INSTRUCTION MANUAL

SERIAL NO. 4843

OSCILLOSCOPE CAMERA C-12

Tektronix, Inc.

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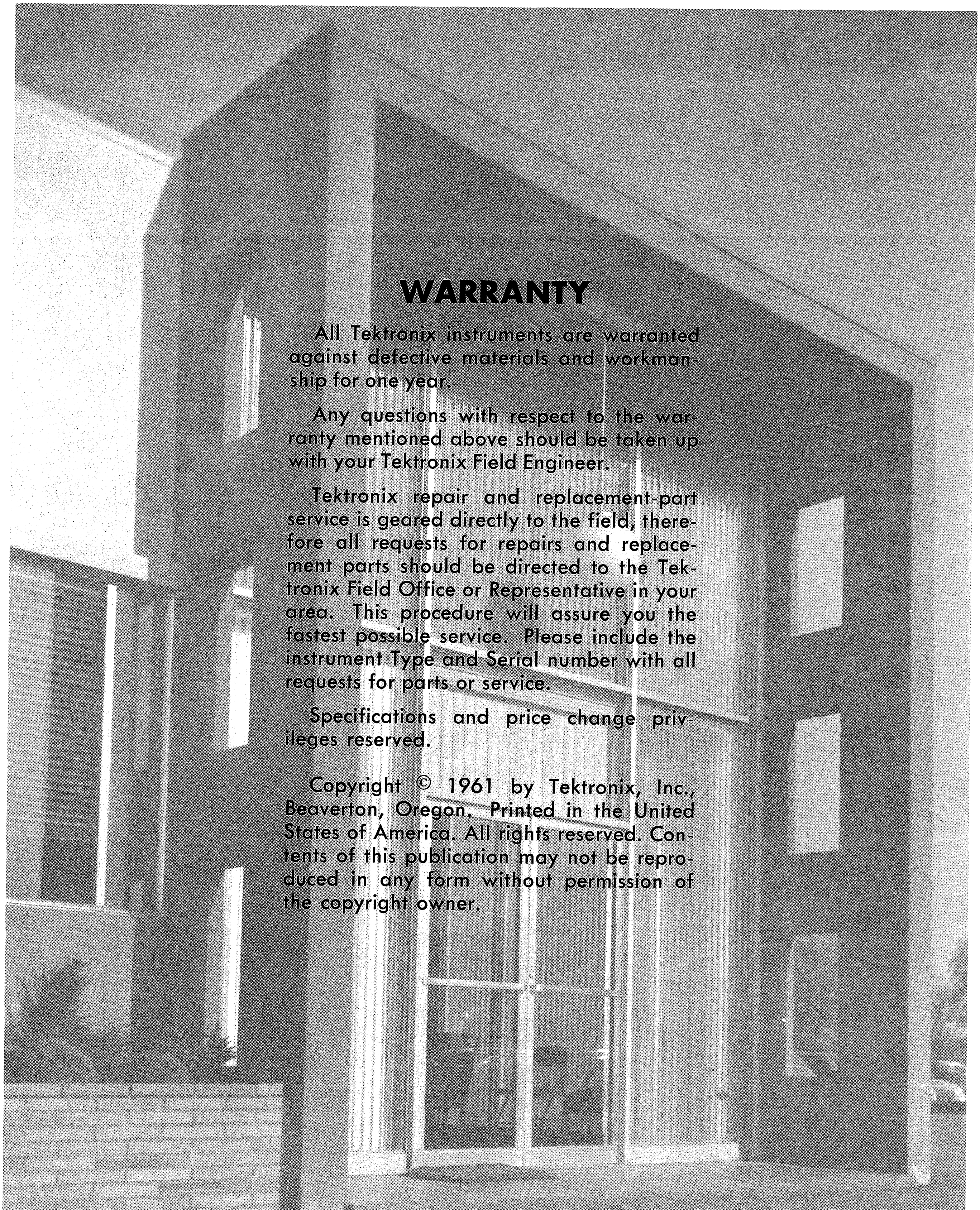


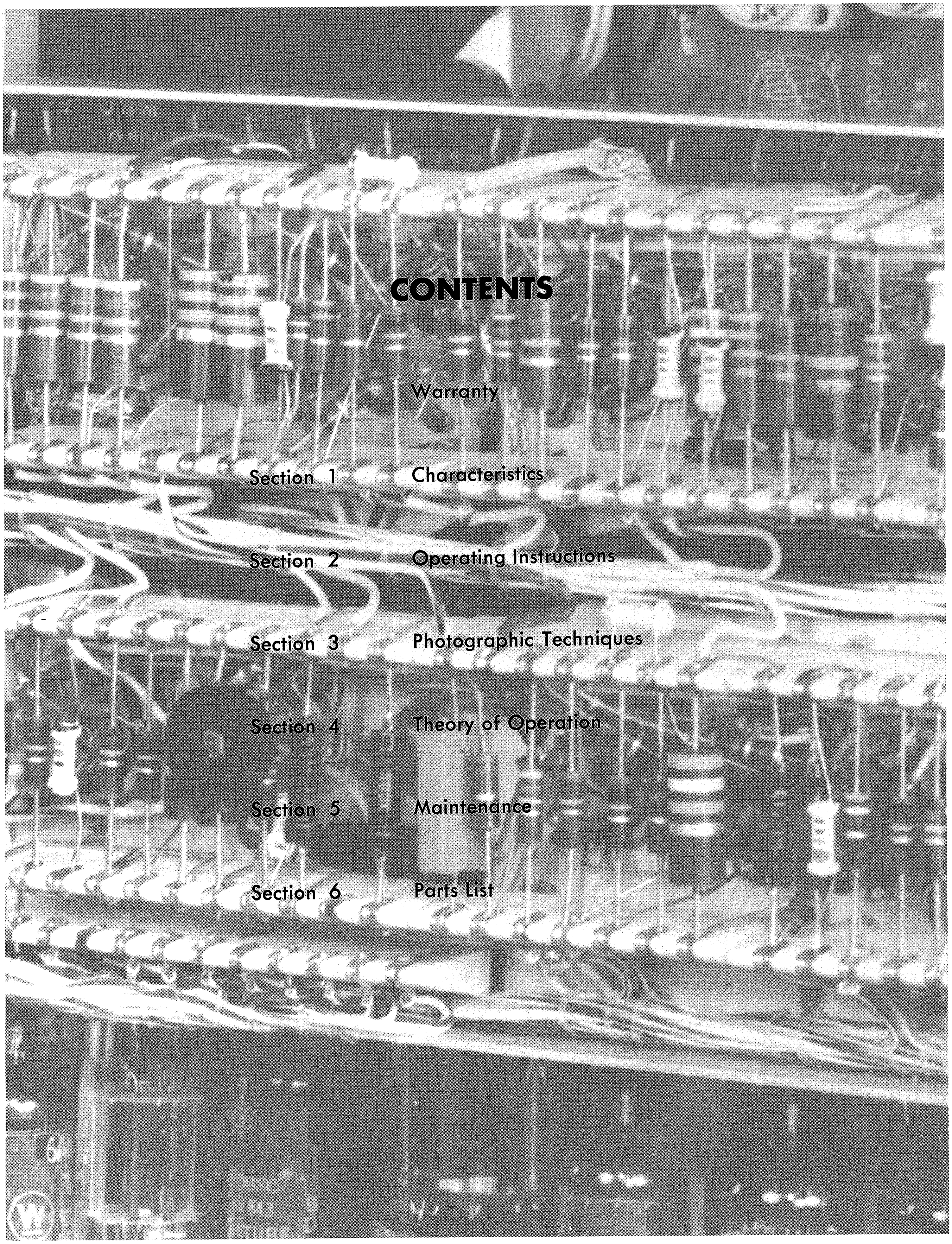
WARRANTY

All Tektronix instruments are warranted against defective materials and workmanship for one year.

Any questions with respect to the warranty mentioned above should be taken up with your Tektronix Field Engineer.

Tektronix repair and replacement-part service is geared directly to the field, therefore all requests for repairs and replacement parts should be directed to the Tektronix Field Office or Representative in your area. This procedure will assure you the fastest possible service. Please include the instrument Type and Serial number with all requests for parts or service.

Specifications and price change privileges reserved.



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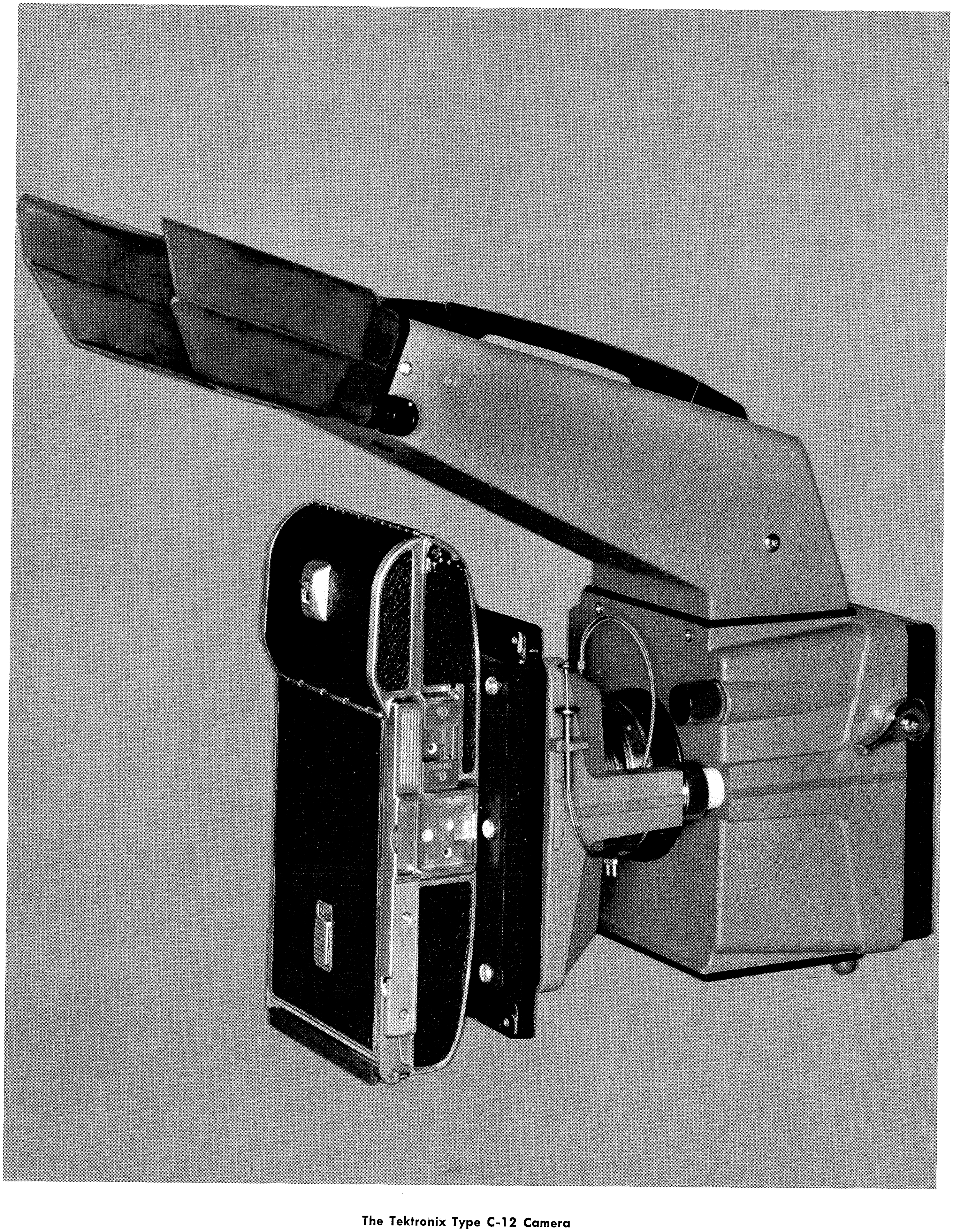
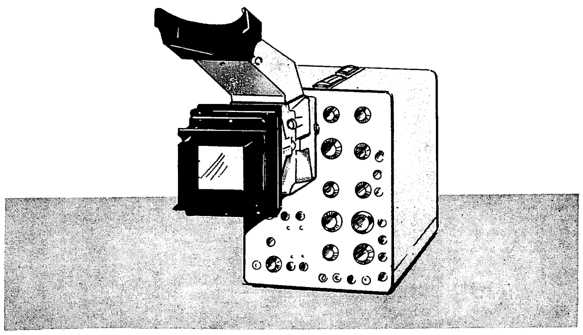


The Tektronix Type C-12 Camera



SECTION 1

CHARACTERISTICS

General Description

The Tektronix Type C-12 Camera has been specifically designed for photographing oscilloscope displays. The optical system of the camera permits displays to be simultaneously viewed and photographed. Photographs are made directly from the oscilloscope screen so the image is not reversed. The viewed image is undistorted and is also not reversed.

The C-12 Camera provides many new convenience features. Lift-on mounting is used so that the camera can easily be mounted or removed. Swing-away hinges allow the camera to be swung out of the way when not in use. The viewing hood provides comfortable viewing with or without glasses. The camera back allows any of the parfocal film-holding backs to be locked in any of 5 detented positions. Camera backs can also be rotated in 90-degree increments so that the long axis of the film will be parallel or perpendicular to the trace, as desired.

Six interchangeable lenses can be used with the camera. The wide range of object-to-image ratios and maximum apertures permit you to select the lens which is just right for your application. Parfocal backs which can be used with the camera allow you to make your photographs on Polaroid® and conventional roll and sheet film, in several different sizes. (See Table 1-1.)

Shutter Speeds

Alphax No. 1 Shutter—Time, Bulb, 1/10, 1/25, 1/50, and 1/100. X Synchronization.

Alphax No. 3 Shutter—Time, Bulb, 1, 1/2, 1/5, 1/10, 1/25, 1/50, and 1/100. X Synchronization.

Alphax No. 4 Shutter—Time, Bulb, 1, 1/2, 1/5, 1/10, 1/25, and 1/50. X Synchronization.

Camera Backs

Polaroid Roll Film—Maximum image size 2.890 × 3.825 inches (73.4 × 97 mm).

Polaroid 4×5—Maximum image size 3.500×4.500 inches (88.8 × 114.3 mm).

Graflok 2¼ × 3¼—Maximum image size 2.323 × 3.223 inches (59 × 82 mm).

Graflok 4 × 5—Maximum image size 3.770 × 4.710 inches (95.8 × 119.6 mm).

Graflok Roll Film for 120 or 620—2.255 × 3.250 inches (57.3 × 82.5 mm).

Other Graflok Backs

Optical System

Photographs taken directly from oscilloscope screen through beam-splitting mirror. Two-mirror system for observation of the oscilloscope display. Negligible parallax between viewed and photographed displays.

Transmission Characteristics of Beam-Splitting Mirror

Transmission of light through beam-splitting mirror to camera lens nearly constant at approximately 65% for all visible light frequencies.

Viewing Hood

The viewing hood can be used by persons with or without glasses.

Position of Backs

Any of the standard camera backs can be rotated in 90-degree steps. The long axis of the film can be either parallel or perpendicular to the trace.

Multiple Exposures

Five indentations on the standard camera backs permit the camera back to slide to any of five positions. In addition the camera backs can be set between indented positions so that any desired number of photographs can be made on a single sheet of film.

Lens and Shutter Settings

Both lens and shutter settings can be made from the side of the camera without removing or unlatching the camera from the oscilloscope.

® Registered trademark of the Polaroid Corporation.

Focusing

Focusing to compensate for slight differences between oscilloscopes is accomplished by means of a single-knob control.

Mounting

A special graticule cover is provided for mounting the camera on most Tektronix 5-inch oscilloscopes. Adaptors are available for mounting the camera on other oscilloscopes. Both the special graticule cover and the adaptors have a hinged fitting which is used to support the camera. The hinged fitting allows the camera to be easily swung in or out of the operating position.

Size

Approximately 15 inches high, 16 inches deep, and 10 inches wide.

Weight

Approximately 14 pounds with Polaroid Land back.

Standard Camera Complement

1—Basic Camera Frame
1—Polaroid Back
1—4 × 5 Back (Also used for focusing the camera)
1—Camera Mount
4—Graticule Nuts
1—Cable Release
1—Dust Cover
1—Instruction Manual

Optional Accessories

Choice of Lens
Nonparallax Graticule Attachment
Light Filters
2¼ × 3¼ Graflok Back
3¼ × 4¼ Graflok Back
Prefogging Unit
Case
Solenoid Shutter Actuator
Polaroid 4 × 5 Film Holder
Polaroid 2 Minute Timer (Can be attached to side of viewing hood using the hole provided.)
Special Oscilloscope Mounting Adaptors

TABLE 1-1

LENS CHARACTERISTICS

Lens No.	Type	Max. Aperture	Focal Length	Object-to-Image Ratio	Shutter
1. (standard)	Oscillo-Raptar	f/1.9	75 mm	1:0.9	Alphax No. 3
2.	Oscillo-Raptar	f/1.9	75 mm	1:0.7	Alphax No. 3
3.	Oscillo-Amaton	f/4.5	75 mm	1:0.7	Alphax No. 1
4.	Simpson	f/1.5	85 mm	1:0.9	Alphax No. 4
5.	Simpson	f/1.5	85 mm	1:1	Alphax No. 4
6.	Simpson	f/1.5	85 mm	1:0.5	Alphax No. 4

NOTES

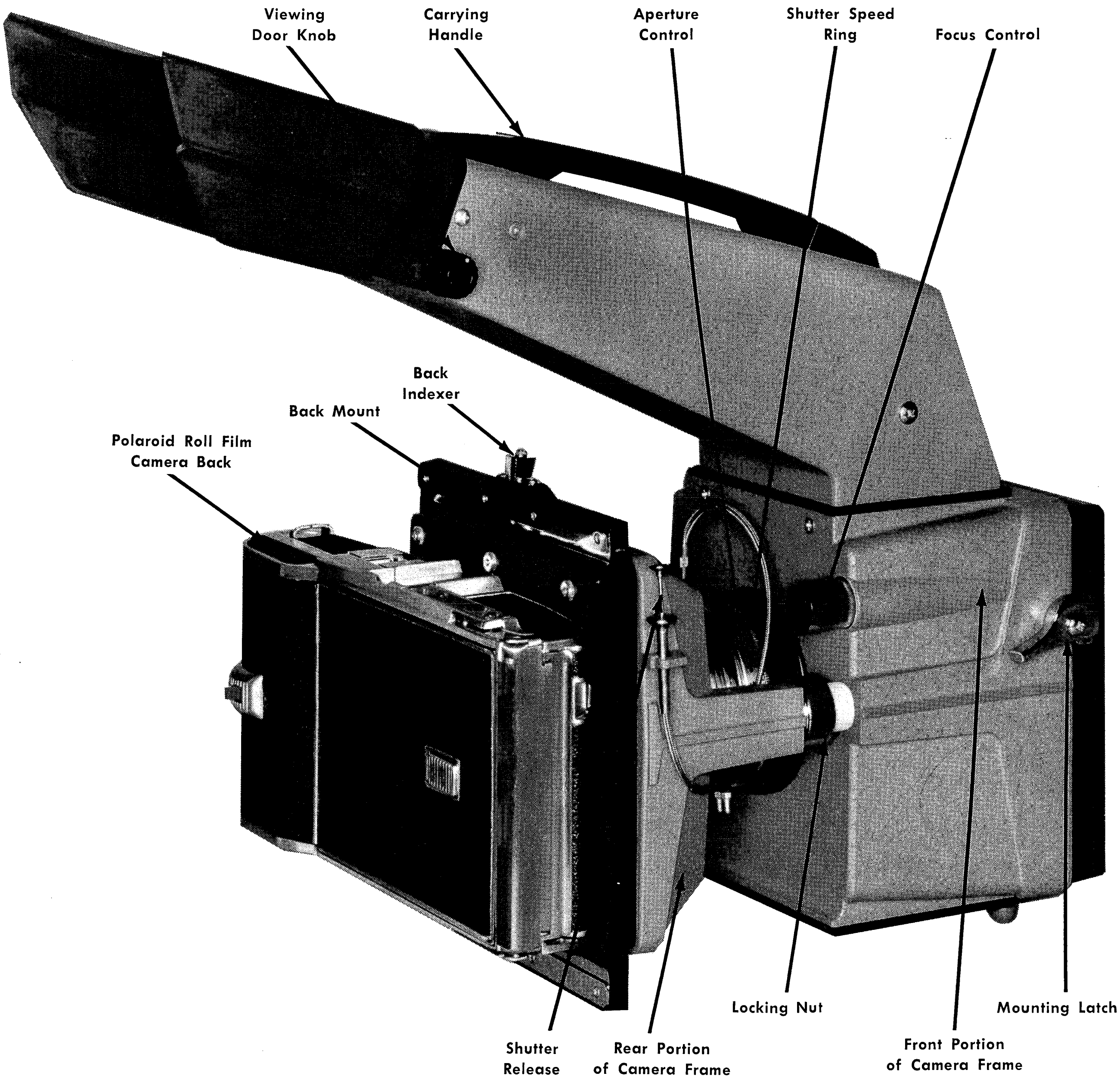
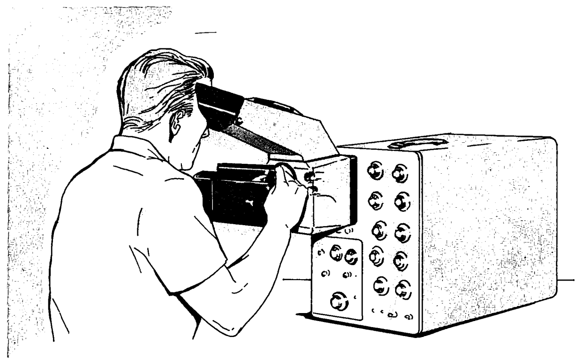


Fig. 2-1. Type C-12 Camera showing the operating controls.



SECTION 2

OPERATING INSTRUCTIONS

Control Functions

The various controls for the Tektronix Type C-12 Camera are shown in Fig. 2-1. Their functions are as follows:

Mounting Latch—Locks the camera against the special graticule cover to provide a light-tight seal. When released, the camera can be swung out of the way.

Locking Nuts—Hold the rear portion of the camera frame to the front portion. The two locking nuts are loosened to permit the camera lens to be changed.

Focus Control—Adusts the distance from the front of the camera lens to the oscilloscope display to permit proper focus to be obtained.

Shutter Speed Ring—Selects the desired shutter speed.

Aperture Control—Selects the desired lens opening (f-stop value).

Back Release—Permits the back mount to be removed from the camera frame and rotated through 90-degree increments.

Back Indexer—The spring-loaded control indexes the back to one of the five notched positions. The Back Indexer also permits the back to be completely removed from the back mount and rotated in 90-degree increments.

Shutter Release—Controls operation of the shutter.

Viewing Door Knob—Opens or closes the viewing door. The door should be kept closed when the viewing hood is not being used.

Mounting the Camera

A special mount is supplied with each camera and is used to attach the camera to the oscilloscope. The camera mount takes the place of the normal graticule cover on the oscilloscope.

To mount the camera on the oscilloscope, first remove the graticule cover from the oscilloscope by unscrewing the four knurled graticule nuts. For most photographic work it is recommended that any light filters also be removed.

Check the oscilloscope graticule for scratches and be sure that it is clean. Place the graticule on the graticule studs so that the scribed side is toward the crt and so that the clear illumination slots are up.

Release the Mounting Latch on the camera and remove the camera mount by swinging it out from the camera body and then sliding it off the hinge pins. Use the four graticule nuts supplied with the camera to attach the camera mount to the oscilloscope. The new graticule nuts are slotted so that a screwdriver or coin can be used to securely tighten them. Make certain that the hinge fittings of the mount are to the left. The camera can now be put in place by engaging the hinge pins on the camera frame with the hinge fitting on the camera mount. The camera can be removed at any time by simply lifting it off the camera mount. The hinge system permits the camera to be moved up to the oscilloscope screen when in use or to be swung away. Fig. 2-2 shows the camera mounted on an oscilloscope.

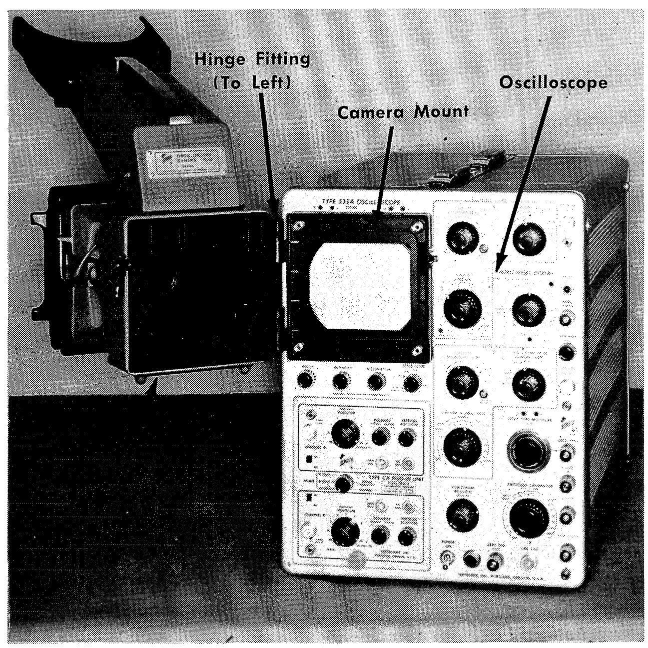


Fig. 2-2. Type C-12 Camera mounted on oscilloscope. Note the special camera mount installed on the graticule studs.

The Mounting Latch on the camera frame is used to lock the unhinged side of the camera to the camera mount. Before fastening the Mounting Latch, be sure to remove the plastic dust cover from the opening at the front of the camera body. Then swing the camera closed against the camera mount and lock it by raising the Mounting Latch until snug.

Adjusting the Lens Aperture

The Aperture Control (see Figs. 2-1 and 2-3) is used to control the lens opening. The dial is calibrated in f-stop numbers with a small pointer to indicate the settings.

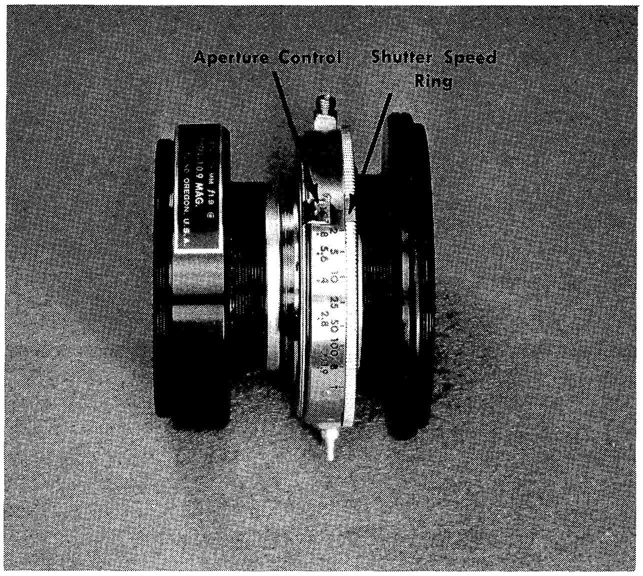


Fig. 2-3. The Oscillo-Raptar 1:0.9 lens showing the aperture and shutter controls.

The lens setting to be used for a particular picture depends on a large number of factors. Wherever possible, use of f-stop numbers lower than f/4 should be avoided. As in all cameras, the best depth of field is obtained at the smallest openings (largest f-stop numbers). This is important in the Type C-12 as well as other oscilloscope cameras because the trace and graticule cannot simultaneously be brought into focus when the f-stop number is lower than f/4. In applications where it is necessary to use the lens wide open, special techniques can be used to obtain a satisfactory picture with both the trace and graticule in focus. These techniques are described in the Photographic Techniques section of this manual. A special accessory is also available for producing a virtual image of the graticule in the same plane as the trace. The accessory makes it possible to obtain proper focus of both the trace and the graticule at the widest lens openings.

Additional information on selecting lens openings for particular applications is given in the Photographic Techniques section of this manual.

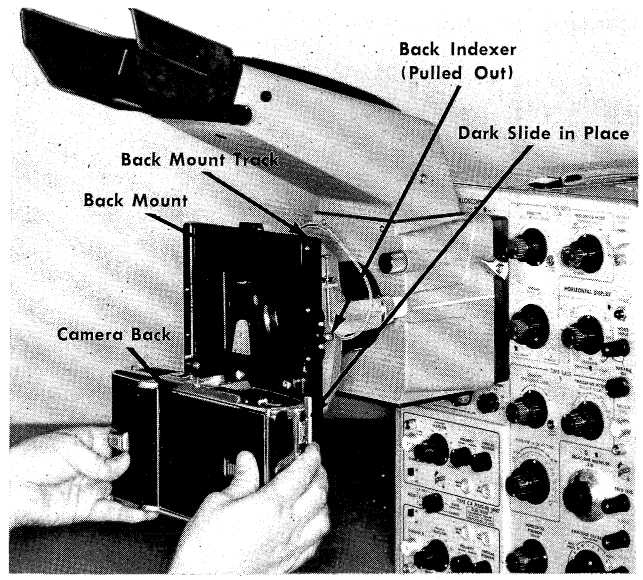
Selecting the Shutter Speed

The camera shutter speed is selected by means of the Shutter Speed Ring (see Figs. 2-1 and 2-3). Numbers shown are actually the reciprocals of the shutter speeds. For example, when the Shutter Speed Ring is set at 25, the shutter is open 1/25 second. As with the aperture setting, many factors determine the shutter speed used for a particular picture. Care must be taken that the right combination of lens opening and shutter speed is chosen so that the desired results may be obtained. More information on selecting the shutter speed is contained in the Photographic Techniques section of this manual.

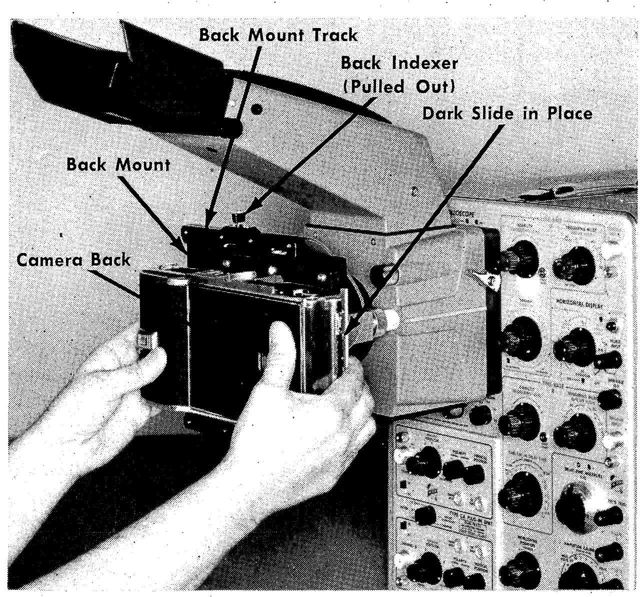
Mounting the Camera Backs

Lift up the Back Release Lever and slide the ledge on the bottom of the Back Mount into the slot on the camera frame. Press the top of the Back Mount up against the camera frame and press down on the Back Release Lever to lock the Back Mount into place. The Back Mount can be placed on the camera frame to permit either vertical or horizontal sliding of the camera backs.

When the Back Mount is in place, pull out the Back Indexer and give it a half turn. This holds the indexer out and permits the desired camera back to be slid onto the tracks on the Back Mount; see Fig. 2-4. Be sure to hold onto the camera back until you have given the Back Indexer



(a)



(b)

Fig. 2-4. Part (a) shows the Back Mount installed to permit vertical sliding of the camera backs. Part (b) shows the Back Mount installed for horizontal sliding of the backs.

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another half turn and permitted it to drop into place. The Back Indexer prevents the camera back from coming completely out of the mount but does permit the backs to be indexed to the desired position by means of the five notches in the back.

The dark slide should be left in the film back until the back has been placed in the proper position and a check made that the shutter is closed. The dark slide should also be used whenever the camera back is changed if either back contains film. Failure to use the dark slide will result in the exposure of one or more film frames.

Focusing the Camera

Install the 4×5 focusing camera back and press the release button on the back (see Fig. 2-5). Set the lens for maximum aperture (f/1.5, f/1.9, or f/4.5 depending on the lens) and set the Shutter Speed Ring on Time (T). Obtain a sharply focused trace on the crt using the oscilloscope Focus and Astigmatism controls. Then lock the camera in place on the oscilloscope. Open the camera shutter and observe the image on the ground glass screen of the focusing back. Adjust the Focus control on the camera to produce a sharply focused image of the oscilloscope trace on the ground glass screen.

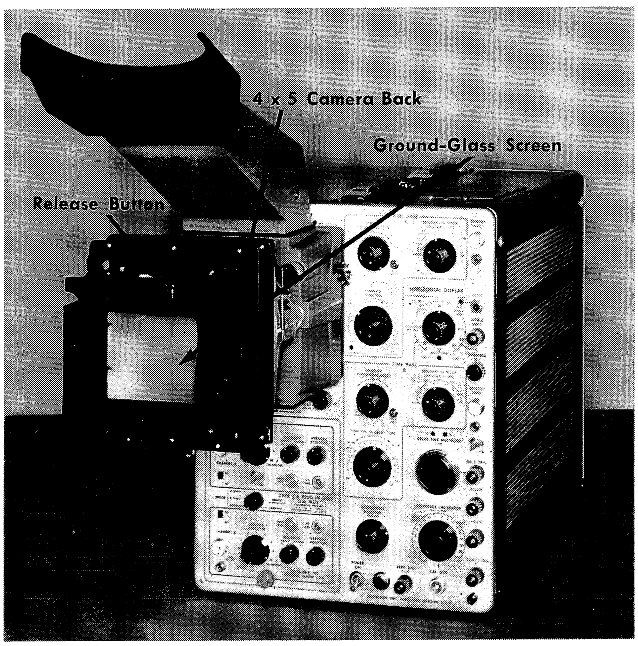

Fig. 2-5. The 4 x 5 camera back installed on the camera to permit focusing of the camera.

The camera is normally focused on the oscilloscope trace rather than the graticule since it is usually most desirable to photograph the fine detail of the trace. Even with the camera focused on the oscilloscope trace, the focus of the graticule will usually be quite satisfactory. The camera can, of course, be focused on the graticule if desired.

Selecting the Camera Back

The choice of a camera back will depend primarily on the intended use for the photograph, how quickly you want the finished photograph, how large an area you wish to photograph, and on the magnification factor of the particular lens used. If you want to obtain a negative from which a number of prints can be made, either Polaroid negative film or conventional film is quite satisfactory. On the other hand, if you only want one print or a positive transparency, and you want to obtain the print or transparency with minimum delay, the logical choice would then be one of the Polaroid backs.

With either Polaroid or conventional film, the size of the film used by the selected back must be at least as large as the image from the lens. This will depend on the object-to-image ratio of the camera lens and on the size of the oscilloscope display. For example, the roll film back for 120 or 620 film would probably not be used with a 1:0.9 lens and a 10-centimeter wide oscilloscope display. This is because the image of the display is 9 centimeters wide and the long dimension of the film is only about 8.25 centimeters. Thus at least 7.5 mm would be cut off of the photograph.

In actual practice, the film size should be at least 5 mm larger than the size of the image to allow for normal tolerances in the construction of the camera backs and for the position of the film in the back.

Selecting the Position of the Back

The camera back can be rotated in 90-degree increments in either of two ways. First, the Back Mount can be rotated by lifting the Back Release Lever. This permits the tracks on the Back Mount to run either vertically or horizontally. This in turn allows the film back to slide either horizontally or vertically. The film back itself can also be rotated by sliding it off the Back Mount, rotating it, and sliding it on the Back Mount in the new position. If either of these methods are used, you must place the dark slide into the camera back before rotating the back in order to prevent exposing the film.

For most applications involving only a single exposure per frame, it will normally be most convenient to install the Back Mount so that the tracks run horizontally. The Back Indexer knob can be either up or down as desired. Either the long or the short axis of the film can be made to run parallel with the trace by rotating the film back itself.

When more than one exposure per frame is required, you will probably want to install the Back Mount so that the tracks on the mount run vertically. This will permit the film back to move vertically and allow more than one trace to be photographed on a film frame. Again the film back can be installed with the long axis of the film either parallel or perpendicular to the trace.

Using the Viewing Hood

The viewing system of the C-12 uses a two-mirror system which allows you to view the oscilloscope display at a right angle to the display. This is the same view the camera lens sees and consequently there is a minimum of parallax between the observed and photographed display.

Both the viewer and the camera see the oscilloscope display orthogonally. The viewed image is undistorted.

It will be noted that a slight double image of the oscilloscope display can sometimes be seen in the viewing hood. This is the inevitable result of the finite thickness of the glass support for the beam-splitting coating. The unwanted image reflects from the back surface of the beam-splitting mirror. A special four-layer dielectric coating is deposited on the mirror surface to reduce the unwanted reflection to a very low level. The double image does not appear in photographs unless the display intensity is quite high.

The viewing hood allows persons either with or without glasses to observe the display. When the viewing hood is not being used, the viewing door should be closed to prevent light from entering. If the door is left open, a reflection of the open door may appear on the photograph. When you are observing the trace, light will be sealed out if your face is pressed against the rubber of the hood.

Releasing the Shutter

The Shutter Release control is located on the right side of the camera frame in a special holder. When the cable release button is pressed, the shutter mechanism is actuated. In all positions of the Shutter Speed Ring except Time (T) and Bulb (B) the shutter mechanism operates independently of the time that the release button is held in. In the Bulb position of the Shutter Speed Ring, the shutter remains open as long as the release button is held down. When the button is released, the shutter closes. In the Time position of the shutter control, the shutter is opened the first time that the button is pressed. It is then necessary to press the release button a second time in order to close the shutter.

The shutter can also be operated without using the cable release by using the lever at the left side of the lens assembly. The lever is raised to actuate the shutter mechanism.

CAUTION

Do not attempt to force the Shutter Release Lever. When the Shutter Speed Ring is set at T, the release lever will not return to the closed position the first time the lever is actuated. Attempting to force the lever to the closed position will bend the levers and render the shutter useless. Press the release a second time to close the shutter.

Changing Lenses

Any of six lenses can be used with the Type C-12 Camera. The lenses can be changed by a few easy steps as follows (see Fig. 2-6):

First, simultaneously unscrew the two locking nuts which hold the rear portion of the camera frame to the front. Pull the back portion of the camera frame away from the front portion and install the dark slide in the camera back. Then disconnect the cable release from the lens assembly. Unscrew the complete lens assembly from the camera frame. Screw on the new lens assembly after first checking the lenses and cleaning them if necessary. The lenses used with the C-12 Camera are keyed so that when they are mounted on the camera and screwed all of the way in, they automatically reach the proper position. Connect the cable release to the new lens assembly and mount the rear of the camera frame on the studs from the front position. Adjust the position of the locking nuts so that the front of the lens can seat against the front portion of the camera frame. Simultaneously tighten the locking nuts until snug. If the locking nuts are tightened excessively, pressure on the shutter assembly may make the shutter inoperative. After refocusing, the camera is ready for use.

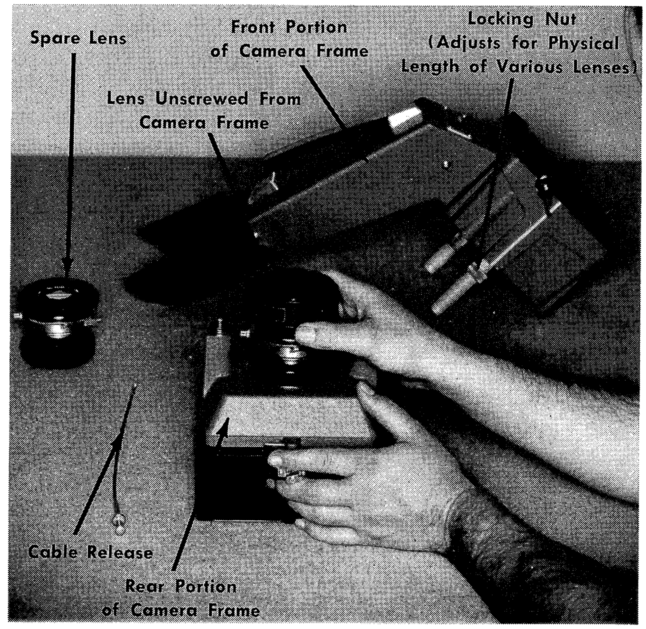

Fig. 2-6. Changing camera lenses.

Use of the 4 x 5 Film Back

Loading the Film Holders. 4×5 cut film in a variety of types is available at most photographic suppliers. Before using the film, it must be first installed in a film holder in a darkroom. To prepare the film holders, put the dark slides about half way in with the silver side of the metal edges out. This position of the dark slide will be used to indicate that film in the holder is not exposed. When the film is exposed, the dark slide should be turned over so the dark side of the metal edge is out (see Fig. 2-7).

Some films can be loaded into the film holders using a safety light while others require complete darkness. Read the instructions accompanying the film to determine if a safety light can be used. After reading the instructions, enter the darkroom and adjust the light conditions accordingly. Open the film holder doors. While holding a sheet of film by the edges only, feel for the notches on the edge of the film which indicate the type of film and the proper way to insert the film into the holder. Place the film holder so that the film holder door is to your right. Then with the identification notches on the film in the top right corner, carefully slide the film into the holder. This assures that the film emulsion is facing out. Then close the film holder door and completely insert the dark slide. Some dark

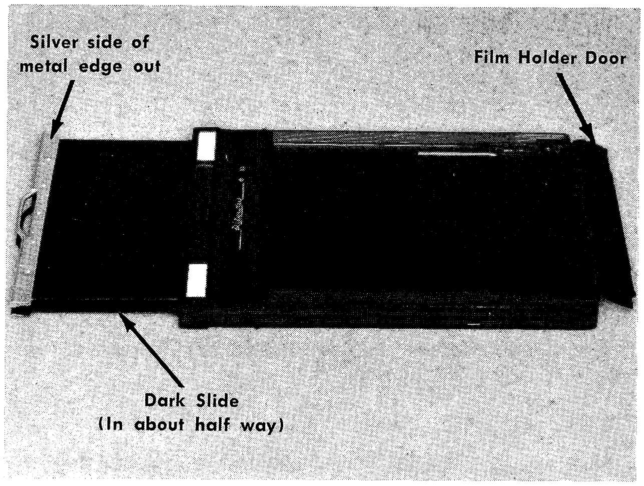

Fig. 2-7. A film holder ready for loading in the darkroom.

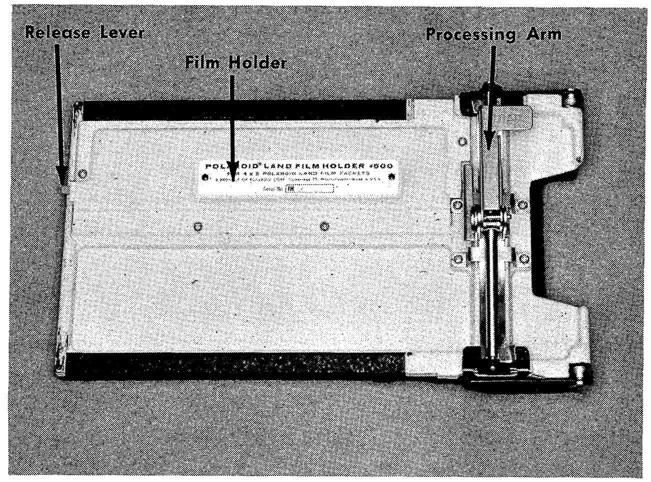

Fig. 2-8 The Polaroid 4 x 5 Film Holder.

slides have small bumps along the silver metal edge. If the dark slides you are using have these you can check that the dark slide is inserted properly by feeling for these bumps. Repeat the loading procedure for the other side of the holder. The film holder is then ready to use.

Placing the Film Holder in the Camera Back. The film holders are placed in the camera back by lifting up on the spring back and sliding the holder in. The film holders must be inserted so that the ends of the dark slides are protruding. A check should then be made that the camera shutter is closed.

Exposing the Film. With the film holder properly inserted in the camera back, and the shutter closed, pull out the dark slide nearest the camera lens. Make your lens and shutter settings and obtain the desired display on the oscilloscope screen. Press the shutter release button to expose the film.

When the film has been exposed, replace the dark slide so that the dark side of the metal edge is out. This indicates that the film has been exposed. Then pull the film holder out of the camera. If another picture is to be taken, turn the film holder over and reinsert it in the camera. Remove the second dark slide and make the second exposure. Replace the dark slide with the dark side out and remove the film holder from the camera. The film holder can then be taken to the darkroom where the film can be removed for processing.

Using the Polaroid Land 4 x 5 Film Holder

Loading the Film Holder. Insert the holder into the back of the 4×5 back on your camera just as you would a standard film holder (see Fig. 2-8). Engage the slide locks on the camera back into the slots on the film holder.

NOTE

The weight of the holder makes it advisable to use slide locks in addition to the spring back to prevent light leaks and dropping the holder. Locks move into slots on the sides of the holder.

Place the processing arm up in the LOAD position. There's a right and a wrong side to the film packet—be sure to insert the packet so that the side with the colored printing is facing you. Hold the packet about in the center and insert the metal-capped end into the holder. Push it gently (without buckling) past the rubber roller.

After the metal cap is inserted beyond the rubber roller, shift your hold on the packet to the extreme right-hand end. Do not press the pod area and do not buckle the packet, for you might damage the picture. Push the packet all the way in until it stops. The colored block and arrow will just be visible when the packet is completely inserted. (See Fig. 2-9.)

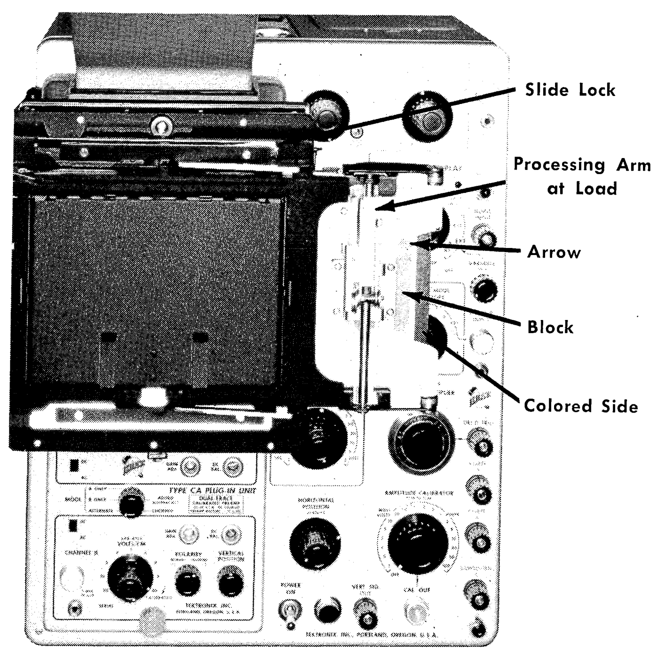

Fig. 2-9. Polaroid 4 x 5 Film Holder installed in the 4 x 5 back. The position of the film packet should be as shown when the packet is properly inserted in the holder.

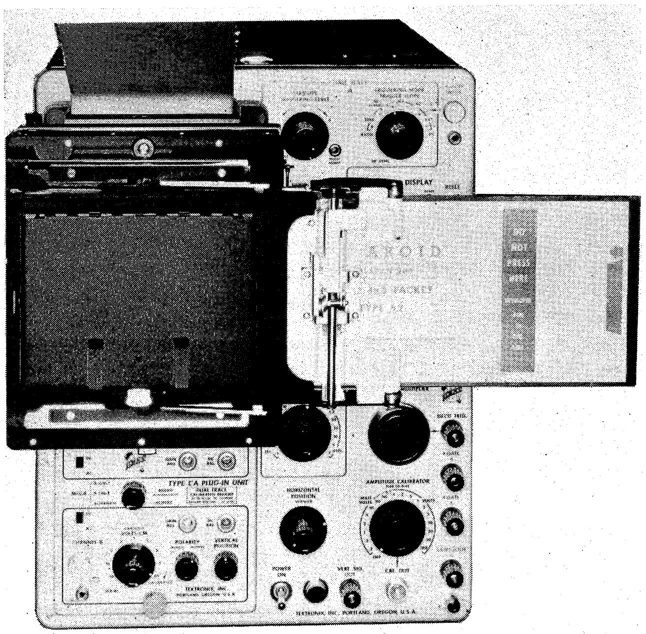

Fig. 2-10. Polaroid film packet ready to be exposed.

Exposing the Film Packet. The envelope of the packet acts as a dark slide. When you are ready to expose the film, gently pull the envelope out of the holder until it stops (see Fig. 2-10). You will feel a slight resistance as the dark slide envelope detaches from the negative and metal cap just as you start to pull. To avoid the danger of fogging, the dark slide envelope should not be withdrawn for a longer period than absolutely necessary.

Make the exposure just as you would for conventional film. The speed rating of the film is printed on the packet and further instructions are contained in the film box. Take care not to bend or permit moving air to whip the envelope out of its natural position, as this may cause a light leak.

After exposure, reinsert the envelope all the way into the holder. Make sure again that the envelope is fully inserted by checking on the colored block and arrow. If the envelope will not reinsert easily all the way, withdraw it slightly and try again. Don't force it—you will only crease the paper. You can now either develop your picture immediately or you can remove the exposed packet for processing at a later time.

How to Develop the Picture Right Away. Swing the processing arm down to the PROCESS position. This action closes the processing rollers. When you pull the packet out, these rollers break the pod and spread the developing reagent.

To start development, pull the packet out with an easy, confident, fairly rapid motion until it stops. Your picture is now developing. See instructions packed with your film packets for recommended development time.

The pulling speed is important only in the matter of avoiding extremes. A slow, inching pull may cause mottle or streaks. Too fast a pull may result in the packet coming right out of the holder, past the stop. This can cause damage to the rollers and pictures.

Swing the processing arm back to the LOAD position and pull the packet the rest of the way out of the holder. It is important not to bend or buckle the packet during development time. If possible, lay the packet on a flat surface during development time, or replace it in the packet box. Your holder is now ready to take another packet for exposure.

How to Remove the Finished Picture. After the recommended development time, remove the envelope of the packet by hooking the tips of your fingers, or fingernails, under the edge of the metal cap while you give the envelope a moderate tug with the other hand, gripping the packet on the colored block. Don't squeeze the metal cap as this will hold the envelope more securely. Use the finger tips only, and let the thumb rest along the edge.

Now peel the picture away from the negative. Take just the white sheet in one hand, the brown paper and negative in the other, and peel them apart. You should coat each picture as soon as possible, using print coaters supplied with each box of packets. Follow coating instructions found in film tip sheet.

How to Remove Exposed Packet for Development Later. Occasionally you may want to expose a series of pictures without developing each packet right away. Here's how to remove the packet without developing.

After exposing the negative and reinserting the envelope all the way, make sure the processing arm is in the LOAD position.

Push the release lever on the left side of the holder as far down as it will go (about $^3/_8$ inch) and hold it down. Slowly pull the packet out of the holder. Do not let go of the release lever until the packet is completely out.

To identify the exposed but unprocessed packets, bend over one corner (away from the metal cap). This will prevent mix-ups when shooting fast.

How to Develop Exposed Packets at a Later Time. With the processing arm in the LOAD position, insert the exposed packet as described previously. Make sure the packet is fully inserted. Swing the processing arm down to the PROCESS position and proceed to develop your pictures in the normal manner.

Using the Polaroid Land Roll Film Back

How to Load the Back. The Polaroid Land Roll Film Back can be most easily loaded when the back is removed from the camera (however, film can also be loaded when the camera back is in place on the camera). For purposes of these instructions, it will be assumed that the back is removed (see Fig. 2-11).

When you remove the film from the box, save the print coater and printed Picture Tips which come with it. (The Picture Tips contain up-to-date information about the film.)

To prepare the camera for loading, swing the latch lever down. The back will open slightly. Set the back down on a flat surface, then lift open the back cover and lay it flat. Lift up the inner panel and lay it flat. This is the position in which the camera back is loaded.

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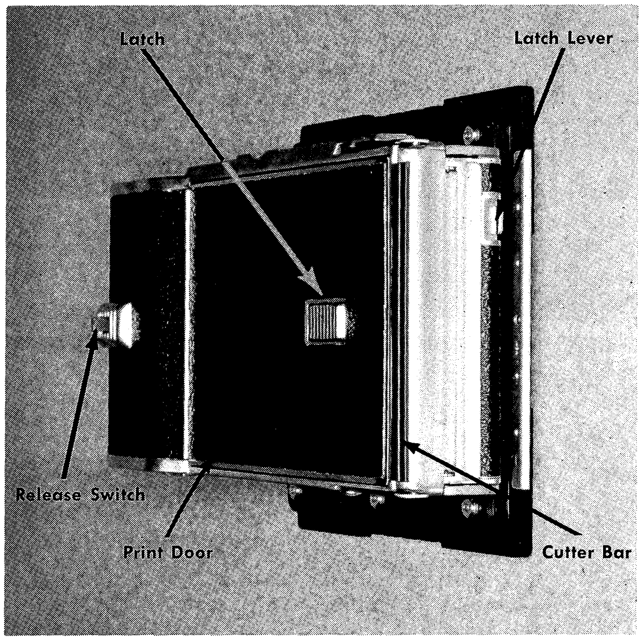


Fig. 2-11. The Polaroid Roll-Film Back.

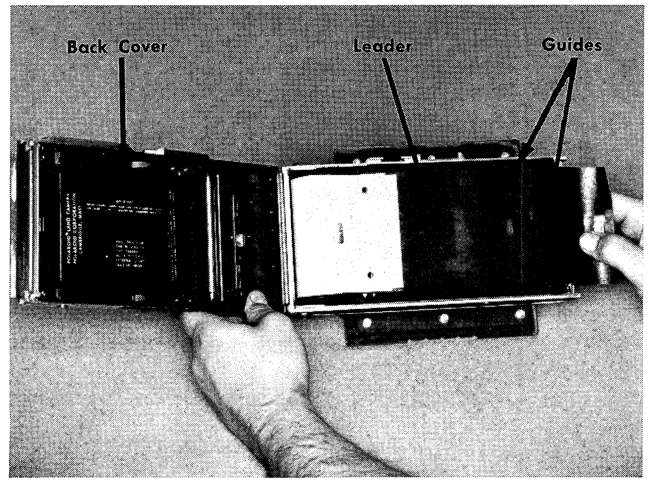


Fig. 2-13. The leader of the film roll must be brought around the roller on the inner panel. Care must be taken that the leader is aligned between the guides on the inner panel before the back is closed.

Before loading, examine the rollers in the back. The picture roll papers will pass between these rollers, which squeeze the developer reagent evenly between the positive and negative sheets. It is important to keep these rollers clean. Use a damp cloth to remove any specks or deposits that may appear on the rollers as the back is used.

Remove the film carefully from its foil wrapper. The film actually contains two rolls: a large white positive roll and a spooled negative roll. When you unwrap the film, be careful not to break the tape seals on the top of the spooled roll and the underside of the large roll. Drop the rolls into the wells in the back as shown in Fig. 2-12.

Now close the inner panel, folding the film leader over the steel roller on the edge of the inner panel. Lay the leader flat *between the guides at the outer edge of the panel* (see Fig. 2-13). Be sure that the white paper lies smooth and flat, not tucked into the well.

Then close the back cover, squeeze it tightly shut, and swing the latch all the way out to engage the prongs. Swing the latch all the way in to lock. There will be a short tab of black paper extending beyound the cutter bar.

With your right hand, lift the cutter bar by its plastic edge and grip the tab firmly. Pull the tab straight out until it comes to a firm stop. Don't be surprised if you seem to be pulling out a lot of paper on this first pull. You must pull out the entire leader (about 15 inches) before the film stops, but it will stop automatically.

Close the cutter bar by pressing it all the way down. It will latch closed, and you can now tear off and discard the excess paper.

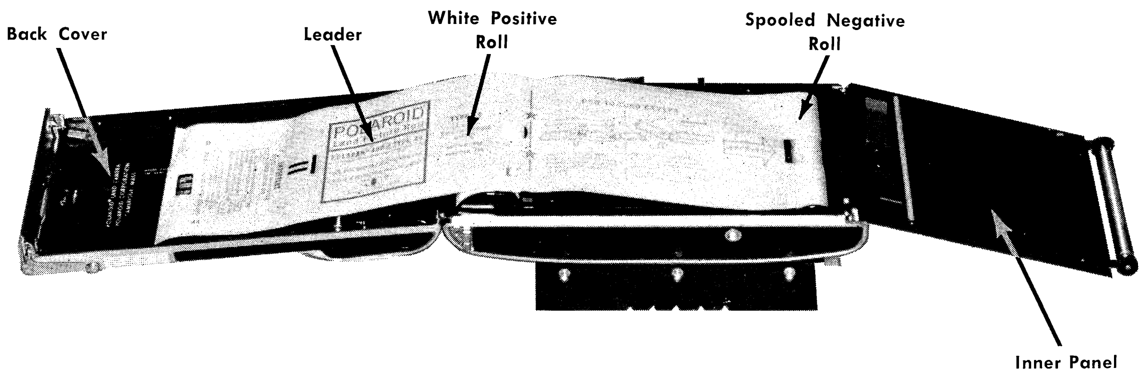


Fig. 2-12. The Polaroid Roll-Film Back opened for loading. The white positive roll is dropped in the well at the left while the spooled negative roll is dropped in the well at the right.

The back is now ready for the first picture. Mount the back on the camera. Make the shutter and lens settings as required for the type of film used and take pictures as with conventional films. You can always tell what picture is ready to be taken by lifting the cutter bar and looking at the tab.

How to Develop the Picture. Throw the red release switch in either direction to release the film. (If you should throw it accidentally at any time, don't worry—no harm is done.) Open the cutter bar by lifting the plastic edge and take a firm grip on the paper tab. You'll find the best grip to use is along the length of the forefinger and thumb.

Pull the tab ***straight*** out with a single motion. Pull it about as hard and rapidly as you might pull down a window shade; not hard enough to pull the shade off the roll (or the film off the spool), but not slowly and hesitantly either. Remember, the film will stop automatically.

NOTE

If the tab will not pull easily, throw the red switch again.

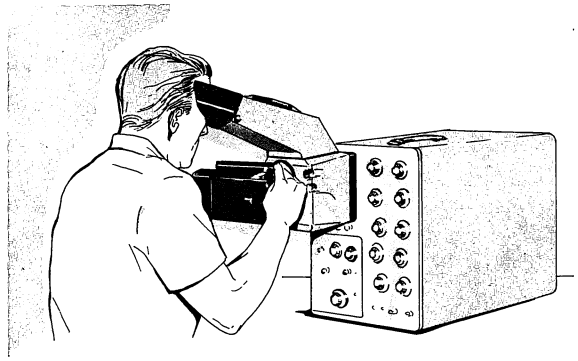
After you pull the tab, press down and latch the cutter bar. Tear off and discard the excess paper.

Wait the recommended development time. Pulling the tab has started the development process, and advanced the film into position for the next picture. Follow the instructions in the Picture Tips for development times under various conditions. It is important for you to check the Picture Tips for exact development time. This time varies for different types of film, and even the development time for a particular film may change.

When the development time is up, slide back the latch on the print door and open the door. Lift the print out carefully, starting with the cutout. Don't let the print fall back on the damp negative. Then close and relatch the print door.

Coat each print as soon after removal from the back as possible. First remove the curl by drawing the print face up over a straight edge, such as the edge of the cutter bar.

Apply the print coater along the entire length of the print, including edges, borders, and corners, with 6 or 8 firm overlapping strokes. For the last two or three pictures in each roll press the coater hard against the tab end of the print (not the image) for a moment to release extra liquid, then spread the liquid smoothly across the print.



SECTION 3

PHOTOGRAPHIC TECHNIQUES

Writing Rate

Writing Rate is a figure of merit which roughly describes the ability of a particular camera system mounted on a particular oscilloscope to photograph fast moving traces. The writing rate figure expresses the maximum spot speed (usually in centimeters per microsecond) which can be photographed satisfactorily.

The faster the oscilloscope spot moves, the dimmer the trace becomes. This is because the electron beam strikes each point on the phosphor coating for a shorter period of time. A camera system and oscilloscope which have a high writing rate are required for low repetition rate displays at the fastest oscilloscope sweep rates.

Fig. 3-1 shows one way in which writing rate can be calculated. A single trace of a damped sine wave is displayed. The frequency of the damped waveform is such that the rapidly rising and falling portions of the first cycle or two fail to photograph. The writing rate of the system is found as follows: Starting from the left, find the first rapidly rising or falling portion of the damped sine wave which is

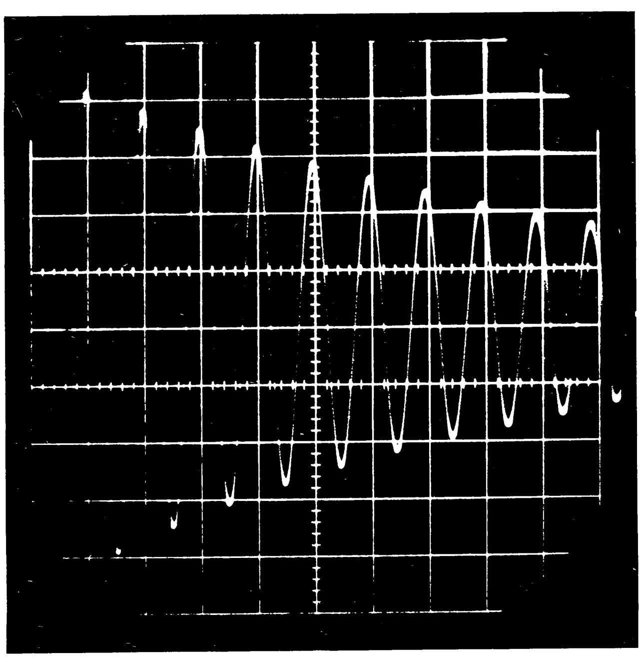


Fig. 3-1. A single-shot damped sinusoidal waveform which can be used to measure the maximum writing rate of an oscilloscope-camera combination.

photographed in its entirety. Let D represent the vertical distance in centimeters between the peaks which are connected by this portion. If D is three or more times as great as the horizontal distance occupied by one cycle (so that the horizontal component of velocity is small compared to the vertical component), the maximum writing rate in centimeters per microsecond is given approximately by:

$$\textit{Maximum writing rate} = 3.14\,Df$$

where f is the frequency of the damped wave in megacycles.

It is inadvisable to speak of the absolute writing rate of any oscilloscope or camera, because so many variables are involved. Among the variables which must be considered are the speed of the camera lens, the type of crt phosphor, the type of film, the crt accelerating potential, the camera optical arrangement, the object-to-image ratio of the camera lens, and development time of the film.

It is possible to compare the effectiveness of two films by measuring their writing rate under the same conditions. In other words, you can determine which of the two films is the more effective under those particular conditions without being able to assign a specific value to either film.

The rated speed or ASA rating of a film doesn't tell you much about its effectiveness in recording single oscilloscope traces. This is because the ASA rating is measured for normal daylight intensities and spectral characteristics while the very short exposures of fast crt traces are several orders of magnitude smaller and have various spectral outputs. There is usually some relationship between ASA rating and maximum writing rate, however. Thus it would be safe to assume that a film with a very high ASA rating would have a higher maximum writing rate than a film with a lower ASA rating.

Selecting the CRT Phosphor

There are a great number of phosphor types presently available to the purchaser of a cathode-ray oscilloscope. Each of these phosphors has certain advantages and disadvantages compared to the others. There is no one phosphor which is best for all applications. Of the many types of phosphors available, four are most commonly in use. They are the P1, P2, P7 and P11. Other phosphor types are usually restricted to special applications. Since the P1, P2, P7, and P11 phosphors are the ones most commonly used, information contained in this portion of the manual will primarily concern these phosphors.

For low sweep rate or repetitive-sweep applications where a high writing rate is not required, practically any type of phosphor is satisfactory. It is only for single-sweep or low-

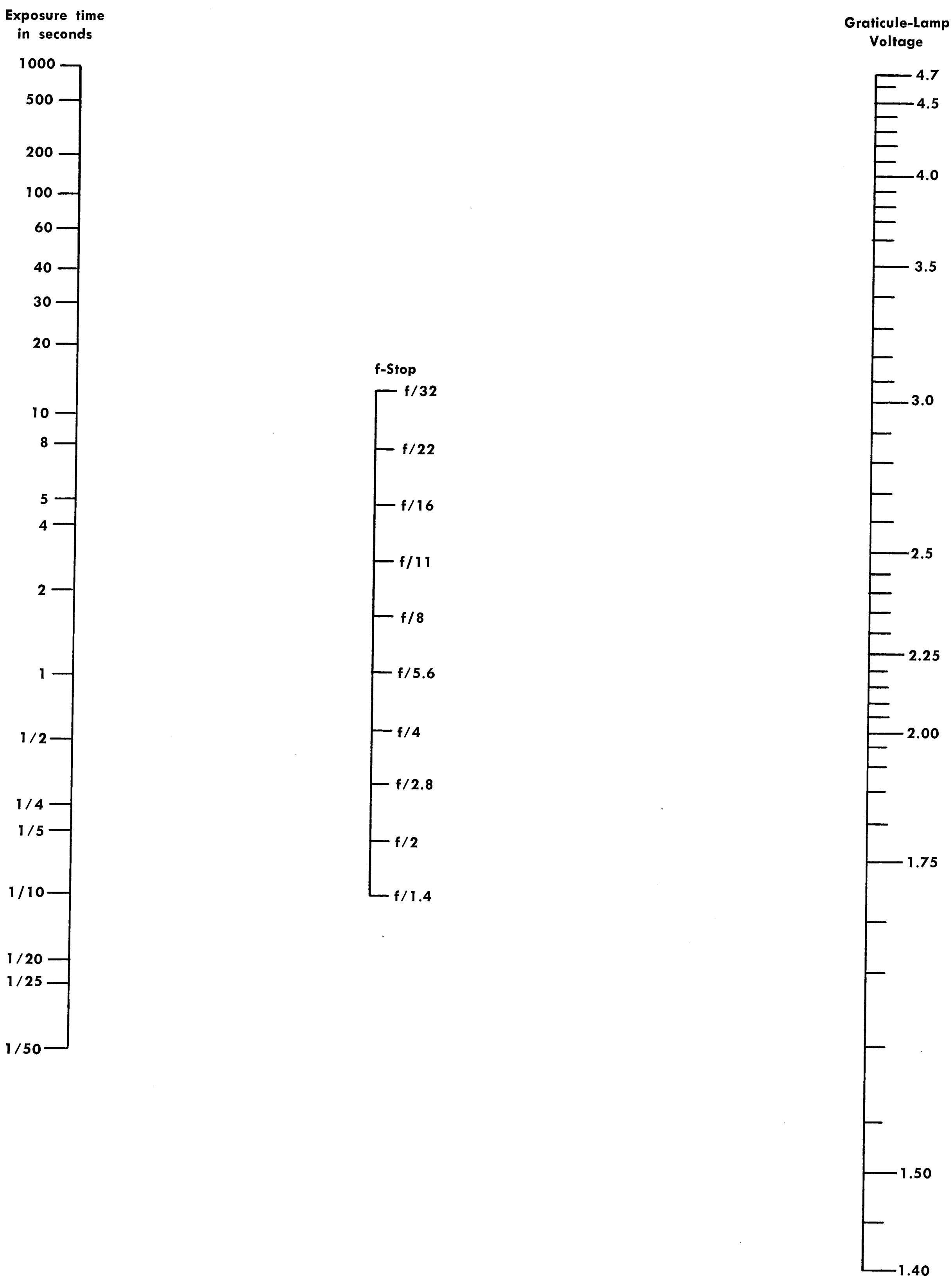


Fig. 3-2. Nomograph for Type 47 Polaroid film. The nomograph can be used to determine the proper shutter and lens settings for the camera.

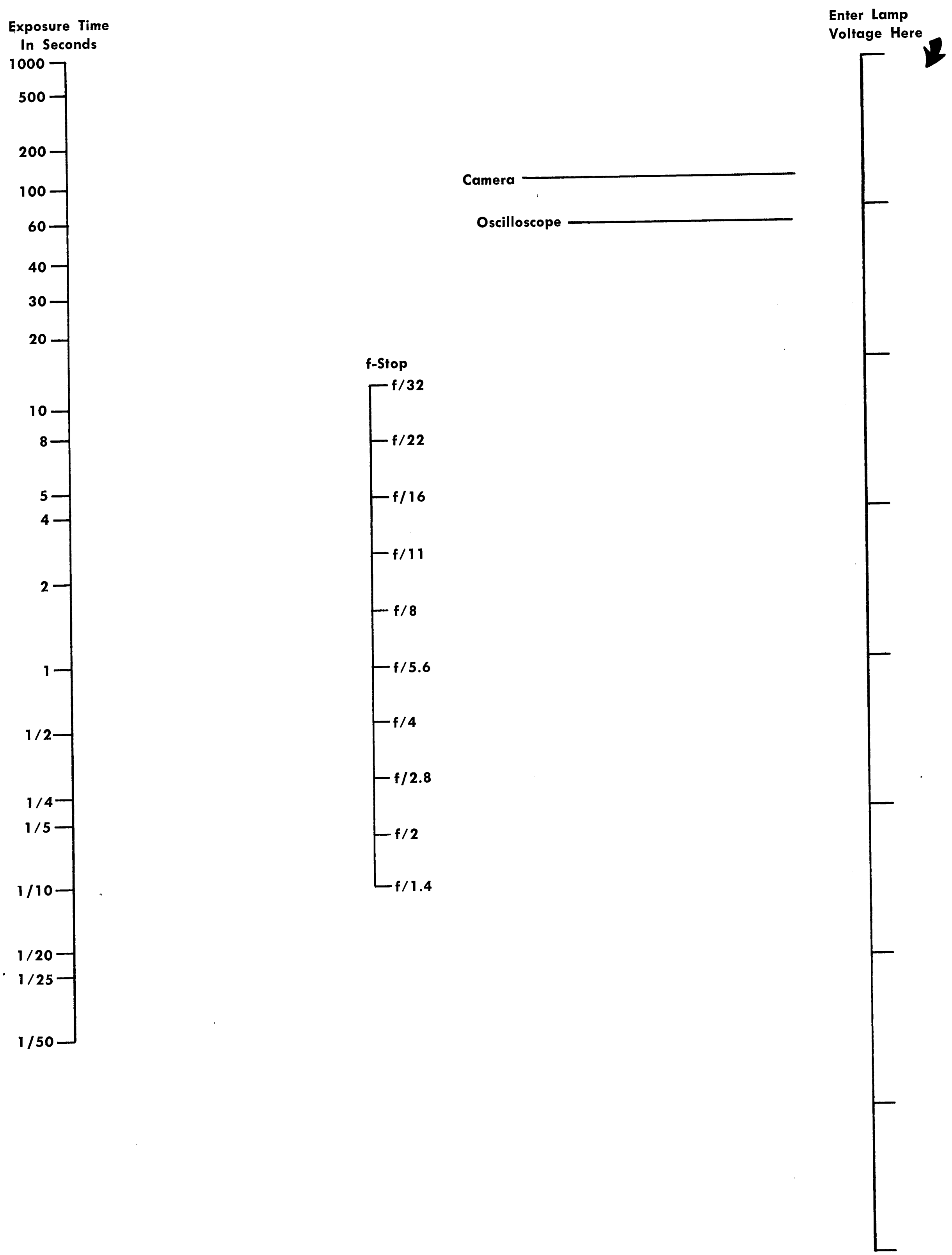


Fig. 3-3. The graticule lamp voltage column in the above nomograph is left blank so that you may add the figures for the particular film you are using.

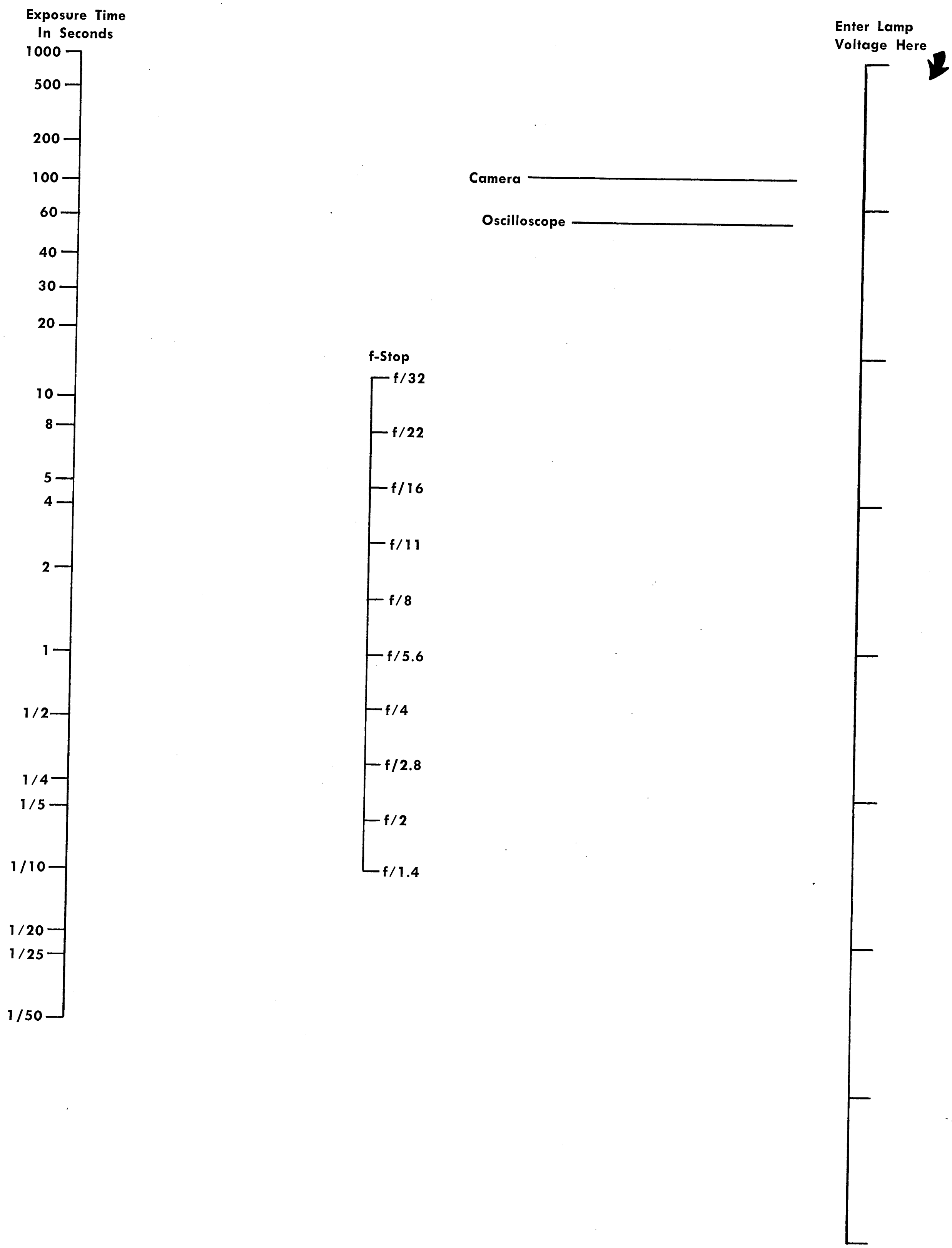


Fig. 3-4. The graticule lamp voltage column in the above nomograph is left blank so that you may add the figures for the particular film you are using.

repetition-rate applications at the fastest sweep rates where selection of the crt phosphor is important. In low-repetition-rate applications at the fastest sweep rates, use of the proper phosphor can mean the difference between getting a good photograph and not getting one at all.

Probably the most important single characteristic of a phosphor for photographic purposes is the color of its emitted light. A blue or violet fluorescence has the highest actinic value and thus is most suitable for photographic work. In general, it can be stated that (for all other things being equal) the shorter the wavelength of the visible peak emitted light, the better the phosphor for photographic applications.

Most users of oscilloscopes are concerned not only with photographing the oscilloscope trace but in observing it directly as well. For such applications it is important to have a phosphor which gives good results in both types of applications. This frequently results in the choice of a phosphor such as P2 where the emitted light has a large enough actinic value to give a good writing rate and also has sufficient persistence to permit easy viewing.

It has been our observation that the P11 phosphor has the highest comparitive writing rate of any common phosphor and is thus best for photographic work. The short persistence of the phosphor is somewhat undesirable for general purpose work but the disadvantages of this are slight. Type P11 should be chosen whenever the ultimate in photographic ability is required. Type P11 emits a short-duration blue light.

The Type P2 phosphor is only slightly less suited for photographic work than the P11. Its comparative writing rate is approximately one half that of P11. It has a bluish-green fluorescence followed by a long duration green phosphorescence. The long persistence of the trace makes it very well suited to general purpose applications.

The Type P7 phosphor has an initial short-duration greenish-blue fluorescence followed by a long-duration yellow phosphorescence. It may be used for general purpose applications, but is slightly inferior to the Type P2 phosphor for photographic applications. Its comparaitive writing rate is approximately three fourths that for P2.

Type P1 phosphor has both green fluorescence and phosphorescence. It is also well suited for general purpose applications. For photographic applications, Type P1 compares approximately with Type P7.

Since the Type P2 phosphor appears to be best for combined general purpose use and photographic applications, it is standard on most Tektronix oscilloscopes. Type P11 is standard on some Tektronix oscilloscopes where extremely rapid sweeps make it possible to obtain maximum benefit from the advantages of this phosphor. Other phosphors can be obtained on any of the Tektronix oscilloscopes.

Selecting the Proper Film

For most oscilloscope work you will find Polaroid film the most convenient. This film permits you to see the picture very soon after taking it and makes it unnecessary to expose a whole roll of film before developing it.

Several types of Polaroid film are commonly used. Polaroid 200 speed film such as Type 42 is quite economical and gives good results for low and medium writing rate applications. Polaroid 400 speed film such as Type 44 costs slightly more than 200 speed film but is better suited for high writing rate applications. Even with 400 speed film, you will find it impossible to photograph displays which require an extremely high writing rate. Polaroid 3000 speed film such as Type 47 is much faster than either Types 42 or 44 and can be used to obtain satisfactory photographs of practically any oscilloscope display. Type 147 Polascope Polaroid film with an equivalent ASA rating of 10,000 provides one of the highest writing rates of any film on the market. Type 147 was developed specifically for oscillophotography.

Other types of Polaroid film commonly used produce a positive transparency rather than the usual positive prints. Polaroid films of this class are Types 46, 46L, and 146L. Types 46 and 46L have an equivalent ASA rating of 800. Type 146L has an equivalent ASA rating of 200.

Conventionally-developed films are cheaper than Polaroid and are probably more convenient for taking many pictures at a time. Eastman Tri-X is very good for this purpose. Although its ASA rating is less than that of other films, Tri-X responds better to very low light levels and therefore provides a higher writing rate than most other films.

Determining Shutter Speed and Lens Opening

Most oscilloscope displays can be adjusted over a wide range of intensities. The primary limitations are that the trace must not be so dim that it cannot be photographed and should not be so bright that it cannot be properly focused. Within these limits any intensity setting of the trace can be photographed using the proper shutter speed and lens opening.

There really is no completely satisfactory way of determining the brightness of the oscilloscope trace other than by laboratory methods. About the only means readily available is to judge the brightness by observation. The inaccuracies which would result from this type of observation are obvious. It is much more satisfacttory to use the oscilloscope graticule as a reference. The graticule can be set at a particular level of brightness merely by controlling the voltage applied to the graticule lamps. The setting of the graticule brightness depends not on a visual observation but on the results of a voltmeter indication. If the camera settings are made to obtain a good picture of the graticule, and the trace intensity is adjusted to match that of the graticule, a good photograph of both should be obtained. This is, in general, the method normally used.

A nomograph of shutter and lens setting as a function of graticule voltage is included in Fig. 3-2 for Type 47 Polaroid film. In most cases any combination of lens and shutter settings for the appropriate graticule voltage can be used. There are two restrictions, however. First, for repetitive-sweep applications the shutter must remain open long enough for several oscilloscope sweeps to occur. If this is not done, one portion of the photographed display may appear brighter than the others. The second restriction applies to single-sweep applications. For single-sweep displays, the shutter must be left open long enough for the single sweep to occur.

There are two methods of determining the shutter speed and lens setting from the graticule voltage. The first method is used where the intensity of the trace can be varied over a wide range without adversely affecting the spot focus on the crt phosphor. In this type of application, which includes most photographic work, the graticule voltage is set to some convenient value and the trace intensity is adjusted to match that of the graticule. The desired shutter and lens settings for the particular graticule voltage are then selected and the picture taken. This method has an advantage in that a large number of photographs can be taken with the same graticule voltage without changing either the lens or shutter setting.

In the second method, the trace intensity is set first and the graticule brightness is adjusted to match the intensity of the trace. The lens and shutter settings can then be determined from the graticule voltage in the usual manner. This method is used primarily in applications where the trace intensity can only be varied over a very narrow range. Low repetition-rate displays at the fastest sweep rates would be an example of this type of application. In such an application, you will probably need to obtain the highest possible writing rate. Therefore you should adjust the trace for the maximum brightness which can be obtained without loss of sharp focus and then adjust the graticule for the same brightness.

In either of the methods described, the graticule should be positioned for white lines. It is somewhat difficult to match the intensity of a blue or green trace against the brightness of these white graticule markings. This is one of the difficulties of the method and a difficulty which can only be resolved with experience in the method. You will note that with phosphors such as P11, however, which contain a high blue output, good photographs are obtained when the trace actually appears to be slightly dimmer than the graticule markings. As an aid to correcting this difficulty, some people use blue or green light filters. This method makes both the graticule markings and the trace appear to be the same color, making the job of matching the intensities somewhat easier. However the filters reduce the amount of light reaching the camera lens and thereby reduce the maximum writing rate of the camera-oscilloscope combination. This difficulty is eliminated if the filters are used in the viewing system only. Filters for the viewing system only will be available from Tektronix.

The nomograph shown in Fig. 3-2 is constructed for the C-12 Camera with a 1:0.5 object-to-image ratio and Type 47 film. If the lens you are using has another object-to-image ratio, the settings shown in the nomograph will be changed somewhat. The amount of change for any of the lenses normally used with the C-12 Camera can, however, usually be ignored.

In addition to the nomograph in Fig. 3-2, two other nomographs are included (see Fig. 3-3 and 3-4). These nomographs do not have the figures in the Lamp Voltage column. This permits you to record the figures from your best results for the particular lens system and film you are using.

Fig. 3-5. Approximate f-stop numbers on the SCALE ILLUM. control of a late model Tektronix oscilloscope.

The nomograph was constructed from empirical data. Settings indicated by the nomograph should give good results in all cases but such things as the normal variations in film mean that this nomograph can be used only as a guide and not as an absolute standard.

On some of the late model Tektronix oscilloscopes, the Scale Illumination control is marked in approximate f-stop numbers (see Fig. 3-5). These scales are not intended specifically for the Type C-12 Camera and can therefore be used only as guides. The scales are intended for use with Type 44 Polaroid film with an exposure of 10 seconds and for Tri-X and Type 47 Polaroid films with an exposure of 1 second. These scales can be used in place of nomographs in adjusting the brightness of the graticule.

Reciprocity

Decreasing the f-stop number by one unit (e.g., from f/8 to f/5.6) doubles the area through which light can pass and expose film in the camera. Theoretically, such a decrease in the f-stop number requires that the exposure time be halved to produce the same exposure as obtained previously. This results in what is known as the Law of Reciprocity. The Reciprocity Law works quite well for medium intensity light at medium shutter speeds. The law fails, however, for very short exposures from bright light or for very long exposures from dim light. It is only for exposures in the range of approximately 1/250 second to 1 second that the Reciprocity Law can be used. The nomograph shown in Fig. 3-2 takes into account the failure of Reciprocity.

Effects of Camera Magnification on Exposure

The camera or lens object-to-image ratio is the ratio of the object size to the image size. For example, a 1:1 lens is one whose object is the same size as the image. As mentioned previously, the object-to-image ratio of the camera lens has a definite effect on the exposures obtained.

The object-to-image ratio affects the amount of light which will fall on a given point on the film. The smaller the image on the film, the greater the intensity of the light. Therefore the larger the object-to-image ratio of the lens, the less time required to obtain a good exposure of the film. With a 1:0.5 lens slightly less exposure time is required to photograph a display than is required with a 1:0.9 lens. The differences in the exposure time required with the various lenses used in the Type C-12 Camera are so slight, however, that they can usually be ignored. There is much less than one camera stop difference between a 1:1 and a 1:0.5 lens.

It is important to note that a slightly better writing rate can be obtained with a large object-to-image ratio than can be obtained with a smaller object-to-image ratio. Here again, though, the difference is fairly small unless there is a wide difference in the ratio.

Photographing Repetitive Signals

The following steps can be used to photograph recurrent traces. The steps are arranged assuming that the intensity of the trace can be varied over a wide range. If this is not the case, adjust the intensity of the trace first and then adjust the brightness of the graticule markings to match that of the trace.

1. Position the graticule for white lines and adjust the graticule for a convenient level of brightness.
2. Adjust the intensity of the trace to match that of the graticule. Adjust the oscilloscope Focus and Astigmatism controls for the sharpest possible trace.
3. Set the camera lens to its largest opening (smallest f-stop number) and carefully focus the camera on the oscilloscope trace using the focusing 4 × 5 back.
4. Determine the correct shutter and lens settings from the graticule voltage. Either the nomograph or previous photographs can be used to determine these settings. Wherever possible use an f-stop number higher than f/4 so that both the trace and graticule will be in sharp focus.

It is important when photographing recurrent sweep displays that you use an exposure time which is long enough for several sweeps to occur. If the exposure time is not long enough, portions of the photographed display may appear brighter than other portions. This is illustrated in Fig. 3-6.

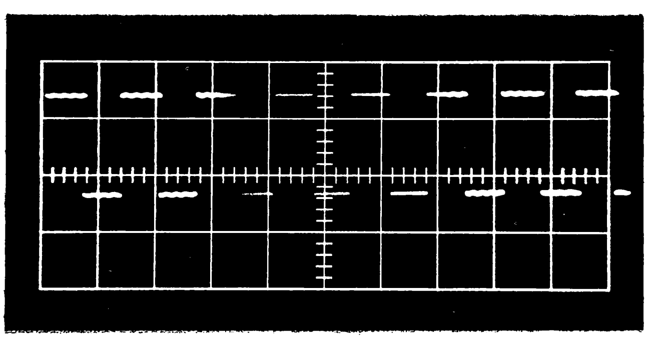


Fig. 3-6. Photograph of a repetitive signal obtained with too short an exposure time.

Photographing Single-Sweep Displays

Single-sweep displays are formed when the oscilloscope spot sweeps across the screen only once. The spot only appears on the screen for the interval of the sweep (as little as 12 nanoseconds on some oscilloscopes). The actual exposure time is thus determined not by the shutter setting but by the duration of the sweep plus phosphor persistence, provided the shutter is open sufficiently long. In the usual single-sweep application, the graticule exposes the film for the time set by the shutter while the spot on the screen exposes the film for only the duration of the sweep. It is therefore not usually possible to adjust the trace and graticule for the same intensity and obtain good pictures since the effective exposure times for the two are different.

Success in obtaining good photographs of single-sweep displays will come only with experience. A few tips, however, may reduce the amount of experimenting required. The first thing which must be remembered is that the time the shutter is open must be greater than the sweep time. If the time of the event to be photographed is known or if it can be initiated at a desired time, the shutter need only be open for a period slightly longer than the sweep time. However, if the time of occurrence of the event to be photographed is not precisely known, the shutter will have to be left open a longer period of time to be certain that the event will be photographed. These factors pretty well determine the shutter speed which should be used.

The camera lens setting will be largely determined by how much control you have over the intensity of the trace. If you can obtain a fairly bright spot without sacrificing sharp focus, do so. This will enable you to use an f-stop number higher than f/4 and will permit both the trace and graticule to be in good focus. If the trace is quite dim and cannot be intensified without loss of focus, set the lens at its lowest f-stop number. The important point here is that since the shutter speed has already been determined, the selection of lens opening will determine how well the trace photographs. In single-sweep applications you must make your camera settings for the trace intensity and duration. You cannot use the graticule as a reference.

Once the lens and shutter settings have been determined, these can be used to find the correct graticule voltage from the nomograph or from previous results. Selection of the appropriate graticule voltage will insure that the graticule photographs properly.

Methods of Improving Writing Rate

Several factors which affect writing rate have already been discussed. Their effects will be summarized here. In general, writing rate can be increased by any of the following methods: (1) using a faster lens (lower f-stop numbers), (2) using a more sensitive or faster film, (3) using a crt phosphor with a higher actinic value, and (4) using a large object-to-image ratio. In addition, there are several other methods which can be used. There is a large number of ways available to improve writing rate, however it is not practical in most cases to use all methods simultaneously. Even though use of a particular method by itself may double the writing rate, for example, use of that method in conjunction with several other methods may produce only a slight improvement. In other words, the improvements in writing rate produced by the various methods are not all additive.

The writing rate of Tri-X film can be increased in some circumstances by increasing the development time. In contrast, the writing rates of the various Polaroid films can sometimes be increased by decreasing slightly the recommended development time. Decreasing the development time of Polaroid film will, in some circumstances, nearly double the maximum writing rate. Although the background is considerably lighter and contrast is lowered, detail can be seen in parts of the picture which would not be visible if normal development time were used.

A method which sometimes produces very good results with either conventional or Polaroid films is prefogging. In prefogging, the film is exposed to a predetermined amount of light for a definite period. The intensity of the light and the period of the exposure are so chosen that the film is brought right to the threshold of being exposed. A lesser amount of light is then required to expose the film than would be required without prefogging. The method is rather analogous to pushing a boulder to the edge of a cliff. Only a slight amount of extra effort is required to get the boulder to go over the edge while a great deal of effort is necessary if the boulder is back several feet from the edge. Prefogging the film "pushes it to the edge". The prefogging technique can produce an increase in maximum writing rate of two or more times depending on film type, film condition, the nature of the prefog light and other variables. Prefogging results in a slightly foggy background on the photographs and somewhat less contrast. This is a small price to pay for a large increase in writing rate, however.

Postfogging is very nearly the same as prefogging. The difference is that the film is exposed to the controlled light source after the exposure rather than before. Postfogging produces very nearly the same increase in writing rate as prefogging.

A special prefogging unit will permit you to prefog film a specific amount. If you do not have a prefogging unit, some experimentation will be required to determine the best amount of prefogging light. The amount of prefogging should be just sufficient to make the background in prints slightly hazy rather than completely black.

While not strictly a means of improving writing rate, transillumination permits you to better see information which is recorded on Polaroid prints. In the technique of transillumination, the print is observed with a source of bright diffused light, such as a light bulb, directly behind the print (see Fig. 3-7). The light passing through the print brings out detail which would otherwise not be evident.

Several of the techniques used to improve writing rate can be combined resulting in a very appreciable increase. For example, with Polaroid films the techniques of under development, prefogging, and transillumination will frequently result in a large increase in the maximum writing rate.

Eliminating Parallax and Focusing Difficulties

As described in Section 4, the fact that the oscilloscope trace and graticule are not in the same plane results in some parallax. This also makes it impossible to obtain good focus simultaneously on both the trace and graticule at f-stop numbers below f/4. Both of these difficulties can be eliminated where necessary by either of two methods.

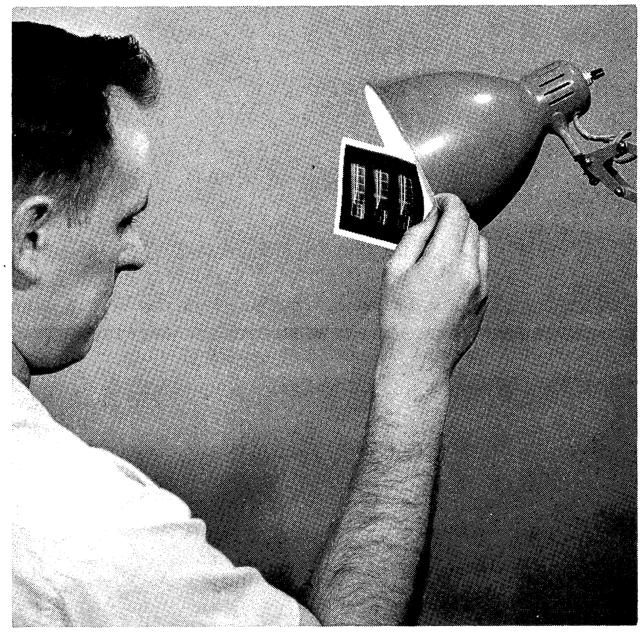


Fig. 3-7. Using transillumination of a Polaroid print to see otherwise invisible information on the print.

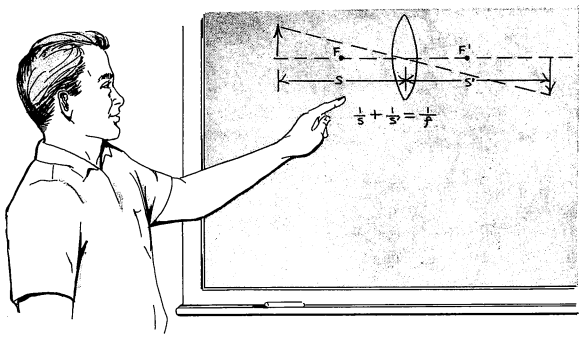
The first method involves double exposing the film. First set up the oscilloscope display as usual and focus the camera on the trace. Turn down the graticule intensity to minimum and make the first exposure of the trace only. Then turn up the graticule to its former brightness and refocus the camera on the graticule. Turn down the oscilloscope trace and make a second exposure of the graticule only. The resulting photograph, due to refocusing between exposures, will have no parallax between graticule and trace and will also have both the graticule and trace in proper focus. Care must be taken in using this method that the position of the film for the second exposure is the same as for the first exposure.

The second method involves the use of the Nonparallax Graticule Attachment described in Section 4. Here a virtual image of the graticule is projected on the oscilloscope screen in the same plane as the trace. Photographs taken will therefore have no parallax between the trace and graticule and both will be properly focused. The conventional graticule on the oscilloscope should be removed when the Nonparallax Graticule Attachment is used.

Precautions for High Ambient Light Photographic Work

When the Type C-12 Camera is used in areas of high ambient light, (such as outdoors in bright sunlight) some special precautions should be taken to insure good results. First, make doubly certain that the viewing hood door is closed (or that your face blocks the light) before taking the picture. Allow sufficient time after the door is closed to permit the phosphorescence of the crt screen to decay.

Also, if a long exposure time is required, it may be necessary to cover the camera with a dark cloth to prevent the bright light from fogging the film. The camera will not normally need to be covered unless time exposures are taken.



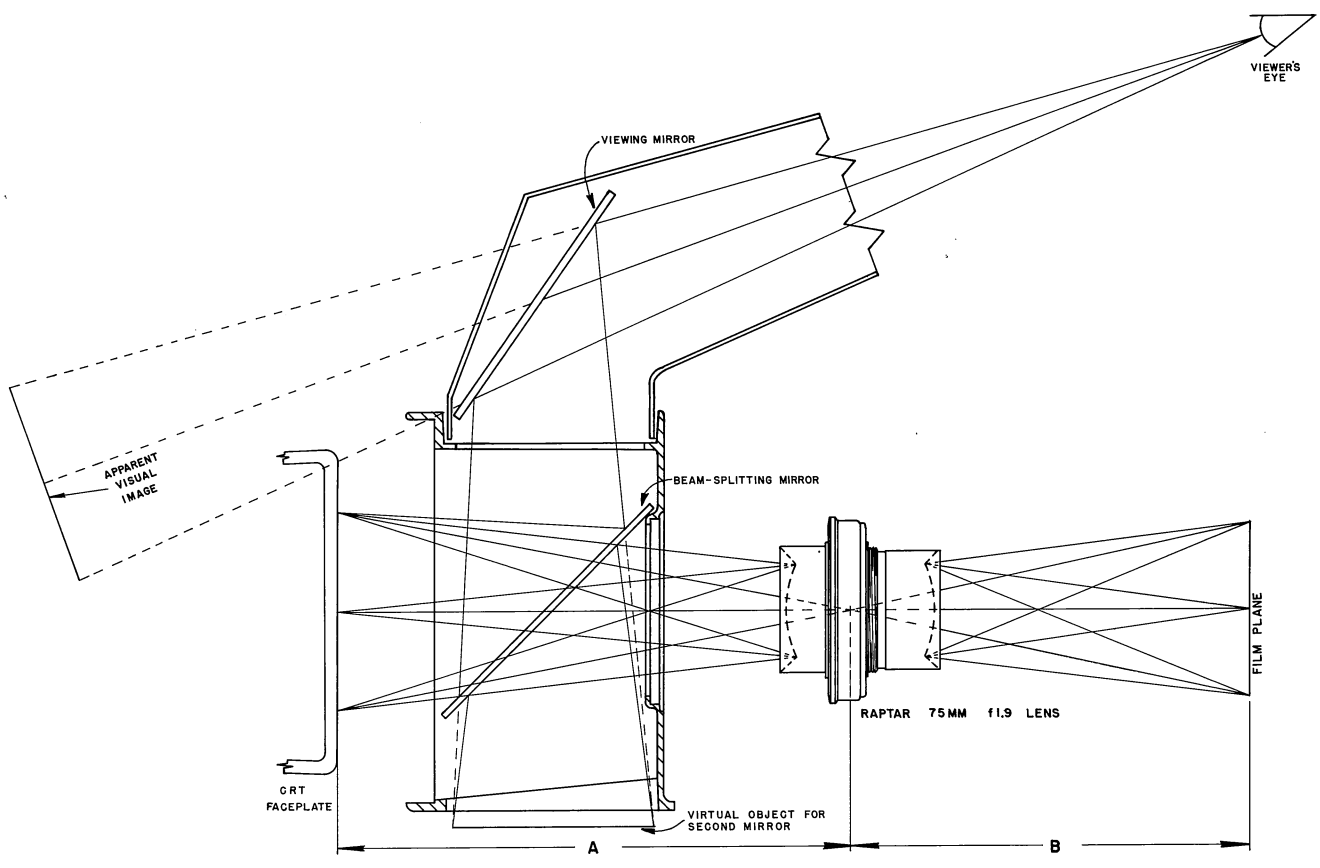
SECTION 4
THEORY OF OPERATION

Lens System

Figure 4-1 shows the construction of the Type C-12 Camera. The camera lens is directed at the oscilloscope screen through the beam-splitting mirror. At the 45-degree angle at which the mirror is mounted, it transmits approximately 65% of the incident light to the lens and reflects approximately 35% of the incident light to the second mirror and viewing system.

There are basically 3 different lenses which are available for the Type C-12 Camera. They are the Oscillo-Amaton f/4.5, the Oscillo-Raptar f/1.9, and the Simpson f/1.5. All three are ideally suited for oscilloscope camera applications.

Of the three lenses, the Oscillo-Amaton has the smallest maximum aperture. Although not as fast as the other two lenses, it is well suited for application where the oscilloscope trace is moderately bright. These applications include work involving repetitive signals and work at slow sweep rates. A drawing of the Oscillo-Amaton lens system is shown in Fig. 4-2. The three lens elements used in the lens system produce a high degree of lens correction.



MAGNIFICATION RATIO	1:1	1:0.9	1:0.7	1:0.5
A	150MM	158MM	182MM	225MM
B	150MM	142MM	128MM	112MM

Fig. 4-1. Optical arrangement of the Type C-12 Camera.

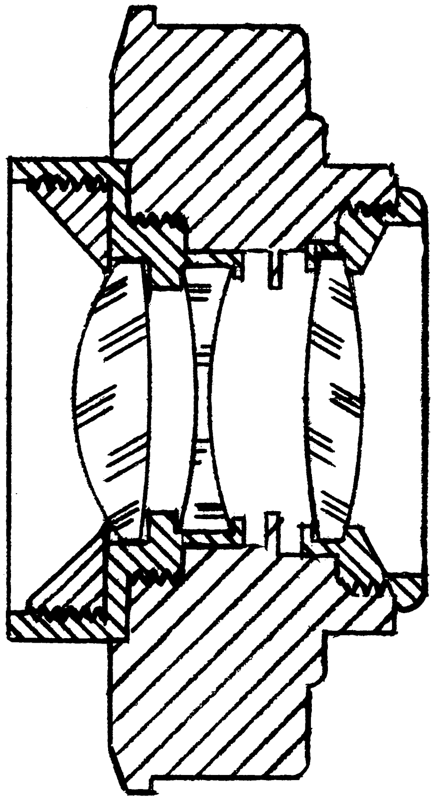


Fig. 4-2. Sectional view of the Oscillo-Amaton Lens System.

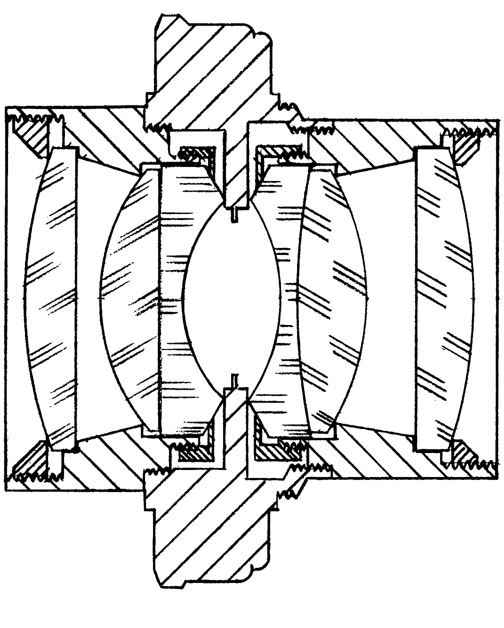


Fig. 4-3. Sectional view of the Oscillo-Raptar Lens System.

The Oscillo-Raptar lens has a much greater maximum aperture than the Oscillo-Amaton and is used in applications where a very fast lens is required. This includes single-sweep applications at the fastest oscilloscope sweep rates. The Oscillo-Raptar lens is approximately 5½ times as fast as the Oscillo-Amaton. The Oscillo-Raptar is shown in Fig. 4-3. The lens system was specifically designed for oscilloscope applications. The high amount of correction provided by the lens system provides faithful reproduction of the oscilloscope display on the film of the camera.

The Simpson lens shown in Fig. 4-4 is intended for applications involving extremely dim oscilloscope traces. The Simpson lens is approximately 1½ times as fast as the Oscillo-Raptar and 8¼ times as fast as the Oscillo-Amaton. This lens includes a high degree of correction to produce images which are faithful reproductions of the original oscilloscope display. It also has been designed specially for oscilloscope applications. The focal length of the Simpson lens is slightly different from the other two types, being 85 mm instead of 75 mm.

All three lenses provide negligible distortion of the image. Their essential differences are in their ability to photograph extremely dim traces such as those produced in single-sweep applications at the highest sweep rates.

The physical length of the three lenses is quite different. In order to allow for this and also to compensate for manufacturing tolerances, a special lens mounting system is used. This mounting system consists of the studs protruding from the front portion of the camera frame and the two locking nuts. The studs and the locking nuts permit lenses of virtually any reasonable length to be installed in the camera.

The object-to-image ratio of a particular lens system depends on the focal length of the lens and on the object and image distances. When it is desired to obtain a given magnification with a particular lens, the magnification and the focal length of the lens determine both the object and image distances. The magnification of a lens is given by the formula:

$$m = \frac{f}{s - f} = \frac{s'}{s}$$

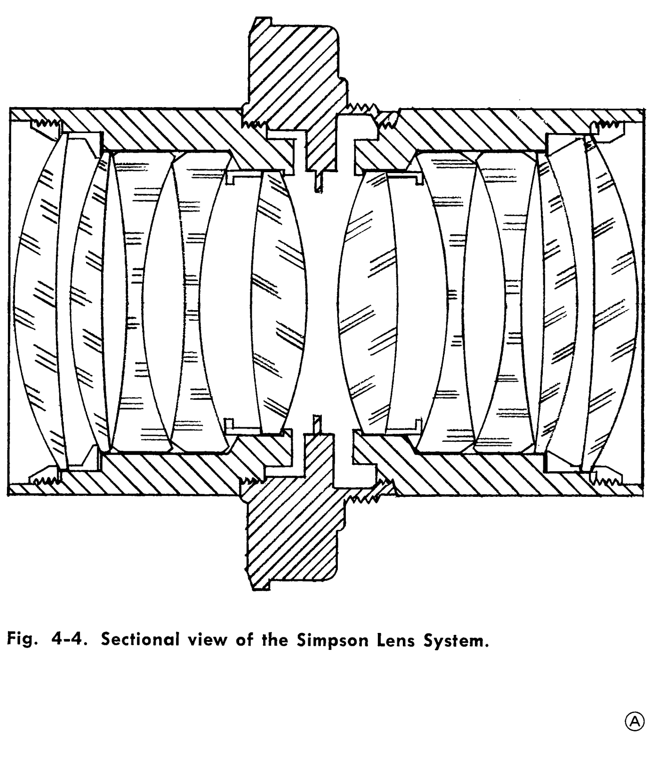


Fig. 4-4. Sectional view of the Simpson Lens System.

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where m is the magnification, s is the object distance, s' is the image distance, and f is the focal length of the lens. The image distance is also determined by the lens focal length and the object distance by the following relationship:

$$s' = \frac{sf}{s-f} = sm$$

The various lenses used with the Type C-12 Camera are installed in appropriate lens mounts which give the proper object and image distances and thus the desired object-to-image ratio. The image distance is set by screwing the lens into the rear of the camera frame. The lens mount automatically assures that the proper image distance is obtained. The proper object distance is then automatically obtained when the camera is focused.

The f-stop value for a particular lens system is found by dividing the focal length of the system by the diameter of the limiting aperture. Thus:

$$\text{f-stop value} = \frac{f}{a}$$

where f is the focal length of the lens and a is the diameter of the limiting aperture. Two means are available for increasing the speed of a lens (decreasing the f-stop value). These are (a) decreasing the focal length of the lens, and (b) increasing the diameter of the limiting aperture.

One characteristic of all lenses is that as the f-stop value is decreased, the depth of field for that lens is also decreased. This result occurs regardless of whether the f-stop

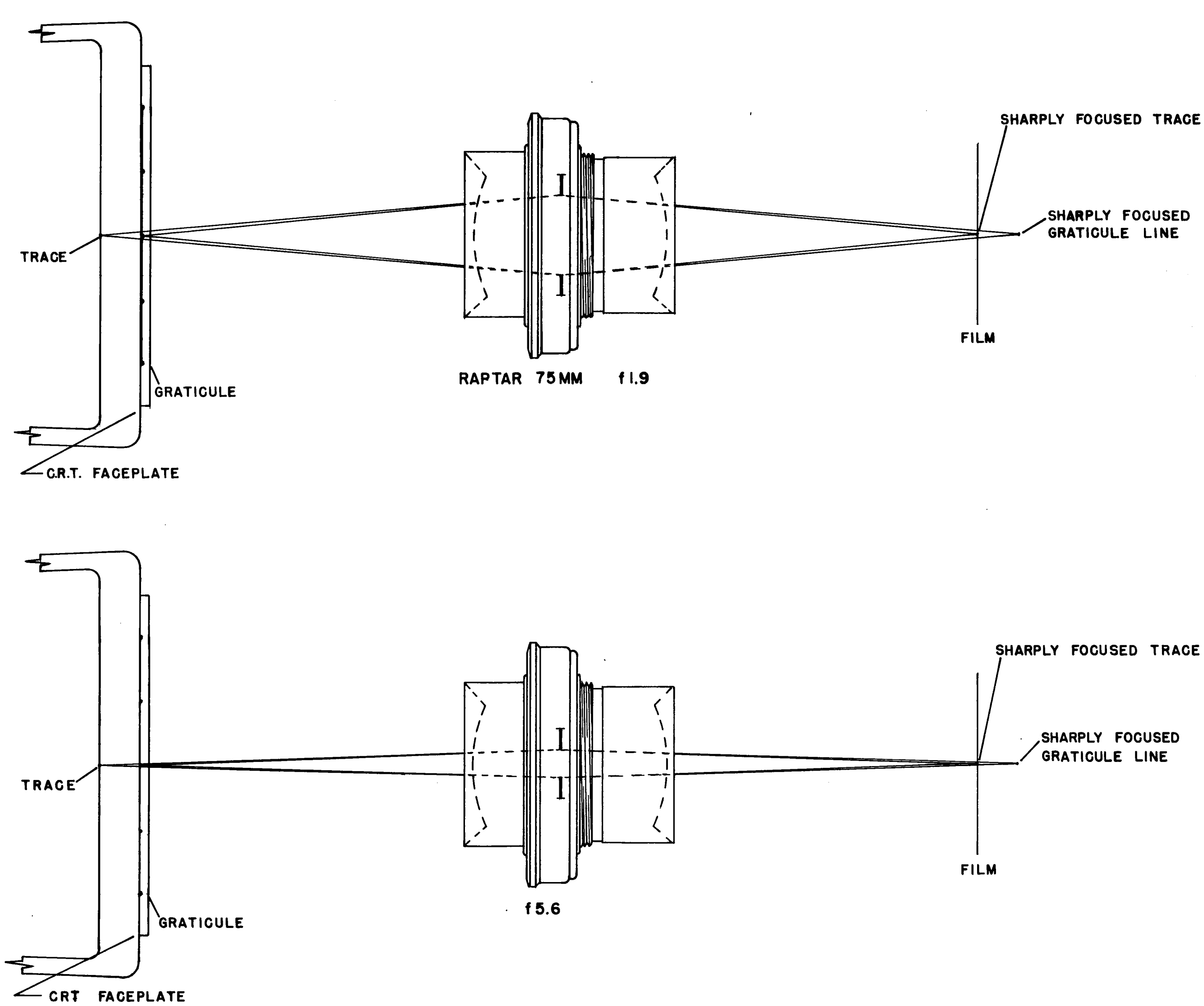


Fig. 4-5. Depth of field for different aperture settings. In the upper drawing, a fairly large aperture permits light rays through the outer extremities of the lens to converge rapidly to focus on the film. When the object distance is changed slightly, the image on the film is defocused quite rapidly due to the sharp convergence of the light rays. In the lower drawing the same lens is shown but with a smaller aperture. Rays through the outer extremities of the lens now converge much more slowly to the image on the film. When the object distance is changed slightly the image is defocused much more slowly due to the slower convergence of the rays.

value is decreased by shortening the focal length or by increasing the diameter of the limiting aperture. This is demonstrated in Fig. 4-5. An f/1.9 lens is shown in the upper drawing. It can be seen that the rays from the object on the axis which pass through the extremities of the lens opening converge sharply to the image on the film. This means that if the object is moved slightly, the image will be moved slightly away from the film shown in the drawing. This will result in the image becoming out of focus due to the wide divergence of the rays. Since only a slightly different object distance will result in the image being out of focus, the lens is said to have a low depth of field.

The lower drawing of Fig. 4-5 shows the same lens with the aperture reduced. This results in a value of f/5.6 for the lens system. A construction similar to the upper drawing shows that the light rays through the outer extremities of the lens now converge much more slowly to the film. Thus it is possible to change the object distance by a much greater amount before the image is defocused by the same amount. This lower lens system thus has a better depth of field than the upper lens system.

Depth of field is extremely important in lens systems designed to photograph oscilloscope displays. The low depth of field of an f/1.5 or f/1.9 lens means that care must be taken to properly focus the image. This characteristic makes it difficult to obtain proper focus simultaneously on two objects in different planes. Thus the oscilloscope trace and graticule (which are in different planes) cannot be simultaneously brought into proper focus at f-stop values less than f/4. In order to increase the depth of field of the lens system sufficiently to permit both the graticule and oscilloscope trace to be in focus, it is necessary to increase the f-stop value of the lens by decreasing the size of the aperture. Whenever possible, the large f-stop values should be used.

The characteristic by which the depth of field decreases as the f-stop value is decreased explains why the camera must be focused at the smallest f-stop value of the lens.

Fig. 4-6 shows another effect of the graticule not being in the same plane as the oscilloscope trace. Because the trace is farther from the camera, parallax occurs which makes displayed signals appear smaller than they really are in both the horizontal and vertical directions. This effect can either be eliminated by means of the Nonparallax Graticule Attachment or compensated for by increasing the vertical gain and speeding up the sweep rate of the oscilloscope.

Viewing System

The viewing system used in the Type C-12 Camera consists of a viewing hood and two mirrors, as seen in Fig. 4-1. Light from the oscilloscope screen strikes the beam-splitting mirror where part is transmitted to the camera lens and part is reflected to the second mirror.

A virtual image of the oscilloscope display is formed by the beam-splitting mirror. The virtual image acts as the object for the second mirror surface. The second mirror then forms a virtual image which is viewed by the observer. Due to the 45-degree arrangement of the beam-splitting mirror, the observer views the oscilloscope display as though he were looking directly toward the oscilloscope screen on a line perpendicular to the screen. This orthogonal view is full size but the image is approximately 20 inches away. In all cases the lens is considerably closer to the oscilloscope screen. The difference in the two distances produces a small amount of parallax between the viewed and photographed images. The small amount of parallax can usually be ignored.

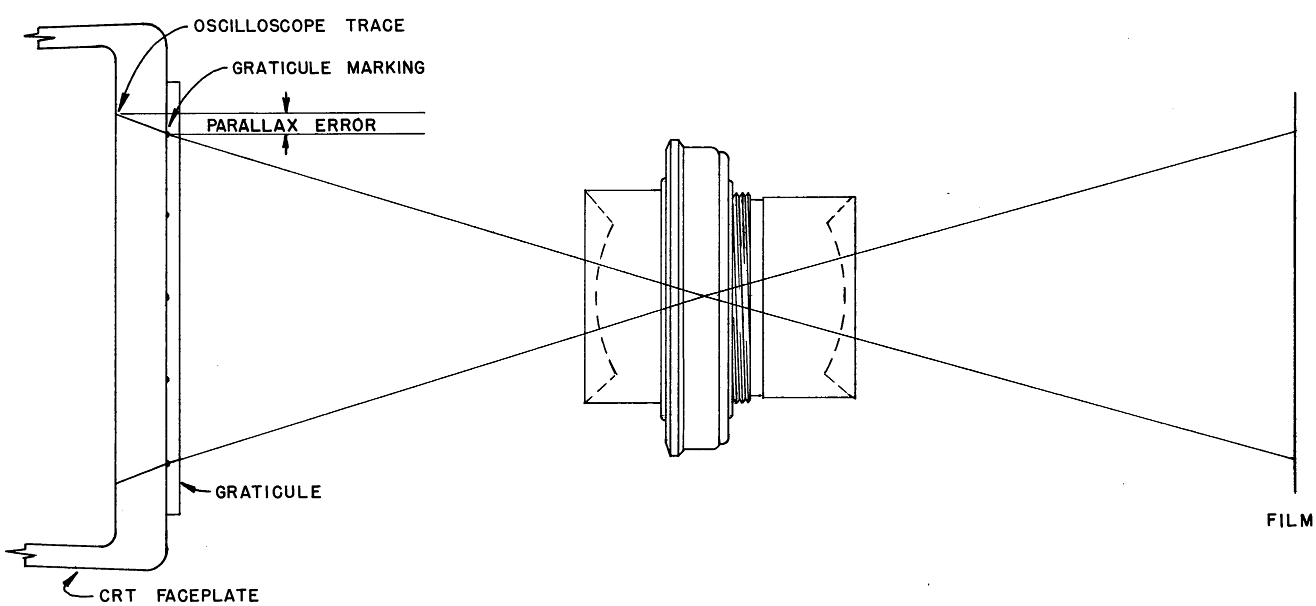


Fig. 4-6. The fact that the oscilloscope trace and graticule lines are not in the same plane introduces a certain amount of parallax error as can be seen from the illustration. The oscilloscope trace is actually higher than the graticule line; however, on the film both appear to be at the same level.

The double mirror viewing system is suitable for observing full 8 × 10 centimeter oscilloscope displays.

Optional Nonparallax Graticule Attachment

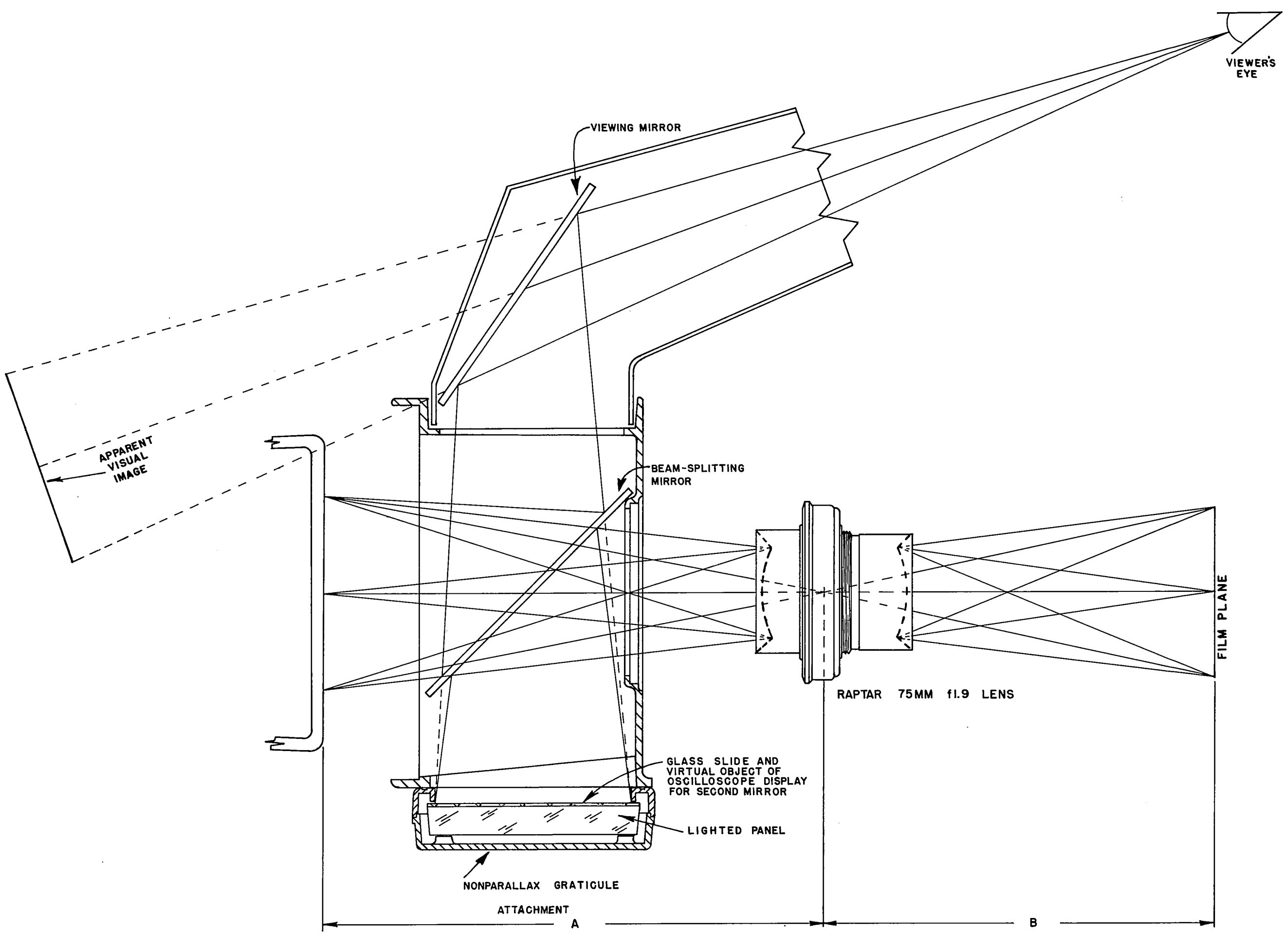
The optional Nonparallax Graticule Attachment makes use of the beam-splitting mirror to produce a virtual image of the graticule in the same plane as the oscilloscope trace and also an image which can be viewed. The construction of the nonparallax graticule system is shown in Fig. 4-7. The graticule which is mounted in the Nonparallax Graticule Attachment is lighted by small lamps in the assembly. The graticule is partially reflected and partially transmitted by the beam-splitting mirror. The reflected image is directed to the camera lens while the transmitted light is applied to the second mirror and is used in the viewing system. The object distance of the Nonparallax Graticule is very carefully adjusted to be in the plane of the oscilloscope trace when the oscilloscope trace is properly focused. Since the graticule image is in the same plane as the oscilloscope trace, no parallax occurs between the graticule and trace and no difficulty is encountered in simultaneously focusing both trace and graticule.

The Nonparallax Graticule Attachment is constructed so that special purpose scales may be mounted in the unit and projected on the screen of the oscilloscope.

Focusing the Camera

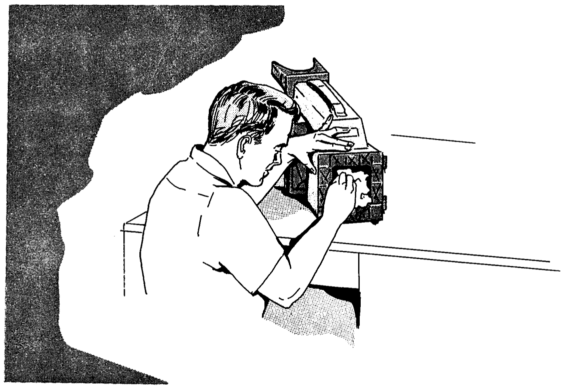
The lens mounts for the lenses used with the Type C-12 Camera fix the image distances for the lenses. Proper focus of the camera is then obtained by adjusting the object distance. This is accomplished by means of a knob and screw which adjust the distance from the front of the lens to the oscilloscope screen. Due to the fact that the image distance is fixed, when the camera is properly focused, the desired magnification is automatically obtained.

All of the backs used with the Type C-12 Camera provide the same image distance. This means that any two backs can be interchanged without affecting either the magnification of the lens system or the focus of the image.



MAGNIFICATION RATIO	1:1	1:0.9	1:0.7	1:0.5
A	150MM	158MM	182MM	225MM
B	150MM	142MM	128MM	112MM

Fig. 4-7. Optical arrangement of the Type C-12 Camera with the Nonparallax Graticule Attachment.



SECTION 5

MAINTENANCE

General Care of the Camera

The Type C-12 Camera should be given the same care as any other precision optical device. Care should be taken in handling the lenses and in operating the shutter mechanism to assure that they are not damaged. The camera should be kept covered when not in use to prevent dust accumulating on it.

Lens Care

In order to obtain maximum use from your camera, care should be taken that the lenses are kept clean and are properly installed in the instrument. When lenses require cleaning, the entire lens assembly can be removed from the camera by first loosening the locking nuts, then separating the rear of the camera from the front and finally unscrewing the lens from the rear of the camera frame. When replacing the lens, do not force the parts together. If the parts are mated properly, they will fit together easily.

Loose dust on lenses should be removed with a soft camel-hair brush. Fingerprints and other smudges can be removed with a high-quality lens tissue. Be careful that you do not scratch the lenses when cleaning them.

Do not attempt to disassemble the lenses. The lens assemblies are sealed and should therefore not permit dirt to get on the inner surfaces of the lenses. Each lens is individually adjusted at the factory to obtain the correct magnification factor. If the lenses are disassembled, and then reassembled, the magnification factor of the lens will probably be altered.

Special lubricants have been applied to the shutter during manufacture which makes further lubrication unnecessary during its lifetime. It is essential that neither oil nor graphite be used on the shutter, as either may ruin it. If the shutter acts sluggish it may be the result of continuous wear or extreme atmospheric conditions. Dust should present no problems since the shutter is sealed inside the lens system.

Mirrors

The two mirrors used in the C-12 Camera require a minimum of maintenance. Normally the only thing required is to keep the mirrors clean. The mirrors can be cleaned in the same manner as the lenses. A soft camel-hair brush can be used to remove loose dust after which fingerprints and smudges can be removed with a high-quality lens tissue.

Cleaning the Polaroid Back

Polaroid backs used with the C-12 Camera should be inspected after each roll of film is exposed and before the next roll is put in the camera. Any reagent on the rollers or other parts of the back should be removed immediately using a moist rag. If reagent is left on the rollers of the back, it may get on the next roll of film and ruin some of the pictures.

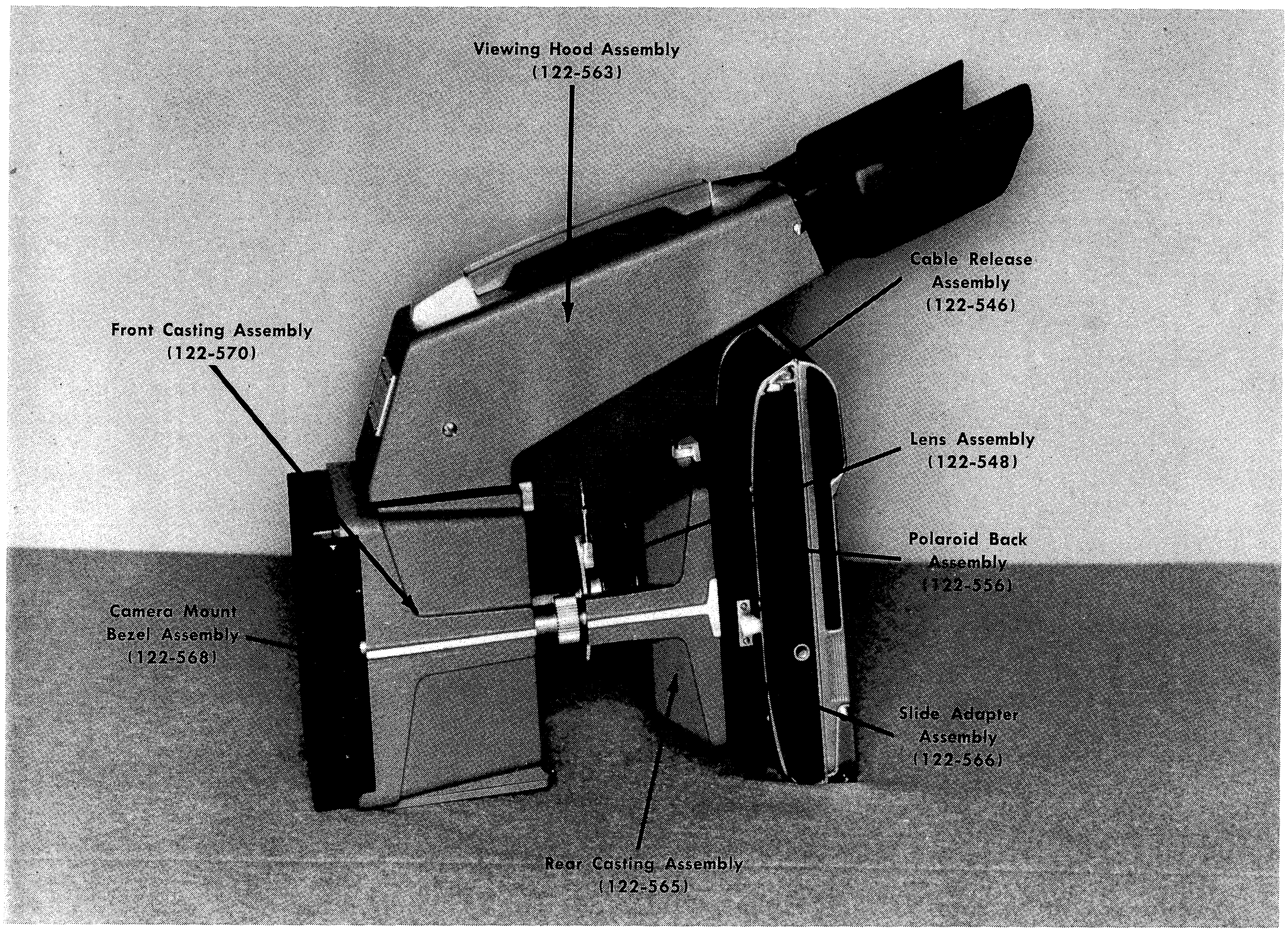
SECTION 6

PARTS LIST

HOW TO ORDER PARTS

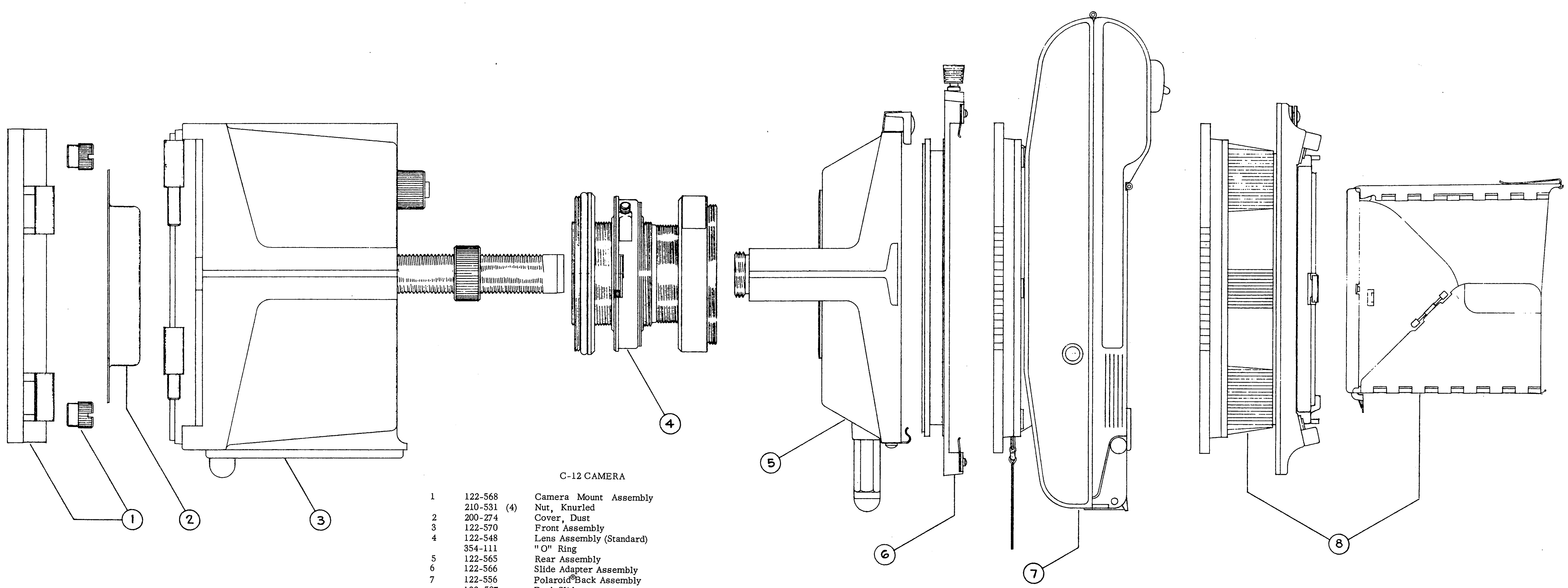
Replacement parts may be purchased from or through your local Tektronix Field Office. Be sure your order contains the following information; Camera type (C-12), serial number, part or assembly name, and part number. Any questions concerning an order should be taken up with your Tektronix Field Enigneer.

If a part you have ordered has been replaced with a new or improved part, you will be notified before a replacement is made. Tektronix Field Engineers are informed of such changes. When necessary, new parts are accompanied by replacement information.



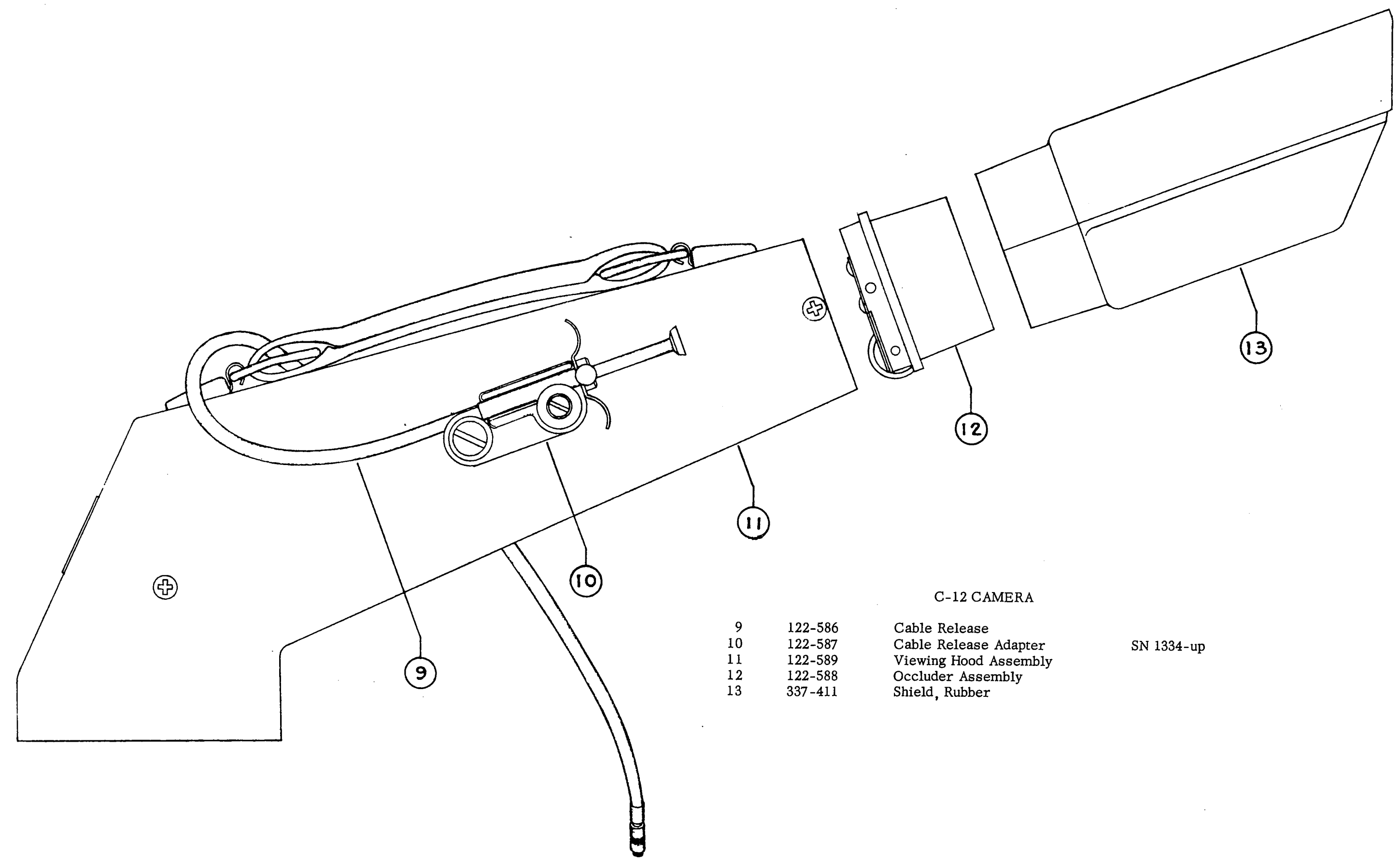
The Tektronix Type C-12 Camera with Polaroid Roll-Film Back attached.

NOTES



C-12 CAMERA

1	122-568		Camera Mount Assembly
	210-531	(4)	Nut, Knurled
2	200-274		Cover, Dust
3	122-570		Front Assembly
4	122-548		Lens Assembly (Standard)
	354-111		"O" Ring
5	122-565		Rear Assembly
6	122-566		Slide Adapter Assembly
7	122-556		Polaroid® Back Assembly
	122-597		Dark Slide
8	122-557		Graflox Back Assembly
	122-510		Focusing Hood



C-12 CAMERA

9	122-586	Cable Release	
10	122-587	Cable Release Adapter	SN 1334-up
11	122-589	Viewing Hood Assembly	
12	122-588	Occluder Assembly	
13	337-411	Shield, Rubber	

A

MANUAL CHANGE INFORMATION

At Tektronix, we continually strive to keep up with latest electronic developments by adding circuit and component improvements to our instruments as soon as they are developed and tested.

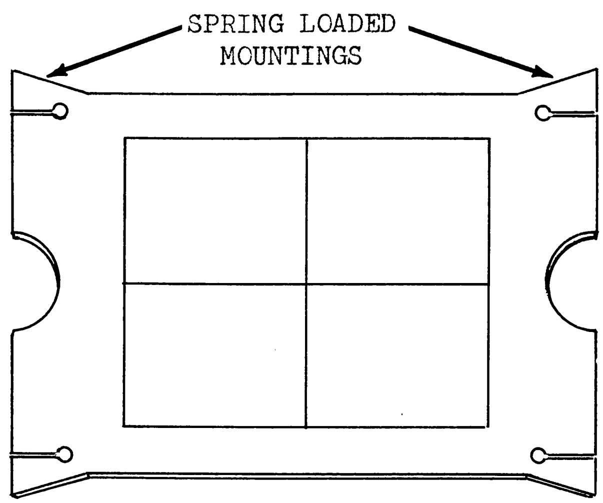
Sometimes, due to printing and shipping requirements, we can't get these changes immediately into printed manuals. Hence, your manual may contain new change information on following pages. If it does not, your manual is correct as printed.

C12, C13 and C19 CAMERA FOCUSING PLATE

Accurate focusing of the Tektronix Camera is possible by using the frosted plastic focusing plate. The focusing plate is an operational camera accessory shipped with each camera.

Focusing Procedure

To use the Camera Focusing plate, the regular Polariod Land camera back must be opened and the plate inserted where the film normally rests. The illustration shows the location of spring loaded mountings that will hold the plate firmly in place.



To install, insert the two bottom mounting ears inside the edge of the camera-back film compartment. Without compression, the upper mounting will not fit inside the camera. With nothing more than finger pressure, gently press the upper mounting ears into the film compartment. When properly mounted the frosted side of the focusing plate will face the camera lens and be flush in the normal film position.

With a properly focused crt display (such as the CALIBRATOR waveform) proceed as follows. Open the camera aperture to its widest point. Set the shutter control to T (for Time) and open the shutter. (It may be necessary to use a dark cloth hood to reduce bright room light when viewing the frosted plate.) Looking at the focusing plate, adjust the camera focus knob for best focus of the crt trace. This is important when taking large aperture single shot pictures.

For repetitive sweep photography you may prefer to focus the camera half way between best trace and best graticule focus. Under this second condition it will be necessary to stop down the camera aperture for best focus of both the crt trace and graticule. Remove the focusing plate, install the desired film in the camera, and proceed to take pictures.

The 4X5 Graflok back which is referred to in the Standard Camera Complement of the C12 and C19, has been replaced with the Camera Focusing Plate, Tektronix part no. 387-460. The instructions for use of the Focusing Plate are outlined above.

The 4X5 Graflok back is now available as an optional accessory and may be ordered by part no. 122-557.

A new type of shutter may now be found in your camera. The Ilex shutter has the same shutter speeds as the Alphax No. 3 Shutter.

The standard lens now furnished with the C19 is a Fl. 9, 1:05, Wollensak. The Wollensak lens may be ordered by part no. 122-549.

CAUTION

Experience has shown that the shutter release cable should not be operated in the position shown in the photographs in this manual. Continued operation in the position shown may break the shutter release cable and damage the shutter.

The new cable holder shown below prevents this breakage.