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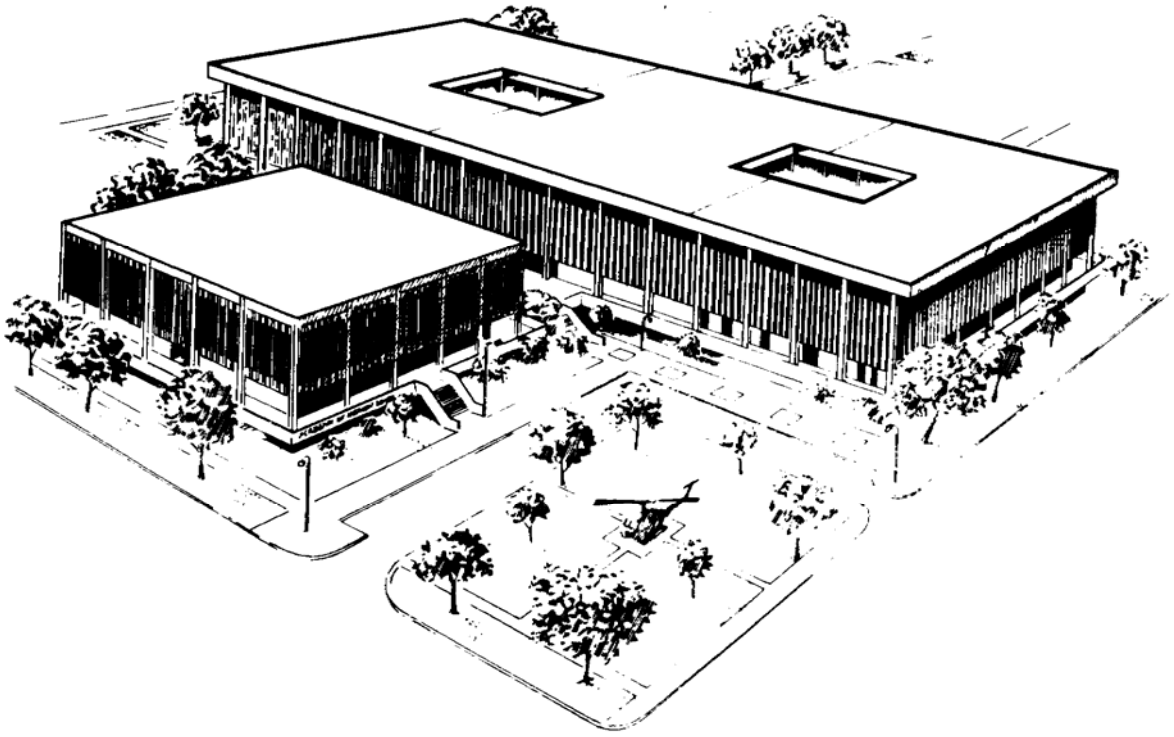

X-RAY FILM PROCESSOR

SUBCOURSE MD0359 EDITION 100

DEVELOPMENT

This subcourse is approved for resident and correspondence course instruction. It reflects the current thought of the Academy of Health Sciences and conforms to printed Department of the Army doctrine as closely as currently possible. Development and progress render such doctrine continuously subject to change.

ADMINISTRATION

Students who desire credit hours for this correspondence subcourse must enroll in the subcourse. Application for enrollment should be made at the Internet website: http://www.atrrs.army.mil. You can access the course catalog in the upper right corner. Enter School Code 555 for medical correspondence courses. Copy down the course number and title. To apply for enrollment, return to the main ATRRS screen and scroll down the right side for ATRRS Channels. Click on SELF DEVELOPMENT to open the application; then follow the on-screen instructions.

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CLARIFICATION OF TERMINOLOGY

When used in this publication, words such as "he," "him," "his," and "men" 'are intended to include both the masculine and feminine genders, unless specifically stated otherwise or when obvious in context.

USE OF PROPRIETARY NAMES

The initial letters of the names of some products may be capitalized in this subcourse. Such names are proprietary names, that is, brand names or trademarks. Proprietary names have been used in this subcourse only to make it a more effective learning aid. The use of any name, proprietary or otherwise, should not be interpreted as endorsement, deprecation, or criticism of a product; nor should such use be considered to interpret the validity of proprietary rights in a name, whether it is registered or not.

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CORRESPONDENCE COURSE OF
THE U.S. ARMY MEDICAL DEPARTMENT CENTER AND SCHOOL

SUBCOURSE MD0359

X-RAY FILM PROCESSOR

INTRODUCTION

This subcourse teaches procedures for preventive maintenance checks and services (PMCS), calibration/verification (C/V) services, and repairs for the AFP 14-X3 and X-OMAT x-ray film processors. Diagnostic quality x-ray films are possible only through the proper use, care and maintenance of x-ray film processors. The medical equipment repairer is responsible for PMCS, C/V, safety testing, and repair of x-ray film processors. It may be necessary for the medical equipment repairer to teach the equipment operator how to properly care for the x-ray processor.

Subcourse Components:

This subcourse consists of four lessons. The lessons are:

Lesson 1, Perform Preventive Maintenance Checks and Services on the AFP 14-X3 X-ray Film Processor.

Lesson 2, Perform Preventive Maintenance Checks and Services on the X-OMAT X-ray Film Processor.

Lesson 3, Perform Calibration/Verification on X-ray Film Processors.

Lesson 4, Remove and Replace or Repair Defective Components of X-ray Film Processors.

Here are some suggestions that may be helpful to you in completing this subcourse:

--Read and study each lesson carefully.

--Complete the subcourse lesson by lesson. After completing each lesson, work the exercises at the end of the lesson, marking your answers in this booklet.

--After completing each set of lesson exercises, compare your answers with those on the solution sheet that follows the exercises. If you have answered an exercise incorrectly, check the reference cited after the answer on the solution sheet to determine why your response was not the correct one.

Credit Awarded:

Upon successful completion of the examination for this subcourse, you will be awarded 7 credit hours.

To receive credit hours, you must be officially enrolled and complete an examination furnished by the Nonresident Instruction Branch at Fort Sam Houston, Texas.

You can enroll by going to the web site http://atrrs.army.mil and enrolling under "Self Development" (School Code 555).

A listing of correspondence courses and subcourses available through the Nonresident Instruction Section is found in Chapter 4 of DA Pamphlet 350-59, Army Correspondence Course Program Catalog. The DA PAM is available at the following website: http://www.usapa.army.mil/pdffiles/p350-59.pdf.

LESSON ASSIGNMENT

LESSON 1	Perform Preventive Maintenance Checks and Services on the AFP 14-X3 X-ray Film Processor.
TEXT ASSIGNMENT	Paragraphs 1-1 through 1-4.
TASKS TAUGHT	Perform Preventive Maintenance Checks Services on the AFP 14-X3 X-ray Film Processor.
LESSON OBJECTIVES	When you have completed this lesson, you should be able to:

1-1. Identify the cautions and warnings concerning PMCS on the AFP 14-X3 X-ray Film Processor.

1-2. Identify the major components of the AFP 14-X3 X-ray Film Processor.

1-3. Identify the procedural steps necessary to perform the operator level daily, weekly, monthly, quarterly, and semi-annual PMCS on the AFP 14-X3 X-ray Film Processor.

1-4. Identify the procedural steps necessary to perform the medical equipment repairer level annual and five-year PMCS on the AFP 14-X3 X-ray Film Processor.

1-5. Identify the procedural steps necessary to perform the medical equipment repairer's level PMCS per a locally established schedule on the AFP 14-X3 X-ray Film Processor.

SUGGESTION Work the lesson exercises at the end of this lesson before beginning the next lesson. These exercises will help you accomplish the lesson objectives.

LESSON 1

PERFORM PREVENTIVE MAINTENANCE CHECKS AND SERVICES ON THE AFP 14-X3 X-RAY FILM PROCESSOR

1-1. GENERAL

a. Preventive Maintenance Checks Services consists of routinely performed cleaning, visual inspection, and servicing of equipment. The objectives of PMCS are to minimize equipment down time, maximize equipment life and assure its safe and effective operation. A good PMCS program maintains equipment in a serviceable condition by detecting and correcting minor faults before they become major defects. A PMCS may include, but is not limited to: cleaning, adjustment, alignment, lubrication, inspection, and replacement of high mortality parts.

b. Cleaning is the most important form of preventive maintenance. Chemical accumulation of processor parts causes corrosion or damage. This may seriously affect the quality of x-ray films produced.

c. Proper lubrication is critical to extend the processor life. Over-lubrication or improper lubrication will shorten the processor life or contaminate the chemicals.

d. There are two levels of PMCS, the equipment operator's PMCS and the medical equipment repairer's PMCS.

e. Maintain accurate maintenance records to ensure that you perform PMCS on schedule.

1-2. OPERATOR LEVEL PREVENTIVE MAINTENANCE CHECKS AND SERVICES

a. **Perform Daily Preventive Maintenance Checks Services.** After the operator completes his daily operations with the AFP 14-X3 X-ray Film Processor, he performs the daily PMCS.

(1) The operator cleans the processor as a part of the daily shutdown procedure. He cleans the developer rollers (located in the developer rack), top cover, side panels, feed tray, and receiving bin. See figure 1-1. To do this the operator performs the following shutdown procedure:

(a) Turn the power switch OFF.

(b) Fully close the water supply valve to the processor.

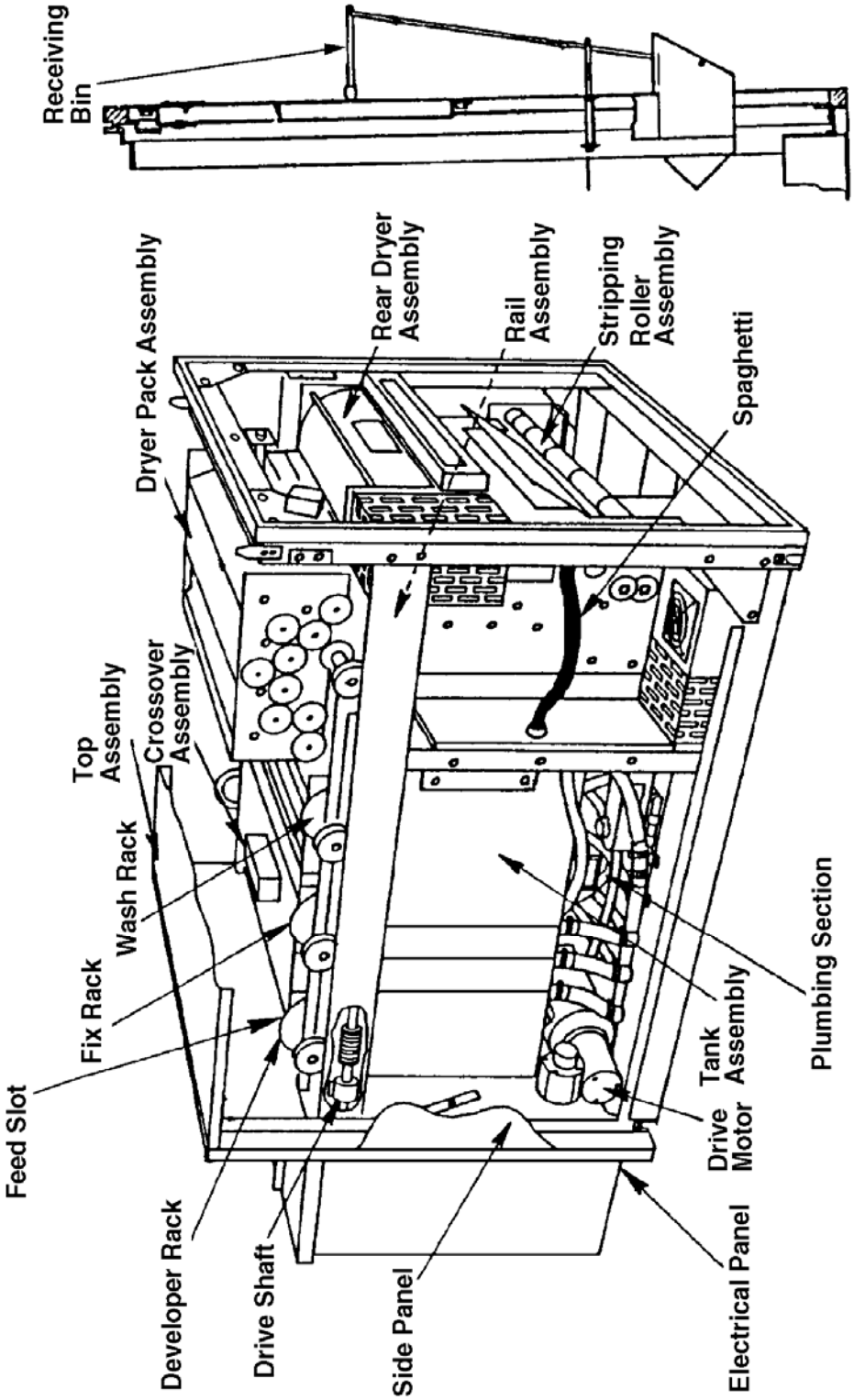


Figure 1-1. External view AFP 14-X3 X-ray Film Processor.

(c) Remove the top cover, the splash guard, and all cross-over assemblies.

1 Clean the top cover by wiping it off with a clean, damp cloth.

2 Thoroughly rinse all of the removed parts with warm water, and allow the splash guard and cross-over assemblies to dry overnight outside of the processor. See figure 1-2.

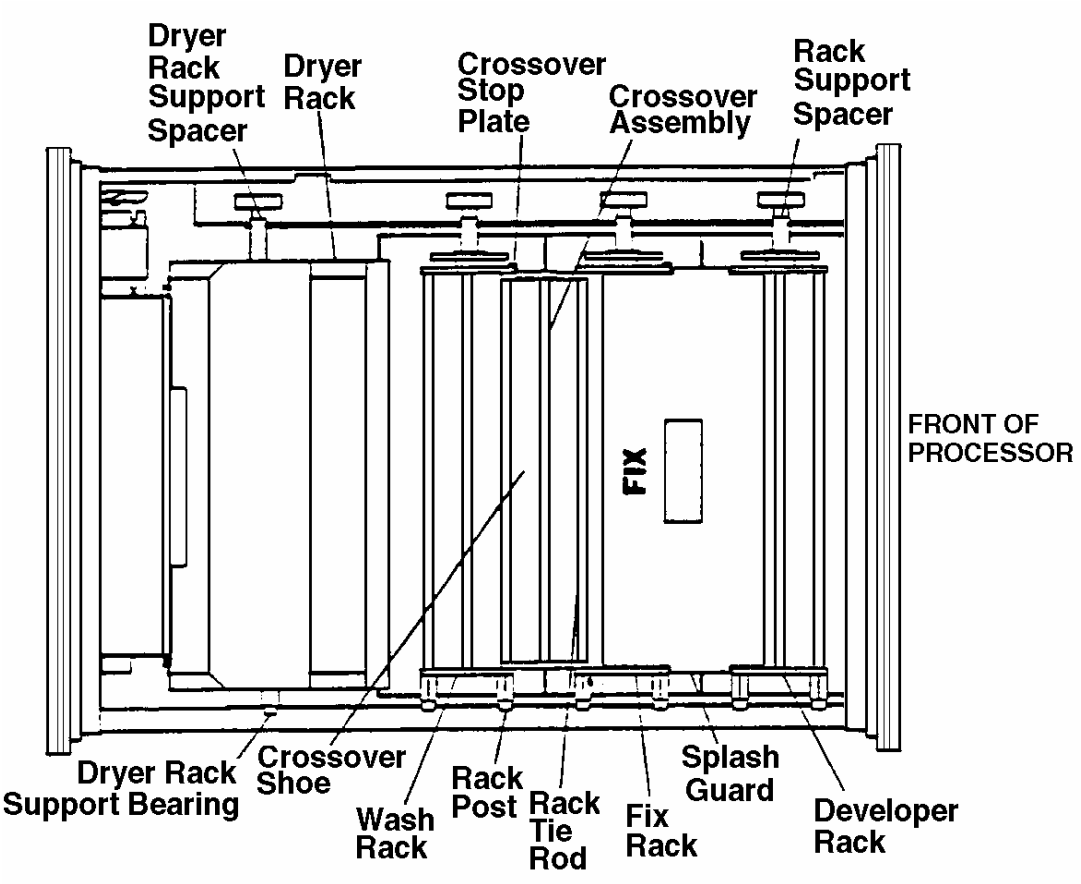


Figure 1-2. Top view, cover removed.

3 Wipe off any solution deposits from the exposed developer and fixer roller surfaces. Use separate, clean, damp cloths for each rack to prevent contamination of the chemicals.

(d) Wipe off the side panels, feed tray, receiving bin, and frame with a damp cloth. Clean up any chemical splashes or spills.

(e) Replace the top cover. Leave it rotated to one side to prevent condensation build up from the chemicals.

(f) Prior to using the processor again, check the chemical level and replenishment rate. Consult the film and chemical manufacturer's literature for correct usage.

NOTE: If the processor is in continual use (24 hours a day), drain it at least once a day and clean it thoroughly once a week. You drain the developer and fix tanks by opening the valves on the drain lines from the pump.

(2) The operator checks the chemical and replenisher levels. He consults the film and chemistry manufacturers' representatives for proper film and chemistry handling and bases the amount of replenisher on the film manufacturer's recommendations.

b. **Perform Weekly Preventive Maintenance Checks And Services.** The equipment operator performs the following steps weekly. The weekly PMCS takes approximately 30 minutes.

(1) Clean the developer rack.

(a) Remove the developer rack from the processor. Use a dip pan underneath it to prevent chemistry spills into the processor or the surrounding surfaces.

(b) Thoroughly rinse the developer rack with warm water (about 90º Fahrenheit). Turn the rollers manually to clean the chemistry solution between them. Use a soft brush or pad to remove chemistry deposits.

(2) Check the wash tank for evidence of "algae" (bacterial slime) build-up. Algae will, under certain conditions, build up in the wash tank. For example, if the tank dries slowly after it drains, existing algae can form spores. The spores seed new algae as soon as you add water. The following techniques help reduce or eliminate this problem:

(a) Be sure the wash tank drains each time you shut down the processor. Leave the top cover open slightly to rapidly dry-out the wash tank. See the NOTE above concerning draining and cleaning the tank daily if it is in continual use.

(b) Use filtered cold water for the wash.

(c) Thoroughly rinse and scrub all surfaces in the wash tank with a soft brush on a regular weekly basis.

(3) If slime is not controlled using the above techniques, rinse the wash tank weekly using the following procedure:

(a) Drain the wash tank and remove the rack.

(b) Turn the machine on to keep the automatic wash drain closed. Fill the tank with fresh, warm water. Add 1/2 ounce (oz) (15 milliliters [ml]) of a 5 percent solution of sodium hypochlorite (such as "Clorox" brand household bleach). Allow it to sit for 1/2 hour, then drain and thoroughly rinse the tank. If lower concentrations are not effective, control slime build-up by increasing the sodium hypochlorite, in 1/2oz (15ml) increments up to a maximum of two oz (60ml) per tank full of water.

WARNING

Control the use of sodium hypochlorite (bleach) very carefully. When combined with fixer, it releases chlorine gas which, in a confined area, **can be fatal**.

DO NOT use it in any other area of the processor under any circumstances.

DO NOT exceed the maximum recommended concentration (five percent).

DO NOT add it to existing wash water. Use only as directed above.

(4) Check the (optional) external water filter. Replace the filter cartridge, if necessary, following the AFP 14-X3 operations and service manual.

(5) Perform the following lubrication steps:

(a) Apply a thin coat of SAE-30 oil to the drive chain. Be careful not to drip any oil on the electrical wiring. See figure 1-3.

(b) Apply a moderate amount of AFP-8827 grease to the plastic drive shaft running gears. See figure 1-4.

(6) Replace the top cover. Leave it slightly ajar.

NOTE: Do not drip any lubricants into the chemistry. It will contaminate it.

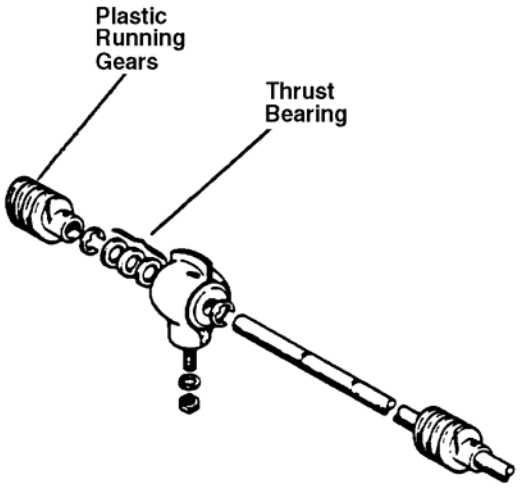


Figure 1-3. Drive motor.

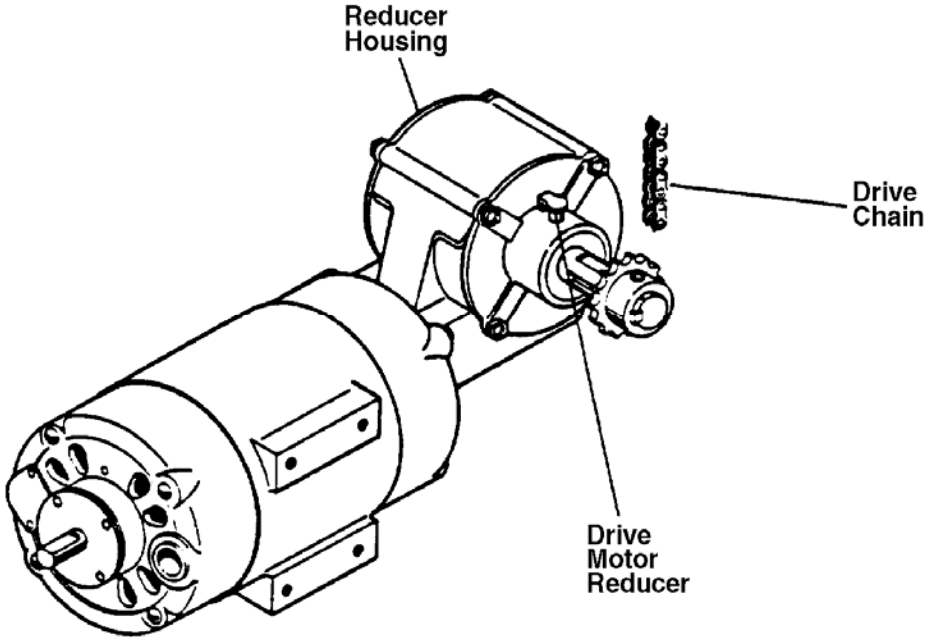


Figure 1-4. Drive shaft.

c. **Monthly Preventive Maintenance Checks And Services.** As you process film, by-products are released into the systems. Every month, you should schedule two additional hours of processor downtime to thoroughly clean the developer, fixer, and wash systems. Operators perform monthly PMCS after they complete the daily and weekly PMCS. Teach the operator the following steps.

(1) Remove the splash guards, cross-overs, and transport racks.

(2) Place them in a sink and rinse thoroughly.

(3) Remove any stubborn deposits or stains using an AFP pad.

NOTE: DO NOT use an AFP pad to clean any rubber roller surfaces.

(4) Change the developer and/or fixer, if due, based on the recommendations of the chemicals supplier. If not due, go to step (5). Follow these steps when changing chemicals.

(a) Drain the solution tank(s).

(b) Remove the splash guard(s), cross-overs, and the appropriate processing rack(s) from the processor.

(c) Rinse off the above parts with warm water (about 90º Fahrenheit [F], 50º Celsius [C]). Clean off any chemical deposits. Use an AFP pad to remove stubborn deposits, but do not use AFP pads on any of the rubber roller surfaces.

(d) Stand each rack upright on a flat surface. Check for squareness and that all rack screws are secure. Test each rack by feeding a piece of processed film through while turning the drive gear by hand. If the rack does not turn smoothly or transport properly, correct the problem.

(e) Adjust the rubber squeegee roller on the wash rack. To do this you tighten or loosen the set screw in the rack frame just opposite the roller bearings. A piece of paper inserted between the rollers should just "drag" when the rollers are adjusted correctly. Be sure to check on both ends of the rack to assure that the rollers are parallel. See figure 1-5.

(f) Rinse and flush the tanks and circulation lines with warm water. When normal rinsing is not adequate, the use of a systems cleaner, such as KLENE-OX is recommended. When using systems cleaners be sure to carefully follow the instructions on the package.

WARNING

Systems cleaners such as KLENE-OX contain sulfamic acid or other equally hazardous chemicals. Do not allow any of these chemicals to come into contact with your skin. In case of contact, rinse the affected area with running water for at least 20 minutes. If any of these chemicals enter your eyes, ears, nose, or mouth, obtain medical attention immediately.

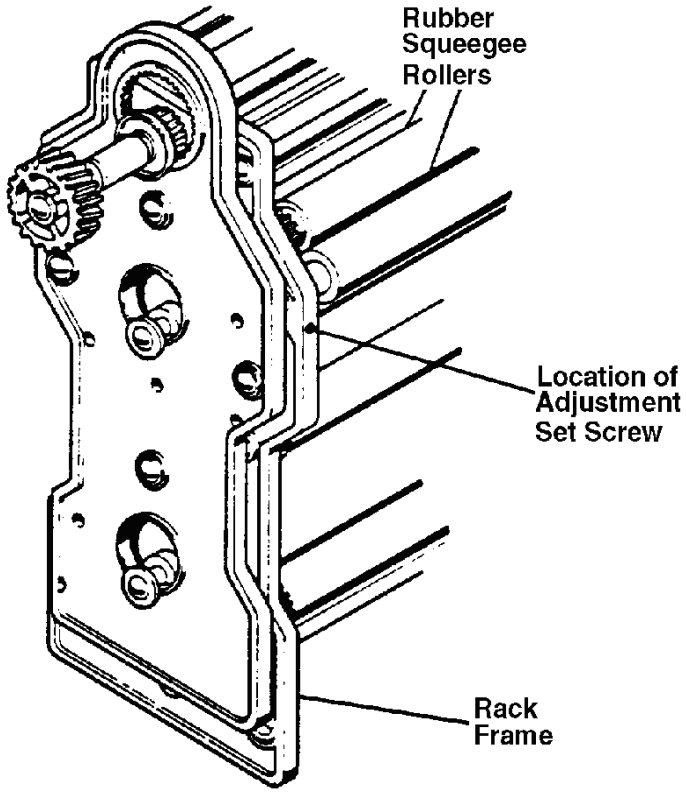


Figure 1-5. Squeegee roller adjustment.

NOTE: Do not soak any of the rubber rollers in a systems cleaner. Use the systems cleaner only as directed on the package label. Always rinse the processor tanks and lines thoroughly several times after using a systems cleaner.

(g) Remove and clean the developer filter element and housing. See (5) below.

(h) Rinse the replenisher tanks and lines with warm water.

(i) Reinstall the racks, cross-overs, and splash guards.

(j) Remove the rear (lift-out) section of the dryer and wipe down the entire dryer area with a damp cloth. Wipe down the dryer rollers with a damp cloth.

(k) Vacuum out the entire dryer section.

(l) Reinstall the lift-out dryer section.

(m) Wipe down the entire processor. Look for indications of leaks or chemical residue build-up. Correct as necessary.

(5) Service the developer filter element and housing. The AFP 14-X3 is equipped with a serviceable element developer filter. The filter is located on the left side of the processor, directly under the wash tank. Service the developer monthly, or each time you drain and replace the developer, whichever occurs most often, as outlined below. Refer to figure 1-6.

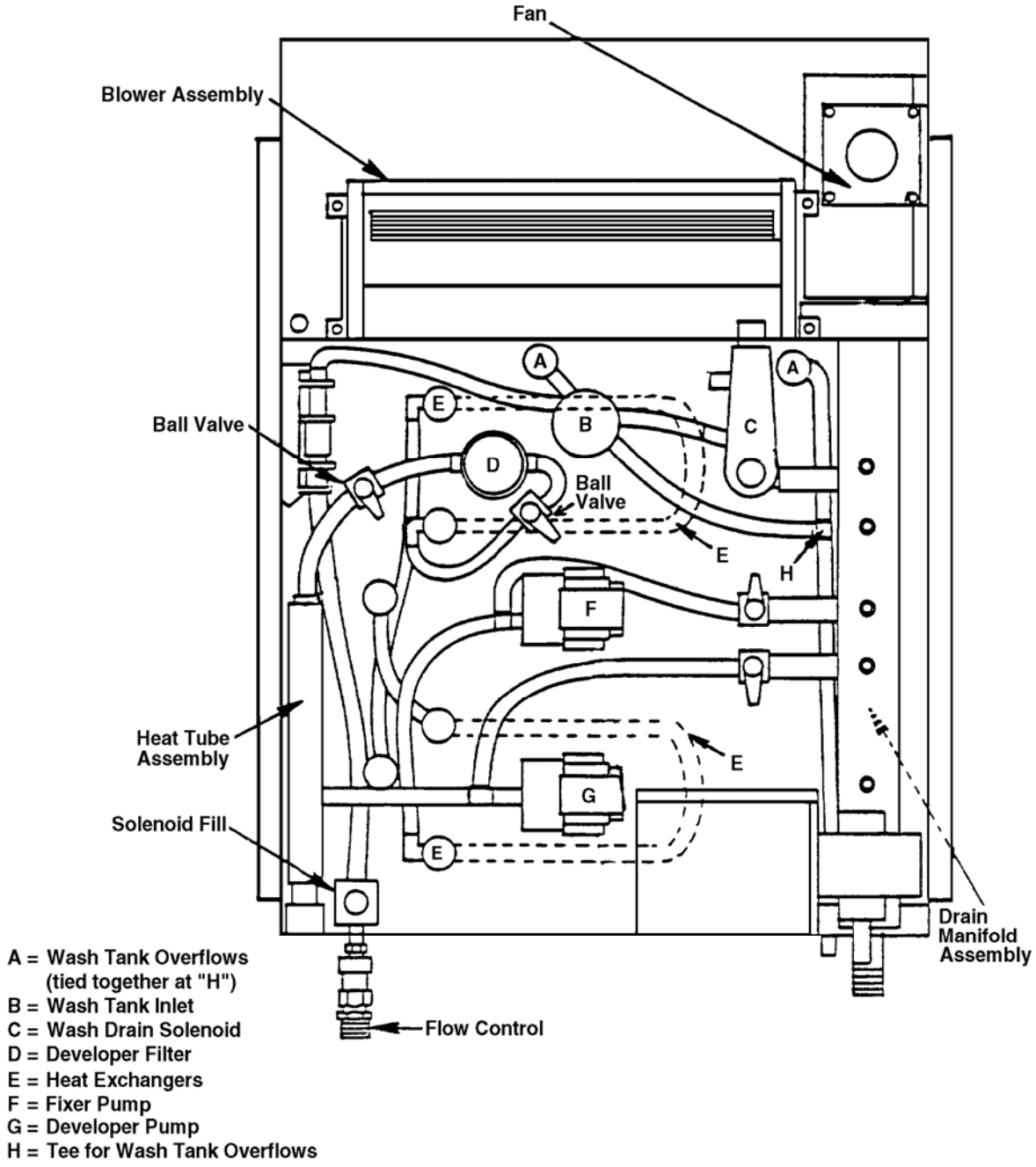


Figure 1-6. Plumbing cross section.

CAUTION: Failure to follow these steps exactly as listed can lead to chemical leakage and damage to the processor.

(a) Remove the top cover and left side panel from the processor.

(b) Turn both developer flow control valves, located on the input and output lines to the filter, to the OFF position.

(c) Loosen the filter mounting clamp two full turns and remove the filter assembly from its mount.

(d) Place paper towels or cleaning cloths under the filter cartridge to absorb any developer spilled or splashed during servicing.

(e) Firmly grasp the upper housing in one hand and the lower housing in the other hand. Carefully unscrew the lower housing and remove it, with the filter element inside, from the processor.

(f) Carefully rinse out the lower housing and the filter element using warm water. If any debris remains, soak the element until it rinses clean.

(g) Remove and clean the sealing O-ring from the top of the housing. Coat the O-ring with a silicon lubricant. Replace it on the housing.

(h) Reinstall the lower housing and element in the processor. Tighten only hand-tight. Position the filter assembly in its mounting clamp and tighten the clamp.

(i) Open the two flow valves connected to the filter housing.

(j) Start the processor and inspect for leaks around the housing seal and hose connections.

(6) Check the hose clamps, plumbing, and rack bearings.

(7) Perform the following lubrication steps:

(a) Apply a thin coat of AFP-8827 grease to each of the wet section rack drive shafts under the support spacers (see figure 1-7).

(b) Also apply a coat of AFP-8827 grease to the dryer drive shaft under the support bearings (see figure 1-8).

NOTE: Use a thin film of lubricant only. Excessive lubricant will travel along the drive shaft and into the chemistry.

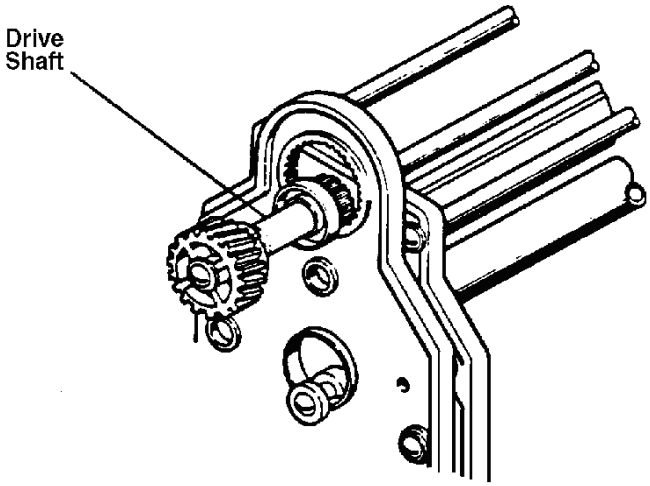


Figure 1-7. Wet section rack.

d. **Perform Quarterly Preventive Maintenance Checks Services.** After performing the daily, weekly, and monthly PMCS and after it has been three months since the previous quarterly PMCS, the operator performs the quarterly PMCS. It consists of adding several drops of SAE-30 oil to the output shaft bearing on the drive motor reducer. Refer to figure 1-3.

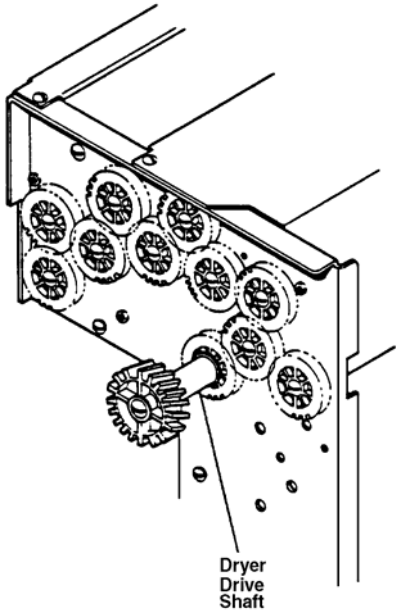


Figure 1-8. Dryer rack.

e. **Perform Semi-Annual Preventive Maintenance Checks Services.** After it has been six months from the previous semi-annual PMCS, the operator performs semi-annual PMCS. The semi-annual PMCS consists of adding a moderate amount of AFP-8827 grease to the drive shaft thrust bearing. Refer to figure 1-4.

1-3. MEDICAL EQUIPMENT REPAIRER'S LEVEL PREVENTIVE MAINTENANCE CHECKS AND SERVICES

The medical equipment repairer performs PMCS yearly. He also performs PMCS every five years.

a. **Perform Annual Preventive Maintenance Checks Services.** After it has been one year since the previous annual PMCS, you perform annual PMCS.

(1) Disassemble the fix pumps and clean as follows. Refer to figure 1-9.

(a) Remove the four pump head assembly screws, Item C.

(b) Gently separate the pump head assembly. Locate and save the internal O-ring seal inside the pump head.

(c) Remove the impeller from the pump head. Thoroughly clean all pump head parts in warm water.

(2) Reassemble the fix pump by reversing the steps in (a)-(c), above. Lubricate the internal O-ring with a silicone-base lubricant before installing. Do not over tighten the self-tapping assembly screws.

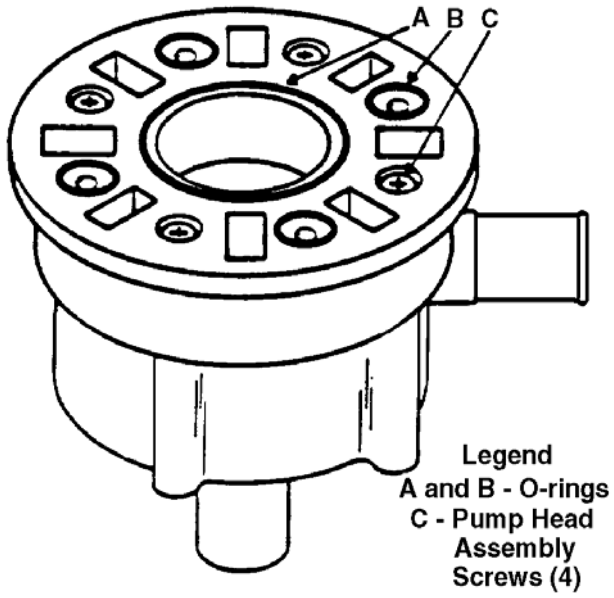


Figure 1-9. View of circulation pump head.

(3) Install the fix pumps:

(a) Carefully install the pump in reverse order of removal. Lubricate the five O-rings that seal the pump to the tank base with a silicone-base lubricant before installing.

(b) Test the pump for operation with water before installing the chemistry.

b. **Perform Five-Year Preventive Maintenance Checks Services.** After it has been five years since the previous five-year PMCS, you, as medical equipment repairer, perform the five-year PMCS.

(1) Clean out the drive motor reducer housing. Refill it to approximately 3/4 full with Hodson No. 2-1000 No-Melt Grease, or equivalent. Refer to the operations and service manual for specific instructions.

(2) Repack the drive motor bearings with Beacon No. 325 Ball Bearing Grease, or equivalent in accordance with the AFP 14-X3 operations and service manual.

NOTE: The following parts are factory lubricated for the life of the component: main drive shaft bearings, dryer blower motors, replenisher pump motor, and muffin fan(s). Additional lubrication may contaminate the factory lubrication and shorten service life.

1-4. MEDICAL EQUIPMENT REPAIRER'S PREVENTIVE MAINTENANCE CHECKS AND SERVICES PER AN ESTABLISHED CHEDULE

The medical equipment repairer must perform a more comprehensive preventive maintenance checkout procedure according to an established PMCS schedule.

a. **Wet Section.**

(1) Clean all the racks. Refer to figure 1-2. Two rack posts and one support spacer, which fit into the processor frame, support each solution rack. The solution racks must be correctly seated into the processor frame for the racks to transport film properly.

(a) Remove the rack from the processor. When removing a solution rack, lift it by the upper tie rods and not by the rack drive shaft. Be careful not to drip fix solution into the developer. Use a drip tray to prevent solution contamination. Place the rack upright on a flat surface and make sure that it is square. The side plates should be flat on the surface. If they are not, loosen the screws on one side plate, press it down flat, and tighten the screws. Repeat this process with the other side plate.

(b) Operate the rack manually and check that it operates freely.

(c) Insert a large piece of previously exposed and processed film into the entrance side of the rack. Manually feed the film through the rack. The film must be transported smoothly, without binding or hesitating. If the film is not being transported properly, look for the area in which the trouble occurs. Examine the area for misaligned parts.

(d) Inspect the film for scratches or marks. Keep in mind that although the rack may successfully transport the film when dry, it may still cause problems in the processor. If in doubt, perform the "rack disassembly/reassembly" procedure in Lesson 4, Remove and Replace or Repair Defective Components of X-ray Film Processors.

(e) Clean the rollers of a rack with a damp cloth. Use an AFP pad to remove stubborn deposits.

CAUTION: Do not use an AFP pad on rubber rollers.

(f) Check the squeegee roller tension. To minimize drying streaks or water marks on film, slightly increase the tension on the exit squeegee rollers. Do this by inserting film between the rollers. Tighten the set screws on the rack side plates with a 5/64-inch Allen wrench until the film just drags on the rollers as you remove the film. Refer to figure 1-5. Make certain that the squeegee rollers are parallel after you have made the adjustment. Ensure that excessive drag does not cause the rack to bind. After making the squeegee adjustment, manually turn the rack worm gear (main rack gear) by hand. Make certain the lower squeegee roller is being driven. If it is not, tighten the set screws.

CAUTION: Do not over-tighten the set screws. Over-tightening may bottom out the screws and bind the gears.

(2) Clean the crossovers. The crossover assemblies fit between the developer and fix and between the fix and the wash racks. Wipe them with a soft damp cloth.

(a) They provide a smooth, curved surface (or shoe) which bends the film down into the fix rack (from the developer) and into the wash rack (from the fix).

(b) For the film to transport properly through the processor, you must install the developer and fix crossover assemblies correctly. See Figure 1-2. Make certain the crossover assemblies fit down on the upper tie rods of the solution racks. Also ensure that the crossover shoes do not interfere with the operation of the solution rollers on either side of them. Refer to figure 1-10.

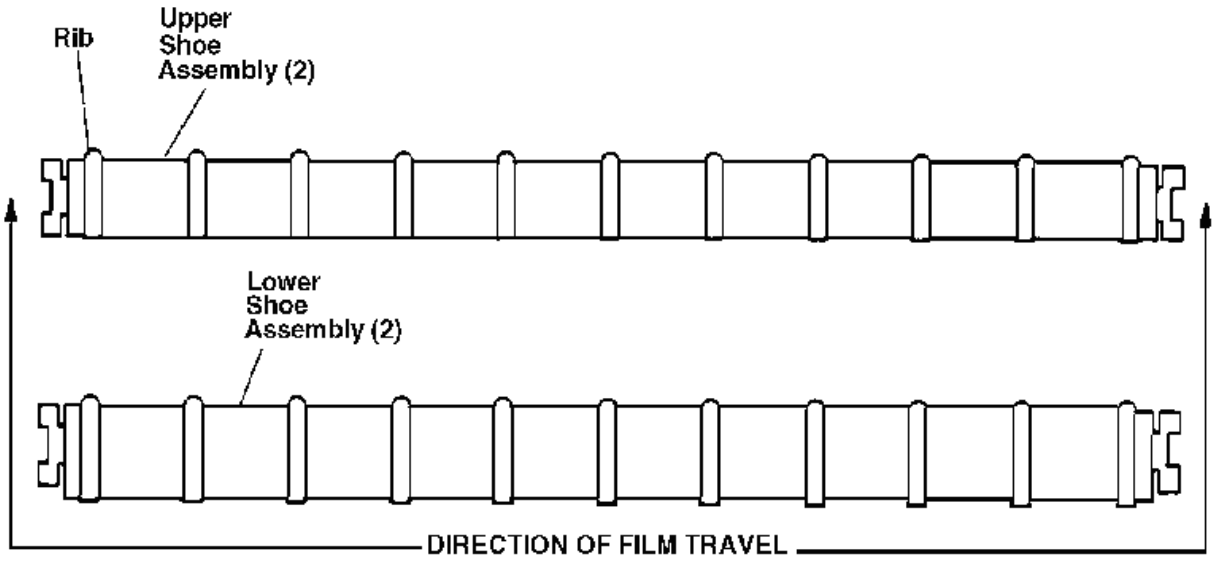


Figure 1-10. Shoe assemblies.

(3) Clean the splash guard. The splash guard rests across the tops of the developer and fix solution racks completely covering the developer/fix crossover assemble. Refer to figure 1-2. The splash guard protects against solution contamination.

(a) To gain access to the splash guard, remove the top cover from the processor.

(b) Remove the splash guard by lifting the guard straight up.

(c) Reinstall the guard by positioning the word "FIX" on the splash guard directly over the fix rack.

(4) Check the wear surfaces. Check the gears, pins, bearings, and other wear surfaces.

(5) Check the rollers. Check the rollers for wear or excessive build-up of residual matter. Roller marks are "plus or minus density" impressions on the film perpendicular to the film path. They are usually at regular intervals along the length of the film. Roller marks occur repeatedly, not just on one sheet of film.

(a) If the marks are not predictable from sheet to sheet, they may be the result of film or chemistry problems. A film manufacturer's representative can best solve these problems.

(b) Roller marks most likely occur in the first half of the developer rack, where film is most sensitive to impressions. The marks can be on either side of the film.

(c) To determine which side of the film a particular mark is on, use household bleach to remove the emulsion from one side. If the marks disappear, they were on that side of the film. This will help you determine whether the marks are made by the inner rack rollers (top of the film), the outer rack rollers, or both.

(6) Check the transport path. Check for worn or warped film guides and loose fasteners. Ensure that the film moves through the racks individually. Plastic or metal parts that are out of adjustment can cause film scratches in the direction of film travel. Burrs, dirt, or dried chemicals on the feed tray, shoe assemblies, or crossovers can also scratch the film repeatedly.

(a) If scratches are not predictable, sifting dirt in the solution tanks could be the cause. They could also be caused by film, chemical, or film handling problems.

NOTE: Plus density marks occur before the fix. Minus density marks occur in the fix and after.

(b) Film is most sensitive to impressions in the developer rack. As with roller marks, it is in the developer rack that scratches most often occur. Scratches at the top of the film may be caused by the crossovers or top guide shoes. Similarly, scratches on the bottom may be caused by the guide shoes in the bottom of the rack being out of alignment or dirty.

(c) To find the location of the problem, remove the fix/wash crossover. Feed a sheet of film. Retrieve the film from the fix rack and inspect it for scratches. Replace the crossover, making sure it fits correctly.

(d) You should consult the sensitized materials manufacturer for a solution to any problems you cannot correct.

(e) Remove the dryer and repeat the process, adding each component in the film path after the film has passed through the previous one. This procedure should isolate the problem. If the problem is in a rack, refer to paragraph a(1), above.

(7) Check the tanks. Clean the tanks and check for algae build-up as well as for evidence of leakage. The wash tank drains automatically when you turn the power switch OFF. Leave the top cover slightly ajar to allow the tank to dry out. Failure to do this causes dirt to accumulate in the tank and permits algae to grow. Dirt transfers to the film as the film passes through the tank. If the incoming water contains significant impurities it may cause streaks or spots on film. Filtering the incoming water supply helps eliminate this problem.

(a) When power is first applied to the processor, the drive system and the water solenoid activate for 4 1/2 minutes. During the warm-up period, while the processor is in the jog cycle, additional water enters the tank. If the wash tank is not filled by the time the first film passes through it, check for a restriction in the incoming line. This could be caused by a dirty water filter or a shutoff valve that is not completely open.

(b) A flow restrictor and water solenoid regulate the flow of water to the wash tank. Refer to figure 1-11. The solenoid activates whenever the drive motor is on. Water flows from the water inlet through the flow restrictor. This reduces the flow rate to 3/4 gallons per minute (min [2.8 liters per min]). The water then flows through the solenoid valve and into the wash tank.

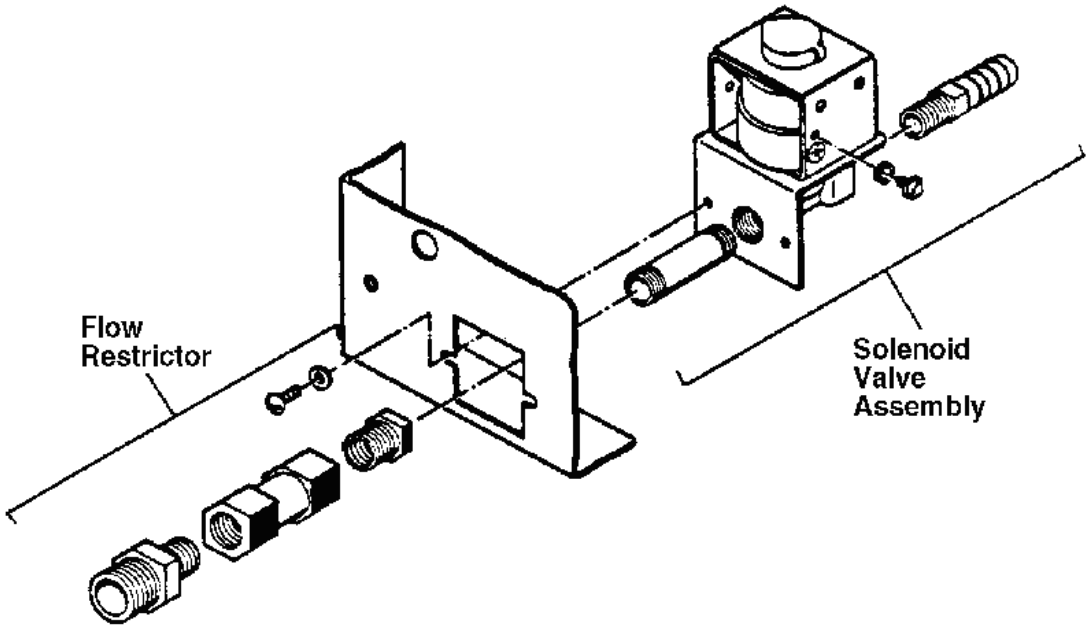


Figure 1-11. Water solenoid and flow restrictor (exploded view).

(c) Check the operation of the water fill solenoid by turning the power switch to ON. The solenoid valve should click on and water should flow into the wash tank. When the transport system turns off, water should stop flowing.

(d) The solenoid valve is located just behind the electrical panel, on the left side of the processor. Power is supplied to it through relay K2. Check the approximate line voltage between TS6-7 and TS6-12 when you activate the transport system. If there is proper voltage but the valve does not operate, you may need to replace the coil, or remove and repair or replace the valve. See Lesson 4, Remove and Replace or Repair Defective Components of X-ray Film Processors.

(e) Refer to 1-2b(2) for methods of controlling algae growth.

(f) Check the tanks for evidence of leakage. To discover the source of leakage remove a side panel from the tank area. Look for deposits or spotting under the tanks. If a leak is occurring around a fitting, drain the tank to a point below the level of the fitting. Remove the fitting and clean it. Inspect the seal and replace it if it is damaged. Be sure to clean up any splashes below the tank. Inspect the wiring and the components to make sure there is no damage.

(8) Check the drive motor, shaft, and chain. The drive motor is located on the right side of the processor, beneath the developer tank. See figure 1-1. It drives the entire transport system through a set of sprockets, a drive chain, and a main drive shaft. The horizontal worm gears on the main drive shaft mesh with the main rack gears on the developer, fix, wash, and dryer racks. This drives the rollers in the racks to advance the film. Rollerless crossover assemblies between the developer/fix and fix/wash racks minimize crossover time. The speed at which the film is advanced through the racks is predetermined by the speed of the drive motor, the reducer gear ratio, and the size of the drive sprockets. The manufacturer's specifications list the developer and dry-to-dry times. The transport system on the AFP 14-X3 operates whenever the power switch on the control panel is in the ON position. The drive motor normally has enough torque to turn the drive shaft, even if one of the racks is struck. Motor failure would most likely occur from an internal short or bind.

(a) Check the mesh with the rack gears.

(b) Check for the correct chain tension. The processor drive chain is located inside the electrical compartment. Remove the front panel and the chain guard to gain access to the drive chain. See figure 1-12. The drive chain may require periodic adjustment to maintain the correct tension of the chain on the drive sprockets. Adjust the drive chain tension spool until the chain deflection (or play) is about 1/8 to 1/4 inch (0.3 to 0.6 centimeter [cm]). Do not over-tighten the chain, as this will cause excessive sprocket wear. If you need to remove the chain (for example, when checking for a bind in the drive shaft), remove the connecting link from the drive chain. Then remove the drive chain from the sprockets.

(c) Lubricate the drive chain.

(d) Lubricate the output shaft bearing on the drive motor reducer.

(e) Check and grease the plastic running gears on the shaft with a moderate amount of AFP 8827 Grease. See figure 1-4.

(f) Lubricate the drive shaft thrust bearing by applying a moderate amount of the same grease to the thrust bearing at the end of the main drive shaft. Wipe off the old grease before adding the new grease.

(g) Check the amp draw and the motor operation. Refer to figure 1-13.

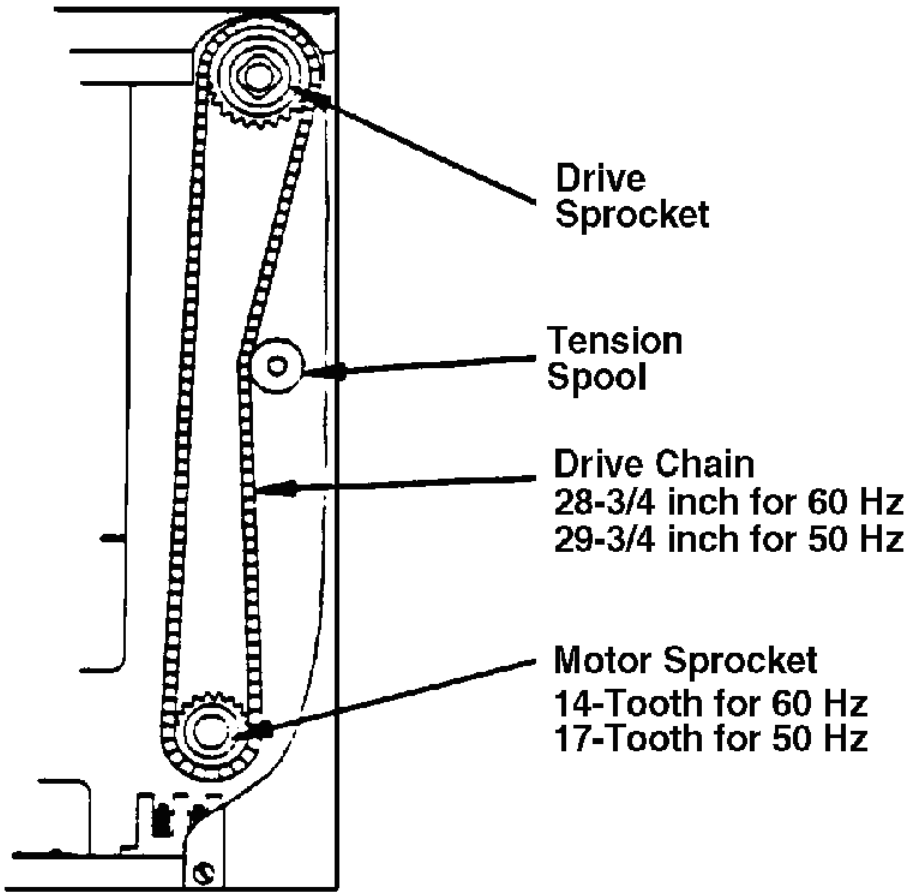


Figure 1-12. Drive chain adjustment.

Fuse	Circuit	Amps at 115v 60 Hz*	Amps at 220v 50 Hz*
F1	Transformer	0.5	0.5
F2	Replenisher Pump	0.75	1.0
F3	Blower Motor	3.0	2.0
F4	Drive Motor and Wash Solenoid	1.9	1.0

* All amperage values are nominal and may vary $\pm$ 6 percent.

Figure 1-13. Current draw of fused circuits.

(9) Check the circulation system. Separate pumps circulate the developer and the fix in the solution tanks. The pumps operate constantly when the power switch is ON. A solenoid valve turns the water ON and OFF. See figure 1-14. The level detector circuit automatically fills the developer tank and keeps it filled using detector probes at the top of the developer tank. A replenisher pump activates and adds replenisher to top off the tank. Expended fix and developer solutions overflow into the drain ports on the right side of the tanks and into the drain manifold. If the fix drain port becomes plugged, the solution flows into a safety drain port. The wash tank has an overflow weir at the rear of the tank for skimming action. When you turn off the machine, the drain solenoid opens and the wash tank drains directly into the drain manifold. Poor solution circulation can contribute to a variety of problems associated with temperature control and film artifacts. Lack of proper circulation can be caused by the following conditions: stagnating chemistry, resulting in deposits in tanks and lines; lack of regular draining and flushing of tanks and lines; application of power when tanks are empty causing pumps to overheat; kinks or restrictions in the lines.

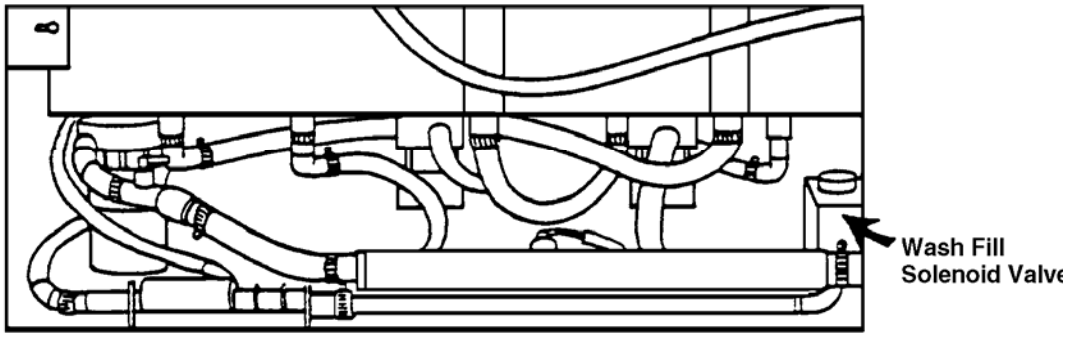


Figure 1-14. Wash fill solenoid valve location.

(a) Check for clogged circulation lines and flush as necessary. Since the pumps and lines are below the tanks, they must be flushed whenever you change the chemistry. To do this, you turn OFF the power switch and remove the top cover and side panels. You drain the developer and fix tanks by opening the valves on the drain lines from the pump. You fill the developer and fix tanks with water up to the standpipe level. Turn ON the power switch. Run the processor for a few minutes, then turn OFF the power switch. Drain the tanks. Make sure all connections are tight before adding new chemistry.

(b) Check for evidence of leakage. Refer to paragraph 1-4a(7)(f).

(c) Check that the tank solutions circulate. The developer and fix circulation pumps are identical. If a pump motor is operating, but the solution is not circulating, check for a stuck impeller. If you run the pumps when they are dry, the impellers and plastic pump housings will be damaged by excessive heat, causing the impeller to jam. A foreign object wedged between one of the impeller blades and the housing could also cause a stuck impeller. To check for a stuck impeller, drain the solution tank and remove and disassemble the pump. See Lesson 4, Remove and Replace or Repair Defective Components of X-ray Film Processors.

(d) Check for proper water solenoid activation. Refer to paragraphs 1-4a(7)(a) through (d).

b. **Dryer Section.**

(1) Check the transport rack. The dryer rack rests on a support bearing and a support spacer, which fit into the frame of the processor. Refer to figure 1-2. The dryer rack must be seated into the processor frame for the rack to transport the film properly.

(a) Clean off the rack rollers. Remove the dryer rack from the processor and clean it. Examine the dryer rack to see that all of the rollers are being driven and that the strippers and collars are all in place on the discharge rollers (stripping rollers).

(b) Lubricate the dryer drive shaft bearings beneath the support bearing.

(c) Check for worn bearings and springs.

(d) Check for unobstructed film transport through the rack.

(e) Vacuum the entire dryer section.

(2) Check the air system. The blower motors remain off during the initial warm-up of developer solution. They turn on when power is first applied to the dryer heaters. They remain on until you turn off the power at the end of the day.

(a) Clean the blower and air ducts.

(b) Clean the blower motor.

(c) Check the blower motor for excessive draw. Check the power to the blower motor between TS3-4 and TS3-7, while the blower is running. There should be line voltage. The power is switched on when the normally closed relay K3 is switched off after solution warm-up. If the blower is not working at all, check fuse F3.

c. **Electrical System.**

(1) Check the front panel. Perform the power supply and fuse test if there is a processor electrical malfunction. This check verifies that proper power is delivered to machine components. Refer to figure 1-15.

(a) Plug the power cord in. The MAINS indicator should light. If it does not, check the wall electrical outlet, or the secondary taps of the power transformer, as appropriate. If the processor works but the indicator does not light, the light bulb is probably burned out.

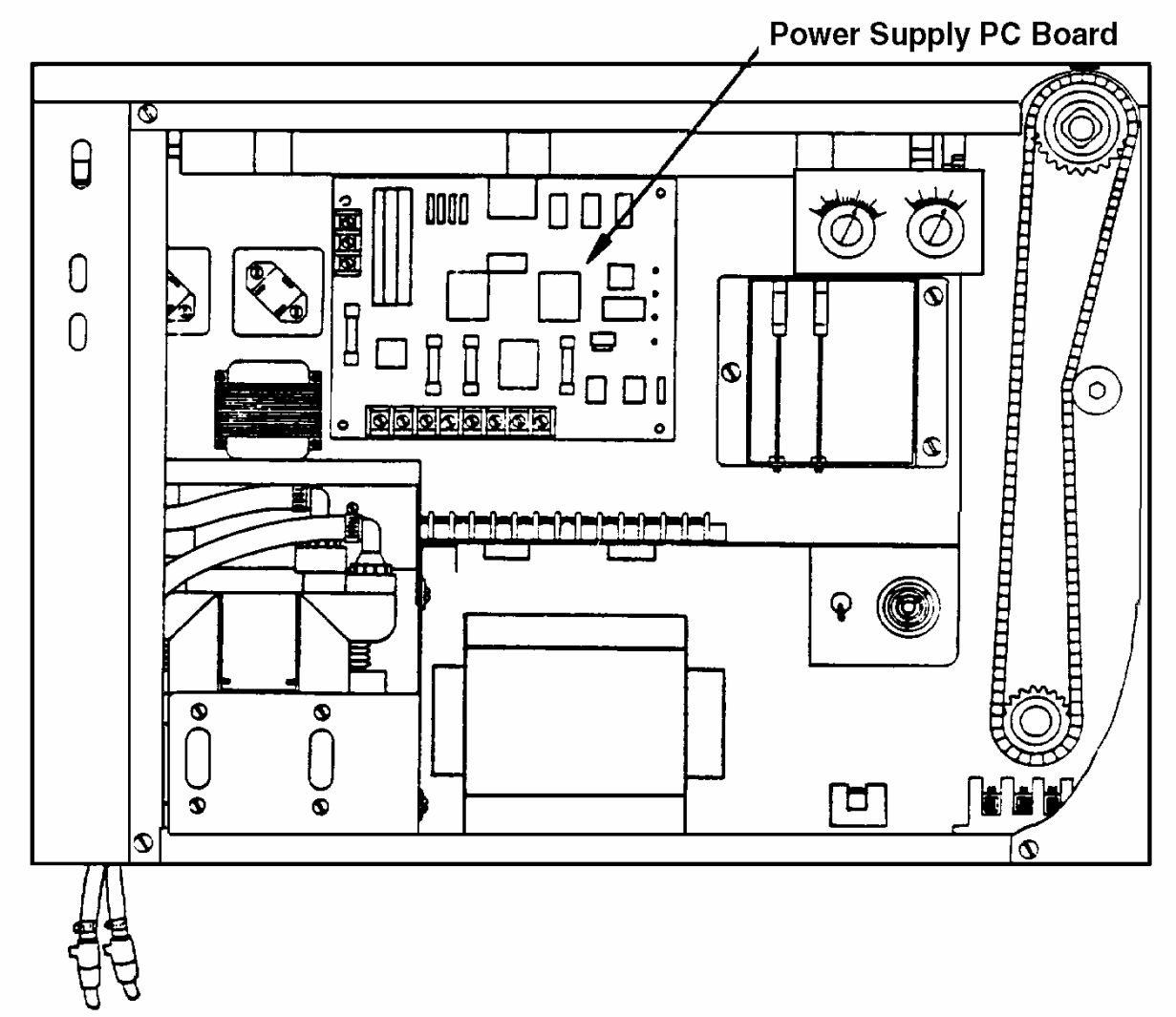


Figure 1-15. Power chassis components.

(b) Remove the front cover. Check the four fuses located on the power supply printed circuit (PC) board J1. Check the current draw on a circuit which blew a fuse. Connect the ammeter leads across the blown fuse. Check the current draw in the run condition. Figure 1-13 lists the current draw for each of the circuits. Excessive current draw in a motor circuit usually indicates shorted windings or a frozen armature.

CAUTION: A blown fuse indicates an excessive current draw in the circuit. Always determine the cause of the excessive draw. Never replace fuses with fuses which have higher amperage ratings.

(c) Turn the power on. Check for 12 ± 0.5vdc (volts direct current) between TP4 and TP1 (common) on the power board J1. If there is no voltage, check for 16vac (volts alternating current) between TS2-3 and TS2-1. If there is voltage at TS2, but not at TP4, check the F1 fuse. If the fuse is good, the power board is not functioning properly. You must replace it.

(d) Remove the PC card cage cover. Refer to figure 1-16. Check for 12 ± 0.5vdc between TP6 and TP1 (common) on the timing PC board J2, and between TP8 and TP1 (common) on the temperature board PC board J3. Also check for 20 ± 2vdc between TP7 and TP1 on J2. If any of these voltages are missing, disconnect power, remove the PC boards, and clean the contacts with an eraser. Check the PJ1 connector to make sure it is clean and tight. Reinstall the PC boards and recheck the voltages. Replace a PC board that has a voltage problem.

(2) Check the film switch activation. Check the film switch by measuring the voltage or resistance as outlined by figure 1-17. The film feed switch consists of two or three sensor fingers attached to a rod over the film feed slot. Refer to figure 1-18. A counterweight rotates the fingers back up after they are released. The switch itself is located on the left end of the rod. You can adjust the switching point by loosening the nylon actuating block that changes the switching point, and retightening the fastener. Remove the front panel to gain access to the film switch. Replace the film switch if it is faulty.

(3) Check the transport timing. The timing PC board J2 has three timers for the film processing sequence. See figure 1-19. Check each timing function with a watch. If a timing function is not correct, check for a drive signal at led (light emitting diode) DS1 of PC board J2. DS1 should light when the timers activate the drive system. If it lights, the problem is not with the timers. Refer to section 1-4a(8). If DS1 does not light, perform the power supply and fuse test in section 1-4c(1). If the power supply is good, the J2 PC board is faulty. You must replace it.

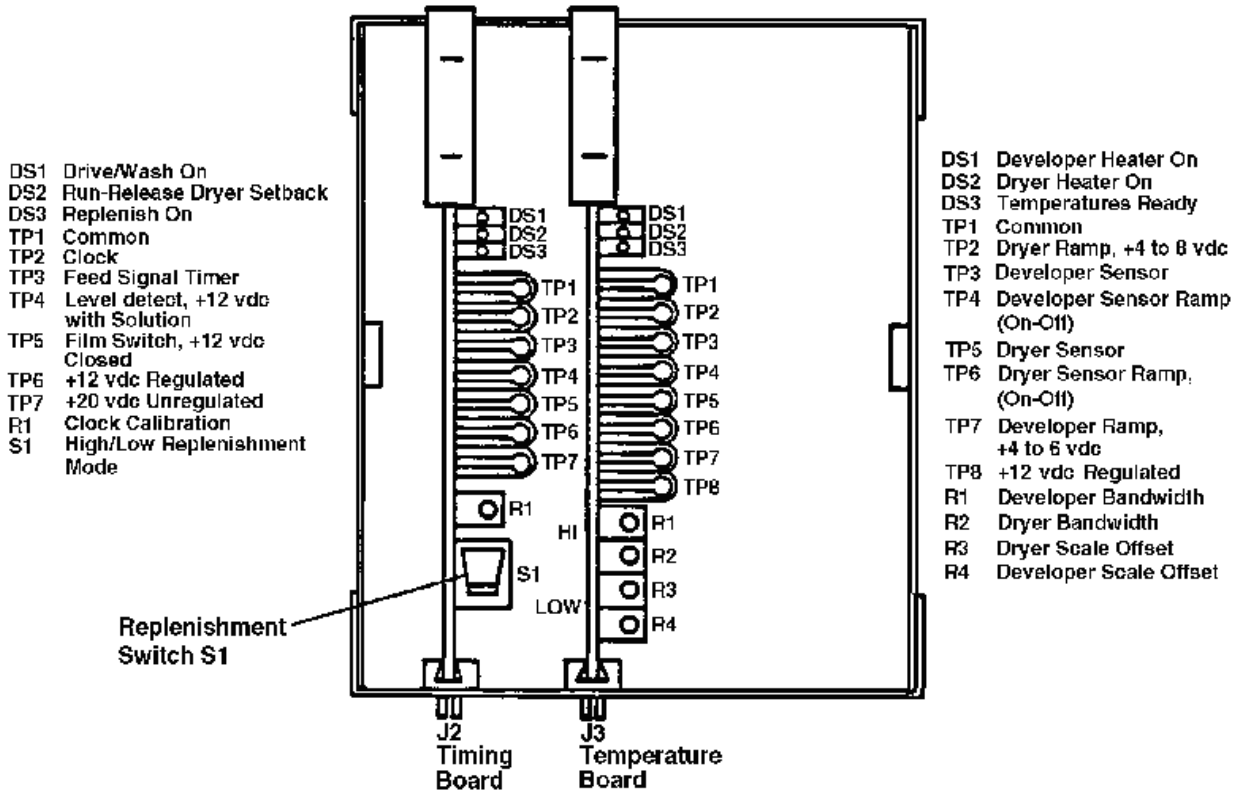


Figure 1-16. Adjustment and test point on PC boards.

Test	Test Points	Reading	Condition
Voltage	TP5 and TP1 on PCB J2	12vdc	Switch depressed
		0vdc	Switch released
Resistance	NO and COM at switch, leads disconnected	0 ohms	Switch depressed
		infinite ohms	Switch released

Figure 1-17. Film switch check.

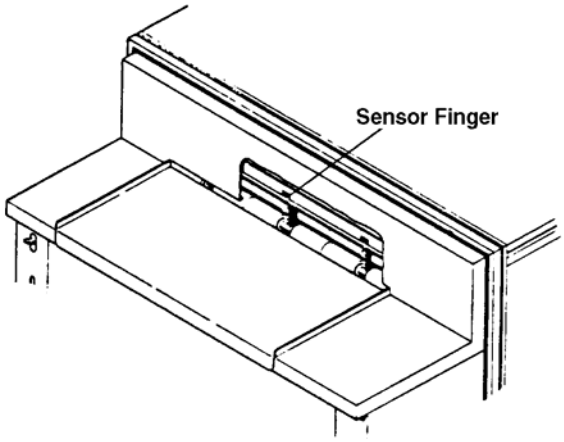


Figure 1-18. Film switch.

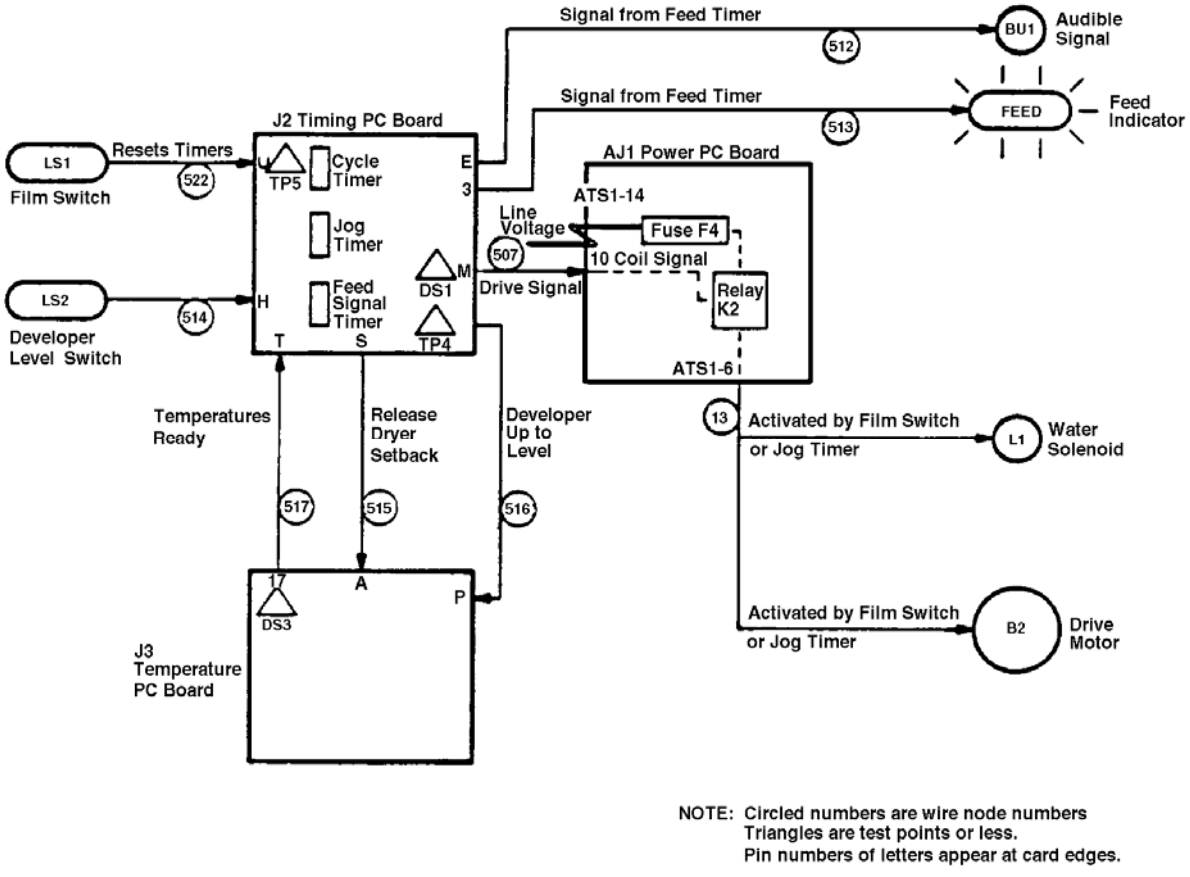


Figure 1-19. Signal flow diagram of timing circuit.

(4) Check FEED indicator and audible signal timing. Check that the FEED indicator lights after 2 1/2 seconds and that there is an audible "beep" signal. The feed signal timer starts counting as soon as you release the film switch. It counts 2 1/2 seconds and then turns on the TEMP/FEED indicator and sounds the audible "beep" signal. The TEMP/FEED indicator will not light if there is insufficient developer in the rack, if the developer and/or dryer have not reached temperature, or if the film switch is actuated.

(a) If the TEMP/FEED indicator functions, but the audible signal does not, it is likely that the signal is faulty. Disconnect the leads to the audible signal and hook a penlight battery or an ohmmeter with a 1.5v (volt) battery to the audible signal. Observe polarity. The signal should emit a humming sound.

(b) If the audible signal functions, but the TEMP/FEED indicator does not, it is probably due to a burned-out bulb.

(c) If the audible signal is producing a faint constant beeping sound, the power supply voltage is incorrect. The supply voltage must be within 6 percent of 115vac or 220vac. If you are configured for 220vac operation, it may be necessary to change the transformer output tap. Check with a voltmeter and adjust accordingly.

(d) Failure of the TEMP/FEED indicator to light after a sufficient warm-up time should be diagnosed by using the following procedure. The components in the feed and timing circuit are shown in figure 1-19. The procedure for checking the cause of unusually slow warm-up is the same. If there is insufficient developer, see the following paragraph (e). If the developer has not reach temperature, see the following paragraph (f). If the dryer has not reached temperature, see the following paragraph (g). If the film switch is activated, see the following paragraph (h).

(e) If there is insufficient developer, remove the top cover and check the solution levels. If the developer is below the level detector probes, the replenisher pump should be running. It should continue to run for 30 seconds after the solution level reaches the detector. If the pump is not running, refer to replenishment system below, paragraph (7). If the pump is running and replenisher is being added, but it does not raise the solution level in the tank, the tank is leaking or draining. Check all fittings to make sure they are not leaking solution. Refer to diagnosing leaks, paragraph 1-4a(7)(f). If there is sufficient developer, but the replenisher pump is still running, the level detector is not working.

(f) If the developer has not reached temperature, check the temperature with a process thermometer. If there is no heating, refer to temperature control, paragraph (6) below. If the replenisher pump is still running, the problem could be the developer level detector. If the thermometer shows that the solution is being heated, check for adequate circulation. Also check the water temperature and ambient (overnight) air temperature. Room temperature and extremes in incoming water temperature can inhibit warm-up.

NOTE: The top cover of the processor must be in place during warm-up.

CAUTION: Do not use a mercury thermometer. It may break and contaminate the tank.

(g) If the dryer has not reached temperature, check that you have plugged in the dryer. Refer to paragraph (6), below.

(h) If the film switch is activated, it is possible, though not likely, that the film switch is stuck. Check for free movement of the switch. If the switch does not activate the drive system when pressed, refer to sections 1-4c(2), Check the film switch activation, and 1-4c(3), Check the transport timing.

(5) Check the jog function. When the processor is on but not processing film, the jog timer counts. It starts as soon as the cycle timer completes its count, and counts for 3 minutes. After each 3 minute interval, the jog timer activates the drive motor and wash solenoid for 9 seconds. In the low volume mode, the replenisher pump also activates for 9 seconds. The jog sequence repeats continually as long as you do not feed film into the processor.

(6) Check the temperature control. A single 1500 watt heater heats the developer and fix. It is located in a tube under the developer and fix tanks on the left side of the processor. The dryer has two 750 watt coil heaters which heat air directed to the film surfaces by blowers and air ducts. Both the developer and dryer heaters are controlled in the same way. Set the desired temperature on the temperature control dials inside the front panel. Temperature probes in the bottom of the developer tank and in the dryer air duct feed back the actual temperature. A temperature controller signals two triac switches, one for the developer heater and one for the two dryer heaters. The triacs switch line voltage to the heaters.

(a) Check the actual temperatures against the dial settings.

(b) Check the amp draw of the developer and dryer heating elements. Refer to figure 1-16. For warm-up, when you first turn on the power, the controller switches full power to the developer heater only. You can check this by observing the leds on PC board J3. This indicates when a heat signal is being sent to a triac. DS1 indicates developer heat, DS2 indicates dryer heat. Refer to figure 1-16.

(c) When the temperature of the developer is within 1ºF (0.6ºC) of the dial setting, the controller begins switching power to the dryer. Under power, the dryer blower turns on and DS2 on PC board J3 begins to blink. DS1 and DS2 alternately blink, indicating that the developer is close to the set point temperature. It also indicates the dryer is being brought up to the set point temperature.

(d) When DS3 lights, both the developer and dryer have reached the temperature band. The dryer temperature at this point is automatically set back from the set point temperature. The temperature controller maintains proper temperatures by alternately switching power to the heaters. You will observe DS1 and DS2 blinking at a 50:50 ratio or less when there is no film in the processor.

(e) When you load film into the processor, more heat is available to the dryer to bring it to set point temperature. Leds DS1 and DS2 show a proportion of up to 20:80 for the first sheet of film, which varies depending on the operating load. More heat becomes available to the dryer by a setback circuit. The circuit runs from a signal on J2 (DS2 lights), activated by the film switch. The setback circuit has the effect of increasing the dryer temperature dial setting by changing the resistance of the dial and temperature probe input to the temperature controller.

(f) The flow chart in figure 1-20 gives a procedure for checking a no heat condition. Diagnose other heating problems in the same way. The leds on PC board J3 indicate whether or not the controller circuit is functioning. If these leds are working, the problem is probably not in the PC board. A quick way to check if the PC board is working is to turn up one temperature dial and turn down the other. You should see DS1 or DS2 light. If neither of the leds light, perform the power supply and fuse check in section 1-4c(1)(a)-(d). Replace the PC board J3 if the power supply is good. Perform temperature calibration in Lesson 3, Perform Calibration/Verification on X-ray Film Processors, after installing a new PC board.

(g) Shorting causes constant power to the heating element, therefore constant heat, resulting in high developer activity or evaporation. Since the developer heater has a safety thermostat, a shorted triac may cause overheating, cut off until the element cools down, then cause overheating again. This shows as erratic temperature control. A shorted dryer heater triac causes overheating, which will trip the dryer thermostat. If the thermostat trips again after you push the reset button, the problem is probably due to a shorted triac. A faulty temperature probe can also cause erratic temperature control.

(h) You check power to the developer heater at terminal strip TS6. Turn OFF the power switch and turn up the developer temperature dial. Turn the power switch ON again, so that DS1 on the PC board J3 lights. Check for line voltage between TS6-6 and TS6-19, when SD1 is lit. Turn down the temperature dial and check for no voltage, when DS1 is not lit. If there is voltage at TS6 when DS1 is not lit, then triac CR1 is shorted and you must replace it.

(i) The developer heater has a safety thermostat (TH3) that automatically resets after it cools down (figure 1-21). The cutoff point is approximately 130ºF. A shorted triac can cause fluctuating developer temperature and results in the heater heating up, cutting off and cooling down, and then heating up again. The voltage between TS6-6 and TS6-19 is line voltage. If there is no voltage on a hot heater, thermostat TS3 may have cut out. Wait for it to cool off and recheck the voltage.

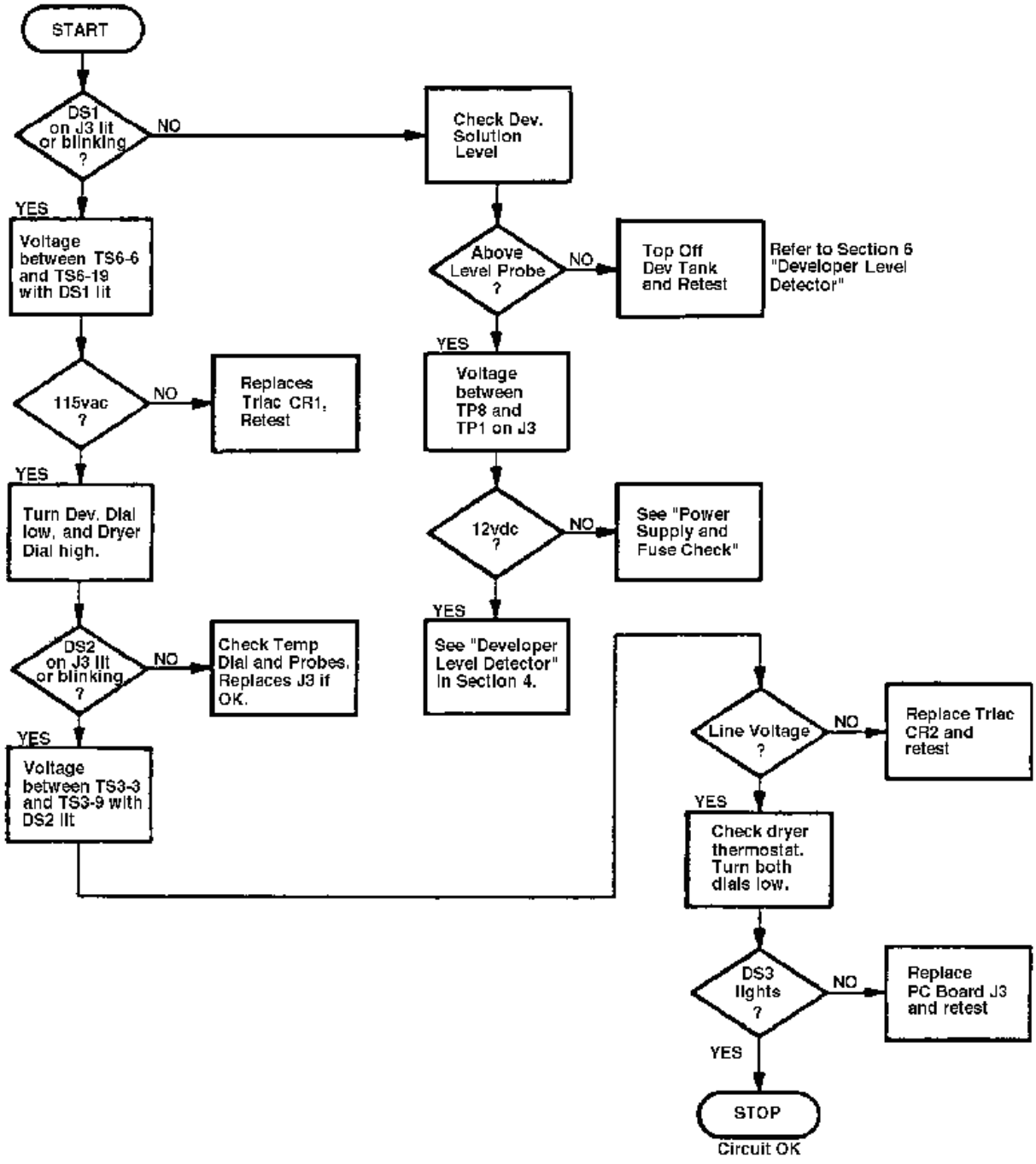


Figure 1-20. Flow chart for checking a no heat condition.

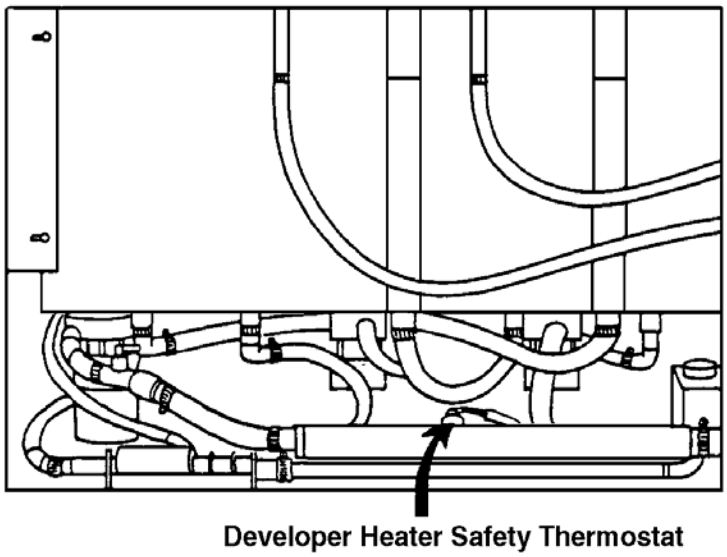


Figure 1-21. Location of developer heater safety thermostat.

(j) You check the power to the dryer heaters at TS3, located on the right side of the dryer assembly. Turn the dryer temperature dial up and the developer temperature dial down. Press the film switch to activate full power to the dryer. led DS2 on PC board J3 should light. Check for line voltage between TS3-3 and TS3-9, when DS2 is lit. Turn down the dryer temperature dial and check for no voltage, when DS2 is not lit. If there is voltage between TS3-3 and TS3-9 when DS2 is not lit, the triac is shorted and you must replace it. See figure 1-22.

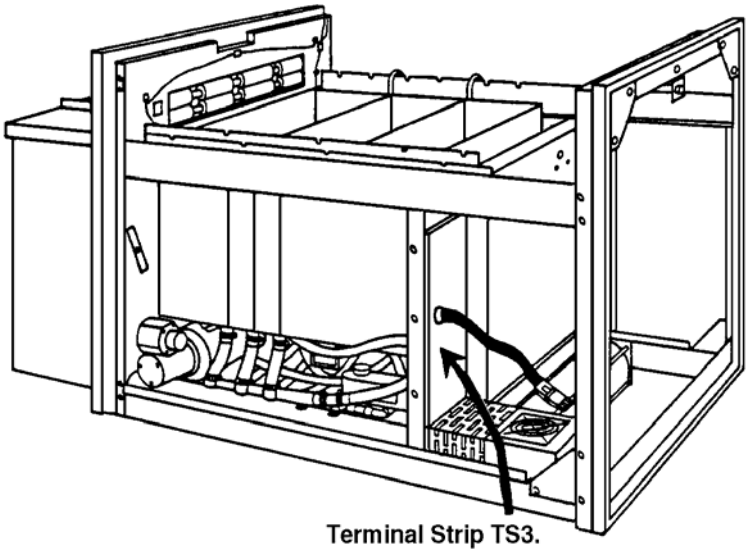


Figure 1-22. Location of terminal strip TS3.

(k) The dryer safety thermostat(s) (TH1 and TH2) cut off power to the dryer heaters if ambient temperature in the dryer exceeds approximately 165^{o} F. A constant heat condition (shorted triac) in the dryer could cause this, as could a clogged air flow, or a blower motor failure. You must manually reset the safety thermostat(s). See figures 1-23 (front dryer) and 1-24 (lift-out dryer). Allow the dryer to cool before pressing the reset button. If a thermostat trips a second time, remove the dryer assembly, clean it, and check all components.

(l) Triac testing requires that you disconnect the power. Take a piece of tape and mark the wires at the triac so that you do not reverse them when you reconnect. Remove the wires from the terminal strips at the triac. Use an ohmmeter to check for infinite resistance across terminals MT1 and MT2. Using a jumper, or the bare ohmmeter probe, connect the gate terminal to terminal MT2. There should not be a low ohms reading across terminals MT1 and MT2.

NOTE: Some ohmmeters do not provide enough current to activate the triac. Therefore, this is not a sure test. This is only a functional check that can indicate that a triac is probably good.

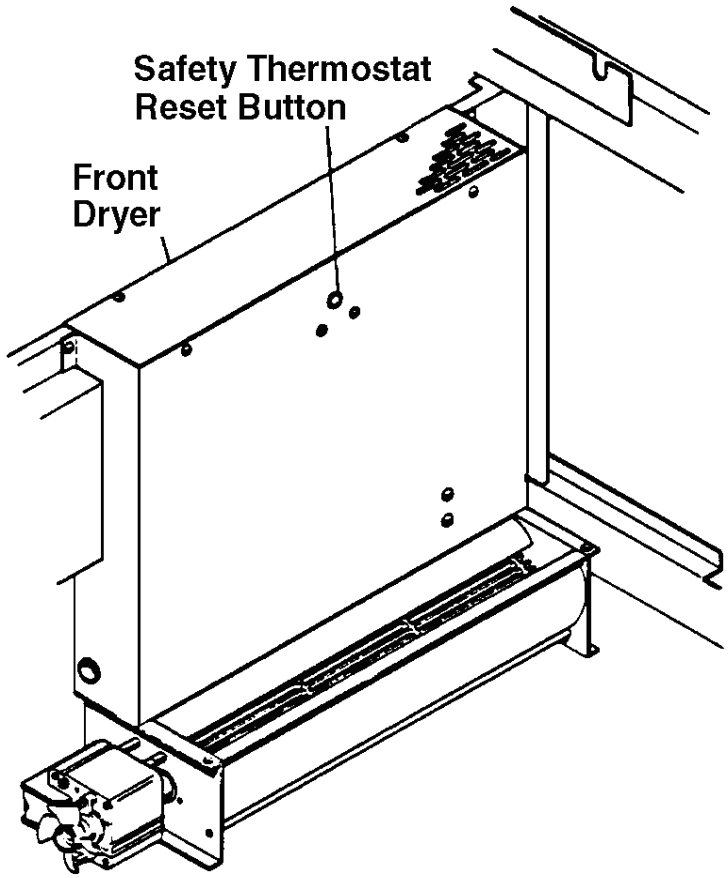


Figure 1-23. Front dryer and safety thermostat reset button.

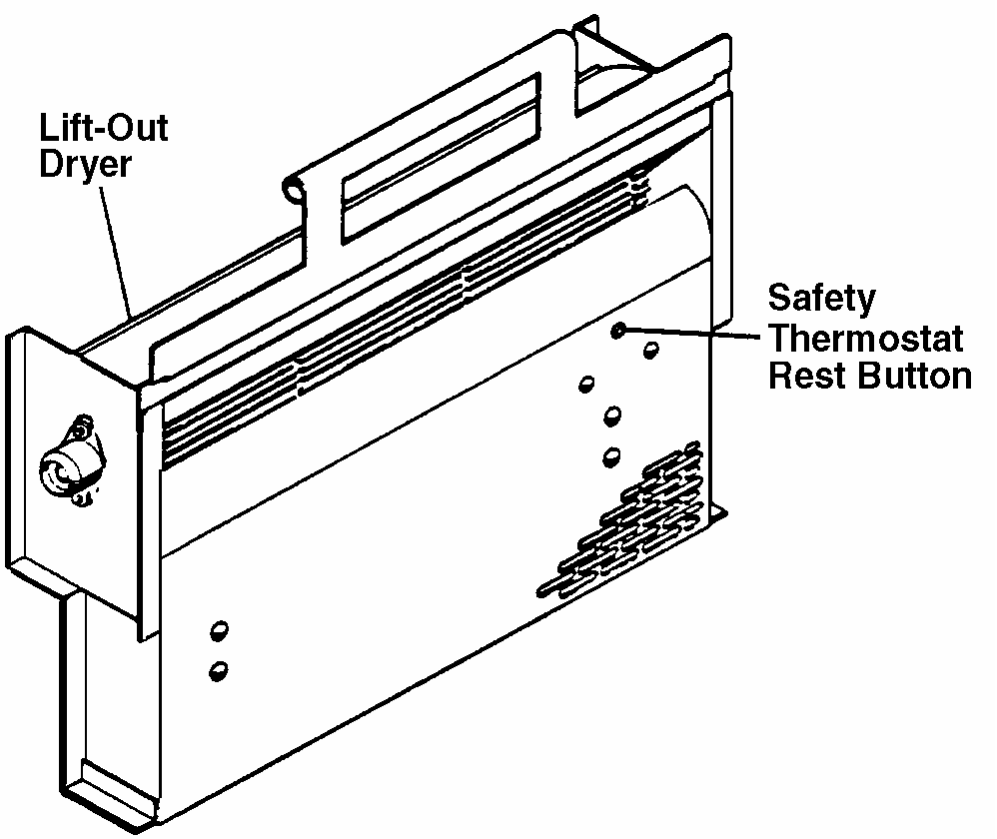


Figure 1-24. Lift-out dryer and safety thermostat reset button.

CAUTION: Do not turn on machine power with the triac leads disconnected. This will burn out the opto-isolater on the AJ1 PC board. Do not switch the leads on a triac.

(m) Temperature sensor testing requires that you disconnect the leads of the probe from the rest of the circuit and check for resistance between the leads. The developer sensor is connected to terminal strip TS5, at TS5-2 and TS5-3. You check the dryer sensor at TS3-2 and TS3-1. The resistance of the sensor varies with temperature. Figure 1-25 gives the resistance of the sensor according to temperature. Both developer and dryer sensors are the same. If in doubt, check at room temperature.

Temperature		Resistance Ohms (± 10%)
º F	º C	
70	21	1160
77	25	1000
84	29	864
91	33	750
99	37	652
106	41	570
113	45	499
120	49	438
127	53	385
135	57	340

Figure 1-25. Temperature sensor resistances.

(n) It is unlikely that a temperature dial will fail or cause a problem. However, a worn swing contactor could cause the temperature dial to not set the temperature properly. You can check this by disconnecting the power, removing the J3 PC board, removing the potentiometer box and checking it with an ohmmeter. Resistance across the two leads should vary smoothly from 0 to 2500 ohms, as you turn the dial.

(7) Check the replenishment system. The replenishment system operates in two switch-selectable modes. The mode switch is switch S1 on the timing PC board J2. See figure 1-16. In the high volume mode, replenishment occurs while film being fed into the machine depresses the film switch. In the low volume mode, replenishment occurs not only when film depresses the film switch, but also whenever there is a jog cycle. This mode is intended to prevent chemistry stagnation from a lack of use. In both modes, replenishment occurs if the developer solution falls below the level probes, and for 30 seconds after the solution is up to the probe level.

(a) Check for proper pump activation. To check for proper operation in the high volume mode, press the film switch and observe the pump. Also observe led DS3 on the J2 PC board, which is the pump run signal. The pump should run when you press the switch and stop when you release the switch. In the low volume mode, check that the pump runs during the jog cycle (9 seconds every 3 minutes), as well as when you press the switch. If DS3 lights but the pump does not run, the problem is probably in fuse F2, relay K1, or the pump.

(b) If there is no replenishment, check for empty storage tanks, air in the lines, or a leaky pump that sucks air. Clean the storage tanks and flush lines. The developer and fix pump bellows have poppet valves and O-rings that can cause problems if they are not seated properly or are dirty. Visually check that they are functioning properly. Position the poppet valves so that their stems point against the direction of the replenisher flow. See figure 1-26.

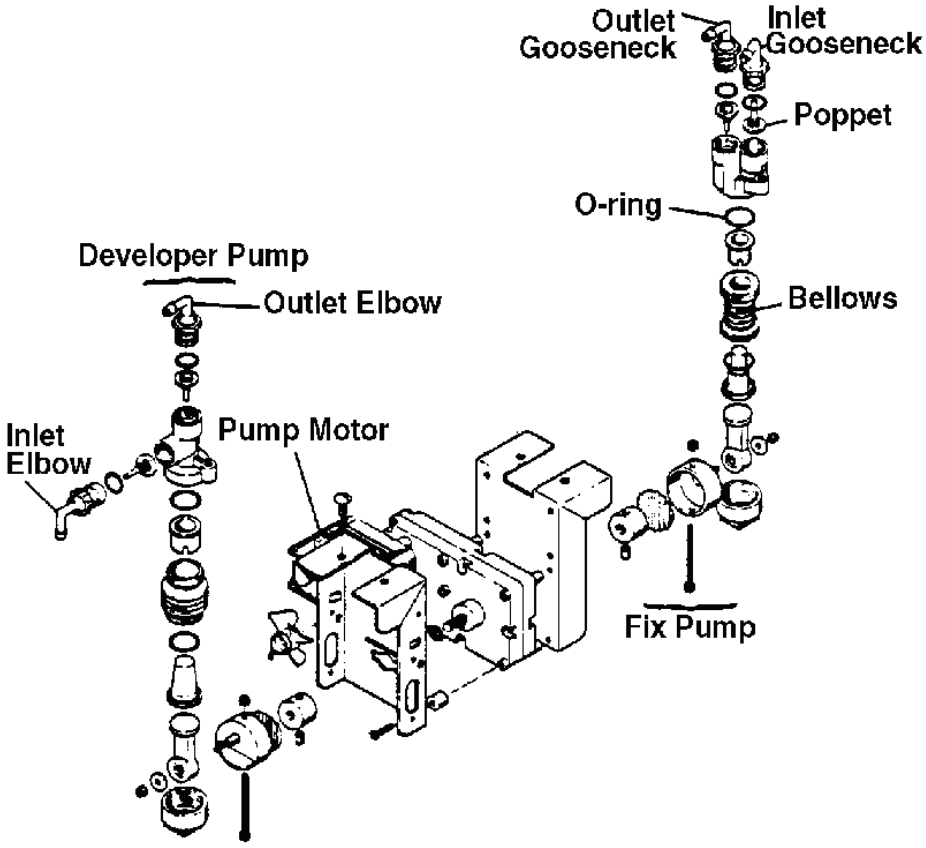


Figure 1-26. Replenishment pump(s).

(c) Check the replenishment rates. If the pump is not delivering enough replenisher, check the hoses and connections for air leaks. Make sure the connections are airtight. Increase the pump volume by adjusting the stroke on the pump to bleed the lines. If the pump seals are not sealing even when wetted, replace them.

(d) Check amp draw. Power to the pump is supplied through relay K1, fuse F2, and terminal strips ATS1 and TS6. Check for line voltage between ATS1-1 and TS6-10 while depressing the film switch.

(e) Check and clean the level probes in the developer tank.

d. **Accessories.** You are required to service the accessories to the AFP 14-X3.

(1) Maintain the external wash water recirculation pump.

(a) Daily top off water reservoir replacing the four gallons drained off at the previous day's shutdown.

(b) Depending on the volume of film being run, change the wash water in the reservoir every 3-7 days. Slime or residue on dried film indicates that the reservoir water should be changed.

(c) When changing water, thoroughly rinse the wash tank, wash rack, and water reservoir.

(d) If the pump runs, but delivers little or no water, service the pump valves using the following procedures.

1 Verify that the wash water solenoid is operating when you place the processor in the process mode. Check that it is clear of debris.

2 Inspect the line(s) between the water reservoir and the pump for kinks or other damage.

3 Do not lengthen the distance between the water supply and drain. Do not position the water reservoir so that more than 36 inches of lift is required.

4 Clean the check valves in place, if the pump is moving any water, to remove any debris obstruction or crystallized chemistry. Refer to figure 1-27.

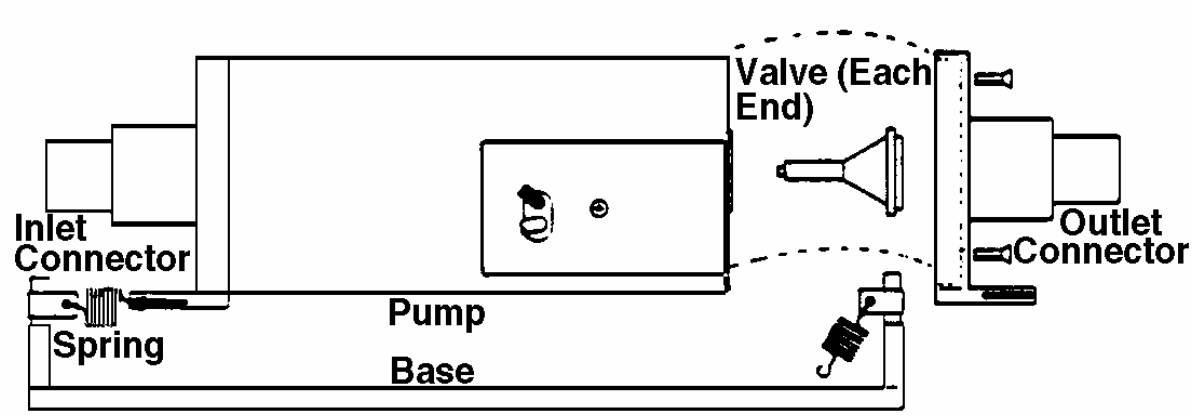


Figure 1-27. Wash recirculation pump.

a Place the supply hose in a container of warm water, not over 120ºF.

b Activate the pump by pressing on the manual replenish switch or by tripping on of the film detector fingers with film.

c For stubborn deposits and larger pieces of foreign matter disassemble the pump for cleaning.

d Clean the valves, using hot water if necessary, to remove any chemical residue.

e When reassembling, take care to install the pump valves exactly as you removed them.

5 Replace the valves, if necessary.

(2) Perform PMCS on the daylight loader.

(a) Routinely clean the daylight loader with a cloth and warm water.

(b) To prevent build up of chemical fumes inside the bag, leave side zippers open when film is not being loaded.

Continue with Exercises

EXERCISES, LESSON 1

INSTRUCTIONS: Answer the following exercises by circling the lettered response that best answers the question.

After you have answered all of the exercises, turn to "Solutions to Exercises" at the end of the lesson and check your answers. For each exercise answered incorrectly, reread the lesson material referenced after the solution.

1. Which of the following procedures is accurate for daily PMCS for the AFP 14-X3 X-ray Film Processor?

   a. Ensure the water supply valve is open and clean with water from the wash tank.

   b. After rinsing parts thoroughly with warm water, blow dry using the blower fans.

   c. Use separate damp cloths to wipe down the developer and fixer rollers.

   d. Tightly replace the top cover of the processor to prevent algae growth.

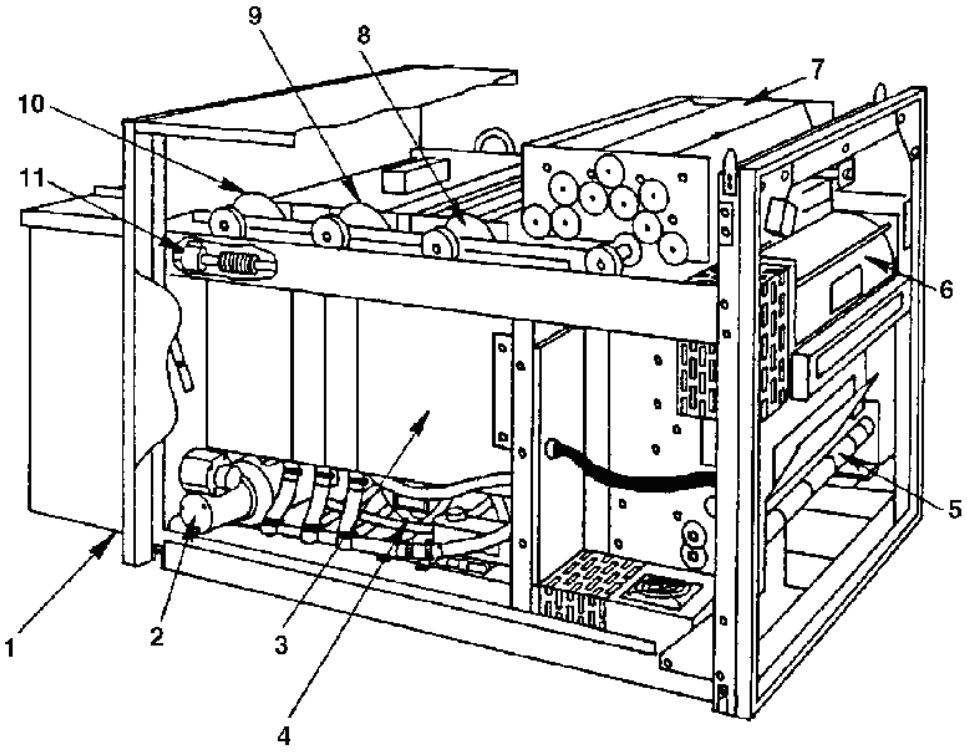


Figure 1 for exercises 2 through 4. External view - AFP 14-X3.

2. Refer to Figure 1. Which number identifies the rear dryer rack assembly?

   a. 1.

   b. 5.

   c. 6.

   d. 7.

3. Refer to Figure 1. Which number identifies the developer rack?

   a. 7.

   b. 8.

   c. 9.

   d. 10.

4. Refer to Figure 1. Which number identified the drive motor?

   a. 1.

   b. 2.

   c. 4.

   d. 6.

5. Which of the following procedures will help to deter the growth of algae in the AFP 14-X3 X-ray Film Processor?

   a. Using filtered cold water in the wash tank.

   b. Sealing the tank top each time you drain the tank.

   c. Adding Clorox to the existing wash water.

   d. Drain the tank at least once a week.

6. Which of the following statements is true about servicing the developer filter in AFP 14-X3 X-ray Film Processor?

   a. Service the developer filter element and housing whenever you replace the developer.

   b. Remove the filter element from the lower housing to clean it.

   c. Use KLENE-OX, or equivalent systems cleaner, to lubricate the O-ring.

   d. Use a 5/64-inch Allen wrench to tighten the clamp securing the filter assembly.

7. Quarterly PMCS for the AFP 14-X3 X-ray Film Processor consists of which of the following tasks?

   a. Adding a moderate amount of AFP-8827 grease to the drive shaft.

   b. Adding a moderate amount of AFP-8827 grease to the drive shaft thrust bearing.

   c. Repacking the drive motor bearings with Beacon No. 325 Ball Bearing Grease, or equivalent.

   d. Adding several drops of SAE-30 oil to the output shaft bearing on the drive motor reducer.

8. For the AFP 14-X3 X-ray Film Processor, the medical equipment repairer performs PMCS for which of the following time periods?

   a. Daily.

   b. Weekly.

   c. Monthly.

   d. Annually.

9. With the AFP 14-X3 X-ray Film Processor, how many circulation pump head O-rings must be lubricated before reassembly?

   a. One.

   b. Four.

   c. Five.

   d. Eight.

10. Which of the following tasks do you perform during the five-year PMCS on the AFP 14-X3 X-ray Film Processor?

   a. Disassemble the fix pumps and clean.

   b. Clean out the drive motor reducer housing and refill.

   c. Lubricate the internal O-ring in the fix pump with a silicone-base lubricant.

   d. Lubricate the dryer blower motors, and replenisher pump motor.

11. Which of the following statements is true about cleaning all the racks in the AFP 14-X3 X-ray Film Processor?

   a. When removing a solution rack, lift by the rack drive shaft.

   b. After cleaning, manually feed through a previously exposed and processed film.

   c. Rely on a successful film transport with dry film to predict success in the processor.

   d. Use an AFP pad on <u>all</u> rack rollers to remove stubborn deposits.

12. Which of the following statements is true when checking for correct chain tension on the AFP 14-X3 X-ray Film Processor?

    a. The processor drive chain is located in the crossover assembly.

    b. Overly taunt chain tension causes excessive sprocket wear.

    c. The drive chain tension is set at the manufacturer's and should not require adjustment.

    d. To remove the chain, you remove the connecting link from the drive chain, then remove the chain from the sprockets.

13. Which of the following statements is true when checking for circulation of the tank solutions with the AFP 14-X3 X-ray Film Processor?

    a. The developer and fix circulation pumps are identical.

    b. You must lubricate the motors at least quarterly.

    c. The magnetically driven pump impellers are directly attached to the pump motor drive shafts.

    d. To check for a stuck impeller, run the pumps when they are dry to see if you get excessive heat.

14. Which of the following is a procedure for checking the air system for the AFP 14-X3 X-ray Film Processor?

    a. Call the manufacturer's representative for consultation when the blower motors remain off during the developer solution warm-up.

    b. Check power to the blower motor while the blower is running.

    c. When you check the amp draw between TS3-4 and TS3-7 there should be no line voltage.

    d. If the blower is not working at all, check fuse F2.

15. When checking for film switch activation on the AFP 14-X3 X-ray Film Processor, which of the following statements is true?

    a. When measuring voltage, you should get a reading at TP5 and TP1 on PCB J2 of 12vdc when you release the film switch.

    b. When measuring resistance, you should get a reading of infinite ohms when you depress the film switch.

    c. When measuring the voltage, you should get a reading at TP5 and TP1 on PCB J2 of 12vdc when you depress the switch.

    d. When measuring resistance, you should get a reading of 0 ohms when the switch is released.

16. What are the three timers on the AFP 14-X3 X-ray Film Processor timing PC board J2?

    a. The cycle, power, and line timers.

    b. The jog, audible signal, and feed timers.

    c. The temperature, developer, and film switch timers.

    d. The cycle, jog, and feed signal timers.

17. What is the purpose of the jog function with the AFP 14-X3 X-ray Film Processor?

    a. To ensure that the dryer blower turns on at the appropriate time in the processing cycle.

    b. To activate the drive motor and wash solenoid periodically when the processor is on but not processing film.

    c. To ensure no circulation occurs when the processor is on but processing is not occurring.

    d. To heat and cool the developer and dryer heaters alternately.

18. To test that the temperature controller maintains the proper temperatures, you observe DS1 and DS2 blinking at what ratio when there is no film in the AFP 14-X3 X-ray Film Processor?

    a. 50:50

    b. 20:80

    c. 80:20

    d. 30:70

19. If the AFP 14-X3 X-ray Film Processor's dryer heaters exceed approximately 165ºF the dryer safety thermostat(s) cuts off power. You must do which of the following?

    a. Remove the front dryer and then the lift out dryer, in order to test independently of one another.

    b. Use the automatic reset button and test a second time.

    c. Allow the dryers to cool before pressing the manual reset button.

    d. Remove the dryer assembly and clean it on the first sign of a problem.

20. Which of the following do you use or observe when checking the replenishment system on the AFP 14-X3 X-ray Film Processor?

    a. In a low volume mode, the pump should run only when you press the film switch.

    b. In a high volume mode you press the film switch and observe the pump to see that it runs and that when you release the switch, it stops.

    c. In a high volume mode you need to check that the pump is activating during the jog cycle.

    d. In both modes, you should observe the led DS3 on the J3 PC board, which is the pump run signal.

Check Your Answers on Next Page

SOLUTIONS TO EXERCISES: LESSON 1

1. c (para 1-2a(1)(c)3)
2. c (figure 1-1)
3. d (figure 1-1)
4. b (figure 1-1)
5. a (para 1-2b(2)(b))
6. a (para 1-2c(5))
7. d (para 1-2d)
8. d (para 1-3)
9. c (para 1-3a(3)(a))
10. b (para 1-3b(1))
11. b (para 1-4a(1)(c))
12. d (para 1-4a(8)(b))
13. a (para 1-4a(9)(c))
14. b (para 1-4b(2)(c))
15. c (para 1-4c(2), figure 1-17)
16. d (figure 1-19)
17. b (para 1-4c(5))
18. a (para 1-4c(6)(d))
19. c (para 1-4c(6)(k))
20. b (para 1-4c(7)(a))

End of Lesson 1

LESSON ASSIGNMENT

LESSON 2	Perform Preventive Maintenance Checks and Services on the X-OMAT X-ray Film Processor.
TEXT ASSIGNMENT	Paragraphs 2-1 through 2-4.
TASKS TAUGHT	Perform Preventive Maintenance Checks and Services on X-ray Film Processors.
LESSON OBJECTIVES	When you have completed this lesson, you should be able to:

2-1. Identify the cautions and warnings concerning PMCS on the X-OMAT X-ray Film Processor.

2-2. Identify the major components of the AFP 14-X3 X-ray Film Processor.

2-3. Identify the procedural steps necessary to perform the operator level daily, and weekly PMCS on the X-OMAT X-ray Film Processor.

2-4. Identify the procedural steps necessary to perform the medical equipment repairer level monthly, quarterly, semi-annual, and annual PMCS on the X-OMAT X-ray Film Processor.

2-5. Identify the procedural steps necessary to service the X-OMAT X-ray Film Processor.

SUGGESTION	Work the lesson exercises at the end of this lesson before beginning the next lesson. These exercises will help you accomplish the lesson objectives.

LESSON 2

PERFORM PREVENTIVE MAINTENANCE CHECKS AND SERVICES ON X-OMAT X-RAY FILM PROCESSOR

2-1. GENERAL

The X-OMAT Processor is the mechanical link in a system for rapid processing of specific types of sheet and roll films. The X-OMAT Processor transports the film mechanically, utilizing rollers, at a specific speed through the processing and drying cycle. Because of the rapid processing cycle and the mechanical requirements involved in transporting film between rollers, the X-OMAT Processor requires specially formulated solutions. These solutions control the swelling of the film emulsion, keep emulsion tackiness at a minimum, and prepare the film for reliable transport. The processor maintains the solutions at the proper temperatures. This combination of film, chemicals, and mechanical transports results in radiographs processed rapidly to uniformly high quality. If you recognize and understand the importance of this mechanical-chemical relationship, there will be little difficulty keeping the processor in top operating condition. You should use the procedures below in a periodic maintenance program.

2-2. OPERATOR LEVEL PREVENTIVE MAINTENANCE CHECKS AND SERVICES

Experience indicates that operation with a minimum of service problems depends upon well-established work habits and good housekeeping. You must train operating personnel to follow the recommended cleanup procedures.

a. **Perform Daily Preventive Maintenance Checks and Services.**
Train the operator to perform the daily PMCS as part of the shutdown procedures.

(1) Turn the power off.

(2) Remove the crossover and the squeegee assemblies. Clean the rollers with a damp cloth and wipe them dry. Handle these assemblies carefully to avoid twisting them out of square and to avoid disturbing the guide shoe settings. Refer to figures 2-1 and 2-2.

(3) Wipe off all chemical deposits in the processing section.

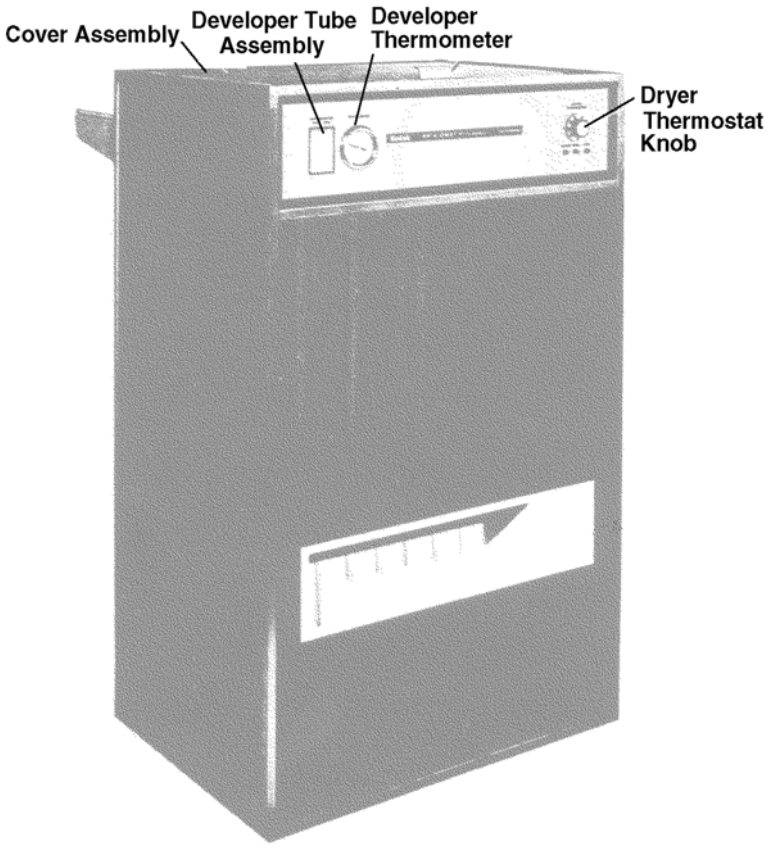


Figure 2-1. X-OMAT X-ray Film Processor.

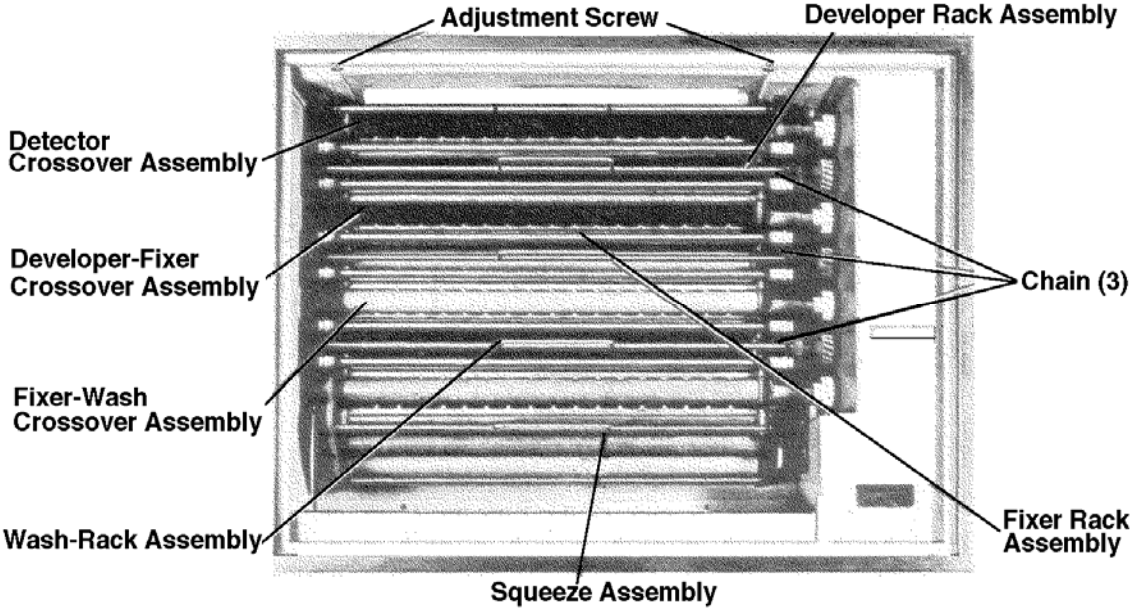


Figure 2-2. Rack, crossover, and squeegee assemblies.

b. **Perform Weekly Preventive Maintenance Checks and Services.** In addition to the steps in the daily procedure and after it has been one week since the previous weekly PMCS, the operator performs the weekly PMCS. Train the operator to perform the following steps weekly. The operator also uses these procedures whenever he changes solutions.

(1) Remove the racks, rinse them with running water, and wipe them with a clean cloth. Using a soft brush, clean off all chemical deposits.

CAUTION: Developer can be seriously contaminated with relatively small amounts of fixer. When removing the fixer rack, use the splash guard between the developer and fixer tanks. Also, use the rack drip tray when removing or replacing racks.

(2) Remove any foreign matter from the solutions.

(3) Check the tension of the chain to make sure that it turns freely and that the rollers do not hesitate. Refer to figure 2-3.

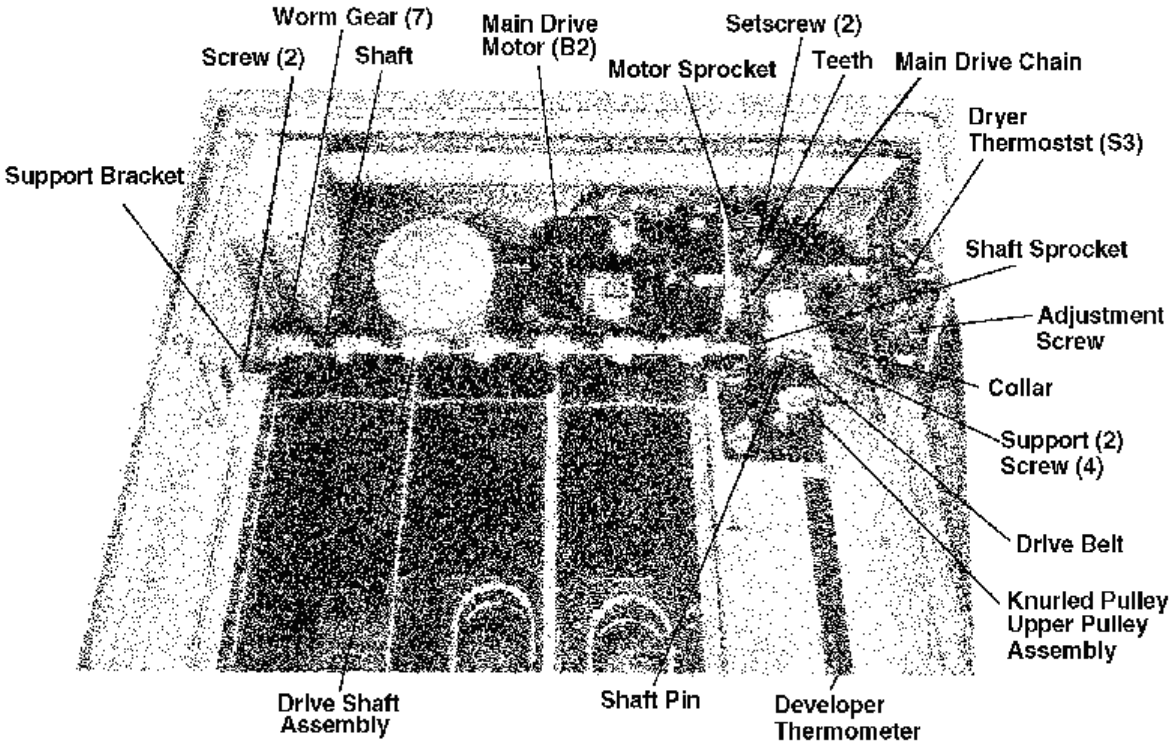


Figure 2-3. Drive shaft assembly and motor.

(4) Be sure that the removable roller gears, sprockets, and idlers are properly engaged.

(5) Check the space between the turnaround side plates and the rack side plates. The space must be equal and the plates parallel on both sides.

(6) When replacing the rack, the crossover, and the squeegee assemblies, make sure they are seated firmly.

CAUTION: To prevent contamination, lower the racks very slowly. This will avoid spillover from one tank to the next.

(7) Check the solution recirculation. A slight movement on the solution surface indicates that the recirculation pumps are operating.

(8) Check the calibration of the mixing valve thermometer. With a thermometer of known accuracy, check the solution temperature in the developer tank. It should be 95ºF (35ºC). If necessary, adjust the developer thermostat. Refer to figures 2-4 and 2-5.

(9) Clean the replenisher strainers. Refer to figure 2-4.

(10) Check the transport rollers to be sure that they are rotating.

(11) Check the dryer air-tube slits for cleanliness. Refer to figure 2-6.

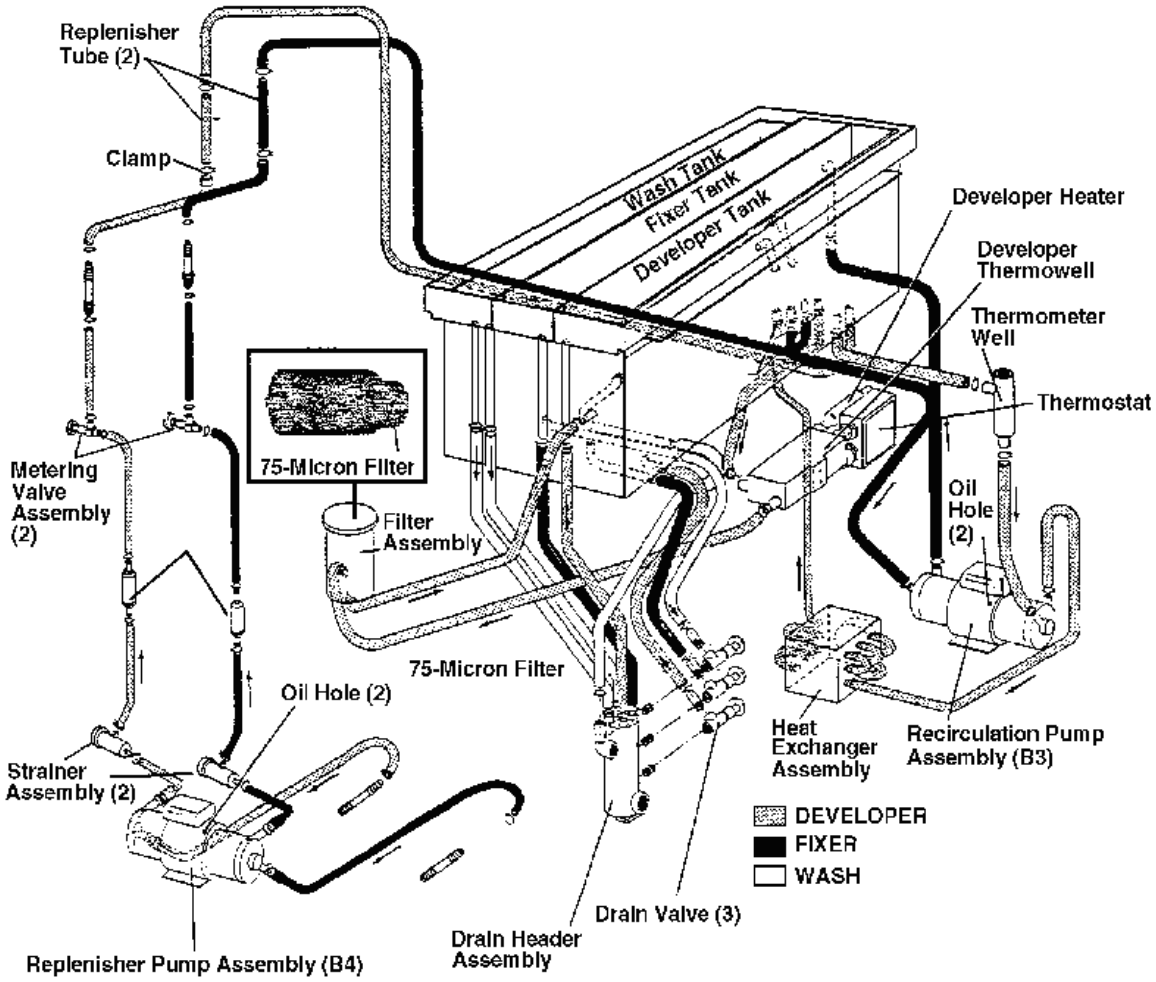


Figure 2-4. Piping assembly.

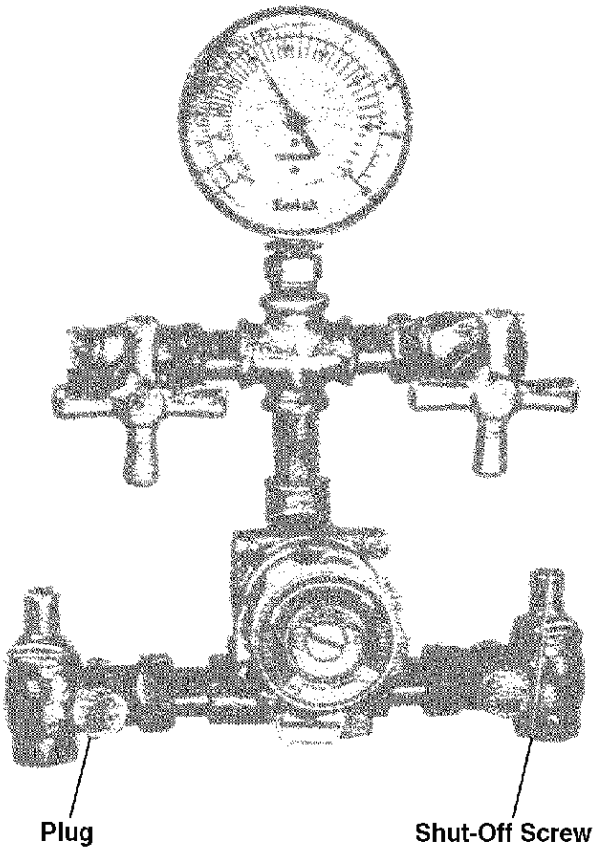


Figure 2-5. Mixing valve.

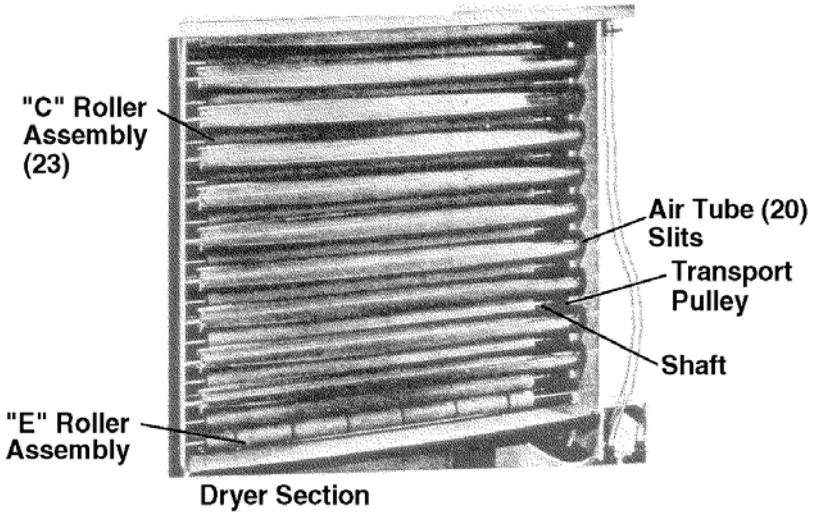


Figure 2-6. Air tube slits.

2-3. MEDICAL EQUIPMENT REPAIRER LEVEL PERIODIC PREVENTIVE MAINTENANCE CHECKS AND SERVICES

a. **Perform Monthly Preventive Maintenance Checks and Services.** After the operator has performed the daily and weekly PMCS and it has been one month since the previous monthly PMCS, you, as the medical equipment repairer, perform the monthly PMCS.

(1) At least once a month or after 5,000 films, change the developer recirculation system filter cartridge in accordance with the operating and service manual for the X-OMAT. Refer to figure 2-4.

(2) Check the main-drive chain to determine if lubrication is required. Refer to figure 2-3.

(a) Use NLG1--No. 2 Lithium Ball and Roller Bearing Grease.

(b) Apply to the surface of the chain. Be careful not to catch your fingers in moving chains or sprockets.

(3) Change the developer solution when processing less than 50 sheets per 8 hours of processor operation in accordance to the instructions in the chemical manufacturer's manual and the operation and service manual for the X-OMAT.

b. **Perform Quarterly Preventive Maintenance Checks and Services.** After performing the daily, weekly, and monthly PMCS and after it has been three-months since the previous quarterly PMCS, you, as the medical equipment repairer, perform the quarterly PMCS.

(1) Use the KODAK Developer System Cleaner and a sponge to clean the developer rack rollers. (For access to the inner rollers, remove all outer rollers from the entrance side, except the bottom one. Remove the studs and nuts from the drive side.)

(2) Clean the replenisher and the processor tanks.

c. **Perform Semi-Annual Preventive Maintenance Checks and Services.** After performing the daily, weekly, monthly, and quarterly PMCS and after it has been six-months since the previous semi-annual PMCS, you, as the medical equipment repairer, perform the semi-annual PMCS.

(1) Clean off the existing grease on the worm drive gears of the main drive and the dryer drive. Apply a small amount of NLG1--No. 2 Lithium Ball and Roller Bearing Grease to the surface of the gear teeth on the main drive and the dryer drive.

(2) Add several drops of light oil, such as SAE-20 motor oil, to the oil holes in the recirculation and replenishment pump motors. Refer to figure 2-4.

d. **Perform Annual Preventive Maintenance Checks and Services.** After performing the daily, week, monthly, quarterly, and semi-annual PMCS and after it has been one-year since the previous annual PMCS, you, as the medical equipment repairer, perform the annual PMCS.

(1) Drain and refill the main-drive motor gear housing through the oil refill hole (on the top) to the oil level hole (on the side). Refer to figure 2-3.

(2) Use a light oil such as SAE number 20 motor oil.

2-4. SERVICE THE X-OMAT X-RAY FILM PROCESSOR

To minimize service problems, it is advisable to inspect the various components periodically for signs of wear and/or maladjustment. Apply lubricants where necessary. Question the operators to determine the performance of the processor throughout the previous period. Inspect the processor for general cleanliness. Make notes to advise the operator as to the effectiveness of the daily and weekly routine maintenance. Insert several 14 by 17-inch films and observe them as they progress through the processing and drying sections. If film cocking occurs, note at which point it first takes place so you can adjust the defective section.

a. **Inspect the Film Guide Assembly (Feed Tray).** Refer to figure 2-7.

(1) Check the film guide assembly for squareness.

(a) Push a 14 by 17-inch film up to the detector rollers.

(b) If the film is not square to the side guide, loosen the wing nuts under the feed tray and square the side guide with the edge of the film.

(c) Retighten the wing nuts.

(2) Check the film guide for static. Check the bottom of the feed tray and the top of the feed stand to be sure they are free from corrosion and dirt. This can insulate the feed tray from the processor.

CAUTION: To prevent scratches on the feed tray and damage to the rollers, keep all foreign objects off the feed tray.

b. **Inspect the Detector Entrance Crossover Assembly.** Refer to figure 2-8.

(1) Check the cleanliness of the detector roller. Clean with a dry brush such as a toothbrush.

NOTE: DO NOT immerse or use water on this assembly.

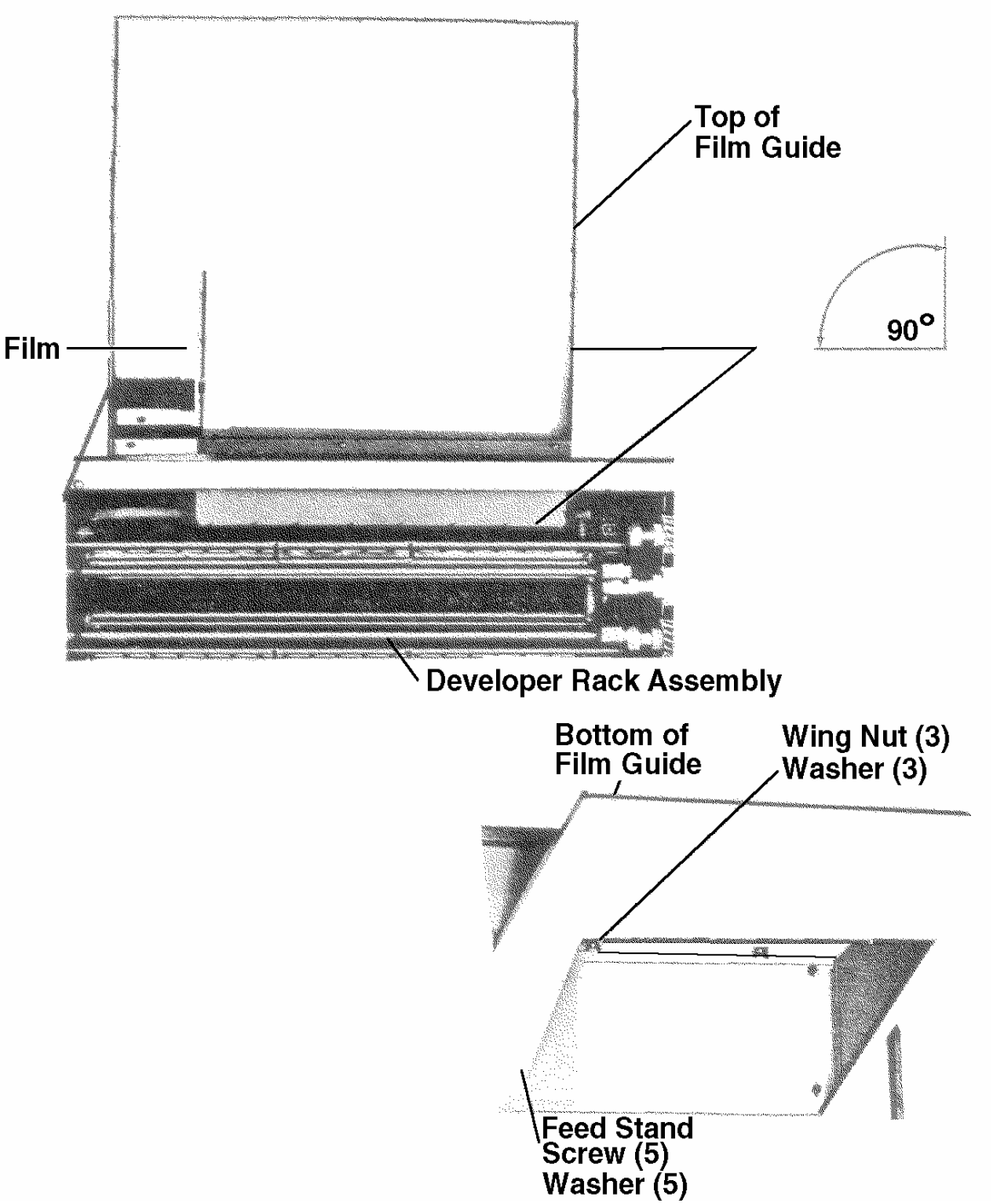


Figure 2-7. Film guide adjustment.

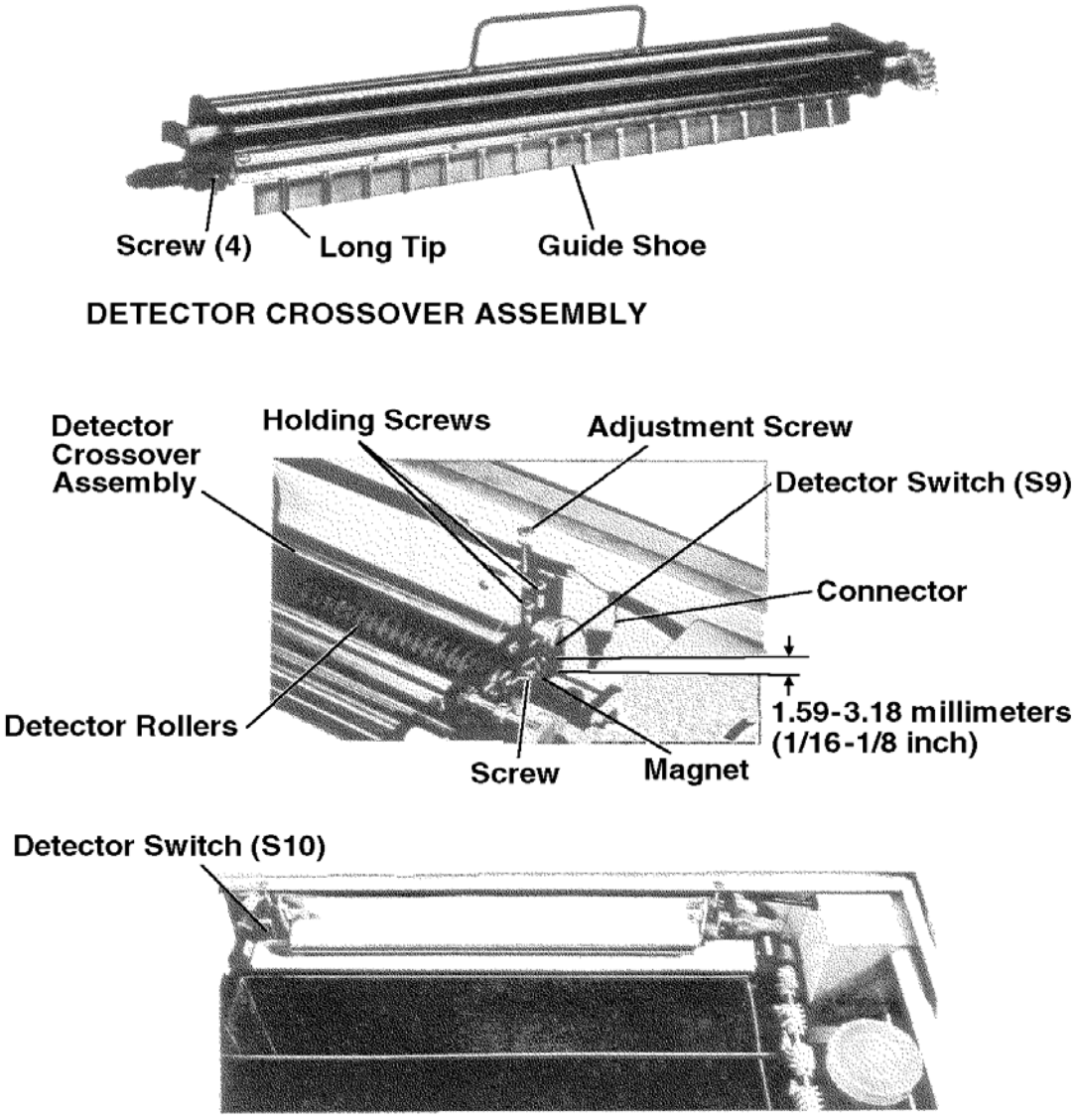


Figure 2-8. Detector crossover assembly.

(2) Check the concentricity of the roller. Rotate the rollers. Check the following components and replace as necessary:

(a) Bearings for wear.

(b) Drive gear teeth for burrs, foreign matter or wear.

(3) Check the guide shoe for burrs. Examine the ribs and tips of guide shoe for burrs. Use fine No. 400 sandpaper to remove any roughness. Refer to figure 2-8.

(4) Check the adjustment of the detector switch. Refer to figure 2-8. Check for proper detector switch adjustment by doing the following:

(a) Loosen slightly the four holding screws (two on each side).

(b) Insert a 14 by 17-inch film between the detector rollers.

(c) Turn the adjusting screw counterclockwise until the switch plunger is free from the rocker arm, turn clockwise until you hear a click, then turn the screw 1/4 turn farther.

(d) Tighten the two holding screws.

(e) Make the adjustments in (c) and (d) above, on the other side.

(5) Check the detector switch for corrosion. Check the switch for signs of corrosion. Replace if necessary.

c. **Inspect the Time-Delay Relay.** To check the time-delay relay, energize the detector switch. The film-feed signal bell should sound three seconds after you de-energize the switch.

d. **Inspect the Operation of the Film-Feed Signal Bell.** Check the plunger. If the plunger is not clean, the bell may be inoperative. DO NOT lubricate the plunger.

e. **Inspect the Crossover Assemblies.** Refer to figure 2-9 for an example of a crossover assembly. You inspect both the developer-fixer crossover assembly and the fixer-wash crossover assembly.

CAUTION: When you remove the crossovers from the processor, always place them upside down on a flat surface. This will avoid twisting them out of square or disturbing the guide shoe setting.

(1) Check the crossover for cleanliness.

(a) Keep all rollers clean.

(b) Wipe daily with a damp cloth.

(c) Use warm water and a plastic abrasive material such as Scotch-Brite if deposits accumulate.

(d) DO NOT immerse these assemblies.

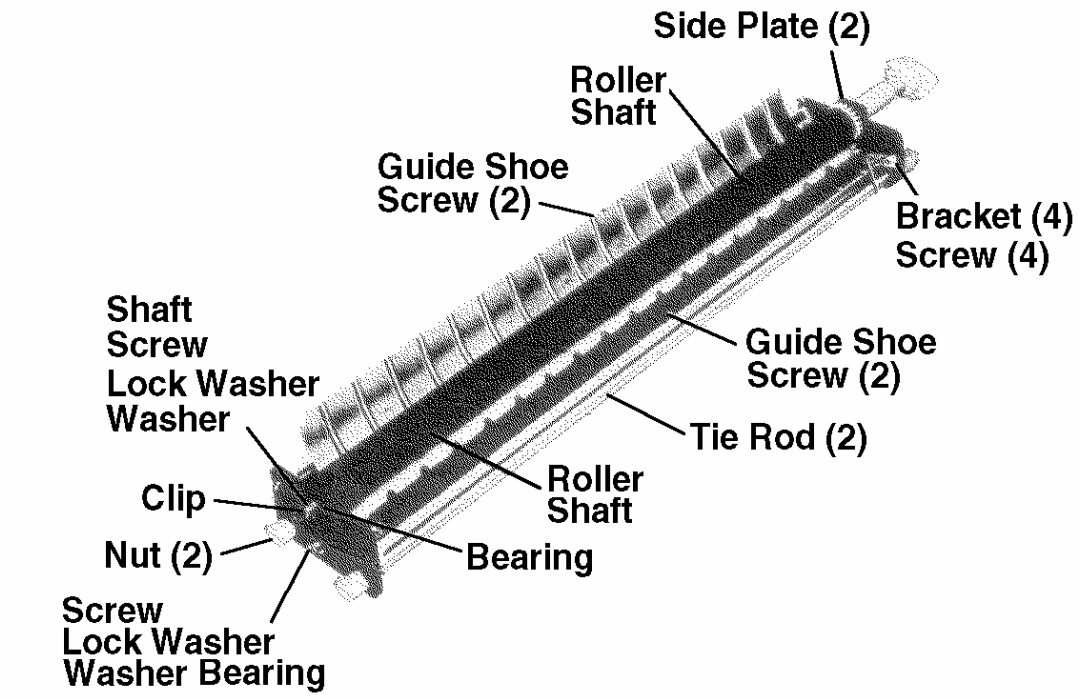


Figure 2-9. Crossover assembly.

(2) Check the crossover.

(a) Examine the rollers for broken teeth. Replace if necessary.

(b) Check the assembly for squareness by turning upside down on a flat surface.

(3) Check the resilient roller. Check for smoothness. Replace if necessary.

(4) Check the guide shoes. Examine the ribs and tips of the guide shoes for burrs.

(a) Use fine number 400 sandpaper to remove any roughness.

(b) Be sure, when reinstalling the guide shoes, that the longer tips are in the direction of travel.

(c) Adjust the guide shoes by loosening the mounting screws and locating the guide shoe in the center of its adjustment swing.

NOTE: Readjustment may be necessary when replacing the assembly. The exit guide shoe must not touch the inner top roller in the rack.

(5) Check the bearing, brackets, and nuts. Examine the bearings, brackets, and nuts for signs of wear or breakage. Replace if necessary.

(6) Check the drive gear. Examine the drive gear for signs of wear or burrs. Replace if necessary.

f. **Inspect the Squeegee Assembly.** Refer to figure 2-10.

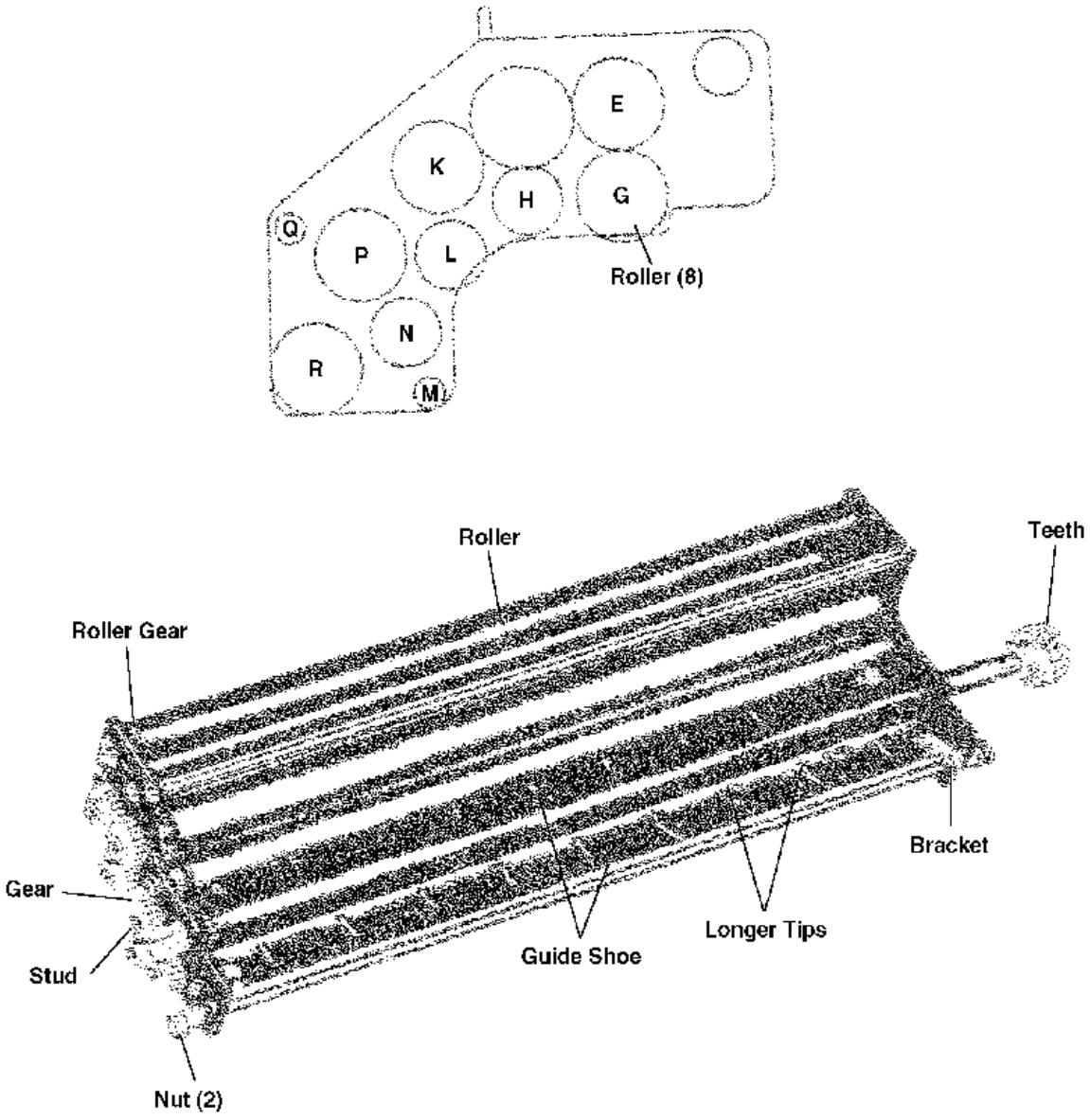


Figure 2-10. Squeegee assembly.

(1) Ensure rollers turn freely. Check that all rollers turn freely. Be sure the three idler rollers spin freely. Idler rollers are H, L, and N in figure 2-10.

(2) Clean the rollers. Clean all rollers by wiping them daily with a damp cloth. If deposits accumulate, use warm water and a plastic abrasive material such as Scotch-Brite.

CAUTION: DO NOT immerse.

(3) Check the squeegee assembly.

(a) Examine the rollers for broken teeth. Replace any roller with broken teeth.

(b) Check for squareness on a flat surface.

(4) Check the resilient roller. Check for smoothness. Replace if necessary.

(5) Check the guide shoes. Examine ribs and tips of the guide shoe for burrs. Refer to figure 2-10.

(a) Use fine number 400 sandpaper to remove any roughness.

(b) Be sure, when reinstalling the guide shoes, that the longer tips are in the direction of travel.

(c) Remove the stud and gear to adjust the center guide shoe,

(d) Adjust the shoe so that the leading tips are in the full open position without hitting the upper roller.

(e) Adjust the exit guide shoe by loosening the mounting screws (two on each side).

(f) Locate the shoe in the center of its adjustment swing.

(6) Check the brackets and nuts. Check the guide shoe brackets and the support nuts for signs of breakage. Replace parts, if necessary.

(7) Check the gears. Check the gears for signs of wear or burrs. Replace if necessary.

g. **Inspect the Roller Racks.**

(1) Remove the roller racks to clean. Remove the racks from the processor and rinse the rollers with warm water. Water temperature should not exceed 110ºF (43.3ºC).

CAUTION: When removing the fixer rack, prevent contamination of the developer with fixer by placing the splash guard on the partition between the developer and fixer tanks.

(2) Remove built up deposits. Discoloration of rollers is not harmful, but removes any build up of deposits.

(a) Use warm water and a plastic abrasive material such as Scotch-Brite on hard rollers.

(b) Use warm water and a towel on soft rollers.

(c) Pay particular attention to the non-submerged rollers at the top of the rack.

(3) Clean inner rollers. Clean inner rollers by removing all outer rollers on the entrance side except the bottom one. Remove the studs and nuts from the drive side.

(4) Eliminate algae. A slippery condition of the wash rack rollers is usually caused by bacterial growth.

(a) Periodic use (determined by experience) of an algae eliminator such as Algex or Dowicide G, can prevent this condition.

(b) The most effective method of using an algae eliminator is to add it to the wash tank and allow the rack to remain in the solution overnight. Before starting the processor, drain the wash tank and rinse the rack.

(c) If the processor is used on a 24-hour-a-day basis, add the algae eliminator to the wash tank during operation and proceed as normal.

(d) To minimize bacterial growth, drain the wash tank at shutdown. Be sure to close the drain valve before start-up.

(5) Check rollers. Be sure all sprockets are properly engaged in the rack chain. Check all rollers visually for unusual warping and bow. Be sure the rack itself is square. Pay particular attention to the roller configuration. Refer to figure 2-11.

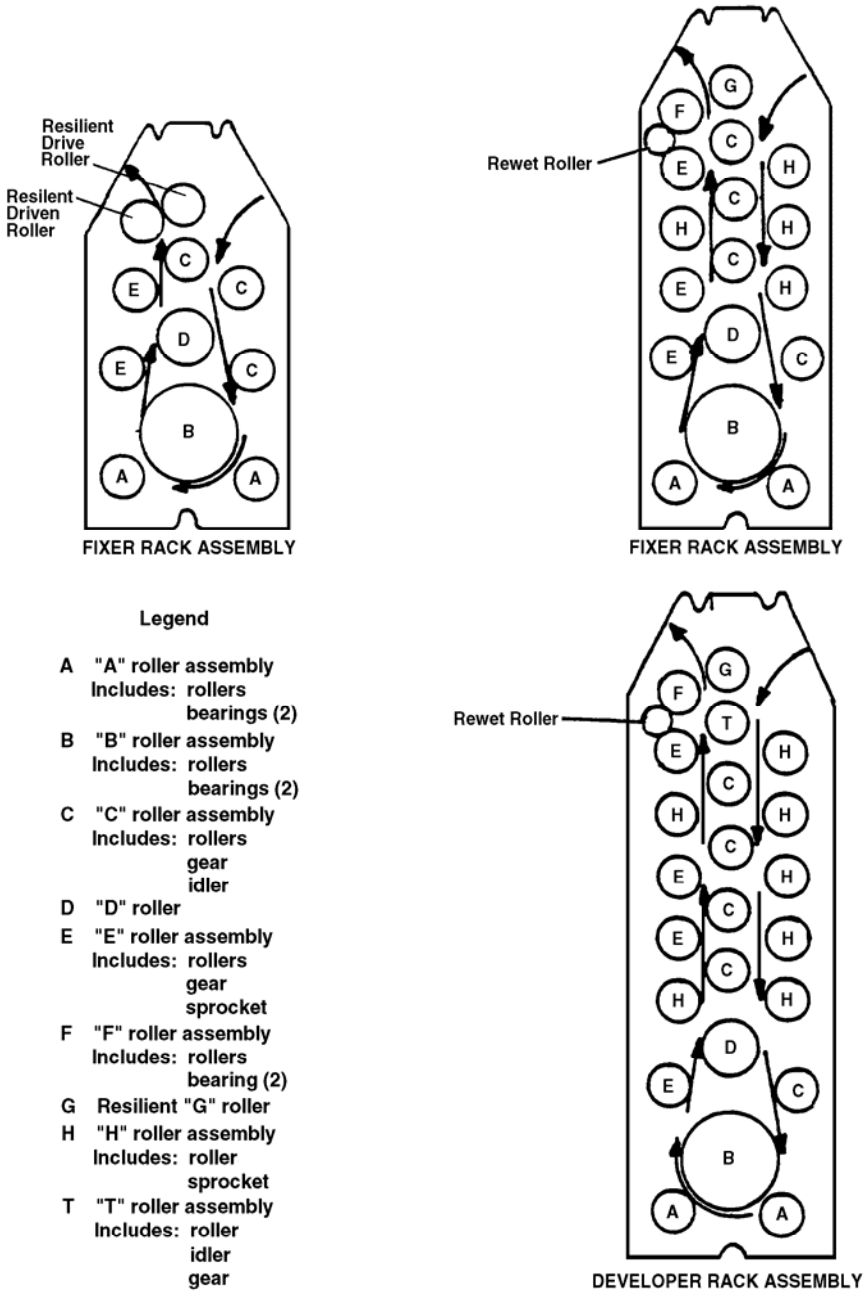


Figure 2-11. Roller configurations.

(6) Check and adjust the chain.

(a) Check for spread or distorted links. Rotate the rack by hand so that the entire length of chain has passed over the drive sprocket.

(b) Check the chain tension. Too tight a chain causes the rack to turn with difficulty and causes bearing wear. Too loose a chain causes the rollers to hesitate. The chain can be adjusted by lowering the turnaround. When you reach maximum adjustment, remove a link or replace the chain, and raise the turnaround.

(7) Check springs. Clean, check for wear, and replace if necessary.

(8) Check the rewet roller. Check the rewet roller for signs of wear. Be sure the roller is in contact with rollers above and below it.

(9) Check the baffle. Be sure to center the tube portion of the rack baffle on the hole so that it may depress when you put the rack into the tank. Refer to figure 2-12.

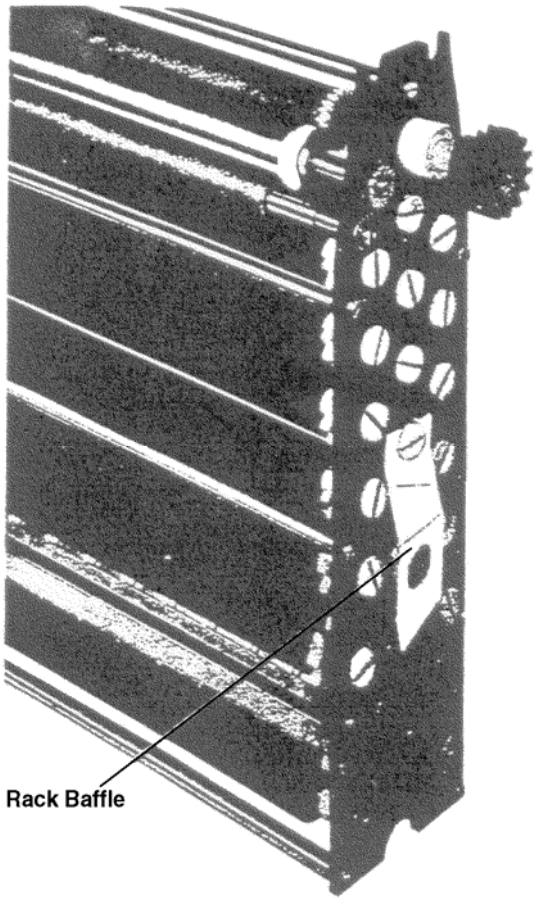


Figure 2-12. Rack baffle.

h. **Inspect the Turnaround Assemblies.**

(1) Clean the roller. You must keep all rollers clean.

(a) Wipe them with a damp, rough cloth.

(b) Use a household detergent to clean accumulated deposits.

(c) Use a plastic abrasive material such as Scotch-Brite on the master roller.

(d) Be sure to rotate the roller evenly to prevent any flat spots.

(2) Check the springs. Check the turnaround springs for proper tension. Rollers should not apply undue pressure on the film. Refer to figure 2-13.

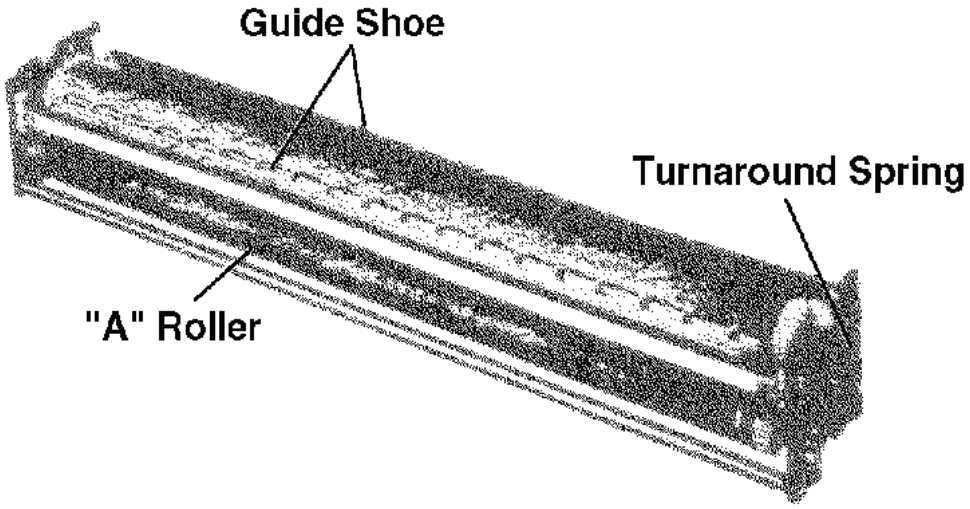


Figure 2-13. Turnaround assembly.

(3) Check the guide shoes. Examine ribs and tips of the guide shoes for burrs. Use fine number 400 sandpaper to remove any roughness.

(4) Check the rollers. Check the "A" rollers. Refer to figure 2-11.

(a) Pay particular attention to the surface of the rollers. Be sure that they are secured to the core and that the surface is smooth and without defects.

(b) Note that the long hub and the wide spacer are on the driver side of the turnaround.

i. **Inspect the Main-Drive and Dryer Drive System.** Refer to figure 2-3.

(1) Check the chain. Check the main-drive chain for wear and tension.

(a) Be sure to align the motor sprocket with the main-drive sprocket if adjustment is necessary.

(b) Lubricate the chain as necessary.

(2) Check the bearings, sprockets, and worm gears. Check these components for wear and replace as necessary.

(a) Replace sprockets if teeth are unduly sharp.

(b) Be sure worm gears are free from burrs.

(c) Lubricate the bearings and gears as necessary.

(3) Check the dryer-drive belt. Check the belt for signs of wear. Adjust or replace the belt as necessary.

(4) Check the pulley assembly. Examine the rubber sleeve on the upper pulley assembly for signs of wear. Refer to figures 2-3 and 2-14.

(a) Be sure to secure the sleeve to the pulley.

(b) If the sleeve is not secure, cement it in place with adhesive, such as Pliobond.

(c) If the sleeve is stretched or worn, replace the pulley assembly.

(5) Check the bearings. Check the bearings in the upper and lower pulley assemblies for signs of wear. If the pulley tilts, it indicates the need for bearing replacement.

j. **Inspect the Plumbing Connections.** Visually check all pump, valve, tubing, and tank connections for any signs of leaks.

CAUTION: When removing or installing the spring-type clamps, be sure to use special pliers, such as Corbin Hose-Clamp Pliers. (The use of safety glasses is recommended.) Do not open the clamp more than necessary to slip it off or over the tubing; otherwise, spring tension will be lost.

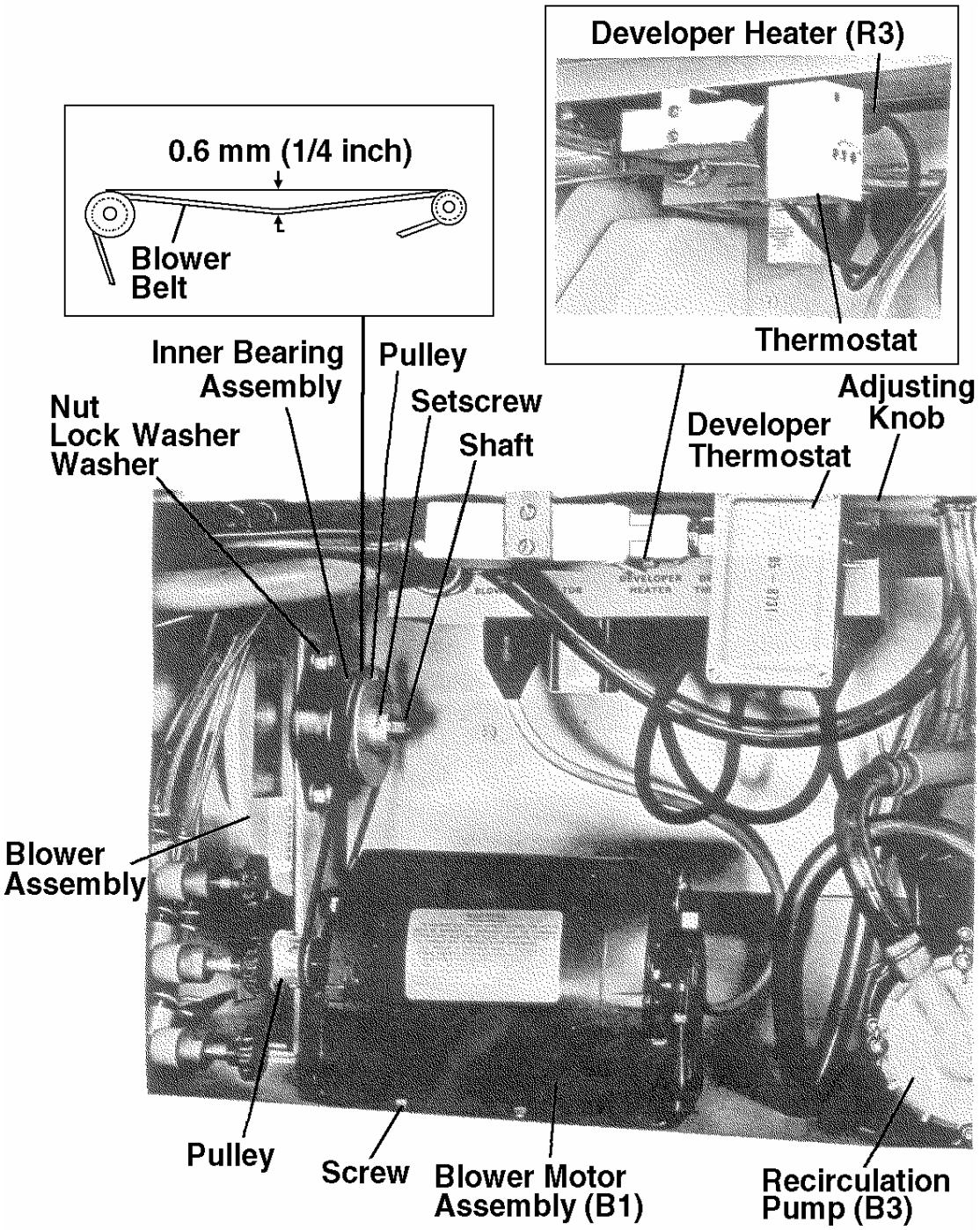


Figure 2-14. Lower pulley assembly and developer thermostat.

k. **Inspect the Developer Recirculation System.** After changing developer solutions or when conducting scheduled services you, as the medical equipment repairer, check the developer circulation system.

(1) Check the turbulence at solution surface. Remove the developer-fix crossover, activate the pumps, and check the turbulence at the solution surface. If there is no recirculation, check to see that the pump is operating.

(2) Check the developer recirculation system filter. Change the filter at least once a month or after feeding approximately 5,000 films in accordance with the manufacturer's service manual. A dirty filter will decrease turbulence.

(3) Lubricate. After it has been six months since you have lubricated the processor replenisher and the recirculation motors, you must lubricate them per procedures in paragraph 2-3c(2).

l. **Inspect the Developer Thermostat.** With a thermometer of known accuracy, check the developer solution within the processing tank. The developer thermostat has been set at the factory to 95ºF (35ºC). If adjustment is necessary, see Lesson 3, Perform Calibration/Verification of X-ray Film Processors.

m. **Check the Incoming Water Supply**. If you cannot maintain accurate developer temperature, check the incoming water supply to be sure it is adequate. See Lesson 3 for calibration procedures.

n. **Inspect the Mixing Valve.** See figure 2-5.

(1) Check the strainers. If there is insufficient water being delivered to the processor even though the line pressure is normal, check the strainers for cleanliness.

(a) Turn off the water at the slotted shut-off screw, or at the valves (if installed) ahead of the mixing valve.

(b) Remove the hex-head plugs and clean the strainers.

(c) Be sure the strainers cover the openings toward the pipe unions when you reinstall them.

(2) Adjust the temperature. If the wash tank water temperature is too hot or too cold, adjust the temperature. See Lesson 3 for calibration procedures.

(3) Check the gauge. The external water gauge should be set at 85º to 90ºF (29.4º to 32.2ºC). Refer to Lesson 3 for the verification procedures to check the gauge.

o. **Inspect the Flow-Control Valve.** If the incoming water supply is adequate but the wash water supply is inadequate, check the flow-control valve at the inlet on the intake side of the valve for foreign matter. Replace the valve if necessary.

p. **Inspect the Developer Heater.** If the developer temperature is incorrect, check to see if the developer heater is defective.

q. **Inspect the Fixer Recirculation System.** Besides any scheduled preventive maintenance check, check and flush the system whenever you change solutions.

(1) Use warm water.

(2) Activate the pumps and check the turbulence.

(a) Be sure the splash guard is in place.

(b) Use the drip tray when removing the rack.

(3) If there is no recirculation, be sure that the pump is operating.

r. **Replenish the Processor Chemicals.** After the developer solution has been used for one month to process less than 50 films per 8 hours of processor operation or after three month's have elapsed, you replenish the processor chemicals.
See Lesson 3 for recommended rates of chemical replenishment.

s. **Inspect the Tubing.** Check that the tubing is free from kinks or any foreign matter.

t. **Inspect the Strainer Assemblies.**

(1) Clamp off the tubing ahead of the strainer assembly.

(2) Clean the screens of foreign matter and chemical deposits with a brush and warm water. Refer to figure 2-15.

u. **Inspect the Valves.** Clamp off the tubing between the disconnect and the pump; separate the disconnect. If there is drippage from the check valve:

(1) Clamp off the tubing above the check valve.

(2) Remove and clean it.

v. **Inspect the Dryer Air Tubes.** Check the air tubes for cleanliness. When replacing be sure the slots are toward the film path. Refer to figure 2-6.

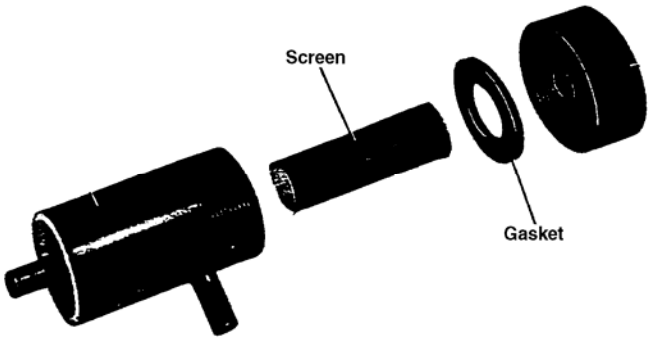


Figure 2-15. Strainer assembly.

w. **Inspect the Dryer Transport Rollers.** The dryer transport rollers must be clean and free from excessive bowing.

(1) Clean with a damp cloth or a plastic abrasive material such as Scotch-Brite.

(2) Be sure the setscrews are tight.

(3) Check the transport roller pulleys for signs of wear. Be sure the pulley is secure to the shaft. Even a slightly flat pulley is cause for replacement.

(4) Check the six O-rings for signs of wear. Replace if necessary.

(5) Check the blocks and supports for cleanliness. Clean with cotton swabs and warm water.

(6) Be sure that all transport rollers are properly seated.

x. **Inspect the Dryer Temperatures.** The dryer operating temperatures can range from 90º to 150ºF (32.5º to 65.6ºC) depending upon the ambient conditions.

(1) To minimize dryer marks, set the dryer thermostat to operate at the lowest temperature consistent with good drying.

(2) If the dryer does not come up to the proper temperature within 10 to 15 minutes or does not maintain a fairly constant temperature while processing a full load of film, it is possible that one or both of the heater elements are not functioning. Refer to Lesson 3 for calibration procedures.

Continue with Exercises

EXERCISES, LESSON 2

INSTRUCTIONS: Answer the following exercises by circling the lettered response that best answers the question.

After you have answered all of the exercises, turn to "Solutions to Exercises" at the end of the lesson and check your answers. For each exercise answered incorrectly, reread the lesson material referenced after the solution.

1. Which of the following procedures does the operator perform daily?

   a. Remove the racks and rinse them with running water.

   b. Verify removable roller gears, sprockets, and idlers are properly engaged.

   c. Remove the squeegee and crossover assemblies and clean the rollers.

   d. Clean the replenisher strainers with soap, warm water and a wire brush.

2. What is the purpose of the splash guard and the rack drip tray?

   a. To keep deposits from accumulating on the rack assemblies.

   b. To keep the developer solution from contaminating the fixer.

   c. To keep the fixer solution from contaminating the developer.

   d. To protect the drive and dryer motors from getting wet.

3. Which of the following procedures does the operator perform weekly?

   a. Lubricate the main-drive chain.

   b. Check the calibration of the mixing valve thermometer.

   c. Clean the developer rack rollers with a system cleaner.

   d. Drain and refill the main-drive motor gear housing.

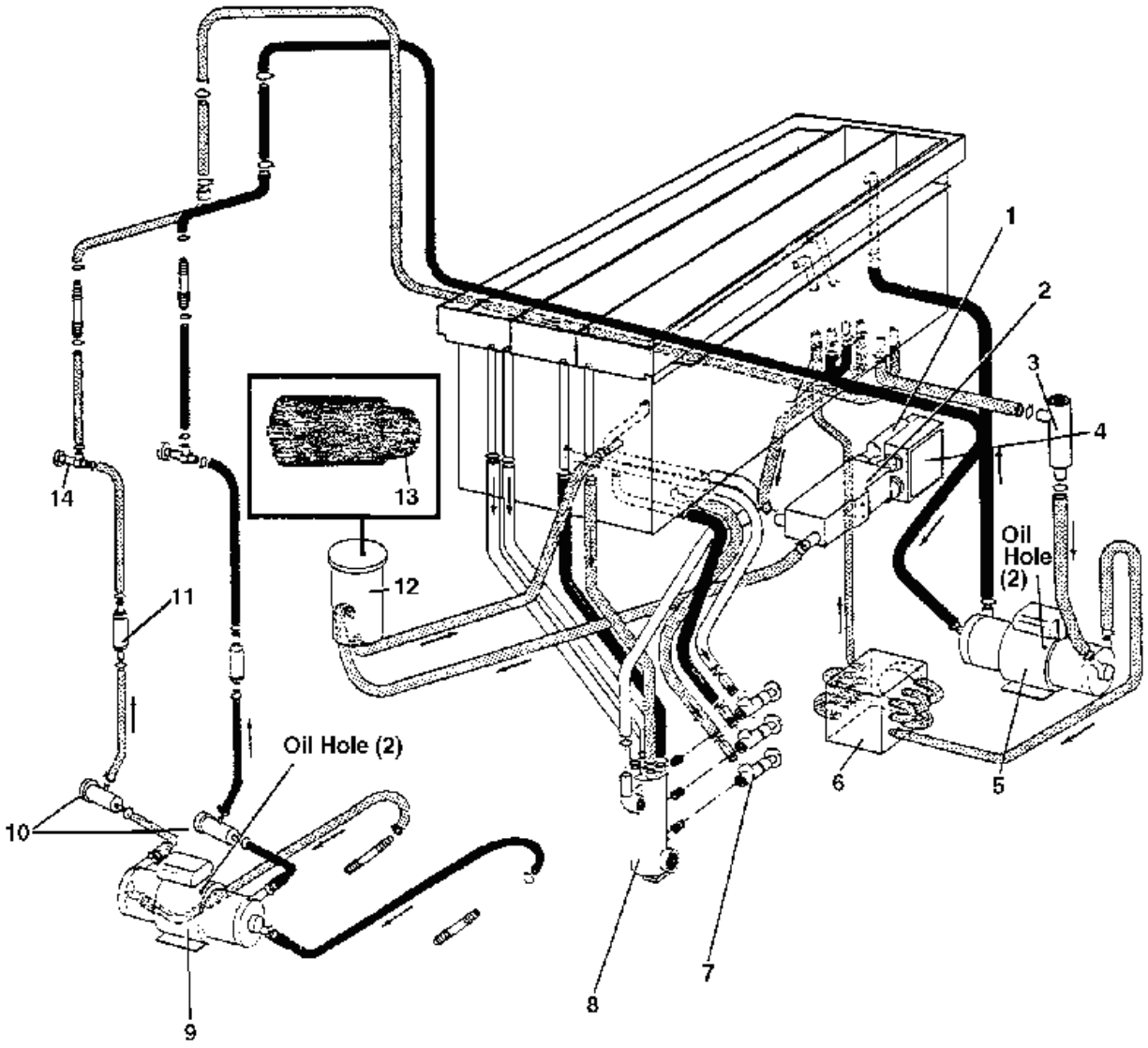


Figure 1 for exercises 4-6. Piping assembly.

4. Refer to Figure 1. What is the number of the recirculation pump assembly?

   a. 5.

   b. 8.

   c. 9.

   d. 12.

5. Refer to Figure 1. What is the number of the strainer assembly?

   a. 1.

   b. 8.

   c. 9.

   d. 10.

6. Refer to Figure 1. What is the number of the metering valve assembly?

   a. 3.

   b. 6.

   c. 11.

   d. 14.

7. You are servicing the X-OMAT Film Processor. You are inspecting the roller racks. Which of the following procedures do you use?

   a. Replace the roller if discolored.

   b. Rinse the roller with warm water.

   c. Ensure the chain tension is loose enough to remove a link.

   d. Ensure the rewet roller is <u>not</u> touching the roller around it.

8. Which of the following procedures is an effective method for using an algae eliminator with the X-OMAT Film Processor?

   a. Add it to the wash tank and allow the rack to remain in the solution overnight.

   b. Add it to the developer tank during operation and proceed as normal.

   c. Add it to the fixer tank during operation and proceed as normal.

   d. Drain all tanks at shutdown.

9. What do you use to remove roughness from guide shoes?

   a. Warm water, not to exceed 110 degrees F.

   b. Mildly abrasive cleaner such as Ajax.

   c. Plastic abrasive material such as Scotch-Brite.

   d. No. 400 sandpaper.

10. Which of the following procedures do you use if you find that the pulley sleeve is not secure to the pulley?

   a. Tighten the set screw holding the sleeve to the pulley.

   b. Replace the pulley sleeve.

   c. Cement the pulley sleeve to the pulley.

   d. Tighten the belt so the sleeve is held to the pulley.

11. How often do you change the developer recirculation system filter?

   a. Weekly or after feeding 500 films, whichever comes first.

   b. Monthly or after feeding 5,000 films, whichever comes first.

   c. Monthly or after feeding 1,000 films, whichever comes first.

   d. Yearly or after feeding 5,000 films, whichever comes first.

12. At what temperature does the manufacturer set the developer thermostat?

   a. 85ºF.

   b. 90ºF.

   c. 95ºF.

   d. 150ºF.

13. Which of the following do you use when cleaning the strainer assemblies?

    a. Alcohol and a soft cloth.

    b. Cold water and a sponge.

    c. Warm water and a brush.

    d. Ajax and a wire brush.

14. Which of the following is a procedure to minimize dryer marks?

    a. Set the dryer thermostat to operate at the lowest temperature consistent with good drying.

    b. Set the dryer thermostat at 150ºF.

    c. Set the dryer thermostat 15ºF above ambient conditions.

    d. Set the dryer thermostat to operate at the highest temperature consistent with quick drying.

Check Your Answers on Next Page

SOLUTIONS TO EXERCISES: LESSON 2

1. c (para 2-2a(2))
2. c (para 2-2b CAUTION)
3. b (para 2-2b(8))
4. a (figure 2-4)
5. d (figure 2-4)
6. d (figure 2-4)
7. b (para 2-4g(1))
8. a (para 2-4g(4)(b))
9. d (para 2-4h(3))
10. c (para 2-4i(4)(b))
11. b (para 2-4k(2))
12. c (para 2-4l)
13. c (para 2-4t)
14. a (para 2-4x(1))

End of Lesson 2

LESSON ASSIGNMENT

LESSON 3	Perform Calibration/Verification on X-ray Film Processors.
TEXT ASSIGNMENT	Paragraphs 3-1 through 3-4.
TASKS TAUGHT	Perform Calibration/Verification on X-ray Film Processors.
LESSON OBJECTIVES	When you have completed this lesson, you should be able to:

3-1. Identify the cautions and warnings to observe when calibrating the AFP 14-X3 X-ray Film Processor.

3-2. Identify procedures required to calibrate the AFP 14-X3 X-ray Film Processor.

3-3. Identify the cautions and warnings to observe when calibrating the X-OMAT X-ray Film Processor.

3-4. Identify procedures required to calibrate the X OMAT X-ray Film Processor.

SUGGESTION Work the lesson exercises at the end of this lesson before beginning the next lesson. These exercises will help you accomplish the lesson objectives.

LESSON 3

PERFORM CALIBRATION/VERIFICATION ON X-RAY FILM PROCESSORS

3-1. GENERAL

Performing PMCS on a routine basis ensures that the x-ray film processor remains serviceable and operates properly. In addition to performing PMCS, you must also calibrate the processor. Calibrating such items as the developer and dryer temperatures, and the replenishment levels, is critical to the quality of the resulting processed film. To perform these tasks you need a medical equipment repairer's tool kit, a voltmeter, and a non-mercury process thermometer.

3-2. CALIBRATE THE AFP 14-X3

a. **Calibrate the Temperature.**

(1) Calibrate the developer scale offset. You have replaced the temperature PC board J3, a temperature sensor, or dial and must, therefore, calibrate the circuit using the following procedures.

(a) Allow the processor to warm up to the desired temperature setting. The FEED indicator should be lit.

(b) Remove the top cover and front panel.

(c) Place an accurate process thermometer in the developer solution.

CAUTION: Do not use a mercury thermometer, as the mercury will contaminate the tank and rack if the thermometer should break.

(d) Measure the voltage between TP3 and TP1 (common) on J3. Refer to Lesson 1, figure 1-16. Note this voltage (approximately 5.5vdc), and keep the voltmeter hooked up to the test point.

(e) Use a small screwdriver at trimpot R4 on J3 for this step. Set the temperature dial to the actual solution temperature. Quickly adjust R4 to bring the voltage back to the previously noted voltage.

(2) Calibrate the dryer. Repeat the same procedure for the dryer.

NOTE: You must check dryer temperature with the top cover in place.

(a) Place a thermometer of known accuracy in the dryer air path to measure actual temperature.

(b) Replace the top cover.

(c) Measure the voltage of the dryer sensor at TP5, using TP1 as common.

(d) Press the film switch to activate the drive, and wait 1 minute for the dryer to reach full temperature.

(e) Trimpot R3 is used to calibrate the dryer.

(f) Set the actual dryer air temperature on the temperature dial (see figure 3-1) and adjust R3 to return the voltage at TP5 back to the previously noted voltage.

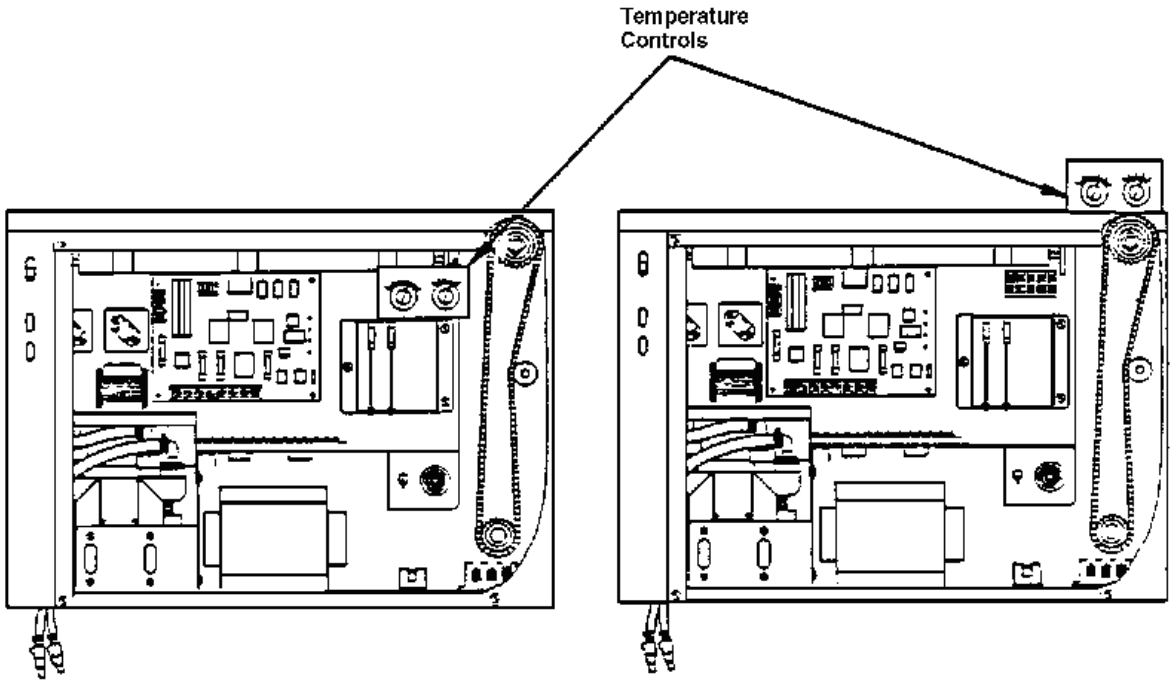


Figure 3-1. AFP 14-X3 temperature controls.

b. **Calibrate the Replenishment.** Calibrate the pumps so that the total amount of replenisher pumped while the sensor fingers are depressed by a sheet of film is equal to the amount of replenisher needed for that sheet of film.

(1) Bleed air from the replenisher lines. Check that the pump is pumping adequately.

(2) Take the standard size sheet of film that the customer will run and determine the amount of replenishment required, based on the film manufacturer's recommendations. Since you can adjust the developer and fix replenisher pump heads independently, you can use different rates of developer and fix.

(3) Detach the developer replenisher gooseneck from the left side of the developer tank and place it in a graduated cylinder of sufficient capacity. Refer to Lesson 1, figure 1-26.

(4) Run the standard size sheet of film through the processor and collect the developer replenisher in the cylinder.

(5) If the amount of replenisher does not correspond with the sensitized materials manufacturer's recommended rate, adjust the stroke of the pump.

(a) To adjust the rate of replenishment, turn the volume screw on the replenisher pump clockwise to increase the rate. Turn counterclockwise to decrease the rate. Do not touch the locknut.

(b) Continue to adjust the volume screw and measure the replenisher delivered into the beaker until the amount delivered matches the recommended rate.

(6) Run the film through the processor again, collecting the entire quantity pumped for the film. If necessary, readjust the pump stroke to obtain the desired quantity.

(7) Calibrate the fix pump head in the same way.

3-3. CALIBRATE/VERIFY THE X-OMAT X-RAY FILM PROCESSOR

a. **Calibrate the Developer Thermostat.** As discussed in Lesson 2, the developer thermostat has been set at the factory to 95ºF (35ºC). If adjustment is necessary, turn the adjusting knob in the proper direction. Refer to Lesson 2, figure 2-14. To readjust the temperature range on the thermostat, do the following.

(1) Loosen the setscrew of the knob.

(2) Reposition the knob to increase or decrease the temperature.

(3) Retighten the setscrew on the flat of the shaft.

b. **Verify the Incoming Water Supply.** To provide the proper temperature regulation, 30 to 65 pounds of line pressure must be supplied to both sides of the mixing valve. The hot-water temperature must be at least 15ºF (8.3ºC) above the temperature set at the mixing valve. The cold-water temperature must be at 15ºF (8.3ºC) below the temperature set. Check the flow of the incoming water supply as follows:

(1) With the wash rack removed, drain the wash tank completely.

(2) Close the wash tank drain valve.

(3) Turn on the hot-water and cold-water valves fully.

(4) Check that the tank fills to overflowing in approximately 90 to 100 seconds.

(5) If the temperature continues to fluctuate, replace the thermostat switch.

c. **Calibrate the Mixing Valve.**

(1) Adjust the temperature. If the water temperature is too hot or cold you must adjust the temperature.

(a) Turn the mixing valve handle screw to the hot position.

(b) Loosen the handle screw and remove the handle.

(c) Turn the adjusting screw clockwise to reduce outlet temperature or counterclockwise to increase the outlet temperature. Refer to figure 3-2.

CAUTION: DO NOT turn the screw more than 1/2 turn at a time.

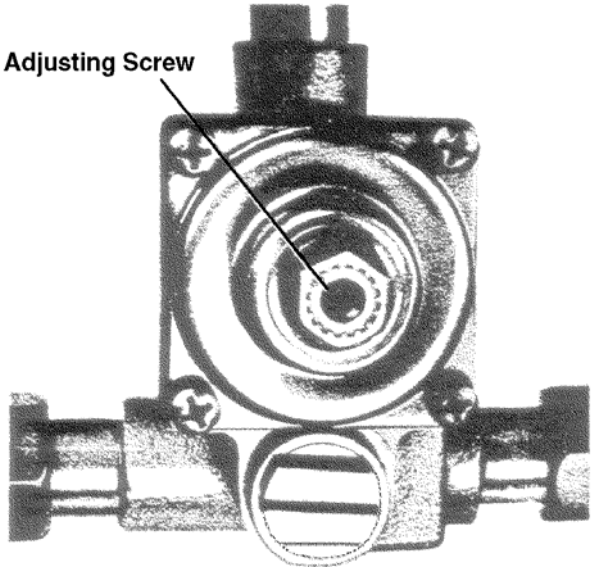


Figure 3-2. Valve adjusting screw.

(2) Verify the gauge temperature. As stated in Lesson 2, the external water gauge should be set at 85º to 90ºF (29.4º to 32.2ºC). To verify the gauge temperature, do the following.

(a) Place a long-stemmed thermometer of known accuracy in the processor wash tank.

(b) If you cannot maintain proper temperature, check the temperature of the hot water supplying the mixing valve to see that it is at least 15ºF (8.3ºC) above the temperature set at the mixing valve.

NOTE: Temperatures showing on the gauge and the thermometer are not necessarily the same, because they are taken at different points. But readings should be consistently within two degrees of each other.

d. **Calibrate the Dryer Thermostat.**

(1) Verify that the film is drying properly. If the film is not drying properly, check that the setting on the dryer thermostat is within the normal range of 120º to 150ºF (49º to 65.5ºC).

(2) Check the temperature without film being in the dryer. If the film is not drying properly, but the dryer thermostat is set within the normal range, check the temperature without film being in the dryer.

(a) Do not remove the receiving bin or the panel assembly.

(b) Place a thermometer of known accuracy (with the bulb up) in the left-hand corner of the dryer.

(c) Ensure that the bulb of the thermometer does not touch any surface while you are measuring the temperature.

(3) If there is a variance of more than ± 5º F between the thermostat setting and the thermometer reading, reset the position of the thermostat by doing the following.

(a) Remove the thermostat knob.

(b) Loosen the locking screw.

(c) Replace the knob; set the dial to the same reading as the thermometer.

(d) Remove the knob; do not turn the shaft, tighten the screw, and replace the knob.

3-4. ADJUST THE CHEMICAL REPLENISHMENT RATES FOR THE X-OMAT X-RAY FILM PROCESSOR

For an average-size distribution of film, the recommended rates of chemical replenishment for each 14-inch length of KODAK RP, RP/L, or RP/S X-OMAT x-ray film are shown in figure 3-3. To set the rates, proceed using the following procedures.

Average Number of Films Processed During 24 Hours of Processor	Recommended Rates of Replenishment (in milliliters [ml]) per 14-inch Length of Film Travel		Ball Float Settings	
Operation	**Developer**	**Fixer**	**Developer**	**Fixer**
Up to 24	95ml	135ml	3.8	3.7
25-50	90ml	135ml	3.4	3.7
51-75	85ml	135ml	3.0	3.7
76-100	75ml	135ml	2.2	3.7
101-125	70ml	120ml	1.7	3.1
126-150	65ml	120ml	1.4	3.1
Over 150	60ml	100ml	0.9	2.2

Figure 3-3. Chemical replenishment rates.

a. Remove the dryer end panel.

b. Energize the replenisher switch (D). Refer to figures 3-4 and 3-5.

(1) Compare the level reached by the ball float with the guide on the replenishment chart.

(2) Use the center of the ball floats for calibrating.

(3) If an error exists in either the developer or fixer replenishment rate, rotate the appropriate replenisher valve (E) until the ball float (F) setting reaches its proper level.

NOTE: If larger quantities of film are processed, the developer and fixer solutions in the processor tanks should be changed at three-month intervals or as experience indicates. Mix developer-replenisher solution only in quantities large enough to be used up in one week if using internal replenisher tanks, in two weeks if using external tanks.

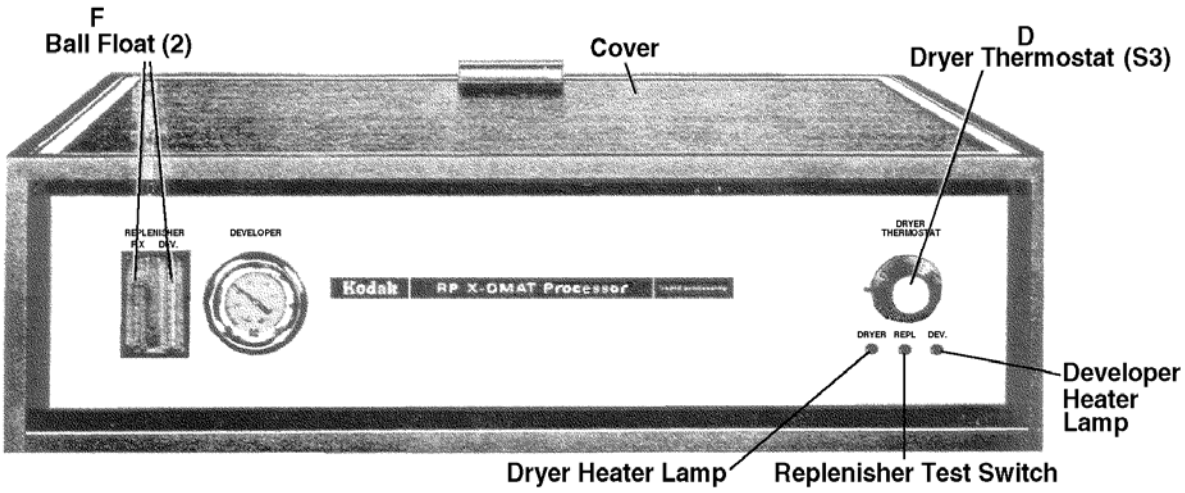


Figure 3-4. Replenisher switch and ball floats.

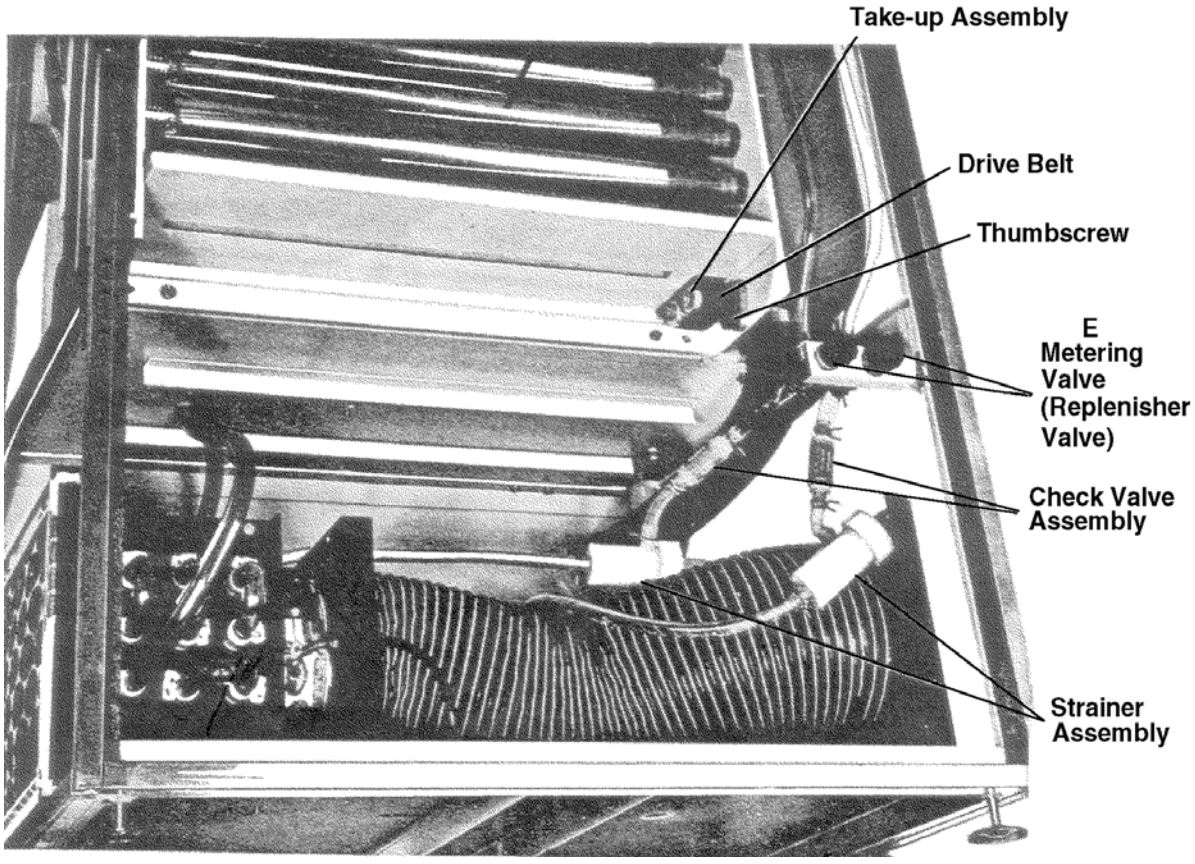


Figure 3-5. Replenisher valves.

Continue with Exercises

EXERCISES, LESSON 3

INSTRUCTIONS: Answer the following exercises by circling the lettered response that best answers the question.

After you have answered all of the exercises, turn to "Solutions to Exercises" at the end of the lesson and check your answers. For each exercise answered incorrectly, reread the lesson material referenced after the solution.

1. Which of the following procedures do you use to calibrate the developer scale offset on the AFP 14-X3?

   a. For access to the developer tank, remove the side panels.

   b. Place an accurate mercury process thermometer in the developer solution.

   c. Note the voltage between TP3 and TP1 (common) on J3 which should be approximately 7.5vdc.

   d. Set temperature dial to actual solution temperature and adjust the voltage back to the previously noted voltage.

2. Which of the following procedures do you use to calibrate the replenishment on the AFP 14-X3?

   a. Bleed air from the replenisher lines and check that the pump is pumping adequately.

   b. Calibrate the developer and fix replenisher pump heads at the same rate.

   c. Adjust the rate of replenishment by turning the volume screw on the replenisher pump clockwise to decrease the rate.

   d. Always tighten down the locknut when you have completed the adjustment.

3. Which of the following procedures do you use to check the incoming water supply on the X-OMAT?

    a. Open the wash tank drain valve and fully turn on both mixing valves.

    b. Verify the hot water temperature in the wash tank is over 15ºF (8.3ºC) below the temperature set at the mixing valve.

    c. Verify the cold water temperature in the wash tank is 15ºF (8.3ºC) below the temperature set at the mixing valve.

    d. Verify that the time necessary to fill the wash tank to overflowing is approximately 60 seconds.

4. Which of the following procedures do you use to calibrate the mixing valve on the X-OMAT?

    a. Turn the mixing valve handle screw to the cold position to adjust the water temperature.

    b. Turn the adjusting screw clockwise to reduce the outlet temperature.

    c. DO NOT turn the screw more than one full turn at a time.

    d. If you cannot maintain proper temperature check the temperature of the hot water supplying the mixing valve.

5. Which of the following procedures do you use to calibrate the dryer thermostat on the X-OMAT?

    a. Place a thermometer of known accuracy in the bottom of the dryer to measure actual temperature.

    b. Place a thermometer of known accuracy in the dryer with the bulb resting against the dryer surface.

    c. Reset the temperature dial if there is a variance of more than ± 2ºF between the thermostat setting and thermometer reading.

    d. Reset the temperature dial if there is a variance of more than ± 5ºF between the thermostat setting and thermometer reading.

6. Which of the following are the recommended replenishment rates when there is an average of 60 films processed during 24 hours of X-OMAT processor operation?

	Developer	Fixer
a.	90 ml	120 ml
b.	75 ml	135 ml
c.	70 ml	120 ml
d.	85 ml	135 ml

Check Your Answers on Next Page

SOLUTIONS TO EXERCISES: LESSON 3

1. d (para 3-2a(1)(e))
2. a (para 3-2b(1))
3. c (para 3-3b)
4. b (para 3-3c(1)(c))
5. d (para 3-3d(3))
6. d (figure 3-3)

End of Lesson 3

LESSON ASSIGNMENT

LESSON 4	Perform Remove and Replace or Repair Defective Components of the X-ray Film Processors.
TEXT ASSIGNMENT	Paragraphs 4-1 through 4-7.
TASKS TAUGHT	Perform Remove and Replace or Repair Defective Components of the X-ray Film Processors.
LESSON OBJECTIVES	When you have completed this lesson, you should be able to:

4-1. Identify the cautions and warnings to observe when removing and replacing or repairing defective components in the AFP 14-X3 X-ray and X-OMAT Film Processors.

4-2. Identify the theory of operation for the AFP14X3 and the X-OMAT X-ray Film Processors.

4-3. Identify the procedures required to remove and replace or repair these defective AFP 14-X3 X-ray Film Processor components: solution rack, circulation pump(s), wash tank fill solenoid, drive motor, developer heater, developer sensor, and dryer sensor.

4-4. Identify the procedures required to remove and replace or repair these defective X-OMAT X-ray Film Processor components: wash rack assembly chain, time-delay relay K2, developer heater, and developer replenishment pump.

SUGGESTION	Work the lesson exercises at the end of this lesson before beginning the next lesson. These exercises will help you accomplish the lesson objectives.

LESSON 4

PERFORM REMOVE AND REPLACE OR REPAIR DEFECTIVE COMPONENTS OF X-RAY FILM PROCESSORS

Section I. AFP 14-X3 X-RAY FILM PROCESSOR

4-1. GENERAL

In order to properly maintain the AFP 14-X3 X-ray film processor you must be familiar with its theory of operation. You must also know how to remove and replace or repair a malfunctioning component that you discovered during PMCS or calibration/verification. The following procedures are examples of the methods to use to correct common malfunctions. For further information on removing and replacing or repairing defective components of the AFP 14-X3, refer to the manufacturer's service manual.

4-2. OPERATING SEQUENCE--OVERALL OPERATION--AFP 14-X3

The operator feeds exposed film into the processor at the film feed tray at the front of the processor. As film trips the film feed detectors, the processor automatically changes from stand-by to process mode. When this happens the transport (drive) system starts, the dryer begins to heat, and wash water flow is initiated. An all roller transport system moves the film through the developer, fixer, wash, and dryer sections. This system deposits the processed and dried film into the receiving bin at the rear of the processor. The following is a technical description of the electronic circuits that allow this process to occur.

WARNING

As significant damage or personal injury may result from improper service techniques, only medical equipment repairers thoroughly familiar with electronic servicing and high voltage repairs should attempt any of the repairs or adjustments described in this section.

a. When you turn on the S1 ON-OFF switch:

(1) The developer and fix circulation pump drive starts.

(2) The processor enters a special start-up mode. In this mode:

(a) The level sensor checks the developer level.

(b) The replenisher pump runs until the level is correct.

b. Next, the developer heater controls activate and heat the developer up to the set temperature.

(1) Only when the developer reaches the set point for the first time are the dryer heater and blowers energized.

(2) While the dryer is heating, the developer heat is maintained.

(3) When both temperatures are up to the set point and the developer level is correct, the ready light comes on indicating the processor is ready to process film.

c. After reaching the temperature set points, the unit goes into a standby mode. In standby, the following occurs:

(1) Drive stops.

(2) Recirculation pumps operate.

(3) Temperatures are maintained.

(4) Dryer temperature is set back several degrees.

d. When you introduce film, the drive system starts and runs for several minutes causing the film to pass through the processor totally.

(1) The film entrance switch, at the feed tray roller, senses the film when you introduce it.

(2) While the film is activating the entrance switch, the replenishment pump operates adding developer and fixer.

(3) After the film enters fully, the ready light lights and the audible signal sounds.

e. During the standby mode, the processor periodically enters a jog cycle (for 9 seconds every 3 minutes).

(1) In the jog cycle, the drive runs to prevent the crystallization of chemistry on the rollers.

(2) You may program the replenishment pump to operate during the jog cycle by setting the switch on the temperature control PC board to the "LO" position.

(3) The control panel also has a manual switch to activate the replenishment pump for test and calibration.

4-3. ELECTRONIC CONTROLS INTRODUCTION - AFP 14-X3

The AFP 14-X3 has a solid state control circuit for all timing and temperature control functions. Three circuit boards contain the circuitry. They are the power board ([PC] Assembly--Power 115/230vac), the temperature board (PC Assembly--Control, Temperature), and the timing board (PC Assembly - Control, Timing).

a. **Power Board Function.** Refer to figure 4-1.

(1) The power board is a low voltage supply.

(a) It provides +20vdc unregulated which is used to operate the replenisher, drive, and blower relays, as well as the feed light and audible signal.

(b) The unregulated +20vdc power is supplied to the temperature board where it is separately regulated, as well as to an additional +12vdc regulator on the power board.

(2) The +12vdc regulator:

(a) Powers the zero crossing detection circuit on the power board. The zero crossing detection circuit generates firing pulses for the triacs in conjunction with the temperature board logic.

(b) Provides regulated power to the timing board.

(3) There are NO adjustments on the power board.

b. **Temperature Control Board Function.** Refer to figure 4-2.

(1) The temperature board controls:

(a) The power level of the developer heater. (The developer heater indirectly controls the fixer temperature.)

(b) The power level of the dryer heater. The dryer heater has a standby temperature control to reduce the power delivered to the dryer during the "standby" mode.

(c) The power sharing between the developer and dryer heaters limits the line current draw.

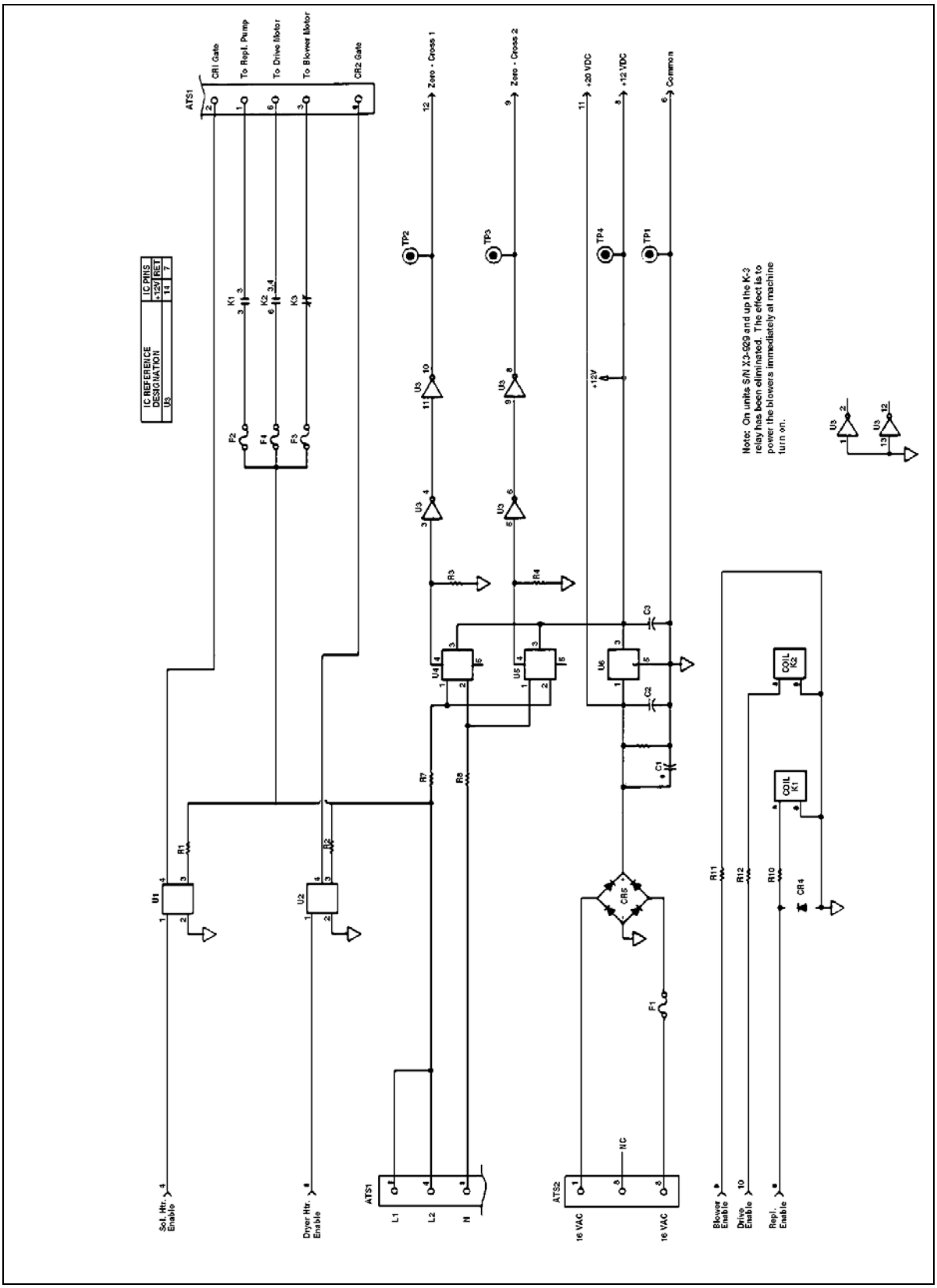


Figure 4-1. Power board.

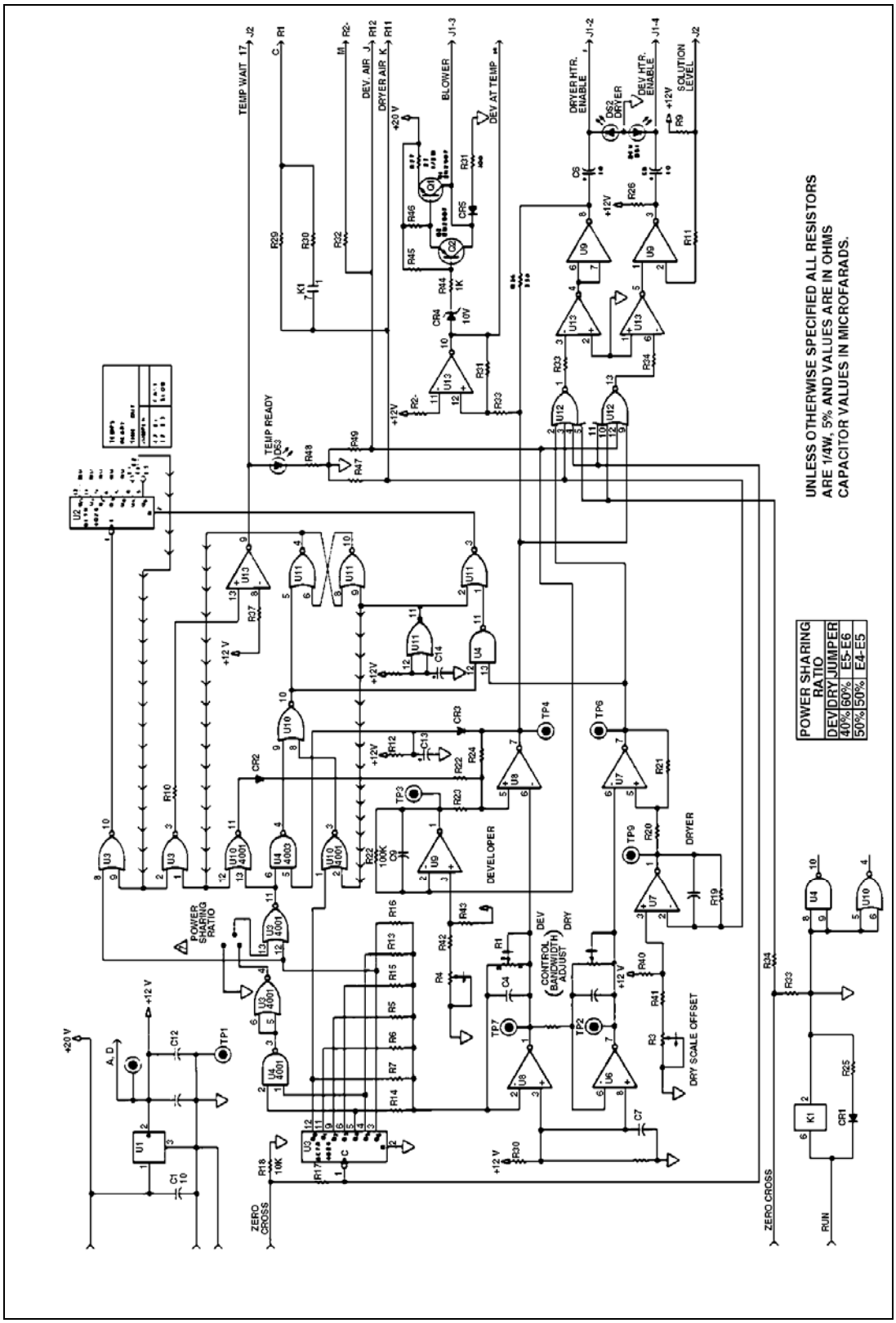


Figure 4-2. Temperature board.

(2) The temperature board senses whether both developer and dryer are at the proper temperature, and signals the timing board of this fact.

(a) Circuitry is provided to minimize the effect of transient temperature variations on the ready light.

(b) In normal operation the temperature ready time out function generates a loss of ready light, 90 seconds after either developer or dryer temperature has fallen below its proportional control range.

(3) The temperature board has a ramp generator circuit that provides a proportional control range for the developer and dryer temperature controls.

(4) The temperature board has its own +12vdc power supply. This power supply prevents fluctuations in the analog signal levels.

(5) Circuitry to drive the triac opto-isolators is on the temperature board as are the following controls:

(a) R1: Developer proportional bandwidth.

(b) R2: Dryer proportional bandwidth.

(c) R3: Dryer scale offset.

(d) R4: Developer scale offset.

c. **Timing Control Board Function.** Refer to figure 4-3.

(1) The timing board contains the developer level sensing circuitry.

(2) The timing board accepts the film switch input and responds by turning on the replenisher pump.

(3) The timing board has a system clock which controls the time ratio of the following timers.

(a) Cycle timer (automatic standby timer).

(b) Feed signal timer (time between films).

(c) Jog timer (automatic anti-crystallization cycle).

(d) Replenishment timer (short burst of replenishment during machine turn-on and during jog).

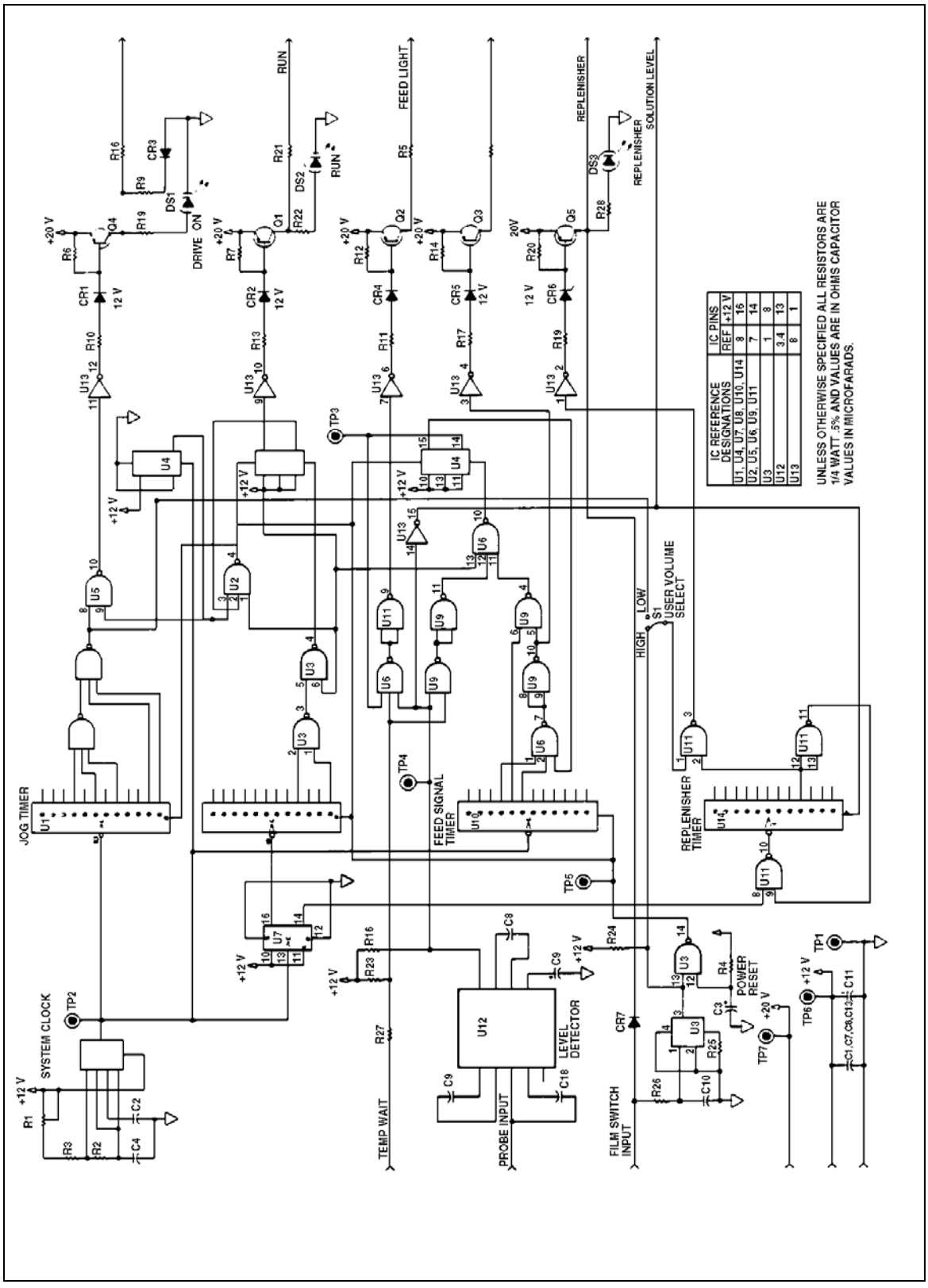


Figure 4-3. Timing control board.

(4) The jog timer, cycle timer, feed signal timer, and replenishment timer are located on this board.

(5) The transistor drive circuitry powers the following functions from the +20 volt power supply:

(a) Drive relay.

(b) Run light and run/standby temperature relay.

(c) Feed light.

(d) Audible signal.

(e) Replenishment pump relay.

(6) The following controls are on the timer board:

(a) R1: System clock frequency.

(b) S1: Replenishment switch.

NOTE: "High" means a high film usage installation where jog cycle replenishment is not needed. "Low" means a low usage installation.

4-4. BROAD LEVEL THEORY OF OPERATION--AFP 14-X3

a. **Power Board.** Refer to figure 4-1.

(1) Power supply. A 16vac transformer T-1 supplies the low voltage (+20 and +12vdc) power.

(a) CR-5 on the power board rectifies this.

(b) Capacitor C1 filters it.

(c) A 7812 three terminal regulator regulates the 12vdc.

(d) Capacitors C2 and C3 bypass the regulator and prevent oscillations.

(2) Zero crossing.

(a) The zero crossing detection circuit uses two opto-isolators connected in anti-parallel. Resistors R7 and R8 are current limiting resistors, and are connected directly to the incoming power line. The opto-isolator's output circuit are emitter followers. When L1 of the power line is positive compared to N, the led in U4 is high and current flows through the opto-transistor, causing U3 pin 3 to be logic true.

(b) Conversely, when L2 is negative with respect to N, U5 conducts and U3 pin 5 is logic true, and U3-3 is low.

(c) The two successive stages of U3, a CMOS Schmidt trigger inverter gate produces a signal with sharp logic transitions. See figure 4-4.

(d) Zero crossing is defined as the coincidence of TP2 and TP3 of the power board both being logic low. This signal goes to the temperature board where U12, a 4-wide NOR gate, looks for this coincidence, as well as its power burst signal and thermistor check signals.

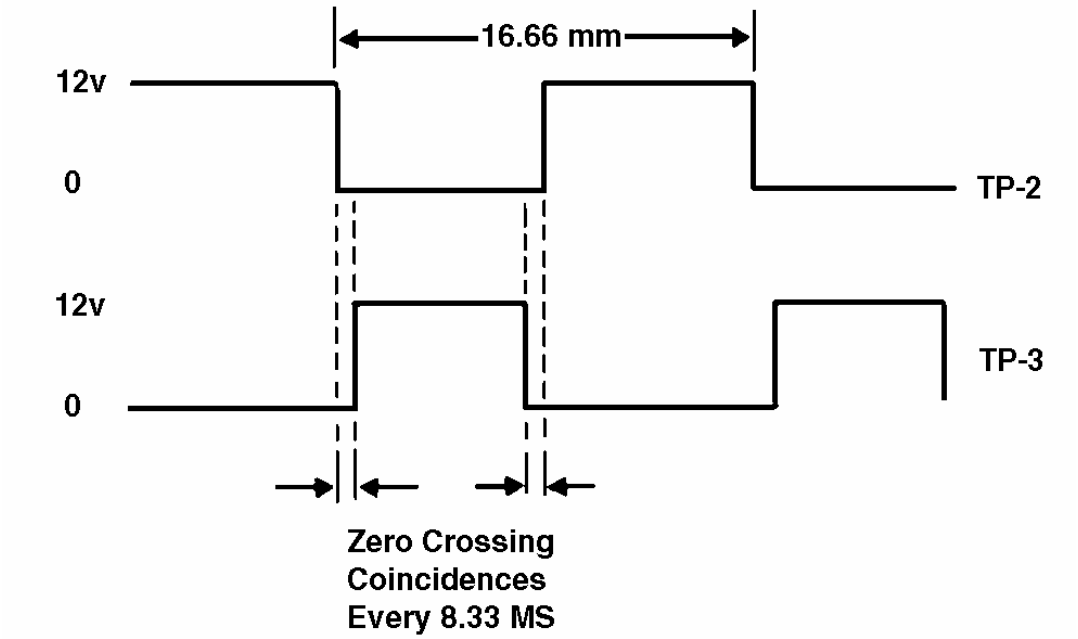


Figure 4-4. Power board zero crossing circuit.

(3) Triac drivers. The triac drivers are opto-isolators which generate a short gate turn on pulse.

(a) R1 and R2 for the developer heater and dryer triacs, respectively, limit the gate turn on current.

(b) The voltage to fire the gates is generated across the triac when it is in its non-conducting state.

(c) When the voltage across the triac is approximately 10 volts, there is sufficient current to fire the triac gate. Be sure not to disconnect the load from the triac when testing. If the voltage across the triac is too great, for too long, resistor R1 and/or R2, as well as the opto-isolator, will burn out due to a current on 1 ampere flowing through the opto-isolator. Refer to figure 4-5 to see the normal gate trigger current as seen with a Tektronix Model 6302 current probe.

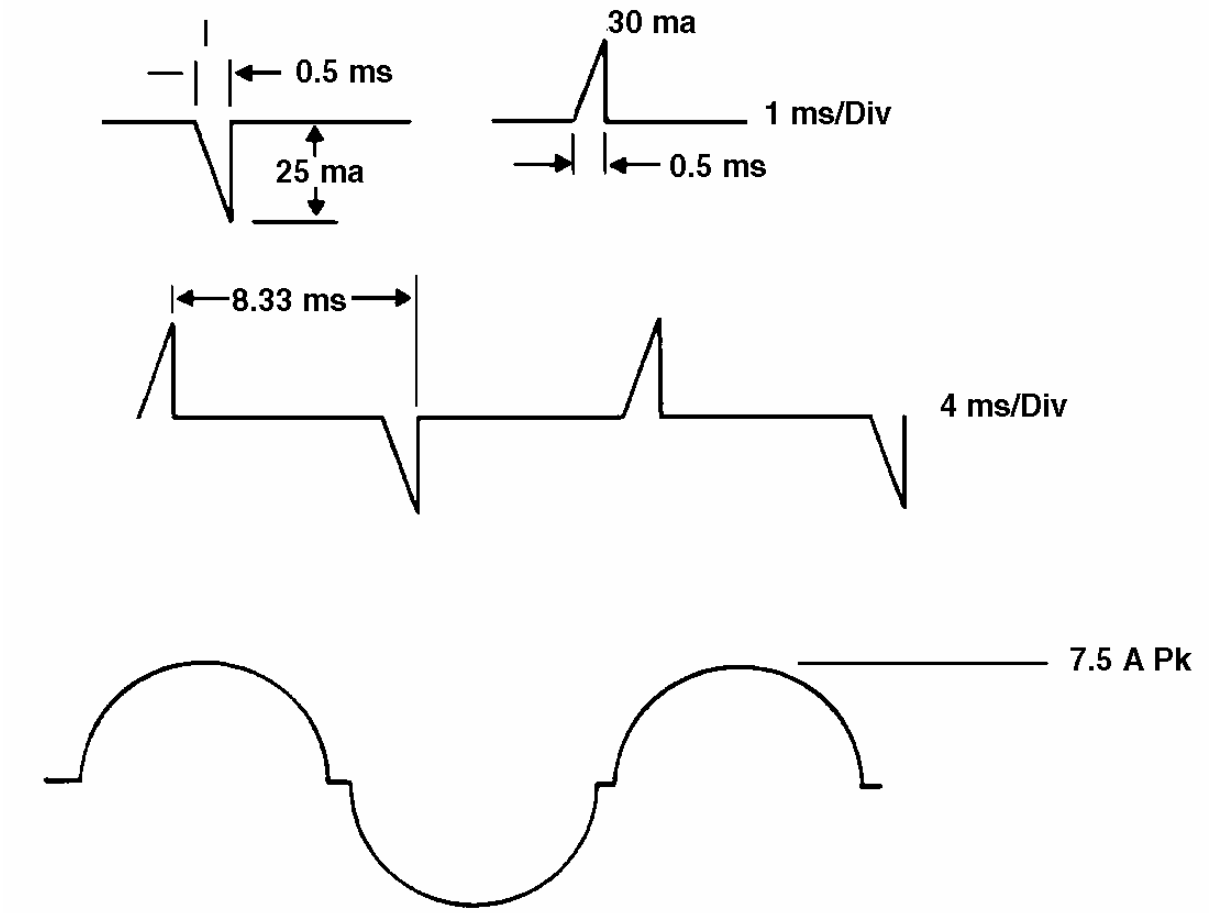


Figure 4-5. Dryer/developer current.

b. **Temperature Control Board Function.** Refer to figure 4-2.

(1) Ramp generator. The temperature control board senses an error voltage that is produced by comparing the thermistor/set point voltage with the proportional control ramp.

(a) One of the zero crossing signals from the power board is connected to a 4024 binary counter (U5). A series of weighting resistors is connected to the outputs of U5. These resistors are, in turn, connected to the current summing input of U6, pin 2. The resistors are in a binary sequence, and generate a staircase ramp.

1 There are seven bits forming this ramp.

2 At the end of the full count, the counter is not reset, but instead begins to count down because of its overflow and generates a ramp.

3 At TP-7, you can check the amplitude of the ramp, and adjust R1 for 2 volts peak to peak. The ramp runs between 4 and 6 vdc, with a period of 2 seconds. Refer to figure 4-6 to see the wave form.

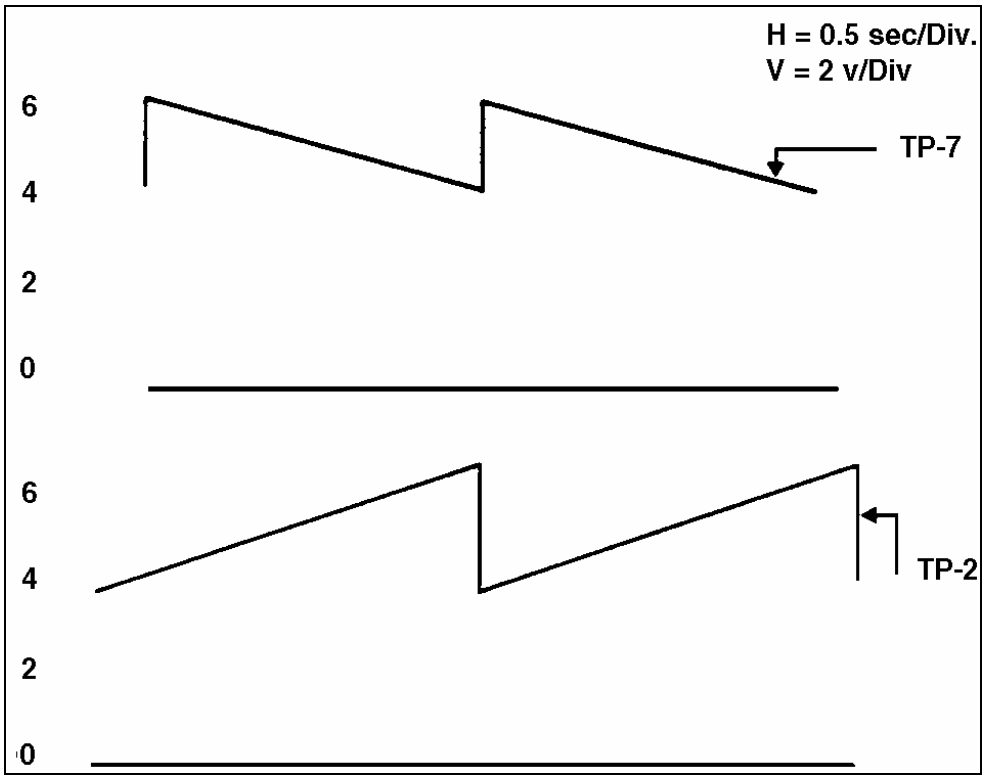


Figure 4-6. Temperature board wave forms.

(b) The output of U6-1 is then fed to U6-6 where it is inverted. The dryer ramp may be viewed at TP2. After adjusting the developer ramp, R2 may be adjusted to produce an amplitude of 3 volts p-p. This ramp has a period of 2 seconds and goes from 4 to 7 volts

(2) Calibration amplifier. U7A and U8A are CMOS op-amps. They are used as summing amplifiers to add the offset (calibration) voltage to the error signal for the dryer and to add the offset (calibration) voltage to the error signal for the dryer and developer, respectively.

(a) The voltages present at TP-5 and TP-3 represent the amplified error voltage of the dryer and developer, respectively, in normal operation. After the unit has reached thermal equilibrium, the voltage will vary between 4 and 7vdc, with respect to TP-1 (signal ground).

(b) Resistor R-3 controls the dryer scale off-set, and is used to cause the dial scale for the dryer temperature to agree with the actual temperature of the air. Similarly R-4 is used to calibrate the developer temperature.

(c) When the unit is warming up, and the temperature error is large, the voltage at TP-5 and TP-3 will approach zero. The respective power circuits will call for full heat, as limited by the current sharing circuit.

(3) Temperature comparator. Amplifiers U7B and U8B are configured as high gain comparators. Resistors R21 and 24, respectively, provide hysteresis which limits oscillations and provides some latching action.

(a) You may observe the operation of the dryer and developer comparators at TP-6 and TP-4. Refer to figure 4-7 to see typical wave forms.

(b) Whenever the ramp voltage, which is applied to the inverting input of the comparators (U7B and U8B) exceeds the DC input voltage from the previous stage of this circuit (U7A and U8A), the output of the comparator goes low, and heat will be called for, if the remaining logic conditions permit.

(4) Power sharing circuit. Power sharing is provided to prevent both the developer and dryer heater from being turned on simultaneously. In addition, power sharing provides preferential heating to the developer solution during start-up. This is necessary due to the large volume of solution that must be heated. The dryers warm up relatively quickly, at which time the power is apportioned, during the remaining operation of the processor, according to the factory setup of the board. A series of inhibit signals are present to ensure that power sharing takes place.

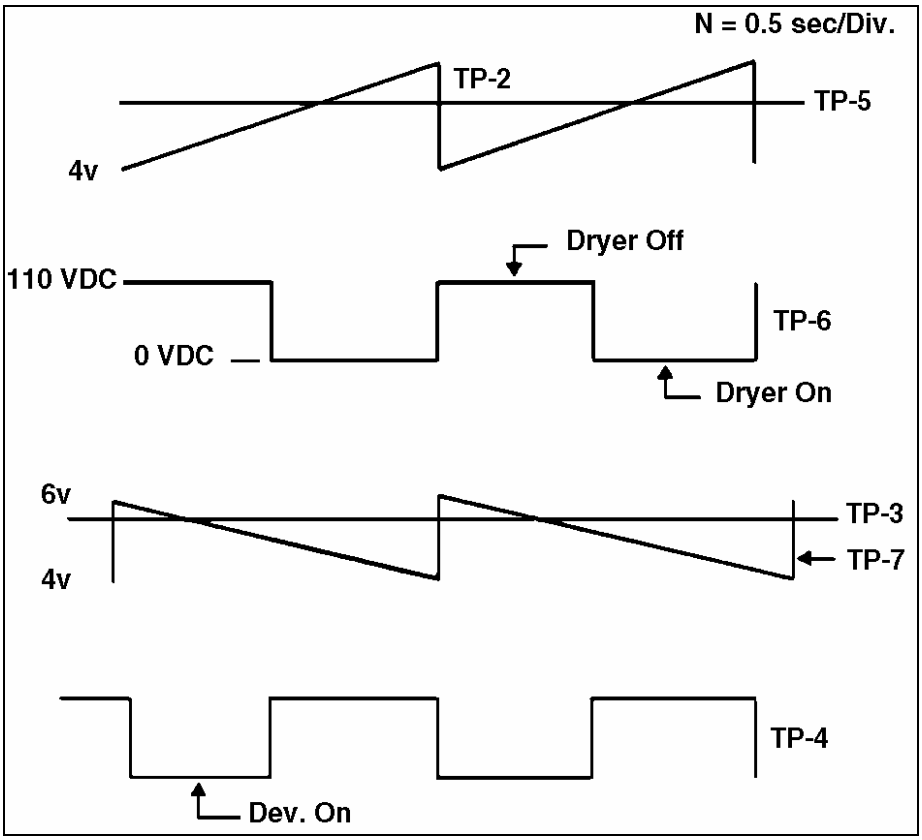


Figure 4-7. Temperature board wave forms.

(a) On turn-on, the input to U11-D is low causing a high at U11-11.

1 Via the actions of NOR gate U10-A and the flip-flop formed by U11-B and C, a "1" is produced at U11-4.

2 In addition, counter U2 is reset at U2-11.

3 When capacitor C14 charges up, the U2 reset line goes high and the counter starts.

4 If the dryer and developer are not up to temperature, then indicator DS3, "temps ready," will be off, and the timing board will get a "temp wait" signal.

(b) During start-up, the reset line on the Temperature Ready Timer, U2-2, toggles from low to high when the output of U11-D performs its power-up transition. With the reset line high, the counter output is zero. This puts a "0" on U3A-2.

(c) The power sharing timer is U5. The zero crossing pulses clocks this from the power board.

1 Normally gates U4-A and U3-D decide at which count of the timer priority is shifted from the developer to the dryer.

2 The output of U3-D is initially held low by the action of the flip-flop U11-B and C, which was determined to be "1" at turn on.

3 The developer heater will run at 100% power until it reaches the proportional control region.

(d) Once U8B (pin 7) goes high, indicating that the developer is near operating temperature, a series of events takes place:

1 U4B-5 goes high. This allows the power sharing pulse, which is generated on a one second interval, to clock through U4-B, setting U4-4 low.

2 U10-10 will then clock low. Meanwhile, the dryer is beginning to heat up. As soon as it reaches its proportional region, U7B-7 (TP-6) will go high. This will cause the output of U4D-11 to go from "1" to "0." This will, in turn, reset counter U2.

3 In order for the Temperature Ready light (and therefore the Film Feed light) to properly function, both the developer and dryer comparator outputs must either be "1" or make periodic transitions before U2 reaches the end of count. Every time the comparator output goes high, the Time-Out counter is reset.

(e) Power sharing is effected via the effect of CR-2 on the developer sense circuit.

1 When the output of U10 goes high, voltage is supplied to the positive input of op amp U8B-5. This turns off the developer heat.

2 When the developer heat is off, U8B-7 is high.

3 This, in turn, supplies power to the output driver, U9B via its open collector pull up resistor R36.

4 In normal operation, the developer calls for little heat. The dryer needs more heat and is allowed to run whenever the developer is not calling for heat.

(5) Triac drive circuitry. The triacs require a pulse at the zero crossing of each half cycle of the power line. The triacs are opto-coupled to the logic, as described in the power board section. U9 generates the opto drive pulses. These are open collector NOR gates. Because the optos, and their associated indicator leds, DS1 and DS2 (for the developer and dryer), are capacitive coupled, the circuit will not function if the zero crossing pulses are missing or defective.

(a) In order for the optos to be triggered, all inputs to U12A or B must be low. Thus, both zero crossing pulses must be low, which will occur at the true zero crossing.

(b) The respective comparator output must be low and the thermistor must be connected.

(c) At each zero crossing, U12A or B generates a pulse. This is inverted by U13A or B, which is then inverted by U9B or A. In addition, the solution level signal must be satisfied, and be low at U9-2.

(d) When power is called for, DS1 or DS2 will be lit. If the opto-isolator is removed or its led is open, the indicators will not go on. These indicators are key troubleshooting aids.

(6) Blower control circuit. A circuit is included to prevent the dryer blower from operating during the developer warm-up period.

(a) A latching circuit is made from the heavy positive feedback around U13. Initially the output of U13 is low.

(b) This, in turn, pulls the base of the PNP transistor Q-2 low, causing Q-2 to conduct.

(c) The fan relay, R-3 on the power board, is normally closed. Energizing the coil turns off the fan.

(d) When the developer reaches temperature, U8B-7 goes high, causing the latch formed by U13D to go high, and turn off relay R-3. The fans will then go on.

(7) Dryer standby. When the unit goes into standby, the dryer temperature is reduced to the extent possible to insure recovery when a film is fed. Relay K-1 is opened, reducing the reference current to the thermistor circuit by removing R30 from its parallel combination with R29.

4-5. REMOVE AND REPLACE OR REPAIR DEFECTIVE COMPONENTS - AFP 14-X3

There are a number of operating problems that you, as a medical equipment repairer, must correct by removing the defective component and replacing or repairing it. Some of these are covered in Lesson 1, Performing PMCS on the AFP 14-X3 X-ray Film Processor. The ones discussed in this lesson are the most common malfunctions you will have to correct.

a. **Tools.** A medical equipment repairer's tool kit contains the following equipment as a minimum:

(1) Wrenches.

(2) Standard screwdrivers.

(3) Volt-ohmmeter or digital multimeter.

(4) Allen wrenches.

(5) Process thermometer (metal, not mercury).

(6) Pin extractor.

b. **Film Transport Problem.** These are covered in detail in Lesson 1, paragraph 1-4a(1) through (6).

c. **Solution Rack Problem.** If the solution rack does not operate properly when you check and clean it per the procedures in Lesson 1, paragraph 1-4a(1), you may have to disassemble it. Use these additional guidelines:

(1) Work on one rack at a time.

(a) Place the rack on its side on a flat surface.

(b) Do not interchange the parts from one rack with those from another rack. The rollers are hollow and can collect chemical residue which will contaminate the solution in another tank.

(c) Lay out any parts removed from the rack in the order in which they are removed, so that you can easily remember how to reassemble them. Note the exact position of each size roller and the rubber exit rollers in the assembly.

(d) Always place the shoe assemblies in the rack so that the ribs point in the direction of film travel. Refer to Lesson 1, figure 1-10.

(e) Replace tan phenolic and rubber rollers in the same locations from which you removed them.

(f) Some racks have plastic inlets at the side of the racks which permit solution to directly enter the racks. These plastic rack inlets are necessary for proper solution circulation.

(g) The stainless steel pins on the moving plate will not fit into the roller cranks, paddle shaft crank(s), or pivot links, unless you place all cranks and links in the down position before installing the moving plate.

(2) After you reassemble the rack:

(a) Place it on a flat surface and check that it is square. Tighten any loose tie rod or shoe assembly screws.

(b) Feed a 14-inch (35 centimeters [cm]) piece of previously exposed and processed film through the rack while turning the rack worm gear (main rack gear) by hand. Make certain the rack transports the film properly. If the rollers and gears do not turn without binding, eliminate the cause of the bind.

d. **Circulation Pump(s) Problems.** You can easily remove the developer and fixer circulation pumps for cleaning and/or servicing. If you determine that a circulation problem stems from the pump, use the following procedures to remove it.

(1) Unplug the processor from its power outlet.

(2) Drain and thoroughly rinse the tank from which you will be removing the pump.

(3) Disconnect the pump power cable from the terminal strip.

(4) Disconnect all hose connections from the pump body.

(5) Remove the drain filter disk from the bottom of the processing tank to expose the four pump mounting screws.

(6) Carefully remove the four screws and lower the pump.

(7) For disassembly and reassembly of the pump see Lesson 1, paragraphs 1-3a through c.

e. **Wash Tank Fill Solenoid Problem.** If you checked for proper voltage per the procedures in Lesson 1, paragraphs 1-4a(7)(a) through (f), and found that the valve does not operate, the coil may need to be replaced, or the valve may be stuck. You need to remove and inspect the solenoid valve. You do this by using the following procedures. Refer to Lesson 1, figure 1-11.

(1) Turn off the power. Turn off and disconnect the external water supply.

(2) Disconnect the wiring, including the green ground wire. Note from which terminals you removed the wires.

(3) Unscrew the flow restrictor from the front.

(4) There are two screws holding the valve, located on both sides of the water inlet. Remove them and bring the solenoid out of the left side of the machine.

(5) Remove the red plastic cap. Pull the valve down and out of the coil.

(6) Remove the valve operator by turning the hex fitting counterclockwise.

(7) Check the action of the spring.

(a) Remove any foreign matter from inside the valve.

(b) Check the valve seat for possible corrosion or damage.

(8) If you find damage, replace the valve.

f. **Replenishment Problem.** Procedures for correcting replenishment problems are covered in Lesson 1, paragraphs 1-4c(7)(b) through (e).

g. **Drive Motor Problem.** The drive motor does not have enough torque to turn the drive shaft even though no racks are stuck and power is being supplied at terminal strip TS6. Therefore, you have determined that the drive motor must be replaced. Use the following procedures. Refer to figure 4-8.

WARNING

Disconnect the power supply to the processor before removing the front panel, as severe electrical shock will result from coming into contact with "live" electrical components.

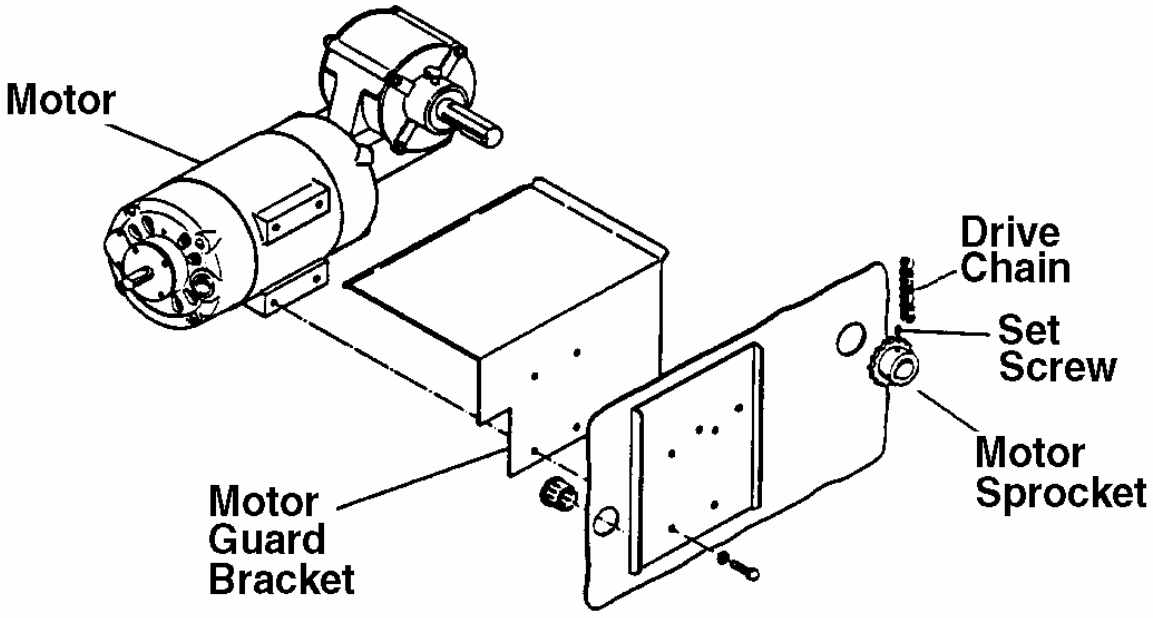


Figure 4-8. Drive motor (exploded view).

(1) Remove the front cover and right side panel.

(2) Disconnect the motor wires at terminal strip TS6.

(3) Remove the four nuts on the motor mounting plate.

(4) Use an Allen wrench to loosen the set screw on the motor drive sprocket.

(5) Remove and replace the drive motor.

h. **Developer Heater Problem.** There is an infinite resistance between either of the hot leads and the green ground lead of the heater. You determine you must replace the developer heater. Use the following procedures.

(1) Drain the tank.

(a) Place a cloth below the open end of the heat tube to soak up spilled developer.

(b) Disconnect power to the machine.

(c) Remove the front and left side covers.

(d) Open the drain valve/petcock to drain the developer into the recovery system.

(2) Disconnect the heater wires from terminal strip TS6. Unthread the wiring.

(3) Use a wrench to unscrew the heating element from the heat tube.

(4) Reverse this procedure to install a heater.

i. **Developer Sensor Problem.** The resistance of the developer sensor is out of tolerance. You determine the developer sensor is malfunctioning and that you must remove it. Use the following procedures.

(1) Disconnect the power and drain the developer tank to a level below the sensor.

(2) Disconnect the sensor leads. Unscrew the knurled collar on the sensor and pull the sensor out.

(3) When installing a new sensor:

(a) Make sure the O-ring and washer are in place between the tank fitting and the knurled collar. Refer to figure 4-9.

(b) Tighten the collar until the sensor feels snug.

(c) Check the fitting for leaks.

(d) Perform the "temperature calibration" described in Lesson 3.

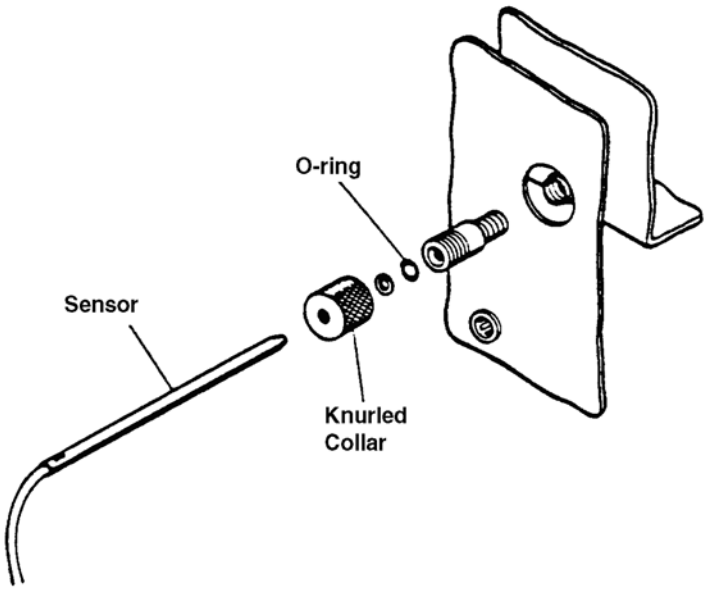


Figure 4-9. Developer sensor assembly.

j. **Dryer Sensor Problem.** If you must remove the dryer sensor, use the following procedures:

(1) Disconnect power. Remove the leads from the dryer sensor at TS3. Remove the lift-out dryer and lift-out rack.

(2) Remove the four screws securing the cover on the front heater. Drop the cover down to expose the heater components.

(3) Loosen the clamp securing the sensor and slide out the sensor.

(4) After installing a new sensor, perform the "temperature calibration" described in Lesson 3.

Section II. X-OMAT X-RAY FILM PROCESSOR

4-6. GENERAL

In order to properly maintain the X-OMAT X-ray film processor, you must be familiar with its theory of operation. You must also know how to remove and replace or repair a malfunctioning component. The following procedures are examples of the methods to use to correct common malfunctions. For further information on removing and replacing or repairing defective components of the X-OMAT refer to the manufacturer's service manual. Refer to figure 4-10 for a pictorial representation of the electrical sequence of operation and figure 4-11 for a circuit diagram of the X-OMAT.

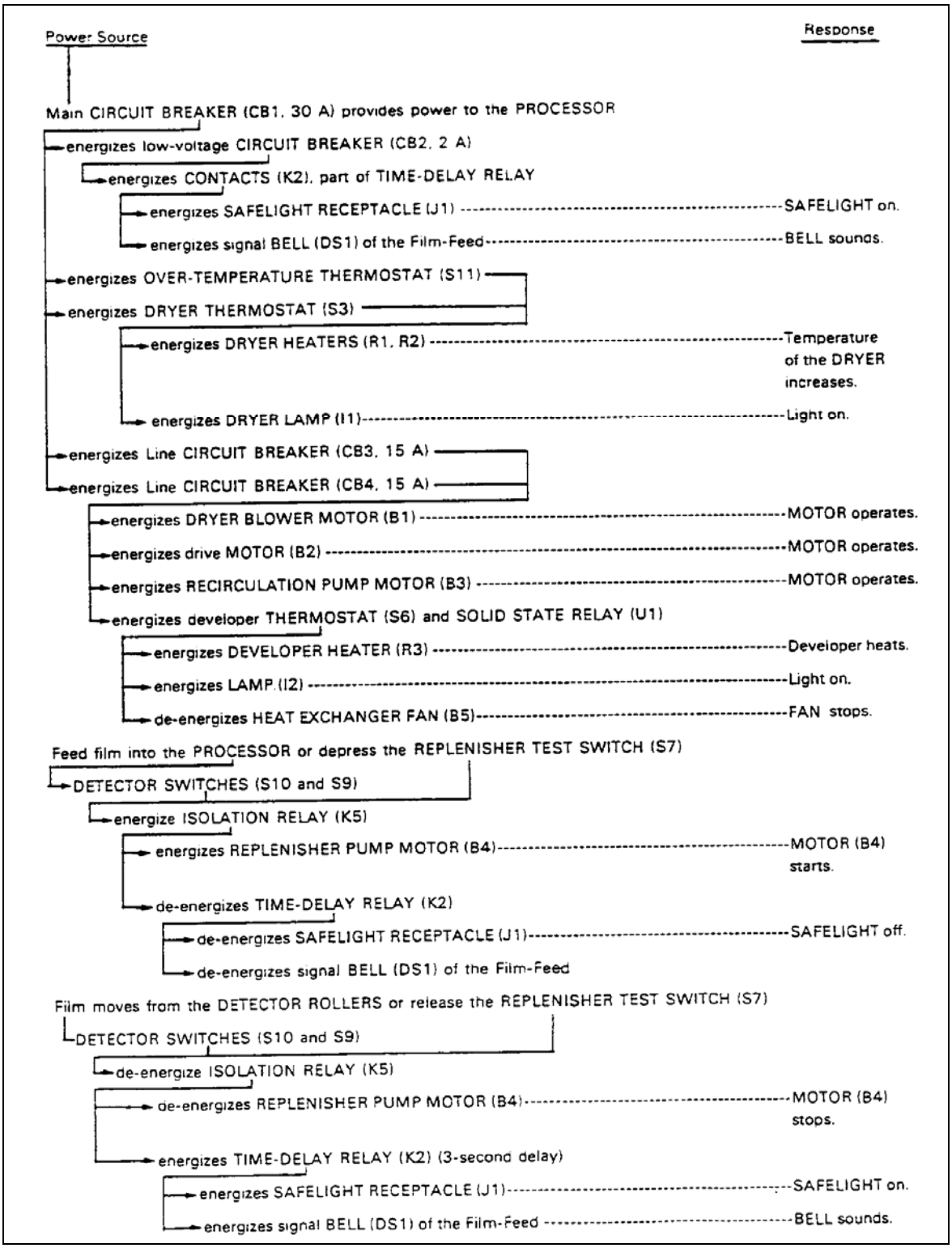


Figure 4-10. Electrical sequence of operation.

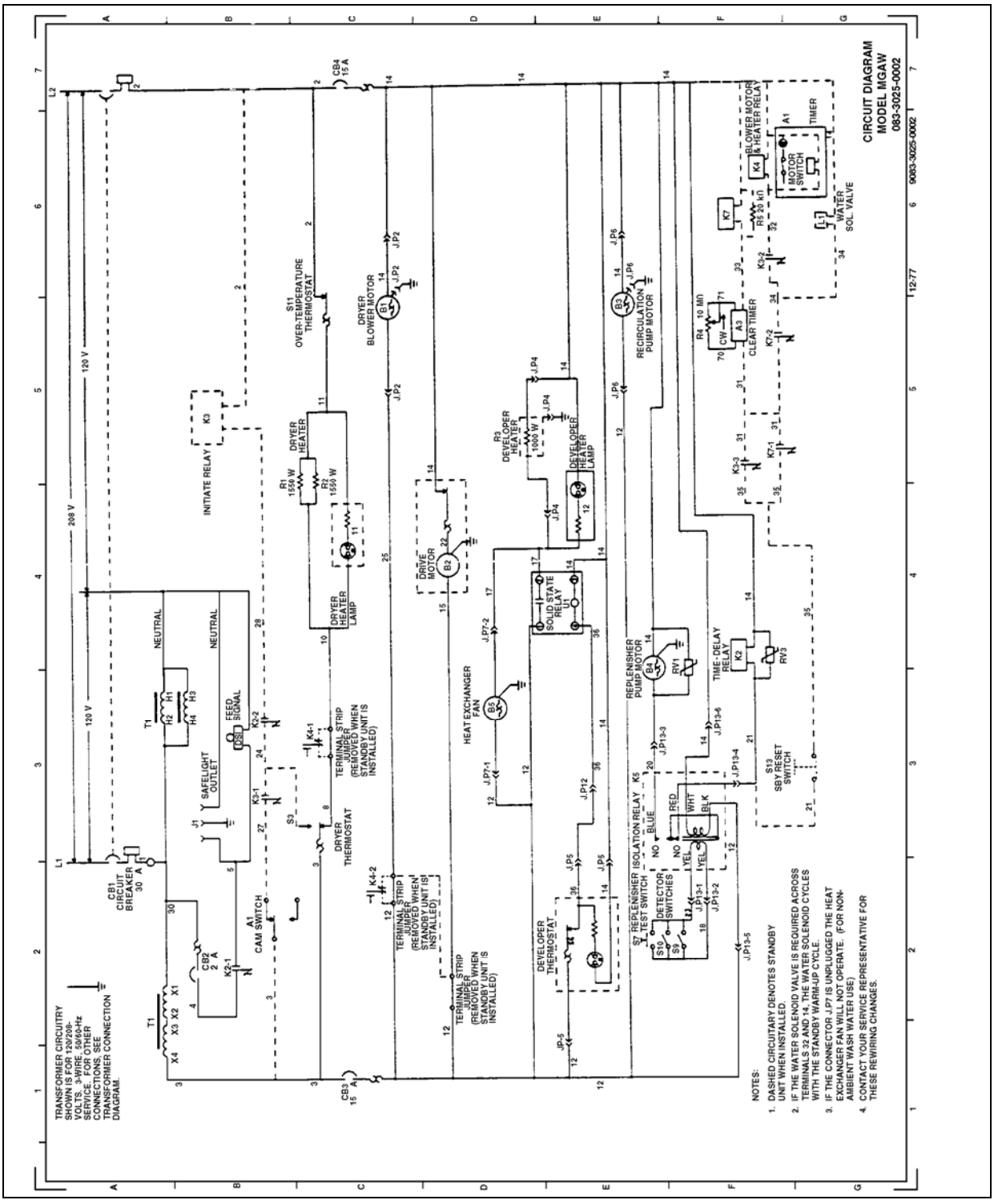


Figure 4-11. Circuit diagram for the X-OMAT film processor.

4-7. REMOVE AND REPLACE OR REPAIR DEFECTIVE COMPONENTS--X-OMAT

a. **Wash Rack Assembly Chain Tension Problem.** The chain on the wash rack assemblies is loose. To adjust it, use the following procedures.

(1) Loosen the four holding screws.

(2) Rotate the four adjusting screws clockwise to increase the tension (or counterclockwise to loosen the tension).

(3) Tighten the four holding screws.

(4) If the chain is too loose with maximum adjustment, remove a link. Refer to figure 4-12.

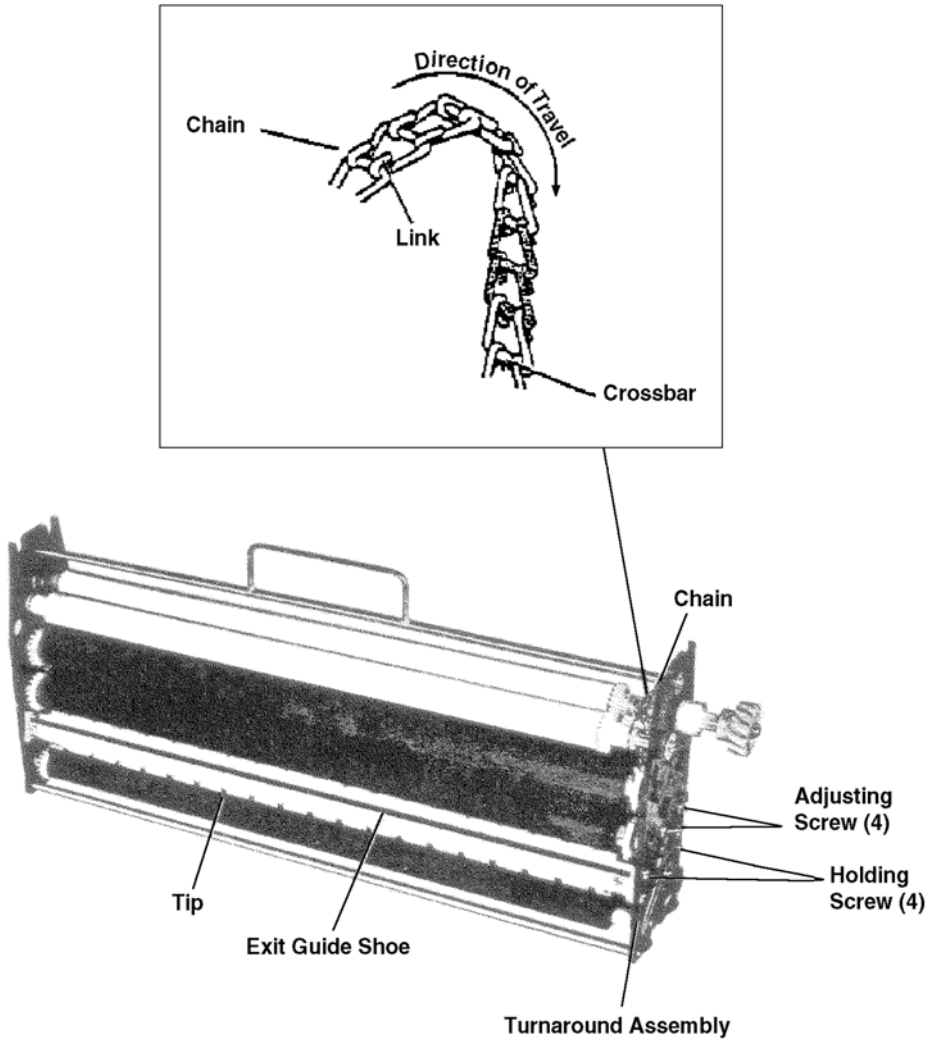


Figure 4-12. Wash rack assembly.

(a) Insert a screwdriver between the two links to be broken.

(b) Apply force to open the two links.

(c) Open the opposite end of the link that was opened and remove the link.

(d) Reconnect the open end of the link and close it with a pair or pliers.

b. **Time-Delay Relay K2 Problem.** The X-OMAT processor is feeding double films and you have isolated the malfunction to a faulty K2 relay which sets the time interval for the signal bell to feed film and for the safelight. You must install a new K2 relay. Use the following procedures. See figure 4-13.

(1) Locate relay number K2.

(2) Remove relay number K2.

(3) Replace relay number K2.

c. **Developer Heater Problem.** The developed x-ray films are fuzzy. You have isolated the malfunction to the developer temperature being too high and have decided to replace the developer tank heater. Refer to Lesson 2, figure 2-14.

(1) Remove the developer tank heater.

(a) Disconnect the power from the unit.

(b) Apply clamps to the tubing to stop the developer, or drain the developer.

(c) Locate the developer tank heater.

(d) Remove the inlet and outlet hoses from the heater.

(e) Remove the electrical connection.

(f) Remove the heater.

(2) Replace the developer heater.

(a) Replace the heater unit.

(b) Replace the electrical connection.

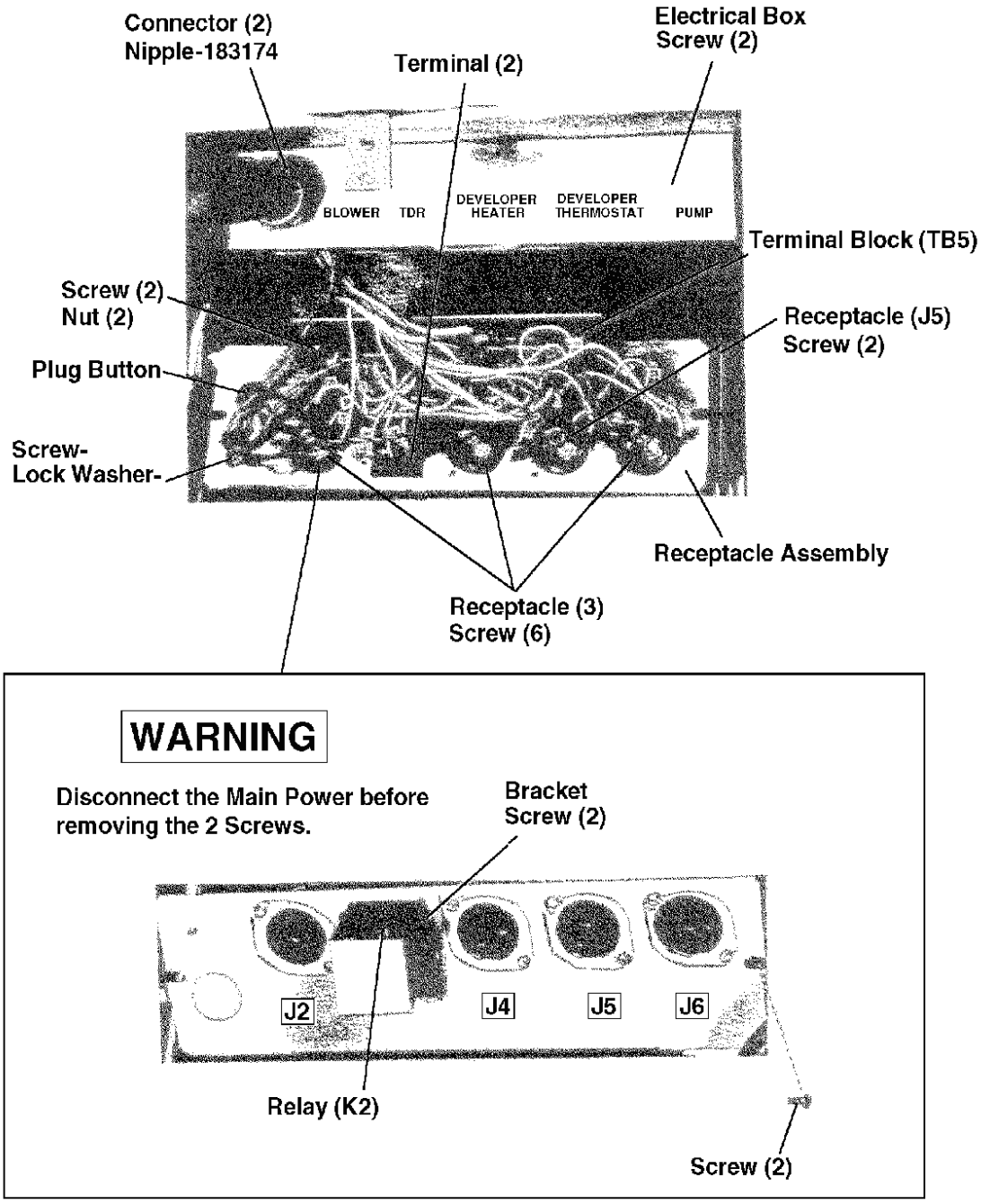


Figure 4-13. Time-delay relay K2.

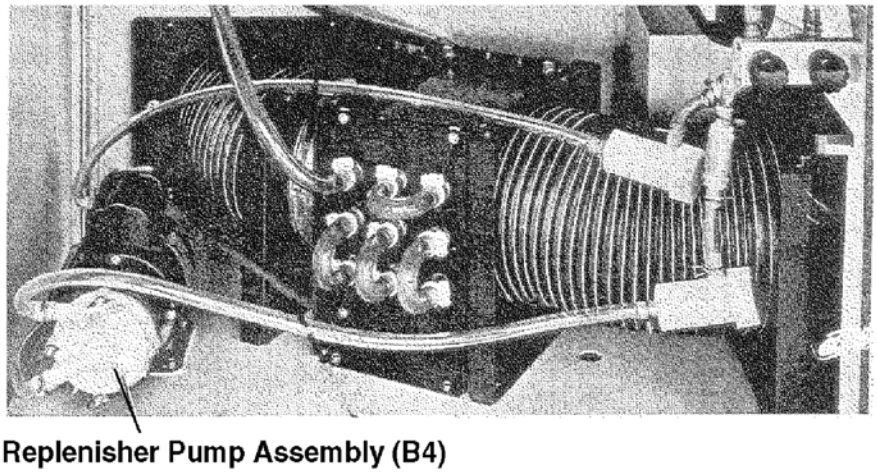


Figure 4-14. Developer replenisher pump.

(c) Replace the inlet and the outlet hoses from the heater.

(d) Release the clamps that are stopping the tubing or refill the developer.

(e) Reconnect the power to the unit.

d. **Developer Replenishment Pump Problem.** The x-ray films are losing contrast. You have isolated the fault to a malfunctioning developer replenisher pump. You must remove and replace it. Refer to figure 4-14.

NOTE: The recirculation pump and the chemical-replenisher pump are identical except for the orientation of the pump housings. When repairing pumps, replace the O-ring. Refer to figure 4-15.

(1) Remove the developer replenishment pump assembly.

(a) Remove the power from the unit.

(b) Locate the replenisher pump.

(c) Remove the inlet and outlet hose.

(d) Remove the electrical connection.

(e) Remove the pump assembly.

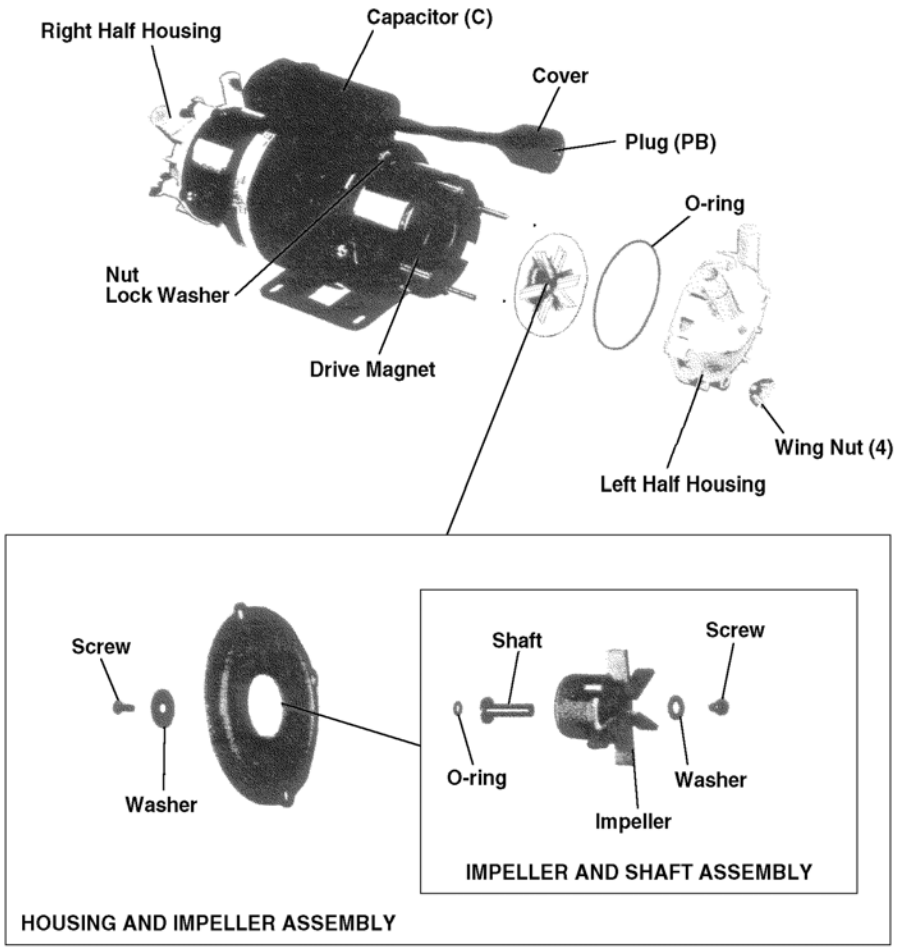


Figure 4-15. Recirculation and replenisher pump assemblies.

(2) Replace the developer replenishment pump assembly.

(a) Replace the pump assembly.

(b) Replace the electrical connection.

(c) Replace the inlet and outlet hose.

(d) Replace the replenisher pump.

(e) Replace the power to the unit.

Continue with Exercises

EXERCISES, LESSON 4

INSTRUCTIONS: Answer the following exercises by circling the lettered response that best answers the question.

After you have answered all of the exercises, turn to "Solutions to Exercises" at the end of the lesson and check your answers. For each exercise answered incorrectly, reread the lesson material referenced after the solution.

1. Which of the following statements is true about the operation of the AFP 14-X3 X-ray Film Processor?

   a. When you first turn on the ON-OFF switch S1, the developer heater heats the developer up to set temperature at the same time the dryer heater heats the dryer to set temperature.

   b. In the standby mode, both developer and dryer temperatures are maintained.

   c. The replenishment pump operates while film is activating the entrance switch, adding developer and fixer.

   d. During the standby mode, the processor periodically enters a jog cycle (for 20 seconds every 5 minutes).

2. Which of the following are the three electronic circuit boards for the AFP 14-X3?

   a. The electronics board, triac board, and the replenishment board.

   b. The developer board, the fixer board, and the dryer board.

   c. The opto-isolater board, the hysteresis board, and the thermistor board.

   d. The power board, the temperature board, and the timing board.

3. What is the purpose of the power sharing circuit on the AFP 14-X3?

    a. To prevent both the developer and dryer heater from being turned on simultaneously.

    b. To provide preferential heating to the dryer during start-up.

    c. To provide replenishment to the developer and fixer when necessary.

    d. To ensure that neither the developer or dryer heaters overheat.

4. Which of the following statements is true about removing and replacing or repairing a solution rack for the AFP 14-X3?

    a. Remove and work of all solution racks at the same time.

    b. Always place the shoe assemblies in the rack so the ribs point in the direction of film travel.

    c. Place all cranks and links in the up position before installing the moving plate.

    d. You can always interchange parts from one rack to every other rack.

5. Which of the following is the first step in removing the developer heater for the AFP 14-X3?

    a. Disconnect the power to the machine.

    b. Unscrew the heating element from the heat tube.

    c. Drain the tank.

    d. Disconnect the heater wires from the terminal strip.

6. Which of the following is a procedure for installing a developer sensor in the AFP 14-X3??

    a. Be sure the developer tank is drained completely.

    b. Always replace the O-ring and washer.

    c. Tighten the clamp securing the sensor and slide it in.

    d. Perform temperature calibration.

7. Which of the following statements is true about the X-OMAT X-ray Film Processor electrical sequence of operation?

    a. The dryer heater is energized before the developer heater.

    b. The developer heater is energized before the dryer lamp light comes on.

    c. The replenisher pump motor is only energized when you feed film into the processor.

    d. The replenisher pump motor is energized before the recirculation pump motor is energized.

8. What does the K2 relay control on the X-OMAT X-ray Film Processor?

    a. It energizes the dryer heaters and dryer lamp which turns on.

    b. It energizes the replenisher pump motor which starts.

    c. It sets the time interval for the signal bell to feed film.

    d. It allows the power sharing pulse to clock through U4-8, setting U4-4 low.

9. Which of the following is the first step for removing the developer tank heater on the X-OMAT X-ray Film Processor?

   a. Remove the inlet and outlet hoses from the heater.

   b. Disconnect the power from the unit.

   c. Locate the developer tank heater.

   d. Remove the electrical connection.

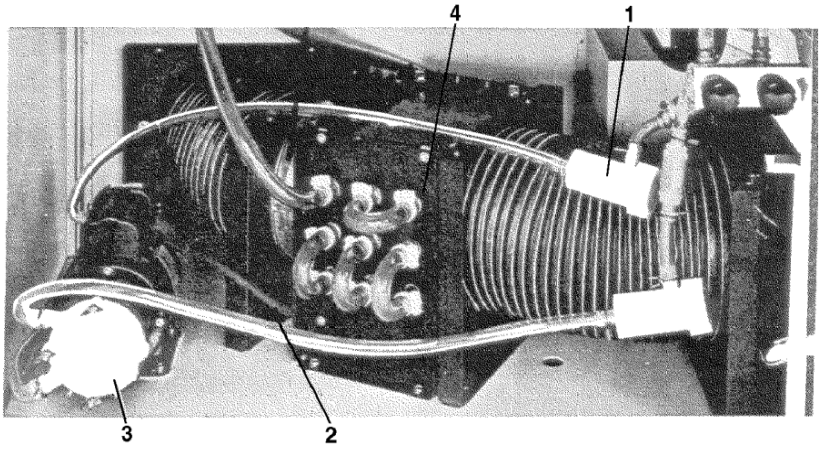
10. Refer to the figure below. What number identifies the replenisher pump?

   a. 1.

   b. 2.

   c. 3.

   d. 4.



11. Which of the following is a procedure for removing and replacing the X-OMAT X-ray Film Processor's developer replenishment pump?

   a. As the first step, locate the replenishment pump.

   b. Remove the outlet arm inlet hose.

   c. Always replace the O-ring.

   d. Replace pump assembly before you replace the pump.

Check Your Answers on Next Page

SOLUTIONS TO EXERCISES: LESSON 4

1. c (para 4-2d(2))
2. d (para 4-3)
3. a (para 4-4b(4)
4. b (para 4-5c(1)(d))
5. c (para 4-5h(1))
6. d (para 4-5i(3)(d))
7. a (figure 4-12)
8. c (para 4-7b)
9. b (para 4-7c(1)(a))
10. c (figure 4-14)
11. c (para 4-7d NOTE)

End of Lesson 4