OPERATING AND MAINTENANCE
MANUAL

FOR

(R)

THE OXBERRY ELECTROSYNC OPTICAL PRINTER
OPERATING MANUAL
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1. OPTICAL PRINTER CAMERA and CAMERA CARRIAGE

The heart of special effects step optical printing is the ability to register the film in the camera and in the projector(s) precisely. The OXBERRY Process Camera and Carriage in this equipment provides that necessary registration.

It is also important to realize that this precision registration will be maintained in either direction and at all shooting speeds.
1.1 FILM FORMATS:

The OXBERRY Camera as installed is capable of accepting components for the handling of a large variety of film formats including 8mm, 8mm, 16mm, double 16/32mm, 35mm and other special formats. The film is transported in this camera by means of a sprocket and it is registered in exact position by means of a shuttle with fixed pin registration.
1.1.1. DARKROOM LOADING THE MAGAZINE:

The magazine is opened by rotating the covers located on the outside of the lobes of the magazine in a counterclockwise direction. The film is threaded from the feed side of the magazine (which is at the left side when the bottom of the magazine is down and the opening is toward the person doing the threading), over the roller, out through the opening at the bottom of the magazine, over the bar separating the two sections of the magazine, back through the opening on the take-up side of the magazine, back through the opening on the take-up side of the magazine, over the roller and wound on the spool. (Fig. 2) The covers are replaced on the two lobes of the magazine and screwed clockwise until they are hand tight. The magazine is then taken from the darkroom, placed on the camera such that the front of the bottom section of the magazine is engaged by the camera's magazine seat and locked in place by means of the knurled knob at the back of the camera's magazine seat. (Fig. 1-6)
Once the magazine has been loaded with raw stock in
the darkroom, further loading of the camera does
not require use of a darkroom. In this case it is
sufficient to open the takeup side of the magazine
(make sure before opening that it does not contain any
exposed film), pull out three feet of film from the feed
side of the magazine, insert it through the bottom of
the takeup side of the magazine, over the roller and
wind it over the take-up core.
1.1.2. PREPARING THE CAMERA FOR THREADING:

(Fig. 3) The camera is prepared for threading in the following manner:

The load/run switch on the camera panel is switched to load position, the camera door is opened, the knurled knobs located between the guide rollers on the top side and on the bottom side of the sprocket are rotated counter-clockwise until stopped. The button on the shuttle (Fig. 4) (detent pin) is raised up until locked in place. The loop on the bottom of the magazine is pulled from the feed side of the magazine until enough film is available to be threaded around the sprocket and through the shuttle and buckle switches. (Fig. 1-5)
1.1.3 THREADING (Fig. 3):

Place the film between the chrome guide plates in the shuttle. Place the film from the feed side of the magazine on the top side of the sprocket. Be sure the sprocket teeth enter the perforations in the film. Replace the guide rollers by turning the knurled knob between them clockwise. Place the film from the take-up side of the magazine on the sprocket, again being sure that the sprocket teeth enter the perforations, replace the guide rollers by rotating the knurled knob between them clockwise. The film in the shuttle should be slipped either up or down until the fork pin engages a sprocket hole. Release the button (detent pin) on the shuttle. To check that the camera has been properly threaded, rotate the knurled knob on the shaft between the camera and the drive motor (Fig. 1-7) by hand and watch that the shuttle transports the film correctly and the sprocket feeds and takes it up correctly. Four or five turns of the drive shaft should be enough to check this out thoroughly. If the film is being transported correctly, put the control switch into run position, reset the
buckle switch and run a few frames in stop motion mode (refer to the appropriate section of this manual). The camera is now ready for photography and the door should be closed.
1.1.4. BI-PACKING:

It is sometimes necessary to run titles that must be included in the developed film simultaneously with the exposing of that film to the photographed images. When this is to be done, a specially modified 400 ft. Bi-pack magazine is used. This is mounted directly onto the camera. The regular 400 ft. magazine is mounted on top of that modified magazine.

The shuttle should be adjusted by rotating the screw on the cam follower to the position where the number "2" is facing up rather than the number "1". This has the effect of adjusting the gap between the pressure plate and aperture face to allow two film layers to pass without undue pressure.

The adjustment is located on the yoke where the roller bearing normally comes in contact with the cam to raise and lower the stripper plates. The bearing is fastened to the yoke by means of a screw on an eccentric cam. The
eccentric cam is marked with a "1" on one side and a "2" on the opposite side. Normally, the number "1" is showing up and then the shuttle is adjusted for one film operation. In order to adjust the shuttle for two film layer operation, the screw at the front of the roller and the eccentric should be removed, the eccentric turned around until the number "2" shows at the top and then the screw replaced and tightened.

Threading through the camera is accomplished as described before with the exception that two films are being threaded simultaneously over the sprocket and through the shuttle. In order to assure sharp contact printing of the bipack film, it is important that emulsion be in contact with emulsion. Also as the camera is threaded with the shutter in closed position (0°) the exposed film has to be threaded in the shuttle such that the frame lines are in proper position when the film is registered on the pins (in sync). Finally, the bipack takeup motors have to be turned on by means of a switch positioned in the back of the camera next to the takeup motors. (Fig. 1-3) By switching to bipack position to bipack position the four takeup motors are powered rather than the normal two.
1.2 SHUTTER OPENING:

The camera is equipped with a standard rotary shutter. It has a 170° opening which determines the exposure time as a function of camera speed. The exposure time may be reduced by the use of the dissolving shutter which serves to reduce the angle of this opening. The shutter rotation and film advance are tied together and as such film is advanced each time there is an exposure.
1.2.1 FADE/DISSOLVE (FD/DX) SHUTTER:

The Fade/Dissolve shutter is an auxiliary shutter to the main shutter; it also has an $170^\circ$ opening and rotates simultaneously with the main shutter. In open position, its opening coincides with the opening of the main shutter resulting in exposure over $170^\circ$ of shutter rotation. However, the FD/DX shutter can be rotated with respect to the main shutter. This rotation can be accomplished either via the electrical FD/DX control system or manually using the FD/DX dial on the side of the camera. (Fig. 1-8) Using this shutter, the exposure angle (and hence the corresponding exposure time) can be changed to any desired value between $0^\circ$ to $170^\circ$.

To pass film without exposing it also this shutter can be closed in advance by rotating it to $0^\circ$ (the position is also marked close). To move the shutter manually, the control knob must be depressed to release the electrical brake locking it and turned to the desired angle simultaneously.
1.3 BUCKLE SWITCH:

The camera is equipped with a set of very sensitive sense fingers that act as a buckle switch. (Fig. 1-5) When any of these sensing fingers is touched a buckle situation is sensed. When this happens, the camera is allowed by the electronic logic system to be driven to the closed shutter position (0°), the drive motor is de-energized and the red buckle light on the camera control panel is turned on. A buckle situation may usually indicate that either the film is not being taken up properly or that the film has snapped, has run out or is not threaded properly. To recover from a buckle condition, the cause has to be remedied and the red buckle light/push button has to be depressed.
1.4 FD/DX FRAMES SELECTOR.

This is used in conjunction with the automatic fade and dissolve controls detailed in Section 6. It is used to select the length of a FD or DX. This selector is infinitely variable between 8 and 128 frames, though it is marked and notched at only specific positions. These positions corresponding 8, 16, 24, 32, 48, 64, 96 and 128 frames. The markings and notches are put at these particular points because they represent the most frequently used frame length selections. However, the dial can be set at a point between any of these with a proportional change in the length of the resulting fade or dissolve. In this case it is best to determine ahead of time the correct and desired position by trial and error.

* On equipment with electronic FD/DX these controls are different and are described in a special insert page for this option.
1.5 TILT CONTROL (see Fig. 4)

This control is used to rotate the camera up to $\pm 10^\circ$ around a normal optical axis through the center of a 35mm sound aperture. It is used to tilt an image or to correct tilt in the original footage. The tilt is adjusted by means of two square shafts in the front of the camera carriage. A crank handle is supplied with the printer to operate these shafts. The left hand shaft is a locking mechanism. It can be released by rotating it counter-clockwise two revolutions. After the tilt is done and readjusted back to its right angle it should be locked before resuming the shooting. The second shaft is the tilt adjustment. When this shaft is rotated, the camera is tilted and as it is tilted a dual counter indicates the amount of tilt. A finer indicator of the tilt is marked on the dial located around the tilt shaft. These indications are in arbitrary units and can be used only to guarantee repeatability of setting. It should be noted that as the tilt is around the center of the 35mm sound aperture it is not around the center of a 16mm aperture.
1.6 OUT OF FOCUS CONTROL (See Fig.)

This control enables the operator to defocus an image when desired. It is located on the back of the camera carriage. It has two parts, one is a locking mechanism to guard against defocusing the image accidentally and the second is the defocusing control. By means of the hand crank supplied, the defocusing system can be unlocked simply by turning that shaft two turns counterclockwise. Once the out-of-focus system is unlocked the handle can be moved to the second shaft. Turning the shaft in either direction moves the system out of focus. The amount of movement is indicated by an indicator calibrated in .001". Normally this indicator is set to "0" at normal focus position and thus returning it to zero will put the system back into sharp focus. After returning to focus the system should be locked again so as to prevent accidental misalignment.
The standard 5111A Printer does not have tilt control nor automatic focus on the camera. Instead it has a very simple sizing and focus adjustment system. The camera carriage is locked into position by a locking screw on the bottom left of the camera carriage (Fig. 1-10). Once the lock is released by turning it counter clockwise the camera's position can be changed by means of an adjustment control located on the bottom center of the camera carriage (Fig. 1-12).

The lens carriage can be moved in a like manner via similar controls on the lens carriage (Fig. 1-36, Fig. 1-13). By viewing through the viewer or a precision scope it is possible to move the camera and lens carriage such that a image of the required size is viewed in best focus. After this is done both carriages should be locked back in position securely.
1.7 DIGITAL FRAME COUNTER: (Fig. 1-34)

Although this writeup is located in the camera section, it actually applies to all counters whether for the camera or projectors. The counters are electronically activated digital counters that display the current frame count of the camera or projector in 5 bright \( \frac{1}{2} \)" digits. Each counter receives count signals from its associated encoder. These signals make the counter count up by one digit or down by one digit whenever a frame has been changed. In order to avoid ambiguity, the encoder signals are such that a count signal is sent to the counter at a definite point in the frame. The camera signal is sent when the camera is in the process of exposing a frame (180° position). The count signal to the counter will always cause the proper count sequence even if the encoder is rotated back and forth over the count point. Two count modes are available: frame count and foot-frame count. In the first mode the digital number represents the number of frames counted (up or down) from the starting zero point (or any other reference as desired). In the second mode the field of numbers is grouped into two sections, the first 2 digits count frames from 0 to 15 the second field of 3 digits counts each group of 16 frames as one foot.
(corresponding to 16 frames of 35mm per foot of film.)
The two fields are separated by a dot when in this mode.
The group of 3 digits in foot/frame mode represents a
maximum count of 1000 foot of 35mm film but only 400 ft.
of 16mm film hence an additional indication has been
provided to double the counter range. This extra digit
is represented by a decimal dot beyond the last digit
which appears once the 1000 ft or the 100000th frame
has been reached.

The controls of each counter are on the left side of its
front panel. The top switch is marked For/Rev and its
function is to reverse the direction of the counter with
respect to the corresponding machine element. This
means that when this switch is in forward position, the
counter will count up when the camera (or projector) goes
forward and count down when it is going in reverse. However,
when this switch is in Rev. position, the counter will count
down when the camera (or projector) goes forward and
will count up when the camera goes backward. The next
switch down is a pushbutton switch marked CLEAR. When
depresseed it clears all counter digits to "0". While
depressed it also energizes all the segments of every
digit making it easy to spot a malfunctioning segment.
The next switch down is a momentary lever switch with
center off. This switch is used to preset the counter to
an arbitrary number. It makes the counter count up
when the FOR/REV switch is in FOR and count down
when it is in REV. Two count modes are available:
FAST which counts in hundreds and SLOW which counts
the units. The lowest switch is the frame/foot-frame
switch. In frame position, the counter counts as a
regular digital counter. In Foot-Frame mode a decimal
point appears between the second and third digits and
the counter counts modulo 16 i.e., the first two digits
count from 0 to 15 and then on the next frame the third
digit counts up one representing one foot and the first
two digits are reset to zero. The counter is, hence,
a foot frame counter for 35mm film.
Being electronic counters, they are susceptible to losing their count during a power failure. To protect against this eventuality, the power supply for the counters includes batteries that are constantly being charged. In the case of a power failure, these batteries can keep the counter's display on for several hours.

The totalizing counter\(^1\) is an additional counter counting the camera frames. It can be used to record the total number of frames (or feet) used up from the total magazine load or on a given job etc. It also acts as a backup for the camera counter. Normally, this counter is reset to zero when a newly loaded magazine is mounted.
1.8 SUPERIMPOSITION VIEWER (Fig. 1-2)

1.8.1: The viewer is located on the camera at the left hand side closest to the lens mount. The viewer is controlled from the combination push button and indicator light located on the camera panel (Fig. 1-14) on the control console. Pressing this button in momentarily will cause the viewer prism to be moved into position by an electric motor so that the operator may view through the eye piece the image that will be exposed on the film in the camera. When the viewer is in position for viewing, the indicator lights inside the viewer button and that in the viewer by-pass push button will come on. While the viewer is in view position, the film in the camera cannot be exposed or transported. However, the viewer by-pass push button located next to the viewer push button can be pressed to override this interlock and to allow the film in the camera to be transported as long as the bypass is held down. It should be borne in mind, however, that the viewer prism being in position for viewing will keep the film in the camera from being
exposed. The by-pass can only be used as an override to allow the transporting of film. After the projected image has been viewed, the viewer can be moved out of the way by pressing the viewer button again. When the viewer no longer obstructs the aperture in the camera, the indicator lights on both the viewer button and the viewer by-pass button will go out.
1.3.2 RETICLE AND REGISTRATION PIN PLATE:

The registration pin plate is used for positioning and viewing a single frame of 35mm film in exactly the same position it would be photographed in if it were part of a film bipacked in the camera. The reticle is marked in the following manner: The largest rectangle is marked "FULL" and delineates the image that will be exposed by a "FULL" aperture onto 35mm film. When this aperture is used (on its proper size and center) a sound track cannot be added to the film. The next smaller rectangle marked "CAMERA" delineates the image that will be exposed by the aperture onto 35mm film when a sound tract is to be used on that film. The next smallest rectangle marked "PROJ" delineates that area of the image on sound 35mm film that will be projected onto the screen. The next smallest rectangle dotted and marked "T.V." delineates that area of the image that will be projected by a T.V. camera. The next markings represent 16mm format. The first rectangle in this group marked "CAMERA" delineates the image that will be
exposed by the aperture on 16mm film. The next
to smallest rectangle marked "PROJ" delineates that
area of the image on 16mm film that will be projected
onto the screen. The smallest rectangle dotted and
marked "T. V." delineates that area of the image on
16mm film which will be projected on a T. V. screen.
1.9 INTERCHANGING COMPONENTS IN THE CAMERA

1.9.1 REMOVING SPROCKET ASSEMBLY:

The two thumb screws, one in the upper right hand corner of the assembly and one in the lower left hand corner of the sprocket assembly are unscrewed releasing the sprocket assembly consisting of the film guide, guide rollers, the sprocket itself and the plate on which these units are mounted. The new sprocket assembly is introduced, the drive shaft is engaged carefully by rotating the sprocket wheels slowly until the key on the back side of the sprocket engages the sprocket drive and then the thumb screws contained in it are screwed into the two holes just vacated. This is precision equipment and the sprockets should be kept under complete control as they are being interchanged to insure that they are not damaged. (Components should fit and engage smoothly, force should never be used.)
1.9.2 INTERCHANGING SHUTTLES:

The shuttle is removed by swinging the two thumb locks holding the back of the shuttle up and away from the center of the shuttle. This will release the shuttle allowing it to slip out of the camera body. The new shuttle is taken and slipped in very carefully. At first, the fork of the shuttle may not be oriented properly to go over the cam; therefore, as the shuttle is slipped into place the fork should be moved so that the cam will fit between the tines of the fork as the shuttle is being slipped in. A second adjustment will have to be made when the shuttle is almost completely in. The follower that rides in the face of the cam may have to be adjusted back and forth so as to go into the groove of the cam. After this last adjustment is completed, the shuttle can be slid all the way in and the two locking levers can be turned back to lock the shuttle in place.
1.9.3 REPLACING RETICLE AND PIN PLATE:

While the 35mm reticle has all of the markings that are necessary for either 16mm or 35mm photography, it has pins for registering only 35mm film properly in the viewer. When it is necessary to properly register 16mm film, the 35mm reticle must be removed and replaced by the 16mm reticle with 16mm registration pins on it. The viewer consists of two parts that are mounted onto the printer by tongues and grooves. The part with the eye piece in it and the part with the reticle in it (Fig. 1-2) should be taken as one unit and carefully slid up and outwards until clear off the grooves. The part with the eye piece in it is then slipped out and off the part containing the reticle. The eye piece is then slipped onto the new piece containing the 16mm reticle and pin plate and the entire unit, very carefully, slipped back into place on the printer. When replacing these units on the printer, they should be slipped down gently but firmly until stopped. If this is not done, the alignment between the viewer, camera and projector will be lost.
2. MAIN LENS SYSTEM

2.1 MAIN LENS AND MOUNT

A 103mm f/2.8 EKTAR printing or a 105 f/2.8 printing Nikkor lens is supplied with the printer as standard equipment. This lens is mounted into the compound lens mount between the camera and main projector.

The lens mount compound permits the operator to move the lens vertically or horizontally in a plane normal to the optical axis of the printer by means of two hand controls (Fig. 1-1, Fig. 1-9) and also to move the lens along the optical axis by means of a hand control supplied (Fig. 1-13). A precision dial indicator on each axis of movement registers directly and accurately the position of the lens mount. When the equipment is aligned initially, the lens is positioned on the exact center of the apertures such that it also moves along that optical axis (tracks). Also, the follow focus system is adjusted for sharp focus over the entire range of zoom. At this position all three
dial indicators are set to zero and this becomes the normal operating position of the lens. In order to photograph off center (push-off) all that needs to be done is to offset the lens from center by turning the compound's hand controls. The control on top of the compound will displace the image vertically while the control in front of the compound and toward the operator will shift the image horizontally. At all times the exact position is given by the dial indicators (graduated in increments of 0.0005") permitting absolute 2 repeatability of position. The third crank control can be used for focus changes or for defocusing an image using lens displacement.
2.2 INTERCHANGING LENSES:

The lens supplied with the printer is selected to cover the entire zoom range, be sharp and color corrected and should satisfy all requirements of normal use. However, situations may arise in which a different lens may be needed for a particular application. When it is required to change the lens and a lens of proper size and mount is available, it can be interchanged with the normal lens. However, in this situation the follow focus (when available) will be inoperative and focusing will have to be done all ways manually by moving the camera and lens mount along the optical axis (within the available range). If a lens is very close in focal distance to the 103mm, the follow focus may be adjustable to accommodate it.

The procedure for changing the lens is very simple. However, the new lens must be mounted in the proper mount. The existing lens is removed by moving the lens mount to a
position at a convenient distance from the projector (at least 6''). The mounted lens within its holder is removed by releasing the two wing tabs in the front of the lens mount. The lens can be pulled forward in the direction of the projector until it clears the mount completely and can be removed (make sure to store it in a safe, clean and dry place.) Before inserting the new lens—this lens should be cleaned properly. The replacement lens (assuming it is compatibly mounted) is placed in the position of the lens just removed and secured tightly by means of the locking tabs.

As mentioned above, the follow focus will generally not be operative with a replacement lens and manual focusing must be used. Also the tracking position of the new lens will generally be different than the lens it has replaced and the lens has to be tracked again by proper adjustment of the lens mount and its indicators. (See appropriate section on tracking the lens).
3. MAIN PROJECTOR SYSTEM

The controls of all projectors are basically identical and so are the procedures for threading, the shuttle and sprockets, the take ups and major components like motors, counters, encoder electronics, etc. Hence these components will be dealt with once (for the main projector "A" and this will be applicable also to any other projector in the system.)
3.1 FILM FORMATS:

The projector heads, as installed, are capable of accepting components for the handling of a large variety of film formats including 8mm, 88mm, 16mm, double 16/32mm, 35mm and other special formats. Normally, ASA standard negative perforation pins are used but also positive perforation can be supplied. The film is transported by means of a set of sprockets and a fixed pin registration shuttle using either dry or liquid gates which are available for most film formats.
3.1.1. THREADING THE PROJECTOR:

The projector is prepared for threading in the following manner:

The control switch marked LOAD/RUN on the projector control panel (Fig 1-15) should be put into the LOAD position and the LOAD light should go on. In this position the projector is turned automatically and is stopped in the position in which the stripper plates are off the pins and the shuttle is ready to be loaded. Also, the thread knob of the projector (Fig. 1-32) is free to be turned manually to check the threading. In LOAD the take-up motors will also be stopped -- facilitating the threading process.

First the projector's component and takeups should be adjusted for the proper film formats. If this is not the case, follow the procedure indicated in the section named inter-changing projectors components. The film is then placed on the takeup reel (Fig. 1-24) located below the projector and threaded as per figure 5 (make sure that the film direction and
emulsion are proper). The guide rollers on each of the sprockets are relaxed by rotating the knurled knob between the rollers clockwise for bottom sprocket and counter-clockwise for upper sprocket. Thread the film over the spring rollers as shown in Fig. 5 and then between the guide roller and over the sprocket teeth making sure that the teeth are in the film's perforations.

By turning the knurled knob of the bottom guide rollers counter-clockwise return the guide rollers to their original position securing the film onto the sprockets' teeth. The detent pin on the shuttle is then pushed left until locked in open position. The film is slipped between the pressure plate and the stripper plate, positioned in the aperture off frame (projector is now in thread position) and the detent pin is released. Move the film gently up or down until the pin enters the proper film perforation. The film is then placed between the sprocket and guide rollers of the upper sprocket and secured by turning the knurled knob of the guide rollers clockwise. The film is then thread onto the upper spring roller assembly and attached to a film core placed on the upper take-up. If Bi-Pack is to be used² the second film is
thread the same way as the first except that the second set of takeups is used, the switch in the back of the takeup motor assembly has to be switched to four motor operation and the shuttle has to be adjusted for two film operation (see in camera section).

If the projector is equipped with a film cuer, (Fig. 1-35) it is located near the gate and the film has to be threaded through it. The cuer latch needs to be opened and the film placed in the cuer gate flatly against the back making sure that the edge of the film presses against the micro-switch rollers and guides and then the cover is latched close.

For liquid gate loading, see instructions with the particular model of liquid gate.
3.1.2 CHECKING THE PROJECTOR FOR PROPER THREADING:

To check the projector for proper threading the threading knob should be first turned manually (while the LOAD light is still on). The film transport by the sprockets and shuttle should be observed to be smooth with a proper film loop maintained. Once proper transport is verified manually, the slack film on both takeup sides should be taken up, manually, the projector trip key should be in off position, the takeup tension controls set at proper value (see control section) or turned fully counterclockwise if proper tension setting is not yet known and LOAD/RUN SWITCH put into RUN position. The projector should turn to one of the registered positions (90° or 270° depending on the direction of the projector FOR/REV switch, the LOAD light should go off and takeup tension applied automatically. Takeup tension may have to be adjusted via the proper controls. Note that at this point, there is power on the drive system and the threading knob should not be rotated manually any more. The film frame in
the aperture should be observed. It should be in registration. If it is not in registration but one or two perforations off, then the projector should be put back into LOAD condition the shuttle detent pin disengaged and the film slipped up or down to correct the position error observed, the pin should be re-engaged in the new position and the above check and turn-on procedure repeated.
3.1.3 LOCATION OF MAIN PIN IN SHUTTLE

The location of the "main" pin also designated the "big pin" or "Full pin" varies for the various shuttles depending on their intended use. This is done to insure that as the film is placed in the various shuttles (camera, main projector, aerial image projector, etc.) the same perforation is always used for registration. Hence it is important to know which are the positions of this pin in order to be able to decide on proper interchangeability of the shuttles.

The large pin (full fitting pin for the sprocket holes) is located in the lower right hand corner in the camera. It is located in the lower left hand corner in the main (A) projector. In the accessory projectors, it is located in the following fashion: in the beam-splitter (C head) projector it is in the lower right hand corner (the same as the camera), in the aerial image (B head) projector it is in the upper right
hand corner, and in the beam-splitter aerial image
(0 head) projector it is in the upper left hand corner.

The corner locations are given when the shuttle is viewed
from the direction of the lamphouse in the projectors
or the direction of the sprocket in the camera.
3.2 PROJECTOR COUNTER:

The projector counter is identical to the camera or totalizing counters except for the notation on its front. Hence, the same operating instructions given in the camera section apply. Also in case of need any of these counters can be replaced by any of the others. The exception is the counter for a frame cuing system. In that case the counter and its operation are described in the literature of the frame cuing system.
3.3 CONDENSER AND FILTER HOLDER

The description that follows in this section is applicable for the 5111-A Optical Printer only. All other Optical Printers have a fixed condenser lens that is mounted directly behind the shuttle. This condenser is generally not to be removed. When cleaning is required it should be done in location with the shuttle removed.
CONDENSER AND FILTER HOLDER

A tubular condenser and filter holder is supplied with the 5111A Printer. This holder is mounted on the Bell and Howell Lamphouse exit tube and secured by means of a knurled thumb screw (see figure 1). In this filter holder a filter carrier is inserted which can be used to insert required 2 x 2 filters. The filter carrier is located in the tube to the left of the slot opening. It can be removed by loosening slightly the thumb screw securing the carrier (Fig. 1-28) and then sliding the carrier with the help of this screw to the slot at which point it can be removed from the holder, filters can be changed and the carrier replaced to its original position. A set of condenser lenses is supplied with the 5111A Printer intended and marked for use at various reduction and blowup ratios. These lenses are placed in the holder tube on the right side of the slot at properly marked positions. (Fig. 1-29, 30) They are inserted and removed in the same way as the filter carrier. For blowup and reduction ratios other than
the one marked the closest set should be used.

Generally experience will indicate the conditions under which the condenser needs to be changed.
3.4 CHANGING FORMAT IN THE PROJECTOR

3.4.1 INTERCHANGING SHUTTLES

The procedure for changing the shuttle in the projector is exactly as the procedure for changing the shuttle in the camera as described in paragraph 1.8.1. Again, it should be pointed out that these are precision mechanisms and should be handled with care when being replaced.
3.4.2 CHANGING SPROCKETS

In order to change the sprockets on the projector, a 3/16" allen key is needed. The projector should be turned off and in LOAD. The existing sprockets are removed by opening the two allen screws on each side of the sprocket while holding the sprocket to prevent them from dropping, then it can be removed by pulling it toward the operator. The new sprocket is inserted into the location just vacated. The sprockets should be placed such that the guide rollers on each sprocket should be closest to the shuttle. Care should be taken when the sprockets are inserted so that the coupling keys engage properly and the sprocket turns freely. Once this is set into place properly, the allen screws can be tightened and secured.
3.4.3 ADJUSTING THE FILM TAKEUP AND FEED

The arms located between the 1,000 foot and 400 foot reels on both the feed and takeup sides of the projector must also be adjusted for the 16mm film. This is accomplished by pulling the hub of each reel out until detented. After the reels are pulled forward, the guides are pushed back till they are detented. The net effect of these two adjustments will be to put the 16mm film on both the feed and takeup sides on the same center as the shuttle aperture. For printer having automatic tension control, care should be taken that this roller is properly centered.
4. LAMPHOUSE

Several Lamphouses are used with the OXBERRY OPTICAL PRINTERS. They are divided into two parts:

a) Normal Incandescent light sources using mostly Quartz (R) Hellogen bulbs manufactured by Oxberry.

b) Additive light sources which are available as manual additive systems or as automatic tape controlled systems.
4.1. LAMPHOUSE

The standard lamphouse supplied with the 5111A is the Bell and Howell Automatic Color Additive Lamphouse. The operating and maintenance instructions for it are given in the appendix A to this manual. The cues for the lamphouse are generated by a source depending on the option used. They are supplied by either a mechanical cuer using micro-switches activated by notches in the film by R.F. cues generated by metallic patches glued onto the film (RF cues should not be used with liquid gates) or by a frame cuing system in which the cues result from the comparison of the data read from the perforated frame cuing tape and the Projector's frame number as given by the projectors special frame cuing counter. For operation with the frame cuing option see literature furnished with this optional equipment.
4.2 SUBTRACTIVE LAMPHOUSE

The standard lamphouse with the OXBERRY Optical Printer is a subtractive Lamphouse using a Quartz Hellogen bulb and subtractive filter. A filter holder is included as part of the system to allow for insertion of many 3" and 2" standard filter to achieve proper collar balance and density. A voltmeter and a variac control are used to set the proper operating voltage. Changing this voltage affects both the light intensity and the color temperature of the light. As these changes are rather drastic with the change of voltage, it is normally advisable to use a constant voltage source for the lamp circuit (like a constant voltage transformer). If the lamp voltage is set at 117V the light output is high and color temperature is the nominal for the bulb used. As the lamp voltage is reduced the color temperature is reduced and so is the light output but the life of the lamp is sharply increased. Hence, in operations where there is sufficient light many users will operate at a voltage of between 90-100 VAC and by doing this increase the life of the lamp considerably. It is of course mandatory to compensate for the loss of light and the color shift of the light using a filter pack.
A blower is supplied with the lamphouse.

The blower is connected such that it is turned on each time the lamp is turned on. If for some reason there is no flow of air due to some malfunction severe damage may be caused to the lamphouse and associated optics. Make sure always that when the lamp is turned on there is proper flow of constant air.
5. CIRCUIT BREAKERS AND FUSES

Every circuit of this equipment is protected by one or two circuit breakers and in some cases when need for the protection of delicate components also by proper fuses. Each circuit breaker can also be used to switch off the circuits protected by it. Some of the circuit breakers like the main projector power switch look like switches which then can be used and operated as regular power switches to run their circuit on and off. When one of these circuit breakers is tripped because of an overload, it automatically jumps towards the off position. To reset a circuit breaker of this type the switch should be turned all the way to the off position and then back to the on position. It should not be held there and if the overload conditions persist it will trip again. The second type of circuit breaker has two red buttons, a larger one which is also the reset button and a smaller one that can be used to trip the breaker by simply depressing it momentarily which will open the circuit. When this type of circuit breaker is tripped the larger button jumps out. To reset it, a short period of time has to be allowed for it to cool down and then the larger red
button pushed momentarily in. If the overload condition persists it will trip again (it should never be held in). If a condition exists in which a circuit breaker trips repeatedly a qualified service technician should be called. Most circuit breakers are located on the circuit breaker panel as shown in Fig. 1-7. The layout of this panel is given in Fig. 6. However, other circuit breakers are located at various locations of the equipment. The fuses and breakers associated with the Bell and Howell Lamphouse are described in appendix A and those associated with non-standard accessories or optional equipment are listed with that equipment. In this section only the circuit breakers and fuses which are part of the standard 5111A but are not shown on the circuit breaker panel will be described. This is an important part of an operating manual because the lack of this knowledge may cause an operator to lose valuable time or call for costly repair service while simple inspection by the operator or another qualified person at the facility may reveal a tripped circuit breaker or a blown fuse as the cause for an apparent malfunction. It should be noted that whenever
circuits carrying high voltage are examined or worked on this should be done only by a person qualified to do so and carefully observing all required precautions.

The standby battery circuit has its own breaker. This breaker is located on the bottom of the inside of the door (in the center). It is of the type that is tripped by depressing the small red button and is reset by the other. Its function is to protect the standby 6 volt batteries and the circuits they power in case of a short. It also has a second function. Normally the battery circuit is keeping the batteries charged at all times even when the main switches of the printer are turned off. This is done to guarantee that the batteries are kept fully charged for the eventuality that they may be needed. However, in order to be kept on charge this requires that the printer be plugged into a live outlet. If the house power is interrupted for several hours or the printer is unplugged from the power source these batteries will discharge in several hours and not be available when needed. Hence, whenever the printer is unplugged from the power source or the power source is turned off for any length of time, the battery circuit should be opened by tripping the
circuit breaker. When main power is restored, this breaker should be reset.

The servo amplifiers driving the camera and projector motors are protected by several fuses and one circuit breaker. The circuit breaker is mounted above the amplifier on the back of the lower part of the printers' structure (in the earlier models the breaker is mounted on top of the amplifier in the printers' housing and can be accessed only with the door open). This circuit breaker protects the output stages of the servo amplifiers as well as the three fuses located in them. It is a specially fast acting breaker such that it trips before the fuses can blow or before the output stages can be damaged. This circuit breaker may be tripped accidentally when the thread knob of the camera or projectors are forced by hand against the servo system when it is not in LOAD or in the case of a mechanical jam of the camera or projector. This breaker is of the switch type (usually with a white switch lever) and is reset by switching it to off and then to the on position.
As mentioned above several more fuses are located in the servo amplifier module. They are described in detail in appendix B of the service manual. There they will only be listed so that the operator may be aware of their existence.

Three fuses protecting the output stages of the amplifier are mounted inside the amplifier chassis above the blue printed circuit board. They are hard to access and are protected by the circuit breaker. An A.C. power line fuse is located at the right bottom part of each amplifier. If this fuse is blown there will be no power to the amplifier and even the blowers mounted on each amplifier will not be turning. The last fuse in the servo amplifier is hard to find because it does not look like a fuse (it looks rather like a resistor). This is a signal fuse which supplies the amplifier with the drive signal. It is a fast-acting 1.5 Amp fuse and is located at the top left corner of the printed circuit board. In order to replace it, a soldering iron must be used (for more details on these fuses see appendix B of the maintenance manual).
6. CONTROL CONSOLE

The control console is the entire top half of the printer's door. On it are located all the switches, dials and other electrical controls that are required for the operation of all the printer's functions. Many of the functions resulting from the operation of any of these controls may also depend on several other controls and on the status of the various parts of the printer. Hence, the function described for each of these controls will be achieved only when all other required status and control conditions are satisfied. For example, the camera's trip key whose function is to advance a frame in the camera will perform its function only if (among other conditions that need be satisfied) the camera buckle has not been activated and the camera switch is not in OFF position. In general, when describing the function of a control it will be assumed that all other conditions required for its function to be performed have been met. Fig. 7 is a layout of the control console with all controls called out.
6.1 CAMERA PANEL

The camera panel contains the controls required to activate the camera and viewer. These are described in the following sections. It is shown in Figure 1, call out 14.
6.1.1. BUCKLE SWITCH AND INDICATOR

The buckle switch is a reset switch for the buckle condition. When a buckle condition arises by somehow tripping the sensitive buckle sensing fingers in the camera, the red buckle light located in the buckle switch will light up. When this happens the camera, if in mid exposure, will complete the frame and then stop. As long as the buckle condition is not reset the camera's film transport will be inoperable. Also as long as the condition causing the buckle has not been remedied, depressing the buckle reset will not help. Only after the cause of the buckle condition has been corrected (by adjusting film tension, re-threading, etc.) can the buckle condition be reset by depressing the buckle switch and the buckle light will go off.

In 5111A Printer having buckle sensors on the projector, the buckle light may go on as a result of a buckle condition
on the projector. This will make the projector drive inoperative and also inhibit camera operation when the projector is in "SYNC" mode but it will not inhibit camera operation when the projector is in "IND" mode. To correct this condition the cause for the projector buckle has to be corrected and then the buckle reset button depressed.
6.1.2 VIEWER SWITCH AND INDICATOR

Like the buckle switch this control consists of both a pushbutton switch and an indicator light in it. When the light is on it indicates that the viewing prism in the superimposure viewer is in viewing position; i.e., behind the lens. In this position the camera advance is inoperative and the frame in the projector can be viewed through the viewer. Depressing this switch when lit will move the viewer prism out of position and the light will go off. Depressing the switch when the light is off will cause the viewing prism to be moved into view position and the light will go on. A safety circuit in the printer inhibits activating the viewer when the camera trip key is depressed or transporting film when viewer is in view position.
6.1.3. VIEWER BYPASS SWITCH AND INDICATOR

This switch is located next to the viewer control switch. It lights up whenever the viewer is in view position. Normally when in view position the camera film transport is inoperative, however, it may be desired to operate the camera film transport while viewing (either because the camera and projector are operated in "SYNC" or for other reasons). Depressing and holding down the viewer bypass switch makes the camera film transport operative for as long as the bypass switch is depressed. It must be clear that no film exposure can be made because the viewing prism is behind the lens in the viewing position only now the film can be transported.
6.1.4. FWD/OFF/REV SWITCH

This switch located on the top left corner of the camera panel selects the direction of the camera film transport. In "FWD" position the camera will advance in the forward direction when activated. In "REV" the camera will run backward when activated. In "OFF" the trip key will not activate the camera at all.

In "OFF" position the camera motor is under power and the takeups are kept on. Only the trip key is disabled. By experience it was found convenient to allow the operator to advance film in the projector kept in "SYNC" position while viewing and by using the camera trip key. Hence it has been wired so that when the projector is in "SYNC" and the camera switch in "OFF" position depressing the trip key will advance the projector (or projectors) that is in "SYNC" mode while keeping the camera inoperative.
6.1.5. "LOAD"/"RUN" SWITCH

The "LOAD" condition indicator is positioned under the FOR/OFF/REV Switch. When this light is on it indicates that the camera is in "LOAD" condition. In the "LOAD" condition the takeups are OFF and the camera motor is de-energized. In this position the threading knob can be turned manually and film can be loaded into the camera and checked. In order to get into LOAD condition, the camera must be in "O°" position. This is the point in which the camera normally be stopped.

The LOAD/RUN switch located under the "LOAD" indicator can be used to put the camera in either mode. When this switch is turned to "LOAD", LOAD condition will normally be achieved. When the switch is put into RUN position, the "LOAD" indicator should go off, power should be restored to the takeups and the camera motor should be energized.
"LOAD" condition can also arise with the switch in "RUN". This can happen as a result of the action of the "safety" circuit. In order to prevent the motor from driving the camera at excessive speeds a safety circuit was incorporated in the printer's logic. Whenever the camera appears to be running faster than a preset speed as adjusted in the safety card, it will automatically switch the camera into "LOAD" condition and thus de-energizing the drive motor and stopping the camera. To reset this condition, the RUN/LOAD switch must be turned to "LOAD" and then back to run.
6.1.6. CAMER A TRIP KEY

This key when depressed will activate the camera film transport as long as it is held down. A mechanical locking device on the key makes it possible to lock it in depressed position for continuous shooting. The locking mechanism is released by depressing the trip key again allowing the mechanical lock to jump out.
6.1.7. **FD/DXSWITCH**

The FD/DX switch on the camera panel permits the selection of the curve used when the dissolving shutter is activated in automatic mode. "FD" represents a FADE which is done on a logarithmic curve and "DX" represents a DISSOLVE which appears to be linear to the viewer. Switching to either position has no effect until the dissolving shutter is actually activated and film transported.
6.1.8. IN/OUT Switch and Indicator Light

This is a lever switch with center position OFF. As long as it is in center position it has no effect on the dissolving shutter. When it is switched to the "OUT" position, it activates the camera mechanism such as frames are advanced the dissolving shutter will move along the predetermined curve (FD/DX) to reduce the exposure of successive frames until there is no more exposure and the auxiliary shutter is closed. The number of frames required is determined by the setting of the dissolve length control dial located on the right hand side of the camera. (Fig. 1-8) The indicator light goes on when the switch is activated and stays on until action is done. Setting the switch to IN when the auxiliary shutter is closed will fade or dissolve a scene in. Switching to the center OFF position at any time freezes the relative angle of the auxiliary shutter at its last position and thus keeping the exposure at the last level.
6.2 PROJECTOR PANEL (Fig. 1-15)

In a printer having several projectors each projector is controlled by an identical projector control panel and as such only one need be described. Also most controls on the projector panel have similar functions to their counterparts on the camera panel and hence the reader will be so directed.
6.2.1 FOR/OFF/REV SWITCH

Its operation is similar to that of the corresponding camera switch except that in OFF position the projector trip key is completely disabled.
6.2.2. LOAD/RUN SWITCH AND INDICATOR

The function of this switch is similar to the corresponding switch on the camera panel except that the projectors are not normally stopped at the "O\(^{\circ}\)" loading position. Hence when the switch is switched from RUN to LOAD the projector will move to the \(90^\circ\) or \(270^\circ\) position where it can be loaded. Only after reaching this position will power to the drive motor and takeups be cut off. When switched to RUN to projector will be driven to the \(90^\circ\) or \(270^\circ\) registration position depending on whether the projector is in FOR or REV (OFF is same as FOR) and power to the takeups will be applied.
6.2.3 "SYNC/IND" SWITCH

When in "IND" mode the projector is activated only by its own trip key in the same manner as the camera. However when switched to "SYNC" mode the projector is set to operate in synchronization with the camera. In "SYNC" mode the projector trip key is thus inoperative.

The "electrosync" printer operates using a novel synchronization system. This system does not require the projector to keep always in exact synchronism with the camera. It does require only that when the camera is ready to expose film the frame in the projector is at that time already in registration and that it keeps stationary for the entire duration of the exposure. Using this approach it is possible to register the frame in the projector while in sync such that the operator can observe the next frame to be photographed fully registered and in focus. After the camera has completed its exposure and during its film advance phase the projector is advanced rapidly to the next frame. This is different and more convenient than earlier optical printers but it may require some adaptation by an operator used to the older synchronization method.
To guarantee absolute synchronization an elaborate safety circuit has been incorporated in the printer. If for some reason the projector is inhibited from advancing (by either being in LOAD, being OFF, jammed or for any other reason) the camera will expose the current frame in registration and stop. It will wait for the projector to signal that it has advanced to the next frame. The same is true in reverse. In "sync" if the camera is inhibited from advancing then the projector will stop and wait. This safety system operates on a continual basis such that if, for example, the projector is slowed down then the camera will wait for it between exposures. Hence synchronization is maintained with maximum latitude for error. It should be noted, though, that when the projector is inhibited from advancing the camera in "sync" will expose one frame as the current frame in registration and then expect the signal from the projector that it has advanced. If the indication is not detected the camera will stop and wait. This means
that each time the camera trip key is depressed the camera will take one exposure and stop waiting for the projector. It will not run continuously unless the projector is also advancing but it will make single exposures whenever the trip key is released and depressed again.
If the projector is in LOAD or for another way kept inoperative the camera will not realize it until after the first frame has been exposed. Hence it is the operator's responsibility to check that the frame as seen in the projector is the one to be photographed next before depressing the trip key. In order to maintain proper synchronization the projector and camera must be capable of instantaneous start and stop and the projector's speed must also exceed that of the camera. This limits the maximum speed on "sync" operation to roughly 600 F.P.M.
7. SPEED PANEL

The speed panel is a control panel through which the speed of the camera can be controlled. The speed panel has a set of seven pushbutton switches, a variable speed dial with a light indicator and a digital speed indicator. The digital indicator on the panel displays constantly the desired speed number of the camera in frames per minutes. The speed control panel controls directly only the camera speed but the projector speed is tied into the pushbutton controls such that higher projector speeds are set to correspond to higher camera speed ranges.

At pushbutton setting of speeds up to 240 FPM the projectors speed is approximately set at about 370 FPM (this is the rate of speed at which the projector's will be running when in IND mode). At the 340 FPM pushbutton setting the projector's speed is set to about 560 FPM. At rewind setting (as described below) the projector's speed is set to about 720 FPM.
7.1. PUSHBUTTON SPEED CONTROL

The pushbutton controls are used to select the required camera speed. Each button has a light indicator and when depressed the light goes on. The nominal speed selection is engraved on each pushbutton. Normally as adjusted the rates of speed indicated reflect the camera shooting speed, i.e. the rate of speed of the camera during exposure time. This may be a higher or a lower number than the average number of frames processed. The difference is due to the fact that the camera is operated at a constant pull-down speed, i.e. the film is always advanced at a rate of about 200 FPM. This is a desirable characteristic because it increases the printer's throughput when using long exposures while also making sure that the film is being transported as gently as possible when fast exposures and higher speeds are used. Hence, when the pushbutton is set to 85 FPM for example, the average rate of processing will be higher because the film will be advanced between exposures at a rate of 200 FPM. The numbers engraved on the pushbuttons are the nominal rate settings, however, the real rate of
speed (provided the system is adjusted properly) is shown on the digital indicator. There is an internal adjustment behind each pushbutton to adjust the speed selection to the desired value which may or may not be the same as the markings on the pushbuttons.
7.2. DIGITAL SPEED INDICATOR

The digital speed indicator is a digital read-out displaying the speed setting of the camera. This read out will indicate the correct running speed of the camera when the system has been calibrated properly. That speed may be slightly different than the pushbutton markings or if desired set by means of internal adjustment to a desired value other than the pushbutton indication. Being a digital readout of an analog voltage level means that the last digit of the read out may change from time to time. This is natural and should be no cause for concern. In any case being off the correct value by less than 5% is meaningless in terms of exposure (in most instances) and no corrective action is required. The speed of the camera varies during each frame due to the variable pulldown speed employed. In some of the models the digital read out is reading both speeds and as such the indication given varies during the frame. In these models the readout should be used as indication only when the camera is stopped.
7.3. VARIABLE SPEED DIAL AND INDICATOR

The variable speed dial is the control for the camera speed when the manual pushbutton is depressed. By means of this dial the speed of the camera can be controlled continuously from virtually zero to approximately 720 FPM. This dial is tied to a cam controlled microswitch. When the dial is set to above the 520 FPM range the microswitch is activated, the system is put into a high speed mode, and the indicator light is turned on. In this state the camera logic is set such that the camera is inhibited from stop motion action. Hence if the trip key is activated when the indicator light is on the camera will start running at high speed and will not stop when the trip key is released. To stop the camera it is required to turn the speed dial to a point where the indicator light goes off. At the high speed mode the projector speed is automatically set to 720 F.P.M. but unlike the camera it can be stopped at this speed. The camera is inhibited from stop motion action for the safety of the film and that of the camera components, however, under the control of the predetermined counter the camera can be run at high speed.
and stopped at a desired frame. In the high speed mode
the pulldown speed is de-activated and the camera speed is
constant during the entire frame. It is important to note
that although the system will operate in "sync" in the high
speed mode there is no guarantee that synchronization will
be indeed maintained and this is not a recommended mode
of operation. The high speed mode is intended as a wind/
rewind speed and should be generally used as such although
exposures can be taken assuming the proper precautions are
taken to stay within the equipment's limitations.
3. PREDETERMINED/SKIP/ADD CONTROL PANEL:  (21)

This control panel permits the operator to automatically control the camera and projector operation for sequences where a large number of frames is desired or repetitive sequences are used. It is a very helpful labor and time saving device. The panel has two separate control systems. The predetermined counter and the Skip/Add device. Each one of these can be turned on and used independently or they can be used together.
8.1 PREDETERMINED OPERATION

This counter system permits the operator to pre-select a number of frames desired and have the printer run this number of frames and stop when the count is reached automatically. The predetermined counter is located on the left side of the control panel and is put into operation by turning it ON with its power switch (top switch to the right of the counter). The rotary switch under the power switch is a selector switch. It can be turned to select the device being controlled by the counter (i.e. the camera or any of the available projectors). Once a device has been selected via this control, the counter will count down the number of frames run by this device. At the end of the count it will inhibit its further running until the counter is reset. The counter is a digital counter that can be set by means of tab switches located under each digit. Pressing the switch down once advances one digit, lifting the switch counts down one digit. Each digit is set independently (there is no carry over).
The digital number appearing on the face of the counter indicates its predetermined setting; there is no indication of current count. The pushbutton under the selector switch is the reset button. It has a built-in indicator light which lights up when the predetermined count has been reached. When this light is on, the device selected is totally inhibited from advancing. Depressing this button resets the counter and turns the light off. Before starting a predetermined sequence, the reset button should be depressed even if not lit to make sure that the counter is reset to start. If the camera or projector is stopped by the predetermined counter, then resetting the counter will allow it to resume operation if its trip key is still depressed. This procedure can be used but only with great caution. If the reset button is "double pressed", a second reset may result (starting the count again after one or two frames have already been taken). This could cause miscounts particularly at high speeds. The safer way to operate is to release the trip key first, reset and then activate the trip key again.

It should be noted that when a projector is operated in
"sync", stopping the projector will also stop the camera because of the built safety logic. However, in this case the camera will not have been stopped by the counter but by a "sync" default. Hence, whenever in "sync" operation the predetermined counter should be used with selector switch set to stop the camera and not the projector. The predetermined counter can stop the camera at high speeds because it does it in two stages (without affecting exposure). First, the camera speed is reduced to the pull down speed and then the camera is stopped. This makes it possible to use the predetermined counter safely even in the high speed mode without fear of damage to film.
8.2. SKIP/ADD OPERATION

The SKIP/ADD panel is turned on by means of a power switch located on the right hand corner of the panel. Whenever this switch is on, the SKIP/ADD device will be affecting the operation of the printer. Skip operation means that at the selected sequence the projector will be advanced by itself (keeping the camera stationary) such that this projector frame or frames is not copied by the camera, i.e. skipped. The resulting copy will thus be shorter than the original.

ADD operation means that at the selected sequence the camera is advanced by itself (keeping the projector stationary) such that the registered projector frame is copied again one or more times by the camera adding it into the copy. The resulting copy will be longer than the original. It is clear from the above that either skip or add operation involve the camera and one or more projectors which should be put in "sync" with it. The selector switch located beneath the power switch is used to select either skip or ADD and (if available) the projector which is selected for the skip/add operation.
The selection of the sequence desired for either skip or add mode is done by means of the two digital counters. They are set in similar fashion as described for the predetermined counter. The counter on the right is marked MATCHED FRAMES and it indicates the number of frames in the sequence for which the camera and projector will run in "sync". The second counter is marked SKIP/ADD FRAMES and it indicates the number of frames that will be either skipped or added in the copy. For example: It is desired to extend a scene and make it longer so as to convert a scene originally taken at 16 frames/sec to 24 frames/sec. This means that for every 2 frames of the original we want to have three frames in the copy. In other words, after every two frames of the original it is desired to add one frame into the copy. Rewording it again, it is desired to ADD one additional frame after running two frames MATCHED. Hence the MATCHED FRAME counter has to be set to 2 and the SKIP/ADD counter has to be set to 1. The selector switch is set to ADD. If the reverse operation is desired, i.e. 24 frames/sec. needs to be shortened to 16 frames then after every 2 matched frames 1 has to be skipped.
The counter settings stay the same, only the selector switch is turned to skip. The reset button located at the bottom right corner of the panel is used to reset the sequence to its starting point. Small indicator lights at the top of each counter indicate whether the system is in the MATCHED FRAMES part of the sequence or the SKIP/ADD part.

The SKIP/ADD system can be used in continuous running or at stop motion. The length of the sequence is limited only by the number of digits on the counter (9999) and as such the device can be used for duplicating a frame many times over or selecting frames that are separated from each other by a large constant number (every 20th frame for example.)
8.3 COMBINED PREDETERMINED AND SKIP/ADD

The Predetermined and Skip/Add System can be operated independently. However, in many instances it would be beneficial to operate them together. As one can select at will which device is predetermined, it is possible to select the stop point either from the original by setting the predetermined frame number and selecting the projector to be controlled. If the camera is predetermined, the count of the counter will be that of the resulting copy. The predetermined count will hence, be different depending on whether the projector or camera are controlled. Whenever possible, it is desirable to stop the camera rather than the projector as explained in 8.1.
9. TENSION CONTROL PANEL (18) (19) (20)

9.1 CAMERA TENSION CONTROL (13)

This is a control dial that adjusts the voltage for the camera takeup motors. The tension should be set at a level determined by experience such that the tension is sufficient to take up the film in the magazines without damaging it (due to excessive tension). In general, this setting may be different for 16mm film than for 35mm or 8mm, but otherwise will not require changing. Sometimes the film in the magazine is badly wound and then it may be required to increase the tension for proper takup. When the tension setting is too low, a film buckle may occur turning the buckle light on and stopping the camera. To correct this, the tension should be increased and the buckle reset.
9.2 PROJECTOR TENSION CONTROL (19), (20)

Two separate controls\(^2\) are available to control the tension of the projector's takeups: the one controls the taking up (19) and the second controls the tension of the braking power on the unwinding reel (20). In equipment having these two controls the tension control is adjusted (by experience) for proper takeup tension. Too much tension will damage film perforation while too little tension will let the film sag on takeup. When a free loop is generated due to the sag, the film may rip when the projector is stopped and the loop is taken up all at once. The braking tension is adjusted to prevent the film from unwinding by itself without creating too much tension on the film being taken off. The automatic tension control on this equipment senses the takeup tension and (within limits) keeps it constant for the length of the film. In equipment that does not have the automatic tension adjustment, adjustment of the tension may be required as the film is being taken up and the load on the takeups increases.
MAINTENANCE MANUAL
GENERAL NOTES

1. Unless otherwise specified, the oil recommended for these machines is 40-50W (or equivalent).

2. Lubrication (unless otherwise specified) is Beacon Grease, Exxon #325 (or equivalent).
   Made by: Exxon Co., Houston, Texas 77001 U.S.A.

3. The following lubricants are also recommended in various sections: Never Seez Compound (or equivalent)
   Made by: Never Seez Compound Corp., 2910 South 18th Ave.
   Broadview, Illinois 60153.

4. Silicone spray – Krylon #1325 (or equivalent).
10. INTRODUCTION

The Electrosync Optical Printers have been built with extreme care so as to minimize the need for maintenance and repair. However, whenever a failure which requires repair does occur, the design and construction are such as to make the repair or maintenance procedure as simple as possible and that above all, the machine's down time is kept to a minimum.

These maintenance instructions are designed to guide the user's technical personnel in the care and maintenance of the printer. It assumes:

a) That the personnel will attempt only that level of technical operations for which they are qualified.

b) That a recommended level of spare components is available.

c) That in any case where doubt exists as to any technical procedure, competent advice and assistance will be called for.

The construction of the equipment is modular. Most major electrical assemblies are connected by means of plugs and cables and all operating electronic circuits are on plug-in circuit boards. This set up allows easy interchange.

In addition, a set of test cards is available to assist in the trouble shooting of electrical problems. These test cards use a set of LED indicators to show the status of various circuits.
Notwithstanding the rugged construction and durability of the equipment, it should always be kept in mind that this is a highly complex and precise machine requiring care in handling and constant attention to proper use and upkeep. In particular, it is very important to operate the equipment in a proper environment. If the environment is not controlled properly, the chance of machine failure will be greatly increased. Also the probability of ruined work will increase very sharply due to dirt, dust, smoke and improper humidity.

The preferable environmental conditions are as follows:

Temperature  \[ 65^\circ - 80^\circ F \quad (18^\circ - 27^\circ C) \]

Relative humidity  \[ 50\% - 70\% \]

A dust free, well ventilated area is very important. In particular, when liquid gates are used, proper ventilation to reduce fume concentration is a must. The exhaust tube of the liquid gate's support system should be vented to the outside and the room should be ventilated well and supplied with clean, dust free air.

Smoke in the air has a tendency to settle on exposed surfaces and over a period of time create films that deteriorate the performance of lenses and other optical components. This settled smoke is very difficult to remove, in particular from internal elements of lenses and coated optics.
All exposed metal surfaces of the machine that are not specifically scheduled for lubrication should be kept clean and regularly wiped and protected with a very thin coating of a silicone oil to inhibit corrosion.
11. CAMERA

11.1 The camera requires maintenance mainly in two forms:
a) regular cleaning, b) lubrication at prescribed intervals.

11.1 A CLEANING THE CAMERA

It is advisable to inspect and clean the camera each time
film is threaded. This inspection and cleaning should
include all the surfaces that come in contact with film.
In particular, the shuttle, sprockets and film guides.
These areas tend to collect dust and film clippings
(especially if the film used is slightly shrunk).
The inner surfaces of the camera should be cleaned using
a vacuum device. Do not blow into the camera because this
will only push dirt and film clippings into the internal
section of the camera where they are inaccessible by
ordinary means. Dirt that is caked-on should be cleaned
using a piece of cloth moistened with some perchlorethylene
or an equivalent cleaning solution. The shuttle and sprocket
are best cleaned when removed from the camera because
outside the camera access is better and also because dry,
clean compressed air can be used to blow dirt out of the
shuttle. In cleaning the shuttle, particular attention
should be given to the film aperture to guarantee that it
has no build-up of dust, lint or film chips.
11.1. B1 CAMERA SHUTTLE SLIDES (19 Fig.3)

The camera shuttle slides are the sliding surfaces into which the shuttle is inserted. They are snug but must allow for easy removal and insertion of the shuttles. These slides should be oiled every two weeks by applying a drop of 40-50 SW oil (or equivalent) on each surface. Make sure that no excess oil is left on the surfaces and all excess should be wiped off.
CAMERA SHUTTLES (fig. 8)

Shuttle assemblies should be oiled and lubricated regularly. The frequency depends on the usage and the environmental conditions. The frequency given is for normal use of 40 hours per week and normal humidity. If the usage is heavier or if the area is very dry, lubrication is desired more often. Figure 8 shows the locations to be lubricated on a typical shuttle. The locations shown to be oiled should receive one drop of oil every two weeks. The best way to apply the oil to these locations without overoiling, is by applying it with the end of a toothpick.

It is most important to apply oil to the sliding rod on both sides at least every two weeks. The pivot points of the transfer yoke should be lubricated with oil at five points as indicated. The latch lift and latch should be oiled every three months and the inside shaft of the cam follower should be oiled every three months (this requires disassembly of the roller). The fork faces should be lubricated with Beacon grease every two weeks as well as the cam follower surface. Finally, the slide springs pressure points should be lubricated with "Neverseez" compound every three months.
Make sure that no oil or grease gets onto any surface that is in contact with the film and that all excess oil anywhere is wiped off. If a buildup of dry oil or grease is noticed, it should be removed before re-oiling or greasing.
CAMERA SPROCKET (Fig. 3)

The sprocket bearings are permanently lubricated and sealed but the gears and the key engaging the sprocket to the drive should be lubricated semi annually with a light application of grease. This is done by removing the sprocket assembly from the camera and applying the grease to its back area. The gears should then also be greased after removing any dried up grease or grease that is mixed with dirt and film chips.
CAMERA INTERNAL MECHANISMS (Fig. 9, Fig. 10)

The camera areas shown in Figure 9 i.e., the cams and the shutter's nylon gears should be greased every six months. They are accessible by removing the shuttle. Care should be exercised here not to let any of the grease get between the main camera shutter and dissolving shutter because this may cause the blades to lock together and prevent proper operation of the camera. The two locking tabs holding the shuttle in position and shown in Figure 9 should also be oiled lightly every six months as well as the door hinges and the door locking cam.

By removing the back cover of the camera, the gears shown in Figure 10 are exposed. These gears should be lubricated by a light application of beacon grease. Also, the FADE/DISSOLVE Cam and reciprocating slide should be lightly greased. The disc and ball integrator mechanism is lubricated and sealed in the factory and normally should not be opened. Care should be taken not to allow oil or grease to get on the electrical wiring and onto the solenoid brake surfaces.

Several other mechanisms associated with the camera are lubricated. The camera dissolve length control dial and viewer prism slide are greased in the factory and unless these parts are disassembled for other work they normally need no lubrication. Other moving parts like viewer hinges, cranks rotating shafts and dials should be oiled.
lightly every three months making sure not to over oil
and yet also not letting moving, rotating or sliding surfaces
dry up completely.

1. b. 5    CAMERA TAKE UP MOTORS

These motors are permanently lubricated and sealed in
the factory at the time of manufacture. Unless they are
taken apart for repair, they should not be lubricated.
The application of oil may change the composition and
viscosity of the lubricating grease and do more harm than
good.

1. b. 6    CAMERA MAGAZINE COVERS

The threads on the magazine covers should be cleaned reg-
ularly and they should be lubricated with a light appli-
cation of Molycote on the rim of the threads semi-annually.
1.b.7 STOP MOTION MOTOR COUPLING AND THREAD KNOB

The gears of the coupling have been lubricated in the factory using Beacon grease and need to be lubricated only once a year by adding grease as required. To add grease, the cover at the rear of the coupling should be removed by opening the two screws holding it and revealing the gears.
11.2 PRINTER BEDS AND CARRIAGES

2.a Cleaning the Printers' Beds and Carriages
The surfaces of the printers beds and carriages should be kept clean and free of corrosion. The surfaces should be wiped clean and moistened with a very fine protective coating or silicone oil.

2.b The sliding surfaces and racks should be oiled regularly at least every two weeks. Some of the carriages have oiling pads on their sides; when these pads are kept moist they self lubricate the surfaces on which they are riding. When liquid gates are being used, there is always the possibility of Liquid Gate fluid spilling on any of the surfaces. This fluid dissolves and washes away lubricants, hence in these cases, lubrication should be more frequent as needed.

All sliding or moving surfaces on the camera carriage should be lubricated every three months or earlier if conditions require it. The lens carriage of the 5111A Printer (Fig. 11) has two oiling holes. The sliding rods should be oiled every three months. The lens carriage for the 5116 and 5117 do not have oiling holes and the sliding rods need to be oiled directly.

The dovetails and rolling and sliding surfaces of the main projector mount should be lubricated using Beacon grease every six months and the moving surfaces of the carriages for the A. I. projector lens and projector should be oiled lightly every three months.
The carriages are driven by means of precision lead screws. These screws should always be kept slightly moist with oil. Under normal conditions, oiling every three months is adequate. A buildup of dirt and hardened oil and residues on the screws may prevent smooth motion of the carriages; in particular, the movement of the Aerial Image projector under follow focus operation. Hence, it is important to prevent these build ups.
11.3 THE PROJECTORS

All projectors of the Printer are mechanically similar. They have the same cams, shuttles, drive motors, etc. As such, the following write ups will apply essentially to any projector.

11.3.1 LUBRICATING THE PROJECTORS (Fig. 12)

The projector gears and cam (as shown in Fig. 12) should be greased every three months. At the same intervals oil should be applied lightly to the projectors threading knob shaft, film reel shafts and film retaining arms. The sprockets should be lubricated like the camera sprockets.
11.3.2 PROJECTOR SHUTTLES (Fig. 8, Fig. 13)

The projector dry shuttle is for maintenance purposes identical to the camera shuttle so reference should be made to the appropriate section on the camera for shuttle.

In the case that a Liquid Gate (or Wet Gate) is used, the location as shown in Figure 13 should be greased and oiled.

As the Liquid Gate fluid dissolves oil and grease very readily, these gates should be inspected daily for proper lubrication. Also the fact that a Liquid Gate has glass windows puts a heavy responsibility on the operator because any dirt or scratches on any of the windows in the aperture will be more or less in focus and will show up on the film. The operator has to check the liquid gate for cleanliness very carefully before every job is shot. If any dirt shows up, it should be cleaned away as per the instructions supplied with each Liquid Gate.
11.3.3  
Projector Shuttle Slide

(see Camera Shuttle Slides)

11.3.4  
BLOWERS

All blowers should be checked and cleaned semi-annually. Using a vacuum cleaner and a small bursh all accumulated dust and dirt on the fan blades should be removed. If needed, a solvent solution can also be used like trichloroethane. The filter should be checked and either cleaned or replaced with new filter material. Finally, the blade should be rotated by hand just to make sure that it can rotate freely without any obstruction.
12. OPTICAL

The optical systems are designed to require almost no maintenance in the field.Unless the system is disturbed due to transportation or other maintenance procedures, the only areas that would require periodic attentions are the cleanliness of the optical components and the adjustment of the light source following the replacement of a light bulb.

Keeping the printer in a clean environment free of fumes and smoke that may settle on the optical components cannot be over-emphasized. Accessible optical elements should be cleaned as they become dirty. Loose dust should be blown off with a gentle air brush. Do not use a high pressure source of unfiltered air. The high pressure may push dirt into internal areas of lenses where they cannot be removed without taking the lens apart. The air may also carry and propel hard particles against the glass elements causing them damage. The best policy is to keep the printer in an environment requiring the least amount of cleaning of the optical components and whenever cleaning becomes necessary, it should be done with the gentlest possible means and proper lens cleaning materials.

The replacement of the light bulb in the projector and its realignment will be discussed in section 12.1 to follow.

The following sections will describe alignment procedures which may apply to machines of specific configurations and not to machines of other configuration; whenever needed, this will be so indicated.
will be discussed in section 12. 1 to follow.

The following sections will describe alignment procedures which may apply to machines of specific configurations and not to machines of other configuration; whenever needed, this will be so indicated.
12.1 REPLACING A LAMP AND ADJUSTING THE LAMPHOUSE

Two types of light sources are available with the electrosync optical printers:

a) Additive light sources from various manufacturers
b) Subtractive light source manufactured by OXBERRY(R)

The procedure for replacing the lamp and the procedure for aligning the additive light sources varies from manufacturer to manufacturer. If your machine has one of these light sources and it was supplied by Oxberry with the printer, then appendix A to this manual is the operations and maintenance manual for the light source as supplied by its manufacturer.

If this printer is supplied with an Oxberry subtractive light source then this section contains the instructions on how to change the lamp and on how to realign the lamphouse for the new lamp. Before doing any work on the lamphouse, make sure that the lamp is turned off and that sufficient time has elapsed to allow the lamp and other components to cool down enough for safe handling. Also keep in mind that quartz halogen bulbs should never be touched with the hand on the glass areas. The grease from the hand will coat and deteriorate these high temperature lamps.

To replace a light bulb, the top cover of the lamphouse must be removed. This is done by loosening the thumb-screws holding the top of the lamphouse. Loosening these screws allows the top
of lamphouse, which is also the ventilation outlet, to be lifted off. Once this top is removed, the lamp is accessible from the top and it can be removed. If the lamp is broken for some reason, do not try to remove it by hand but use tools, always making sure that power to the lamphouse has been completely turned off.

Two types of lamps may be used in the printers. One is the standard incandescent lamp without a pre-focused reflector. The second type is a quartz Halogen lamp which in most cases has a pre-focused reflector next to the filaments. If the lamp is of the pre-focused type, the reflector which is positioned right behind the filaments serves to reflect that portion of the light that is normally projected backward. This reflector is very close to the filaments and as such, the filaments and the reflected image can be focused together. If the lamp is not of the pre-focused type, then the light projected backward needs to be reflected forward by a parabolic mirror located in the rear section of the lamphouse. In order to obtain an even field of light from the lamphouse, the filament's image must be focused and centered on the location of the iris in the camera's taking lens.

To accomplish this, focus an aerial image in the camera at 1:1. If the printer has an aerial image section, open the aerial image lens wide and then remove all films from the gates. Also remove all the filters, ground glasses, etc. from the light path. Cover the camera lens cap with a piece of white paper and place the lens cap on the camera taking lens.
Reduce the lens voltage until only a reddish glow is seen on the paper. By loosening the thumb-screws on the sides of the lamp-house, it can be made to slide back and forth. Now move the camera lens to the right approximately 2" so that the lens cap is now placed at roughly the same position that the iris of the lens occupied previously. At this position the lamphouse should be moved back and forth until a sharp image of the filament is formed on the paper. If a lamp with two layers of filaments is used or if a pre-focused lamp is used, two images will be seen at different focus points. Adjust for best focus as a compromise between the two positions. When a non pre-focused lamp is used, a secondary image will be seen as a result of the reflected image from the mirror in the rear of the lamphouse. This image will be focused separately.

Once the primary image has been focused, it should be centered on the lens. This is accomplished by loosening the locking screw at the bottom of the lamphouse permitting the lamp to be moved sideways by means of the other thumbscrew on the side next to the bottom of the lamp base. The image can be shifted up or down by loosening the thumbscrews holding the bottom part of the lamphouse and lowering or lifting the lamp. After the image is centered, these screws should be tightened. The secondary image (for lamps without pre-focused reflectors can now be adjusted.
The parabolic reflecting mirror at the rear of the lamphouse is mounted on a type of gimble mount allowing it free movement. It can also be pushed in and out by means of the rod sticking out of the rear cover of the lamphouse. The four thumb screws at the rear section of the lamphouse secure this mirror in position. When these screws are loosened slightly, the mirror can be shifted in or out and by doing so changes the focus point of the reflected image until it coincides with the main image. By moving in tandem the two screws on both sides of the mirror, the reflected image can be shifted sideways and by turning the top and bottom screws in tandem, the image will be moved up and down. By adjusting the reflected image, it is possible to fill in areas in the main image and help in making the light field as even as possible. From experience, it will be found that this adjustment procedure may need to be repeated to obtain a most even field. Once the adjustment is satisfactory, all locking thumbscrews should be secured. Note that the screws holding the mirror should always be operated in tandem because each opposite pair holds the mirror in position. Opening one without tightening the other simultaneously will leave the mirror free on this axis while tightening one without tightening the other will cause it to shift. Do not overtighten any of these thumbscrews because additional stress may be caused due to the rise in temperature once the lamphouse is turned on.
12.2 AUTOMATIC IRIS CONTROL

In systems having Automatic Iris Control this cam driven mechanism is designed to keep the camera exposure constant while zooming. The cam is cut in the factory and should never need attention. The only adjustment is the proper starting lens opening. Move the lens to 1:1 position and adjust the lens opening to f 5.6 at this point.
12.3 CAMERA TILT ALIGNMENT

The 5111 and 5111-A Printer do not have camera tilt and hence this section will not apply.

The camera tilt adjustment is to adjust the camera's optical axis to coincide with the physical axis of rotation of the camera. The height of the camera's axis of rotation is machined exactly at the factory hence, the only adjustment available is along one sliding axis (toward the operator and back). It is also assumed that the camera is adjusted at the factory to be exactly parallel to the projector.

It is preferable to do this adjustment using a microscope in the camera (see section 12-4) for instruction on the use of the microscope). After the microscope is adjusted, insert target films in the main projector and camera shuttles and move to 1:1. Then adjust the lens mount so that the centers of the two images coincide. Unlock the camera tilt control and tilt the camera. The images should rotate around their common center. If the centers shift from each other, the tilt control needs adjustment. First the camera needs to be released. This is done by tilting the camera all the way toward the operator to gain access to the four screws holding the camera down to the camera carriage. These four screws should be loosened slightly so that the camera is
still securely held but enough so that it can be shifted by applying pressure or tapping it. Turn back to zero tilt and align the target films and tilt again. If the camera center rotates around the projected center, shift the camera physically to reduce the error by half and use the lens compound to correct the rest of the error and to realign the centers. Repeat the above process until the tilting of the camera is done on the optical axis without misalignment of the centers. At this point the camera screws should be secured tightly.
The best way to adjust the follow focus mechanism of the camera is by using a microscope viewing an image formed in the camera's aperture. When a microscope is not available and the viewer is properly aligned then the viewer can be used. But the results will very likely not be as good as when a microscope is used and corrections using film tests may be needed.

In general, once the follow focus is adjusted and the dial indicator is set to zero, there should be no reason to repeat this procedure unless the system is disturbed.

The adjustment given here will assume the availability of a microscope (which is available as an accessory to the printer).

To adjust the follow focus, open the camera lens wide. Place a translucent film with one finely ground surface into the camera shuttle making sure that the ground surface faces the aperture and that the film is properly registered. Remove the sprocket assembly from the camera and also the round plug at the rear wall next to the stop motion motor. Insert a 45° microscope into the camera (If a 45° microscope is not available a straight microscope can be used after the stop motion motor is removed). Now focus the microscope precisely on the ground surface of the film and secure the microscope tightly.
A target film should now be placed in the shuttle of the main projector. Make sure that the emulsion faces the right direction and that the pressure plates are down. Move the camera to reduction and unlock the defocus control by turning the locking control two rotations in the counter clockwise direction:

a) While observing the image in the scope, adjust the "Out of Focus" control to a sharp image.

b) Move the camera to 1:1 position. While observing the image in the scope, use the micrometer control on the bottom front part of the lens carriage to bring the image into sharp focus.

c) Repeat steps a) and b) until images are at sharp focus at both positions.

d) Move camera to "Blow Up". Check the image, and if it is not sharp use the lens carriage focus control to adjust for sharp focus.

e) Move camera to Reduction. Check for focus and adjust with camera "Out of Focus" control.

f) Repeat steps a) and b).

g) This is an iterative process that may need repeating several times until the image remains sharp on the entire blowup to reduction range. When this is achieved the defocusing control locks should be locked and the defocusing dial indicators set to zero. If
the image needs to be defocused for a job, it can now be
done easily by unlocking the camera defocus control,
defocusing the image and then returning to proper follow
focus by returning to the zero position on the dial indicator.
12.5 SUPERIMPOSITION VIEWER ADJUSTMENT

This adjustment should also be done with the help of a microscope in the camera. See instruction in section 12.3 on the mounting of the microscope. Put a target film in the main projector and align to coincide with the image in the camera. The viewer is aligned such that a) it's focus plane coincides with that of the film in the camera gate, b) the reticle is adjusted in its mount to coincide with the aperture in the camera. The procedure is as follows:

a) To focus the viewer, the viewer cover holding the reticle plate and eyepiece must be released. This cover is secured by means of three 10-32 allen type cap screws on the viewer cover. These three screws should be loosened. At the rear of the viewer cover, there is a \(\frac{1}{4}-28\) screw. Rotating this screw moves the cover back and forth and changes the focal plane of the viewer. Adjust this screw until sharp focus coincides between reticle and camera film plane (as adjusted by scope). At this point, viewer is in focus and the cover can be secured.

b) The next step is to adjust the reticle. When the part of the viewer which holds the eyepiece is hinged open, the reticle is accessible. The reticle is held in position by means of four screws - one on top, one on the bottom and two on the right side - and by a spring on the left side loading it
against the side screws. By operating the top and bottom screws in tandem, the reticle can be shifted up and down and by adjusting the two screws on the right, the reticle can be shifted sideways and tilted. This is done until reticle's center coincides with the center in the camera; i.e., the image of target film in the main projector which has been previously aligned to the camera's aperture. When this is done, secure the reticle by locking the top and bottom reticle alignment screws. Be careful not to move the reticle when this is done.
12.6 TRACKING THE CAMERA

The tracking of the camera is the process by which the camera's aperture center, the optical center of the lens and the center of the projectors' aperture are all set on one optical axis and this axis being parallel to the physical travel axis on the printer's bed.

Mount the microscope and adjust it in the camera (as shown in Section 12.3). Load target films in camera and projector shuttles.

The tracking alignment is now done as follows:

a) Move camera to Reduction.

b) Align the target film centers using the lens mount controls and zero the indicators.

c) Move camera to 1:1.

d) Measure with lens mount dial indicators the shift needed to realign the centers.

e) Move lens mount to create equal errors in the other directions; i.e., if the error was .01" East go to .01" West.

f) Use the controls of the main projector to realign the centers.

g) Repeat steps a) to f) until there is no tracking error.

The projector position should now be secured and all indicators set to zero.
12.7 TRACKING THE AERIAL IMAGE PROJECTOR

The aerial image projector must be tracked only after the main bed is perfectly tracked. This tracking process will align the physical travel axis of the A.I. bed with that of the main bed. It will also align the A.I. projector optical center and the optical axis of the A.I. lens with the optical axis of the main projector and camera. The tracking of the A.I. procedure is very involved and should be undertaken only after it is certain that it is absolutely needed and that an apparent problem is not due just to an accidental shift of the lens mount indicators from their zero position. To perform this alignment, the achromatic condenser lens in the back of the main projector must be removed. After the process is completed, the condenser will be replaced.

Mount and align the microscope in the camera as shown in 12.4.
Insert target films in camera and aerial image projector.
Loosen three of the four screws holding down the A.I. bed allowing it to be moved using a rubber hammer.

Align as follows:

a) Move aerial image projector to Blowup and focus the image.
b) Use A.I. lens compound to align the target centers and then zero the indicators.
c) Move projector to 1:1 and if there is a tracking error, use the lens mount to double the error in the same direction.
d) Move the projector bed to correct the error.
e) Repeat steps a) to d) until there is no tracking error.

The projector bed should now be secured making certain that it does not shift during the process of securing it.

The replacement of the achromatic condenser is a very critical procedure. It must be positioned such as not to move the projected image but it must also be mounted exactly at right angle to the optical axis. If it is not exactly square, distortion and uneven light field may result. After the adjustment is completed, the holding screws should be tightened, double checking that no shift occurs at this stage. A further visual check can be done as follows: When the iris of the camera lens is closed and also the iris of the projector lens is closed, the circular spot of light seen projected on the camera iris should be well shaped and exactly centered in the iris.
12.8 ADJUSTING THE AERIAL IMAGE FOLLOW FOCUS

The aerial image follow focus unit is a servo controlled unit that electronically calculates the required position of the projector. For any position of the lens mount, this unit calculates in analog fashion the focus position of the projector and drives it there. The respective positions of the projector and lens mount are indicated back to the circuit by two very high precision potentiometers which in turn are driven by the precision lead screws via a gear mechanism. These lead screws actually position the lens and projector. The follow focus operates on the principle that an operational amplifier is used to compare the voltages of the lens and projector potentiometers to a constant reflecting the focal distance of the lens. It then drives the projector through the servo system to balance these two inputs. For the unit to be aligned properly, the value of the voltages (or resistances) of the two potentiometers and the value of the constant should be adjusted to reflect respectively, the physical locations of the projector and lens and the actual focal distance of the lens. Because of the way in which these values interact in the system, it turns out that one potentiometer has more effect when the system is at Reduction. This potentiometer is designated as the Reduction potentiometer. The second potentiometer has more effect at blowup and is designated as such.
The third control is a trimmer for the value representing the lens constant. It is more effective at 1:1 and is, therefore, designated as such.

In this system, it is very difficult to do the actual alignment by moving the precision potentiometers. In order to make this process easier, small multi-turn trimming potentiometers have been added in series with each of the precision potentiometers and are designated by the same names. The precision potentiometers are adjusted in the factory for the proper value (19Kω for the blowup potentiometer, 18Kω for the Reduction). Thus, fine adjustment can then be done with the trimmers. They are located under the metal plug that is on top of the follow focus box.

The potentiometer closest to the printer is the trimmer at blowup, the next is the trimmer for reduction and the third is the 1:1 control.

The alignment procedure is as follows:

a) Bring the aerial image to B. U. (blowup)

b) Use the B.U. trimmer to adjust the image for best focus.

c) Bring the A. I. to 1:1.

d) Use the 1:1 potentiometer to adjust for best focus.

e) Bring the A. I. to reduction

f) Use the reduction trimmer to adjust to best focus.
This process is an iterative process; i.e., go back to steps a) through f) and each time the required correction should be less until the aerial image is in focus over the entire range.

If during the adjustment the reduction or blowup trimmer reach their limit, then the precision potentiometer need to be turned slightly to bring the trimmer back into the center of its range. This procedure requires the removal of the cover box and the loosening of the precision potentiometers. It should be done only when certain that it is needed.
13. ELECTRICAL MAINTENANCE

There is very little in the form of preventative maintenance on the electronic components because most components will operate for extremely long periods without showing any visible signs of deterioration. The only components that can be examined periodically (every three months) are the electromechanical components and power supplies. These include: relays, motors, encoders, tachometers, DC power supplies and standby battery.

While preventative maintenance is very simple on the electronic systems, trouble-shooting to pinpoint the cause of a malfunction is more complex and requires trained personnel. This manual will, therefore, include a set of electronic circuit diagrams and some guidance to trouble-shooting the most common problems.
13.1 ELECTROMECHANICAL RELAYS (Fig. 14)

Most power relays are located on the inside of the control console as shown in figure 14. Machines having motorized zoom may also have some additional relays not on this panel. In general, the power relays are encased in a transparent casing allowing visual observation. The relays contacts should be examined for signs of sparking and excessive wear. If any of the contacts of a relay are found to be badly deteriorated, then the relay should be replaced.
13.2 MOTORS AND TACHOMETERS

All the motors and tachometers are enclosed and very little can be done to examine them. They should be observed periodically to make sure that they do not overheat, bind or show signs of mechanical wear. The noises they emit when operating properly become a good indication to the trained operator.
13.3 ENCODERS (Fig. 15)

The encoders are mounted on the back of each of the camera and projector motors. It consists of a set of dual printed circuit boards containing the sensors, L.E.D.1's and circuitry and a cam. The cam is opaque and prevents the L.E.D.1's light from reaching the corresponding sensors. As the cam rotates, cut out slots on the various channels allow the passage of light and the sensing of thecams position. The operation of the encoder depends on sensing these slots of the cam. Some of the possible causes of malfunctions that can be checked periodically are as follows:

a) Anything that would obstruct light passage can cause a malfunction. Check for dirt or dust on the L.E.D.1's or sensors.

b) The cam is rotating in a narrow space between the L.E.D.1's and the sensors. If this cam shifts up enough to touch any of the lenses, they may be scratched. When the lenses are scratched, they transmit less light and the encoder may malfunction.

c) The encoder cam is positioned by means of a split collar clamp and four screws. If these screws loosen up, the cam may shift from the proper angular orientation causing a malfunction of the printer.
To assist in checking the encoder's operation, a set of L.E.D. indicator lights are placed on the encoder circuit board (see drawing #9-208-3047). Each L.E.D. corresponds to one encoder channel. These lights should go on and off corresponding to the cam's cutouts. They could indicate failure in two modes. If an L.E.D. fails to go on or if it stays on all the time.

A second set of indicators of the operation of the encoder is available with the optional test cards (drawings numbers 9-107-3000, 9-207-3001 and 9-107-3002).
13.4 D.C. POWER SUPPLIES AND STANDBY BATTERIES

The power supplies' voltages can be checked every six months to detect any deterioration in output. As most supplies are adjustable, corrective action can often be taken. The standby batteries are rarely actually used but they should be checked every three months to make sure that they are charged and thus able to take over in case of power failure and keep the electronic counters operating.
13.5 GENERAL VISUAL INSPECTION

General inspection of the equipment when the machine is being maintained or is idle between jobs can save problems at a later time. It is useful to inspect the equipment regularly for a variety of potential troubles. Some of them are listed as follows:

a) Check all plugs to make sure they are secure.
b) Check servo amplifier fans — they should rotate freely.
c) Check contacts on the camera speed control panel.
d) Check wiper contacts on rheostats.
e) Check operation of microswitches.
f) Check and replace burnt indicator lamps.
g) Inspect cables and wire harnesses for wear, heat or mechanical damage.
13.6 BUCKLE SENSORS (Fig. 1)

The camera (and in some of the 5111-A printers also the projector) is equipped with a set of very sensitive buckle sensors. When the film or any other object touches these sensors, they are tilted from their normal position. When tilted, they interrupt the electrical continuity of the buckle circuitry. Once the buckle sensors are disturbed, the buckle circuit latches in this condition until the integrity of the buckle circuit is restored (i.e., sensors are back in normal position) and the buckle reset button is pressed. Sometimes, the buckle sensors, which are spring loaded contacts that are pressed against a printed circuit board, do not make good electrical contact. This may cause false buckle stops or the inability to reset the buckle circuit. If a camera test card is available (see drawing 9-107-3000) the L.E.D. buckle test indicator will indicate the lack of electrical continuity. In most cases, when the problem is due to a bad contact between one of the sensors and the circuit board, it can be rectified by pressing the sensors back against the camera and turning them. This wiping action of the contacts, will in most cases, clean the contacts and restore good electrical continuity.
14. ELECTRICAL ADJUSTMENTS

Several adjustments are available to control the proper operation of the printers. All are adjusted at installation but they may have to be repeated in case of component replacement or drift with time. To perform these adjustments, the only specialized equipment needed is a digital voltmeter.
14.1 ADJUSTING THE SERVO AMPLIFIERS (See Appendix B)

The camera, projectors and follow focus motors are driven by servo amplifiers. The detailed instructions and schematics for these amplifiers are given in Appendix B. In this section, only the information needed to adjust these amplifiers in the context of the printers will be given.

In general, when there is power on the system and the camera or projectors are not in "LOAD" condition, there should be power on the motors. The closed servo speed loop of the projectors with tachometer feedback and the closed position loop of the follow focus servo keep the motors powered and locked. If the motors are forced against this loop, excess power may be drawn from the amplifier. This will normally trip the circuit breaker at the output of that amplifier. Occasionally, due to fatigue, fuses within the amplifier may blow first. This will cause total loss of power to the motor which will be free to turn. The circuit breaker can be reset and fuses replaced.

If an amplifier is replaced or if drift develops, the amplifier may need readjustment. The recommended procedure for readjusting the amplifier is as follows:

a.) Set current limit to maximum clockwise (c.w.)

b.) Disconnect input signal from the terminal board (Pin 2 as counted from the top) and turn off power to the motor by tripping the circuit breaker.
c.) Measuring with a digital voltmeter between ground (Pin 4) and Pad 9 (on the continuation of the terminal board), adjust C-balance so as to zero this voltage (to within a few millivolts).

d.) Connect the voltmeter across the output of the amplifier and adjust A-balance to zero.
e.) Reconnect the input wire and turn the amplifier on. There should be no drift.
f.) The input gain and tachometer gain of the amplifier can now be adjusted. This adjustment procedure depends on the usage of the amplifier and is described in the related sections.

If the amplifier cannot be balanced or if there is no output, refer to Appendix B. There is a possible malfunction in the amplifier.
14.2 ADJUSTMENT OF THE CAMERA SPEED

The speed of the camera is set by means of two adjustments. One is the gain of the servo amplifier driving the camera motor. The second is the input voltage to this amplifier which is determined by the output of the camera speed panel (23 Fig 1).

The digital readout on the speed panel reads the input voltage to the amplifier. The gain of the amplifier needs to be adjusted such that this voltage indeed results in the proper actual speed of the camera. The situation is complicated slightly by the fact that the camera is normally not driven at constant speed. The film advance speed ("pulldown" speed) is always set to approximately 200 FPM. This means that at shooting speeds below 200 FPM, the camera is speeded up at pulldown and at shooting speeds above 200 FPM, the camera is slowed down at pulldown.

If one clocks the average camera speed, it will be timed as slightly higher than indicated for speeds below 200 FPM and will measure less for speeds above 200 FPM. To set the speed precisely, the pulldown speed should be disabled but for all practical purposes, it is sufficient to compensate for it when timing the 180 FPM speed. Once this is done, all other speeds will also follow.
It should be adjusted to put the printer into high speed mode at a camera speed of approximately 520 FPM. To adjust this — set the speed controls to manual. Release the set screw locking the cam and turn it such as to activate the microswitches when the indicator shows 520.
14.3 ADJUSTMENT OF PROJECTOR SPEED

The speeds of the projectors are related to the camera speeds. It will vary in stops depending on the pushbutton setting of the camera panel. This speed is normally adjusted to 360 FPM for camera speeds 80-240 FPM, to 500 FPM for camera speed setting of 320 FPM and at 700 FPM at high speed.

Only one of the low speeds can be adjusted independently the other is factory set by a divider ratio. Normally the 500 FPM speed is adjusted and the 360 FPM speed is derived.

The projector speed adjustments are located in the control console behind the relay panel. They are accessible by opening the door at the bottom of the control console. Each projector has two multiturn potentiometer.

When the projector is at "high-speed" mode the high-speed potentiometer is adjusted to 700 FPM. When the projector is at normal independent running mode and the Camera speed push button is at 320 FPM, the second potentiometer is adjusted for a projector speed of 500 FPM.

If these speeds cannot be attained with the projector's amplifier set at maximum tachometer gain and maximum input gain, then the tachometer gain should be slightly reduced and the procedure repeated.
The safety card includes a specialized circuit that is designed to prevent the motors from driving the camera and projectors at excessive speeds which could harm the film or delicate mechanical parts. This circuit senses the encoder's outputs and clocks them. If the camera or projectors are running too fast, the safety card will turn that motor off by putting it into "LOAD" condition.

The safety card has a potentiometer control for each projector and for the camera. This control should be set to switch the particular motor to "LOAD" when safe speed is exceeded. It should be noted that the safety circuit measures ten frames before activating the "LOAD" state, hence, the adjustment should be done slowly and double checked. Normally the safety limits should be adjusted before the speed setting. Occasionally, adjustment needs to be done when a card is replaced. In that case the speed of each one of the motors must be increased temporarily to perform the adjustment. Set the printer in high-speed mode. Increase the speed of the motor to be adjusted by reducing the tachometer gain of its amplifier, and set the appropriate safety control to a speed of 800-900 FPM. Return the tachometer gain to its original position and double check the motor speeds.
It is not possible to produce a comprehensive trouble-shooting chart for equipment that is that complex. But with some guidance and eventually experience it should become relatively easy to pinpoint the source of most malfunctions.

At the end of this section there is an extensive package of electrical schematics. They are of three kinds:

a) Wiring lists to allow the tracing of wires.

b) Circuit diagrams.

c) Logic diagrams for specific systems.

The use of these diagrams requires the knowledge of a trained electronic technician. However, most of the problems can be corrected without this detailed knowledge and with the help of the optional test cards and a sufficient supply of spare components.

Before actually attempting any trouble shooting make sure that all the controls are set correctly, that no safety interlock inhibits operation, that all circuit breakers are on etc. Only when absolutely sure that there is a malfunction and not an operators error try to troubleshoot.

Problems will generally be of two kinds:

a) Specific problems localized to one function.

b) Problems of general nature affecting many functions.
The problems of the first kind normally point generally to the source of the problem (this is not always the case but it is a good start). For example if the projector counter counts with errors, the first suspect will be the counter itself. It can be checked by interchanging it with another counter. It may, however, turn out that the encoder of the projector is at fault and not the counter. Interchanging the counters will normally reveal that.

Problems of the second kind normally involve factors associated with many circuits. For example several counters do not count correctly and the camera and projector do not perform correctly or cannot be controlled properly. This would indicate a common factor that could be a low power supply output due to power supply malfunction, low line voltage or a bad backup battery.

In general the first step of the examination will be to check via the controls the extent of the malfunction and determine if it seems to be of kind a) or b). If the problem is of type a) and the circuit is one of those covered by the test cards (assuming this option is available) this is the first thing to examine. Next step is to try replacing or interchanging modular components with spares or identical ones. For example spare circuit cards, counters, interchanging projector control panels, etc. In most cases this will reveal the malfunctioning part.
If the problem is of type b) check power supply voltages, examine for plugs that may have become loose or disconnected, a card that may not be plugged in all the way etc.

The guide that follows indicates only the very rudimentary problems. If the problem persists a detailed study of the schematics may be required or consultation with the engineers and technicians at the factory.
The compensation is done by adjusting the actual speed to 183 FPM when 180 FPM is indicated. First, the 180 FPM pushbutton on the speed panel is depressed. Corresponding to each of the pushbuttons, there is a small multiturn potentiometer in the back of the panel (this is accessible from the rear when the console is open). The potentiometer corresponding to the 180 FPM speed should be adjusted such that the indicator reads 180. Set the camera to run continuously and adjust the amplifier for the actual camera speed by timing it to 183 FPM. Make sure that there are no projectors in sync when this is done.

The speed adjustment on the amplifier is done by first setting the tachometer gain (normally "gain 1") to maximum (C.W.). Then adjust the input gain (normally "gain 2") to achieve an actual camera speed of 183 FPM. If this adjustment gets to maximum and 183 FPM is not achievable, continue the adjustment by reducing the tachometer gain.

Once the proper speed is achieved at 180 FPM, all other speeds can be adjusted using the potentiometers on the speed panel and the speed indicator.

The camera speed panel has one additional adjustment. This is the high speed cam. This cam is located on the shaft of the manual speed potentiometer and is accessible from the rear.
CAMERA CARD  Controls camera operation.

PROJECTOR CARD  Controls projector operation.

If the above runs continuously and cannot be stopped via the controls, check relay 640-1. If the above cannot be set into "LOAD", check H11b1.

CAMERA 2 CARD  Controls the synchronization between camera and projectors.

SAFETY CARD  This card checks the running speed of the camera and projectors; if any one exceeds the maximum safe speed as set on the potentiometers it will put that motor into "LOAD" condition. If the system jumps into "LOAD" or cannot be taken out of "LOAD", check this card and its settings.

The safety card will also sense that cables from the encoder including the tachometer feedback to the amplifier have been disconnected and it automatically puts the particular motor into "LOAD" condition. This is done because if there is no tachometer feedback the servo motor will "run wild" at high speed. Also, if there is no encoder input, the safety card cannot determine whether the speed is safe.

BUCKLE CARD  Controls the buckle circuit and latch. If this card is removed, the camera and projector can be run but the buckle safety will be inoperative. If buckle condition cannot be reset and the integrity of the buckle sensors is found to be good by the camera test card, then try replacing the buckle card.
ENCODER  Each encoder has 9 channels of which six are being used by the projector and five by the camera (see schematic item 24). If the encoder channel becomes marginal or inoperative, the results could be:

Counter will not count or miscount.
Motor will not stop but continue to run.
Motor will not switch into "LOAD" when the switch is turned to "LOAD" or it will run a few frames before stopping.

COUNTER  Counter will not count in forward or reverse or it will count incorrectly. If encoder is good and problem is in the counter, try to change the following I.C.s on the board:

CD 4037
MC1 4528/38
CD 4510
CD 4029
INTERCHANGEABILITY  Many modules are interchangeable and as such serve for cross testing. Make sure, as much as possible before interchanging components, that there is no other part that has caused the original problem and which may likewise damage the replacement component.

ELECTRONIC COUNTER  All are interchangeable except for frame cue counter.

ENCODERS  All interchangeable (not the cams).

SERVO AMPLIFIER MODULES  All interchangeable.

PROJECTOR CARD  All interchangeable.

PROJECTOR CONTROL PANELS  All interchangeable.

SERVO MOTORS  All interchangeable.

COUNTERS FOR SKIP/ADD AND PREDETERMINED UNITS  All interchangeable.