

THE POWELL TANK

and

CINE

FILM

PROCESSING

PRICE: 75 CENTS

POWELL ENGINEERING CO.

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INTRODUCTION:

The Powell Cine Processing Tank is a simple, compact and inexpensive instrument that will provide the amateur or the professional movie maker with a foolproof means of processing black-and-white or color motion picture film with a minimum of time and effort. It has been designed with the express thought of providing a piece of equipment sufficiently simple to encourage the beginning movie maker yet sufficiently exacting and rugged to meet the requirements of the advanced amateur and the professional.

To the experienced worker in motion picture making the processing of motion picture film is no mystery. However, for the benefit of the beginner, whose Powell Cine Processing Tank is his first entry into the field of processing, this manual presents a brief discussion of processing theory, together with details of the use of the tank.

This manual contains considerably more information on black-and-white film processing than on color film processing. The reason is very simple. Most black-and-white films, regardless of manufacturer, can be processed in standard processing solutions, easily obtainable by the user and with standardized procedure. Thus a generalized discussion of black-and-white processing, including recommendations as to processing chemicals and procedure, can readily be devised and intelligently presented. Each type of color film, however, requires processing solutions, processing procedure and handling strictly for that one film for best results and consequently generalized instructions are impossible to give. Thus the movie maker must obtain processing details from the manufacturer of the film he chooses and also to rely upon the manufacturer as a source of processing chemicals.

The user of the Powell Tank is urged to write to the film manufacturers or distributors and to the various dealers listed in this manual to obtain information as to availability of film and for processing information. This must be done for color film and should be done even for black-and-white film, for manufacturers' recommendations for black-and-white film should supersede any generalized information given in this manual. The budding movie maker must realize that his own ingenuity in seeking sources of information and of supplies will serve him well and will give him a distinct advantage over anyone who uses any one generalized source of information.

At the present time black-and-white film is readily available to the amateur movie maker from any of the several sources listed in this manual. However, color film is not so readily available, especially in small quantities, and the Powell Tank user should acquaint himself with the available sources as soon as possible. In the future color film for the amateur will become increasingly available as American manufacturers increase their output and as foreign-made film is imported in increasing quantities. But until then the movie maker may have some difficulty in obtaining supplies.

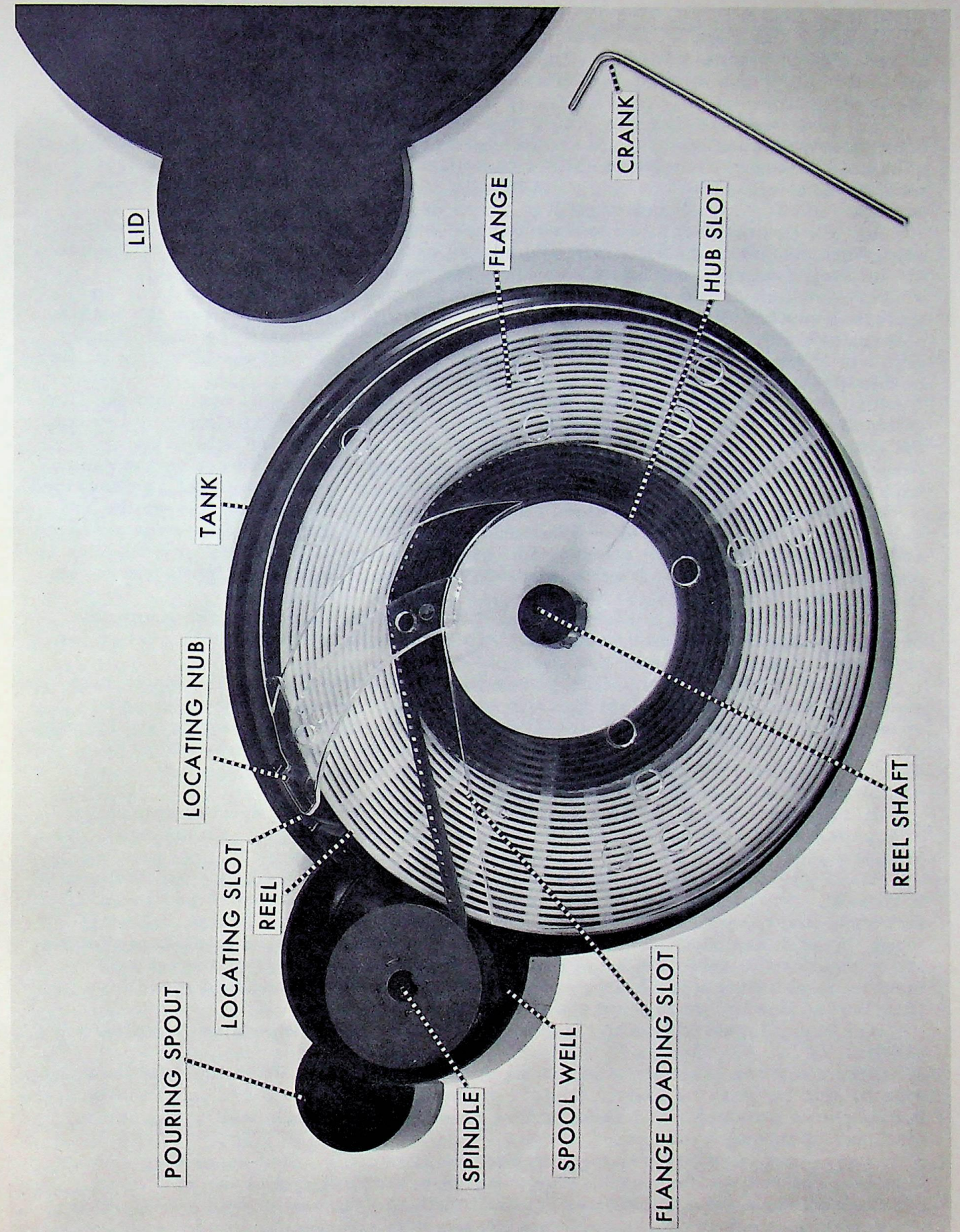
This manual makes no attempt to give any information concerning any specific film, black-and-white or color, for the makers of the Powell Tank feel that their obligation is to explain the use of the tank whereas it is the premise of each film manufacturer to supply information regarding its film and other products.

Many of the available black-and-white films have been tested by Powell and all have given good photographic results and have been easy to process. Most of the available color films also have been tested and some have proven very satisfactory as to both color and definition. Anscochrome films and chemicals are the most readily available at the present, at least with 8mm perforations, and it is suggested that these films could be a good starting point for the color processor-to-be. Two films which give excellent results are Anscochrome #242 in 100 foot rolls and a duplicating film, #244, available only in large rolls. Black-and-white films are so readily available from bulk film houses (see list at back of this

manual) that no specific suggestion need be made.

If undue difficulty is encountered in obtaining 8mm perforated color films, the operator should consider availing himself of the reperfoming services offered by the bulk film supply houses and some of the film laboratories. For a modest fee 16mm color film, which is considerably more readily available than 8mm film, can be reperfomed to make 8mm film. The reperfoming work done by the film houses is of professional caliber and the amateur movie maker can expect results from reperfomed film that compares favorably with factory-perfomed film. Some slight unsteadiness may be encountered in reperfomed films, but in general such films are quite acceptable by amateur standards. The catalogues published by the bulk film houses give details of reperfoming services offered.

The makers of the Powell Tank welcome each new user to the fascinating field of "do-it-yourself" movies, and hope that everyone will have many hours of pleasure and satisfaction.



GENERAL INSTRUCTIONS FOR USING POWELL TANK:-

1. Loading the Tank:- The tank should be loaded only on subdued light, such as is required for camera loading, and the same consideration and care should be given to loading the tank as is given in loading the camera to prevent fogging of the leading film end.

a. Make certain that reel and flange are properly assembled. Check tension between reel and flange and adjust lock nut on bottom of shaft such that reel and flange are firmly together with sufficient pressure to eliminate lost motion yet to allow reel to turn readily with respect to flange when the crank is turned.

b. Place reel assembly in tank and make certain that hole in bottom of reel shaft engages the short spindle in the center of the tank and that the locating nub on the flange engages the locating slot on the inside of the tank.

c. Set tank on flat surface with the pouring spout pointing toward you and the broad top end of the tank pointing away from you. In this position the loading slot in the flange is positioned at the lower left-hand portion of the tank directly adjacent to the supply spool well. Position the reel such that the film slot in the hub is located at the top end of the loading slot in the flange.

d. Place supply film spool on the spindle in the spool well such that the film will pull off the spool on the right hand side of the spool and will point up toward the film slot in the hub of the reel. (In this position the 3-slot hole in the American-made film spools will be pointing upward. Such may not be the case with foreign-made spools. However, film should exit from the spool as described).

e. Cut end of film square and cut off four or five sprocket holes on the top side of the film at the end to be inserted in the film slot. Cut with sharp scissors and make the cut at the very bottom of the sprocket holes. In this way the film is prepared for insertion in the film slot which, by necessity, is slightly narrower than the film itself.

f. Bend the cut portion of the film end at right angles and make a suitable crease in film so that right angle bend will remain and will act as an anchor for holding film in slot.

g. Insert cut portion of film end in film slot. Insert crank in hole in reel shaft and while holding film in place in slot turn the crank slowly about one quarter turn clockwise so as to position film slot, with film inserted, at approximate top portion of tank and completely under the solid portion of the flange. This step is necessary to make certain that film is firmly in film slot and will not be forced out when reel is turned.

h. Remove crank, place lid of tank over reel shaft and firmly position lid around the entire periphery of tank so as to make certain tank is light tight. Replace crank.

i. Turn crank slowly clockwise to remove film from supply spool and place it on reel. Turn crank for 22-1/2 turns to remove entire exposed portion of film from the supply spool. For the average 33-foot film spool the total of 22-3/4 turns of the reel thus performed will place all but about twelve to eighteen inches of the film on the reel and the few inches remaining on the supply spool will contain no picture and will serve as an anchor to prevent unwanted movement of film in tank during processing and agitation.

j. It is suggested that the tank be loaded several times with a practice roll of film.

2. Place tank on level surface for all processing steps. Tank must be level from side to side but may be raised slightly at the front (say about 1/8 inch) to aid in the pouring in of solutions. Tank should be on a firm base such that it will neither skid nor tip during agitation.

3. Agitation:- Agitation during processing is accomplished by raising and lowering the reel in the tank by means of the protruding end of the reel shaft. The crank handle may be inserted to aid in obtaining a grip on the reel shaft. Raise and lower the reel at such a pace that reel can be raised once and lowered once in

two seconds, i. e., one cycle in two seconds. This means that the reel will be raised and lowered two to three times in five seconds and seven or eight times in fifteen seconds of agitation. (The reel can be raised and lowered only a small distance when the lid of the tank is in place. This small stroke, however, is adequate for all agitation requirements for black-and-white film and for most of the steps in color film processing. Additional information on agitation requirements for color film will appear in the color section of this manual.) During agitation be sure to hold cover of tank with one hand to prevent tank from jouncing or cover from lifting off.

4. Pour all solutions into tank by means of a graduate with a good pouring spout. It is suggested that a 32-ounce graduate be used with the proper amount of solution or wash water in it to fill the tank. Tank requires 20 ounces of solution to cover film properly. Solutions can be poured out of tank directly into a wide-mouth supply bottle without use of graduate. Wide-mouth supply bottles are recommended for all solutions.

5. Lid of tank must remain in place for the first several steps of either black-and-white or color processing. After those steps are completed and film can be exposed to light without harm. (Note:- Follow manufacturers' recommendations explicitly as to this point), the lid of the tank can be removed. The remainder of the processing may be performed with the lid off, but the operator may choose to replace lid to aid in pouring out of solutions and to prevent reel from becoming dislocated during agitation. Exact technique must be worked by operator to suit his individual requirements.

6. Removal of film from Reel:- Film can be removed from reel, either before or after drying, by loosening the shaft nut, placing the top of reel on the palm of one hand, and pulling the film from the reel with the other hand. When the film is dry, the film may be deposited in some large basket as it is removed from the reel and then removed from the basket by spooling onto a storage spool or reel of some type. Care must be exercised in removing wet film from reel for emulsion is easily damaged when wet. Wet film should be pulled from reel and wound on some type of drying rack, or other support, in one step. Depositing wet film in any receptacle is definitely not recommended. Exact technique must be worked out by the individual operator.

7. Drying of Film:- Drying may be accomplished with the film left on the reel, if desired, or the film may be removed and placed on some suitable drying rack or other support. The operator should design some drying rack to suit his particular needs or should purchase a drying rack from a photo supply house. Film may be hung from a clothesline or other line strung indoors using small hooks through the sprocket holes of the film or if a long room is available suspended from each end.

If drying is to be done with the film on the reel, the reel should be suspended from some support by means of a wire or hook through the hole in the top of the reel shaft, and the blast of air from an average size electric fan should be directed onto the reel from below. The air should enter the reel through the spaces in the grooves of the reel and thus will pass by the wet surface of the film. An air blast must be used with the film on reel. Drying cannot be properly performed in still air. A fan type electric heater may be used instead of an ordinary fan to permit rapid drying. However, temperature of the heated air should not exceed about 110° F.

8. Lubrication of Reel and Tank Bottom:- After reel, flange and tank are dried following use, the hub of the reel and the inside of the bottom of the tank should be lubricated by rubbing with paraffin before flange is replaced on the reel and before assembled reel is replaced in tank. Only a small amount of paraffin is needed for proper lubrication. Excess lubrication is to be avoided to prevent particles of paraffin from coming in contact with the film when the tank is next used.

PROCESSING OF BLACK-AND-WHITE CINE FILM:- THEORY

Processing of black-and-white amateur motion picture film is usually performed by the "reversal" method, sometimes known as the "direct positive" method, as distinguished from the "negative-positive" method usually employed for professional films. The "reversal" method produces the finished projection print on the same film that was originally exposed in the camera. The "negative-positive" method utilizes two films, - one film exposed in the camera and developed to a negative, and the other the positive film printed from the negative and processed into the final projection print.

The primary advantage of the reversal processing method is obvious. Only one film is required, thereby reducing the cost of film needed and the complexity of processing required. The complexity of processing is reduced by eliminating the need for printing equipment and for two separate processing procedures. The secondary advantages are not readily evident but are very important:- (1.) Finer-grained results for any given film stock are had with reversal processing than is possible with negative-positive processing using two films, and (2.) somewhat higher film speeds are realized when film is exposed for processing by reversal.

The disadvantages of reversal processing are:- (1.) Processing procedure is more complicated and more exacting than for negative film or for positive film separately, and (2.) copies of original film are more difficult and more costly to make than are prints from a negative film. These disadvantages, however, are usually of very little consequence to the amateur movie maker.

Generally speaking, any black-and-white motion picture film can be processed to a direct positive by reversal. However, best results are obtained from films having emulsions specifically designed for reversal processing. Regular negative emulsions, when reversal processed, give poor contrast and excessive minimum density, whereas positive emulsions give excessive contrast and are generally unsuitable for continuous tone photography due to limited color sensitivity. Emulsions designed for reversal processing possess characteristics of both negative and positive emulsions and are found on most films available to the amateur.

Processing by reversal consists of three basic steps:- (1.) Development of exposed film to a negative, (2.) Removal of negative image by chemical means, and (3.) Development of remaining emulsion into the final positive. The practical procedure, however, consists of six steps, with intervening water washes, followed by final washing and drying as follows:

- (1.) First Development:- Development of exposed film to a negative;
- (2.) Bleach:- Removal of black silver negative image by chemical action;
- (3.) Clear:- Removal of stain produced during bleaching;
- (4.) Re-Exposure:- Exposure of remaining emulsion to light to render developable;
- (5.) Second Development:- Development of exposed remaining emulsion to produce positive image;
- (6.) Fix:- Final fixing and hardening of redeveloped film;
- (7.) Final Wash:-
- (8.) Drying:-

Each of these steps will be briefly discussed.

First Development:- In this step the exposed film from the camera is developed to a negative. This negative by necessity will be very dense and quite contrasty. Inasmuch as the final projection print will be produced on this very film on which the negative now appears, such negative must be completely developed and must have the contrast and general density that is desired in the final projection print. The unexposed portion of the emulsion, and thus the undeveloped portion, will bear the positive image that later will be developed in one of the following steps.

A strong, rapid-acting developer must be used to produce complete

development of the negative image. Complete development must be had to produce clean, clear highlights in the final print. Usually a small amount of weak silver bromide solvent is included in the first developer to aid in cleaning out the highlights by dissolving away the insensitive silver bromide particles that will not develop up and thus otherwise would remain to produce "muddy" results. This added solvent works on the simple principle that the insensitive silver bromide particles are easier to dissolve out than to develop up.

Kodak D-19 Developer, or equivalent, with potassium thiocyanate as silver bromide solvent, serves excellently as first developer for all reversal films generally in use today.

First Wash:- This wash is very important. It serves to stop gradually the first development and to remove traces of the first developer. The gradual stopping of development allows some continued development in the bottom portions of the emulsion and thus helps to produce complete development of the entire emulsion without over development of the top of the emulsion. An acid shortstop could be used to arrest development, but the arresting would be too rapid for best results and the use of the acid tends to increase the possibility of stain in the finished film. Consequently the recommended water wash serves best.

(Note:- The remaining washes, which follow each of the subsequent steps, serve solely to aid in removal of preceding solution from emulsion and to prevent contamination of the following solution)

Bleach:- After the negative image has been produced and the film properly washed, the next step is to remove the black silver negative image and thereby to leave on the film the remaining unexposed portion of the emulsion which contains the positive image and which is yet to be developed. Removal of the black silver negative image is accomplished by use of an oxidizing agent, usually potassium dichromate, in a solution of acid, usually dilute sulfuric acid. The oxidizing agent dissolves the silver of the image by converting it into a complex chemical compound that is soluble in the acid solution and thus is removed from the film emulsion. The use of potassium dichromate as oxidizing agent serves the added function of hardening the film emulsion by action of the chromium on the emulsion during the bleaching process.

After the bleaching is complete all traces of black silver negative image will have disappeared and the film will then contain only the desired positive image, as yet undeveloped, and will be stained deep yellow by the dichromate of the bleach solution.

Clear:- This bath serves only to remove the yellow stain from the film, such as was not removed by the intervening water bath between the bleach and the clear, and to remove the remaining sulfuric acid solution. Ordinary sodium sulfite solution serves very well as clearing solution following the recommended dichromate-sulfuric acid bleach bath.

After the clearing is complete the film emulsion will have returned to its original color and the yellow stain will have disappeared.

Re-Exposure:- This step serves to expose the remaining silver bromide particles in the emulsion and thus to render them developable. As previously stated, this remaining portion of the original emulsion is in the form of the desired positive image. Re-exposure is best performed in conjunction with the water wash following the clearing bath and with the film immersed.

Second Development:- After the remaining emulsion has been exposed the positive image is ready for development. This second development merely develops up completely all the silver bromide particles left behind after the negative image was removed by the bleaching bath and thus produces the black silver positive image. Kodak D-19 Developer, or equivalent, without added silver bromide solvent, serves excellently as second developer.

Fix:- This step removes any cloudiness remaining in the highlights of the positive image after the second development and to remove any undeveloped silver bromide particles that may inadvertently have been left behind. It also hardens the

emulsion for future hard use. Actually, if the preceding steps have been conducted properly, no undeveloped silver bromide particles will remain. Also no additional hardening is needed for normal amateur use other than that provided in the dichromate bleach bath. However, this final fixing serves as an excellent safeguard to prevent future staining of the film and to give added hardening if needed.

Kodak Acid Fixer, or equivalent, at half strength, is quite suitable as a final fixing bath for reversal processing.

Final Wash:- Final wash in reversal processing serves the same purpose as does the final wash in any photographic processing, - to remove traces of fixing bath and to prepare film for drying. This wash should preferably be performed with running water, or with many changes of still water during the prescribed washing period. As an aid in removing water drops during the subsequent drying step, a small amount of any ordinary wetting agent can be added to the final change of water used. Kodak Photo-Flo can be used for this purpose or a few drops of ordinary liquid dishwashing detergent can be used.

Drying:- Film must be completely dried after final wash. Irreparable damage will be done if the improperly or incompletely dried emulsion is subjected to even normal handling. Drying may be accomplished in any manner convenient for the operator provided that good circulation of air is had. If heated air is used, such air should not exceed a temperature of 110° F.

EQUIPMENT AND CHEMICALS NEEDED FOR PROCESSING

BLACK-AND-WHITE FILM IN POWELL CINE PROCESSING TANK:-

Equipment:-

- 1- Gallon jar (wide-mouth) or gallon pitcher for mixing prepared developer.
- 1- Half-gallon amber bottle for storage of mixed developer for future use.
- 5- One-quart amber bottles for storage of processing solutions actually in use.
- 1- Stirring paddle or rod.
- 1- Thermometer with range approx. 50° F. to 90° F. or thereabouts.
- 1- Interval timer capable of being set accurately to intervals as short as one minute and as long as approx. fifteen minutes.
- 1- Set measuring spoons (1/4, 1/2 and 1 teaspoon, and 1 tablespoon).
- 1- Small funnel (plastic or glass).
- 1- 1-Oz. Graduate.
- 1- 32-Oz. Graduate.

(Note:- This list of equipment is a suggested minimum for efficient operation, using ready-packaged chemicals insofar as possible. The addition of other items of equipment can come at the discretion of the operator.)

Chemicals:-

1. Kodak D-19 Developer:- 1-Gallon size cans, as needed.
2. Kodak Acid Fixer:- 1-Gallon size cartons, as needed.
3. Potassium Thiocyanate:- 1 Oz. or 4 Oz., as desired.
4. Potassium Dichromate:- 4 Oz. or 1 Pound, as desired.
5. Sulfuric Acid (Concentrated):- 4 Oz. or 1 Pound, as desired.
6. Sodium Sulfite (Anhydrous):- 1 Pound or 5 Pounds, as desired.

(Note:- The smaller quantities above are suggested minimum quantities to be stocked. The larger quantities are suggested for those operators who plan to process large amounts of film.)

Miscellaneous Notes:-

1. Either narrow-mouth or wide-mouth amber bottles may be used. Choice must rest with the individual operator.
2. Thermometer must, for best results, be accurate within plus-or-minus one-

half of one degree. Such thermometers are easily obtained from any photo supply house.

3. Cooking timers can be used if necessary in an emergency. However, regular photo timers are definitely preferred for their greater accuracy and the greater ease with which they can be set to short intervals.
4. The 1-oz. graduate suggested is to be used only for measuring the required quantity of concentrated sulfuric acid (1/2 fluid ounce). Any measuring device capable of measuring 1/2 fluid ounce and made of glass or porcelain will be satisfactory. Do not use plastic or metal devices.
5. If operator chooses to weigh out the various chemicals instead of spooning them out by volume, as suggested in instructions for PROCESSING SOLUTIONS, a set of photo chemical scales must be included as required equipment. Such scales are readily available from photo supply houses.

BLACK-AND-WHITE REVERSAL PROCESSING SOLUTIONS SUITABLE FOR POWELL CINE PROCESSING TANK:-

(Quantities given are for one quart of each solution)

First Developer:-

Kodak D-19 Developer, or Equiv.	32 Fluid Ounces
Potassium Thiocyanate	35 Grains (1/2 Level Teaspoon)

Bleach:-

Potassium Dichromate	1/4 Ounce (1 Level Teaspoon)
Sulfuric Acid (Concentrated)	1/2 Fluid Ounce

Clear:-

Sodium Sulfite (Anhydrous) (*)	3 Ounces (3 Rounded Tablespoons)
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Second Developer:-

Kodak D-19 Developer, or Equiv.	32 Fluid Ounces
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Fix:-

Kodak Acid Fixer, or Equiv.	3 Ounces (3 Heaping Tablespoons)
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Kodak D-19 Developer and Kodak Acid Fixer are prepared packaged items in dry form ready for immediate preparation of liquid solutions. Potassium thiocyanate, potassium dichromate and sodium sulfite (anhydrous) are individual chemicals in dry form. Sulfuric acid (concentrated) is an individual chemical in liquid form. All of these items are available from any well-stocked photographic supply house and from most photographic dealers.

Solution Capacity:- Four standard 25 ft. rolls of 8/8mm film depending somewhat on the time interval over which the solutions are used. The more rapidly the solutions are used the better are the results.

Solution Life:- Up to three months if stored in full stoppered bottles without use. Up to three weeks, only, with use depending upon the rate of use. Suggested optimum:- About one week to ten days.

Whereas it is always preferable to weigh out photographic chemicals in dry form, quite acceptable results can be obtained with a minimum of effort by using the volumetric equivalents indicated above. No trouble will be encountered in measuring out the proper quantities of any ingredient except the potassium thiocyanate in the First Developer. This chemical is somewhat deliquescent (i. e.,

tends to absorb moisture from the air and to become quite damp) and thus measurement is not so easy as if the chemical were dry. However, with care on the part of the operator the proper quantity (1/2 level teaspoon) can be measured.

WARNING:- IN ALL CASES WHEN USING CONCENTRATED SULFURIC ACID ALWAYS ADD THE ACID TO THE WATER WHEN DILUTING. NEVER DO OTHERWISE OR A DANGEROUS SPATTERING OF THE ACID MAY RESULT.

(*) Note Concerning Clearing Bath:- Certain black-and-white films may be quite susceptible to the solvent action of the sodium sulfite in the regular Clearing Bath. If so, dilute regular Clearing Bath 1-to-8 and use this dilute Clearing Bath once, only. Refer to manufacturer's specifications to determine if any certain film must be so handled.

Mixing Instructions :-

First Developer and Second Developer :- Mix one gallon of Kodak D-19, or equivalent, Developer in gallon container according to directions on the can. Pour one-half of this gallon into an amber half-gallon bottle and set aside for future use. Divide remaining half-gallon into two quarts. Pour one quart into a 32-oz. graduate, add measured amount of potassium thiocyanate, stir until thiocyanate is completely dissolved and pour into a one-quart amber bottle. Label this bottle "FIRST DEVELOPER". Pour remaining one quart into a second one-quart bottle and label this bottle "SECOND DEVELOPER".

Bleach:- Fill 32-oz. graduate approximately 3/4ths full of water. Add measured amount of potassium dichromate and stir until completely dissolved. Add measured quantity of sulfuric acid in small amounts, stirring continuously. The required quantity of acid (1/2 fluid ounce) should be added to the solution in six or eight small portions, with continuous stirring, over a period of approximately one minute or more. After the acid is added add water to make full quart (32 oz.) and pour completed solution into a one-quart amber bottle. Label this bottle "BLEACH".

Clear:- Fill 32-oz. graduate approximately 3/4ths full of water. Add measured amount of sodium sulfite and stir until completely dissolved. Add water to make a full quart and pour into a one-quart amber bottle. Label this bottle "CLEAR".

Fix:- Fill 32-oz. graduate approximately 3/4ths full of water. Add measured amount of Kodak Acid Fixer, or equivalent, and stir until completely dissolved. Add water to make a full quart and pour into a one-quart amber bottle. Label this bottle "FIX".

All mixed solutions should be kept tightly capped in a cool place and away from light, especially direct sunlight.

For those operators who prefer to prepare their own developers and fixing bath, the following formulas are suggested:

<u>First Developer :-</u>	<u>For One Quart of Solution</u>
Metol, or equivalent	32 Grains
Sodium Sulfite (Anhydrous)	1-1/2 Ounces
Hydroquinone	120 Grains
Potassium Bromide	80 Grains
Sodium Carbonate (Monohydrate)	1-3/4 Ounces
Potassium Thiocyanate	36 Grains

Second Developer :- (Same as First Developer but with thiocyanate omitted)

<u>Fixing Bath :-</u>	<u>For One Quart of Solution</u>
Sodium Thiosulfate ("Hypo")	4 Ounces
Sodium Sulfite (Anhydrous)	110 Grains
Acetic Acid (28% by volume)	6 Fluid Drams
Boric Acid (Crystalline)	56 Grains
Potassium Alum	110 Grains

BLACK-AND-WHITE PROCESSING USING POWELL TANK-
CONDENSED PROCEDURE :-

	<u>TIME</u>	<u>TEMPERATURE (°F.)</u>
<u>First Development</u> ----- (See Note Below)		68
Wash -----	3 Min.	60-75
<u>Bleach</u> -----	3-5 Min.	60-75
Wash -----	2 Min.	60-75
<u>Clear</u> -----	3 Min.	60-75
Wash -----	2 Min.	60-75
Re-Exposure ----- (See Note Below)		
<u>Second Development</u> -----	3-5 Min.	65-70
Wash -----	2 Min.	60-75
<u>Fix</u> -----	5 Min.	60-75
Final Wash -----	10 Min.	60-75
Drying ----- (As Required)		Air not over 110

Note Regarding First Development:- Time for First Development will depend primarily upon the type of film used and to some degree on the exact agitation technique. For most of the reversal films available at the present time to the amateur the development time will be six to eight minutes. Exact timing will have to be determined for each film used by experiment. The effect of variations in agitation technique usually will not have a noticeable effect.

Note Regarding Re-Exposure :- Re-Exposure should be made with film under water. Expose film on reel to light of #1 Photoflood bulb, in suitable reflector, held about 18 inches from film. Expose for approximately two minutes.

Note Regarding Bleach:- Three minute timing will usually be satisfactory for most films when bleach bath is fresh. Increase to five minutes as bath is depleted through use.

Note Regarding Second Development:- Three minute timing will usually be satisfactory for most films when developer is at or near the maximum temperature of the recommended range. Increase to five minutes when developer is at or near minimum recommended temperature.

Note Regarding Final Wash:- Final wash should be made with running water for best results. Water should run fast enough to produce two changes of water, at least, per minute.

BLACK-AND-WHITE PROCESSING USING POWELL TANK- DETAILED PROCEDURE:-

First Development:- Pour in developer as rapidly as possible and set timer for desired number of minutes after pouring in is completed. Agitate for first 15 sec. after timer is started and for the first 15 sec. of each following minute. After completion of development pour out the developer as rapidly as possible.

Wash:- Pour in wash water as rapidly as possible, then agitate steadily for 20 sec. and then pour out wash water as rapidly as possible. Repeat this process for a total of three changes of water. (The 20 seconds may be counted off rather than using timer inasmuch as timing is not critical. The cycle described required approximately one minute).

Bleach:- Pour in bleach solution as rapidly as possible and set timer for 3 minutes to 5 minutes after pouring in is completed. Agitate for first 15 sec. after timer is started and for the first 15 sec. of each following minute. After completion of bleach pour out the solution as rapidly as possible.

(The lid of the tank may now be removed, if desired, to inspect the film. The remainder of the processing may be performed, if desired, with the lid removed)

Wash:- Pour in wash water as rapidly as possible, then agitate steadily for 20 sec. and then pour out wash water as rapidly as possible. Repeat this process for one more change of water for a total of two changes. (The 20 seconds may be counted off rather than using timer inasmuch as timing is not critical)

Clear:- Pour in clear solution as rapidly as possible and set timer for the recommended three minutes after pouring in is completed. Agitate for first 15 sec. after timer is started and for the first 15 sec. of each following minute. After completion of clear pour out solution as rapidly as possible.

Wash:- This wash may be performed exactly like the wash following the Bleach.

Re-Exposure:- Fill tank with water. Expose film to light of one #1 Photoflood bulb, preferably in a suitable reflector, held approximately 18 inches from the film. Move the light in small circles during exposure to assure even exposure of all parts of the film. With bulb in reflector, expose for two minutes; without reflector, expose for three minutes. Pour out water at end of exposure.

Second Development:- Pour in second developer as rapidly as possible and set timer for 3 minutes to 5 minutes after pouring in is completed. Agitate for first 15 sec. after timer is started and for the first 15 sec. of each following minute. After completion of development pour out the developer as rapidly as possible.

Wash:- This wash may be performed exactly like the wash following the Bleach.

Fix:- Pour in fix as rapidly as possible and set timer for the recom-

mended five minutes after pouring in is completed. Agitate for first 15 sec. after timer is started and for the first 15 sec. of each following minute. After completion of fixing pour out the solution as rapidly as possible.

Final Wash:- Use running water, preferably. Allow water to flow fast enough to produce at least two changes of water in tank per minute. Start water running into tank and adjust rate of flow when tank starts to overflow. Set timer to 10 minutes. After ten minutes shut off running water and empty tank. Add one or two drops of liquid dishwashing detergent to tank and fill with water. Agitate for about 30 seconds and then pour off water. Film is now ready to be dried. (If running water is not available proceed exactly as stated in previous washes except repeat process for a total of ten changes of water, at least. After the last change of plain water, add one or two drops of liquid dishwashing detergent, agitate for approximately 30 seconds and then pour off water. Film is now ready to be dried.) (Note:- Kodak Photo-Flo solution, or equivalent, may be used instead of detergent according to directions on bottle)

Drying:- Drying of the film may be done with the film on the reel, or the film may be removed and placed on a rack or other support. (Refer to GENERAL INSTRUCTIONS respecting Drying of Film for further details)

PROCESSING OF COLOR CINE FILM:- THEORY

Color film available for amateur use that also can be processed by the user, in such equipment as the Powell Tank, is of the "reversal" or "direct positive" type and has the chemicals for forming the color image incorporated in the emulsion. Films such as Kodachrome and Moviechrome cannot be processed by the amateur inasmuch as color must be added during the processing and the entire procedure must be performed in costly and complicated continuous-processing machines available only to large commercial installations. Thus whenever color film is referred to in this manual the type with "color couplers" or "color formers" in the emulsion is meant.

Present-day color film consists of three separate thin emulsion layers mounted on top of one another on a common clear film base and is known as the "integral tri-pack" type. These three emulsions are very thin and the combined thickness of the three layers is very little more than the thickness of the single emulsion layer on black-and-white reversal film. The top emulsion is sensitive to blue light, only, and thus takes a picture with blue light, only. The middle emulsion responds to green light, only, and thus takes a picture with green light, only. The bottom emulsion, next to the film base, is responsive to red light, only, and thus takes a picture with red light, only.

The top emulsion, which is exposed by blue light, contains, in addition to regular silver bromide particles for producing a black silver image upon development, a chemical that will produce a yellow dye image. The middle emulsion, which is exposed by green light, contains silver bromide and a chemical that will produce a magenta dye image. The bottom emulsion, which was exposed by red light, contains silver bromide and a chemical that will produce a cyan dye image.

Processing of color film, with its three emulsion layers, consists of four basic steps:-

- (1.) First Development, - in which the three emulsion layers are developed to a black-and-white negative consisting of three separate portions. No color is formed during this step.
- (2.) Color Development, - in which the remaining emulsion in all three layers is developed to a fine black-and-white positive and at the same time three dye images are formed in the same positions as the corresponding black-and-white positive images.
- (3.) Bleach, - in which both black silver negative image and black silver

positive image are dissolved and returned to the form of silver bromide. The color dye images are not changed in this step.

(4.) Fix, - in which the silver bromide in all three emulsion layers is dissolved and removed leaving behind only the desired yellow, magenta and cyan dye images. At this stage the color film is now a true color transparency.

Several secondary processing steps are included in the complete processing procedure for all color films. In general these secondary steps are:- re-exposure, stop bath to terminate development, hardening bath to protect film emulsion from mechanical damage, clearing bath to dispose of developer residue, several washes, stabilizer bath to protect dye images from fading, and final drying. The number and type of secondary steps vary greatly from one color film to another and thus further detail pertaining to color processing technicalities cannot be incorporated in this manual. However, processing details are published by the respective film manufacturers and the user of the Powell Tank is urged to avail himself of as much literature as will suit his purpose for the specific films he chooses to use.

After processing is completed the finished color transparency contains three pure color dye images. The yellow dye image in the top emulsion transmits green light and red light and blocks blue light. The magenta dye image in the middle emulsion transmits blue light and red light and blocks green light. The cyan dye image in the bottom emulsion transmits blue light and green light and blocks red light. The three dye images are, from top to bottom, in inverse proportion as to intensity to the respective intensities of the blue, green, and red light that produced the original exposure in the camera. Thus when projected with white light the three dye images pass certain colors of light and hold back other colors in proper proportion so as to reproduce the colors of the original subject matter.

In addition to the three image emulsions, color film contains other emulsion layers, such as a yellow filter layer between the top image emulsion and the middle image emulsion to block blue light from the middle and bottom image emulsions, and an anti-halation emulsion layer next to the base of the film to prevent light spatter that would cause a fuzzy image. However, these other layers are secondary in function and are disposed of in the processing procedure without any further concern on the part of the operator.

EQUIPMENT AND CHEMICALS NEEDED FOR PROCESSING COLOR FILM IN POWELL CINE PROCESSING TANK:-

Equipment:- The equipment recommended for use with black-and-white film will be adequate for color film with the following additions and/or exceptions:

1. Additional 32-oz. (one quart) amber bottles will be required for storage of solutions. A maximum of nine bottles (four more than the five recommended for black-and-white film) will be needed.
2. Two additional 32-oz. graduates will be required (for a total of three) to hold solutions in readiness for pouring into the tank. Some color steps occur with no intervening time to get solutions in readiness and in such case the several solutions involved must be kept in readiness to be poured in just as soon as a previous solution is poured out.
3. The thermometer used with color film must be accurate to at least plus-or-minus one-half of one degree in the range of recommended processing temperatures.
4. The timer used with color film must be capable of being set to and of properly measuring intervals as short as 20 seconds and as long as 30 minutes. A quality brand of timer must be used. The average cooking timer will not be adequate.

Chemicals:- Chemicals for processing color film are available or are to be made available by film manufacturers in kit form and are sold through regular

photographic dealers. The makers of the Powell Tank recommend that only standard packaged chemicals be used and that film manufacturers recommendations be followed throughout and that so-called substitutes be avoided. Generally color chemicals are packaged by film manufacturers in one-pint size and in one-gallon size or larger. Thus the color processor will need two pints or one gallon of chemicals as best suits his requirements. (If the gallon size chemical kit is used, additional gallon amber bottles will be needed as regular equipment)

Mixing Instructions for Processing Chemicals:- Mix all processing solutions according to manufacturers' directions furnished with chemical kits. No other instructions are needed.

Solution Capacity:- One-quart of processing solutions will handle properly a maximum of two 25 ft. rolls of 8/8mm film. (The so-called "25 ft." rolls are actually 33 ft. long, or thereabouts, including leader and trailer)

Solution Life:- Two weeks, if solutions are stored unused in stoppered bottles. If solutions are kept cool, life can be extended to three weeks. Once solutions are used, however, deterioration sets in and life is limited to about one-half, depending upon the rate of depletion.

COLOR PROCESSING USING POWELL TANK:- PROCEDURE

The entire step-by-step procedure for processing color reversal film by the user is explained in detail in the instructions that accompany the kits of processing chemicals provided by the film manufacturers. No other explanation is needed and no further comment is necessary here inasmuch as the procedure varies greatly according to the film used. However, a few precautions and suggestions should be given regarding the use of the Powell Tank in processing color film as distinguished from the use of the small tanks for 35mm film or roll film around which the chemical kit instructions are written.

1. Timing for all steps must be as recommended by the film manufacturer in the instructions. However, for the Powell Tank all solutions must be poured into the tank before timer is set for the step involved and the solutions must be poured out of the tank after the end of the recommended timing for the step involved. This advice is substantially the same as for black-and-white film but is repeated here to add emphasis. In this way the timing for the various steps in the procedure is extended by the pouring-in and pouring-out time and usually this added timing is adequate to compensate for the fact that the agitation possible with the Powell Tank is generally less, depending upon the operator, than the vigorous agitation called for in color film instructions. The agitation possible in the Powell Tank, considering the relatively short stroke of the film reel, is generally only moderate.
2. Agitation timing should be as recommended by the film manufacturer, inasmuch as agitation requirements vary greatly from one film to another and variations in agitation can affect the final results in color film much more so than in black-and-white film. Agitation recommendations for some color films may be the same as recommended in this manual for black-and-white film, but generally color film agitation is more frequent, - say once each 20 seconds -, and for shorter duration, - say five seconds, only, - than the 15 seconds of each minute suggested in this manual for black-and-white film.
3. If satisfactory results are not had by following the suggestion in Item 1, above, regarding pouring of solutions, and evidences of underdevelopment still persist, the operator may increase the timing of First Development up to 20% over recommended timing and of Color Development up to 10% over recommended timing without adverse side effects. None of the other steps, other than the washes, need to be increased over recommended timing.

4. Washing of color film is definitely more critical than for black-and-white film, and each wash step may be increased by 50% over recommended timing to allow for the comparatively longer pour-in and pour-out time for the Powell Tank as compared with small 35mm tanks. The wash timing should be increased so as to allow for two changes of wash water for each minute of washing recommended by the film manufacturer. If running water is used for washing, increased timing should not be used. Furthermore, if operator chooses to perform washings with lid of tank removed (after initial steps of procedure have been completed with lid on), extended wash time need not be resorted to inasmuch as pour-in and pour-out time is greatly reduced when lid is removed.
5. Care must be exercised in removing wet color film from Powell reel inasmuch as color film, when wet, is more easily damaged than is black-and-white film. The manner of removing film from reel can be the same as for black-and-white film.
6. Care must be exercised in loading wet color film on drying rack. Use of some sort of drying rack, as devised by the operator, is recommended rather than the use of a clothesline or other line as suggested for black-and-white film. Drying time for color film is usually longer than for black-and-white film.
7. Color film may be dried on the Powell reel in the same manner as recommended for black-and-white film and the same general precautions will apply. However, do not attempt to speed up the drying time by using a heavy air blast. A moderate flow of air from an ordinary electric fan or electric heater will be sufficient.
8. Care must be exercised in removing dry color film from rack or reel when placing the film on storage reels or projection reels. Color film is generally more susceptible to scratches due to cinching the film too tight on the storage reel.

SOURCES OF SUPPLY OF FILM, CHEMICALS AND EQUIPMENT :-

- A. Regular Retail Photo Dealers :- Your regular photo dealer will probably have chemicals and equipment in stock and should have catalogue information regarding availability of film from various of the film manufacturers listed below.
- B. Bulk Film Supply Houses :- These houses specialize in furnishing film, chemicals and equipment for home processing through mail-order purchase. Black-and-white film is always carried and color film is usually offered. Powell Tank users are urged to write to these houses for catalogues.

Superior Bulk Film Co.
442-450 North Wells St.
Chicago 10, Illinois

ESO-S
47th and Holly Streets
Kansas City 12, Missouri

Solar Cine Products, Inc.
4247-49 So. Kedzie Ave.
Chicago 32, Illinois

Western Cine Service
114 East Eighth Avenue
Denver 3, Colorado

- C. Film Manufacturers and Importers :- Manufacturers, distributors and importers generally do not sell direct to users. However, these houses are the best sources of information as to availability of film and technical literature covering their own products.

Eastman Kodak Co.
Sales Service Division
Rochester 4, New York

(Black-and-white and color film. Made in U. S. A. No color film for 8mm home processing.)

ANSCO
Division General Aniline & Film Co.
Binghamton, New York

(Black-and-white and color film. Made in U. S. A. Most readily available 8mm color.)

E. I. DuPont de Nemours & Co.
Photo Products Division
Wilmington 98, Delaware

(Black-and-white and color film. Made in U. S. A.)

Gevaert Company of America
321 West 54th Street
New York 19, N. Y.

(Gevaert black-and-white and color film from Belgium)

AGFA, Incorporated
516 West 34th Street
New York 1, New York

(AGFA color film from Germany)

Burleigh Brooks, Inc.
10 West 46th Street
New York 36, New York

(Perutz black-and-white and color film from Germany)

Bell & Howell
7100 McCormick Road
Chicago 45, Illinois

(DuPont-Bell & Howell color film. Made in U. S. A.)

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