromide, 10%*	19.0 ml
Benzotriazole, 0.2%*	37.0 ml
Water to make	1.0 l

*The range of tones which this developer can produce on bromide enlarging papers depends on the amounts of bromide and benzotriazole added up to the maximum indicated in the formula. With 19 ml of bromide and no benzotriazole a warm black is produced. With no bromide and 37 ml of benzotriazole a pronounced blue-black tone results. Prepared with both restrainers a nearly neutral black is produced on most papers. For those people who are fussy like myself, the amounts of both restrainers can be adjusted to produce a perfectly neutral black on most papers. An added benefit of this method is the retention of maximum emulsion speed for the paper, since any addition of restrainer past what is just needed to suppress fog results in loss of emulsion speed. Ansel Adams in his fine book The Print discusses this refinement in detail.

FORMULA FOR PUSHING TRI-X TO ASA 2500

By Ken Edwards
Edwards Custom Color
Warrentown, Virginia

The following concentrated developer can be used for processing TRI-X to a contrast index roughly 0.4 (normal ASA 400) or it can be used to process TRI-X to an ASA of 2500.

For normal ASA, the developer is used for 12 minutes at 68°F. This developer is somewhat forgiving as far as time and temperature are concerned. It is not affected as other developers are, so that a development range of 10 to 14 minutes is permissable.

EDWARDS 20 X CONCENTRATED DEVELOPER

Water 125°F	500.0	ml
Metol	10.0	grams
Pyrocatechol	5.0	grams
Sodium Sulfite (anhy)	100.0	grams
Potassium Carbonate (anhy)	75.0	grams
Benzotriazole	0.1	gram
Potassium Iodide 0.2%	20.0	ml
Water to make	1.0	liter

The above concentrate should be stored in several small 100 ml bottles, filled to the brim so as to make an airtight seal against oxidation. I recommend small bottles for those who expect to process as few as 4 rolls a week (120 size). For those of you who plan to do more, larger bottles would be appropriate. The slight discoloration towards tan of this solution does not affect the results. The longevity of the formula has not been tested thoroughly, but the working solution should keep at least four weeks.

TRI-X ASA 400

The above 20 X concentrate should be diluted one part concentrate to 20 parts of water, process 12 minutes at 68°F using normal agitation.

FOR PROCESSING TRI-X 2500 ASA

The 20 X concentrate should be diluted one part concentrate to 20 parts water. Process 14 minutes at 80°F.

SUBSTITUTE FORMULAS FOR:

Microdol-X * Diafine * Neofin Blue * Acufine

By Ronald W. Anderson

I have not bought film developer for several years, and a couple of years ago set out on a Winter project to see if I could equal the performance of several popular developers with home compounded formulas.

I decided at the outset of my project to consider only so-called "one shot" developers. Replenishment systems are inaccurate and involve mixing replenishers.

Kodak has a publication called "Processing Chemicals and Formulas for Black and White", (Photography 5th Edition 1956). In it they list D-23, which is not really a fine grain developer, and D-25 which they claim is as good as the old Paraphenylene diamine developers. The times they list for development are discouraging: 20 minutes. They also mention a modification of D-25 that is half-way between D-23 and D-25. The difference between D-25 and the substitute formula is that D-25 contains 15 grams of Bisulfite instead of 7.5 grams.

Substitute for Microdol-X

Water	750.0 ml
Elon or Metol	7.5 grams
Sodium Sulfite (anhy)	100.0 grams
Sodium Bisulfite	7.5 grams
Water to make	1.0 liter

This formula works fine with the normal developing times given for Microdol-X (both use 1:3 dilution). The results: the same, even to image tone. This substitute formula does not have the same weight as packaged Microdol-X. The powdered mix is much heavier per liter than the above.

I did induce one of the Organic Chemists at the University to extract the developing agent from a sample of Microdol-X, and we determined that the only developing agent is Elon (or Metol) by comparison of Infrared spectrum (absorbtion).

Diafine Substitute

Solution A

Water	750.0 ml
Sodium Sulfite (anhy)	35.0 grams
Hydroquinone	6.0 grams
Phenidone	0.2 gram
Sodium Bisulfite	6.0 grams
Water to make	1.0 liter

(Same weight per liter as Diafine A - dry ingrediants)

Solution B

Water	750.0 ml
Sodium Sulfite	65.0 grams
Sodium Metaborate	20.0 grams
Water to make	1.0 liter

(Same weight per liter as Diafine B - dry ingrediants)

Instructions and results are the same as Diafine. Too grainy for me but gives more than a stop true speed increase. If 20 grams borax is substituted for the Sodium Metaborate, the results are like that of D-76 with the advantages of non-critical temperature, etc. of a two bath.

Substitute Formulas for Neofin Blue

Beutler's Formula

FX-1 looks very much like Beutler's formula when the dilutions are taken into account. Beutler's is made in two stock solutions, diluted for use. The grain produced is incredible on fast film; but, on Panatomic-X or the now unobtainable Isopan IFF, or Adox KB-14, the image sharpness is unlike anything I've ever seen short of the results with Neofin Blue, which I believe is essentially the same thing.

Beutler's Formula

Stock Solution A

Water	750.0 ml
Elon	10.0 grams
Sodium Sulfite	50.0 grams
Water to make	1.0 liter

Stock Solution B

Water	750.0 ml
Sodium Carbonate	50.0 grams
Water to make	1.0 liter

Use 1 part A, 1 part B and 8 parts water. Panatomic-X exposed at EI 50 develops in 4 minutes at 75°. The Elon in solution A is well preserved, and A will last 6 months or more in a partially filled bottle. Solution B will keep indefinitely. I have noted that when I make solution B with tap water, what I suppose to be calcium carbonate settles as a scum on the bottom. De-ionized or distilled water does not produce this effect which seems to cause no harm in any case.

Substitute for Acufine

My experiments indicate that FX-4 is extremely close to Acufine. This formula was published in the November 1971 B/W Volume 3 Newsletter so it will not be repeated here. The results are very similar both in densities and developing times. I normally use D-76 1:1 for my 2-¼ negatives, but when I want a speed gain of

Substitute for Acufine

My experiments indicate that FX-4 is extremely close to Acufine. The results are very similar both in densities and developing times. I normally use D-76 1:1 for my 2-¼ negatives, but when I want a speed gain of one stop or a little more, I use FX-4. It works fine diluted 1:1 just like D-76, and is similar enough that the times work out the same for both. The only difference in the results is the one stop speed gain. I am convinced that Phenidone does produce a real, legitimate, unpushed, actual gain in effective film speed.

FX-4

Water	700.0	ml
Metol	1.5	grams
Phenidone	0.25	gram
Hydroquinone	5.0	grams
Sodium Sulfite (anhy)	100.0	grams
Borax ($10H_20$)	2.5	grams
Potassium Bromide	1.0	gram
Water to make	1.0	liter

Develop at 68° for the following times:

Kodak:

Pan-X (MF)	5 min.	Plus-X	7 min.
Pan-X (RF)	6 min.	Veri-Pan	7 min.
Plus-X Pan (MF)	6 min.	Tri-X (MF)	7 min.
Plus-X Pan	7 min.	Tri-X (RF)	8 min.

One closing thought. The developing times given with old formulas (even from recent sources) are usually for old films. I have found that developing times from one-quarter to one-half those given usually work quite well with our modern 'thin emulsion' film.

* * *

TWO NEW FILM & PAPER DEVELOPERS

Cyril Peckham, well known English photographer recently published two black and white formulas that we feel are unusual in the British Journal of Photography - December 26, 1969.

Mr. Peckham uses Metol because he believes that Phenidone only acts as a "catalyst which is super-active with Hydroquinone." He maintains that "given the right formula, Metol develops a finer grain that Phenidone." He also states that Metol with Pyrocatechol and borax "play an important and unusual role. The borax accelerates the Metol, but that it heavily restrains the Pyrocatechol. Good balance between these opposing forces removes the need for Potassium Bromide or any other anti-foggant."

NO. 1 BLACK AND WHITE NEGATIVE DEVELOPER

Water	700.0	ml
Sodium Sulfite (anhy)	0.350	gram
Pyrocatechol	0.415	gram
Metol	2.6	grams
Sodium Sulfite (anhy)	4.6	grams
Sodium Bicarbonate	28.0	grams
Borax, powdered (anhy)	0.416	gram
Sodium Sulfite (anhy)	113.0	grams
Water to make	1.0	liter

DIGNAN NOTE: The initial small amount of Sulfite is to prevent the oxidation of the Metol, but it is not enough to prevent the Metol from dissolving - so we suggest that you follow the formula as written and make no attempt to simplify it by adding all the Sulfite together.

This developer should be used with constant agitation at 72°F.

HP-3 Plates (ASA 400)	10 minutes
HP-4 Roll film (ASA 400)	7 minutes
FP-4 Roll film (ASA 150)	8 minutes
PANATOMIC-X (ASA 100)	8½ minutes

LONG LASTING AMIDOL PAPER DEVELOPER

There is no doubt that Amidol is a very good black & white paper developer. It gives rich blacks on all grades of Bromide and Chloro-Bromide papers. It is the only developing agent that will function in either acid or alkali.

The big problem with Amidol has always been its very poor keeping properties. Mr. Peckham tried all of the recommended chemicals that are supposed to act as preservatives (lactic acid; Metol; Hydroquinone) and found that these did not work. He maintains that Pyrocatechol does work and that the following solution "can be used to exhaustion and will keep for several weeks as a clear solution."

PECKHAM AMIDOL PAPER DEVELOPER

Water	700.0	ml
Sodium Chloride*	2.0	grams
EDTA, Disodium**	2.6	grams
Sodium Sulfite (anhy)	28.0	grams
Pyrocatechol	2.33	grams
Sodium Metaborate, $8H_2O$	2.6	grams
Amidol	2.33	grams
Water to make	1.0	liter

* Un-iodized salt

** Can substitute EDTA Tetrasodium

Mr. Peckham again calls attention to the fact that borate (in this case Metaborate) is used to restrain the Pyrocatechol, however, if stale paper is used, Bromide should be added.
(Ed: try one gram per liter.)

* * *

LITHOGRAPHIC DEVELOPER CONCENTRATE

For Half-Tone and Line Negatives

By D. William Reichner

The following formula yields a Litho Developer Concentrate that can be favorably compared to the commercially available Kodalith developers.

PART A
CONCENTRATE

Water (cold, approx 70°F)	300.0 ml
Diethylene Glycol	240.0 ml
Hydroquinone	120.0 gm
Formaldehyde (37%)	210.0 ml
*Sodium Bisulfite	300.0 gm
add water to make	1.0 liter

*add slowly and stir constantly, heat is generated.

PART B
CONCENTRATE

Water (hot, approx. 95°F)	800.0 ml
Potassium Carbonate (anhy)	400.0 gm
Sodium Sulfite (anhy)	24.0 gm
Potassium Bromide	16.0 gm
add water to make	1.0 liter

TO MAKE WORKING SOLUTION:

1 part A + 3 parts water

PLUS

1 part B + 3 parts water

Example: To make one liter of working solution, pour 125.0 ml of Part A Conc. into a tray. Add 375.0 ml water. Stir. Then add 125.0 ml of Part B Conc. and another 375.0 ml. water. Stir until completely mixed.

Developing Time: (At 68° to 72°F) For thin emulsion lithographic sheet film (Japanese or German types) develop from 90 seconds to 2 minutes.

For heavier emulsions (GAF, Kodak, etc.) develop for 2 to 2-½ minutes.

Increase the time of development as the capacity is exhausted or as the tray solution ages.

Capacity: Usually the capacity of a lith developer is not reached before the tray solution deteriorates. However, tests have been made showing that under reasonable ambient temperatures (never exceeding 80°F) the tray solution will yield negatives that will, in turn, produce excellent half-tone offset plates even after 15 hours in an open tray.

The bottled concentrate solutions have a life-span of at least six months (the extent of experiments) but probably much longer.

Follow development with an Acid Rinse of about 10 seconds in a 7.0% Acetic Acid Solution (add 70.0 ml of Glacial Acetic Acid to a quart of water). Then use a fresh Acid Hardening Fixing Bath.

Free, but none-the-less valuable advice: Replace the Stop Bath and the Fixing Bath as often as you replace the Lith Developer. If I had a penny for every pin-hole that could have been avoided. . .

* * *

FORMULAS FOR PROCESSING MICRO-FILM

The following formula is recommended for processing micro-film or Concentrated Lippmann Emulsions:

KODAK D-178 (HIGH CONTRAST)

Water	700.0	ml
Sodium Sulfite (anhy)	90.0	grams
Hydroquinone*	45.0	grams
Sodium Hydroxide	18.0	grams
Potassium Bromide	30.0	grams
Water to make	1.0	liter

*Hydroquinone will not completely dissolve until the sodium hydroxide has been added.

FOR USE: 1 part water to 2 parts stock solution. This formula can also be used for making line negatives. Try 3 to 5 minutes developing time at 68°F.

We wanted to give this formula first so that you could look it over and say, "Gee, I think Dignan goofed... 30. grams of bromide?

The formula is correct. It seems that high solution emulsions are a different animal from normal photographic emulsions.

One gram of silver halide in micro-film covers about 500 square feet of emulsion base. This means that any solvent in the developer rapidly dissolves the silver halide and transforms the mode of development to what is known as "physical development."

What happens in physical development? The unexposed halide is dissolved and re-deposited on the exposed and developing grains. It can be thought of as a plating action. The longer development is continued, the larger the developing grains will become. This effect is just the opposite of what occurs with normal emulsions. Bromide slows development and solvents reduce grain, at least under the right conditions.

The story of micro-film or extreme resolutions could fill a number of books. The only book that we have studied that covers the subject adequately is MICROPHOTOGRAPHY (Photography at Extreme Resolution) by G.W.W. Stevens. Published by John Wiley and Sons, Inc, 1957. As last reported, this 300 or so page book is still available for about $45.00.

Besides covering the history with hundreds of references, the author clearly explains how the average photographer can become involved in making extreme resolution micro-photographs. The nice thing is that he tells you how to build your own equipment without undo expense.

When Mr. Stevens writes about extreme resolution, he means just that. He discusses the subject in terms of photographing an 800 page novel with an average of 400 words to a page and copying the whole book on...are you ready...one square inch!

George Lippmann in 1891 made the finest grained emulsion that is possible to make. They could resolve 6.000 lines/mm. Mr. Stevens briefly tells us how to make a Lippmann emulsion.

The following three solutions are made:

A SOLUTION

Distilled Water	25 parts
Gelatin	1 part

B SOLUTION

Distilled Water	50 parts
Potassium Bromide	½ part
Gelatin	2 parts

C SOLUTION

Distilled Water	5 parts
Silver Nitrate	0.3 parts

Warm A and B in a water bath until the gelatin is dissolved. Cool to 40°C, add part C to A. B is then added to the mixture. Any of the following sensitizing agents can be used:

Pinacyanol, pinaverdol, E11371* cyanine, E1126* erythrosine, etc. No mention in the article was made as to how much dye should be used. The mixed emulsion should be filtered and then coated on glass plates. After the emulsion is set, the plates should be washed in cold running water for 15 minutes and then dried.

Another suggested method that appears very simple is as follows: A 6% solution of gelatin (6 grams to 100 ml water) is mixed and then ad 3% potassium bromide (3 grams). This is coated on glass plates, as soon as the gelatin has set, they are bathed in a 5% solution of silver nitrate. They are then washed with distilled water. Using optical sensitizers with this system may prove difficult. Erythrosine or cyanine are suggested as useful, but what percentage of dye or what procedure should be used was not explained.

*Eastman Organic Catalog Numbers

Commercial extreme resolution emulsions are available from all major manufacturers that are capable of reproducing 1,000 lines per mm, these new plates are much faster than the original Lippmann emulsions. The technology for making this type of an emulsion was an industrial secret until Crawford in 1954 worked out a system at the National Physical Laboratory. Crawford ran approximately equivalent solutions of silver nitrate and potassium bromide drop by drop into a rapidly stirred gelatin solution, at the rate of 2 drops per second. At the end of precipitation, gelatin hardeners and sensitizing dyes are added and the emulsion is coated, set and washed.

The halides of silver that is silver chloride, silver bromide and silver iodide are only sensitive to the blue part of the spectrum. Credit for the discovery that certain dyes could extend the optical sensitivity to red and yellow portion goes to H.W. Vogel of Berlin, who in 1873 wrote a letter to the Philadelphia Photographer. So important was Vogel's discovery that the Society of Photographic Scientists and Engineers conducted a Vogel centennial symposium in 1973 to honor and re-access progress in this branch of photo science. The letter Vogel wrote in quoted elsewhere in this Newsletter.

Younger photographers may give it little thought, but those of us who have been around for a number of years will have no problem remembering that true panchromatic films have only been available for about the last 40 years. The starkness of old photographs is due to the lack of sensitivity to the complete visable spectrum.

The author, Mr. Stevens at the time the book was written worked in the Kodak Research Laboratory in Wealdstone Harrow, England. In the preface, he emphasizes that this book "should in no way be regarded as a publication of the Kodak Company." However, he does mention that he requested permission from Dr. Mees, the head of Kodak research to publish the book, he also thanks a number of colleagues working at Kodak for their help. The book does not list many processing formulas, however the ones that are listed appear adequate for the majority of situations one might encounter.

HIGH CONTRAST NEGATIVE DEVELOPERS

Kodak D19b

Elon	2.2	grams
Sodium Sulfite (anhy)	72.0	grams
Hydroquinone	8.8	grams
Sodium Carbonate (mono)	58.0	grams
Potassium Bromide	4.0	grams
Water to make	1.0	liter

When used at full strength, this developer is useful for obtaining high contrast on microfilm, photomechanical or high speed negative materials, without the use of caustic solutions. It may be used for developing master negatives with development times up to 10 minutes at 20°C (68°F).

PHYSICAL DEVELOPER

STOCK SOLUTION A

Elon	20.0	grams
Citric Acid	40.0	grams
Gum Arabic (20% Sol*)	40.0	ml
Distilled water to make	1.0	liter

STOCK SOLUTION B

Silver Nitrate — 10 percent sol in distilled water

Solution A: should be kept for only about one week after making up.

Solution B: will keep indefinitely in a brown bottle.

As with other physical developers, all vessels should be cleaned before use, preferably with concentrated nitric acid. Caution: VERY CORROSIVE!

*Gum arabic is available from Lithographic houses.

For use, add 1 part of Solution B to 25 parts of A just before starting development and develop for up to 5 minutes at 20°C (68°F). This developer may be used for developing latent images in various emulsions (Lippmann, wetcollodion, silver-albumen, mercury-diazo) and also for intensifying chemically developed images in Lippmann or concentrated Lippmann emulsions.

NORMAL-CONTRAST DEVELOPER

Kodak Formula D158 For Photomechanical or concentrated Lippmann Type Emulsions.

Stock Solution

Elon	3.2	grams
Sodium Sulfite (anhy)	50.0	grams
Hydroquinone	13.3	grams
Sodium Carbonate (mono)	82.0	grams
Potassium Bromide	0.9	gram
Water to make	1.0	liter

For use, dilute with an equal volume of water, and develop for up to 4 minutes at 20°C (68°F). This developer is recommended for maximum resolution plates in applications where preservation of fine grain structure is more important than high contrast, e.g. for micro-radiography.

KODAK FORMULA D165 (Low Contrast Developer for Making Transparencies)

Stock Solution

Elon	6.0	grams
Sodium Sulfite (anhy)	25.0	grams
Sodium Carbonate (mono)	44.5	grams
Potassium Bromide	1.0	gram
Water to make	1.0	liter

Dilute 1 part of Stock Solution with 3 parts of water, and develop for up to 4 minutes at 20°C (68°F). When used with photogravure plates, this developer can be used to make continuous-tone transparencies with a low density range, for use with extreme-resolution emulsions having high contrast and a short exposure scale.

KODAK BLEACH FORMULA R.21

Stock Solution A. Bleaching Bath

Water	800.0	ml
Potassium Bichromate	50.0	grams
Sulphuric acid (concentrated)	50.0	ml
Water to make	1.0	liter

Dissolve the bichromate in the water, then add the sulfuric acid slowly, with constant stirring to the cold solution. For use dilute one part of Stock Solution with nine parts of water. Never add the water to sulfuric acid. As a safer solution to compound, we would suggest the following:

Water	800.0	ml
Potassium Bichromate	9.5	grams
Sodium Bisulfate	66.0	grams
Water to make	1.0	liter

If this solution results in soft emulsions, add 30. grams of Sodium Sulfate and double the time of bleaching.

Clearing Bath

Water	1.0	liter
Sodium Sulfite (anhy)	50.0	grams
Sodium Hydroxide	1.0	gram

Reversal Process

Develop 3 minutes in D. 178.
Wash 2 minutes in running water
Bleach R. 21 A (diluted 1+9) for about 45 seconds
Turn on room lights
Clear for 30 seconds in undiluted R21B
Wash in running water for 2 minutes
Expose for 15 seconds close to a 100 watt bulb
Re-develop in D. 178 for 3 minutes at 68°F
Wash for 5 minutes and bathe 2 minutes in clean industrial spirit to remove senitizing dye.

STOP BATHS KODAK FORMULA SB. 1a

Water	800.0	ml
Acetic Acid (glacial)	50.0	ml
or Acetic Acid (28% solution)	125.0	ml
Water to make	1.0	liter

A short immersion of a concentrated Lippmann emulsion in the above stop bath, after development in a caustic hydroquinone developer greatly reduces the risk of stain.

FIXING BATH Kodak Formula F.53

Water	600.0	ml
Sodium Sulfite (anhy)	50.0	grams
Acetic Acid (glacial)	75.0	ml
or Acetic Acid 28% solution	270.0	ml
Potassium Alum	100.0	grams
Water to make	1.0	liter

Dissolve the sulfite in one quarter of the final volume of warm water (about 52°C or 125°F.) Allow to cool and add the acetic acid slowly and with constant stirring. Dissolve the potassium alum in one half of the final volume of hot water and allow to cool below 21°C (70°F) before adding this to the sulfite-acetic mixture and making up to volume.

ACID HARDENING-FIXING BATH FOR PLATES Formula F. 54a

Water (warm 52°C-125°F)	500.0	ml
Sodium thiosulfate (hypo crystal)*	400.0	grams
To this when cold, add:		
Kodak liquid hardener	75.0	ml
or		
F. 53 Stock Solution	185.0	ml
Water to make	1.0	liter

This bath will fix most plate emulsions in a few minutes, but ten minutes treatment at 20°C (68°F) is recommended to ensure satisfactory hardening of gelatin emulsions. Prolonged immersion of fine grain silver images is to be avoided, since it is likely to result in a reduction of density

*Or you can use 256. grams of sodium thiosulfate anhy -

Of interest to those in Lithography is the use of a weak bleach for cutting or sharpening the dot structure in half tone reproductions. This can also be used to reduce the fog in micro photographs or reduce the width of fine lines.

Water	800.0	ml
Potassium Ferricyanide	2.0	grams
Potassium Bromide	10.0	grams
Water to make	1.0	liter

"The solution tends to become locally exhausted as soon as it reaches an area with a high silver content. But it will tend to continue acting in low density areas where the rate of consumption of ferricyanide is not much greater than the rate of replacement by diffusion from the bulk of the solution. The proportion of the silver removed from a low density may, therefore be much higher than that removed from a high density, and the edge of a blackened area may be attacked more rapidly than the center." After the desired reduction, the emulsion should be fixed.

Diluted bleaches have been used in motion picture color film processing where a sound track of silver is required and where a Cary Lee filter or antihalation layer is present in the emulsion. Because a Cary Lee layer is made up of finely dispersed silver particles, a weak bleach will bleach this fine silver without attacking the heavy silver that makes up the sound track.

Mr. Stevens does not go along with the idea of using extremely purified chemicals to eliminate dust and dirt, he does recommend filtering the solutions and processing with the emulsion held so that it is either standing end or facing the solution. He points out that the three areas where dust is the main problem is in exposing, washing and drying.

SENSITIZING DYES

The subject of sensitizing dyes opens a whole area of questions. We have found only one company in the U.S. that seems to specialize in photo sensitizing dyes. This is the Pierce Chemical Co., P.O. B. 117, Rockford, Illinois. 61105. The catalog that we have lists over 80 different photo sensitizing dyes. They give no hint as to what part of the spectrum is sensitized by these agents. Pinaverdol is listed as 1,1'-6-Trimethyl-2,4-cyanine iodide. This is a strong sensitizing dye for the green portion of the spectrum, also listed is Pinacyanol 1,1'-Diethyl-2,2'-carbocyanine iodide. These sensitizing dyes are used in very small quantities in an emulsion but are nevertheless expensive to anyone interested in experimentation in this extremely complex branch of photo chemistry. The price for one gram can range anywhere from $9.00 to $125.00. One book that delves deeply into sensitizing dyes and how they are synthesized is Photo Chemistry Volume II, Pierre Glafkides. This book is translated from the French and is available from Fountain Press, London.

THE WONDERS OF PHENIDONE

By Patrick D. Dignan

Phenidone is Ilford's trademark for 1-Phenyl-3-Pyrazolidone which was first prepared in 1890. It was not until 1940 that Dr. J.D. Kendall, in the laboratories of Ilford Limited, discovered the photographic reducing properties of this chemical. However, large scale manufacturing of the compound did not become feasible until 1951.

One of the most novel properties of Phenidone is the efficiency effected because it is re-activated by Hydroquinone. In other words, as the Phenidone is oxidized the Hydroquinone reacts with those oxidized products to reform useable Phenidone.

Phenidone is more expensive than Elon, but because the Phenidone is used in much smaller amounts than Elon, the cost is actually less.

Like most organic developing agents, Phenidone's developing properties are dependent on the pH of the solution. Developer activity increases with an increase in pH.

When Phenidone is used alone in, for example, a carbonate-sulfite solution, it gives very fast but extremely soft working developers. A comparison of a developer of such a type with one containing Metol, instead of Phenidone, shows that a silver image can be developed more rapidly with the Phenidone developer, but only a very low density is obtained with the latter no matter HOW LONG DEVELOPMENT IS CONTINUED. This is due apparently to rapid inhibition of the process of development by the primary oxidation products of the developer.

With the addition of Hydroquinone to a Phenidone developer, which also contains Carbonate and Sodium Sulfite, the Phenidone not only acts the same as Metol (or Elon), that is, the combination of the two are super-additive, but the Phenidone possesses the property of being regenerated by the Hydroquinone. This results in a developing solution that is not only active from the start, but one that retains its activity longer.

Phenidone is slightly soluble in cold water, but as the temperature of the solution increases Phenidone becomes more soluble. It is readily soluble in both acid and alkaline solutions.

PHENIDONE HAS A NUMBER OF ADVANTAGES:

1. Phenidone is used in amounts which is only a fraction of that of the Metol.

2. Pharmacological tests on Phenidone have indicated that it has a very low oral toxicity, and that with normal users it is unlikely to cause dermatitis.
A number of years ago Dignan Photographic paid for a series of toxicity tests on this chemical. These tests passed the FDA requirements so that we could safely state that Phenidone is non-toxic. This does not mean that no one could be alergic to it. It does mean that to date, we have not heard of cases where Dermatitis has been caused by this chemical. We would certainly appreciate receiving any information to the contrary.

3. Small quantities of Phenidone enables active developers to be produced at pH's which are lower than those necessary with comparable Metol-Hydroquinone developers (D-76, etc.) This results in better keeping properties in dish and tank use.

4. At a given pH it is possible to achieve a higher degree of CONTRAST than with a HQ developer at the same pH. This is important in the preparation of high contrast X-ray developers.

5. The final oxidation product of a Phenidone-Hydroquinone developer is COLORLESS, which reduces, but does not eliminate, the staining of fingers and clothes. This is due in part to the Hydroquinone.

6. Phenidone is NOT as sensitive to BROMIDE and to changes in bromide concentration during development as buffered Metol-Hydroquinone developers. (One of the by-products of development is BROMIDE--which acts as a restrainer. The lack of Bromide sensitivity means that the working solution using Phenidone will REMAIN CONSTANT OVER A LONGER WORKING PERIOD OF THE SOLUTION).

7. Ilford claims "That a Phenidone-Hydroquinone developer is MORE EFFECTIVE THAN ANY OTHER AVAILABLE DEVELOPER FOR FORCED DEVELOPMENT WHERE LAST-DITCH EXPOSURES WITH MINIMAL HIGHLIGHT BLOCKING IS DESIRED."

8. Phenidone gives no fog with LOW-SPEED emulsion papers. However, with high-speed emulsions it may produce fog. This can be eliminated by addition to the solution of an anti-fogging chemical, such as BENZOTRIAZOLE
High-speed negative material tends to fog, so that a formula compound with Phenidone and Benzotriazole is advantageous.

*Metol and Elon are trade names for the same chemical.

9. BENZOTRIAZOLE added to a paper developer compound with Phenidone, not only prevents fog, but also has the effect of modifying the TONE OF THE SILVER IMAGE so that COLD BLUE-BLACK TONES (which are generally considered desirable) are produced.

DIGNAN'S EXPERIMENTAL ONE-SHOT TYPE OF PHENIDONE DEVELOPER

The following information is in reference to formulas that appeared in Paul Farber's column of May, 1968 in U.S. Camera:

Water (125°f)	750.0 cc
Sodium Ascorbate	2.0 grams
Borax	2.0 grams
Phenidone	0.04 gram
Water to make	1.0 liter

pH: Approx. 9.0

Time: For Plus-X to Tri-X, 10 Minutes at 68°f.

If you wish to substitute Sodium Metaborate (S700), use 1.0 gram instead of Borax.

This developer departs from conventional Sodium Sulfite type of developer by using a derivative of Ascorbic Acid (Vitamin C). This chemical is called Sodium Ascorbate.

The Ascorbate is made by mixing Ascorbic Acid with Sodium Bicarbonate. This solution effervesces releasing CO_2. When this solution is neutral you have a new chemical called Sodium Ascorbate.

The Sodium Ascorbate has a number of functions in this formula: First, it replaces Sodium Sulfite as the preservative. Ascorbic Acid or Sodium Ascorbate acts as an oxygen scavenger, which will prevent the oxidation of the solution.

Secondly, either will act as a very weak developing agent if used alone in an alkaline solution. When used with Phenidone it reacts more like a replacement for Hydroquinone, that is, the Phenidone replaces Metol and the Sodium Ascorbate replaces Hydroquinone and the combination is super-additive. (The combination of the two is greater than either used separately.)

The Phenidone/Sodium Ascorbate combination has a number of other interesting functions: The toxicity of this combination is extremely low. Also, the solubility of the Ascorbate is very high,

so that a very concentrated developer could be compounded. Sodium Ascorbate has better keeping quality than Ascorbic Acid.

Notice that the amount of Phenidone used is extremely low, being 0.04 gram per liter. You must use an analytical balance for weighing out this small amount or you can use a percentage solution.

PERCENTAGE SOLUTIONS OF PHENIDONE

If you try to make a percentage solution of Phenidone using distilled water or tap water, you will find that the Phenidone will refuse to go into solution.

There are a number of methods that can be used to compound a percentage solution of Phenidone. One method is to use hot water.

Water (175°F)	800.0	ml
Phenidone	1.0	gram
Sodium Sulfite	5.0	grams
Water to make	1.0	liter

This will give you a 0.1% solution. 40.0 ml of this stock solution will equal .040 gram. The keeping properties of the above stock solution are poor.

Water (125°F)	800.0	ml
Phenidone	1.0	gram
Sodium Bisulfite	5.0	grams
Water to make	1.0	liter

Phenidone dissolves in this formula because of the acid reaction of the Bisulfite. The Bisulfite also acts like Sodium Sulfite as a preservative. The acid condition of the above solution improves the keeping properties because this is a stock solution. The small amount of acid will not adversely effect the pH.

You may wonder why we have not used Ascorbic Acid instead of Sulfite. The reason is that Ascorbic Acid is easily destroyed by heat. Note the above temperatures. It is also destroyed by alkali.

You may experience fog with old or aged film. The addition of Benzotriazole can be used as an anti-foggant. When this formula is mixed as recommended, 20 grams of Phenidone will process at least 1000 rolls of film!

MICROPHEN: The following is apparently the formula of Ilford's Microphen formula:

Water (125°f)	750.0	cc
Sodium Sulfite (anhy)	100.0	grams
Hydroquinone	5.0	grams
Borax (10H20)	3.0	grams
Boric Acid (granular)	3.5	grams
Potassium Bromide	1.0	grams
Phenidone	0.2	gram
Water to make	1.0	liter

ILFORD OFFICIAL ID-62 (General purpose developer)

Water (125°f)	750.0	cc
Phenidone	0.5	gram
Hydroquinone	12.0	grams
Sodium Sulfite (anhy)	50.0	grams
Sodium Carbonate (anhy)	60.0	grams
Potassium Bromide	2.0	grams
Benzotriazole	0.2	gram
Water to make	1.0	liter

Temperature: 68°f.

Dilute as follows for use:

CONTACT PAPER:	1 to 1.	Develop 45 to 60 seconds.
BROMIDE PAPER:	1 to 3.	Develop 1 1/2 to 2 minutes.
DISH: Plates & Film:	1 to 3.	Develop 2 to 4 minutes.
TANK: DILUTE:	1 to 7.	Develop 4 to 8 minutes.

OFFICIAL FUJI PHENIDONE MOTION PICTURE FORMULAS

Although these formulas are Official for Fuji, they can be used for developing other types of black & white negative positive films. Developing time must be determined by test.

NEGATIVE DEVELOPERS FD-21P

Water (approx 125°f)	750.0	cc
Phenidone	0.20	gram
Sodium Sulfite (anhy)	100.0	grams
Hydroquinone	5.0	grams
Balanced Alkali	1.5	grams
Boric Acid	1.0	gram
Potassium Bromide	0.5	gram
Water to make	1.0	liter

Note: No pH given.

Fuji 35mm super pan 71111 = at 68°f 8 mins. (gamma 0.7)

OFFICIAL FUJI PHENIDONE MOTION PICTURE FORMULAS - Cont'd.

NEGATIVE DEVELOPER FD-25

Water (approx. 125°f)	750.0	cc
Phenidone	0.20	gram
Sodium Sulfite (anhy)	100.0	grams
Hydroquinone	6.0	grams
Balanced Alkali	6.0	grams
Boric Acid	1.0	gram
Benzotriazole	0.01	gram
Water to make	1.0	liter

Fuji 16mm pan. neg. 72161 = 68°f 3 mins. (gamma 0.8)
Continuous agitation.

POSITIVE DEVELOPER FD-31P

Water (approx. 125°f)	750.0	cc
Phenidone	0.1	gram
Sodium Sulfite (anhy)	45.0	grams
Hydroquinone	4.0	grams
Sodium Carbonate (mono)	35.0	grams
Potassium Bromide	3.0	grams
Water to make	1.0	liter

Fuji 8mm fine grain 72363 = 68°f 6 mins. (gamma 3.0)
Continuous Agitation.

HIGH-CONTRAST DEVELOPER FD-41P

(For use with variable area type sound recording films and high-contrast positive films.)

Water (125°f)	750.0	cc
Phenidone	0.10	gram
Sodium Sulfite (anhy)	45.0	grams
Hydroquinone	12.0	grams
Sodium Carbonate (mono)	40.0	grams
Potassium Bromide	2.5	grams
Water to make	1.0	liter

Fuji 35mm (71412) or 16mm (72412) = 68°f 8 mins. (gamma 3.5)

ILFORD PHENIDONE FORMULAS

ID-62 UNIVERSAL DEVELOPER (for papers, plates and films)
THIS FORMULA CAN BE MADE UP AS A TWO PART SOLID PACK.

ILFORD PHENIDONE FORMULAS - Cont'd

Packet A		
Hydroquinone	12.0	grams
Phenidone	0.5	gram
Sodium Metabisulfite	1.25	gram

Packet B		
Sodium Sulfite (anhy)	50.0	grams
Sodium Carbonate (anhy*)	60.0	grams
Potassium Bromide	2.0	grams

*Note: If this is made as a two packet dry powder developer, do not substitute mono or crystal sodium carbonate in this formula.

For preparing of stock solution dissolve the contents of packet A in 700 to 800 cc of hot water (125°f), then add contents of packet B. When solution is complete, add water to make 1000 cc.

DILUTION OF ID-62

1 part stock to 1 part water: for contact papers. (Dev: 45 to 60 secs.)

1 part stock to 3 parts water: for Bromide papers and dish strength negative development. (Dev: 1 1/2 to 2 mins.)

1 part stock to 7 parts water: for tank strength negative development. (Dev: 4 to 8 mins.)

NOTE: For contact papers where a blue-black tone is required, add 0.05 grams of Benzotriazole to the above solution.

ILFORD UNIVERSAL CONCENTRATED LIQUID DEVELOPER

For papers, plates & film.

Water (125°f)	750.0	cc
Sodium Sulfite (anhy)	110.0	grams
Hydroquinone	31.0	grams
Potassium Carbonate (anhy)	100.0	grams
Phenidone	1.28	grams
Potassium Bromide	5.0	grams
Sodium Hydroxide	2.0	grams
Water to make	1.0	liter

DILUTION FOR USE: 1 to 4 for contact papers
1 to 9 for Bromide papers & dish neg. dev.
1 to 19 for tank strength negative

Note: For contact papers where a blue-black tone is required, add 0.05 grams of Benzotriazole to the above concentrated stock solution.

ILFORD PHENIDONE FORMULAS - Cont'd

ID-67 DEVELOPER FOR PLATES & FILMS

Water (125°f)	750.0	cc
Sodium Sulfite (anhy)	75.0	grams
Hydroquinone	8.0	grams
Sodium Carbonate (mono)	45.0	grams
Phenidone	0.25	gram
Potassium Bromide	2.0	grams
Water to make	1.0	liter

DILUTION: For dish: 1 to 2. Dev. 2 1/2 to 5 mins. at 68°f.
For tank: 1 to 5. Dev. 5 to 10 mins. at 68°f.

ILFORD SPECIAL DEVELOPER FOR CONTACT PAPER

Water (125°f)	750.0	cc
Sodium Sulfite (anhy)	50.0	grams
Hydroquinone	12.0	grams
Sodium Carbonate (mono)	72.0	grams
Phenidone	0.5	gram
Potassium Bromide	0.25	gram
Water to make	1.0	liter

DILUTION: 1 to 1. Dev. Time: 45 to 60 seconds at 68°f.

ID-68 OFFICIALLY MODIFIED ILFORD

ID-68 UNIVERSAL FINE GRAIN DEVELOPER

(Mixture A)

Hydroquinone	5.0	grams
Phenidone	0.2	gram
Sodium Metabisulfite	0.75	gram
Sodium Sulfite (anhy)	100.0	grams

(Mixture B)

Borax	3.0	grams
Boric Acid (crystal)	3.5	grams
Potassium Bromide	1.0	gram

Mixture A is dissolved in 700.0 cc of water at 125°f and Mixture B is added with stirring; the solution is then diluted to one liter.

pH: 8.9 Dev. Time: 8 minutes (approximately)

ILFORD PHENIDONE FORMULAS - Cont'd

ILFORD UNIVERSAL DEVELOPER (PQ-FGF)

This formula is a Phenidone replacement of Metol in a D-76 (or ID-11B) type buffered developer.

Water (125°f)	750.0	cc
Sodium Sulfite (anhy)	100.0	grams
Hydroquinone	5.0	grams
Borax (crystal)	3.0	grams
Boric Acid (crystal)	3.5	grams
Phenidone	0.2	gram
Potassium Bromide	1.0	gram
Water to make	1.0	liter

pH: 8.95

The results of using this formula over D-76 is said to be an improvement in the consistency of performance, although with a slightly slower rate of working.

ID-68 FINE GRAIN DEVELOPER FOR PLATES & FILM

Water (125°f)	750.0	cc
Sodium Sulfite (anhy)	100.0	grams
Hydroquinone	5.0	grams
Borax	2.0	grams
Boric Acid (crystal)	1.0	gram
Potassium Bromide	1.0	gram
Phenidone	0.2	gram
Water to make	1.0	liter

Do not dilute for use. Dev. Time: 7 to 11 minutes at 68°f.

ID-68R REPLENISHING SOLUTION

SOLUTION A

Hydroquinone	8.0	grams
Phenidone	0.24	gram
Sodium Metabisulfite	0.75	gram

SOLUTION B

Sodium Sulfite (anhy)	100.0	grams
Borax	10.0	grams
Boric Acid (crystal)	1.5	grams

Dissolve solution A in 700.0 cc of water at 125°f and Mixture B is added with stirring; the solution is then diluted to one liter.

pH: 9.28

ID-68R REPLENISHING SOLUTION

Water (125°f)	750.0	cc
Sodium Sulfite	100.0	grams
Hydroquinone	8.0	grams
Borax ($10H_20$)	9.0	grams
Boric Acid (crystal)	1.0	gram
Phenidone	0.25	gram
Water to make	1.0	liter

pH: 9.28

Note: The difference between the two above formulas is the use of Sodium Metabisulfite which is used to help dissolve the Phenidone and also prevent oxidation. Because the Sodium Metabisulfite is acid, the Borax has been increased in the first formula.

USING REPLENISHERS:

The above replenishers are used in the topping-up method. As a developer is used, a certain amount is carried off by the film that is being processed. The above replenishers are used to replace this loss.

BLEED TYPE REPLENISHERS

Water (125°f)	750.0	cc
Sodium Sulfite (anhy)	100.0	grams
Hydroquinone	6.25	gram
Borax ($10H_20$)	4.0	grams
Boric Acid (crystal)	0.25	gram
Phenidone	0.22	gram
Water to make	1.0	liter

pH: 9.09

Note: The bleed system is used in large processing machines for the CONTINUOUS replenishment of the developer. 365.0 cc of replenisher is required per square meter of film.

CONCENTRATED PHENIDONE DEVELOPER (normal contrast)

By A. Wiedermann

Water (125°f)	750.0	cc
Sodium Sulfite	125.0	grams
Hydroquinone	16.0	grams
Sodium Carbonate (mono)	72.0	grams
Phenidone	1.0	gram
Potassium Bromide	9.0	grams
Benzotriazole -OR-	3.0	grams
Benzotriazole 1% solution	300.0	cc
Water to make	1.0	liter

For use dilute 1 part stock with 50 parts water.
Dev. Time: approximately 15 minutes.
When using this formula, increase exposure one stop.

ID-72 HIGH CONTRAST PHENIDONE DEVELOPER

Water (125°f)	750.0	cc
Sodium Sulfite (anhy)	72.0	grams
Hydroquinone	8.8	grams
Sodium Carbonate (mono)	57.0	grams
Phenidone	0.22	gram
Potassium Bromide	4.0	grams
Benzotriazole -OR-	0.1	gram
Benzotriazole 1% solution	10.0	cc
Water to make	1.0	liter

For use, do not dilute. Dev. Time: Approximately 5 mins at 68°f.

ILFORD X-RAY & HIGH CONTRAST DEVELOPER

(Stock Solution)

Water (125°f)	750.0	cc
Sodium Sulfite (anhy)	150.0	grams
Potassium Hydroxide (anhy)	100.0	grams
Hydroquinone	50.0	grams
Phenidone	1.0	gram
Sodium Hydroxide (anhy)	10.0	grams
Potassium Bromide	16.0	grams
Benzotriazole	1.1	grams
Water to make	1.0	liter

pH: 10.45

DILUTION: 1 part stock to 3 parts water.

ILFORD X-RAY DEVELOPER

(Stock Solution)

Water (125°f)	750.0	cc
Sodium Sulfite (anhy)	150.0	grams
Hydroquinone	50.0	grams
Potassium Carbonate (anhy)	50.0	grams
Phenidone	1.1	grams
Sodium Hydroxide	15.0	grams
Potassium Bromide	20.0	grams
Benzotriazole	0.25	gram
Water to make	1.0	liter

DILUTION: 1 part stock to 4 parts water.

Note: For even higher contrast, increase the Sodium Hydroxide to 20.0 grams and the Benzotriazole to 0.4 gram.

MONOBATHS USING PHENIDONE

Monobaths develop and fix the film in one solution. Each type of film will react differently due to emulsion thickness, etc. When compounding a monobath for any particular type of film, start with the low figures given for the hypo (Sodium Thiosulfate). Make a test. If gamma is too high, increase the hypo about 10.0 grams and conduct another test. Using this system, the gamma can be controlled over a range of 0.65 to 1.05.

MONOBATH BY M. LEVY

Water (125°f)	750.0	cc
Sodium Sulfite (anhy)	60.0	grams
Hydroquinone	30.0	grams
Phenidone	0.8	gram
Sodium Thiosulfate (anhy)	48.0 to 160.0	grams
Sodium Hydroxide	25.0	grams
Potassium Alum	20.0	grams
Formaldehyde 38%	10.0	cc
Water to make	1.0	liter

MONOBATH BY G.W. CRAWLEY

Water (125°f)	800.0	cc
Sodium Sulfite	50.0	grams
Hydroquinone	12.0	grams
Phenidone	1.0	gram
Sodium Thiosulfate (anhy)	60.0	grams
Sodium Hydroxide	10.0	grams
Water to make	1.0	liter

PHYSICAL RESEARCH MONOBATH 438

Water (125°f)	700.0 ml
Sodium Sulfite (des.)	50.0 grams
Hydroquinone	15.0 grams
Phenidone	10.0 grams
Potassium Alum	20.0 grams
Sodium Hydroxide	18.0 grams
Sodium Thiosulfate (anhy)	38.0 grams
Water to make	1.0 liter

In B.P. 761, 301, (11-14-56) Ilford patented the use of Glycin (p-hydroxyphenylaminoacetic acid). They claimed a developing solution which produced an image with low contrast, very fine grain, and with no loss of emulsion speed.

Water (125°f)	750.0 ml
Glycin	5.0 grams
Phenidone	0.2 gram
Sodium Sulfite (anhy)	90.0 grams
Borax	2.0 grams
Sodium Carbonate (anhy)	2.0 grams
Water to make	1.0 liter

CONCENTRATED PHENIDONE DEVELOPER (high contrast)

By A. Wiedermann

Stock Solution

Water (125°f)	750.0 ml
Sodium Sulfite (anhy)	120.0 grams
Hydroquinone	20.0 grams
Sodium Carbonate (mono)	120.0 grams
Phenidone	1.5 grams
Potassium Bromide	15.0 grams
Water to make	1.0 liter

For use dilute 1 part stock to 9 parts water. Dev. time: approximately 3 minutes.

DIVIDED PHENIDONE FILM DEVELOPERS

by: D. William Reichner

What follows is a summary of data accumulated by extensive experimentation in an attempt to find a "universal" divided film developer having great capacity, long life and consistency in results; and relatively panthermic (yielding similar results over a range of temperatures, particularly between 65°f and 80°f). Ideally, the negatives should be clean, have good shadow and highlight detail and the results should be attained at the rated film speed. Further, some provisions should be made to allow for the production of an effective increase in contrast for film shot at a higher than rated ASA speed.

For practical reasons and for comparative purposes, experimentation has been confined to the Kodak emulsions; Panatomic-X, Plus-X, and Tri-X, both 35mm and 120 sizes including the "Professional" versions. Also included in the experimentation is the Agfa-Gevaert emulsion, XL Pan, 120 size. This film is possibly the most common "private-label" black and white film sold in this country in the 120, 620 and 126 sizes - for example, Drug Store and Department Store chains sell this film with their own packaging - its ASA is 125.

Divided Developers are usually two baths used in succession without a rinse. After the second bath the film is put directly into an acid-hardening fixer. There are variations of this procedure, but I restricted my work to that described above.

The first bath contains all the developer ingredients EXCEPT the alkali, thus, no development takes place in the first bath. It is merely absorbed by the emulsion, not USED, but it is depleted by being carried away in the film. The pH is usually close to 7.0.

The second bath contains the alkali, and here is where the development actually takes place. It is USED, and has a definite capacity and must be replaced before it is exhausted. Of course, the alkali is the least expensive part of a developer, so economy is high.

Contamination is the single most important consideration in using Divided Developers. NO alkali must be allowed in the first bath.

The complete procedure that I use might be of some interest. It requires at most 12 minutes until the film is ready to dry (if prints must be made immediately, I make use of Yankee Instant Film Dryer).

(ALL BATHS 65°f - 80°f)

	LOAD TANK
2½ - 3 min.	(A) BATH - (time depends on formula used)
	-NO RINSE-
2½ - 3 min.	(B) BATH - (time depends on formula used)
	-NO RINSE, NO STOP-BATH-
2 - 4 min.	ATF-5 FIXER (formula given below)
½ min.	RINSE
½ min.	PERMA-WASH (hypo-eliminator made by Heico)
½ min.	RINSE
½ min.	WETTING SOLUTION
	DRY (or Yankee Instant Film Dryer)

The following formulations have undergone at least 6 months of experimentation. Standardized exposed film strips of each of the mentioned emulsions have been used over that period of time to determine any variations and to measure life and capacity.

PD-76 is a Phenidone version of Divided D-76.

AP is an acutance Phenidone divided developer.

HAP is a higher acutance version.

XAP is the highest acutance formulation discovered.

(A) BATHS

	PD-76	AP	HAP
Water (95°f)	800.0 cc	800.0 cc	800.0 cc
Phenidone	0.3 gram	0.7 gram	0.7 gram
Metol (Elon)	-none-	-none-	1.8 gram
Sodium Sulfite	100.0 grams	100.0 grams	100.0 grams
Hydroquinone	5.0 grams	5.0 grams	5.0 grams
Potassium Bromide	1.0 gram	-none-	-none-
Benzotriazole	0.2 gram	1.2 gram	1.2 gram
Sodium Bisulfite	18.0 grams	20.0 grams	24.0 grams
Water to make	1.0 liter	1.0 liter	1.0 liter

(B) BATHS

Water (95°f)	800.0 cc	800.0 cc	800.0 cc
Balanced Alkali	-none-	-none-	50.0 grams
Borax ($10H_2O$)	50.0 grams	-none-	-none-
Sodium Carbonate, (monohydrated)	-none-	12.0 grams	-none-
Sodium Sulfite	-none-	100.0 grams	80.0 grams
Potassium Iodide (0.1% solution)	-none-	10.0 cc	10.0 cc
Potassium Bromide	-none-	0.5 gram	0.5 gram
Water to make	1.0 liter	1.0 liter	1.0 liter
TIME: (A) BATH -	3 mins.	2½ mins.	2½ mins.
(B) BATH -	3 mins.	2½ mins.	2½ mins.

XAP (for highest acutance): Use the (A) Bath of HAP, and the (B) Bath of AP, each for 2½ minutes.

Effective Increase in Contrast:

For film shot at a higher than rated ASA speed, compensation can be made by increasing the time in the (B) Bath as follows:

1½ times rated speed - increase time by 10%
2 times rated speed - increase time by 20%
3 times rated speed - increase time by 60% (not recommended)

NOTES ON MAKING SOLUTIONS:

For the (A) Baths, dissolve a pinch of Sodium Sulfite first, then dissolve the Phenidone with or before the Hydroquinone. Make certain it is completely dissolved before adding and dissolving the other ingredients in order.

Potassium Iodide can be made into a 0.1% solution by taking 1.0 gram of Potassium Iodide and dissolving it in water brought up to 1.0 liter total volume.

Use Distilled (or De-ionized) water for all (A) Baths. If this is not available, then use 1.0 gram Calgon (Photo Grade) (C150) per liter before adding ingredients.

AGITATION:

Continuous for the first 15 seconds in each bath, then 2 or 3 spiral turns (or 1 inversion) every 30 seconds.

CAPACITY:

(A) Baths: Unlimited.
(B) Baths: 30 rolls of 120 film, or equivalent area, per liter.
Note: It is a good practice to filter the (B) Bath after some use if precipitation occurs.

SOLUTION LIFE:

Unused: Unlimited. Once used: at least six months (extent of my experimentation), probably more.

ATF-5 is an Ammonium Thiosulfate Acid-Hardening Fixer of extremely rapid activity. The formula has appeared in earlier editions of the Photo-Lab Index, but no longer is given. It has a much longer life than normal fixers, and since it is restricted for film used where timing is controlled carefully, its rapid action is not allowed to proceed to the point where reduction of the film image takes place. Its capacity is also much greater than normal fixers. However, the hardening capability of the bath is the first to be diminished, therefore, do not rely upon hypo-testing solutions or clearing time of film strips to determine the usefulness of the fixer.

ATF-5 RAPID AMMONIUM THIOSULFATE ACID-HARDENING FIXER

Water (95°f)	500.0 cc
Ammonium Thiosulfate (60% sol.)	333.0 cc
Sodium Sulfite	15.0 grams
Acetic Acid, Glacial	15.6 cc
Potassium Alum	15.0 grams
Boric Acid, crystal	7.5 grams
Water to make	1.0 liter

NOTES ON MAKING ATF-5 FIXER

Dissolve all the chemicals in the order given EXCEPT dissolve the Boric Acid separately in a little HOT water and add this last.

TIME AND CAPACITY: Per Liter

1 to 5 rolls of 120, or equivalent area	2 minutes
6 to 10 rolls of 120, or equivalent area	2½ minutes
11 to 15 rolls of 120, or equivalent area	3 minutes
16 to 20 rolls of 120, or equivalent area	3½ minutes
21 to 25 rolls of 120, or equivalent area	4 minutes

--- then DISCARD the Fixer.

USING ATF-5 FIXER WITH PAPER

ATF-5 Fixer can be used with Paper, BUT timing is most critical due to the rapidity of the bath.

For use with paper, dilute one liter of the fixer made according to the formula above with one liter of water. This will make 2 liters of Working Paper Fixer.

Fix Prints for 1 to 2 minutes (never more than 3 minutes).

Capacity of 2 liters of Working Paper Fixer: 20 8x10 sheets, or equivalent area.

* * *

ANOTHER LOOK AT DIVIDED DEVELOPMENT

By Bertram L. Merritt

I am not sure if you have ever published divided D-76 as developed by Richard Starks of Chicago, Illinois but I am sure that no one using it could say anything about it but the highest of praise. It was first published in "U.S. Camera" in 1966 in Paul Farber's old column and I have been using it exclusively ever since. Everything in this article pertains to 35 mm. film and the use of fresh film, fresh developer, careful exposure and development. This developer (and Tri-X) will go a long way before the highlights begin to block up. I have obtained very good 16 x 20's from Tri-X. PLUS-X at 16 x 20 is almost grainless and with PAN-X you can cover your walls. The following notes are the results of my experience with this and other divided developers.

DIVIDED D-76

Bath A

Metol (Elon)	2.0 grams
Sodium Sulfite (Dessicated)	100.0 grams
Hydroquinone	5.0 grams
Potassium Bromide	1.0 gram
Water to make	1.0 liter

Bath B

Borax	60.0 grams
Water to make	1.0 liter

OR

Bath B

Borax	30.0 grams
Water to make	500.0 ml.

Develop at 68°F. Expose normally. I always expose Tri-X at E.I. 200.

Suggested Developing Times	PAN-X	PLUS-X	TRI-X
Developing Agent-Solution A	3 min.	3 min.	3 min.
Alkaline Booster-Solution B	2-3 min.	2½ to 3½ min.	3-4 min.

Note that these are suggested developing times. You may have to find your optimum time based upon your equipment, technique, etc. Increase or decrease by increments of 30 seconds to 1 minute until you find your time.

When we speak of developing times we are always speaking of time in Solution B. Never change the time in Solution A. It's purpose is merely to soak the emulsion with developing agent. Actual developing occurs in Solution B.

Metal type Nikor developing tanks are recommended as they use very little solution and can be poured very quickly. The short developing times demand short pouring times. Do not exceed 20 seconds pouring (in or out) if possible.

A. Do not use a pre-rinse of any kind.

B. Pour in Solution A. Knock sides of tank to dislodge possible air bubbles.

C. Rotate tank in opposite directions every 30 seconds. Invert if using a NIKOR type tank. Always agitate lightly.

D. Pour Solution A back in container.

E. Immediately pour in Solution B. Agitate same as Solution A.

F. After time is up, throw Solution B away. Save only if you are going to develop another roll right away.

G. Do not use shortstop. I prefer a quick water rinse as it saves hypo.

H. Pour in hypo. Follow instructions for your particular brand.

The time for Solution A is not critical. It's purpose is merely to saturate the emulsion with developer. Twice the amount of time in Solution A will make no difference.

The time in Solution B is critical. A change of 30 seconds will be noticed. Solution B (Borax) is the alkaline chemical agent that starts the developer (Solution A) to work. It is commonly called a booster. Ordinary developers have these two mixed together. Divided developers are so called because these components are divided.

Solution B should be used as a one shot. Note that I have two Solution B's in the formula, one for 1.0 liter and another for 500 ml. Make up the one you need for the amount of film you are going to develop. 500 ml. is enough for one roll of film. If I have a large amount of film, I may mix up 120 grams in 2 liters. I purchase 1 and 2 oz. prescription bottles from the drugstore and store several 30 and 60 gram bottles of borax for quick mixing. Saves a lot of time.

Solution A will not deteriorate. It will be used up through normal use and sediment will accumulate at the bottom; but it is still good. I make up a new solution after 6 months only because it takes on a darker color; it contains sediment and I am used to a clear solution. The sediment may be filtered out at any time.

CAUTION!!! Solution A will end up in Solution B through normal use but never allow Solution B to get into Solution A. If this ever happens by mistake, throw it away- -it's no good. The opposite (A getting into B) will cause no great problem.

I have changed the formula slightly from Mr. Stark's original. I found that increasing the amount of borax (from 50 grams to 60 grams) will decrease the developing time and a decreased developing time means finer grain. I have experimented with up to 80 grams per liter and have decreased the time even more but this is an over concentrated solution and some borax will soon recrystallize. Therefore, the developing time is not stable and calculable. On the other hand, I have used an oxide B bath* at developing times up to 12 minutes and still made excellent 8x10's. Mr. Starks advocated keeping Solution B, but as it oxidized so quickly the developing time increased with age and use. The one shot idea is mine and makes for a stable developing time.

I am convinced that there is no better general purpose developer than divided D-76. A partial list of its advantages are:

Very fine grain	Extremely long lasting
Inexpensive	Gross overdevelopment
Very short developing times	still produces acceptable
Excellent tonal gradation	negatives

The above applies to 35 mm. only. I also use 120 once in a while but why bother with 120 when I can get such fantastic results from 35 mm. For 120, just slightly increase developing time.

Just to give you an idea of how long lasting this developer is, some time ago my developing times were increasing and I did not know why. I had to develop Tri-X nine minutes to obtain an acceptable negative. My 8 x 10's were still great but I couldn't find the trouble. Finally it dawned on me that the original bottles of Metol (Elon) and Hydroquinone were changing colors (oxidizing). They were the original bottles I had bought in 1966 and I was still making my Solution A from these 1 lb. bottles. Fresh chemicals solved my problem. I now store these two chemicals (the others are inert) in small amber colored whiskey miniatures with wool cotton stuffed in the inside and melted wax around the top. I expect to use the last of this source sometime around 1985. Believe it or not.

I do a lot of copying. As everyone knows, copies developed on regular film and with regular developers give low contrast. I copy on PAN-X, develop in divided D-76 at twice the regular time and "voila", excellent negatives, excellent gradation, excellent grain. Try it, you'll like it!

*Oxidation due to A bath carry over.

CHRONOLOGY OF DIVIDED D-76

By: Rolland P. Krueger

I was very interested in the Divided D-76 developer, Dignan Newsletter September 1973, so I went to the original source. In "U.S. Camera" there were additional articles on Divided D-76 in Paul Farber's column.

Dec. 1966

Use standard D-76 as the "A" bath for about ½ standard development time, Bath "B" for two minutes.

Formula for Bath "B"

Sodium Sulfite (dessicated)	30 grams
Borax	5 grams
Water to	1 liter

Claims: Can be used as a method of controlling contrast, by how long or short a time the film is left in bath "A".

March 1967 - U.S. Camera

Excerpts from a letter to Paul Farber by Robert Starks. Mr. Starks was the inventor of the Divided D-76 formula.

Mr. Starks gave a modification of the "B" Bath.

Modified "B" Bath		Time of Development-U.S. Camera, June 1968
Borax	25 grams	"A" - 3 minutes
Water to make	1 liter	"B" - 3 minutes

Claim: For use in high contrast situations, cut film speed in half, use a middle tone for exposure reading. (Process for same time in "A" and modified "B". Not for use under "normal" conditions.

Mr. Starks also gave a modification of Divided D-76, FOR AVAILABLE DARKNESS, under low contrast lighting. There will be added grain size. Time of Development - 3 minutes each Bath from U.S. Camera June 1968.

Modified Solution "A"		Solution "B-1" for fast speeds	
Metol (Elon)	4.0 grams	Borax	50.0 grams
Sodium Sulfite	100.0 grams	Water to	1.0 liter
Hydroquinone	7.5 grams		
Pot. Bromide	1.0 gram	Solution "B-2" Super fast speeds	
Water to	1.0 liter	Kodalk	50.0 grams
		Water to	1.0 liter

No exposure indices given.

Other applications of Divided D-76 by Mr. Starks.

For Copy Negatives, from continuous tone materials using fine grain positive film.

Original "A" Bath

Metol (Elon)	2.0 grams
Sodium Sulfite (dessicated)	100.0 grams
Hydroquinone	5.0 grams
Potassium Bromide	1.0 gram

Use - "B-2" second bath.

For Line Copies - Kodak fine grain positive film or Panatomic-X.

Original "A" Bath	"B-3"	
"B-3" Second Bath	Sodium Carbonate	30 grams
	Water to	1 liter

March 1967 - U.S. Camera

Note by Paul Farber on Divided D-76, ORIGINAL FORMULA.
"I feel that I obtain sharper grain image by reducing the sodium sulfite to 50 grams instead of the 100 grams as called for in the original formula."

June 1968 - U.S. Camera

Mixing Chemicals - Mix chemicals in order given.
Start with 750 ml. of water at 125 degrees.
Dissolve each chemical thoroughly before adding the next.

Agitation - Five seconds, at one minute intervals, each bath.

NO SHORT STOP!

DIVIDED FIRST DEVELOPER
FOR B/W DIRECT POSITIVE PROCESSING

By: Phillip T. Jones

As you may know, Eastman Kodak markets a Direct Positive Film Developing Outfit for processing Panatomic X and Direct Positive Panchromatic Film (5246) to positive transparencies for projection viewing. Packaged with easy to follow instructions and four powdered mixes, the kit will indeed produce positive images, although they bear little resemblance to copied original photographs in terms of contrast or gradation. As the instructions indicate: "The contrast of the final positive cannot be changed appreciably by varying the time of development of the negative." And so it is if you use Eastman's first developer, D-67 which is a minor variation on D-19. The resulting transparencies are far too contrasty and will not retain gradation in both the shadows and highlights.

After a few weeks of testing, I have arrived at a two-part first developer formula that will cut the contrast and preserve an excellent degree of detail in both ends of the scale of the positive transparency:

D-67V (a)

Water	750.0 cc
Metol	2.0 gram
Sodium Sulfite	90.0 grams
Hydroquinone	16.0 grams
Potassium Bromide	7.0 grams
Water to make	1.0 liter

D-67V (b)

Water	750.0 cc
Sodium Carbonate	25.0 grams
Sodium Thiocyanate	1.7 gram
Water to make	1.0 liter

Developing times are approximately 5 minutes in the (a) solution and 9 minutes in the (b) solution at 70°F. I recommend vigorous initial and subsequent agitation in solution (b) to avoid mottle and streaking.

Since I teach photography, using the direct positive process is useful in preparing instructional media, and it's certainly advantageous to apply the process to produce transparencies that are faithful to the originals in tonal gradation.

Slides are also useful in promoting my personal work. Mailing a small box of transparencies to a prospective editor or gallery owner has a convenience and expense advantage over shipping an assortment of original prints.

PROCESSING OFFICIAL FORMULAS FOR KODAK BLACK-AND-WHITE REVERSAL FILMS

Reversal processing steps for Kodak 4-X Reversal Film 7277, Kodak Tri-X Reversal Film 7278, Kodak Plus-X Reversal 7276, and Eastman Reversal Duplicating, Type 7361, developed in a continuous processor, are given in the following table.

PROCESSING STEP	TIME OF TREATMENT		
	68°f. (20C)	95°f. (35C)	110°f. (43C)
1. First Developer	2 min.	40 sec.	13 sec.
2. Running Water Rinse*	30 sec.	20 sec.	5 sec.
3. Bleach	50 sec.	40 sec.	10 sec.
4. Running Water Rinse	30 sec.	20 sec.	5 sec.
5. Clearing Bath	30 sec.	20 sec.	5 sec.
6. Running Water Rinse	30 sec.	20 sec.	5 sec.
7. Re-exposure	800 foot-candle seconds		
8. Redeveloper	30 sec.	20 sec.	5 sec.
9. Running Water Rinse**	30 sec.	20 sec.	5 sec.
10. Fixer	50 sec.	30 sec.	5 sec.
11. Running Water Wash ***	AS REQUIRED		
12. Dry	AS REQUIRED		

* Do not use an acid stop bath at this point.

** An acid stop bath, such as Kodak Stop Bath SB-1a can be used in place of a water rinse following redevelopment.

*** The amount of washing needed is determined by the effeciency of the water application and the permissible residual hypo concentration for the intended use.

FIRST DEVELOPER-KODAK D-94

Water, about 70°f. (21C)	750.0	ml
Elon	0.6	gram
Sodium Sulfite	50.0	grams
Hydroquinone	20.0	grams
Potassium or Sodium Bromide	8.0	grams
Sodium Thiocyanate	6.0	grams
Sodium Hydroxide	20.0	grams
Water to make	1.0	liter

KODAK REPLENISHER D-94-R

Water, about 70°f. (21C)	750.0	ml
Elon	1.3	grams
Sodium Sulfite	50.0	grams
Hydroquinone	26.0	grams
Sodium Thiocyanate	7.5	grams
Sodium Hydroxide	34.0	grams
Water to make	1.0	liter

Replenishment Rate-2.2 ml. per foot of 16mm film.

REDEVELOPER KODAK DEVELOPER D-95

Water, about 70°f. (21C)	750.0	ml
Elon	1.0	grams
Sodium Sulfite	50.0	grams
Hydroquinone	20.0	grams
Potassium or Sodium Bromide	5.0	grams
Potassium Iodide	0.25	grams
Sodium Hydroxide	15.0	grams
Water to make	1.0	liter

KODAK REPLENISHER D-95-R

Water, about 70°f. (21C)	750.0	ml.
Elon	2.2	grams
Sodium Sulfite	50.0	grams
Hydroquinone	50.0	grams
Sodium Hydroxide	50.0	grams
Water to make	1.0	liter

Replenishment Rate-0.75 ml. per foot of 16mm film.

BLEACHING BATH R-9

Water	1.0	liter
Potassium Dichromate	9.5	grams
Sulfuric Acid, concentrated	12.0	ml

Caution: Always add the sulfuric acid to the solution slowly stirring constantly, and never add the solution to the acid, otherwise the solution may boil and spatter the acid on the hands or face, causing serious burns.

KODAK BLEACH REPLENISHER R-9Ra

Water	1.0	liter
Potassium Dichromate	30.0	grams
Sulfuric Acid, concentrated	25.0	ml

Replenishment rate - 2 ml. per foot of 16 mm film.

CAUTION: Always add the sulfuric acid to the solution slowly, stirring constantly, and never add the solution to the acid, otherwise, the solution may boil and spatter the acid on the hands or face, causing severe burns.

KODAK CLEARING BATH CB-2

Water	750.0	ml
Sodium Sulfite	240.0	grams
Water to make	1.0	liter

Replenishment rate - 2 ml per foot of 16mm film.

KODAK STOP BATH SB-1a

Water	1.0	liter
Acetic Acid 28%*	125.0	ml

*To make approximately 28% acetic acid from glacial acetic acid, dilute 3 parts glacial acetic acid with 8 parts water.

KODAK FIXING BATH F-10

Water, about 125°F. (50C)	500.0	ml
Sodium Thiosulfate (Pentahydrate)	330.0	grams
Sodium Sulfite	7.5	grams
Kodak Balanced Alkali *	30.0	grams
Acetic Acid 28%	72.0	ml
Potassium Alum	22.5	grams
Water to make	1.0	liter

KODAK FIX REPLENISHER F-19R

Water, about 125°F. (50C)	500.0	ml
Sodium Thiosulfate	420.0	grams
Sodium Sulfite	10.0	grams
Kodak Balanced Alkali *	30.0	grams
Acetic Acid 28%	120.0	ml
Potassium Alum	22.5	grams
Water to make	1.0	liter

Replenishment Rate - 1 ml per foot of 16mm film.

* You can substitute Sodium Metaborate for Kodak Balanced Alkali, 1 to 1.

* * *

UNIVERSAL REVERSAL FORMULAS FOR B & W FILMS

BY

D. WILLIAM REICHNER

AND

MARTIN FIGOTEN

We would like to recommend to those readers who have never made Black and White slides, to try this procedure. We do not mean to imply in any way that color slides are undesirable - on the contrary - about 95% of all slides that we have made have been in color, with different color films serving different purposes for us.

Black and White slides are not just "different" from color slides even though variety in a slide presentation isn't a bad idea in itself. Black and White slides have a completely different impact on the viewer. Some subjects demand this sort of impact. There are some that cannot be pictured with the photographer's intent in visual communication by using color film. The more obvious of these, are dramatic events such as battle scenes, riots, slum conditions, character studies of faces, technical operation of equipment. In these examples, the "prettiness" of color would serve to distract the viewer from the nature of the picture.

Less obvious uses of Black and White slides are those of figure studies and glamour pictures where impact can be of quite a different nature than that produced with color.

If you haven't tried it before - try it now - and don't hesitate to use both color and Black and White slides in the same presentation. We have found that the usual travel slide show can be enriched by such a simple device.

The universal formulas for reversal processing that follows are a modification of an early procedure used with Gevaert Black and White thin-emulsion still and motion picture films. It has been used by the authors for almost ten years with very satisfactory results on a variety of films.

Originally, the modified formulas were designed for Adox KB-14, Kodak Plus-X and Panatomic-X and for certain 8mm/16mm motion

picture films. However, we have found that they also work very well with Adox KB-17, Kodak Tri-X, and certain high-speed Dupont motion picture films. All films that we have used were exposed at rated ASA. No attempt has been made to alter the rated speeds of these films. Attempting to "push" film not originally intended for reversal processing is usually a poor idea in that, contrary to normal negative processing, there is little latitude in exposure for such processing.

The development of the first image (in the first developer) will have a great influence on the final result. Such first development must be complete and any blocking-up or ultra-thin details will suffer in the second development.

These comments are not intended to curtail individual experimentation with different films and procedures, however, an awareness of these limitations should be possessed by the experimenter.

It should be pointed out that there are no figures given as to life expectancy of the various baths below. It might be of interest to relate that we have processed film with baths that had been prepared, used, and replenished, over two years earlier with excellent results. (We don't recommend this as a standard procedure. The circumstances did not allow preparing new solutions, so we had to gamble on the old ones. We were prepared to accept less than average results, but we were lucky.)

Some comments about replenishment: When a bath has been used to such an extent that the amount of replenisher added equals the original volume of the working solution, no further replenishment should be made and the bath sould be discarded once its capacity has been exhausted.

This procedure is an advisable one since there will be an accumulation of processing by-products that could prove detrimental to the processed films. A replenisher is designed to maintain a chemical balance of a bath by regulating the pH and providing those portions of the original bath that have been chemically exhausted, physically removed on the processed film, or altered in activity by processing by-products introduced by carry-over in the film from preceeding baths. (There are other functions of replenishers that are dependent on the nature of the bath being replenished - but a more detailed explanation is not of practical importance to the content of this article.)

GENERAL NOTES:

Dissolve the chemicals in the order listed, making certain that each is completely dissolved before adding the next.

REVERSAL FORMULAS FOR B & W FILMS

Sodium Bisulfite can be replaced by the same amount of Potassium Metabisulfite.

The bleach replenisher is a concentrated form of the working solution. It might be simpler to prepare only bleach replenisher and from this a working solution can be made by taking 200.0 ml of bleach replenisher and adding 800.0 ml of water.

DEVELOPERS

	First		Second	
Water (90°F)	750.0	ml	750.0	ml
Calgon (Photo Grade)*	2.0	grams	2.0	grams
Metol (Elon)	4.0	grams	2.0	grams
Hydroquinone	8.0	grams	4.0	grams
Sodium Sulfite	50.0	grams	60.0	grams
Sodium Carbonate (Mono) (AN 58)	70.0	grams	(39) 47.0	grams
Sodium Thiocyanate	3.5	grams	-none-	
Photo-Flo	3.0	ml	3.0	ml
Potassium Bromide	3.5	grams	1.0	gram
Water to make	1.0	liter	1.0	liter

DEVELOPER REPLENISHERS

	First		Second	
Water (90°F)	750.0	ml	750.0	ml
Calgon (Photo Grade)*	1.0	gram	1.0	gram
Metol (Elon)	5.5	grams	3.0	grams
Hydroquinone	13.5	grams	8.0	grams
Sodium Sulfite	55.0	grams	65.0	grams
Sodium Carbonate (Mono)	76.0	grams	59.0	grams
Sodium Thiocyanate	4.0	grams	-none-	
Sodium Hydroxide	2.5	grams	0.8	gram
Photo-Flo	-none-		3.0	ml
Water to make	1.0	liter	1.0	liter

BLEACH BATH REPLENISHER

	First		Second	
Water (90°F)	800.0	ml	800.0	ml
Potassium Bichromate	5.0	grams	25.0	grams
Sodium Bisulfate	20.0	grams	100.0	grams
Water to make	1.0	liter	1.0	liter

*Also called Sodium Hexametaphate.

	Clearing Bath	Replenisher
Water (95°F)	800.0 cc	800.0 cc
Calgon (Photo Grade)	2.0 grams	2.0 grams
Sodium Sulfite	100.0 grams	120.0 grams
Sodium Bisulfite	5.0 grams	-none-
Water to make	1.0 liter	1.0 liter

REPLENISHMENT SCHEDULE

	(Each roll) 120, 620, 127, 35mm 36 exp.	(Each roll) 35mm 20 exp.	(30 feet Dbl.8mm/...
First Developer	37.0 cc	20.0 cc	92.0 cc
Bleach Bath	26.0 cc	14.0 cc	64.0 cc
Clearing Bath	18.0 cc	10.0 cc	45.0 cc
Second Developer	48.0 cc	25.0 cc	120.0 cc

Replenishment Procedure

Place replenisher amount into empty liter bottle used to store working solution, then pour back used working solution until bottle is filled. Discard any excess working solution.

PROCESSING CHART

Time in Minutes	Temperature in F°	Operation
6*	75	First Developer
1	68 - 80	Rinse
4**	75	Bleach Bath
4	68 - 80	Wash
4**	75	Clearing Bath
2	68 - 80	Wash
2		Second Exposure - 500 Watt lamp at two feet. Film see-sawed in water in white dish. One minute on each side of film.
6*	75	Second Developer
2	68 - 80	Wash
4	75	Acid hardening fixer (any fresh fixer for B & W film - not RAPID FIXER)

PROCESSING CHART (continued)

Time in Minutes	Temperature F °	Operation
4	68 - 80	Wash
1	68 - 80	Wetting solution (any fresh wetting solution for B & W film)

NOTES:

*Time and temperature for BOTH developers can be varied by use of the table below. For best results, it is usually a good practice to maintain the same temperature for all baths and washes.

**Bleaching goes to completion. As a general rule, (for this process) allow two-thirds of the time used in the first developer. See the table below. Clearing bath takes the same time as the bleach.

AGITATION

Continuous for the first 15 seconds in each bath, then 2 or 3 spiral turns (or 1 inversion) every 30 seconds.

TIME-TEMPERATURE TABLE

Temperature in F°	Time in Minutes	
	1st & 2nd Developers	Bleach Bath & Clearing Bath
68	8.0	5.5
70	7.5	5.0
72	7.0	4.5
75	6.0	4.0
77	5.5	4.0
80	5.0	3.5

SIMPLIFIED BLACK AND WHITE SLIDE PROCESSING

By: Robert Morris

This process for producing black and white slides was developed as a comparatively simple and inexpensive method. The slides made are of a quality equal to or better than those produced using the Kodak Direct Positive Film Developing Outfit with Panatomic X film. In addition to lower cost, all working solutions are discarded after use.

The process has been used only with Panatomic X film. For general use a thru the lens meter exposure index of 80 is recommended. For document copying a "white Card" index (thru the lens meter) of 80 to 160 is recommended. Pushing of the Panatomic X film is not recommended as the slides will be too contrasty. The procedure would probably work with other thin emulsion films. It does not produce satisfactory results with Plus X or Tri X films.

The most critical parts of the process (aside from the proper exposure) are the time and temperature of the first developer and the concentration of the Potassium Thiocyanate. No compensation can be made with the second exposure or development. In fact, the time and temperature of the second development is not critical, since it goes to completion. The Potassium Thiocyanate in the first developer removes the precise amount of unexposed silver halide from the emulsion to produce clear highlights in the reversed image. Increasing the amount of Potassium Thiocyanate or the first development time will result in thin shadows and washed out highlights in the positive image.

The second or reversal exposure is a sensitive procedure. If too little exposure is made, the remaining silver halides cannot be developed to completion. If the exposure is longer than that specified or to a more intense light source, chromate complexes probably formed during bleaching and removable only with a fixer, will be rendered developable and will degrade the image and veil the highlights in the slide. If the second exposure were to be made after step 2 (stop-hardener) to avoid the above problem, spots will form in the finished slide. Therefore the film being processed must not be exposed to light until the second exposure and then the process must continue in total darkness until the film has been fixed. Do not remove the film from the reel (a stainless steel wire spiral reel is a must) for the second exposure.

The bleach oxidizes and removes the negative silver image. The clearing bath reduces the bleach remaining after the rinse. Although second development may go to completion, a fixing bath is necessary to remove any silver and chromate complexes that may have been formed. The fixer also hardens the emulsion.

The Potassium Bromide - Potassium Thiocyanate, bleach and stop-hardener stock solutions have unlimited shelf life in filled or partially filled containers. The developer and clearing bath stock

(continued)

solutions have a six month shelf life in completely filled containers. If deionized or distilled water is used and the water is boiled to drive out dissolved air and brown glass bottles are used, the stock solutions should last one year.

STEP	PROCESS	TIME	TEMPERATURE
1	First Development	8 min.	68° ± ½°F
2	Stop-Hardener	2 min.	68° - 72°F
3	Bleach	3 min.	68° - 72°F
4	Rinse	15 sec.	68° - 72°F
5	Clear	2 min.	68° - 72°F
6	Rinse	15 sec.	68° - 72°F
7	Reversal Exposure:	30 to 40 seconds each side of reel 2 to 4 inches from 40 watt fluorescent lamp.	
8	Second Development	6 min.	68° - 72°F
9	Fix	3 min.	68° - 72°F
10	Wash	1 min.	60° - 75°F
11	Perma wash (or equal)	1 min.	68° - 72°F
12	Wash	1 min.	68° - 72°F
13	Wetting agent	30 sec.	68° - 72°F
14	Dry		

PROCEDURE NOTES

1. Prepare stock solutions in advance.
2. Load exposed film into reels, place in tank and cover. Nikor or equal is recommended.
3. Prepare working solutions in glass or stainless steel containers. Have a container of rinse water ready.
4. Start timer and pour in first developer. Agitate for 20 seconds then for 10 seconds at one minute intervals.
5. At end of 8 minute developing period, pour out and discard first developer. Immediately pour in stop-hardener; agitate continuously for first minute.
6. Pour out and discard stop-hardener; add bleach. Agitate continuously for 30 seconds then for 10 seconds at one minute intervals.
7. Pour out and discard bleach; add rinse water; agitate 15 seconds pour out.
8. Pour in clearing bath; agitate continuously for 30 seconds then for 10 seconds in one minute.
9. Pour out and discard clearing bath; add rinse water; agitate 15 seconds; pour out.

(continued)

10. Remove reel from tank and without removing film from reel expose each side of reel 30 to 40 seconds 2 to 4 inches from a 40 watt fluorescent lamp. Rotate reel while exposing; return reel to tank and cover.
11. Pour in second developer; agitate for 20 seconds then for 10 seconds at one minute intervals.
12. Pour out developer and discard; add fixer; agitate for 20 seconds then for 10 seconds at one minute intervals.
13. Pour out fixer and discard; wash; use hypo eliminator; wash again; use wetting agent; dry.

FIRST DEVELOPER WORKING SOLUTION

Developer stock solution	250.0 cc
Po'assium Bromide-Potassium Thiocyanate stock solution	40.0 cc
Water to make	500.0 cc

SECOND DEVELOPER WORKING SOLUTION

Developer stock solution	250.0 cc
Water to make	500.0 cc

STOP-HARDENER WORKING SOLUTION

Stop-hardener stock solution	100.0 cc
Water to make	500.0 cc

BLEACH WORKING SOLUTION

Bleach stock solution	50.0 cc
Water to make	500.0 cc

CLEARING WORKING SOLUTION

Clearing stock solution	100.0 cc
Water to make	500.0 cc

FIXER WORKING SOLUTION

Dilute rapid fixer to paper strength and add recommended hardener as per manufacturers instructions.

DEVELOPER STOCK SOLUTION

Water, 125°F	850.0 cc
Calgon	2.0 grams
Metol	6.0 grams
Sodium Sulfite	50.0 grams
Hydroquinone	6.0 grams
Sodium Carbonate	60.0 grams
Water to make	1000.0 cc

(continued)

POTASSIUM BROMIDE-POTASSIUM THIOCYANATE

STOCK SOLUTION

Potassium Bromide	50.0	grams
Potassium Thiocyanate	50.0	grams
Water, 125°F, to make	1000.0	cc

STOP-HARDENER STOCK SOLUTION

Boric Acid	25.0	grams *
Potassium Alum	75.0	grams *
Water, 160°F, to make	940.0	cc
Acetic Acid, glacial	60.0	cc *

BLEACH STOCK SOLUTION

Potassium Dichromate	100.0	grams *
Sodium Bisulfate	200.0	grams *
Water, 125°F, to make	1000.0	cc

CLEARING STOCK SOLUTION

Sodium Sulfite	150.0	grams *
Sodium Bisulfite	50.0	grams *
Water, 125°F, to make	1000.0	cc

FIXER

Any proprietary rapid fixer with hardener.

*Amount not critical. Plus or minus one gram or one cc.

* * * * * *

AN EXPERIMENTAL REVERSAL MONOBATH

By Arthur Garza and Patrick D. Dignan

Would you like to produce a positive transparency using only one solution. How would you like to shoot Plus-X at 1600? These things are possible with the monobath to be described. We really doubt that you will believe this article until you try the system.

The formula is the result of work done on monobaths by Hutson K. Howell at the Boston University under contract to the United States Air Force, 1954.

If you have experimented with monobaths you may have noticed that if you exposed the film to light before fixation was complete, the low densities may have reversed to a positive. Howell took this cue and came up with a single solution reversal bath. The system does have a few shortcomings. The high minimum density of the positive requires higher lamp wattages during projection. Resolution is lower and the latitude is short requiring flat lighting. Its advantages are: a single solution processing is used, film speed is increased, processing time is short and it can be used with most standard negative materials. Mr. Howell explains the process as follows:

"After the proper processing time with continuous agitation in a tank or tray has elasped, the negative is exposed for a few seconds to a bright light, while still saturated with the developer. An unsheilded 100 watt bulb, or better, a No. 1 photoflood, at a distance of a foot or so will serve. The exposure is not critical. In about 10 seconds the picture will be reversed. A few minutes treatment in an acid hardning bath is recommended before washing. However, an acid rinse is adequate, if the wet negative is carefully washed and handled. The proper solution composition varies with the emulsion type. A general formula which has been employed successfully on several highspeed emulsion types is as follows:

B/W REVERSAL MONOBATH BY HOWELL

Water	800 ml
Metol	5 grams
Sodium Sulfite	50 grams
Hydroquinone	20 grams
Sodium Hydroxide	20 grams
Sodium Thiosulfate (anhy.)	54 grams
Water to make	1 liter

Use at 68°f

The proper dark developing time depends on the emulsion, and to a lesser degree, the camera exposure. It will lie between three and five minutes, with the higher speed emulsions requiring the longer time. If the camera exposure was not low enough to insure

that the whole scene brightness range was placed on the positive curve, then shorter development time will help, since the minimum density lies at higher exposure values for shorter development times.

Conversely, if it is known that the negative was so much underexposed that even the highlights are not placed on the toe of the positive curve, then somewhat longer development time before reversal will help.

It should be bore in mind that longer development time lightens the over-all density, and that over exposure causes the light areas to appear washed out and the highlights to turn negative in appearance. For example, a bright reflection may show a dense black nucleus or core.

If excessive contrast and very high average density result, an increase in the hypo concentration of about 30% will help. If, on the other hand, the positive is flat and washed out, a decrease in the hypo concentration may be beneficial.

The original camera exposure must be rather accurate, in order to place the scene brightness range on the positive region. In general, about one-fourth to one-eighth the usual exposure will suffice. If a meter is used, a good practice is to use an exposure index of four times the rated value. Although this apparently indicates a significant gain in emulsion speed, a practical way to regard it is that the brightest part of the scene must receive no more exposure than than corresponding to a density of about 1.0 on the normal negative characteristic curve for the material".

The system is offered as being experimental. If we assume your exposures are constant, varying the dark time and the amount of hypo used, will vary the result with the emulsion you choose to test. Noticing that the formula does not contain Bromide, adding it may or may not improve the results. Try .5-1.0 gram. Phenidone can be used to replace Metol, try 0.5-1.0 gram. We would like to see the process slowed down. We used 3 minute dark time with Plus-X and Agfa Isopan ISS 120 and it proved too critical to produce consistant results.

We found that we could improve a positive that was too dense by treatment for a few minutes in a weak solution of Farmers Reducer made up as follows:

Water	400 ml
Ammonium Thiosulfate	100 ml
Potassium Ferricyanide	1 gram

(Do Not Dilute) Mix immediately before use, discard after use.

This is used in the light. Reduction should be watched visually.

BLACK AND WHITE TONING DEVELOPERS

Burki and Jenny, in 1943, compounded a developer for black and white prints. For pronounced blue tones to a finished print, the following formula is recommended:

Metol	3.0	grams
Sodium Sulfite	40.0	grams
Hydroquinone	12.0	grams
Sodium Carbonate	75.0	grams
Potassium Bromide	0.8	gram
Water to make	1.0	liter

To every 100 ml of the above developer (as used in a tray), add 2 to 5 ml of a 1% solution of Kodak Anti-Fog #1 or Anti-Fog #2 (nitrobenzimidazole) before using. Both Anti-Fogs are available from Kodak, Lauder, etc.

EDWAL - 106 This is called "The Auto-toning developer".

Water	900.0	ml
Sodium Sulfite (anhy)	85.0	grams
Sodium Carbonate (mono)	174.0	grams
Glycin	28.0	grams
Hydroquinone	9.0	grams
Potassium Bromide	4.0	grams
Water to make	1.0	liter

With this developer it is possible to produce prints in greens, reds, browns, and blacks, of various shades.

The color produced depends on the following factors:

1. Developer dilution
2. Type of paper used
3. Length of exposure
4. Length of development

With slow contact papers (chloride) the colors can vary between green, red, brown and sepia. For chloride and chlorobromide papers dilute developer with 7 parts water. Develop 4 to 6 minutes for brown-blacks.

For bromide papers dilute developer with 3 parts water.

Exposure should be 3 times normal and developed 60 to 90 seconds. At 8 times normal exposure, tones are brighter and tend toward brick red.

With Opal paper, dilute one part developer with 15 parts water to produce green tones. At this dilution, enlarging papers produce "gravure-brown". Enlarging papers should not be given more than 1 to 1½ times normal exposure.

Fix, wash and dry before judging color of prints.

A THREE SOLUTION REVERSAL B/W PROCESS FOR LINE INFORMATION PROJECTION

By Patrick D. Dignan

How many good ideas are lost to the world because someone says "it won't work". They should say "I don't think it will work" and they would even do better if they added "but I'll try it and see what happens."

The above fits into what we are about to explain, because if you understand reversal development, your first thought will be, it won't work.

Well, it just so happens that the following system does work. A number of firms are using it to store and retrieve written or typed information, or line drawings.

The present system uses microfilm. The objects photographed can be a TV type display tube, black & white line copy, printed information, etc. In other words, it is not meant for pictorial information. The three processing solutions consist of the following: DEVELOPER, BLEACH, CLEAR. What you end up with is a positive image. Whites are white; however, black is not black. It is the cream color of the emulsion. The density difference between the clear or white area and the cream color of the emulsion will only read about .52 on a transmission densitometer.

However if you project this positive image, legibility is not a problem, in fact, you can even contact print or enlarge and make a print on any hard printing paper, the results in this case will produce a negative.

TIME TABLE AT 68°F

Kodak D-8	2 to 5 minutes depending on emulsion used.
Wash	2 minutes
Bleach Dichromate	3 minutes
Wash	1 minute
Clear sodium sulfite sols	2 minutes

The solutions are not difficult to mix. Here are recommendations:

KODAK D-8

Water	750.0	ml
Sodium Sulfite	90.0	grams
Hydroquinone	45.0	grams
Sodium Hydroxide	37.0	grams
Potassium Bromide	30.0	grams
Water to make	1.0	liter

For use, dilute with two parts water.

DICHROMATE BLEACH

Water (120°F)	800.0	ml
Potassium Dichromate	9.5	grams
Sodium Bisulfate	66.0	grams
Water to make	1.0	liter

CLEARING BATH

Water	600.0	ml
Sodium Sulfite	100.0	grams
Water to make	1.0	liter

To clear the highlights, one to five grams of potassium thiocyanate should be added to the developer depending on the emulsion used. In other words, we would recommend leaving it out on the first test. Check the results. Are the whites white or vailed? If vailed, add one gram of thiocyanate.

Microfilm is available in any large city. Check the Yellow Pages. Pan-X and Pan F should also produce satisfactory results, or any high contrast copy film such as H&W Control.

DICHROMATE OR BICHROMATE: In the past, this has also been known as red potassium chromate. Perhaps you have wondered why this chemical is difficult to purchase by mail. It is an oxidizing agent and if mixed dry with any number of substances,can cause a fire. In fact, it is used in the manufacture of pyrotechnics, explosives, etc. Also the dust of dichromate can cause a rash or external ulcers. There are no problems using it, but the above cautions should be noted. It is available in most large photo stores and is also available from Litho supply and chemical supply houses.

RAPID BLACK & WHITE FORMULAS

By Patrick D. Dignan

Today, as never before, time is money. We have searched the literature for formulas that will rapidly process black & white film. Although these are not experimental formulas, changes in time, temperature, agitation and especially the emulsion stock will all have a bearing on the results.

FIVE SECOND DEVELOPING AT 120°F

In 1950, a processing machine was constructed by Eastman Kodak for processing Eastman Fine Grain Release Positive Film in 40 seconds at 120°F.

The system was used for the projection in theatres of black and white T.V. By reversing the image on a small T.V. screen to a negative and photographing it on the positive film stock, processing was done at 90 feet per second. This resulted in only a 40 second delay from exposure to projection of the print.

KODAK RAPID DEVELOPER SD-27

Water (90°F)	750.0	ml
Elon or Metol	5.0	grams
Hydroquinone	45.0	grams
Sodium Sulfite	90.0	grams
Sodium Hydroxide	40.0	grams
Potassium Bromide	10.0	grams
Benzotriazole (Anti-Fog 1)	1.0	gram
Water to make	1.0	liter

This formula is normally used for 3½ minutes at 70°F. In this machine, development was accomplished by spraying the solutions at 120°F for 5 seconds. The film was fixed for 10 seconds at 120°F using Kodak Rapid Liquid Fixer (with hardener). The concentrate was diluted with three parts water. Washing was 5 seconds at 120°F. The film was then squeegeed and dried on a heated wheel.

As we have pointed out many times, the ideal situation would be rapid processing at a temperature of 80° to 90°F. Very few water supplies in this country reach temperatures above 80°F in the summer time. In some other countries it does go up to 90°F.

Developing systems that utilize 68°F to 75°F require refrigeration in plants that process a large volume of material. A formula that produces rapid development even at 70°F is given below.

KODAK RAPID DEVELOPER SD-26

Water (90°F)	750.0	ml
Elon or Metol	20.0	grams
Sodium Sulfite	60.0	grams
Hydroquinone	20.0	grams
Sodium Hydroxide	20.0	grams
Potassium Bromide	10.0	grams
Cold Water to make	1.0	liter

Film can be completely processed in four minutes at 70°F using the following time table:

Developer (SD-26)	1 minute
Kodak Rapid Fixer	1 minute
Spray Washing	1 minute
Drying (impingement warm air)	1 minute

Factors influencing time of developing are: Type of emulsion, Temperature, Agitation and composition of the developer. pH and anti-fogs can be adjusted to prevent fog.

The two main problems with rapid processing are not connected with development. Fixing and drying are the two operations that slow down all rapid processing systems.

Another formula that has been used for rapid processing is Kodak D-8.

KODAK D-8

Water	750.0	ml
Sodium Sulfite	90.0	grams
Hydroquinone	45.0	grams
Sodium Hydroxide	37.5	grams
Potassium Bromide	30.0	grams
Water to make	1.0	liter

This is a maximum contrast developer which in normal use is diluted with two parts water. Development is carried out at 68°F for two minutes. This formula can be used undiluted at higher temperatures and produce acceptable results from 15 to 30 seconds. Again this depends on the emulsion used and the method of agitation.

PROCESSING IN 1.5 SECONDS AT 170°F

The Army Signal research and development laboratory at Fort Monmouth New Jersey did it in 1957, for projection of radar signals. They sprayed the following monobath on the film:

HIGH-SPEED MONOBATH PROCESSING SOLUTION

Water (125°F)	750.0	ml
Metol or Elon	12.0	grams
Sodium Sulfite	70.9	grams
Hydroquinone	25.7	grams
Sodium Hydroxide	25.7	grams
Benzotriazole (Anti-Fog 1)	10.0	grams
Sodium Thiosulfate	180.0	grams
Water to make	1.0	liter

Most monobaths precipitate silver compounds and this formula was no exception. It was usable for about two hours which was better than most formulas tested.

One interesting aspect of this project was they used acetic acid vapor to stop developing. Developing and fixing took 0.6 seconds. The stop bath and hot air drying took 0.9 seconds. This stabilized image (not fixed) was projected with yellow light. The system suffered from low contrast, maximum density was only 2.1.

They gave up on this monobath and used separate chambers for developer and fixing. The following developer was used.

HIGH SPEED-HIGH TEMPERATURE DEVELOPER

Water (60 to 70°F)	660.0	ml
Metol or Elon	13.0	grams
Sodium Sulfite	80.0	grams
Hydroquinone	26.0	grams
Sodium Hydroxide	26.0	grams
Benzotriazole	2.0	grams
Aerosol (10% solution)*	10.0	drops
Water to make	1.0	liter

This developed at 185°F for 0.2 seconds.

The following fixing bath was used:

HIGH SPEED HOT CLEARING SOLUTION

Hypo (Sodium thiosulfate, crystal)	500.0	grams
Aerosol	10.0	drops
Water to make	1.0	liter

At 205°F clearing time was 0.2 seconds.
AT 200°F clearing time was 0.4 seconds.

*Wetting Agent

ELEVEN GEOFFREY CRAWLEY FX DEVELOPERS*

Geoffrey Crawley is present editor of "The British Journal of Photography". In 1960 and 1961 he proposed a group of Black and White Developers Designated "FX Series".

FX-1: High Acutance Developer
(Increase ASA 50%)

Water	500.0	ml
Metol	0.5	gram
Sodium Sulfite (Anhy.)	5.0	grams
Sodium Carbonate (Mono.)	3.0	grams
Potassium Iodide (0.001% sol.)[1]	5.0	ml
Water to make	1.0	liter

Use once and discard. Do not add Calgon.

[1]To make 0.001% solution of Potassium Iodide, add 1 gram to 1 liter of water. Take 100 ml of this solution and dilute to 1 liter. Again take 100 ml of this solution and dilute to 1 liter. This will give you a 0.001% solution of Potassium Iodide. (This is equal to 1 mg per 100 ml).

Develop at 68° for the following times:

Kodak Pan-X	13 min.	Kodak Veri-Pan	18 min.
Kodak Plus-X	12 min.		

Mr. Crawley claims the Iodide's action is tc enhance adjacency effects which also accentuates len abberations, flare and camera movement. Highest resolution and definition using FX-1 will be obtained on Kodak Panatomic-X.

*Modified to U.S.A. Chemical availability.

FX-3: Compensating Developing
(Increase ASA 30%)

Water	250.0	ml
Hydroquinone	6.0	grams
Phenidone	0.25	gram
Sodium Sulfite (Anhy.)	75.0	grams
Borax ($10H_2O$)	2.5	grams
Potassium Bromide	1.0	gram
Water to make	1.0	liter

Activity of this developer will increase with storage.

Develop at 68° for the following times:

Kodak:

Pan-X (MF)	5 min.	Plus-X	7 min.
Pan-X (RF)	6 min.	Veri-Pan	7 min.
Plus-X Pan (MF)	6 min.	Tri-X (MF)	7 min.
Plus-X Pan Prof (RF)	7 min.	Tri-X (RF)	8 min.
		Royal-X	10-15 min.

FX-4:
(Increase ASA 60°)

Water	700.0	ml
Metol	1.5	grams
Phenidone	0.25	gram
Hydroquinone	5.0	grams
Sodium Sulfite (Anhy.)	100.0	grams
Borax ($10H_2O$)	2.5	grams
Potassium Bromide	1.0	gram
Water to make	1.0	liter

Use same developing times and temperatures as FX-3.

FX-5: Very Fine Grain
(Reduce ASA 30%)

Water	700.0	ml
Metol	5.0	grams
Sodium Sulfite (Anhy.)	125.0	grams
Borax ($10H_2O$)	3.0	grams
Boric Acid (Crystal)	1.5	grams
Potassium Bromide	0.5	gram
Water to make	1.0	liter

Develop at 68° for the following times:

Kodak Pan-X	8 min.	Kodak Veri-Pan	10 min.
" Plus-X	11 min.	" Tri-X	10 min.

FX-5b: True Fine Grain Developer
(Reduce ASA 30% to 50%)

Water	700.0	ml
Metol	4.5	grams
Sodium Sulfite (Anhy.)	125.0	grams
Sodium Metaborate ($8H_2O$)	2.25	grams
Sodium Bisulfite	1.0	gram
Potassium Bromide	0.5	gram
Water to make	1.0	liter

REPLENISHER

Water	700.0	ml
Metol	7.0	grams
Sodium Sulfite (Anhy.)	125.0	grams
Sodium Metaborate ($8H_2O$)	25.0	grams
Potassium Bromide	1.0	gram
Water to make	1.0	liter

Mr. Crawley maintains that FX-5b produces results resembling the original two powder pack "Microdol" and that the new Microdol-X does give improved definition on Kodak films.

Recommended Developing Times at 68°f.: Ilford and Adox Films

Pan F	10 min.	HP-3 (MF)	15 min.
FP4 (MF)*	8 min.	HP-3 (RF)	17 min.
FP4 (RF)*	12 min.	HP-4 (RF)	15 min.
HP4 (MF)	13 min.	Adox 17°	8 min.
Adox 14°	7 min.	Adox 21°	10 min.

*MF - 35 mm film

*RF - Roll film

For the most consistent results Dignan Photographic does not recommend replenishment. However, the FX-5b formula for replenishment is included with the following increases in processing times:

After first roll increase time 20% every four or five roll. Use replenisher to maintain level of solution until 25 rolls have been processed.

FX-6a: Monobath

(Use normal film speed)

Water	500.0	ml
Calgon	2.0	grams
Sodium Sulfite (Anhy.)	50.0	grams
Hydroquinone	12.9	grams
Phenidone	1.0	gram
Sodium Hydroxide	10.0	grams
Sodium Thiosulfate (Anhy.)	90.0	grams
Water to make	1.0	liter

To adjust contrast vary the amount of Sodium Thiosulfate from 70.9 to 125.9 per liter. For still higher contrast increase Hydroquinone 15-17 grams. Process four to five minutes. Wash 5 to 20 minutes.

DIGNAN NOTE: Depending on type of film processed reticulation or frilling can be a problem with monobaths. We would also recommend that this solution be used for one or two rolls only. When experimenting, have a rapid fixer handy. If film has not cleared, place it immediately in the fixer.

FX-7: Balanced for Ilford & Adox Films
(Increase ASA 60%)

Water	700.0	ml
Metol	1.5	grams
Phenidone	0.25	grams
Sodium Sulfite (Anhy.)	115.0	grams
Sodium Metaborate	4.0	grams
Sodium Phosphate, Dibasic	2.0	grams
Potassium Bromide	2.0	grams
Water to make	1.0	liter

Develop 68° for following times:

Ilford Pan-F	3 min.
FP-3	3½ min.

FX-11:
(Increase ASA 80% to 100%)

Water	700.0	ml
Phenidone	0.25	grams
Hydroquinone	5.0	grams
Glycin	1.5	grams
Sodium Sulfite (Anhy.)	125.0	grams
Borax ($10H_20$)	2.5	grams
Potassium Bromide	0.5	gram
Water to make	1.0	liter

Dissolve the Hydroquinone with the Phenidone at 68°f. Use times listed for FX-3. This developer was compounded to give "fullest possible speed increase with the minimum granularity increase."

Developing times at 68°f.:

Pan-X (MF)	5 min.	Tri-X (MF)	7 min.
Pan-X (RF)	6 min.	Tri-X (RF)	8 min.
Plus-X (MF)	6 min.	Tri-X Prof (RF)	8 min.
Veri-Pan	7 min.	Royal-X	10-15 min.

FX-13: (FX-1 Modified)

Water	700.0	ml
Metol	0.5	gram
Sodium Sulfite (Anhy.)	45.9	grams
Sodium Carbonate (Mono)	3.0	grams
Water to make	1.0	liter

Use on slow films (Veripan). The solvent action of the sulfite removes surface flare and image spread. Faster films show loss of definition and grain disadvantage. 68°f. developing times 2/3 FX-1.

FX-18: Phenidone-Hydroquinone version of D-76
(Increase ASA 30%)

Phenidone	0.10	gram
Hydroquinone	6.0	grams
Sodium Sulfite (anhy)	100.0	grams
Borax	2.5	grams
Sodium Bisulfite	0.35	grams
Potassium Bromide	1.6	grams
Water to	1.0	liter

Develop at 68 degrees using times given for D76 or ID11.

It is claimed that FX 18 has slightly higher resolving power, a slight reduction in grain and minimal speed increase allowing use at stock strength without speed loss (over D76).

FX-19: Phenidone-Hydroquinone version of D-76
(Normal ASA)

Water	700.0	ml
Phenidone	0.75	gram
Hydroquinone	7.0	grams
Sodium Sulfite (Anhy.)	100.0	grams
Water	1.0	liter

Develop at 68°f. using same times as FX-3.

EDWAL FORMULAS

It is a very common happening to pick up an article or book and find that the author is using some formula for a developer that is not manufactured and to top it off, you can't find out how to mix it.

From 1939 to 1947, the Edwal Laboratories of Chicago published a small book called "Modern Developing Methods", under the direction of the founder, Edmund W. Lowe. This book contained a number of interesting formulas. Because the book is no longer in print we are listing some of the formulas for your reference.

EDWAL - 10 (Edwal Negative Developer)

Water	900.0	ml
Metol or Elon	5.0	grams
Sodium Sulfite	100.0	grams
Glycin	5.0	grams
Borax	10.0	grams
Water to make	1.0	liter

This developer was compounded for large negatives for enlargements to 6 or 10 diameters with maximum emulsion speed. It will produce relatively high density, which is needed. With miniature negatives half normal exposure was suggested. 8 to 12 rolls of 35mm or 2¼ x 3¼ can be processed in one liter.

Development time: 70°F - 4½ to 22 minutes depending on type of emulsion.

Above 75°F, Edwal recommended adding Edwal Thermo Salt (Edwal's trade name for Sodium Sulfate) to prevent swelling of the emulsion.

EDWAL - 102 (Paper Developer - Concentrate)
True Black Tones

Water	900.0	ml
Sodium Sulfite	80.0	grams
Sodium Phosphate tribasic	120.0	grams
Glycin	25.0	grams
Potassium Bromide	3.0	grams
Water to make	1.0	liter

Dilute with 3 parts water for chloride or chlorobromide papers.

Development 60°F to 70°F: 3 to 4 minutes.

EDWAL - 120 (For Dense Rich Blacks)

A-BATH

Pyrocatechol	20.0	grams
Sodium Sulfite	40.0	grams
Water to make	1.0	liter

B-BATH

Potassium Carbonate	120.0	grams
Water to make	1.0	liter

When developing chloride or slow chlorobromide papers. Mix one Part A and two Parts B with one part water. Add one to three grams bromide per liter of working solution to produce richer black tones.

EDWAL - 126 (Produces delicate gradation)

Water	900.0	ml
Sodium Sulfite	25.0	grams
Amidol	6.0	grams
Potassium Bromide	0.8	gram
Water to make	1.0	liter

In fully stoppered bottles, this developer will only keep a few days. It is best made up fresh. For chloride contact paper use full strength for one minute. For fast chlorobromide paper dilute with two parts water, develop 3 to 7 minutes, depending on type of emulsion. Edwal recommends 65°F. At 68°F to 75°F this time can be cut to 1 to 3 minutes.

* * *

GET THE HYPO OUT -- OUT -- OUT!

by

D. William Reichner

Browsing in a bookstore in the musty magazine section can sometimes be very rewarding. I recently came across a copy of the Journal of Research of the National Bureau of Standards - C., Engineering and Instrumentation, Volume 67C, No. 1, January through March, 1963. In this journal are found such articles as "Method for Calibrating a Standard Volt Box" and "Equipment for Single Crystal Growth from Aqueous Solution." After these have whet your interest, you can learn about "An Oxygen Partial Pressure Warning Instrument." I must admit that I really could not recommend the above articles for entertaining diversion, however, one other article had some merit for consideration. It is a very academic and thorough paper by C. I. Pope entitled "Stability of Residual Thiosulfates in Processed Microfilm."

At first glance, the subject matter did not appear to be very pertinent for the photographer who deals with "normal" films. After digging through the mass of data, procedures and formulas in this article, however, it became obvious that this is indeed of practical use for the general photographer and his processing procedures.

It is true that Pope deals mainly with the high image density uses for the very thin emulsion microfilms. However, in keeping with accepted scientific inquiry methods, he does provide information about lower densities (appropriate to normal B & W films).

As the relative humidity of the air increases in the storage areas for microfilm records, the rate of decomposition of residual thiosulfate (hypo remaining in the film) increases. This residual thiosulfate reacts with the silver in the image to form silver sulfide which will damage or destroy the image. The concentration of residual thiosulfate in the film varies with the image density and emulsion thickness. The problem, then, is to find a way to eliminate the hypo completely from the film after fixation of the image and before storage.

There are other factors besides image density and thickness of the emulsion that result in hypo being retained in processed film. The most obvious is inadequate washing. Some less obvious reasons were also found. The fixing bath itself will influence the amount of residual hypo in the film if the bath is not fresh. As the fixer is used, it accumulates silver salts (silver thiosulfate complex), the presence of which makes it difficult to remove the hypo by washing.

Washing for one hour, even after using fresh fixer, does not completely remove thiosulfate from the high image density areas of the film. Even after-treatment in alkali solutions did not completely remove hypo.

Tests were made using the formula for hypo removal first proposed by Crabtree, Eaton, and Muehler in 1941. This formula, which follows, is referred to as Kodak HE-1 in the Photo Lab Index.

HE-1 HYPO ELIMINATOR

Water	500.0	ml
Hydrogen Peroxide (3.0% Sol.)	125.0	ml
Ammonium Hydroxide (3.0% Sol.)	100.0	ml
Water to make	1.0	liter

The film was fixed in fresh Kodak F-5 Fixer, washed in running water at 70°F for 3 minutes, treated in HE-1 at 68°F for 10 minutes, and then washed in running water at 77°F for 15 minutes.

The results: The residual thiosulfate was about the same as when film was fixed in fresh Kodak F-5 Fixer, and then washed for 1 hour in running water.

After elaborate experimentation, in particular, the examination of the reasons why washing film in sea water produced less residual hypo, Pope came up with two methods for eliminating ALL traces of hypo in microfilm.

1. By adding 1.0 gram per liter of Potassium Iodide to the fixer, the thiosulfate can be completely washed out rapidly (5 minutes in 77°F running water).

2. By adding 1.0 gram per liter of Potassium Bromide to the HE-1 formula, the residual silver thiosulfate complex ions were then decomposed and the released thiosulfate ions were readily removed by washing or oxidation.

The complete procedure with the modified HE-1 formula as used with microfilms was as follows:

Fixing (in modified F-5 fixer) for normal time and temperature.

Washing in running water for 3 minutes at approximately 77°F

Modified HE-1 for 10 minutes at 68°F

Clearing Bath (formula below) for 2 minutes at 68°F.

Washing in running water for 15 minutes at approximately 77°F.

CLEARING BATH

Water 95°F	800.0	ml
Sodium Sulfite (anhy)	10.0	grams
Water to make	1.0	liter

The results: Absolutely no measurable traces of residual thiosulfate. Now, that is ARCHIVAL permanence!

There may be some concern as to just how useful this information is with "normal" black and white films, after all, microfilm is different from the usual black and white film! Well, yes and no.

Yes, microfilm is usually a relatively slow speed film having a remarkably high resolving power. One type in particular, Agfa Agepe FF, is orthochromatic in sensitivity, resolves 280 lines/mm, has a 5 micron emulsion thickness, and a rating of about ASA 12, with an anti-halation backing which dissolves in the developer on a clear acetyl-cellulose safety base. It is ideal for photographing fine or detailed line drawings.

Removal of hypo from any fixed film is important. The advantage we have in working with normal film at normal densities is that the measures needed to achieve hypo-free film need not be as elaborate as those used with microfilm.

Normal films, which usually have thicker emulsions and bases, require, as Kodak recommends, washing times of about 30 minutes in running water at about 75°F. This is, of course, without the use of any addition to the fixer or without any special after baths.

Applying the information found above to the "normal" film processing, the following procedure is suggested as a means of achieving minimal hypo retention and shorter "wet time".

Fixing (in modified fixer) at normal time and temperature.

Washing in running water for 3 minutes at approximately 77°F.

Modified HE-1 for 5 minutes at 68°F.

Washing in running water for 7 minutes at approximately 77°F.

Capacity of modified HE-1: 12 rolls of 120 film or equivalent area per liter.

SUBSTITUTE FORMULAS FOR KODAK'S HYPO CLEARING AGENT

In 1956, J.I. Crabtree and R.W. Henn published their experiments with sea water and a number of salts to find a hypo eliminator. The results were published in Kodak Communication No. 1790. This information was also used to market Kodak's hypo clearing agent.

The following formulas are used by the larger labs that mix their own solutions:

WORKING SOLUTION - (not concentrate)

Water	1.0	liter
Sodium Sulfite	20.0	grams
Sodium Bisulfite	0.2	gram

The Sodium Bisulfite is in the formula only to lower the pH to 7 - 7.5 to prevent softening the emulsion of film. If papers are to be used, leave out the Bisulfite to deliberately get more softening to improve the gloss. Also, to improve the paper gloss, leave out all hardening agents in the fixing baths.

A concentrate of the above would be as follows:

Hot water	1.0	liter	Dilute 1 part conc.
Sodium Sulfite	200.0	grams	with 9 parts water.
Sodium Bisulfite	2.0	grams	

DIRECTIONS FOR USE

After normal fixing, transfer prints or films to the clearing agent solution with or without a water rinse. The water rinse increases the capacity. 200 8x10 (or equivalent) papers or 150 to 200 8x10 (or equivalent) films per gallon of clearing agent solution.

		AT 65 to 70°F (18.5 to 21°C)	
Papers and Films	Water Rinse After Fixer*	Hypo Clearing Agent (With Agitation)	Running Water Wash
PAPERS			
SW	1 min.	2 min.	10 min.
DW	1 min.	3 min.	20 min.
FILMS	30 sec.	1 to 2 min.	5 min.

*Rinse after fixer may be eliminated. Capacity per gallon of clearing agent solution will then be reduced to 80 8x10's or equivalent for papers and 50 to 60 8x10's or equivalent for films.

RAPID FIXER CONCENTRATE

BY: D. WILLIAM REICHNER

The formulas that follow are designed to be direct substitutions for the very popular Kodak Rapid Fixer. In fact, I have found it to be so close in appearance, activity, capacity, odor, pH, specific gravity, etc. as to be virtually indistinguishable from the "real" stuff. I use the directions for making up and replenishment from the label of an empty Kodak Rapid Fixer Solution A bottle.

The only variance that I have encountered has been a slight cloudiness in the concentrate solution, which in no way detracts from its activity. Even with this cloudiness, the working solution when prepared for either film or paper becomes crystal clear. The source of this cloudiness seems to be from the impurities or preservatives used in the Ammonium Thiosulfate 60% commercial solution.

In order to avoid using concentrated Sulfuric Acid in preparing the Hardener Solution B, I have resorted to the use of Sodium BisulfAte which is a convenient and fairly safe way of providing Sulfuric Acid in a solution. It also yields Sodium Sulfate which doesn't take an active part in the fixer.

Rapid Fixer Solution - Concentrate A

Ammonium Thiosulfate (60% solution)	900.0	ml
Sodium Sulfite	40.0	grams
Glacial Acetic Acid	28.0	ml
Boric Acid, crystals	20.0	grams

Notes on Mixing

The above formula will yield one U.S. Quart or 946.0 ml. There is no water added to make the concentrate. The order of mixing is CRITICAL! Slowly add the Sodium Sulfite to the A.T. (60% sol.), stir until completely dissolved. Very slowly pour in the Glacial Acetic Acid, stirring constantly. Fumes will be generated, so use adequate ventilation. Now for the most boring part. It takes a long time for Boric Acid to dissolve in this solution. Heating the solution will not help and instead it would only add to the air polution problem. Slowly add the Boric Acid and stir and stir and stir. It will finally dissolve but it will seem like forever (it actually takes about 3 minutes of patient stirring). All chemicals need only be at room temperature for the preparation of these formulas.

Hardener Solution - Concentrate B

Water, distilled or deionized	60.0 ml
Aluminum Sulfate ($18H_2O$)	40.0 grams
Sodium Bisulfate	2.5 grams
Water to make 3.6 Fluid Ounces or 106.0 ml	

Notes on Mixing: Aluminum Sulfate ($18\ H_2O$) is normally commercially available in broken lumps or crystal pieces. There is also a dried powder form, where a considerable amount of the water of crystallization has been removed. If you have the dried powder form, use only 27.0 grams in the Hardener formula. The above formula yields the same amount of solution as is found in the Kodak Hardener Solution B bottle.

Working Solutions: In the event that you do not have an empty Rapid Fixer Solution A bottle, the following suggestions are offered:

Film Fixer: To one quart of water, add one-half of Solution A (1 pint or 472 ml). Add slowly, with stirring, half of Solution B (1.8 oz. or 53.0 ml). Add water to make one-half gallon Film Fixer.

Replenishment Schedule: After fixing 20 rolls of 120 film or equivalent area, remove 88 ml of used fixer from the ½ gallon and then add 79 ml of Solution A Concentrate and 9 ml of Solution B Concentrate. This procedure can be followed six times and then all the original concentrates will be used.

Paper Fixer: To one quart of water, add one-half of Solution A (1 pint or 472 ml). Add slowly, with stirring, half or Solution B (1.8 oz. or 53.0 ml). Add water to make one gallon Paper Fixer.

Kodak recommends the use of two fixing baths in succession to raise the capacity from about 100, 8x10's per gallon. There is no time saving.

Fixation Times-Film:

Panatomic-X and other thin emulsions	1 to 2 min.
Plus-X and other average emulsions	2 to 4 min.
Royal-X and other thick emulsions	3 to 5 min.

Paper:

Single Bath Method-fix prints from	5 to 10 min.
Two Bath Method-in EACH bath fix from	3 to 5 min.

Fixation Temperature:

Kodak recommends all fixation be carried out at 65 to 70°F (18 to 21°C).

HOW FAST IS YOUR FIXER?

There is an old photographic wives tale that says, "when using Ammonium Thiosulfate instead of Sodium Thiosulfate, you can cut the time of fixing in half." It is true that you cannot go wrong using this as a guide, but the truth is, Ammonium Thiosulfate is 7 to 10 times faster than Sodium Thiosulfate, when used to fix a photographic emulsion. To check the speed of CLEARING a film in a fixing solution is very simple. Incidentally, when we say clear a film, we mean just that. An undeveloped piece of light exposed film will become completely clear when placed in a fixing bath. You can check clearing time using two 3" or 4" strips of any black & white film. Dip one piece in a Sodium Thiosulfate fixer at about 75°f. Check the amount of time it takes for it to clear. Depending on the formulation of the fixer and the film used, it will take from 5 to 7 minutes for the fixer to clear the film. Dip the other strip in an Ammonium Thiosulfate fixer at the same temperature and you will find that it will clear in from 30 seconds to a minute. Agitation will decrease fixing time. There is one more rule that should not be forgotten: FIX FOR TWICE CLEARING TIME. This rule of thumb assures you that you have completely fixed the emulsion you are using. The above information should be of value to anyone attempting to cut the time of processing.

Many articles on photography will make the statement "fix your prints for twice the time it takes to clear." I don't know what this sentence means and I am certain that the writer is just quoting someone who didn't know what he was talking about. Paper does clear and fix, but because the emulsion in most cases is the same color as the paper, it is pretty difficult to note a change. Here is the only system we know of for checking paper.

Using a negative with white areas predominating, give a normal exposure to a sheet of black and white or color print paper. Cut this into a number of small pieces. Develop one piece normally and place it in the stop fixer you want to check. After one minute, turn on the room lights and check the white areas of the paper. If after a minute or so the paper starts to fog, you will know you have not fixed long enough. Cutting or extending the time of turning on the lights during this test should tell you exactly how long it takes for your fixer to clear. This figure should then be doubled. Before making a final evaluation, the print should be washed and dried with the test times written on the back. It must be remembered that the acid fixer will stop development. If there is undeveloped silver in the paper, it may take a few hours for the fog to show up.

RAPID STOP-FIX

Water (95°f)	700.0 cc
Sodium Thiosulfate (anh.)	130.0 grams
Sodium Sulfite (anh.)	10.0 grams
Sodium Bisulfite	20.0 grams
Ammonium Chloride	30.0 grams
Water to make	1.0 liter

Keeping properties unused: 4 to 6 months.

EXTENDED RANGE DEVELOPER

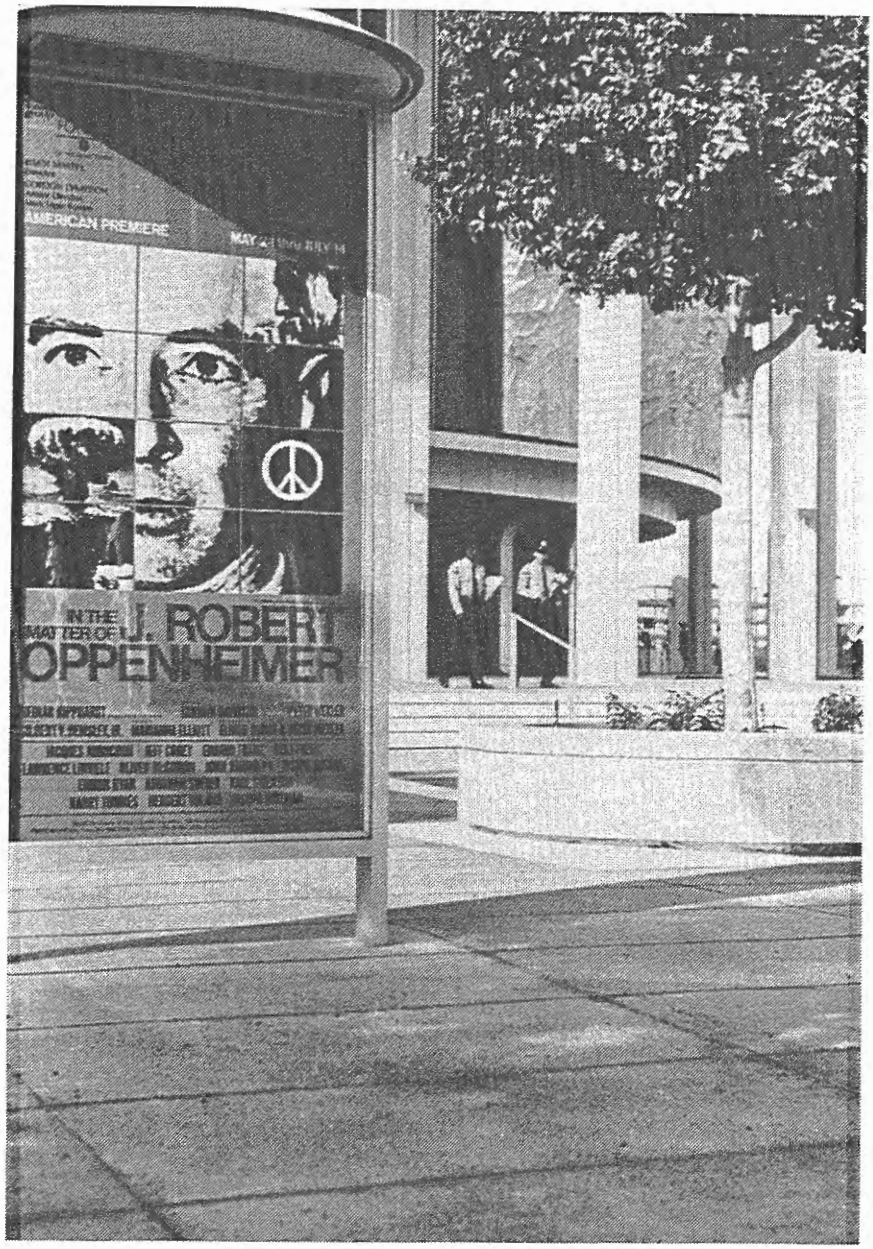
By Adrian Vance

An advertising agency cocktail party is sure to attract an interesting cast of characters and one of the more novel types seemed chained to the punchbowl. After pouring another cup of the "juice", I introduced myself, told him what I did, he offered his hand and name and told me that he was a bomb photographer. "A bomb photographer!" After I recovered, my new acquaintance told me that the big problem, aside from staying alive, was that of capturing the million to one brightness range of the explosion. Ordinary film, handled in the usual way, might result in a print encompassing a range of 30 to one and much of the detail of the emplosion would be lost. "Detail of the explosion?" My patient, but nervous friend went on to tell me that bomb explosions have delicate nuances and the tongues of flame in the shock waves of crushed air form delicate portraits that tell the bomb builders how to improve their product.

The standard way to extend the range of film is to work with dilute solutions of developer and reduce the time that the film is in the solution. The most incredible dilutions and short dunkings failed to do the job so he had tried to compound developers out of everything from "Amphidol" to "Zipperdone." Thus far, the best mixture called for 1.5 grams of Phenidone A plus 30 grams of Sodium Sulfite and enough distilled water to make a liter of solution. The guy really insisted on distilled water and he stuttered rather badly so after struggling with "Sodium Sulfite", he could not have had greater impact as he nobly pursued "distilled."

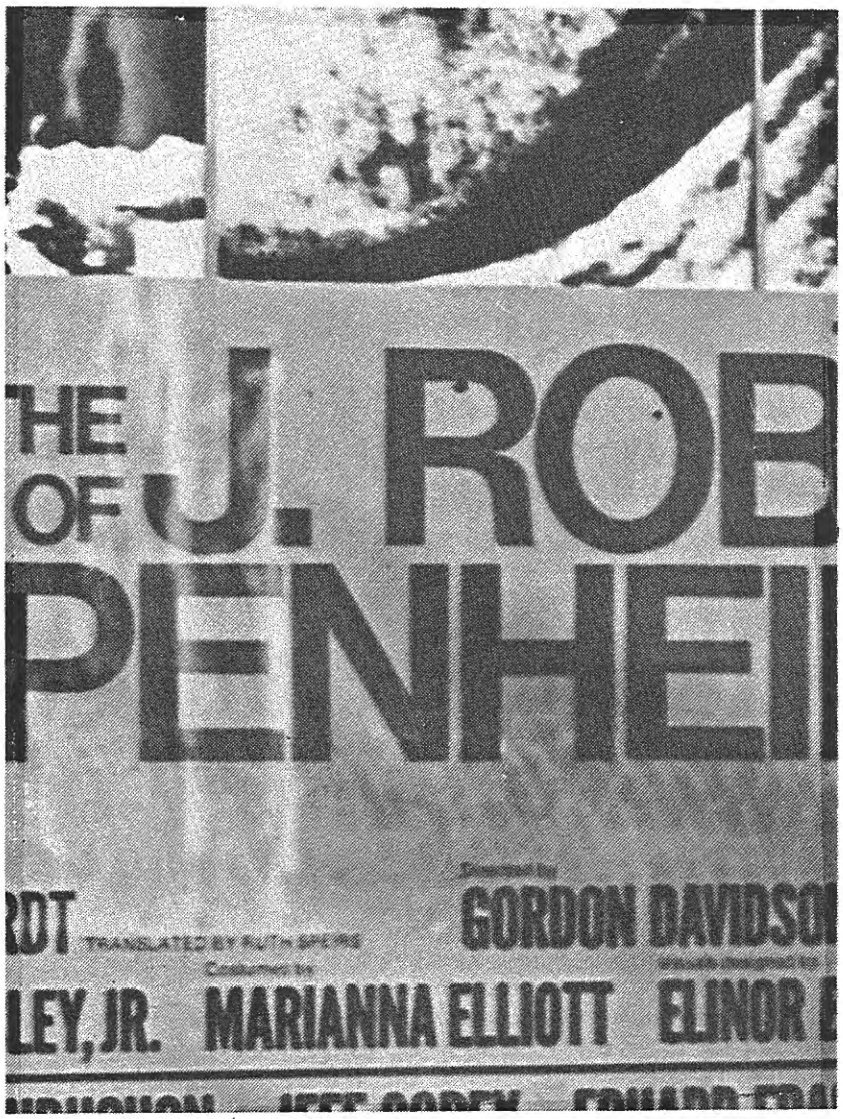
Locating Phenidone A was quite a problem in itself because my new friend, "the Karsch of Dupont", had given me one of its lesser known synonyms. As is often the case in these searches, you collect the dividend of learning everything that there is to know about the product. Much of the information goes into one's permanent collection of useless tidbits, but it is interesting. For example, I was told that Phenidone A is used as a color coupler. Another authority informed me that this material has a very low reduction potential. Reduction potential is the way a chemist indicates the activity of a developer and apparently Phenidone A is a slow runner in this respect. Extending the range of a film would require a weak or slow developer and the tidbit about the color coupler fell into place one day when I realized that such molecules attach to freshly reduced silver in color films. These molecules form a "handle" that the dye can lock onto because dyes normally do not have an affinity for metals. Try to dye a dime if you doubt that one.

(Continued)



The first test with Panatomic X indicated an ASA of four from an eight minute dunking at 75°f. The gamma is about 0.3 and there is very little change in the speed or gamma with a change in the development time. The range extension is incredible and is apparently on the order of one million to one or about 20 stops! I wondered what other possible uses there could be for this developer and my attention was drawn to Kodak's High Contrast Copy Film. This material probably has the finest grain and highest contrast of any available material. I wondered what the net effect would be if I would put these two together in what might seem an unholy mixture.

Grainless film? Believe me that is the impression that I got when I started enlarging a negative of High Contrast Copy film that had been in Extended Range Developer for eight minutes at 75°f. Surely, the grain is there, it has to be, but is it fine. When a normal negative, say Panatomic X, will just be showing grain at 11 or 12 magnifications, this material will show none until somewhere beyond 30 x. That is a poster sized print from 35 mm! The ASA rating of High Contrast Copy and Extended Range Developer is ten so the combination is usually hand held, but if you plan to enlarge very small portions of the negatives use a tripod, because vibration will show up just as it does in extreme telephoto photography. Remember that an 8 by 10 portion of a negative at 30 x, from a 50 mm lens, is equivalent to 1500 mm telephoto in terms of holding and enlargement.



This developer certainly is not made for general purpose photography, but it is a valuable tool if your work encompasses wide ranges of exposure as in the photography of explosions, flashtubes and lasers. I didn't see my friend at the next agency cocktail party. I wonder what, or where he is up to now?

. . . . . .

24 FORMULAS YOU CAN MIX

From this basic "kit" of just six chemicals, you can mix literally dozens of developers.

By PATRICK DIGNAN

HAVE YOU ever longed to try one of the hundreds of b&w formulas recommended for this or that film or paper, but figured you didn't know enough about chemistry to mix your own? Most of these formulas are not available in packaged form . . . so you either mix them or forget them. Once you purchase an inexpensive set of weights and a scale or balance, a couple of graduates, and a few odds and ends like small picnic paper plates and plastic spoons, you are ready—except for the chemicals.

But before we discuss the chemicals you will need, let's look at a representative formula and make sure we understand all of the terms used.

The number of chemical terms used is not extensive. In fact, if you take the time to study a book of photo formulas, you will realize that there is a very definite and *simple* pattern which most formulas follow. Once you see

12 STANDARD FILM DEVELOPERS

	KODAK D-23	KODAK D-76	KODAK D-76R	KODAK D154	ANSCO 22	ANSCO 30	ANSCO 40	ADOX M-Q	ADOX REP.	AGFA 14	AGFA 15	GEVAERT G-251
METOL or ELON	7.5	2.0	3.0	1.25	0.8	3.5	4.5	2.0	3.0	4.5	8.0	1.5
SOD. SULFITE*	100.	100.	100.	22.5	40.0	60.0	54.0	80.0	80.0	8.5	125.	25.0
HYDROQUINONE	0	5.0	7.5	6.0	8.0	9.0	7.5	4.0	5.0	0	0	6.0
BORAX (Gran.)	0	2.0	20.0	0	0	0	0	4.0	18.0	0	0	0
SOD. CARBONATE#	0	0	0	35.0	50.0	40.	54.0	0	0	1.2	14.	45.0
POT. BROMIDE	0	0	0	.5	5.0	2.0	3.0	0.5	0	0.5	1.5	1.0
TIMES	10-12	9-17	—	2-3	5-8	6-8	4-5	10-19	—	10-20	7-12	2-3
DILUTION	0	0	0	0	0	0	1:2	0	0	0	0	0
	D-23 Medium fine grain dev. Increase dev. 10% per roll. Will process 8 to 10 rolls.	D-76 Use full strength for Tri-X. Dilute 1:1 for Plux X.	D-76 REPLENISHER: 30cc per 36 exp. roll of 35mm.	D-154 Contrasty document developer.	22 Title dev. High contrast.	30 X-ray for high contrast.	40 Tray dev. for pack, roll, and cut film.	Adox M-Q Slightly better sharpness than D-76.	Adox Replenisher: add 10 to 25cc per 36 exp roll of 35mm.	Agfa 14 Soft working dev. similar to D-23.	Afga 15 For slow & medium speed films.	Gevaert G-251. Universal type dev. For films & papers.

Times given in minutes, minimum-maximum range, for use at 68°F. Total formula solution in each case, 1000cc. Start with 500cc of water at 125°F. Add chemicals in order given. Dissolve each chemical completely before adding the next one. Dilution: where 0 is listed, use straight; otherwise, first figure is stock solution, second figure equals part(s) water. *Sodium Sulfite (Anh. of Des.) #Sodium Carbonate, Monohydrate

this pattern, all the formulas simplify themselves. This applies to past, present, and future formulas.

D-76 is available in packaged form, but is an old standby so we will use it as an example.

Elon-Hydroquinone Borax Developer For low Contrast and Maximum Shadow Detail:

Water (125°F or 52°C)	24 ounces	750 cc
Elon	29 grains	2.0 grams
Kodak Sodium Sulfite, desiccated 3 oz.	145 grains	100.0 grams
Kodak Hydroquinone	73 grains	5.0 grams
Kodak Borax, granular	29 grains	2.0 grams
Add cold water to make	32 ounces	1.0 liter

The Pattern—Most formulas give you a choice of two systems of measurement, as you will note above in D-76. One is U.S. Avoirdupois, which is measured in the familiar gallons, quarts, pints, ounces, and grains. We suggest that you ignore this part of the formula and move over to the metric system.

There are a number of good reasons for using the metric system, but the main one is that it simplifies mixing. By using it you can save time. It is also used internationally and is based on the *meter*. A meter is approximately 39.37 inches. This is too large an amount to use for measuring solutions so we use the *cubic centimeter*, which is 1/100th of a meter cubed.

Most formulas are compounded to make one liter (or as the British write it, "Litre"). This will make no sense until you realize that a liter is equal to 1000 cubic centimeters. We should say photographically equal. The difference is that a liter is 1000.028 cubic centimeters. We know of no formula where the difference will upset the solution, and by that we do not mean tip it over. A cubic centimeter is abbreviated cc.

A *milliliter* is 1/1000th of a liter, and is equal to one cubic centimeter, or one cc. Milliliter is abbreviated ml. You will find ml and cc used in formulas, and you will find cc used with liter. The thing to remember is: When you see ml, think cc; and when you see liter (or litre), think 1000 cc.

All of the above measurements are used for liquids *only*. Whether water or a liquid chemical like acetic acid—you are measuring volume.

The *gram* is basic to the metric system. The term gram designates the amount of pure water it takes to fill one cubic centimeter at 4°C (or approximately 39.2°F). The gram and the cc are two measurements that make mixing solutions very simple. Take one gram of any chemical and add water until you have 100 cc., and you have a 1% solution. This comes in handy when you need a chemical in very small amounts, and your scales are not very accurate. However, even an inexpensive scale should be accurate to at least one gram.

The *milligram* is used like milliliter to denote amounts less than one gram: for instance, 200 milligrams is 2/10th of a gram. The gram also denotes in most cases that you are weighing a solid.

Most formulas give you a choice of two ways to measure *temperature*, Centigrade and Fahrenheit. If you happen to own a thermometer that is calibrated in Centigrade, use it. However, thermometers calibrated in the Fahrenheit scale are more commonly

12 STANDARD PAPER DEVELOPERS

	KODAK D72	KODAK D163	KODAK D-52	KODAK D154	ANSCO 120	ANSCO 135	AGFA 100	DUPONT 51D	DUPONT 54D	DUPONT 56D	ILFORD ID-20	GEVAERT G251
METOL or ELON	3.0	2.2	1.5	1.25	12.3	1.6	1.0	1.5	2.7	3.3	1.5	1.5
SOD. SULFITE*	45.0	75.0	22.5	22.5	36.0	24.0	13.0	22.5	40.0	33.5	25.0	25.0
HYDROQUINONE	12.0	17.0	6.0	6.0	0	6.6	3.0	6.3	10.6	10.0	8.0	6.0
BORAX (Gran.)	0	0	0	0	0	0	0	0	0	0	0	0
SOD. CARBONATE#	80.0	75.0	17.0	35.0	42.0	24.0	30.0	17.5	87.0	65.0	35.0	45.0
POT. BROMIDE	2.0	2.8	1.5	0.5	1.8	2.8	1.0	1.5	0.8	3.3	2.0	1.0
TIMES	1	1½-2	2	1-1½	1½-3	1½-2	1-2	1½-2	1½-2½	1-2	1½	1-2½
DILUTION	1:1	1:3	1:1	0	1:2	1:1	0	1:1	1:2	1:2	1:1	0
	D72 (Dektol) For Velox-Azo-Y Resisto-Velox Rapid etc.	D163 Enlarging dev. Warm black tones on Chloro-Bromide.	D52 (Selectol) Warm tones on Opal-Athena-Platino, etc.	D154 Contrasty document dev.	120 Soft working developer portrait type.	135 General type dev. for warm tones.	AGFA 100 For normal contrast.	Dupont 51D For warm black tones.	Dupont 54D For cold blue black tones on Chloride.	Dupont 56D Rapid dev. for Velour Black, Varigam, etc.	Ilford ID-20 General type for Multigrade, Plastika, etc.	Gevaert G251 Universal dev. for film & paper.

Times given in minutes, minimum-maximum range, for use at 68°F. Total formula solution in each case, 1000cc. Start with 500cc of water at 125°F. Add chemicals in order given. Dissolve each chemical completely before adding the next one. Dilution: where 0 is listed, use straight; otherwise, first figure is stock solution, second figure equals part(s) of water. *Sodium Sulfite (Anh. or Des.) #Sodium Carbonate, Monohydrate

available. The choice is up to you. I, personally, think and feel in Fahrenheit.

Another part of the pattern you should note is that most of the formulas recommend using *warm* water (125° F) to start with. The reason: heat speeds up most chemical reactions, and most chemicals dissolve faster in warm water. But use *the* temperature recommended. Water that's too hot will destroy some chemicals.

Most formulas start with *less* water than the final solution amount (1000 cc). The reason is simple enough: if you start with 1000 cc and add chemicals, you may end up with a total volume much larger than 1000 cc.

A rule that is not always written in the formula, but which *must* be followed, is: "Dissolve each chemical COMPLETELY in the order given . . . before the next chemical is added." The reason for this is that although most chemicals look alike (the majority are white powders or crystals), they each have a very definite personality all their own. Some refuse to dissolve after another chemical has been added. Some are helpers, such as preventing oxidation of a chemical that is to be added later. Add each chemical slowly, stirring the solution so that the chemical will go quickly and completely into solution.

When you decide to compound your own solutions, *contamination* takes on new meaning and importance. Besides keeping all the utensils clean, it also means preventing one basic chemical from getting, even slightly, mixed with another basic chemical. A few good working rules will solve this. *Rule 1:* Open only one bottle at a time, and weigh out the amount that you will use. Make sure you return the same cap to the same bottle. This rule should be easy, because you should be following this one if you are using bottled developers, fixers, etc. *Rule 2:* Make sure that the spoon you use is clean. We suggest you use inexpensive plastic picnic spoons. A package of 100 costs less than 50¢. If these are kept in a closed container within easy reach, a clean one can be used *each* time you weigh out a different chemical. *Rule 3:* Always use a clean piece of weighing paper on your scale for each chemical. If you do not, you may end up with contamination if you weigh out more than you need and then try to remove some of the chemical from the weighing pan and return it to its original container. The trouble we have found with using prepared weighing paper is that it is never big enough to hold the larger amounts of some chemicals. We have found that small paper plates can be used for holding these larger amounts. Make certain that you place one plate on each side of the scale and zero the scale before you add the weights or the chemicals. When you zero your scale, check the table it's on and make sure that it is level. If not, all of your weighing will be wrong.

We can now go back and write D-76 in our new shorthand, leaving out all of the things we are going to remember, plus all of the items we will not need. It will simply look like this:

D-76 DEVELOPER

Elon	2.0 grams
Sodium Sulfite (des.)	100.0 grams
Hydroquinone	5.0 grams
Borax (granular)	2.0 grams
Water to make	1.0 liter

If you purchase a ready to use can of developer (which is usually in at least two parts) and mix it according to directions, how much longer will it take to mix the above formula? Once you have a corner set up with a balance, weights and the chemicals, *only a few more minutes.*

Since we are discussing D-76, let's take each of the chemicals used and discuss some of the problems that can plague you:

- *Elon*—This is Kodak's trademark for a developing agent. The chemical name is "p-Methyl-amino-phenol Sulfate." This developing agent has been around for many years, and it has collected many trade names which just add to the confusion. Here are a few: Metol, Photol, Rhodol, Veritol, Claritol.

We mentioned earlier that you should dissolve chemicals in the order given. Elon is a very good example of why. It will refuse to dissolve in a strong solution of Sodium Sulfite. Elon is almost always used in small gram quantities, usually one to four grams. This, too, is a part of the formula pattern. A pound of this chemical will last a year or so, if you mix a gallon or two a week.

- *Sodium Sulfite*—This is one of the chemicals that has made photography as we know it today possible. It prevents oxidation of the developing agent or agents. Without it, we would be faced with mixing fresh solutions every few minutes. If you would like to see a developing agent oxidize, let a solution of Elon stand after mixing without this chemical. The solution will slowly turn brown, and eventually black. However, if after it has turned slightly brown (a minute or two after mixing) you add Sodium Sulfite, the solution will immediately revert back to a clear solution.

Sodium Sulfite is used in thousands of b&w and color developers, fixers, toners, hardeners, etc. Most formulas call for relatively large amounts, but it can run from one gram to over 100. Fortunately, it is inexpensive, and I suggest you purchase five or 10 lbs. at a time.

There are, incidentally, three words, any one of which may appear after a chemical, that can confuse not only new experimentors, but old hands, as well. When you see one of the following words, realize that it means something that you should know about *before* you start to mix your own formula. They are DESICCATED, ANHYDROUS, and CRYSTAL. Sodium Sulfite, for instance, is manufactured in more than one form, and the differences between these forms are very important, since they are all part of the world of *water of crystallization.* Here are the chemical formulas for the two types of Sodium Sulfite available: Na_2SO_3, $Na_2SO_3 \cdot 7H_2O$. That's right, it's the same stuff you've been drinking—water.

A processing formula is poorly written if it only lists Sodium Sulfite, because you will not know what type of Sodium Sulfite the formula calls for. If you look up desiccated, you will find that it means "with as much water removed as possible." If you look up anhydrous, you will find that it means "without water". Photographically, these two words can be used interchangeably in a formula. When you purchase Sodium Sulfite here in the U.S., the chances are you will be buying Sodium Sulfite, Anhydrous (or Desiccated), but *check the label.* If the label reads *Crystal*, this could mean that they are referring to $Na_2SO_3 \cdot 7H_2O$. Converting from one to the other form with this chemical is very easy, because Sodium Sulfite Crystal weighs approximately twice as much as Sodium Sulfite Anh. The

difference in weight is *only* water.

To put it another way, let's say the formula calls for Sodium Sulfite, Crystal . . . 200.0 grams. You have purchased Sodium Sulfite Anhydrous. Instead of using 200.0 grams, use 100.0 grams . . . and you will be using the correct amount of Sodium Sulfite. Most processing formulas published in the U.S. list Sodium Sulfite, Anhydrous or Desiccated, but you never know when you'll come across an old formula that reads Crystal. (Water of hydration, incidentally, also applies to a number of other photographic chemicals.)

Learning the difference between the spelling of the various words used in photo chemistry is not only important, it is mandatory. The problem is slightly complicated and confusing. We will discuss here only Sodium Sulfite. Older literature will spell it Sodium Sulphite. These two spellings refer to the same chemical. But, again, take care. You will also run into Sodium Sulfate or Sodium Sulphate. These two refer to the same chemical, but are entirely different from Sodium Sulfite. A few more chemicals in this group should also be watched. One pair is Sodium Bisulfite and Sodium Metabisulfite. These are not the same chemical, although with some changes in a formula they can replace Sodium Sulfite.

- *Hydroquinone*—The chemical name for this is p-hydroxybenzene. It is known by trade names, but for some strange reason most formulas will refer only to Hydroquinone. How lucky can we get! There are hundreds of formulas that use Hydroquinone in conjunction with Elon. The two are said to be super-additive. That is, development is much greater using the two than the development potential of either agent alone. This chemical should not give you problems; it keeps well, although it should be protected from strong sunlight.
- *Borax*—This is usually referred to as "Borax, Granular", but is also known by a number of other names: Sodium borate, Sodium pyroborate, Sodium tetraborate, etc. Again, make sure you know your chemical. If in doubt, any school or Public Library contains a number of chemical dictionaries . . . use them. Borax, granular, refers to Borax $Na_2BO_{47}•10H_2O$. Yes, we are back to the water. This is the form usually called for if the formula reads *Borax*. This is the mild alkaline used in D-76 and any number of other formulas. Keep this bottle closed, or this chemical will give up its water to the air, which will throw off your weighing.

Borax, Anhydrous, has become available in the last few years and, like Sodium Sulfite, the Borax crystal is approximately 50% water, so if you should get Borax, Anhydrous, use 50% less. Perhaps you have started to wonder just why some chemicals contain water and some do not. Some of the reasons are caused by manufacturing problems. It is cheaper to leave the water in. Some chemicals absorb the water from the air, and some give up their water. Chemicals, like people, are all different—and some are even difficult.

Plus Two More

We said earlier that with six chemicals you can mix dozens of formulas, and we plan to keep our word. Let's take a different formula, Gevaert G 251. It contains the following (using our shorthand):

Elon	1.5 grams
Sodium Sulfite (des.)	25.0 grams
Hydroquinone	6.0 grams
Sodium Carbonate (MonoHydrate)	45.0 grams
Potassium Bromide	1.0 grams
Water to Make	1.0 liter

In addition to the chemicals already mentioned, this formula also contains:

- *Potassium Bromide* — Potassium Bromide is available as colorless crystals, or white granules or powder. However, there is no water in this one, so we do not have a hydration problem. Following our pattern, this chemical is used mostly as a restrainer in developers (both film and paper). The amount used varies from 0.5 grams to 5.0 grams, so a little of this chemical will go a long way.
- *Sodium Carbonate Monohydrate*—Yes, you guessed it, water of hydration again. In this case, the formula reads $Na_2CO_3•H_2O$. Mono means one, hydration means water—thus, one water. Most U.S. formulas will refer to Sodium Carbonate monohydrate. The English seem to prefer the Anhydrous. The only problem you will encounter here is when you try to use formulas from British magazines or books. This chemical is more alkaline than Borax. In other words, it will increase the pH.

Except for the formulas, that's about it. So go back to the opening pages of this story where you'll find a small group of standard formulas, published by the various manufacturers of film and papers, to get you started and to show you that there is very little difference between the various ones offered. From here the whole world of mixing your own is open to you. Add an additional chemical or two, for instance, and you'll have dozens more to choose from.

It does take a small investment, but to our way of thinking there's a BIG return, with the added pleasure of being able to say, "I did it all myself!"