

WHICH FILM? WHAT DEVELOPER?

Here are 12 pages of facts, opinions and reference material, designed to help you make excellent black-and-white negatives every time with a minimum of effort.

By John Wolbarst

The case for developing your own films is a simple one to state. No commercial photofinisher can possibly afford to process them with the care and attention that you can bring to bear—if you know what you're doing.

However, care and skill in processing are not by themselves any guarantee that the developed negatives will be of excellent technical quality. For that result you must start with an intelligent choice of the film, proceed to expose it correctly, continue on this path by picking the developer that will best further your aims, and then finish the job with proper processing techniques.

The purpose of this section is to provide you with a set of guideposts intended to help you transform a potentially tortuous and puzzling struggle into a simple, routine, but highly successful performance.

To that end you will find the following, in addition to this introduction: two pages about the various film types and which are best suited to your needs; two pages describing a profusion of useful developers and their characteristics; four pages of the most complete film/developer charts ever published, covering both 35mm and roll films; two pages of detailed information about the importance of relating development to exposure and vice versa and how to go about it.

This material is not intended to be a step-by-step primer in processing, although on the opposite page I have summarized a successful technique. Instead, I have tried to present in simple language principles of operation of equal value to a beginner and the most expert expert.

Relating exposure to processing

It seems to me that no part of this section is more important than that devoted to the exposure/processing relationship. Here's what I mean.

Example: You're snapping fast in very dim light with Ansco Super Hypan which you later develop in FR X-33C, an excellent product but a poor choice for this job. It's a low-energy, ultra-fine-grain formula that cannot bring out the maximum film speed you need for this situation. Your negatives will be sadly thin and lacking in shadow detail.

Example: You're out on a bright overcast day shooting portraits on Kodak Plus-X Pan at a conservative exposure index of 100, and you hope to make big, crisp, smooth-looking enlargements.

Someone says "Promicrol" and that's what you develop with. Wow! What a dense negative! Overexposed about 4X; difficult to enlarge; not satisfactory.

Example: You use the same films for the same picture taking situations, but you switch developers. Super Hypan and Promicrol happen to make a most effective combination for poor light conditions. Conservatively rated Plus-X Pan and X-33C will produce some of the smoothest-looking big blowups you ever had the pleasure of seeing.

These are not far-fetched examples. This is the type of knowledge (or lack of it) which can make the difference between pleasure and disappointment in your photographic hobby.

Try for consistency

In film developing, consistency of results is one of the most important goals. We can standardize various operations to improve consistency, and some are described on pages 62-63.

I found that my own darkroom work became much more consistent when I began to use single-shot developers almost exclusively. A single-shot developer is one which is designed to be used only once (or perhaps twice within a few hours) and then discarded.

Most single-shot developers are made up by diluting a stock solution, which may be highly concentrated. In my charts are dilution recommendations ranging from 1:100 down to 1:1.

With a single-shot developer you use a fresh, equally effective solution each time. I believe that this system provides the most consistent results for average amateur needs.

Some single-shot developers are astonishingly inexpensive to use. Others are pretty costly, when you figure the price per roll developed.

In contrast to the single-shot system is the practice of using the same quart of a conventional developer over and over. Such developers can be kept up to useful strength, despite a considerable amount of use, by careful replenishment with suitable solutions. Many people swear by this technique and there's no doubt that it works well, if the solutions are carefully tended. Some of the best developers in my lists are intended to be used in this manner.

It is unwise to open or mix more of any developer than you can use up in 30-60 days. If you have more than is needed for that period, divide it and store it in smaller airless bottles to avoid spoilage.

What equipment is needed?

The equipment necessary to process negatives to the highest standards of quality is neither elaborate nor expensive. Here is a list of the items:

A plastic 8 x 10 developing tray or similar object, which serves as a temperature regulating water jacket and spill catcher. Do all pouring of chemicals over this; keep the tank in it during the development time.

One or more developing tanks suitable for your particular needs. See page 63 for details of tanks.

An accurate thermometer (page 63).

Graduates, sized according to your needs. Certainly you need a 16-oz. one, probably also a quart size, and possibly a gallon one for mixing large supplies. I keep separate graduates (and funnels) for acid (shortstop and fixer) and alkaline (developers) solutions to avoid contamination. Glass graduates break more easily than metal ones, but in quart and smaller sizes they're easier to read. I haven't had enough experience with plastic graduates to offer an opinion on them.

If you plan to use Agfa Rodinal or Perutz Perinal, you'll need a tiny 10 or 25cc or ml glass cylinder graduate and an eyedropper.

Flexible plastic bottles for solutions used frequently make darkroom work safer. Developer and fixer come in these now; save some or buy new empties, but don't store developer in ex-fixer bottles and vice versa.

Some film clips, with teeth that grip but don't mangle the film.

An accurate timer. A night dial watch with sweep second hand can serve, but a darkroom timer is better. I like the Gra-Lab electric or the General Electric spring-powered timers.

A copy of the Kodak Master Darkroom Dataguide (\$2.95).

A roll of paper towels, and a waterproof rubber or plastic apron.

Running water at the exact location of your work is not absolutely necessary, but it's convenient.

The essential materials

Here is a list of materials which, in my opinion, are desirable in order to do high-quality processing:

Developer. Pick one from the list on pages 56-57. If you haven't any idea where to begin, I'd suggest a small bottle of Edwal FG 7, and you can branch out from there.

Shortstop. Get a small bottle of the kind that turns color when the solution is becoming exhausted.

Fixer: I prefer rapid fixers. There are several. I think it's a good idea to add hardener to the fixer to help avoid scratches. Small bottles of liquid prepared hardener are available.

Hypo neutralizer. Also called wash accelerator. These products reduce washing time tremendously, produce more fixer-free negatives. You can make your own most inexpensively from 2½

ounces of sodium sulfite (anhydrous) and a gallon of water, which is good for at least 100 rolls of film.

Wetting agent. A brief film bath in a dilute solution speeds up drying, helps eliminate water spots on the film. Of them all, I prefer Kodak Photo-Flo. Use sparingly, as directed. Too much is worse than none at all.

A successful processing technique

Following is a brief description of the processing procedures which I use. There are other systems, but this one works for me.

1. Load the tank.
 2. Determine the correct time and temperature for your film/developer combination (charts, pages 58-61).
 3. Start the timer (allowing 10-15 seconds extra for pouring) and fill the tank with developer of the right temperature. Incidentally, temperatures of all solutions, including wash water, should be kept within ± 3 degrees of the developer temperature. If the developing time is short, use the two-tank technique described in Exposure and Processing (page 63).
 4. Agitate continuously the first 20 seconds the film is in the developer and then at intervals as prescribed by the developer manufacturer (see page 63).
 5. About 15 seconds before the developing time is up, pour out the developer, quickly pour in the shortstop, and agitate well for 30-60 seconds. This arrests development.
 6. Pour back the shortstop, pour in fixer, agitate frequently. After the time specified on the fixer bottle, pour back the fixer, wash the film for 60 seconds in running water or with two separate 60-second rinses.
 7. Pour in a wash accelerator (also called hypo neutralizer).
 8. After 2-3 minutes, with frequent vigorous agitation, pour back the wash accelerator and wash the film for 5 minutes in running water, or use 5 separate rinses of 1-2 minutes each, with agitation.
 9. Bathe the film in a wetting agent solution for 1 minute, remove it from the reel, hang it to dry in a dust-free area with a clip or clothespin on the bottom to hold it down. Throw out the used wetting agent bath.
- That processing procedure does not apply if you are using a monobath developer, such as Cormac Unibath CC-1, which develops and fixes the film in a single solution in about 6 minutes. Details of the simple Unibath processing techniques are on the bottle and should be followed carefully.
- Now that we've covered some general aspects, let's get down to the specific question of picking a film and developer. Next page, please.

WHICH FILM?

Here are some pointers to help you make an intelligent choice from among the many types listed.

The films in the charts on pages 58-61 are all standard brands and types, sold in 35mm cartridges and/or one or more roll film sizes, ready to load into a camera.

In the past, 35mm and roll films bearing the same names often differed considerably in their response to a developer. The trend today is to make films of one name with approximately the same development characteristics in all sizes. Ansco Super Hypan and Kodak Tri-X Pan, improved type, are examples.

In such cases there is a single listing for both 35mm and roll films. However, Kodak Panatomic-X 35mm and roll films have quite different characteristics and are listed separately.

The films are classified by their exposure indexes (E.I.) and other characteristics into four groups, under self-explanatory headings.

The most useful films

According to order of picture taking usefulness I would list the groups 3, 4, 2, 1. Films in Group 3 provide an extraordinary combination of speed, exposure latitude, low graininess, and ability to make sharp pictures. They are the first choice for all-purpose films, particularly for 35mm work. Notice the amazingly good definition and lack of graininess in the center illustration *at right*, a 25X blow-up of a 35mm Kodak Plus-X Pan negative. In Group 3, my favorite film is Plus-X Pan, both 35mm and roll.

Most of us want to do quite a bit of shooting indoors or elsewhere in dim light, so Group 4 is next in importance. Please note, however, that some films, marked with a star, are recommended for use only in dimmest light, or where such film speed is absolutely necessary.

If you're shooting 120 roll film, three of the Group 4 films come close to being a "most useful" all-around choice. They are: Ansco Super Hypan, Ilford HP3, Kodak Tri-X Pan. It takes only a 6X

enlargement of a 2¼-in. square negative to make an 11 x 14 print. In 35mm size I prefer the physical characteristics of Tri-X Pan, but have also had wonderful results with HP3 and Super Hypan.

Films for super quality

In Group 2 are films for bright light which fill the need for better definition and less graininess than is possible with Group 3 materials. Superb results are possible with both 35mm and roll films. I can hardly think of a roll film use for which films in this group would not give sufficient definition and lack of graininess, when properly exposed and processed. They are really great.

As compared to the very slow Group 1 films, it seems to me that the faster shutter speeds or smaller lens openings possible with Group 2 types may outweigh some slight inherent advantages of the Group 1 films.

For picture taking abilities I'd place Isopan F and Panatomic-X neck and neck. I prefer the physical characteristics of Panatomic-X 35mm, but Isopan F roll film comes on a much better kind of spool than does Pan-X roll film.

Films in Group 1 are for special purposes. They can produce images of incredibly high quality. But it seems to me that unless you need to enlarge 20X or more they offer no real advantages as compared to Group 2 films. I prefer Adox KB-14.

How sharp? How grainy?

The three illustrations *at right* show graphically some of the differences in definition and graininess that are characteristic of films in widely separated speed groups. Owing to lack of space I could not show samples of all film groups. However, a film in Group 2, such as Kodak Panatomic-X or Agfa Isopan F, would reproduce the test subject almost as well as the Group 1 film shown. The original prints would show the slight difference, but the printed page might not indicate this clearly.

Also missing is one of the unstarred Group 4 films. This would definitely show a decrease in quality, compared to the Plus-X Pan sample, but would be markedly better looking than the Isopan Record illustration.

It's important to note that for ordinary picture taking the big differences in definition and graininess occur when you move from Group 3 to Group 4 films, not when you go down the line to Groups 2 and 1. That's the best possible testimonial to the high quality potential of some of the general-purpose Group 3 films. However, don't try to make these films perform functions that properly belong to Tri-X Pan and Super Hypan. It won't work.

It seems to me that in addition to its

photographic qualities, a film should also be judged on some of its physical characteristics. Most photographers do not consider these at all, which I think is an important error.

Certainly, with 35mm films, we should consider the following: the strength of the film base; its flexibility or brittleness; whether or not the film stays flat or curls after processing; the anchoring of the film in the cartridge. All these things can be as important to the full picture making process as the photographic abilities of the emulsion itself.

American-made 35mm films are more securely anchored in the cartridge than any European films (including Kodak's European brands). In cold, dry weather, film gets brittle, snaps easily. I have found that U.S.-made Kodak 35mm films retain their flexibility remarkably well in these conditions.

Films that curl after processing are harder to handle in enlarging, more likely to break, and more easily scratched than films that stay flexible and lie flat. The tendency to curl is affected by the humidity (lack of it, actually) of the atmosphere. It has been my observation that in a wide variety of conditions Kodak films lie flatter than any others.

Behavior of roll films

In roll films, the behavior of the base is of somewhat less importance than with 35mm films. The base is under little or no strain when passing through the camera. However, a flexible, tractable base is more likely to stay flat in the film plane than one which is as lively as a steel clock spring.

Recent Kodak roll films are very flexible. In fact, so much so that I have found a slight problem in handling them. When loading a developing tank reel from the center out (Nikor reel, for example) you must be very careful not to buckle the film sharply. A sharp bend can produce the pressure phenomenon known as "half moons." These are little crescent-shaped marks that appear in thin areas of developed negatives. You should also exercise the same caution when loading Kodak 35mm films, which buckle easily.

European roll films are wound on what I consider to be a superior type of spool. It has a solid core of wood or plastic and it's easy to thread the paper leader through the slot in a hurry. In comparison, the sheet metal spool of American films is a monumental nuisance.

I have listed a great many films. It would be nonsense to try to use them all. Standardize on a couple, according to your needs, and get to know them well. You'll be amazed at how much can be done with any of them.

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What kind of sharpness and definition of detail can you expect from films in different speed classes?

Even if you have the keenest eyes east (or west) of the Mississippi, you are unlikely to be able to read the encircled type in the contact print above. However, at left center you can see it reproduced enlarged 25X.

This particular sign was photographed because it was a relatively low-contrast subject under steady north light. Instead of being black on white, the color combination was something like black and dark red type on yellow-green. Since most photographic subjects are of low to moderate contrast, this was a more realistic subject for testing than a black on white poster.

The object of the test was to see what differences in sharpness would occur when the same subject was shot with films of different speeds.

The tripod-mounted camera was a Beseler C Topcon with a 58mm f/1.8 F. Auto-Topcor lens set at f/8 and locked in sharp focus. Exposures were controlled by changing shutter speeds. Continuous exposure meter checks showed that the light did not change measurably during the test.

The films from which these 25X blow-ups were made were exposed and developed with close attention to the manufacturers' recommendations, as follows: Top, very slow Agfa Isopan FF, E.I.32, developed in Rodinal 1:100, 14 min. at 68F. Center, medium-fast Kodak Plus-X Pan, E.I.160, developed in D-76 1:1, 8 min. at 68F. Bottom, ultra-fast Agfa Isopan Record, E.I. 1600, developed in Rodinal 1:50, 16 min. at 68F.

In my opinion it would be difficult to make any real improvement in the results shown here by changing developers. Agfa Atomal might make the inherent graininess of Record somewhat less obvious, and enhance detail.

Since contrast has much to do with the look of sharpness in prints, some overdevelopment of Isopan FF to increase contrast would make the letters pop out a little more, and this is such a fine-grained film that the increase in graininess would not be bad.

Similarly, development in FR X-22 would produce a slightly peppier but not too grainy Plus-X Pan negative. However, these changes would not improve the basic quality of the images.

Contrariwise, with such a subject it would be easy to ruin the detail, with any film, by excessive overexposure or overdevelopment, or by choosing a developer which by its nature tends to degrade sharpness.

The point I'm making is that the choice of film alone is not the only factor in the sharpness, or lack of it, of the resulting negatives.

WHAT DEVELOPER?

Take your pick. This list includes: developers for general use; or maximum sharpness; or finest grain; or top film speed. Some you use once and discard; others can be replenished and used many times with good results.

Before you commit your exposed films to the developing process, it's a good idea to know something about the developer you intend to use. Here are brief descriptions of the developers in the charts on pages 58-61.

Although this selection of formulas covers an enormous range of possible processing requirements, it does not include all developers. Perhaps you have a favorite which is missing. That is no indication of lack of regard for a particular product. Nor have I tried to provide developing times for every possible combination of films and developers. Here, again, the absence of someone's most favored combination may only mean that I never got around to trying that particular one.

With but one exception every developer listed is a packaged product of a reputable manufacturer and is nationally distributed and available in large numbers of camera stores. Of course, in a small town the dealer's variety may be limited. I have also included Kodak D-23 because it is a simple and inexpensive mix-it-yourself formula that produces good results.

You will not find in this list any crank formula supersoups guaranteed to do magical things for your films, nor any secret techniques of using the listed developers.

The recommendations in the charts are conservative and are designed to produce essentially "normal" negatives in which full use has been made of the inherent sensitivity of the film.

If you made a great number of identical exposures of the same carefully selected subject, all with the same type film, then cut the film into sections and

developed each piece in different formulas, some differences would be apparent immediately.

Some developers might produce negatives showing only moderate differences in density between highlight and shadow areas (low contrast); others might show great differences in these densities (high contrast). One negative of moderate contrast might show considerably more shadow detail than another negative of moderate contrast (a sign that one developer gives more film speed than another one). One set of negatives might have a clean, clear look in the unexposed portions, while another set might be somewhat fogged in the same areas.

If you enlarged these negatives carefully, you'd begin to see differences in the apparent graininess of the images. And if you made big enough enlargements, differences in the sharpness and definition of details in the subject would become apparent.

I have tried to indicate some of these characteristics in the developer descriptions. If my terms seem to be slightly vague, it's because such characteristics cannot reasonably be described in dogmatic language.

The performance of a given developer depends on a lot more than the mere presence of certain chemicals in the formula. The type of film; the kind of lighting, subject, and exposure; the accuracy of your exposure meter and camera shutter and your use of them; the sharpness with which you focus, and your steadiness or lack of it in holding the camera; processing conditions such as the degree of agitation and temperature control—all these can affect the final outcome in some misleading way. However, I think that if all other conditions are equal, the descriptions will give you a pretty good idea of what to expect from the products.

These descriptions are not derived from some secret, highly complicated, laboratory experiments, nor from a quick perusal of the manufacturer's advertising claims. They are the result of a great deal of careful practical work, involving endless numbers of films and enlargements, and accurate records over a long time. These are my personal opinions.

No doubt some people will disagree, and I'll be interested to hear their comments. Also, if anyone has anything to add to these descriptions, based upon personal experience, I'd like to hear from them too.

AGFA ATOMAL NEW: A fine-grain, soft-working formula. Gives moderate to high film speed, good sharpness. Two-powder form. No replenisher available in small sizes; extend development one minute per roll for several rolls, with increasing graininess. Keeps well. Price: 300cc (11 oz.) powder, 75 cents; 600cc (21 oz.), \$1.20. Agfa, Inc., 516 West 34 St., New York 1, N. Y.

AGFA RODINAL: An ancient German formula of enormous power, used as a single-shot at extreme dilutions. Has outstanding ability to give sharp-appearing images. No fine-grain formula, but graininess pattern, when visible, is very tight, and razor-edged. Concentrate keeps indefinitely, but store it in small air-free bottles. Highly alkaline; avoid skin contact with concentrate. Price: 1/10 litre liquid (3½ oz.), \$1.50; ½ litre (17 oz.), \$3.95. Agfa, Inc., 516 West 34 St., New York 1, N. Y.

ANSCO HYFINOL: New, energetic, moderately soft-working, general-purpose formula. Excellent sharpness, medium fine to fine grain, moderate contrast, high film speeds. Keeps well. Replenisher. Price: 1 gal. powder, to be announced. Ansco, Binghamton, N. Y.

ANSCO ISODOL: (see Kodak DK-50)

ANSCO NORMADOL: Outstanding fine-to medium fine-grain formula of D-76 type, but softer working and gives slightly less film speed (and sharpness) with much less tendency to block up highlight areas. Long life in use and storage. Price: 1 qt. powder, 45 cents. Replenisher. Ansco, Binghamton, N. Y.

CLAYTON P-60: Versatile, powerful but soft-working Phenidone type, producing very high film speeds with medium fine grain, moderate contrast, fairly good sharpness. Keeps well. Stock solution diluted 1:2 to make working solution, which also keeps well. Manufacturer recommends 10 seconds agitation every two minutes. Price: 1 qt. liquid, \$1.90. Self-replenisher. Clayton Chemical Co., 2100 Dempster St., Evanston, Ill.

CORMAC UNIBATH CC-1: A single solution develops, fixes films in 4-7 minutes. Self-limiting action makes it impossible to overdevelop. A good semi-fine-grain formula for beginners and special applications. CC-1 works best with Kodak Plus-X Pan and Panatomic-X, and should not be used with films marked NR. Constant agitation. Good sharpness, moderate film speed, moderate to fairly high contrast with films listed. Price: 16 oz. of concentrate, good for 12 rolls, \$2.25. Cormac Chemical Corp., 80 Fifth Ave., N. Y. 11, N. Y.

EDWAL FINE GRAIN No. 7: Probably the most versatile of all the developers listed, this concentrate is designed for various uses at different dilutions. Times given are for single-shot use. Excellent sharpness and low graininess with slow and medium-speed films; medium fine grain, good sharpness, and

high speed with fast films. For finer grain (and slightly less speed) with fast films, dilute 1:15 in 9% solution of sodium sulfite (directions on bottle) and develop for half the time indicated in the charts. Concentrate appears to have longest shelf life of all developers listed, but store it in small air-free bottles. Price: 1 qt. liquid, \$1.75. Edwal Scientific Products Corp., 420 W. 111 St. Chicago, Ill.

EDWAL MINICOL: An extremely soft-working formula which, when diluted 1:4 to make a single-shot, couples with thin emulsion, high-sharpness films to give negatives of unusual sharpness and minimum graininess, with moderate film speed. Keeps well before dilution. Price: 1 qt., \$1.45. Self-replenisher. Edwal Scientific Products Corp., 420 W. 111 St., Chicago, Ill.

EDWAL THERMOFINE: Versatile, energetic medium fine-grain formula, which may be used at temperatures up to 90F. Good sharpness; high film speed. Long life in use and storage. Price: 1 qt. liquid, \$1.19. Replenisher. Edwal Scientific Products Corp., 420 W. 111 St., Chicago, Ill.

ETHOL UFG: Outstanding, powerful but soft-working formula which may be used at temperatures up to 90F. Gives high film speeds with moderate contrast, fine to medium fine grain, and topnotch sharpness. Times listed are exactly as recommended by manufacturer and may produce development to a somewhat higher degree of contrast than that produced by most other times recommended in the charts. Excellent keeping qualities, but easily contaminated in use, so cleanliness and care are very important. Price: 1 qt. powder, \$1; 1 qt. liquid, \$1.75. Replenisher. Plymouth Products Co., Inc., 1770 W. Berneau Ave., Chicago 13, Ill.

ETHOL TEC: Specialized single-shot designed for use with slow and medium-slow high-sharpness films. The concentrate, in 1 oz. bottles, keeps indefinitely. Diluted: 1:15 (a pint of solution develops two 36-exposure films) it is good for 6-8 hours. Price: Pkg. of three 1-oz. bottles, \$1. Plymouth Products Co., Inc., 1770 W. Berneau Ave., Chicago 13, Ill.

FR X-22: Specialized liquid single-shot, for use with thin emulsion, high-sharpness films at dilutions from 1:9 to 1:19. Excellent performance with films listed, giving low graininess, high sharpness, high film speed. Concentrate keeps well, if kept from contact with air, which ruins it quickly. Price: Pkg. of three 1-oz. bottles, 75 cents. FR Corp., 951 Brook Ave., New York 51, N. Y.

FR X-33C: Very fine-grain, soft-working, low-energy type. Not for use where high film speeds or maximum definition are needed. Keeps well. Price: 1 qt. liquid, \$1.49. Replenisher. FR Corp., 951 Brook Ave., New York 51, N. Y.

FR X-44: New liquid single-shot for use with medium and high-speed films at different dilutions for varying contrast and developing times. Add water to contents of bottle to make amounts indicated in charts. Fine grain, moderate contrast, reasonably good sharpness, moderate to high film speeds. Concentrate keeps well if kept from contact with air, which ruins it quickly. Price: Pkg. of three 1 1/4-oz. bottles, 75 cents. FR Corp., 951 Brook Ave., N. Y. 51, N. Y.

FR X-500: Single-shot Phenidone formula, diluted 1:10, for use with fast and high-speed films. Gives very high film speeds, medium fine grain, moderate contrast and sharpness. Moderate storage life in original sealed bottles. Once opened, should be stored in small quantities in sealed airless bottles. Price: 26 oz. liquid, \$1.39. FR Corp., 951 Brook Ave., New York 51, N. Y.

ILFORD ID-11 (see Kodak D-76)

ILFORD MICROPHEN: Extremely powerful but soft-working British-made Phenidone formula. Gives very high film speeds with medium fine grain and moderate contrast and sharpness. Keeps well. Price: 21 oz. powder, 95 cents; 1 qt. liquid, \$1.25. Replenisher. Ilford, Inc., 37 W. 65 St., New York, N. Y.

KODAK D-23: Simple, inexpensive, mix-it-yourself formula (1 oz. metol; 13 1/4 oz. sodium sulfite, desiccated, and water to make 1 gal.) for powerful, soft-working semi-fine-grain developer. Developing times are close enough to those of straight D-76 to be interchangeable, but it gives somewhat less film speed, less sharpness and mushier-looking graininess pattern than D-76. Keeps well. Replenisher. See Kodak Data Book, Processing Chemicals and Formulas for black-and-white photography.

KODAK DK-50 & ANSCO ISODOL: Two energetic non-fine-grain developers which, diluted, make soft-working single-shots. Moderate to high film speed, excellent sharpness, moderate contrast when diluted. They are not identical in performance. In general, Isodol develops negatives to a slightly higher contrast than will DK-50 in the same time. Use Isodol for Ansco films, DK-50 for

Kodak films, for most precise results. Moderate storage life. Very useful and inexpensive when large numbers of films are to be developed quickly. DK-50, 1 gal. powder, 65 cents. Eastman Kodak Co., Rochester, N. Y. Isodol, 1 gal. powder, 60 cents. Ansco, Binghamton, N. Y.

KODAK D-76: Outstanding single-powder type (Ilford ID-11 is similar but comes in two-powder form). D-76 gives full film speed and shadow detail, with moderate contrast and fine- to medium fine-grain results. Excellent sharpness. Diluted 1:1 it is an excellent single-shot with less tendency to overdevelop highlight areas than straight D-76. Very long life (straight) in use and storage. Price: 1 qt. powder, 50 cents. Replenisher. Eastman Kodak Co., Rochester, N. Y.

KODAK MICRODOL-X: New, improved version of Microdol with longer life, better sharpness characteristics, designed for use either full strength, or diluted 1:3 as a single-shot (16 oz. per 36-exp. film or 120 roll when used 1:3). Very fine grain, soft-working, moderate film speed (full strength). Use and storage life somewhat less than for D-76. Single-powder or liquid form, with replenisher for both types. Diluted 1:3, Microdol-X is supposed to give greater sharpness (excellent) than when used full strength, but most apparent effect is a small but noticeable increase in film speed. Price: 1 qt. powder, 85 cents; 1 qt. liquid, \$1.50. Also may be supplied in packets, each to make 4 oz. Eastman Kodak Co., Rochester 4, N. Y.

MAY & BAKER PROMICROL: Extremely powerful but soft-working formula which gives highest effective film speeds (with certain films) of any developer listed. Medium fine grain, moderate contrast, poor sharpness characteristics. A first choice where maximum film speed is primary consideration, and definition of fine detail is not important. Keeps fairly well. Price: 1 qt. powder, \$1.90. Replenisher. Roberts & Porter, Inc., 622 Greenwich St., New York 14, N. Y.

PERUTZ PERINAL: Powerful German-made single-shot to be used at extreme dilutions. Avoid skin contact with concentrate. No fine-grain formula, but with films listed, graininess is low, with "soft-edged" look when visible. Good sharpness. Outstanding results with medium slow films. Concentrate keeps indefinitely, but store it in small air-free bottles. Price 1/10 litre (3 1/3 oz.), \$1; 1/4 litre (8 1/2 oz.), \$1.60. Burleigh Brooks Co., 10 W. 46 St., New York.

MASTER CHART OF 35MM & ROLL

BEFORE USING THE RECOMMENDATIONS IN THIS CHART, PLEASE BE SURE TO READ FOOTNOTE BELOW,

DEVELOPERS, ALL TYPES fine grain to high energy	GROUP 1, HIGH SHARPNESS very slow, finest grain			GROUP 2, GENERAL PURPOSE medium slow, very fine grain					
	ADOX KB-14, R-14 L.E.I. 16, H.E.I. 32	AGFA ISOPAN FF L.E.I. 16, H.E.I. 25	PERUTZ PERGRANO L.E.I. 16, H.E.I. 24	ADOX KB-17, R-17 L.E.I. 32, H.E.I. 64	AGFA ISOPAN F L.E.I. 40, H.E.I. 80	ILFORD PAN F L.E.I. 25, H.E.I. 50	KODAK PANATOMIC-X, 35MM L.E.I. 25, H.E.I. 64	KODAK PANATOMIC-X, ROLL L.E.I. 25, H.E.I. 64	PERUTZ PERPANTIC 17 & 18 L.E.I. 40, H.E.I. 80
▽									
AGFA RODINAL minutes at 68F dilute as indicated	1:100 13-15 ▽	1:100 13-15 ▽	1:100 13-15 M.E.I.	1:75 14-18 ▽	1:75 14-18 ▽	1:75 11-13	1:75 11-13 ▽	1:75 14-18 ▽	1:75 14-18
EDWAL FG7 minutes at 70F dilute as indicated	1:15 7-9 ▽	1:15 7-9 ▽	1:15 7-9	1:15 11-13 ▽	1:15 11-13 ▽	1:15 11-13	1:15 9-11 ▽	1:15 11-13 ▽	1:15 11-13
EDWAL MINICOL, DIL. 1:4 minutes at 70F	12-16 M.E.I. ▽	12-16 M.E.I.	12-16 L.E.I.	20-24 M.E.I.	20-24 M.E.I.	14-18 M.E.I.	14-18 M.E.I.	20-24 M.E.I.	20-24 M.E.I.
ETHOL TEC, DIL. 1:15 minutes at 70F	7-9 ▽	7-9	8-10 M.E.I.	8-10	10-12 ▽	7-9 ▽	7-9 ▽	10-14 ▽	9-11
FR X-22 minutes at 68F dilute as indicated	1:19 11-13 ▽	1:19 11-13 ▽	1:19 11-13	1:15 10-12 ▽	1:15 10-12 ▽	1:15 10-12 ▽	1:15 10-12 ▽	1:15 12-14	1:15 10-12
FR X-44 minutes at 70F dilute to make number of ounces of solution indicated	Not recommended for use with these films								
FR X-500, DIL. 1:10 minutes at 70F	Not recommended for use with these films								
KODAK D-76, DIL. 1:1 ILFORD ID-11, DIL. 1:1 minutes at 68F	6-8 ▽	6-8 ▽	6-8	7-9 ▽	7-9 ▽	6-8 ▽	6-8 ▽	8-10 ▽	7-9
KODAK DK-50 ANSCO ISODOL minutes at 68F dilute as indicated	1:4 7-9 M.E.I.	1:4 7-9 M.E.I.	—	—	—	—	1:1 3-4 1:4 8-10 M.E.I.	—	—
KODAK MICRODOL-X, DIL. 1:3 minutes at 75F	13-16	12-15	—	—	—	—	10-12 ▽	10-12 ▽	—
PERUTZ PERINAL, DIL. 1:50 minutes at 68F	7-9 ▽	7-9	7-9	9-11 ▽	9-11	7-9	8-10 ▽	9-11 ▽	9-11 ▽

Two exposure indexes are given for each film listed. Unless otherwise noted, use the high one (H.E.I.) for best results. For some film/developer combinations a lower index is needed and this is suggested in the box. If it's L.E.I., use the low index; if it's M.E.I., use an index midway

FILMS & SINGLE-SHOT DEVELOPERS

THE DEVELOPER DESCRIPTIONS ON PAGES 56-57, AND THE EXPOSURE INFORMATION ON PAGE 62.

GROUP 3, GENERAL PURPOSE medium fast, fine grain								GROUP 4, HIGH SPEED AND EXTRA HIGH SPEED films for dimmest light use are marked ★							
ADOX KB-21, R-21 L.E.I. 80, H.E.I. 200	AGFA ISOPAN SS L.E.I. 80, H.E.I. 200	ANSCO ALL- WEATHER PAN, ROLL L.E.I. 64, H.E.I. 125	ILFORD FP3 L.E.I. 64, H.E.I. 160	ALSO, VER. PAN 828 KODAK PLUS-X PAN L.E.I. 80, H.E.I. 200	KODAK VERI- CHROME PAN, ROLL L.E.I. 80, H.E.I. 200	PERUTZ PEROMNIA 21 L.E.I. 100, H.E.I. 200		AGFA ISOPAN U L.E.I. 250, H.E.I. 400	★ AGFA ISOPAN RECORD L.E.I. 650, H.E.I. 1200-1600	ANSCO SUPER HYPAN L.E.I. 200, H.E.I. 500	ILFORD HP3 L.E.I. 200, H.E.I. 400	★ ILFORD HPS L.E.I. 400, H.E.I. 800-1200	★ KODAK ROYAL-X PAN, ROLL L.E.I. 800, H.E.I. 1600-2400	KODAK IMPROVED TRI-X PAN, 1960 L.E.I. 200, H.E.I. 400	
1:75 14-18	1:75 14-18 ✓	1:75 11-13	1:75 11-13	1:75 11-13 ✓	1:75 11-13	1:75 14-18		1:40 9-11	1:50 15-18 ✓	Not recommended for use with these films					
1:15 12-15 ✓	1:15 12-15	1:15 15-17	1:15 9-11	1:15 9-11 ✓	1:15 15-17 ✓	1:15 12-15 M.E.I.		—	1:7 8-10 ✓	1:15 14-16 ✓	1:15 11-13 ✓	1:15 14-16	1:7 8-10 ✓	1:15 11-13 ✓	
—	—	—	14-18 M.E.I.	14-18 M.E.I.	NR	NR		Not recommended for use with these films							
9-14 M.E.I.	9-14 M.E.I.	—	Do Not Use	9-15 M.E.I.	—	12-17									
1:9 15-17 ✓	—	—	1:15 10-12 ✓	1:15 10-12 ✓	—	—									
—	—	—	32 oz. 4	32 oz. 5-7	16 oz. 4	—		—	16 oz. 5-6	16 oz. 4 32 oz. 6 ✓	16 oz. 3 1/4	16 oz. 4 1/2	NR	32 oz. 4 1/2-5 40 oz. 5-6 ✓	
9-11	9-11	10-12	—	6-8	9-11 ✓	9-11		Do Not Use	NR	9-11	9-11 ✓	9-11 ✓	NR	7-8	
9-11	9-11	9-13	7-9 ✓	7-9 ✓	9-13	5-6		—	NR	11-13	11-13	—	NR	—	
1:1 5-6	1:1 5-6	1:1 7-9	1:1 4-5 1:4 8-10	1:1 3-4 1:4 8-10 ✓	1:1 7-10	1:1 6-8		—	1:1 12-15 ✓	1:1 7-9 ✓	—	—	6+ Full Strength ✓	1:1 6-8 1:4 12-15 M.E.I.	
—	—	—	10-12 M.E.I.	10-12 ✓	NR	—		—	—	—	—	—	NR	14-16 ✓	
9-12 ✓	9-12	11-13	8-10	8-10 ✓	11-13 ✓	9-12 ✓		Not recommended for use with these films							

between the high and low numbers. These recommendations are based upon accurate use of an exposure meter as described on page 62. A ✓ means "very useful combination," a recommendation derived from tests and practical use.

MASTER CHART OF 35MM & ROLL

BEFORE USING THE RECOMMENDATIONS IN THIS CHART, PLEASE BE SURE TO READ FOOTNOTE BELOW,

DEVELOPERS, ALL TYPES fine grain to high energy	GROUP 1, HIGH SHARPNESS very slow, finest grain			GROUP 2, GENERAL PURPOSE medium slow, very fine grain							
	ADOX KB-14, R-14 L.E.I. 16, H.E.I. 32	AGFA ISOPAN FF L.E.I. 16, H.E.I. 25	PERUTZ PERGRANO L.E.I. 16, H.E.I. 24	ADOX KB-17, R-17 L.E.I. 32, H.E.I. 64	AGFA ISOPAN F L.E.I. 40, H.E.I. 80	ILFORD PAN F, 35MM L.E.I. 25, H.E.I. 50	KODAK PANATOMIC-X, 35MM L.E.I. 25, H.E.I. 64	KODAK PANATOMIC-X, ROLL L.E.I. 25, H.E.I. 64	PERUTZ PERPANTIC 17 & 18 L.E.I. 40, H.E.I. 80	ADOX KB-21, R-21 L.E.I. 80, H.E.I. 200	
▽											
AGFA ATOMAL NEW minutes at 68F	7-10 ▽	7-10 ▽	7-10 L.E.I.	10-12	10-12 ▽	7-10	10-12	10-12	10-12	10-12	
ANSCO HYFINOL minutes at 68F	—	—	—	—	—	—	—	—	—	—	
ANSCO NORMADOL minutes at 68F	6-9	6-9	6-9	—	7-10	6-9	7-10 ▽	10-12 ▽	7-10	10-12	
CLAYTON P60, DIL. 1:2 minutes at 68F	5-6	5-6	—	6-8	6-8	5-6	6-8	9-11	6-8	9-10	
EDWAL THERMOFINE minutes at 70F	—	—	—	9-11 M.E.I.	9-11 M.E.I.	—	7-9 M.E.I.	9-11 M.E.I.	9-11 M.E.I.	11-13	
ETHOL UFG minutes at 70F times given are exactly as specified by manufacturer	—	—	—	—	4½	—	3	3	—	5	
FR X-33C minutes at 70F	Not recommended for use with these films									—	
ILFORD MICROPHEN minutes at 68F	5-7	5-7	5-7	8-10 ▽	7-9	5-7	—	9-11	7-9	9-11	
KODAK D-76, D-23 ILFORD ID-11 minutes at 68F	D-76 see page 58			6-8	6-8	5-7	4-5½	6-8 ▽	6-8	7-9	
	D-23 4½-5½	D-23 4½-5½	—								
KODAK MICRODOL-X minutes at 68F	—	—	—	—	—	—	8-10 M.E.I. ▽	8-10 M.E.I. ▽	—	—	
MAY & BAKER PROMICROL minutes at 68F	Not recommended for use with these films									—	
UNIBATH CC-1, DIL. 1:1 minutes at 68-75F	4-5 L.E.I.	4-5 L.E.I.	NR	6-7 L.E.I.	6-7 L.E.I.	4-5 L.E.I.	6-7 L.E.I.	NR	6-7 L.E.I.	6-7 L.E.I.	

Two exposure indexes are given for each film listed. Unless otherwise noted, use the high one (H.E.I.) for best results. For some film/developer combinations a lower index is needed and this is suggested in the box. If it's L.E.I., use the low index; if it's M.E.I., use an index midway

FILMS & CONVENTIONAL DEVELOPERS

THE DEVELOPER DESCRIPTIONS ON PAGES 56-57, AND THE EXPOSURE INFORMATION ON PAGE 62.

GROUP 3, GENERAL PURPOSE medium fast, fine grain							GROUP 4, HIGH SPEED AND EXTRA HIGH SPEED films for dimmest light use are marked ★							
AGFA ISOPAN SS L.E.I. 80, H.E.I. 200	ANSCO ALL- WEATHER PAN, ROLL L.E.I. 64, H.E.I. 125	ILFORD FP3 L.E.I. 64, H.E.I. 160	ALSO, VER. PAN 828 KODAK PLUS-X PAN L.E.I. 80, H.E.I. 200	KODAK VERI- CHROME PAN, ROLL L.E.I. 80, H.E.I. 200	PERUTZ PEROMNIA 21 L.E.I. 100, H.E.I. 200		AGFA ISOPAN U L.E.I. 250, H.E.I. 400	★ AGFA ISOPAN RECORD L.E.I. 650, H.E.I. 1200-1600	ANSCO SUPER HYPAN L.E.I. 200, H.E.I. 500	ILFORD HP3 L.E.I. 200, H.E.I. 400	★ ILFORD HPS L.E.I. 400, H.E.I. 800-1200	★ KODAK ROYAL-X PAN, ROLL L.E.I. 800, H.E.I. 1600-2400	KODAK IMPROVED TRI-X PAN, 1960 L.E.I. 200, H.E.I. 400	PERUTZ PEROMNIA 25 L.E.I. 200, H.E.I. 320
10-12 ✓	10-12	10-12 ✓	10-12 ✓	10-12	10-12		10-12 ✓	10-12 ✓	10-12	10-12	12-14	NR	10-12 ✓	10-12
—	6-7 ✓	—	4-5	6-7	—		—	7-9 ✓	7-9 ✓	—	—	8+ ✓	5-6	—
10-12	14-16	—	7-10	14-16	—		12-14	—	12-14	12-14	12-14	NR	—	12-14
9-10	10-12	5-7	6½-8½ ✓	10-12 ✓	8-9		9-10	NR	8-10 ✓	8-10	12-14	NR	7-9 ✓	9-10
11-13	11-13	9-11	9-11	14-16	11-13		13-16	—	13-16	13-16	13-16	NR	9-11	13-16
4½	5	4½	3½	5	8		5	NR	5 ✓	4 ✓	6	NR	6 ✓	5
—	15-19 M.E.I.	—	8½-10 M.E.I.	15-19 M.E.I.	NR		NR	NR	20-25 M.E.I.	20-25 M.E.I.	20-25 M.E.I.	NR	14-17 M.E.I.	NR
9-11	9-11	9-11 ✓	7-9 ✓	11-13	9-11		10-12	12-14	10-12	12-14 ✓	12-14 ✓	NR	5-6	12-14
7-9	9-11 ✓	7-9	4½-6	11-13 ✓	7-9		7-9	12-15	D-76 8-10 D-23 10-12	9-11 ✓	12-15	NR	7-9 ✓	10-12
—	—	—	8-10 M.E.I. ✓	13-15 75F 9-11 M.E.I.	—		—	—	—	—	—	NR	10-12 75F 7-9 M.E.I.	—
—	—	5-6 1½ X H.E.I.	6-7 1½ X H.E.I.	7-8	—		—	9-11	9-11 1½ X H.E.I. ✓	9-11 1½ X H.E.I. ✓	13-15 ✓	NR	6-8 1½ X H.E.I.	—
NR	NR	6-7 L.E.I.	6-7 L.E.I.	6-7 L.E.I.	NR		NR	NR	NR	6-7 M.E.I.	NR	NR	6-7 L.E.I.	NR

between the high and low numbers. These recommendations are based upon accurate use of an exposure meter as described on page 62. A ✓ means "very useful combination," a recommendation derived from tests and practical use.

EXPOSURE & PROCESSING

If you want to make excellent negatives, these two factors must always be considered together.

Ideally, before exposing a film, you should have a pretty complete mental picture of what the final print will look like, what it will be used for, how big it will be enlarged and on what kind of paper, and exactly what developer is to be used to process the negative.

That's a rather demanding standard to work to and hardly anyone, myself included, meets it all the time. However, as a bare minimum you should know what general type of formula will be used to develop that film—high energy for great film speed or extra contrast, ultra-fine grain for that smooth look, high sharpness for best definition, or some compromise of all these qualities.

Why know the developer before snapping the shutter? Because each developer has its own particular effect on the usable film speed, graininess, and sharpness of the film which you are about to expose.

I know of no single developer which combines in one formula the ability to give you the highest possible film speed, the minimum possible graininess, and

the maximum possible sharpness, with any and all films. There are some which present highly effective compromises of two of the three desired aims, and a few which compromise all three to a reasonable degree.

The effect on film speed

Graininess and lack of definition won't become apparent until you enlarge considerably. But the loss or gain of film speed makes itself known immediately in the form of negatives which are so thin that shadow detail is missing, or so dense as to be nearly unprintable.

This is the most obvious change that choice of developer will have on the film you are about to expose. Therefore exposure must be adjusted so as to complement the effect of the developer.

The majority of the developers listed are capable of utilizing most of the film's inherent sensitivity very nicely with normal development. Some others are powerful "speed-gaining" formulas, useful for squeezing out the last bit of sensitivity. A few sacrifice some film speed in favor of extra fine-grain results or for some other reason.

You'll see that for each film in the charts I have supplied two exposure indexes, a low one (L.E.I.) and a high one (H.E.I.). Unless noted otherwise, all processing times given are for use with the H.E.I., using an exposure meter as described below.

Where a film/developer combination is marked L.E.I., use the low exposure index; for M.E.I. use an exposure index midway between the high and low.

If you use the L.E.I. where the H.E.I. is indicated, the worst that can happen is that your negatives will be overexposed and may not enlarge very well. However, if you use the H.E.I. where the L.E.I. is indicated serious underexposure may result, thus entirely ruining your pictures.

These exposure/processing recommendations are designed to produce "normal" negatives that will enlarge easily on #2 or #3 grade of paper.

How much exposure?

The next point to be considered is the actual business of correctly exposing the film, so that when developed properly it will produce the essentially "normal" negatives we want.

A film should be exposed just enough so that all important shadow details will be recorded sufficiently to print pleasingly. If this result is achieved, the film should also record satisfactorily all the other tones in the scene, up to and including the highlights.

It's obvious that if you give much less exposure than this, important shadow detail will be underexposed or lost altogether. The result: Poor image quality.

There's no need to give much more exposure than this optimum minimum, because you already have recorded all the important shadow detail satisfactorily. Heavy overexposure causes increased graininess and loss of sharpness, kills off many of the delicate tonal gradations that make for print beauty, and results in negatives with such dense highlight areas that they may be virtually unprintable.

The matter of meters

There are two main types of exposure meters. Incident light meters measure the brightness of the light falling on the subject; the meter's cell is aimed at the position from which the camera will be used. Reflected light meters measure the brightness of the light reflected from the subject. A few of them can be converted to incident light meters by adding a light diffuser over the cell.

The incident light principle is employed only in a few makes of accessory meters. I know of no camera with a built-in incident light meter, although incident light diffusers are available for some built-in reflected light meters.

It is my firm belief that for black-and-white work, particularly for nearby subjects, the incident light meter is preferable. Those with a "ping-pong ball" light collector require least judgment on the part of the user, measure front, top, and side light, and give very useful "average" readings. Those with flat light collectors ignore side light and under some conditions may introduce a slight overexposure error.

Using reflected light meters

I think that reflected light meters require considerable judgment in use to produce consistently accurate exposures. For pictures of people in soft, even light, take a close reading off the skin, give 2X the indicated exposure to insure adequate detail in dark hair, eyes, and clothes. (Exception: 2X increase is not necessary with brown-skinned people if you make your reading directly off the skin.)

If important parts of the subject are in both bright light and shade, meter both areas and give an exposure halfway between. You can also get an accurate "average" reading off a proper gray card, but who carries one of them around? It's usually more convenient to take a reading off a clean, matte surface white paper held vertical and aimed at the camera position, then give 5X the indicated exposure. This is most useful in dim light.

For distant outdoor subjects, reflected light meter use varies. For middle distance buildings (with no big sky areas in the scene) aim the cell at the subject. If foreground detail is important, point

the cell down at the important areas to offset the effect of sky light. A meter reading off a clear blue sky (aimed away from the sun) gives a surprisingly good "average" scenic reading. For dramatic cloud-filled skies, aim the meter right at them. Ground objects may be somewhat underexposed.

Bucking the electric eye

Electric eye cameras limit greatly your flexibility in exposure control. A few are made so that you can come close with the camera for a reading, depress the shutter release part way to lock the meter, then move back and shoot. However, even with the most arbitrary electric eye system you can control the exposure level by altering the setting for film speed. By using a lower-than-normal exposure index you induce more exposure; by using a higher index you decrease exposure. If your negatives are consistently over- or underexposed you can correct the condition in that manner.

The all-important tank

The most important piece of film development equipment is the tank. Most tanks need to be loaded in darkness. If you lack facilities for light-tight working space, then you must load your tank in a changing bag (not so comfortable or easy) or use a daylight loading tank (35mm only).

I'd recommend a daylight loader for anyone who is reasonably fumble-fingered in the dark, or who wants to develop an occasional film in the bathroom or kitchen. They're the most expensive type of tanks, but worth the money for their convenience.

I prefer the Leitz Rondinax, but I have also had success with the Kodak Day-Load and Agfa Rondix (the least easy to use). These tanks hold only one 35mm film and are not suitable if you need to develop many rolls of film in a reasonable time.

Loading in the dark

Dark loading tanks are of two main types: those that wind the film on the reel from the inside out, and those that wind from the outside in.

The outside-in winders utilize a sort of semi-automatic loading principle in which the two sides of the reel are alternately twisted back and forth and the film is gripped and moved ahead slightly with each cycle. With some tanks you must hold the film down with your thumbs as the reel is twisted. Another type (much preferred) holds the film without need of your fingers. Among outside-in loaders I prefer, by far, the Anscomatic. I have had less trouble loading this tank in the dark than with any other kind. It takes a single 35mm or roll film. Pay no heed to the little

For consistent results you must agitate properly.

Improper agitation can seriously affect, or even ruin, the quality of your negatives, and make it impossible to develop numbers of films with consistent, predictable results.

Insufficient agitation causes streaks and uneven development because the solution in contact with the film becomes exhausted and is not replaced periodically with fresh liquid.

Contrariwise, too much agitation causes overdevelopment. Too violent agitation results in excessive development around the sprocket holes of 35mm films, and this may affect the picture.

Most film and developer manufacturers now recommend constant agitation for the first 20 seconds the film is in the developer and after that for 5 seconds every 30 seconds. Unless otherwise noted, this recommendation applies to all the developers described on pages 56-57. There are exceptions, so be sure to check the descriptions.

Agitation 5 seconds every 30 seconds is extremely important for film/developer combinations with short processing times. However, with times of 10 minutes or more, I think that agitation for 10 seconds each minute will produce about the same results. The important thing is to agitate always exactly the same way, so that the effects are consistent.

Nikor tanks (and similar types) should be agitated by inverting, turning, and righting the tank once per second. With one hand firmly grasp the bottom of the tank from underneath. Let the fingers of the other hand overlap the top and grip the tank so that the lid can't come off. Each time you overturn the tank rotate it about $\frac{1}{4}$ turn. Don't shake Nikor tanks wildly; don't hold the tank vertical and try to spin it or slosh the solution around.

With other types of tanks (FR, Ansco, Yankee, etc.) you rotate a spindle which turns the reel in the solution. Give the spindle one brisk full turn per second. I usually give five turns one way on the minute, then reverse the spin at the half minute.

thermometer built into the reel twirling rod—it's not accurate enough.

Reels that load from the inside out are standard these days for serious amateurs and most professionals who develop their own. Best known are the stainless steel Nikor tanks and reels. Although far from ideal in some respects, they get highest marks for durability. Even if you're developing a single 35mm film (requiring only 8 oz. of fluid) it's best to use the 16-oz. Nikor tank. You get faster filling and more complete agitation than with the 8-oz. tank. Always fill Nikor tanks through a funnel, with the tank tipped slightly off level to let the air out quickly.

Among the less expensive plastic tanks I prefer the FR, adjustable for a single roll film or one or two 35mm films. I think it's the best washing tank of all. Fit a rubber hose over the hollow spindle and water is forced in at the bottom of the tank, swirls up and out.

Accurate timing technique

You should be able to fill or drain a 16-oz. tank in 15 seconds maximum. Even this is too long for 3- or 4-minute developing times. Best way to cope with the fast-acting developers is to use two tanks as follows:

Lights out; load film into one; lights on. Fill another tank with developer of the proper temperature. Lights out; start the timer, drop the loaded reel into the full tank, cap it and start to agitate; lights on. Now fill the empty tank with shortstop. At the end of the developing time douse the lights, transfer the reel to the tank of shortstop; and cap it. Lights on; after about 45 seconds pour out the shortstop, fill the tank with fixer.

What's your temperature?

One last item about another extremely important piece of equipment. Get a good thermometer. In fact, get two. I use an inexpensive glass Kodak stirring rod thermometer for ordinary use, but check it each time against my expensive but very accurate Kodak process thermometer.

Don't try to take temperature readings of closed plastic tanks by inserting a thin thermometer in the hollow center of the reel. This type of measurement is not accurate enough, even though the thermometer itself may be.

It's important to maintain even solution temperatures. Shortstop, fixer, hypo neutralizer, and wash water should be within ± 3 degrees of the developer temperature.

This is best done by keeping the various bottles in a water bath. If you have trouble controlling the temperature of running water, wash your films with separate clean water rinses as described on page 53.—THE END