O.I. Corporation

Model SHLR

Autosampler Instruction Manual

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SECTION 1 - INTRODUCTION

1.1 INTRODUCTION - The autosampler is a compact versatile sample introduction system designed to increase the efficiency of analytical instrumentation. Automatic sample introduction will save lab time, free personnel, and allow overnight utilization of instrumentation.

The sampler, when connected to a liquid sample based analytical instrument will allow the introduction of samples at user defined time intervals. Samples as small as 10 microliters are practical. The sample routine is controlled externally or by the microprocessor based Control Sequencer. The sampler(s) with wash station allows rinsing of the pipet and flushing of the flow cell or injection loop after each sample to minimize carryover. Many sample size options are available for the autosampler. Rack sets accommodating, 10-13 mm OD test tubes, 10-16 mm OD test tubes, and 17-18 mm Mini-Vials® provide for 76 to 114 individual samples. Racks are also available for HPLC vials and ELISA vials. An optional 9 rack set for 28 mm vials is also available.

1.2 TECHNICAL SPECIFICATIONS - Table 1-1 details the technical specifications of the autosampler.

TABLE 1-1. TECHNICAL SPECIFICATIONS

NOMINAL LINE VOLTAGE	100 Vac, 117 Vac, 234 Vac ±10%
LINE VOLTAGE NOISE TOLERANCE	±170% of nominal line voltage, 10 microsecond pulses at any phase angle.
POWER CONSUMPTION	90 watts maximum
AMBIENT TEMPERATURE RANGE	0 to 40 °C
HUMIDITY RANGE	0-100% relative humidity if connected to line voltage.
LINE FREQUENCY	50 or 60 Hertz
PHYSICAL SIZE	Cabinet: / Overall with wash station: Depth: 8.0'' (20 cm) / 10'' (26 cm) Width: 11.5'' (29 cm) / 11.5'' (29 cm) Height: 6.0'' (15 cm) / 17'' (43 cm)
WEIGHT	22 pounds (10 kg)
TUBE CAPACITY	114 - 10 mm to 13 mm tubes - max. height 100 mm; ELISA vials; HPLC vials 76 - 16 mm tubes, 17 or 18 mm vials - max. height 100 mm 27 - 28 mm dia. vials or 29 mm tubes - max. height 76 mm
TRANSIT TIMES: (Nominal line voltage 60 Hz only, 50 Hz instruments will be 5/6 as fast)	Sample to sample: within rack: less than 0.5 sec. rack to rack: less than 0.7 sec. Pipet Control Signals: sample to wash - less than 0.5 sec. wash to sample - less than 0.5 sec. lower - less than 2.5 sec. raise - less than 3.0 sec. Manual Advance Complete cycle from sample 1 to sample 114 - 35 sec max.

®Mini-Vials is a Trademark of Nuclear Associates, Inc.

TABLE 1-1. TECHNICAL SPECIFICATIONS [cont.]

INPUT-OUTPUT CONNECTOR	Sampler without control sequencer: 15 pin Sub 'D' Cinch DA15S Sampler with control sequencer: 9 pin Sub 'D' Cinch DE9P

TABLE 1-2. CONTROL SIGNALS FOR SAMPLER WITHOUT WASH STATION, WITHOUT CONTROL SEQUENCER

Signal	Input/Output Pin Number	Function
RAISE PIPET	3	INPUT - causes pipet to raise when activated by a TTL low or a switch closure referenced to pin 1.
LOWER PIPET	4	INPUT - causes pipet to lower when activated by a TTL low or a switch closure referenced to pin 1.
ADVANCE	2	INPUT - causes racks to advance to next sample when activated by a TTL low or a switch closure referenced to pin 1. If pipet is down, pipet will raise prior to rack advance.
PIPET UP	12	OUTPUT - a TTL high referenced to pin 1; generated when pipet is in the full up position.
PIPET DOWN	13	OUTPUT - a TTL high referenced to pin 1; generated when pipet is completely lowered.
RACKS IN MOTION	10	OUTPUT - a TTL high referenced to pin 1; generated when rack drive motor is running.
STOP POSITION	11	OUTPUT - a TTL high referenced to pin 1; generated when the last sample in the stop rack (the red rack) is in sampling position.

TABLE 1-3. CONTROL SIGNALS FOR SAMPLER WITH WASH STATION, WITHOUT CONTROL SEQUENCER

Signal	Input/Output Pin Number	Function
RAISE PIPET	3	INPUT - causes pipet to raise when activated by a TTL low or a switch closure referenced to pin 1.
LOWER PIPET	4	INPUT - causes pipet to lower when activated by a TTL low or a switch closure referenced to pin 1.
ADVANCE	2	INPUT - causes racks to advance to next sample when activated by a TTL low or a switch closure referenced to pin 1. If pipet is down, pipet will raise prior to rack advance.

TABLE 1-3. CONTROL SIGNALS FOR SAMPLER WITH WASH STATION, WITHOUT CONTROL SEQUENCER [cont.]

Signal	Input/Output Pin Number	Function
PIPET TO SAMPLE	5	INPUT - causes pipet to rotate to sample position when activated by a TTL low or a switch closure referenced to pin 1.
PIPET TO WASH	6	INPUT - causes pipet to rotate to wash position when activated by a TTL low or a switch closure referenced to pin 1.
PIPET UP	12	OUTPUT - a TTL high referenced to pin 1; generated when pipet is in the full up position.
PIPET DOWN	13	OUTPUT - a TTL high referenced to pin 1; generated when pipet is completely lowered.
PIPET AT SAMPLE	14	OUTPUT - a TTL high referenced to pin 1; generated when pipet is at sample (a TTL low is generated when pipet is at wash position).
RACKS IN MOTION	10	OUTPUT - a TTL high referenced to pin 1; generated when rack drive motor is running.
STOP POSITION	11	OUTPUT - a TTL high referenced to pin 1; generated when the last sample in the stop rack (the red rack) is in sampling position.

TABLE 1-4. OUTPUT SIGNALS FOR SAMPLER WITH CONTROL SEQUENCER

Note: These outputs are opto-isolated outputs. The maximum load is 1 TTL gate.

Signal	Pins	Function
PIPET IN SAMPLE	5(+) to 4(-)	OUTPUT - phototransistor will conduct when pipet is at sample and lowered.
PIPET IN WASH	8(+) to 7(-)	OUTPUT - phototransistor will conduct when pipet is at wash and lowered.
RUN COMPLETE	2(+) to 1(-)	OUTPUT - phototransistor will conduct when last tube of stop rack (red) has been sampled, and pipet is raised. Sampler will stop.

SECTION 2 -
UNPACKING, ASSEMBLY AND PREPARATION FOR USE

2.1 UNPACKING - Unpack the container carefully, checking all components and accessory packages against the packing list. Any damages or shortages should be reported immediately. Retain the shipping container in the event the instrument needs to be returned to the factory for service.

2.2 ASSEMBLY - The flow diagrams, Figure 2-1 Basic Unit Assembly; 2-2 Basic Unit with Sequencer Assembly; 2-3 Basic Unit with Wash Station Assembly; 2-4 Basic Unit with Wash Station and Sequencer Assembly should be followed for assembling and checking the sampler.

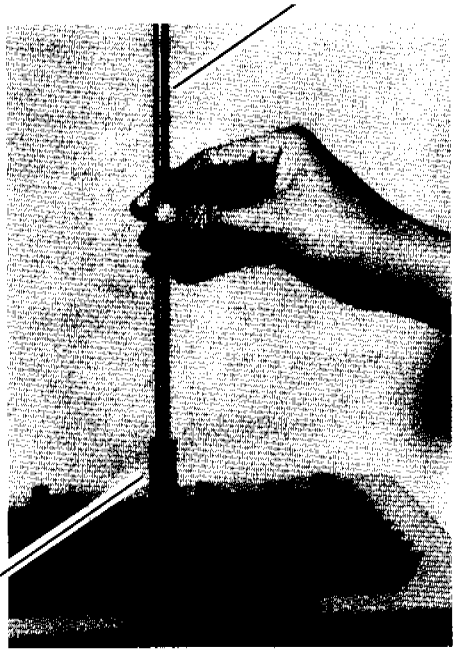
CAUTION

Prior to connecting the sampler to the power mains check the serial tag on the bottom of the instrument to insure that the voltage and frequency rating of the instrument are compatible with the available power mains voltage and frequency. Connecting a sampler to improper voltage or frequency power mains will damage the instrument. Refer to section 5.1 to change power mains rating.

Note: If the sampler is connected to the power mains without test tube racks inserted in the shuttles, the shuttles will cycle continuously until power is disconnected.

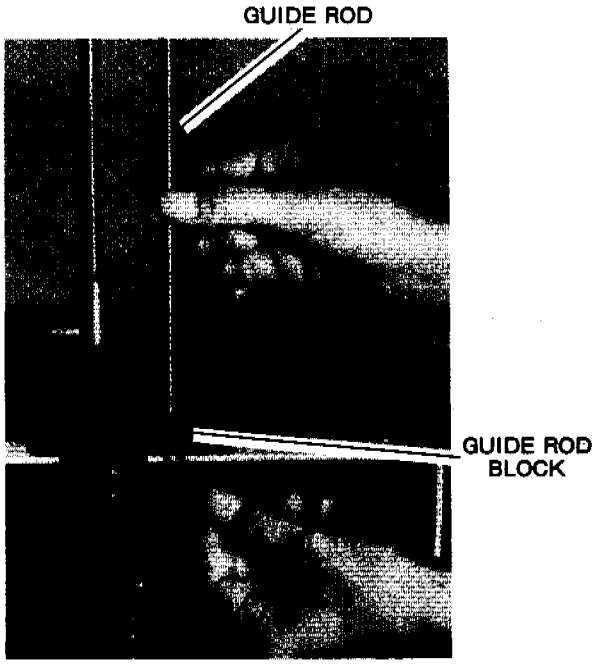
2.2A Basic Unit Assembly [68-1290-050] - Refer to Figure 2-1.

1. Insert the pipet rod, threaded end first, approximately 2-1/2" into the pipet rod guide, and screw in snugly. **DO NOT** use pliers or other mechanical advantage.



Step 1

2. Insert guide rod into guide rod block. Tighten Allen screw with Allen wrench® .



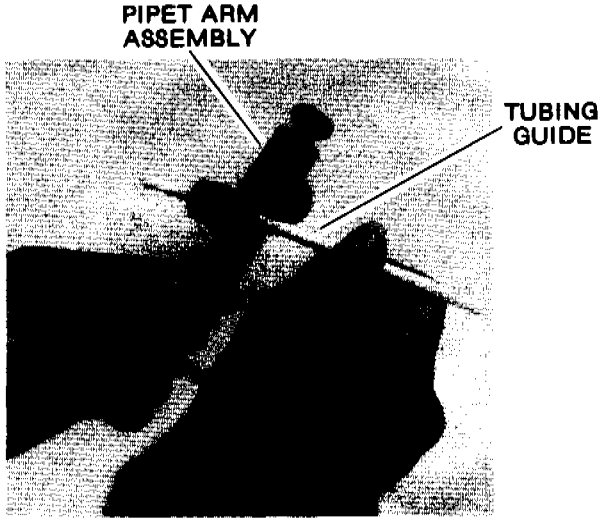
Step 2

3. Insert the test tube racks in the shuttles. Eighteen white racks (eight for 28 mm vial racks) and one red stop rack. Press each rack down firmly to secure it to its shuttle.

Note: The 28 mm vial racks are inserted in every other shuttle. Between the red rack and the first white rack, skip two shuttles.

Note: For septum piercing, see section 2.8.

4. Insert the tubing guide into the pipet arm assembly.



Step 4

®Trademark of Allen Manufacturing Co.

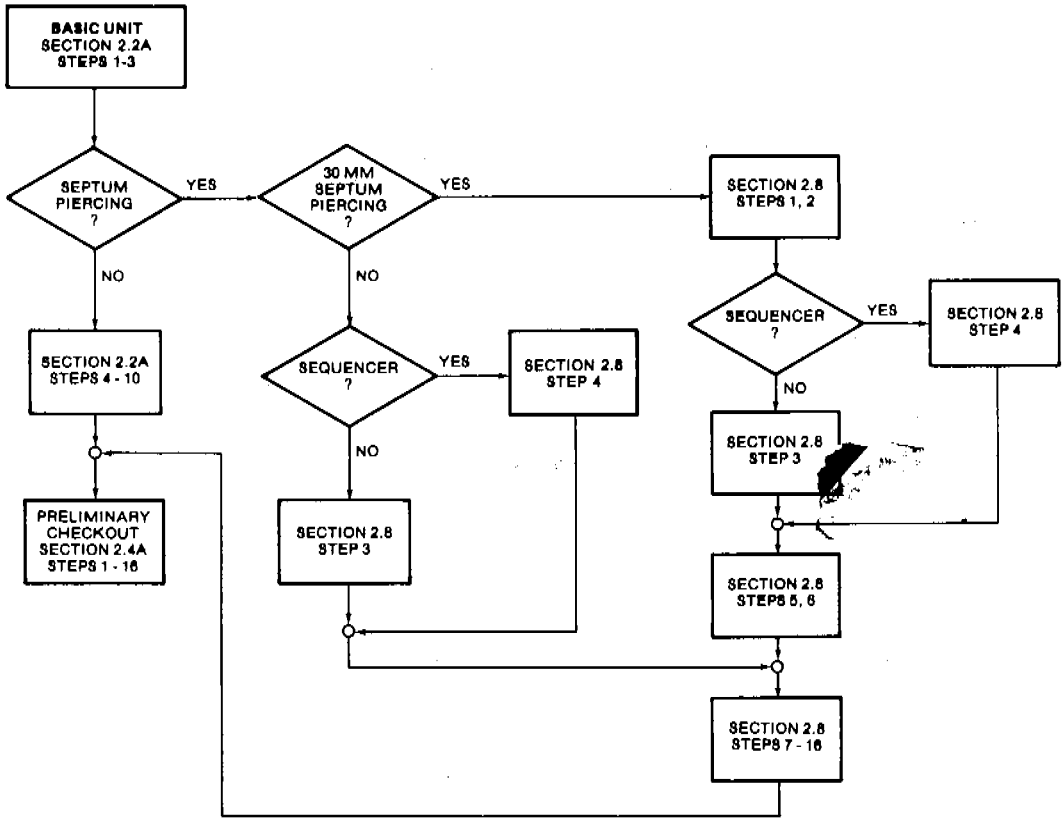


Figure 2-1. Basic Unit Assembly

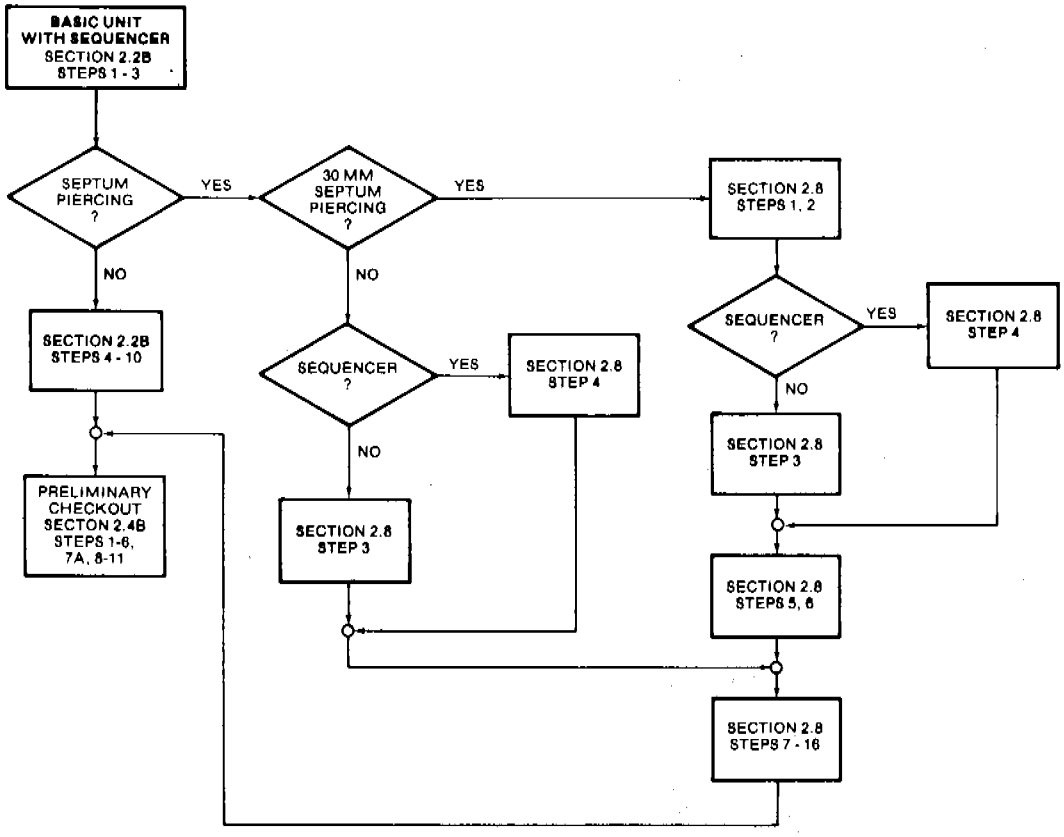


Figure 2-2. Basic Unit with Sequencer Assembly

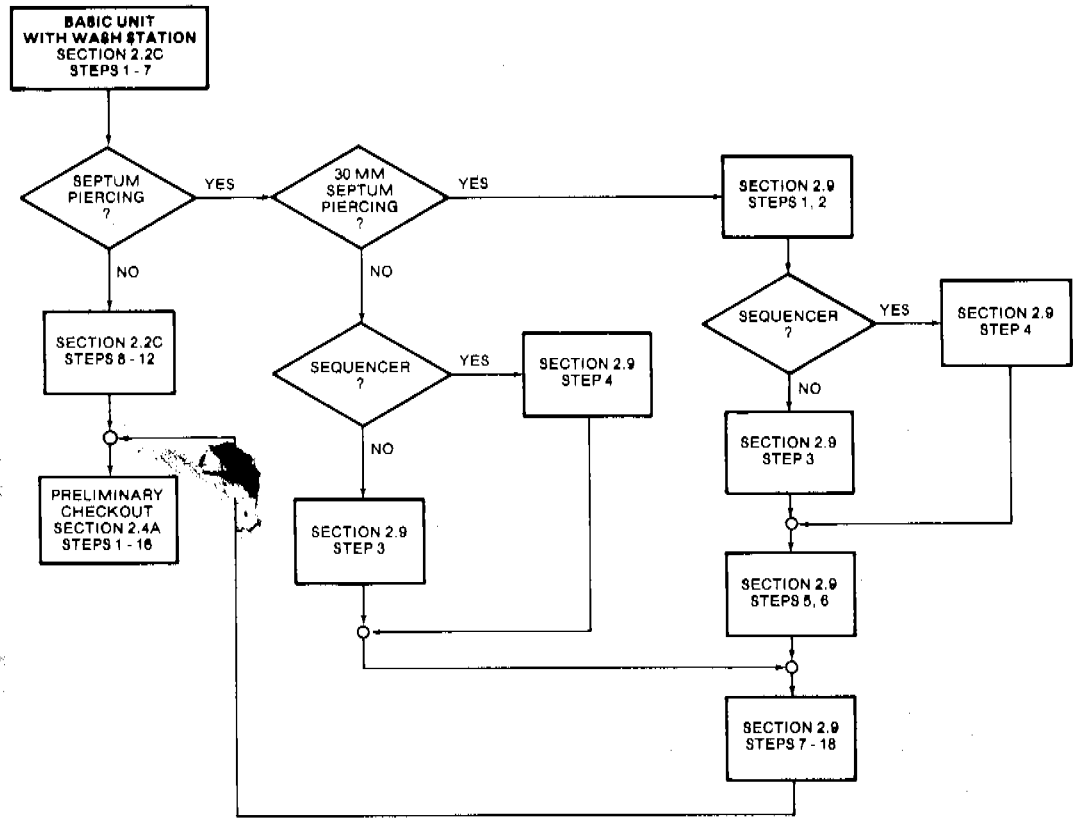


Figure 2-3. Basic Unit with Wash Station Assembly

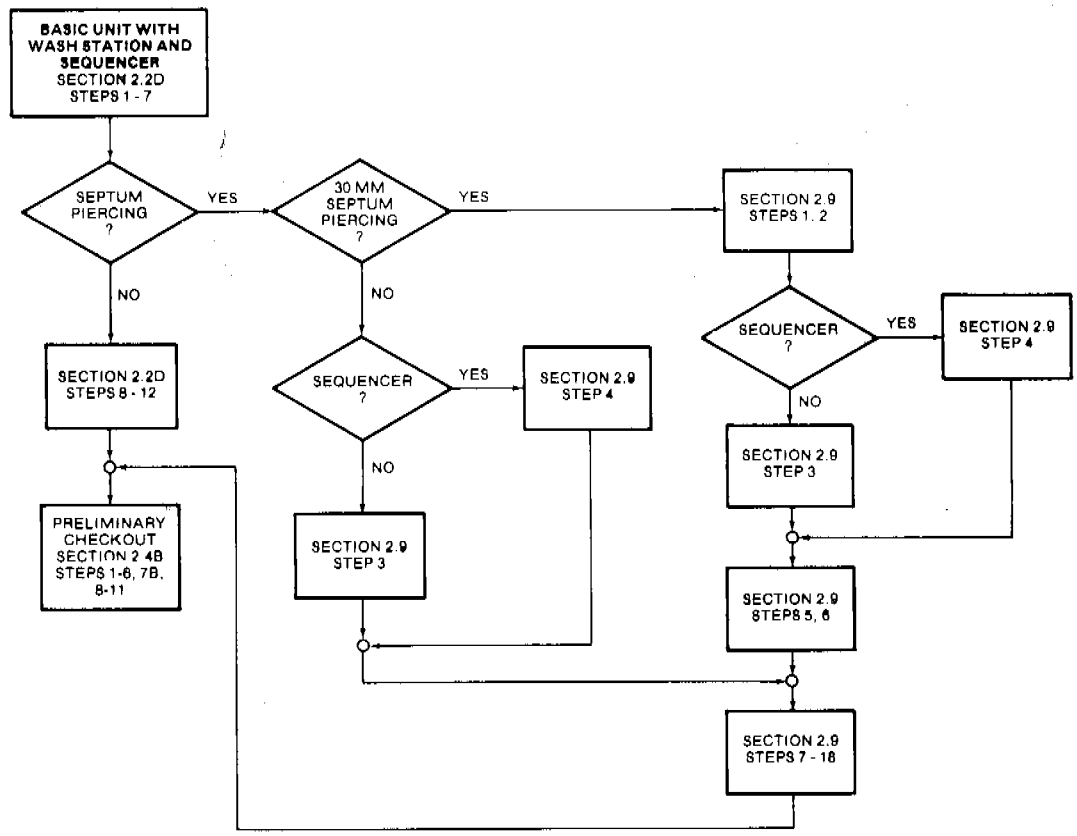
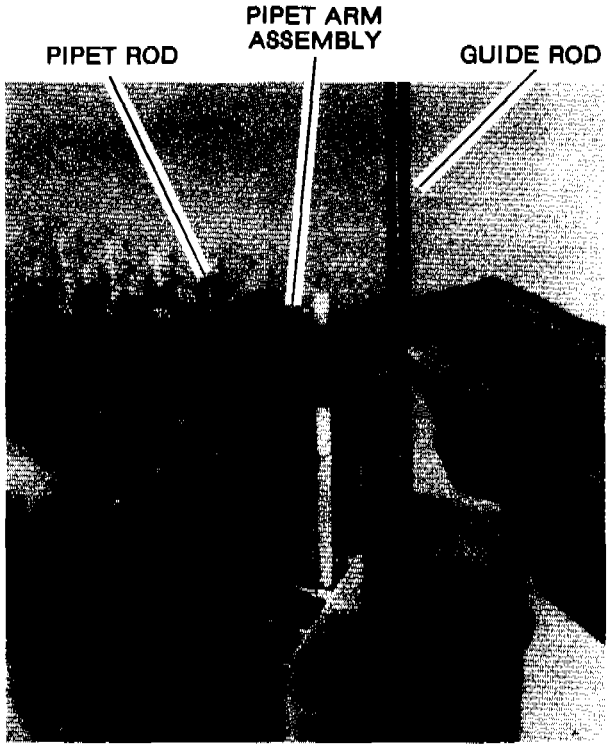


Figure 2-4. Basic Unit with Wash Station and Sequencer Assembly

5. Move the line switch to ON. Racks will advance one sample position. Momentarily short pin 4 to pin 1 on the 15 pin Sub 'D' connector on the rear panel. The pipet rod will lower. Immediately move the line switch to OFF.

6. Insert test tubes in the test tube racks.

7. Mount the pipet arm assembly on the pipet rod, with the guide rod in the slot of the arm. Tighten the knurled screw to secure the arm on the pipet rod, such that the lower plastic nut around the tubing guide clears the test tube by approximately 1/4" (6 mm).



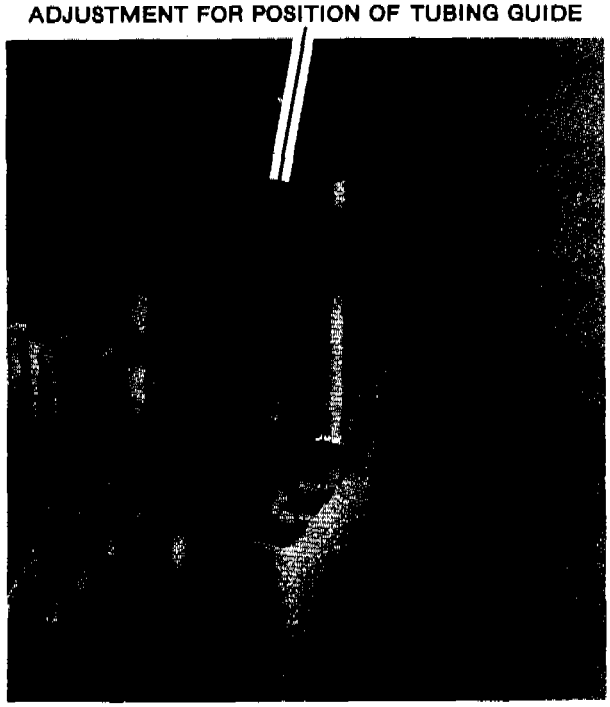
Step 7

8. Tighten the knurled knob holding the tubing guide arm, adjusting the position of the tubing guide so that the guide is in the center of the test tube. Adjust the tubing guide to the desired height (it can be adjusted to reach the bottom of the test tube, or sit just above the top). Insert 0.067" OD tubing of sufficient length to connect to the pump or other aspirating device into the tubing guide through the bottom of the test tube.

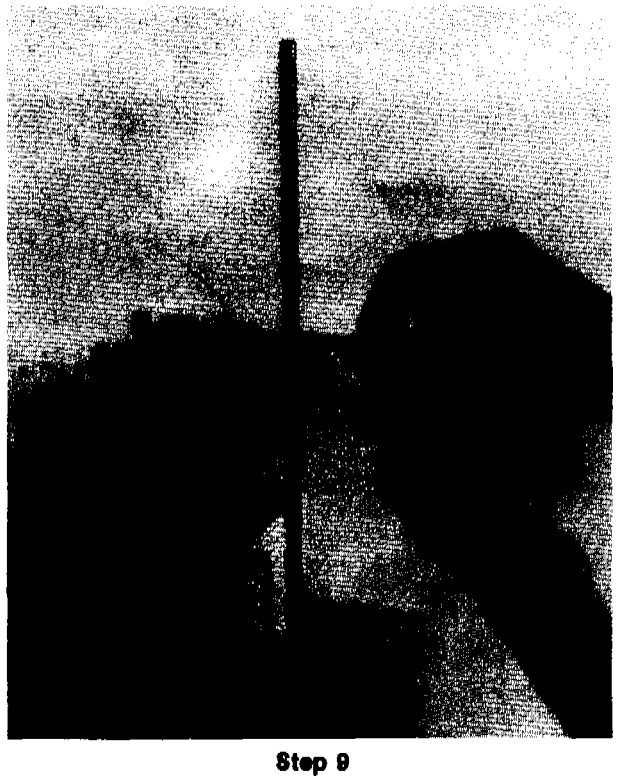
9. Using 3/8" and 1/2" open end wrenches, tighten the lower plastic nut to secure the tubing and tubing guide.

10. Move the line switch to ON. The pipet will raise and the racks will advance one sample position. Move the line switch to OFF. The assembly is complete. Prior to connecting the sampler to a system, complete the preliminary checkout procedure, section 2.4.

ADJUSTMENT FOR POSITION OF TUBING GUIDE



Step 8



Step 9

2.2B Sampler with Sequencer Assembly [66-1290-053] - Refer to Figure 2-2.

1. Insert the pipet rod, threaded end first, approximately 2-1/2" into the rod guide, and screw in snugly. **DO NOT** use pliers or other mechanical advantage. (Refer to section 2.2A, Step 1 photo.)

2. Insert guide rod into guide rod block. Tighten Allen screw with Allen wrench. (Refer to section 2.2A, Step 2 photo.)

3. Insert the test tube racks in the shuttles. Eighteen white racks (eight for 28 mm vial racks) and one red stop rack. Press each rack down firmly to secure it to its shuttle.

Note: The 28 mm vial racks are inserted in every other shuttle. Between the red rack and the first white rack, skip two shuttles.

Note: For septum piercing, see section 2.8.

4. Insert the tubing guide into the pipet arm assembly. (Refer to section 2.2A, Step 4 photo.)

5. Insure that the connector from the sequencer is connected to the 15 pin Sub 'D' connector on the rear of the unit. Move the line switch to ON. Press the MANUAL ADVANCE pushbutton to advance the racks one sample position. After approximately 10 seconds, the pipet rod will lower. Immediately move the line switch to OFF.

6. Insert test tubes in the test tube racks.

7. Mount the pipet arm assembly on the pipet rod, with the guide rod in the slot of the arm. Tighten the knurled screw to secure the arm on the pipet rod, such that the lower plastic nut around the tubing guide clears the test tube by approximately 1/4" (6 mm). (Refer to section 2.2A, Step 7 photo.)

8. Tighten the knurled knob holding the tubing guide arm, adjusting the position of the tubing guide so that the guide is in the center of the test tube. Adjust the tubing guide to the desired height (it can be adjusted to reach the bottom of the test tube, or sit just above the top). Insert 0.067" OD tubing of sufficient length to connect to the pump or other aspirating device into the tubing guide through to the bottom of the test tube. (Refer to section 2.2A, Step 8 photo.)

9. Using 3/8" and 1/2" open end wrenches, tighten the lower plastic nut to secure the tubing and tubing guide. (Refer to section 2.2A, Step 9 photo.)

10. Move the line switch to ON. The pipet will raise and the racks will advance one sample position. Move the line switch to OFF. The assembly is complete. Prior to connecting the sampler to a system, complete the preliminary checkout procedure, section 2.4.

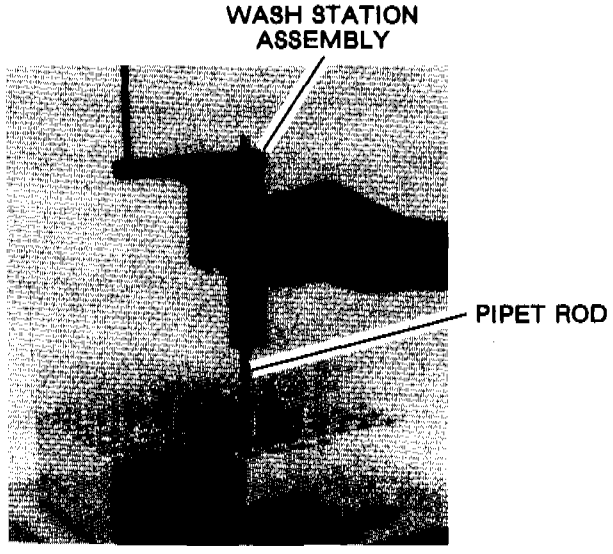
2.2C Sampler with Wash Station Assembly [68-1290-052] - Refer to Figure 2-3.

1. Insert the pipet rod, threaded end first, approximately 2-1/2" into the rod guide, and screw in snugly. **DO NOT** use pliers or other mechanical advantage. (Refer to section 2.2A, Step 1 photo.)

2. Insert test tube racks in the shuttles. Eighteen white racks (eight for 28 mm vial racks), and one red stop rack. Insert test tubes or vials in test tube racks.

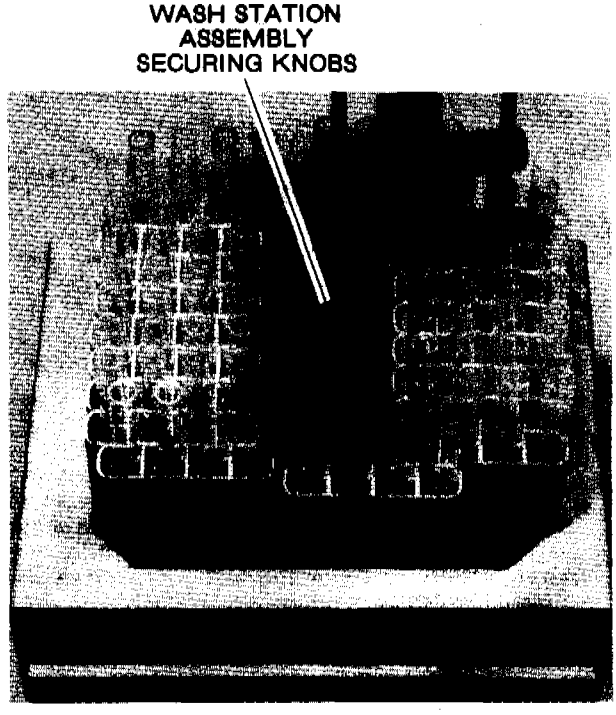
Note: The 28 mm vial racks are inserted in every other shuttle. Between the red rack and the first white rack, skip two shuttles.

3. Place wash station assembly over the pipet rod.



Step 3

4. Insure that the bottom of the wash station assembly rests on the center top plate of the sampler, and secure it in place by finger tightening the two knurled knobs.



Step 4

Note: The wash station may have to be rotated to adjust for proper pipet position in Step 9.

5. Insert the wash vessel in the wash station assembly by sliding it in from the top. The top of the wash vessel should be approximately the same height as the top of the test tubes in the test tube racks. For wash vessel tubing installation refer to the instruction sheet supplied in the Accessory Package, or to section 5.7 of this manual.

Step 5

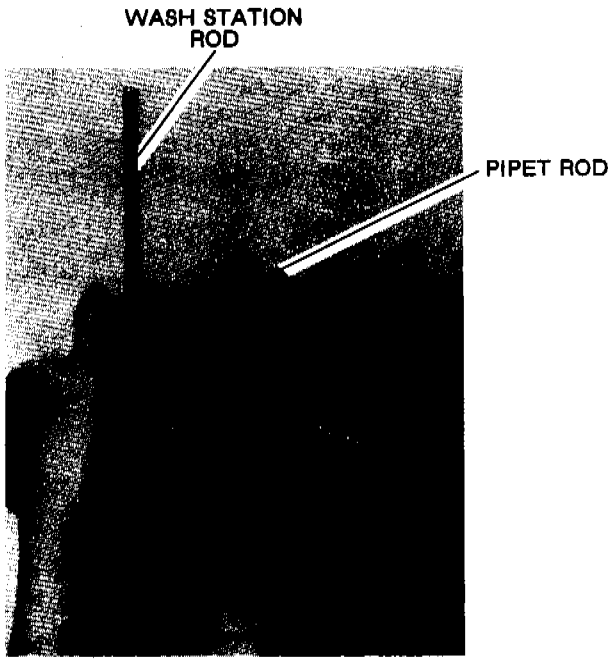
6. Move the line switch to ON. Racks will advance one sample position. Momentarily short pin 4 to pin 1 on the 15 Sub'D' connector on the rear panel. The pipet rod will lower. Move the line switch to OFF.

7. Mount the actuator arm assembly on the wash station rod and the pipet rod. Adjust the height of the actuator arm assembly such that the top of the assembly is even with the top of the pipet rod. Secure the assembly to the pipet rod by tightening the knurled knob.

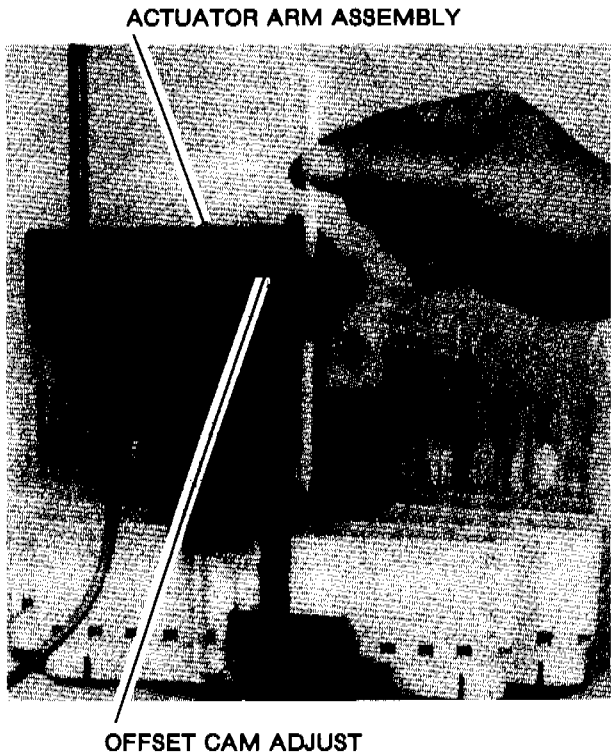
Note: For septum piercing, see section 2.9.

8. Insert the tubing guide through the fitting in the actuator arm and into the test tube to the desired height. DO NOT TIGHTEN THE PLASTIC NUT.

9. If necessary loosen the two knurled knobs securing the wash station and rotate the entire wash station to position the tubing guide in the center of the test tube in the direction parallel with the racks. Adjust the offset cam on the actuator arm to center the tubing guide in the center of the tube in the direction perpendicular to the racks.

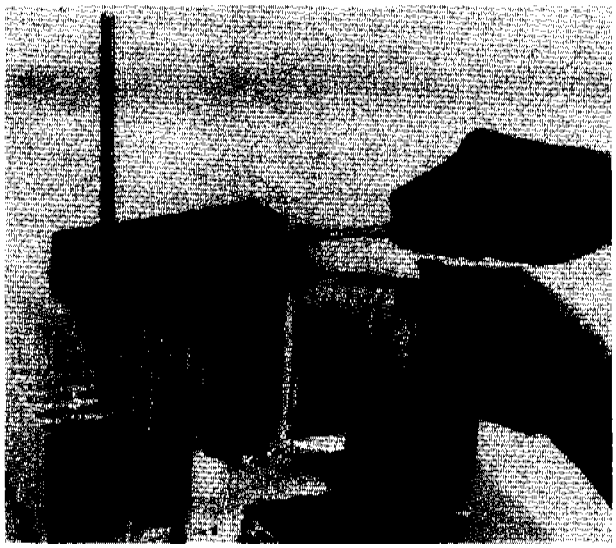


Step 7



Step 8 and 9

10. Insert 0.067" OD tubing of sufficient length to connect to the pump or other aspirating device through the tubing guide into the bottom of the test tube. Using 3/8" and 1/2" open end wrenches, tighten the plastic nut to secure both the tubing guide and the tubing in position.



Step 10

11. Connect the two pin connector from the actuator arm assembly to the two pin jack on the rear of the sampler.

12. Move the line switch to ON. The pipet will raise and the racks will advance one sample position. Move the line switch to OFF. The assembly is complete. Prior to connecting the sampler to a system, complete the preliminary checkout procedure, section 2.4.

Note: For samplers with wash station, peel the backing tape from the "stick on" cable clamp that is on the cable coming from the actuator arm assembly. Position this clamp on the cable and stick it to the rear of the sampler or control sequencer so that the cable is free to follow the movement of the pipet rod without interfering with plumbing and hardware.

2.2D Sampler with Wash Station and Sequencer Assembly [68-1290-054] - Refer to Figure 2-4.

1. Insert the pipet rod, threaded end first, approximately 2-1/2" into the rod guide, and screw in snugly. **DO NOT** use pliers or other mechanical advantage. (Refer to section 2.2A, Step 1 photo.)

2. Insert test tube racks in the shuttles. Eighteen white racks (eight for 28 mm vial racks), and one red stop rack. Insert test tubes or vials in test tube racks.

Note: The 28 mm vial racks are inserted in every other shuttle. Between the red rack and the first white rack, skip two shuttles.

3. Place the wash station assembly over the pipet rod. (Refer to section 2.2C, Step 3 photo.)

4. Insure that the bottom of the wash station assembly rests on the center top plate of the sampler, and secure it in its place by finger tightening the two knurled knobs. (Refer to section 2.2C, Step 4 photo.)

Note: The wash station may have to be rotated to adjust for proper pipet position in Step 9.

5. Insert the wash vessel in the wash station assembly by sliding it in from the top. The top of the wash vessel should be approximately the same height as the top of the test tubes in the test tube racks. (Refer to section 2.2C, Step 5 photo.)

6. Insure that the connector from the sequencer is connected to the 15 pin Sub 'D' connector on the rear of the unit. Move the line switch to ON. Press the MANUAL ADVANCE pushbutton to advance the racks one sample position. After approximately 10 seconds, the pipet rod will lower. Immediately move the line switch to OFF.

7. Mount the actuator arm assembly on the wash station rod and the pipet rod. Adjust the height of the actuator arm assembly such that the top of the assembly is even with the top of the pipet rod. Secure the assembly to the pipet rod by tightening the knurled knob. (Refer to section 2.2C, Step 7 photo.)

Note: For septum piercing, see section 2.9.

8. Insert the tubing guide through the fitting in the actuator arm and into the test tube to desired height. DO NOT TIGHTEN THE PLASTIC NUT. (Refer to section 2.2C, Step 8 photo.)

9. If necessary loosen the two knurled knobs securing the wash station and rotate the entire wash station to position the tubing guide in the center of the test tube in the direction parallel with the racks. Adjust the offset cam on the actuator arm to center the tubing guide in the center of the tube in the direction perpendicular to the racks.

10. Insert 0.067" OD tubing of sufficient length to connect to the pump or other aspirating device through the tubing guide into the bottom of the test tube. Using 3/8" and 1/2" open end wrenches, tighten the plastic nut to secure both the tubing guide and the tubing in position. (Refer to section 2.2C, Step 10 photo.)

11. Connect the two pin connector from the actuator arm assembly to the two pin jack on the rear of the sampler.

12. Move the line switch to ON. The pipet will raise and the racks will advance one sample position. Move the line switch to OFF. The assembly is complete. Prior to connecting the sampler to a system, complete the preliminary checkout procedure, section 2.4.

Note: Peel the backing tape from the "stick on" cable clamp that is on the cable coming from the actuator arm assembly. Position this clamp on the cable and stick it to the rear of the sampler or control sequencer so that the cable is free to follow the movement of the pipet rod without interfering with plumbing and hardware.

2.3 CONTROLS AND CONNECTORS - The controls and connectors for the Sampler are shown in Figure 2-5. Table 2-1 provides a description of each control.

2.4 PRELIMINARY CHECKOUT PROCEDURE -

A. Sampler without Control Sequencer

1. Insure that the leads of the cable connected in section 2.2A, Step 5 or section 2.2C, Step 6 of the assembly procedure are not touching each other.

2. Move the line switch to ON. The pipet should raise if lowered. The racks will advance one sample position.

3. Press the MANUAL ADVANCE pushbutton. The racks should advance one sample position.

4. Momentarily short pin 2 to pin 1. The racks should advance one sample position.

5. Momentarily short pin 4 to pin 1. The pipet should lower.

6. Momentarily short pin 3 to pin 1. The pipet should raise.

7. Momentarily short pin 6 to pin 1. The pipet arm should rotate to the wash vessel (sampler with wash station only).

Note: If rotation is too rapid or sluggish for your application, refer to **Adjustment of Pipet Arm Rotation** in section 5.5.

8. Momentarily short pin 5 to pin 1. The pipet arm should rotate to the sample position (sampler with wash station only.)

9. Momentarily short pin 13 to pin 4. The pipet should lower.

10. Momentarily short pin 12 to pin 2. The pipet should raise, then the racks should advance one sample position.

11. Momentarily short pin 11 to pin 6. Pipet arm should rotate to the wash vessel (sampler with wash station only).

12. Press and hold the MANUAL ADVANCE pushbutton until the last sample position of the red stop rack is at the sampling position.

13. Momentarily short pin 11 to pin 5. No action should occur.

14. Momentarily short pin 13 to pin 5. Pipet should rotate to the sample position (sampler with wash station only).

15. Press and hold the MANUAL ADVANCE pushbutton. Racks should advance to the first sampling position.

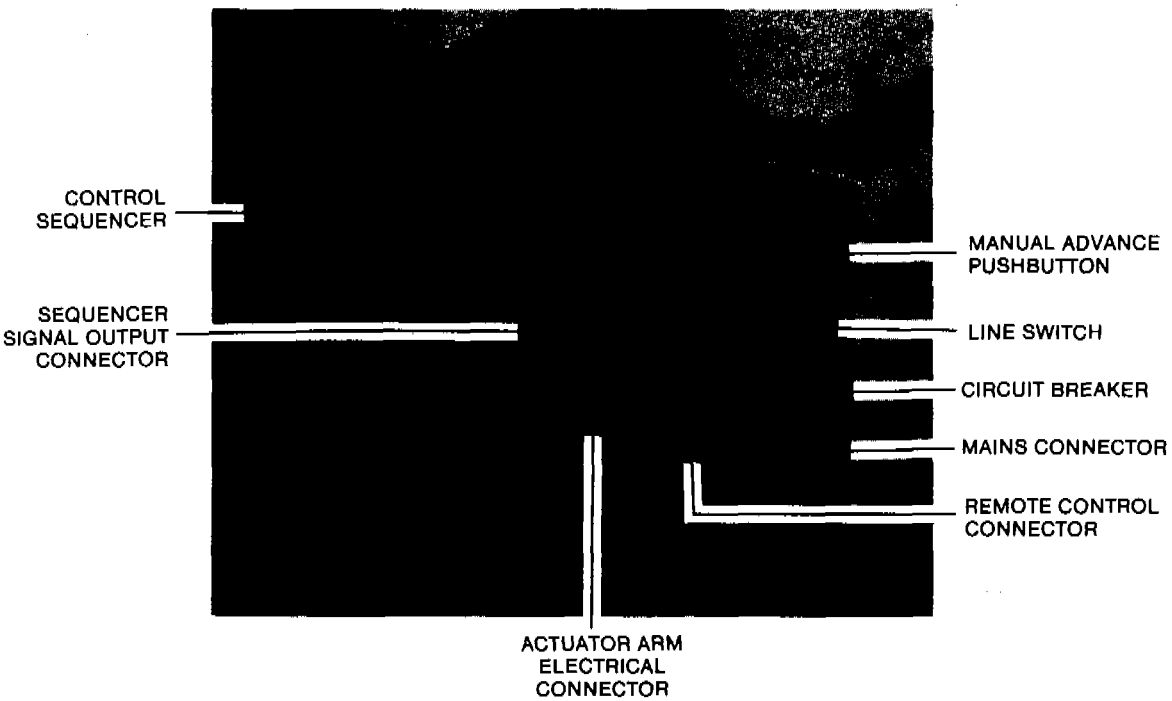


Figure 2-5. Autosampler - Rear View

TABLE 2-1. CONTROLS AND INDICATORS

Nomenclature	Description	Mating Connector	Function
Pipet output (used only on sampler with wash station)	2 pin Cinch plug	2 pin Cinch socket	Connection for rotary control of pipet mechanism
REMOTE CONTROL CONNECTOR	15 pin Sub 'D'	DA15P	Provides input and output interface for remote control of sampler. **Note;** Sampler is shown with the Control Sequencer attached. If Sequencer is used, it is connected to this jack.
MAINS CONNECTOR	3 pin Switchcraft plug	Internal with power cord.	100 Vac, 117 Vac or 234 Vac input to the sampler. **CAUTION** A sampler set up for 100 or 117 Vac operation will be damaged if connected to 234 Vac.
CIRCUIT BREAKERS	Resettable circuit breaker (one 1.5 amp 117 Vac or two 0.7 amp 234 Vac)	N/A	Limits current to sampler from mains. May be pushed to reset, refer to Section 5 if tripping continues.
MANUAL ADVANCE	Momentary push button switch	N/A	Provides means of manually advancing racks to a specific sample or starting position.
OUTPUT SIGNAL CONNECTOR (only samplers with control sequencer)	9-pin Sub 'D' Cinch DE9P	Cinch DE9S	Provides output interface signals to external system.

16. Move the line switch to OFF.

This completes the preliminary checkout of the sampler without Control Sequencer. If checkout was satisfactory, proceed to section 2.5.

B. Sampler with Control Sequencer

1. Remove the four knurled screws securing the cover of the Control Sequencer.

2. For the sampler with a wash station, all four switches on DIP switch S1, should be down. For the sampler without a wash station, S1-1 should be up. For all samplers, set rotary switches S2 to 0, S3 to 3, S4 to 0, and S5 to 2.

3. Replace the cover on the Control Sequencer.

4. Move the line switch to ON. The pipet should raise if lowered. The racks will advance one sample position.

5. Press the MANUAL ADVANCE pushbutton. Racks should advance one sample position.

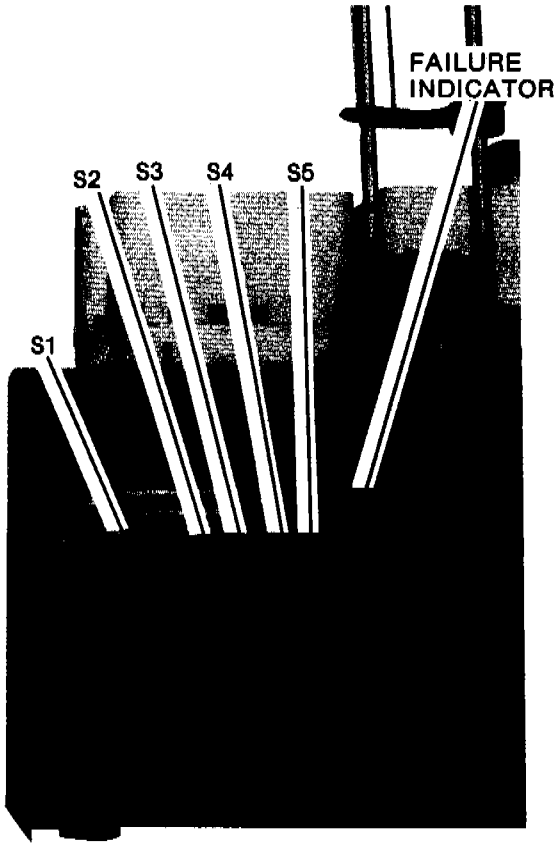
6. Wait approximately 3 seconds, then press the MANUAL ADVANCE pushbutton. Racks should advance one sample position.

7. After approximately 10 seconds the following sequence of sampling should occur.

A. Sampler without Wash Station:

1. pipet should lower into test tube

Note: If anything obstructs the pipet such that it does not completely lower, the pipet will raise and attempt to lower two more times. If the pipet still does not completely lower, the pipet will raise and the unit will stop. The failure indicator on the sequencer circuit board will be illuminated. The line switch must be moved to OFF and then back to ON



Step 2

in order to initiate automatic operation with the MANUAL ADVANCE pushbutton.

2. three second delay

3. pipet should raise

4. two second delay

5. racks should advance one sample position

Note: If rotation is too rapid or sluggish for your application, refer to **Adjustment of Pipet Arm Rotation** in section 5.5.

6. sequence described in steps 1 through 5 should repeat until pipet has raised from the last sample position of the RED stop rack, then the unit should stop operation.

B. Sampler with Wash Station:

1. pipet should rotate to wash vessel

2. pipet should lower into wash vessel

Note: If anything obstructs the pipet such that it does not completely lower, the pipet will raise and attempt to lower two more times. If the pipet still does not completely lower, the pipet will raise and the unit will stop. The failure indicator on the sequencer circuit board will be illuminated. The line switch must be moved to OFF and then back to ON in order to initiate automatic operation with the MANUAL ADVANCE pushbutton.

3. two second delay

4. pipet should raise

5. pipet should rotate to sample position

6. pipet should lower into test tube

7. three second delay

8. pipet should raise

9. pipet should rotate to wash vessel and racks should advance one sample position

10. sequence described in steps 2 through 9 should repeat until pipet has raised from last sample position of the RED stop rack, then the unit should stop operation.

8. Press and hold the MANUAL ADVANCE pushbutton until the sampler has cycled through two or three racks.

9. After approximately a 10 second delay the sampler should commence the sequence described in Step 7.

10. Press the MANUAL ADVANCE pushbutton. Racks should advance one sample position. Sampler should stop operation.

11. Move the line switch to OFF.

This completes the preliminary checkout of the sampler with the Control Sequencer. If checkout was satisfactory proceed to section 2.6.

2.5 INTERFACING TO THE SAMPLER WITHOUT CONTROL SEQUENCER - The autosampler without control sequencer is controlled externally through input control lines. These input control lines are activated by a contact closure between the specific input line and common (pin 1) or by TTL logic low voltage (0 to 0.8 V) with respect to common (pin 1). Inactive inputs will have a voltage of approximately +5 V. Output lines will have a voltage of 2.5 to 5 volts when active and less than 0.8 volts when inactive. Input and output lines and their functions are listed in Tables 1-2 and 1-3.

If the last tube position of the red rack is used for any purpose other than to signal the end of the run, e.g., repeat cycle synchronization; or any time the sampler is indexed off the last tube position of the red rack by external control, the following timing pulses must be used to ensure proper operation:

50 to 100 milliseconds pulse to index the unit from tube-to-tube.

300 to 400 milliseconds pulse to index the sampler off the last tube position of a red rack.

The sampler has a 15 pin Sub 'D' interface connector (Figure 2-6) to connect to controlling equipment.

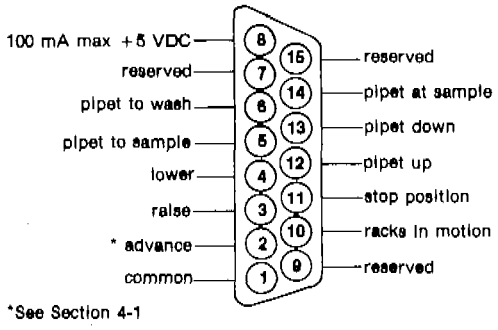


Figure 2-6. Remote Control Connector Pin Configuration

If the sampler is used without the wash station, it can be controlled by only two external signals; the lower signal (pin 4), which will lower the pipet into the sample tube, and the advance signal (pin 2) which will first raise the pipet from the sample tube, and then advance the racks to the next sample.

For example, the single-pole double-throw switch of an injection valve can be connected with pin 1 of the sampler going to the common terminal of the switch, lower (pin 4) to the load sampler position of the switch, and advance (pin 2) to the inject sample position of the switch. The sampler will lower the pipet into the sample whenever the inject valve goes from the inject position to the load sample position, and raise the pipet and advance to the next sample during the injection of the sample just loaded.

Note: With this single switch operation, the inject valve must cycle from load to inject and back to load within 3.5 seconds.

A combination of input signals to control the autosampler and output signals that indicate autosampler status are used to create a sampling sequence. An example sequence for washing and sampling operations is given in Table 2-2.

2.6 INTERFACING TO THE SAMPLER WITH CONTROL SEQUENCER - The microprocessor controlled sequencer available with the sampler provides a pretimed sampling and washing sequence independent of external instrumentation. Three optically isolated outputs provide status signals to external equipment (see Table 1-4). One output indicates when the pipet is down in the sample tube; one when the pipet is down in the wash tube; one when the last sample tube has been sampled.

Sampler Without Wash Station
[see Figure 2-7]
Remove the four knurled screws securing the cover of the control sequencer, DIP switch S1-1 should be in the UP position, and switch S1-2 should be in the DOWN position.

The length of time the pipet will dwell in the sample tube is set by S1-3 and rotary switches S2 and S3. For times less than 100 seconds, S1-3 should be in

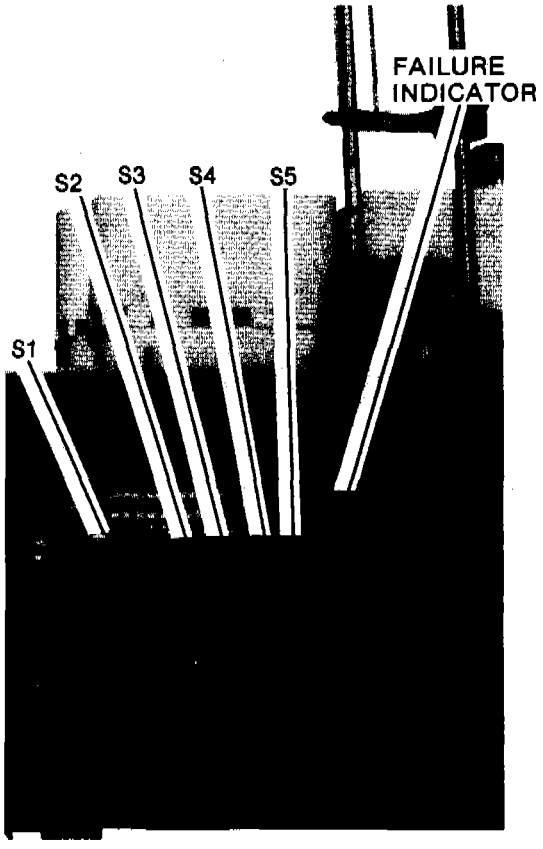


Figure 2-7. Control Sequencer Switches

the DOWN position; set S2 and S3 for the dwell in seconds. For longer dwell periods, up to 990 seconds, S1-3 should be in the UP position; set S2 and S3 for the dwell in units of 10 seconds.

Note: With S1-3 in the UP position, the initial wash, prior to taking a sample will always be 30 seconds. All subsequent washes will be determined by the setting of S2 and S3.

If it is desired to have a delay between samples after the pipet has raised, S1-4 and rotary switches S4 and S5 may be set the same way to generate this delay.

The Control Sequencer has a 9 pin Sub 'D' interface connector (Figure 2-8) to interface with your system. If a delay is selected between samples, the "pipet wash" signal will be generated during this time.

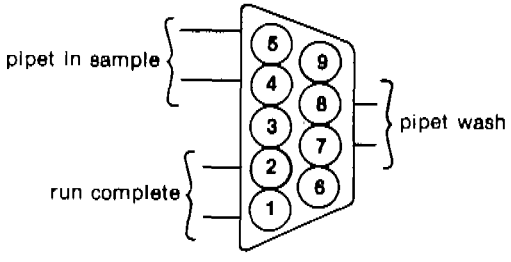


Figure 2-8. Control Sequencer Output Signals

TABLE 2-2. SEQUENCE FOR WASHING AND SAMPLING OPERATIONS

Input Signal [TTL low or a switch closure referenced to pin 1]	Pin#	Action Performed	Output Signal	Pin#
PIPET TO WASH	6	pipet moves to wash position	PIPET AT SAMPLE inactive (less than 0.8 V)	14
LOWER	4	pipet moves down into wash tube	PIPET DOWN active at end of move (greater than 2.4 V)	13
NONE		time delay for wash	PIPET DOWN remains active (greater than 2.4 V)	
RAISE	3	pipet moves up out of wash tube	PIPET UP active at end of move (greater than 2.4 V)	12
PIPET TO SAMPLE	5	pipet moves to sample position	PIPET AT SAMPLE active at end of move (greater than 2.4 V)	14
LOWER PIPET	4	pipet moves down into current sample tube	PIPET DOWN active at end of move (greater than 2.4 V)	13
NONE		time delay for sample	PIPET AT SAMPLE and PIPET DOWN remain active	
RAISE PIPET	3	pipet moves up out of sample tube	PIPET UP active at end of move (greater than 2.4 V)	12
ADVANCE	2	racks advance to next tube	TRAY IN MOTION active during move (greater than 2.4 V)	10

Note: The above sequence may be repeated up to 114 times, sampling the 114 sample tubes, until the last sample tube of the RED rack has be sampled.

Sampler with Wash Station
[see Figure 2-7]

Remove the four knurled screws securing the cover of the Control Sequencer. DIP switch S1-1 should be in the DOWN position, and switch S1-2 should also be in the DOWN position.

The length of time the pipet will dwell in the sample tube is set by S1-3 and rotary switches S2 and S3. For times less than 100 seconds, S1-3 should be in the DOWN position; set S2 and S3 for the dwell in seconds. For longer dwell periods, up to 990 seconds, S1-3 should be in the UP position; set S2 and S3 for the dwell in units of 10 seconds.

The length of time the pipet will dwell in the wash is set by S1-4 and rotary switches S4 and S5 in the same manner.

The Control Sequencer has a 9 pin Sub 'D' interface connector (Figure 2-8) to interface with the system.

Plumbing
Connect the tubing from the tubing guide of the sampler to the aspirator of your system.

The flow through wash vessel should be plumbed with 3/16" (4 mm) ID tubing, with the upper port going to waste, and the lower port going to either a spare channel in the peristaltic pump used to aspirate the sample, or to a gravity feed system. Flow through the wash vessel should be adjusted fast enough such that a complete change of fluid is made between each sample, yet low enough such that the vessel will not overflow.

2.7 OPTIONAL ACCESSORIES -

Sample Racks
Table 2-3 lists the sample racks shown in Figure 2-9,

TABLE 2-3. SAMPLE RACKS AVAILABLE

Tube Size	Tubes/Racks	Total Sample Capacity
10-13 mm*	6	114
10-16 mm*	4	76
18 mm Vials*	4	76
28/29 mm Vials**	3	27
[redacted] †	6	114
AutoSampler ††	6	114

*Maximum tube length 100 mm
**Racks are loaded in every other shuttle; maximum tube length 76 mm.
+ Vials 10.5 mm dia. X 40 mm high
+ + HPLC Vials 11.7 mm dia. X 34 mm high

which are available for the sampler. Racks can be easily changed during operation of the sampler to remove filled tubes and replace them with empty ones. Racks are fitted to their shuttles by pressing the sockets on the bottom of the racks onto the posts on the shuttles. Note that the two posts are different sizes, thus allowing the racks to fit onto the shuttles in only one direction. When changing rack types, no adjustment of the optical position sensing mechanism need be made. The optical sensor which positions the tubes under the pipet will function properly even when different rack types are mixed or if racks are missing. The rack base will rotate to allow the rack to stand on a flat surface.

2.8 30 mm AND 100 mm SEPTUM PIERCING ACCESSORY FOR BASIC UNITS - This accessory converts the pipet arm of the basic unit to accept a septum piercing needle (supplied). With this accessory installed the sampler is capable of piercing the septa listed in Table 2-4 and shown in Figure 2-10.

Note: Steps 1 through 6 apply to additional set up required when septum piercing 30 mm reacti-vials, where a shorter pipet rod travel is required. Section 5.6 covers installation of Teflon® tubing onto needles.

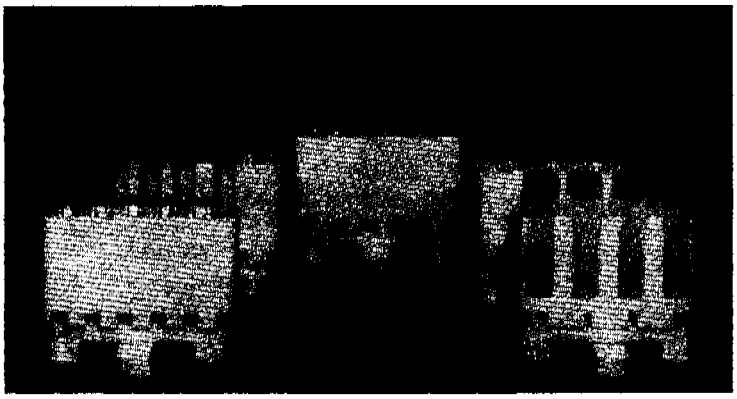
Note: Note the position of the adjust plug. Step 1 is reversed to return to a 4'' pipet rod travel.

1. Disconnect unit from the power mains. On the bottom side of the unit, remove the adjust plug, insert spacer (#60-1293-361), and replace the adjust plug. This is easiest done with the pipet rod in the up position.

Note: If the adjust plug is turned too far in, the pipet rod travel is shortened; if not far enough, the unit may be noisy when the pipet rod reaches its lower limit of travel.

Step 1

*Trademark of E.I. du Pont de Nemours & Co., Inc.



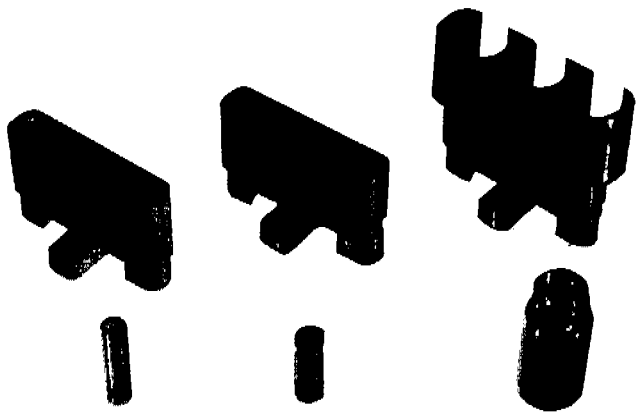


Figure 2-9. Sample Racks

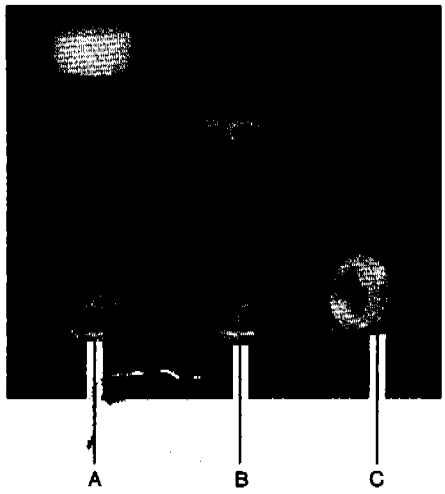


Figure 2-10. Recommended Vials and Septa
(See Table 2-4 below)

TABLE 2-4. RECOMMENDED VIALS AND SEPTA
See Figure 2-10

Isco Part Number	Vial Description	Rack Part Number
(A) 68-1297-056	Conical bottom 2 ml polypropylene vial with polyethylene threaded cap	68-1297-042
(B) 68-1297-057	Flat bottom glass 2 ml vials with polypropylene push-on cap	68-1297-042
(C) 68-1297-058	Polypropylene push-on caps (as above) for 12 mm ID tubes or vials	68-1297-042, 68-1107-020 or 68-1107-025

Available from: Isco, Inc.
4700 Superior Street
Lincoln, Nebraska 68504

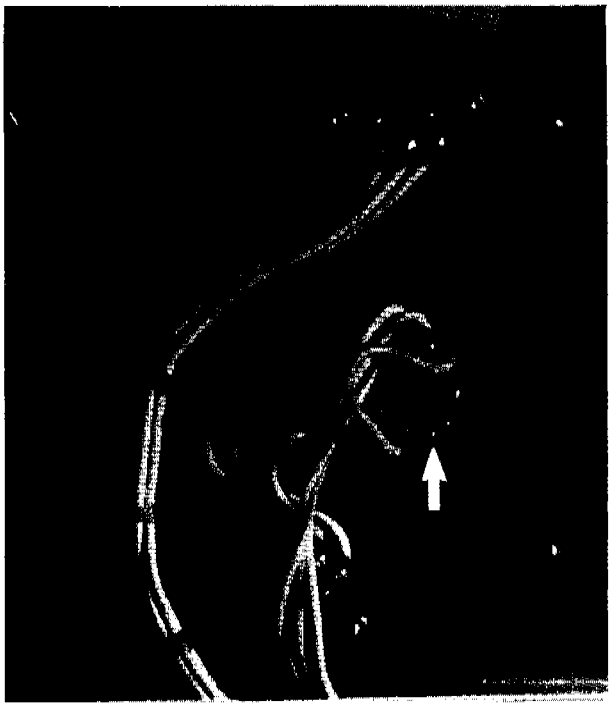
2. Lower the pipet rod (refer to steps 3 and 4).

3. For samplers without the Control Sequencer, move the line switch to ON. Racks will advance one sample position. Momentarily short pin 4 to pin 1 on the 15 pin Sub 'D' connector on the rear panel. The pipet rod will lower. Immediately move the line switch to OFF.

4. For samplers with Control Sequencer, insure that the connector from the sequencer is connected to the 15 pin Sub 'D' connector on the rear of the unit. Move the line switch to ON. Press the MANUAL ADVANCE pushbutton to advance the racks one sample position. After approximately 10 seconds, the pipet rod will lower. Immediately move the line switch to OFF.

5. Remove the case top. On the middle sensor circuit board located on the motor mount, disconnect the yellow jumper from the pin second from the right and connect it to the adjacent pin as indicated by the arrow.

Note: Reverse Steps 1 and 5 to return to a 4'' pipet rod travel.

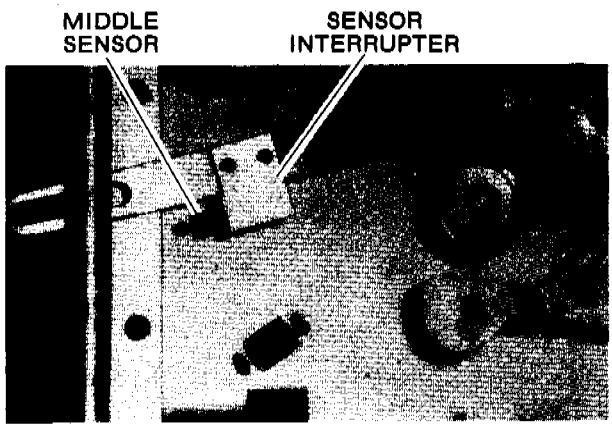


Step 5

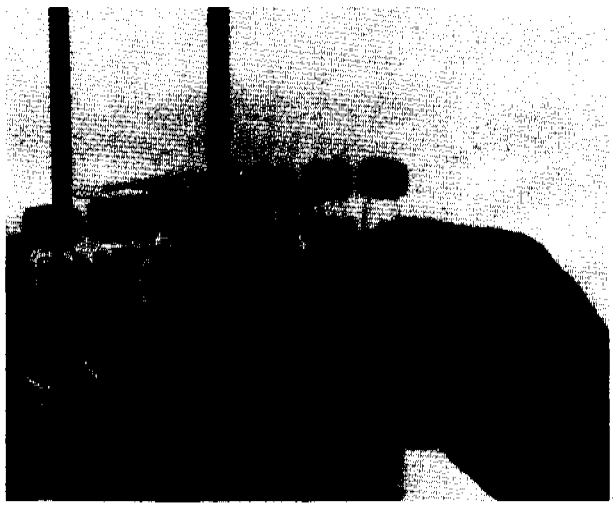
6. Check that the sensor interrupter is at the center of the middle sensor. If not, adjust the adjust plug accordingly (see Step 1 photo). Replace the case top.

7. Insert test tubes or vials in the test tube racks.

8. Mount the hold down foot on the pipet guide rod such that the foot clears the test tubes by approximately 0.08" (2 mm). Tighten with Allen wrench.



Step 6



Step 8

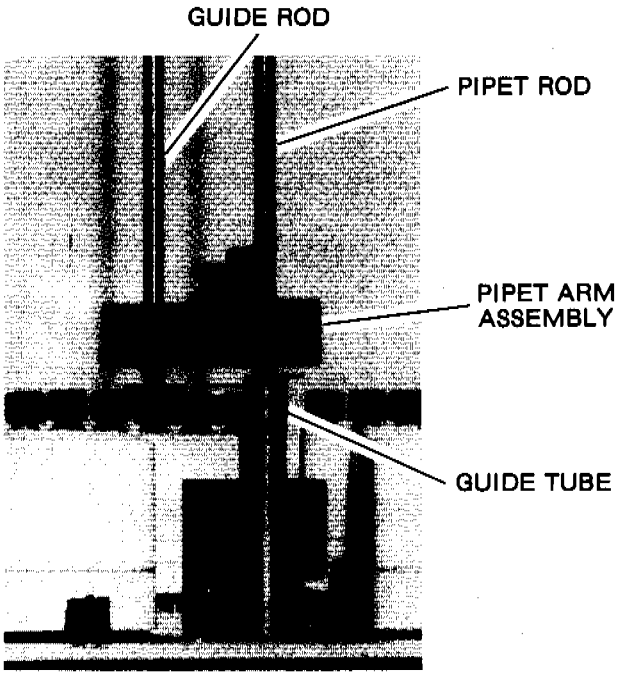
9. Mount the pipet arm assembly, supplied in the septum piercing package between the pipet rod and the guide rod. Tighten the thumbscrew securing the assembly to the pipet rod approximately 1/8 inch (3 mm) above the guide tube.

10. Install the needle so that it protrudes 80 mm (35 mm for the 30 mm septum piercing accessory) from the bottom of the ferrules.

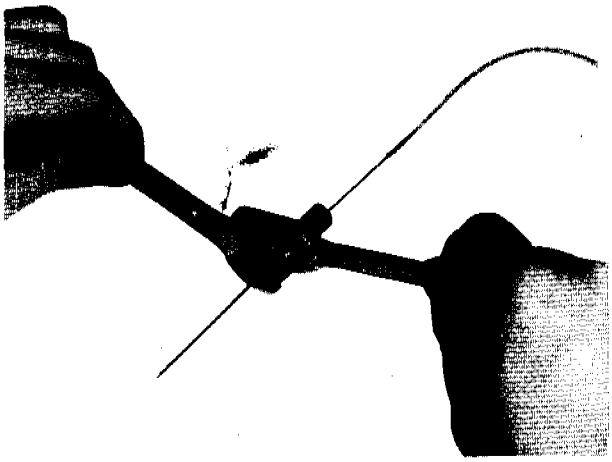
11. Secure the needle in position by tightening the plastic nut using 3/8'' and 1/2'' open end wrenches. To facilitate tightening, remove the pipet guide arm from the pipet arm assembly.

12. Remount the pipet guide arm. Adjust the position of the pipet guide arm so the needle is in the center of the test tube or vial, and tighten the knurled knob.

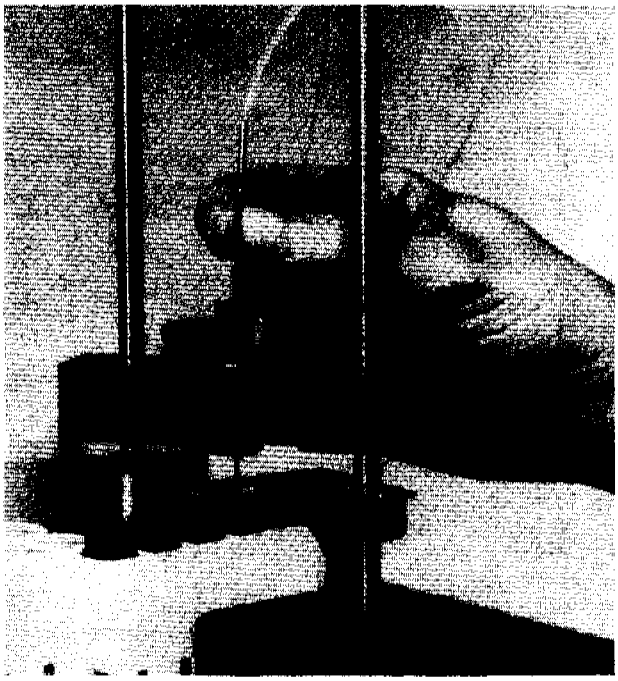
13. Move the line switch to ON. The pipet will raise and the racks will advance one sample position. Move the line switch to OFF. The assembly is complete. Prior to connecting the sampler to a system, complete the preliminary checkout procedure, section 2.4.



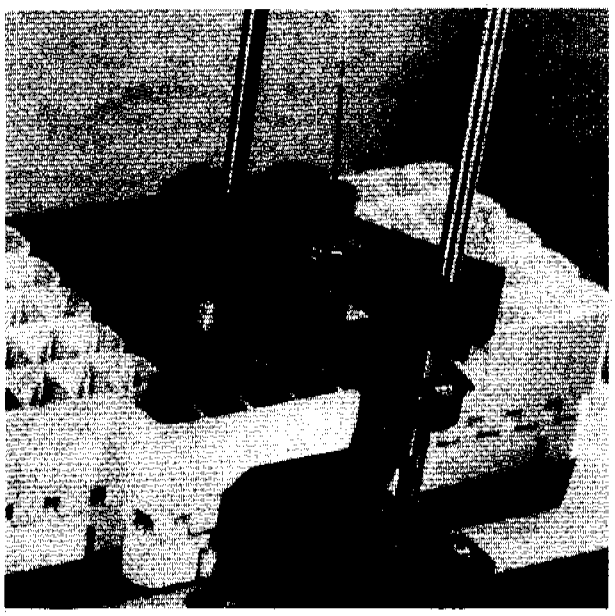
Step 9



Step 11



Step 10



Step 12

2.9 30 mm AND 100 mm SEPTA PIERCING ACCESSORY FOR UNITS WITH WASH STATION - This accessory converts the actuator arm of units with wash station to accept a septum piercing needle (supplied). With this accessory installed the sampler is capable of piercing the septa listed in Table 2.4, and shown in Figure 2-10.

Note: Steps 1 through 6 apply to additional set up required when septum piercing 30 mm reacti-vials, where a shorter pipet rod travel is required. Section 5.6 covers installation of Teflon tubing onto needles.

Note: Note the position of the adjust plug. Step 1 is reversed to return to a 4" pipet rod travel.

1. Disconnect unit from the power mains. On the bottom side of the unit, remove the adjust plug, insert spacer (#60-1293-361), and replace the adjust plug. This is easiest done with the pipet rod in the up position. (Refer to section 2.8, Step 1 photo.)

Note: If the adjust plug is turned too far in, the pipet rod travel is shortened; if not far enough, the unit may be noisy when the pipet rod reaches its lower limit of travel.

2. Lower the pipet rod (refer to Steps 3 and 4).

3. For samplers without the Control Sequencer, move the line switch to ON. Racks will advance one sample position. Momentarily short pin 4 to pin 1 on the 15 pin Sub 'D' connector on the rear panel. The pipet rod will lower. Immediately move the line switch to OFF.

4. For samplers with Control Sequencer, insure that the connector from the sequencer is connected to the 15 pin Sub 'D' connector on the rear of the unit. Move the line switch to ON. Press the MANUAL ADVANCE pushbutton to advance the racks one sample position. After approximately 10 seconds, the pipet rod will lower. Immediately move the line switch to OFF.

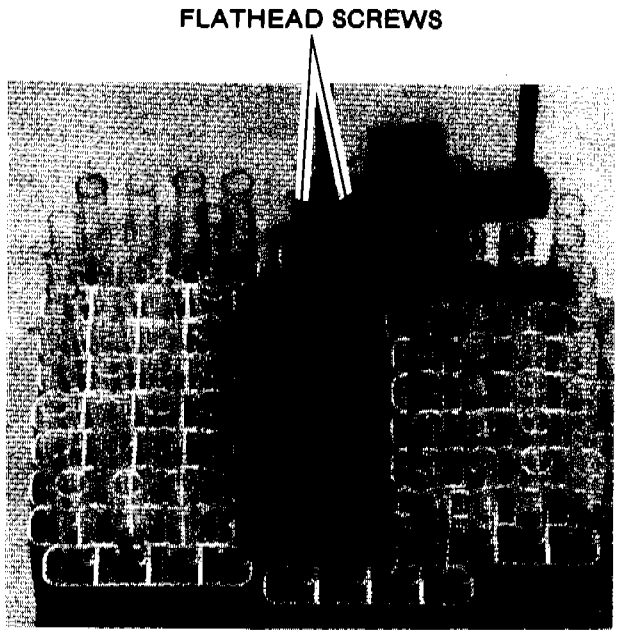
5. Remove the case top. On the middle sensor circuit board located on the motor mount, disconnect the yellow jumper from the pin second from the right and connect it to the adjacent pin as indicated by the arrow. (Refer to section 2.8, Step 5 photo.)

Note: Reverse Steps 1 and 5 to return to a 4'' pipet rod travel.

6. Check that the sensor interrupter is at the center of the middle sensor. If not, adjust the adjust plug accordingly. Replace the case top. (Refer to section 2.8, Step 6 photo.)

Note: Step 7 is specifically for 30 mm reacti-vials using an actuator arm assembly.

7. Remove the guide tube from the wash station by removing the two flat head screws. Replace the guide tube with the short one supplied with the 30 mm septum piercing assembly for units with wash station.



Step 7

8. Insert test tubes or vials in the test tube racks.

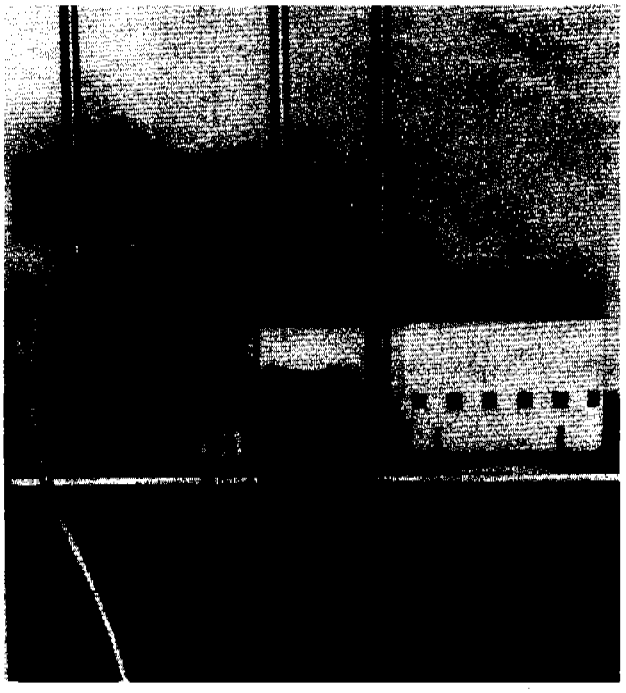
9. Mount the hold down foot on the pipet guide rod such that the foot clears the test tubes by approximately 0.08" (2 mm). Tighten with Allen wrench.

Step 9

10. Remove the bulkhead fitting installed on the actuator arm assembly. Install the bulkhead fitting supplied with the septum piercing assembly.

Note: For the easiest installation and removal, install the bulkhead fittings with the longer threaded end up and through the arm, fastened on the top side with the 3/8'' control nut. A plastic nut and TPR ferrule on the shorter threaded end (underneath the arm) will secure the needle. An additional nut and ferrule may be used above the control nut to further secure the needle, however, this should be unnecessary.

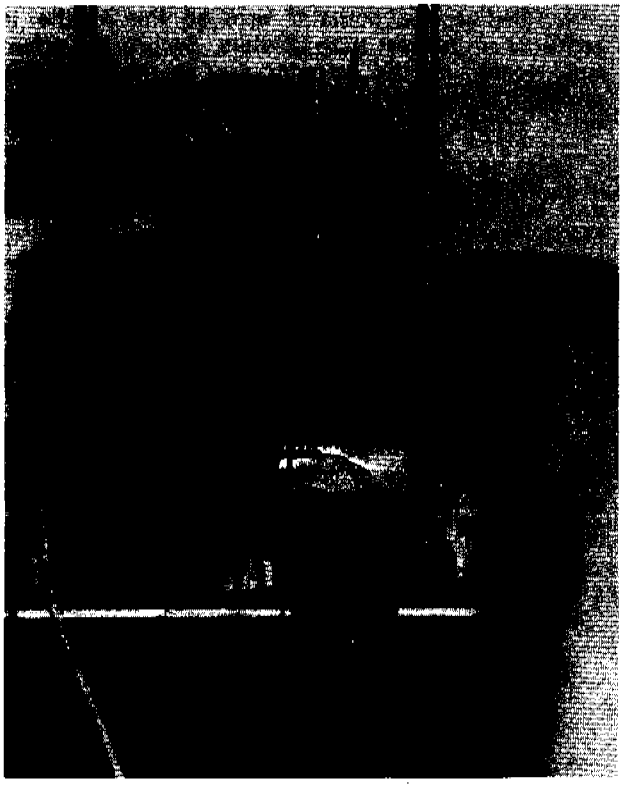
11. Mount the actuator arm assembly on the pipet rod and the wash station guide rod. Adjust actuator arm assembly height such that it is approximately 1/4" above the wash station arm. Secure the assembly to the pipet rod by tightening the knurled knob.



Step 11

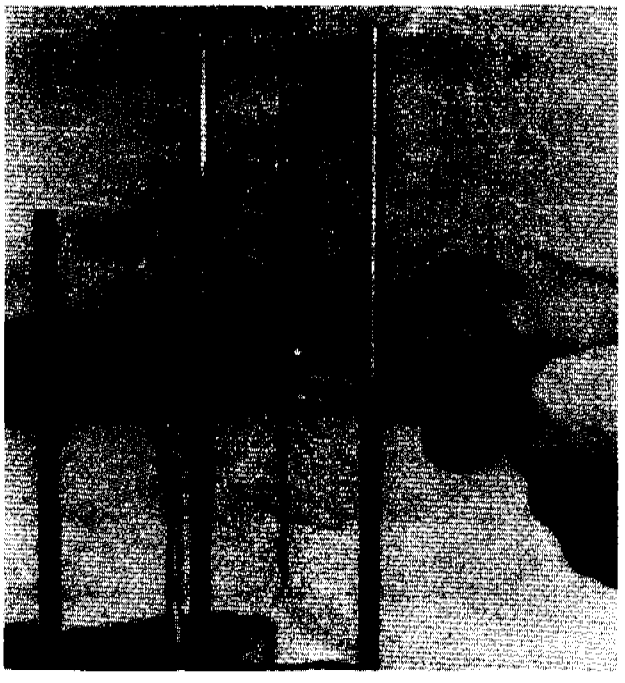
Note: Step 12 is applicable only if the test tubes or the vials and their caps are shorter than the pipet rod travel. If not, raise the pipet (move the line switch to OFF and then back to ON), and install the needle with its point slightly above the hold down foot. Finger tighten the plastic nut.

12. Install the needle to the desired position near the bottom of the test tube or vials. Do not install through the septa at this time. Finger tighten the plastic nut. Raise the pipet rod (move the line switch to OFF and then back to ON). Install the needle with its point slightly above the hold down foot. Finger tighten the plastic nut.



Step 12

13. Secure the needle in position by tightening the plastic nut using 3/8" and 1/2" open end wrenches.



Step 13

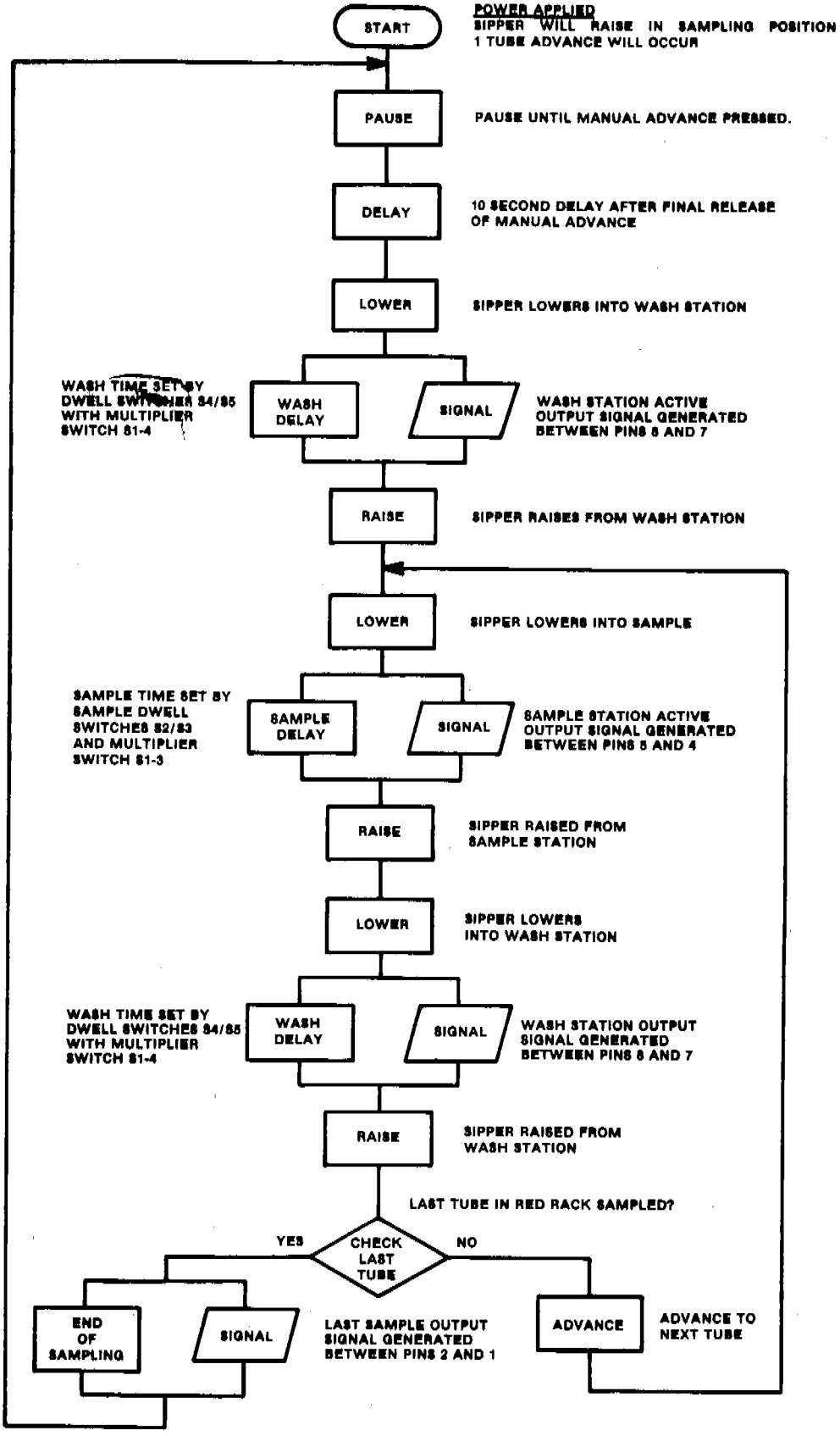


Figure 3-1. Sequence for the Autosampler with Sequencer and Wash Station

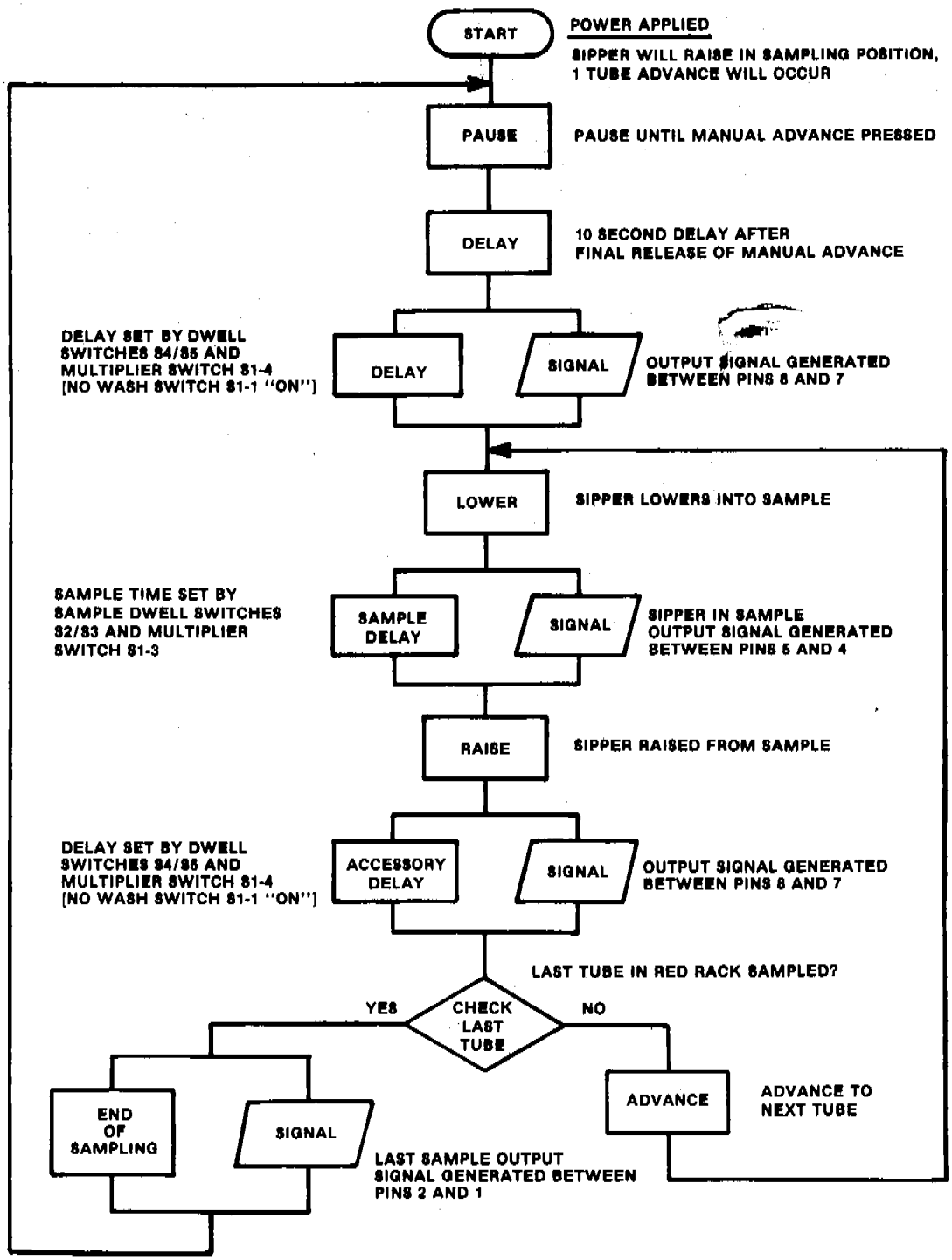


Figure 3-2. Sequence for the Autosampler with Sequencer and without Wash Station

4.1 DETAILED THEORY OF OPERATION [Refer to schematic, Figure 4-1] -

Power Supply
The +12 ± 20% and +5 ±5% DC supplies are derived from the 12 Vac rms secondary of the power transformer. This AC potential is rectified by diodes CR201 and CR202 and filtered by capacitor C201. Voltage regulator HY201 provides the +5 volt supply at a maximum external current draw of 100 mA.

Logic Circuit - Power Up
Upon power up, transistor Q102 will conduct briefly as determined by RC time constant of capacitor C113 and resistors R121 and R120. This sets three flip-flops consisting of HY106A/HY106B, HY104D/HY104C and HY106C/HY107B. Pin 12 of HY106A, Pin 8 of HY104D and Pin 8 of HY106C will be set high (+5 Vdc).

Tray movement by the 117 Vac tray motor B1 is controlled by Triac Q201. The motor actuation sequence is as follows: When Pin 12 of HY106A is set high and HY107C is high by previously set Pin 8 of HY106C and the pipet is in the "up" position, Pin 3 of HY107A will go low. Output Pin 8 of HY105D will then go low. This turns off Q203 which turns on Q206 and Q207 providing the gate voltage to Triac Q201.

The tray motor will run, moving the test tube racks past the sensor assembly mounted on the rear of the sampler. The circuit designations of the optical sensors are U1 and U2. As a rectangular hole reaches the sensor assembly Pin 9 of HY108F will drop low. HY108F and HY108E are wired as a Schmidt trigger to supply a fast rise and fall time of the sensor signal to Pin 4 of HY103B. As the hole in the tube rack reaches the sensor Pin 6 of HY103B will go low, holding Pin 8 of HY105D low causing the motor to continue running and resetting flip-flop HY106 A and B. As the trailing edge of the hole reaches the sensor assembly Pin 9 of HY108F will go high, Pin 6 of HY103B will go high causing Pin 8 of HY105D to go high thus turning on Q203 which will turn off Q206, Q207 and Q201 stopping the motor.

If upon power up the pipet is down it must first rise before the tray motor is allowed to run. Nand gate HY107D forces the pipet up on tray advance if the pipet is down at sample position. Nand gate HY107C prevents tray from moving if the pipet is down at sample position. When Q102 sets the three flip-flops, Pin 8 of HY104D goes high and Pin 11 of HY104C goes low. Two inverters HY102E and HY102G supply the logic states of the "up" and "down" optical sensors. When the pipet is down Pin 12 of HY102G will be low and a high will be found on Pin 14 of HY102E. Pins 9 and 10 of HY103D will then go high causing output Pin 8 to also be high. Pin 3 of HY104A will then go low forcing Pin 3 of HY101 high, thus turning on Q205, Q208, Q202 and pipet motor B2. The motor will run until a flag on the pipet arm interrupts "up" optical sensor U301. Sensor output to Pin 6 of HY102E will go high supplying a low on Pin 2 of HY105A shutting off the motor. The same low to Pin 2 of HY105A is also supplied to Pin 13 of HY107C thus allowing tray motor B1 to advance to the next tube.

Advancing Tray Motor
To advance the tube racks a contact closure or logic level low is applied across Pins 1 (circuit common) and 2 of the 15 pin rear panel connector. This low is applied to Pin 1 of HY106A setting its output Pin 12 high and forcing the tray motor to run in the same manner as described in the power up section.

If the last tube position of the red rack is used for any purpose other than to signal the end of the run, e.g., repeat cycle synchronization; or any time the sampler is indexed off the last tube position of the red rack by external control, the following timing pulses must be used to ensure proper operation:

50 to 100 milliseconds pulse to index the unit from tube-to-tube.

300 to 400 milliseconds pulse to index the sampler off the last tube position of a red rack.

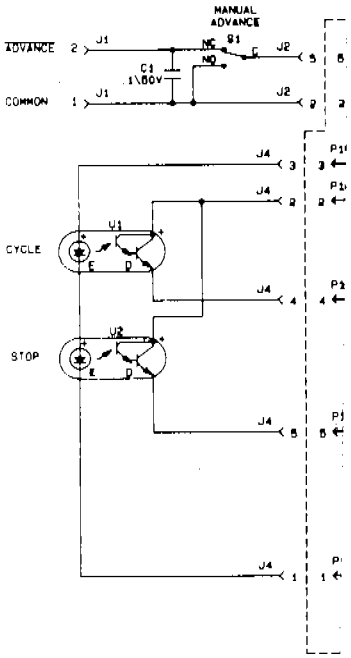
Lowering Pipet
A contact closure or logic level low is applied across Pins 1 (circuit common) and 4 of rear panel 15 pin connector. This low is applied to Pin 13 of HY104C whose output Pin 11 will go high causing Pin 8 HY104D to go low. Pin 4 of HY105B will also be high forcing its output Pin 6 high. Similarly Pin 1 of HY105A will go low forcing Pin 3 HY105A high. Output Pin 8 of HY103D will go high forcing output Pin 3 HY104A low turning on the pipet motor via HY101 and Triac Q202. The pipet motor will continue to run until the "down" sensor U401 is interrupted. This will force Pin 12 of HY102G low turning off the pipet motor.

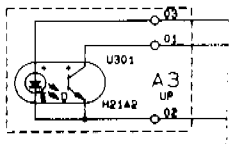
Raising Pipet
This is accomplished by applying a contact closure or logic level low across Pins 1 (circuit common) and 3 of the rear panel 15 pin connector. The circuit operates the same as lowering the pipet as previously discussed except a low is applied to Pin 13 of HY105C.

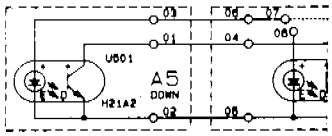
Pipet to Wash
The pipet is rotated to the wash station by applying a contact closure across Pin 1 (circuit common) and Pin 6 of the rear panel 15 pin connector, or a logic level low, referenced to Pin 1, to Pin 6.

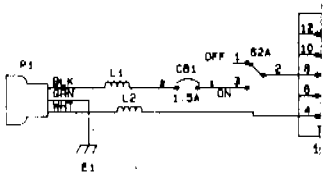
This low is applied to Pin 1 of HY103A whose output Pin 3 will go low forcing Pin 8 of HY106C low if the pipet is up. This low is applied to the base of transistor Q204 turning it off which will turn on Q210. This will allow current amplifier Q209, Q211 to supply current to the solenoid, energizing it and rotating the pipet arm to the wash station.

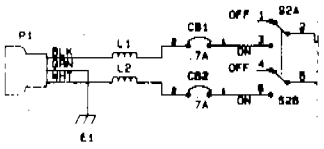
Pipet to Sample
A contact closure or logic level low applied across Pins 1 (circuit common) and 5 will cause the pipet arm to rotate back over the sample. This low is applied to Pin 13 HY103C whose output will go low

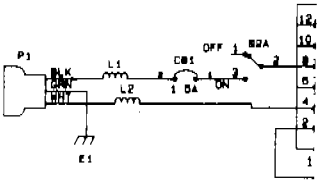






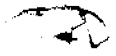






1. UNLESS OTHERWISE SPECIFIED, CAPACITO
VALUES ARE DENOTED IN MICROFARADS.

11-88 ✓



15 PIN CONNECTOR Pin	BUFFER	STATUS Signal
10	HY102C	Tray in motion
11	HY102B	Last position of red rack
12	HY102F	Pipet is up
13	HY102H	Pipet is down
14	HY102D	Sample or Wash

Pin 10 - Logic level high during the time tray motor is moving
Pin 11 - Logic level high when last tube position is reached
Pin 12 - Logic level high when the pipet is at its "up" position
Pin 13 - Logic level high when the pipet is at its "down" position
Pin 14 - Logic level high when the pipet is over the sample tube.
Conversely, this output will be low whenever the pipet is over the wash vial.

setting flip-flop HY106C and HY107B. Pin 8 of HY106C will be high causing transistor Q204 to conduct turning off the current source consisting of Q209 and Q211. The solenoid will then de-energize. Note that when rotating the pipet arm it must be at the up position. This is accomplished by disabling HY103C and HY103A Pins 12 and 2 if these pins are high. They are low only when the pipet is up.

Five buffered outputs are providing status signals available at the 15 pin rear panel connector. Listed above are pin numbers of the 15 pin rear panel connector with the description of these status signals.

Control Sequencer [Refer to Schematic, Figure 4-2] The central processing unit of the sequencer is an 8748 CPU with 1K ROM and 64 bits of RAM.

Output ports DB0 through DB7 serve to communicate with outside instrumentation. Data bus lines DB3 - DB7 are active low lines to control the 5 functions of the sampler. The five functions are:

ADVANCE	DB7	(advance tube racks)
RAISE	DB6	(raise pipet)
LOWER	DB5	(lower pipet)
PIPET TO SAMPLE	DB4	(move wash solenoid nold to sample)
PIPET TO WASH	DB3	(move wash solenoid to wash)

The remaining data bus lines, DB0 - DB2 (active low) are used to sink the LED current for the three optoisolators HY4, HY5 and HY6. The isolators serve to supply completely isolated active low outputs to inform outside instrumentation of the status of operation of the sampler. For example, when the last tube position of the stop rack is in front of the tube rack sensors of the sampler, Pin 12 of HY3 (8748) will be low. This will sink current for the optoisolator HY4 thus allowing the transistor of HY4 to conduct.

Four (internal to the sequencer) output ports P10-P13 supply data to BCD-to-decimal decoders HY1 and HY2. The open collector output of the 74145 decoders feed into the switches S2, S3, S4 and S5. This low going signal coupled through the switches is fed back into the CPU chip on Pins 36 and 37.

The status lines of the sampler informing the sequencer where the sampler is at any one time (racks in motion, etc.) are found at ports P20, P21, P22, P23 and P27.

The four bit switch S1 is simply four on/off switches.

1. Switch S1-1 (NO WASH) when in on position pulls Pin 6 of CPU low thus the wash station solenoid will not be energized.

2. Switch S1-2 (TEST) must be left in off position as it is used during fabrication of the circuit.

3. Switch S1-3 in the on position will multiply (by a factor of 10) time entered in the sample dwell switches S2 and S3.

4. Switch S1-4 in the on position will multiply (by a factor of 10) time entered in the accessory dwell time switches S4 and S5.

4.2 GENERAL OPTICAL SENSOR INFORMATION - Five individual optical sensors are incorporated in the sampler. Three sensors detect the sipper rod position and the other two sensors detect the position of the tube racks.

Referring to the schematic, Figure 4-1, the five optical sensors are depicted as circuit designations U1, U2, U301, U401 and U501. Sensor U301 signals the logic circuitry when the pipet is at its "up" position. U401 detects the pipet when it is at its "down" position. U501 detects the down position when the sampler is set up for septum piercing. The LED in each sensor U301, U401 and U501 emits light in the infrared range when 20 mA flows through the LED. When the flag, mounted on the pipet arm, interrupts the sensor the phototransistor will not conduct because it is not receiving light from the LED. Its collector will then rise to the 5 volt supply as measured at Pin 1 of the optical sensor printed circuit board or Pin 8 of HY102G (down) and Pin 6 of HY102E (up). When the flag is not interrupting the sensor, the phototransistor will conduct and its collector will drop to 0 volts.

Optical sensors U1 and U2 are described in more detail in the electrical adjustment section 5.1. The LED current supply differs from the up/down sensors in that the LED's are in series. A 10 volt supply, derived from zener diode CR103 is applied to the anode. Saturated transistor Q103 and emitter resistor R122 supplies a 40 mA constant current source.

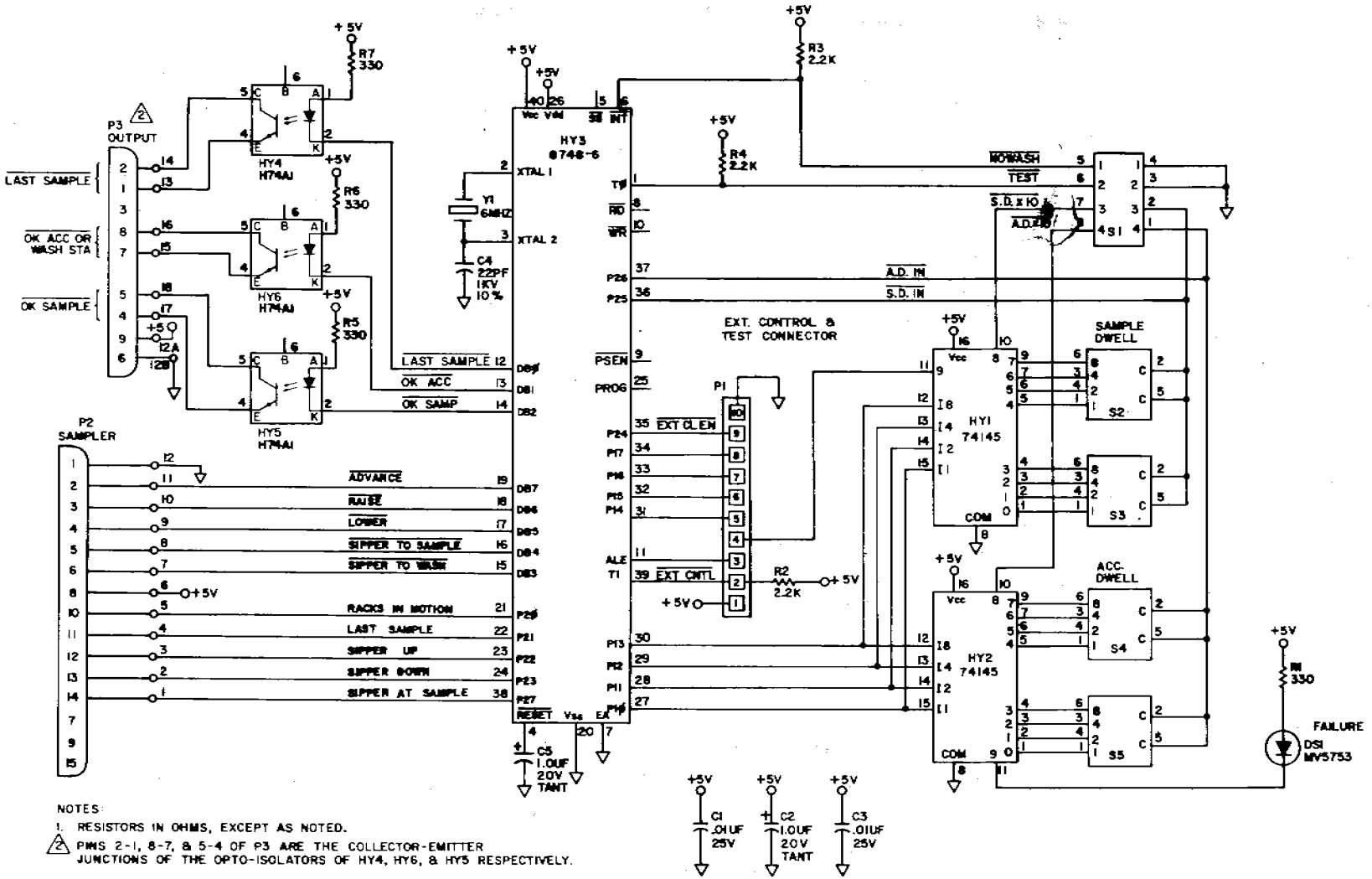


Figure 4-2. Control Sequencer Schematic

5.1 ADJUSTMENT OF TUBE RACK OPTICAL SENSORS - The optical sensors operate on the principal of infrared light reflecting off the side of the tube racks back onto the surface of a phototransistor. The amount of conduction of the phototransistor is proportional to the amount of IR light striking it.

The sensor assembly (refer to Figure 5-1) houses two identical optical sensors stacked on top of each other. The lower sensor, referred to as "cycle" on the schematic, is positioned to detect the rectangular holes on the side of each tube rack. The upper sensor, referred to as "stop" on the schematic, is positioned to detect the hole located at the last tube position of the red stop rack.

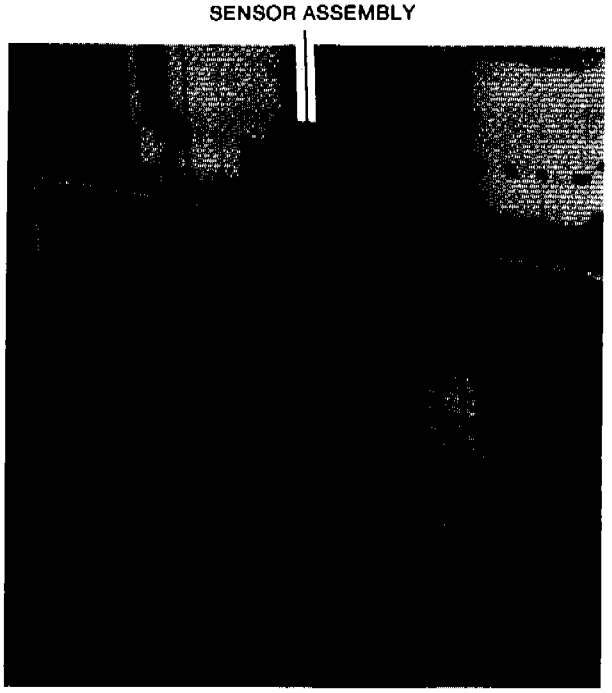


Figure 5-1. Sensor Assembly

The two important parameters are the amount of conduction of the phototransistor when a rectangular hole is centered in front of the sensor and when the rack surface in between holes is positioned in front of the sensor. Adjustment of the sensors requires the use of a voltmeter.

Remove the case top by loosening the two quarter-turn screws on the underside of the sampler. Remove the black thumbscrew holding the sensor assembly to the rear of the sampler. Lift the case top and position it directly behind the sampler and reinstall the sensor assembly with the thumbscrew.

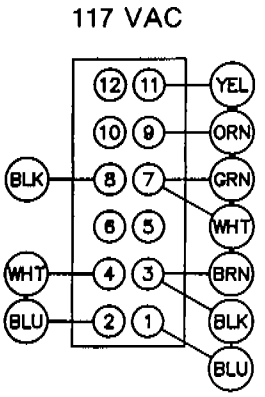
Cycle Sensor
Connect the voltmeter across test point TP201 (negative - locted on the rear printed circuit board) and test point TP102 (positive - located on the forward printed circuit board). Connect the line cord to the sampler and move the line switch to ON. Record the voltage when a rectangular hole is directly in front of the sensor. This is accomplished by moving the exposed gear on the underside of the shuttle tray until a minimum reading is obtained on the voltmeter. Next move the exposed gear until the flat surface of the tube rack is in front of the sensor and record the voltage.

If the dark potential (when hole is centered) is above 0.6 Vdc or if the light potential (flat surface centered) is below 6.0 Vdc adjustment of potentiometer R112 must be made. Turn potentiometer R112 clockwise if the light reading is low or counterclockwise if the dark reading is too high. If this is not possible, cleaning or replacement of the sensor assembly is required.

Stop Sensor
Measuring the conductance of the stop sensor is similar. Connect voltmeter across test point TP201 (negative) and test point TP101 (positive - located on rear printed circuit board). Place the red tube rack in front of the sensor. Record the voltage indicated. Manually move the exposed gear as before until a dip is observed on the voltmeter. The same voltage limits are required as with the cycle sensor. Light voltage reading at any place on red rack other than last tube position should be 6.0 Vdc or greater. The dark reading should be less than 0.6 Vdc. Potentiometer R111 will require adjustment if either parameter is exceeded.

Cycle and Stop Sensor Cleaning
Remove the spring loaded drip shield from the face of the sensor assembly. Using a cotton swab saturated with isopropyl alcohol clean the two rectangular windows.

Changing Line Voltage
Locate the barrier strip mounted on the rear panel. During the following discussion, numbers will be used to identify screw terminals of the barrier strip. The drawing depicts the barrier strip as it would be viewed from the front panel.



The blue, blue, white, and black wires located on Pins 2, 1, 4, and 8 respectively will never change.

Changing to 234 Vac-

Pin	Color
7	Green
5	Brown and white
3	Black
11	Yellow
9	Orange

Changing to 100 Vac-

Pin	Color
7	Green and white
5	No connection.
3	Yellow and orange
11	Brown
9	Black

Changing to 117 Vac-

Pin	Color
7	Green and white
5	No connection
3	Brown and black
11	Yellow
9	Orange

5.2 SHUTTLE REMOVAL - If it becomes necessary to remove the shuttles due to gross spillage or breakage, proceed according to the following steps:

a. Unplug instrument from mains.

b. Turn the two "drive base assembly retaining fastener", 1/4 turn counterclockwise.

c. Remove sensor assembly thumbscrew.

d. Lift entire top cover and shuttle tray assembly off of the bottom case assembly.

e. Remove the two screws holding the center hold down plate.

f. All shuttles can now be removed.

5.3 SHUTTLE INSTALLATION - Follow the shuttle removal procedure for removing shuttles and then proceed with the following steps to replace and time shuttles.

a. Orientate the tray assembly such that the TIMING MARK is closest to the operator and the center rail is parallel to his line of sight (Figure 5-2).

b. Place one shuttle to the left of the center rail, positioned such that the small diameter support post is on the right. Push the shuttle into the near tunnel, small diameter post end first until the center rib on shuttle aligns with the timing mark. Do not disturb this shuttle and proceed (shuttle shown in Figure 5-2 is the correct position in the near tunnel).

c. Place another shuttle to the right of the center rail, such that the small diameter support post is on the right.

d. Push the shuttle into the far tunnel, large diameter post first until the edge aligns with the angle on exit side of center rail (see Figure 5-3).

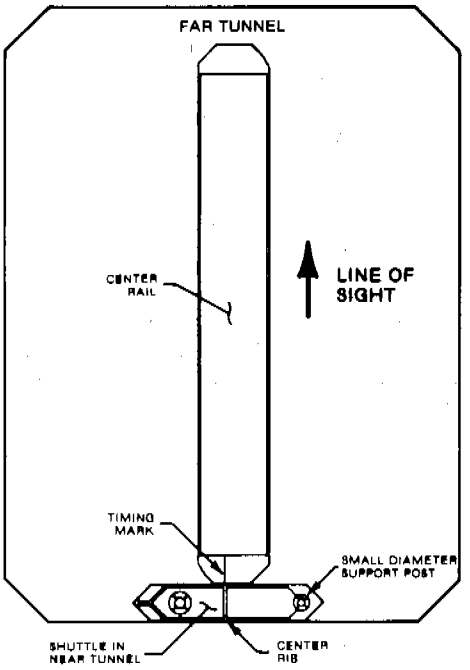


Figure 5-2. Shuttle Timing Diagram

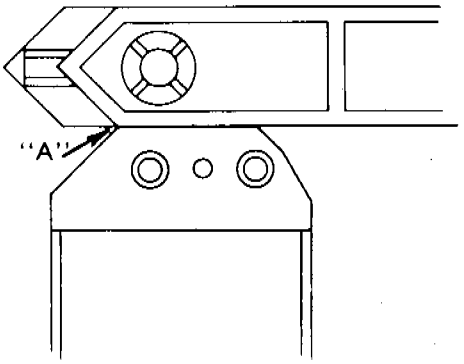


Figure 5-3. Timing Position Far Tunnel

e. Check near tunnel for same positioning (see Figure 5-4).

Note: Edges A and B on far and near tunnel and shuttles need only align within 1/16 inch of position.

If not, repeat step b through e. It may be necessary to realign center rib in step b to 1/16 inch one side or the other of the TIMING MARK.

f. If conditions d and e are met at the same time, proceed with step g.

g. Without disturbing the two end shuttles, replace the remaining shuttles.

Note: Shuttles are all positioned the same i.e., small diameter support post is on the right.

h. Replace center hold down plate.

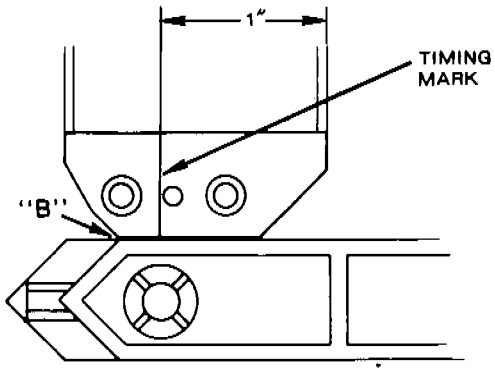


Figure 5-4.
Near Tunnel Final Timing Position

5.4 CONTROL SEQUENCER - Troubleshooting the sequencer can best be accomplished first by isolating the difficulty to the sequencer, then by status testing.

Blinking Failure Codes
When a problem with the sequencer or sampler is detected, the sequencer will indicate the type of problem by blinking a code on the failure LED at a 2 hertz rate followed by a 1 second pause. This will repeat until cleared by interrupting power or switching to test mode. The sequencer cover must be removed to observe the failure LED.

Failure Codes [number of blinks between pauses]:

1 Port 1 - Sequencer Problem
Some of pins 27-34 of HY3 not functional. Tested on power up.

2 Down - Sampler Problem
Down response to lower sipper command not received within 10 seconds.

3 Up - Sampler Problem
Up response to raise sipper command not received within 10 seconds.

4 Advance - Sampler Problem
In motion response to advance command not received within 10 seconds.

5 RAM - Sequencer Problem
Part of RAM locations 1-63 not functional. Test on power up.

6 EPROM - Sequencer Problem
EPROM bitsum does not match correct bitsum. Tested on power up.

7 Sipper to sample - Sampler Problem
Sipper to sample response to sipper to sample command not received within 10 seconds.

8 Sipper to wash - Sampler Problem
Sipper at wash response to sipper to wash command not received within 10 seconds.

9 Bus - Sequencer Problem
Some of pins 12-19 of HY3 not functional. Tested on power up.

10 Sipper sensors - Sampler Problem
Both sipper up and sipper down at same time. Tested before raise or lower operations.

Manual Abort Indication
If a manual abort occurs either due to the manual advance button being pressed while sequencing and not advancing, or due to a problem with rack sensors, the failure LED will be lit until the manual advance is pressed to restart sequencing.

Isolating difficulty to the sequencer is done by proving that the sampler circuitry is functioning properly. Disconnect the sequencer cable from the sampler.

Short Pins 1 (COMMON) and 2 (ADVANCE) of the the sampler 15 pin connector. If the pipet is down it should raise then the tube racks should advance for as long as Pin 2 is shorted to Pin 1. Pin 10 as measured to Pin 1 should read 2.5 Vdc to 5 Vdc (logic high).

Short Pins 1 (COMMON) and 4 (LOWER) of the sampler. The pipet should lower to the down position. Pin 13 as measured to Pin 1 should now measure a TTL logic high, 2.4 Vdc - 5 Vdc.

Short Pins 1 (COMMON) and 3 (RAISE). The pipet should cycle to up position and Pin 12 as measured to Pin 1 should now read a logic high.

Short Pins 1 (COMMON) and 6 (PIPET TO WASH). The pipet should cycle to the WASH station. Pin 14 as measured to Pin 1 should now be a logic low.

Short Pins 1 (COMMON) and Pin 5 (PIPET TO SAMPLE). The pipet should cycle to sample position. Pin 14 as measured to Pin 1 should now be high.

If the sampler performs as described above the difficulty lies with the sequencer.

Since the memory of the sequencer is buried within the CPU chip HY3, removing HY3 will facilitate determining if the difficulty lies with the CPU or discrete components of the sequencer.

Referring to the function table of the 74145 decoder chip you'll see with a BCD input of 6 (LHHL or 0110) output 6 (Pin 7) of the decoder should be logic low. This can't be measured directly because the decoder's output is open collector. But by performing the following procedure we can easily determine this function.

FUNCTION TABLE

NO.	INPUTS				OUTPUTS									
	D	C	B	A	0	1	2	3	4	5	6	7	8	9
0	L	L	L	L	L	H	H	H	H	H	H	H	H	H
1	L	L	L	H	H	L	H	H	H	H	H	H	H	H
2	L	L	H	L	H	H	L	H	H	H	H	H	H	H
3	L	L	H	H	H	H	H	L	H	H	H	H	H	H
4	L	H	L	L	H	H	H	H	L	H	H	H	H	H
5	L	H	L	H	H	H	H	H	H	L	H	H	H	H
6	L	H	H	L	H	H	H	H	H	H	L	H	H	H
7	L	H	H	H	H	H	H	H	H	H	H	L	H	H
8	H	L	L	L	H	H	H	H	H	H	H	H	L	H
9	H	L	L	H	H	H	H	H	H	H	H	H	H	L
INVALID	H	L	H	L	H	H	H	H	H	H	H	H	H	H
	H	L	H	H	H	H	H	H	H	H	H	H	H	H
	H	H	L	L	H	H	H	H	H	H	H	H	H	H
	H	H	L	H	H	H	H	H	H	H	H	H	H	H
	H	H	H	L	H	H	H	H	H	H	H	H	H	H
	H	H	H	H	H	H	H	H	H	H	H	H	H	H

H = high level (off), L = low level (on)

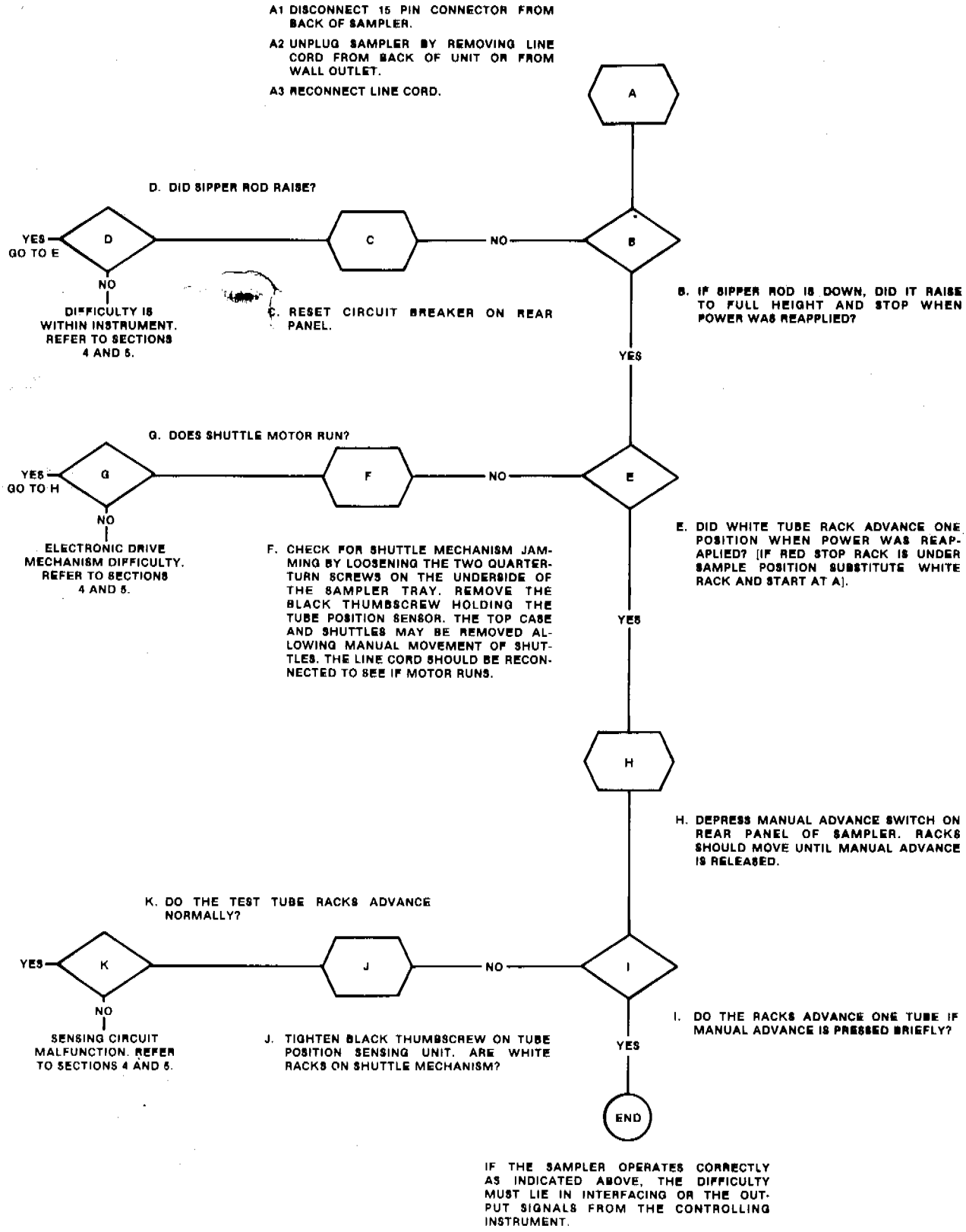
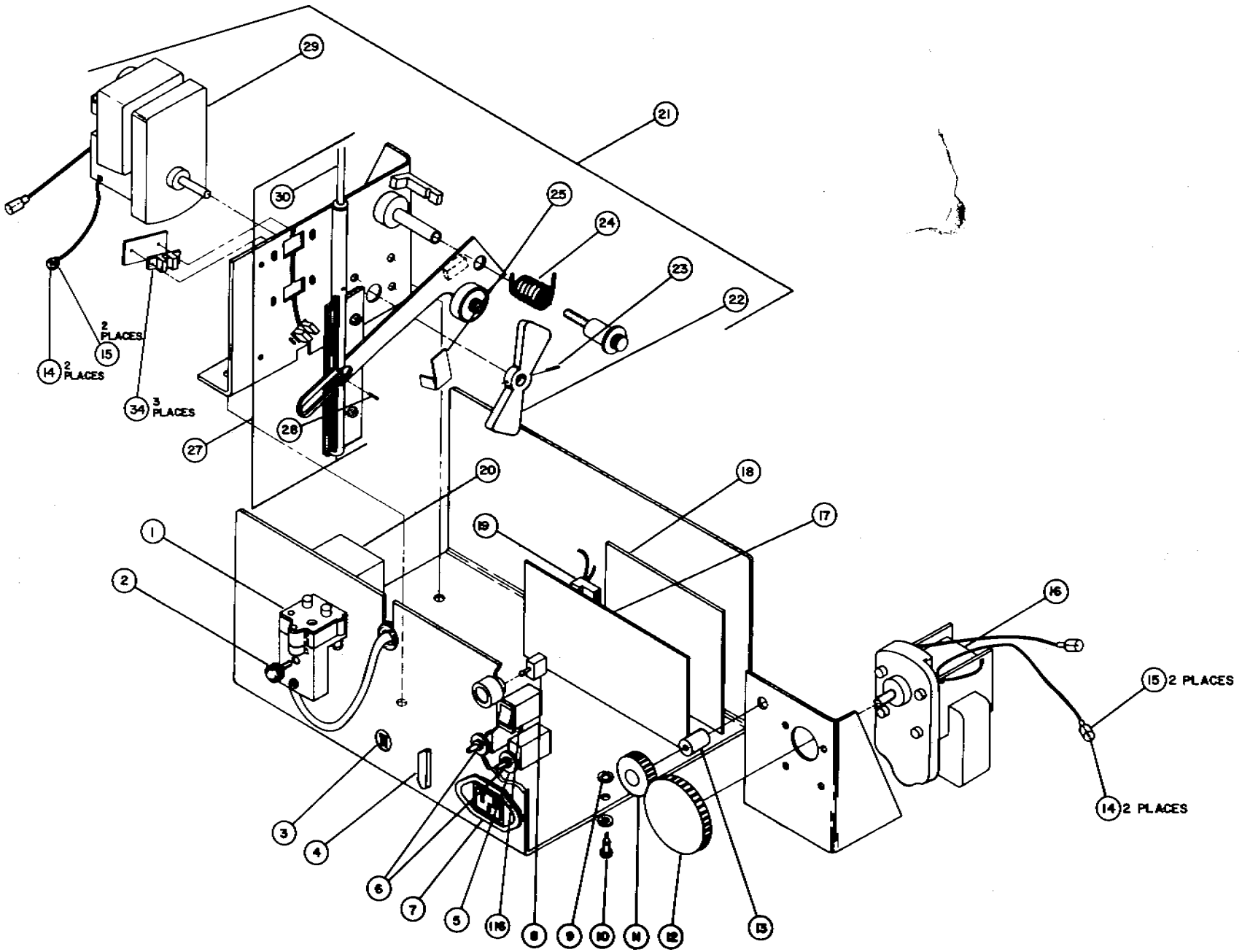


Figure 5-5. Troubleshooting Flow Chart


29
21
30
25
24
23
22
2 PLACES
15
14 2 PLACES
34 3 PLACES
27
28
20
18
17
19
1
2
16
15 2 PLACES
14 2 PLACES
3
4
6
7
5
11
8
9
10
14
12
13

Short Pins 27 and 30 of CPU socket to common allowing Pins 26 and 29 of CPU socket to float high. The above is the number 6 in BCD.

Place 3.3K ohm resistor across 5 volt dc supply and Pin 7 of HY2. Pin 7 of HY2 should now be low whereas all other output pins should be high.

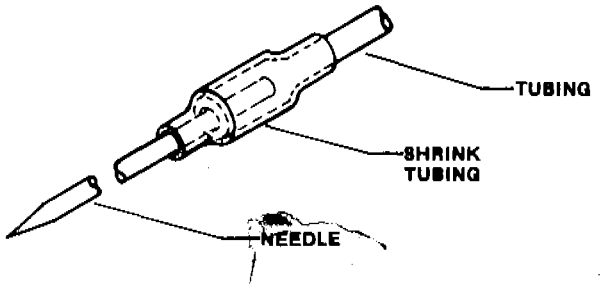
If the 74145 decoders prove to be functional and the 5 switches are proven to be functional with an ohmmeter the difficulty must lie with the CPU chip.

5.5 ADJUSTMENT OF PIPET ARM ROTATION - The rotational speed of the pipet arm is determined by the current to the rotary solenoid, and the leakage rate of the air cylinder damper for the arm. The air damper can be user adjusted with a small screwdriver. Access to the adjustment is through a hole located in the actuator arm assembly to the right of the knurled knob securing the assembly to the pipet rod. A clockwise adjustment of the screw will slow the speed of the pipet arm rotation, counterclockwise will increase it.

5.6 INSTALLATION OF TEFLON TUBING ONTO SEPTUM PIERCING NEEDLES - Remove any remaining Teflon tubing or shrink tubing from the end of the needle. Soften the Teflon tubing in hot water (180°F). Slip approximately ½'' of Teflon tubing over the end of the needle.

Note: Hold the Teflon tubing with the semi-abrasive material e.g., paper towel, when forcing it over the needle. To assist, it may help to partially stretch the ID of the tubing by temporarily fitting it over tapered tubing or rod similar to the pointed end of the needle.

Slip the shrink tubing over the Teflon tubing and needle so there is an equal amount of shrink tubing below the Teflon tubing as there is above the needle. Warm the shrink tubing to 250°F and maintain until the tubing is sufficiently tight. This may be accomplished with a heat gun.



5.7 WASH VESSEL TUBING INSTALLATION ***[refer to Figure 5-6]-***

Gravity Application -
The top spout requires 5/16 ID tubing and the bottom spout requires 3/16 ID tubing.

Pump Application -
The top spout requires 5/16 ID tubing plus the TUBING CONNECTOR (supplied) to connect to 1/8 ID tubing.

The bottom spout requires 3/16 ID tubing. Use TUBING CONNECTOR (supplied) to connect to 1/8 or 1/16 ID tubing.

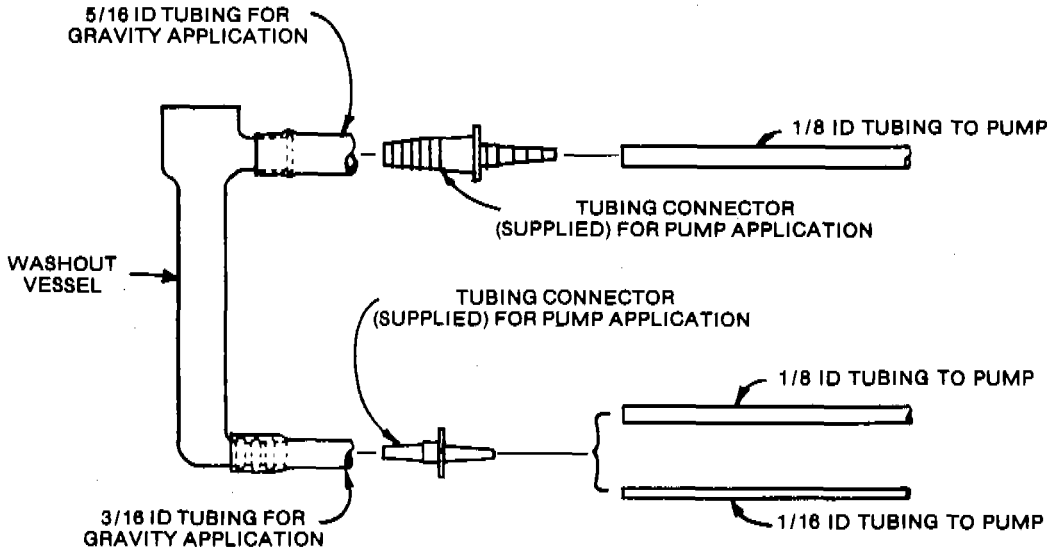
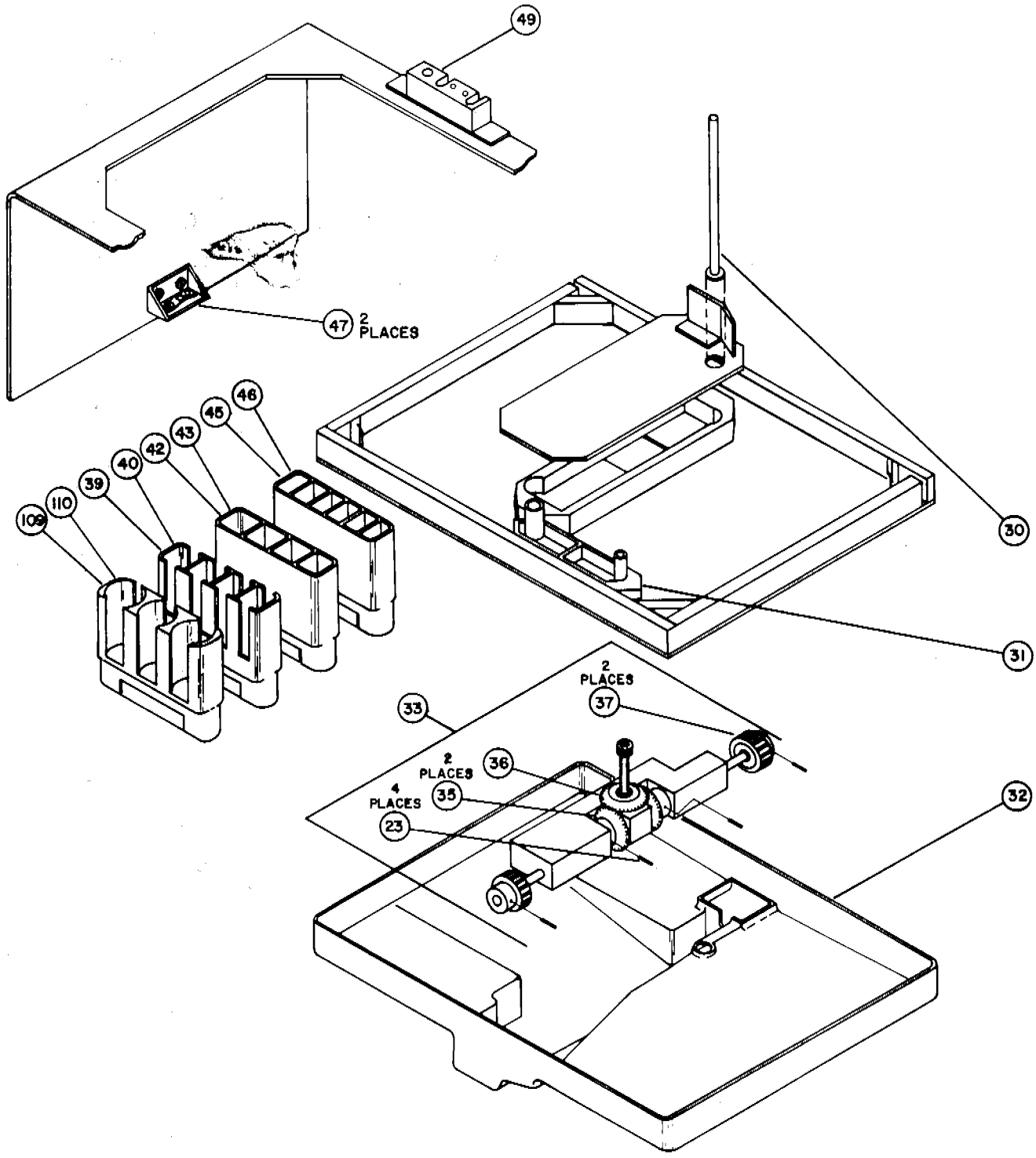


Figure 5-6. Wash Vessel Tubing Installation

Form #687

REPLACEMENT PARTS LIST

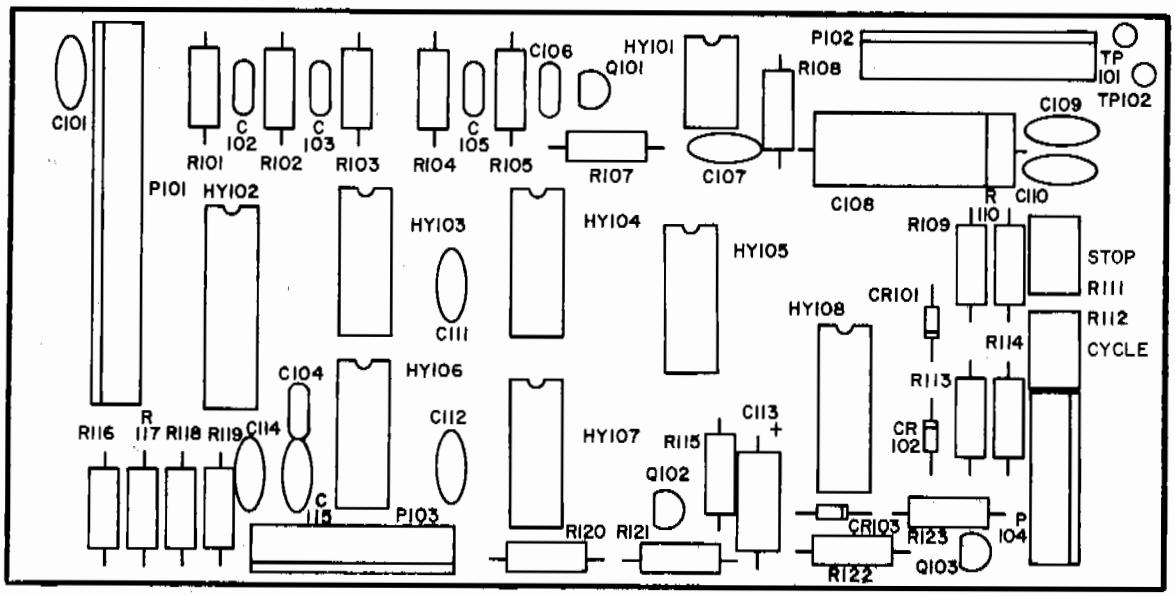
ITEM NO.		DESCRIPTION	
1		Sensor Assembly	
2		Screw Assembly	
3		2 Contact Panel Mount Socket	
4		15 Contact Socket	
5		Circuit Breaker 250V 1 amp	
6		Circuit Breaker 250V .7 amp	
7		3 Pin Panel Mount Plug	
8		Pushbutton Switch	
9		Stud Retainer	
10		Stud #2 Oval	
11		Spur Gear	
12		Shuttle Gear	
13		Spur Gear Bushing	
14		Terminal Plug	
15		Terminal Plug Housing	
16		Motor	
17		Logic Circuit Board (see Sheets 5 and 6)	
18		Power Circuit Board (see Sheets 7 and 8)	
19		8-Pin Socket	
20		Transformer	
21		Sipper Assembly (includes Items 22-30)	
22		Cam-Lifter	
23		Spring Pin 3/32 x .500	
24		Spring	
25		Interrupt	
26			
27		Lifter Assembly (includes Items 28 & 30)	
28		Roll Pin 3/32 x .250	
29		Sipper Motor	
30		Sipper Rod	
31		Shuttle	
32		Drip Pan	
33		Differential Gear Assembly (includes Items 34-37)	
34		Sensor	
35		Drive Gear	


49
47 2 PLACES
46
45
43
42
40
39
110
109
30
31
2 PLACES
37
33
2 PLACES
36
4 PLACES
35
23
32

ISCO Form #687

REPLACEMENT PARTS LIST

ITEM NO.		DESCRIPTION	REV
36		Differential Gear	
37		Shuttle Gear	
38			B
39		18mm Red Stop Rack	
40		18mm White Rack	
41			B
42		16mm Red Stop Rack	
43		16mm White Rack	
44			B
45		12/13mm Red Stop Rack	
46		12/13mm White Rack	P
47		Side Mount Receptacle	
48			E
49		Sensor Mounting Block	E
109		28mm Vial Rack-Red	B
110		28mm Vial Rack-White	B
116		Rocker Switch DPDT CSA 4A	T


C101
C102
C103
C105
C106
HY101
Q101
P102
TP101
TP102
R101
R102
R103
R104
R105
R107
R108
C107
C109
C108
R110
C110
P101
HY102
HY103
HY104
HY105
R109
STOP
R111
R112
CR101
HY108
R114
CYCLE
C104
HY106
C111
C112
R113
C113
HY107
R115
CR102
R116
R117
R118
R119
C114
C115
P103
Q102
R120
R121
CR103
R123
P104
R122
Q103

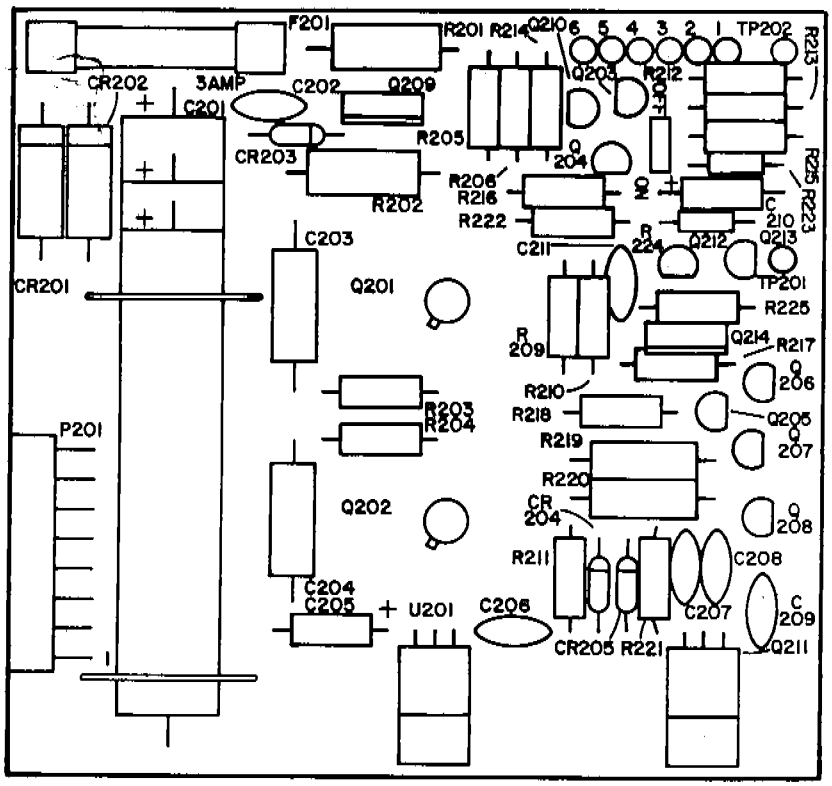
LOGIC BOARD

Form #688

CIRCUIT BOARD
REPLACEMENT PARTS LIST

LOGIC BOARD

ITEM NO.		DESCRIPTION	REFERENCE DESIGNATION	
82		Capacitor 10 Mfd 20 V	C113	
83		Diode 1N914	CR101,CR102	
84		Zener Diode 1N4740	CR103	
85		IC Timer NE555V	HY101	
86		IC TTL Octal 74LS240	HY102	
87		IC Digital TTL 7432	HY103	
88		IC Quad 2 Input SN7400N	HY104,HY107	
89		IC AND Gate 7408	HY105	
90		IC Tri 3 Input SN7410N	HY106	
91		IC MC14049B	HY108	
92		12 Pin Plug PCB Mount	P101	
93		7 Pin Plug PCB Mount	P102	
94		6 Pin Plug PCB Mount	P103	
95		5 Pin Plug PCB Mount	P104	
96		Transistor 2N3702	Q101	
97		Transistor 2N3704	Q102,Q103	
98		Pot Ceramic 10K 1/2W	R111,R112	


F201
R201
R214
Q210
6 5 4 3 2 1
TP202
R213
CR202
3AMP
C202
Q209
C201
Q203
R212
R205
Q 204
CR203
R206
R216
R222
R202
C203
C211
R224
Q212
Q213
C210
R225
R223
CR201
Q201
TP201
R225
Q214
R217
R 209
Q 206
R210
R218
Q205
R219
Q 207
R220
P201
Q202
CR 204
Q 208
R211
C208
C204
C205
U201
C206
C207
C 209
CR205
R221
Q211

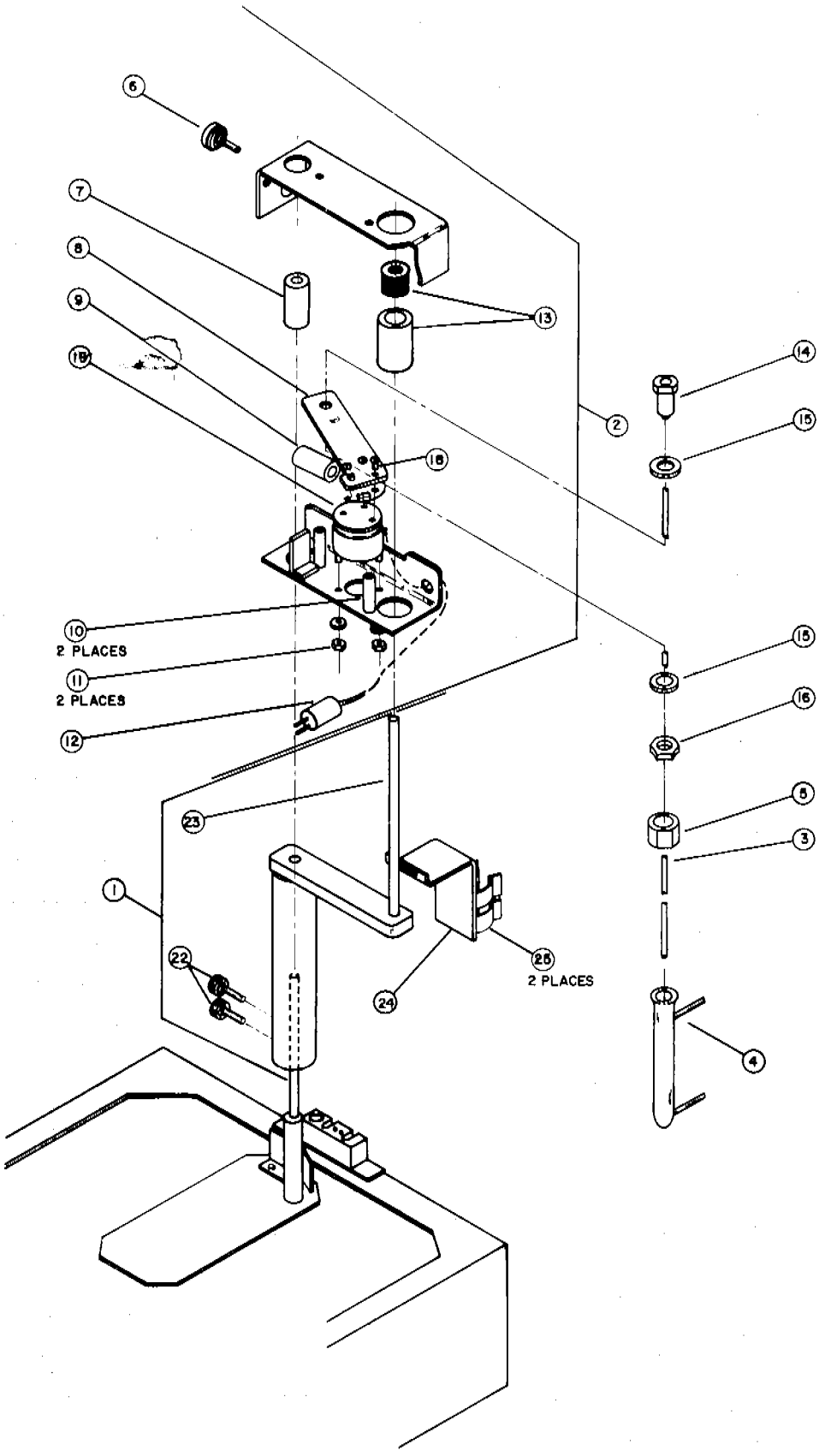
POWER BOARD

ISCO Form #688

CIRCUIT BOARD
REPLACEMENT PARTS LIST

POWER BOARD

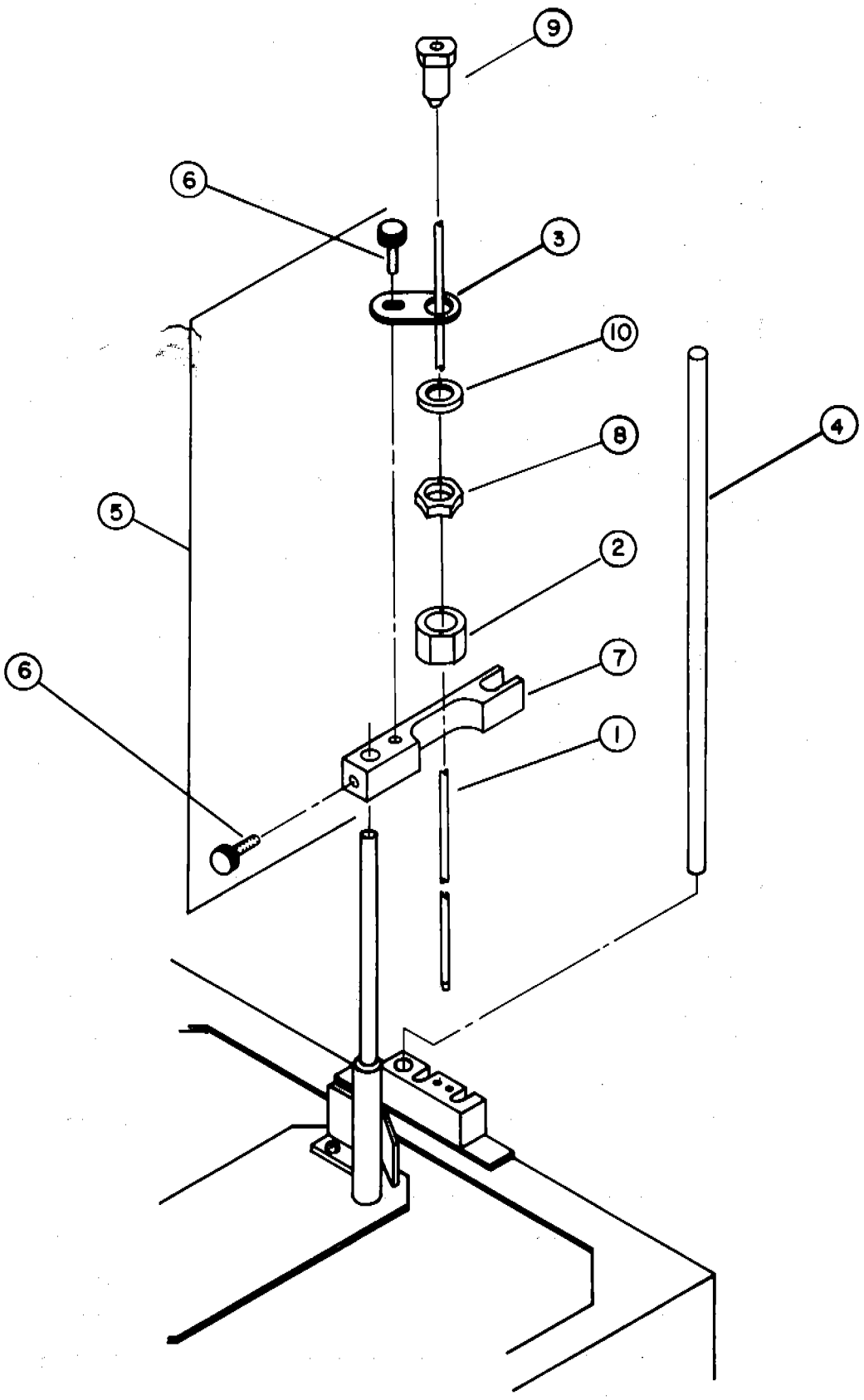
ITEM NO.		DESCRIPTION	REFERENCE DESIGNATION	REV
99		Capacitor 4000 Mfd 25 V	C201	
100		Caopacitor 1.0 Mfd 35 V	C205	D
101		Diode 1N5060	CR203-CR205	K
102				G
103		Voltage Regulator	HY201	D
105		8-Pin Plug PCB Mount	P201	
106				G
107		7-Pin Header Socket		
97		Transistor 2N3704	Q210, Q203, Q204,	
			Q205, Q206,Q212, Q213	T
108		Fuse 3 Amp	F201	K
104		SCR 2N5755	Q201, Q202	F
96		Transistor 2N3702	Q207, Q208	D
111		Spacer	Q201, Q202	F
112		Heat Sink	Q201, Q202	F
113		Transistor 2N6107	Q209, Q211, Q214	T
114		Diode 1N5400	CR201, CR202	K
117		Capacitor 22 MFD 15 V	C210	T


6
7
8
9
19
13
14
15
2
18
10
2 PLACES
11
2 PLACES
12
15
16
5
3
23
1
22
26
2 PLACES
24
4

Form #687

REPLACEMENT PARTS LIST

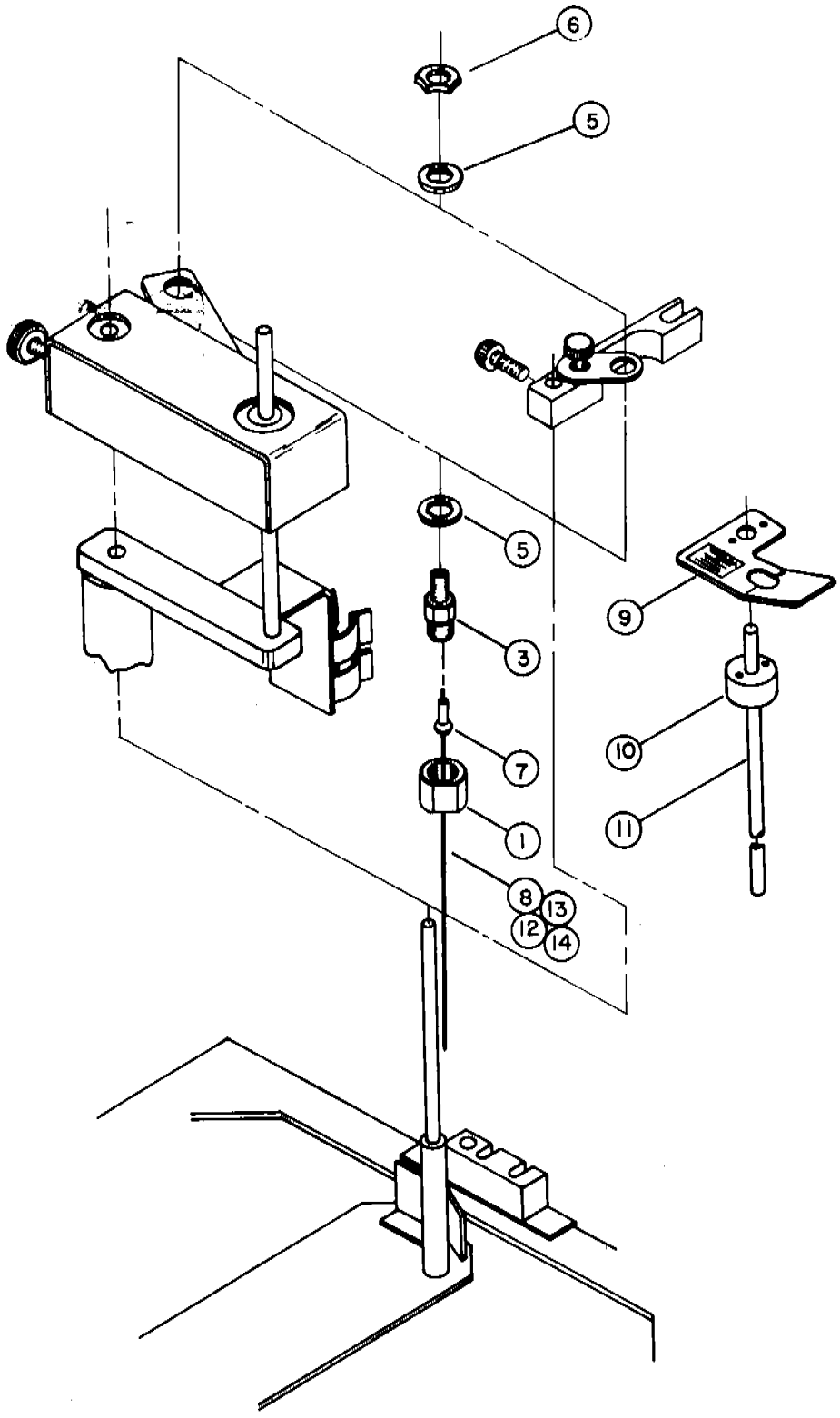
ITEM NO.		DESCRIPTION	
1		Wash Station Assembly (Includes Items 22-25)	
2		Actuator Arm Assembly (Includes Items 6-13, 17-19)	
3		Tubing Guide	
4		Washout Vessel	
5		Nut Modification	
6		Screw Assembly	
7		Rod Adapter	
8		Pipet Actuator Arm	
9		Dashpot	
10		Spacer	
11		Hex Nut 5-40	
12		2 Pin Plug	
13		Bearing Assembly	
14		Collet	
15		3/8 Internal Tooth Lockwasher	
16		3/8-24 Nut	
17			
18		Pan Head Screw 3 - 48 x 1/4	
19		Solenoid Modification	
20			
21			
22		Screw Assembly	
23		Rod Guide	
24		Washout Vessel Bracket	
25		Clip	
26			
27			
28			
29			


9
6
3
10
8
4
5
2
6
7
1

Form #687

REPLACEMENT PARTS LIST

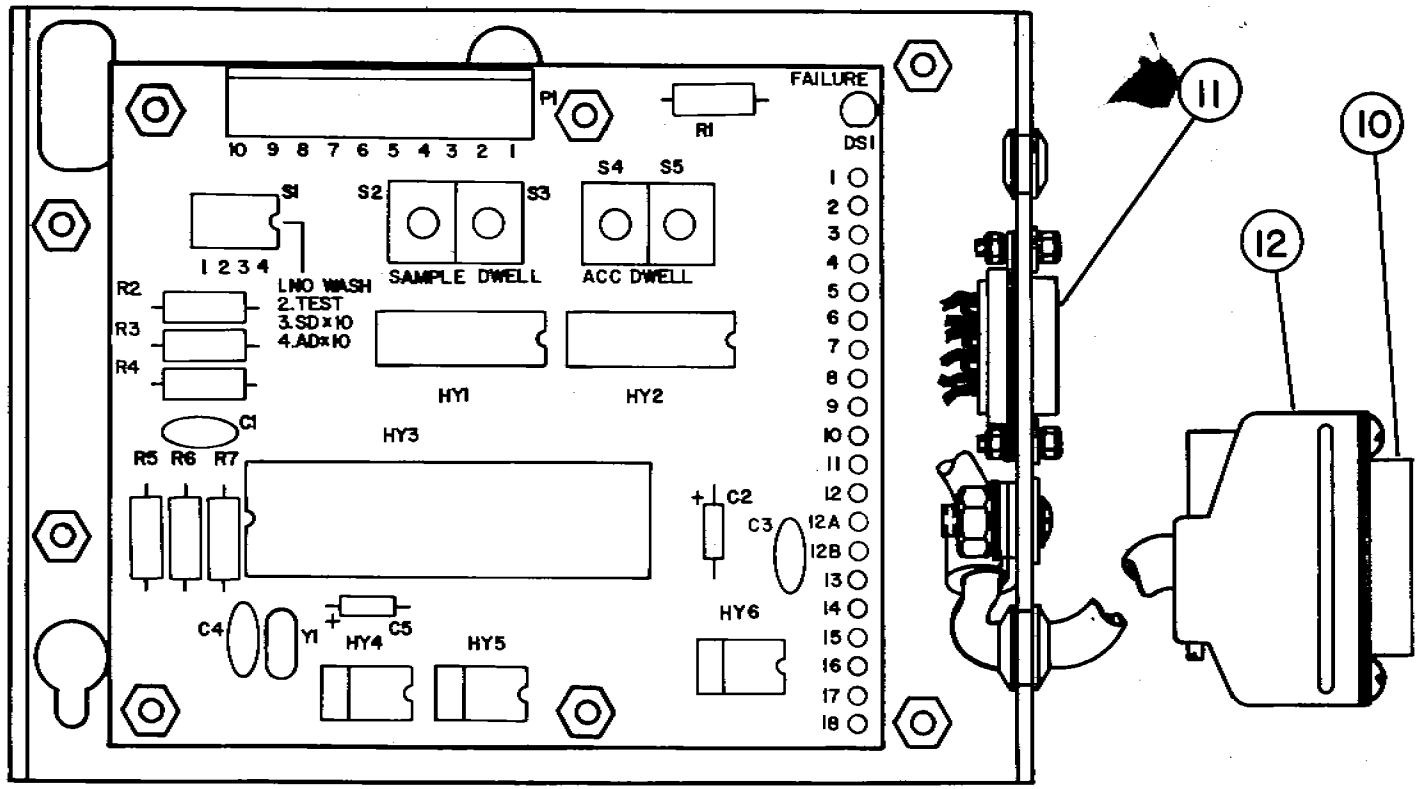
ITEM NO.		DESCRIPTION	
1		Tubing Guide	
2		Nut Modification	
3		Sipper Guide Holder	
4		Hold Down Rod	
5		Pipet Arm Assembly (Includes Items 2,3 & 6-10)	
6		Screw Assembly 10-32 x 3/8	
7		Sipper Pipet Arm	
8		3/8-24 Nut	
9		Collet	
10		3/8 Internal Tooth Lock Washer	
11			
12			
13			
14			


6
5
5
3
9
10
7
11
1
8
13
12
14

Form #687

REPLACEMENT PARTS LIST

ITEM NO.		DESCRIPTION	
1		Connector Nut	
3		Bulkhead Union	
5		Washer	
6		Nut	
7		Ferrule .05 ID	
8		Needle 19 Gauge	
9		Hold Down Foot	
10		Collar	
11		Hold Down Rod	
12		Needle 18 Gauge	
13		Needle Mod Solid Point	
14		Needle Mod Solid Point	


P1
10 9 8 7 6 5 4 3 2 1
R1
FAILURE
DS1
S1
1 2 3 4
LNO WASH
2.TEST
3.SD×10
4.AD×10
S2
S3
SAMPLE DWELL
S4
S5
ACC DWELL
R2
R3
R4
HY1
HY2
C1
HY3
R5 R6 R7
C2
C3
C4
Y1
HY4
C5
HY5
HY6
1
2
3
4
5
6
7
8
9
10
11
12
12A
12B
13
14
15
16
17
18
11
10
12

Form #688

CIRCUIT BOARD REPLACEMENT PARTS LIST

ITEM NO.	DESCRIPTION	REFERENCE DESIGNATION
1	Capacitor 1.0 Mfd 20 V	C2, C5
2	Capacitor 22 Pfd 1 KV	C4
3	LED MV5753	DS1
4	Crystal 6 MHz	V1
5	IC Digital Decoder 74145	HY1,HY2
6	Microprocessor Modification *	HY3
7	IC Optical Isolator H74A1	HY4,HY5,HY6
8	Switch - SPST	S1
9	Switch - Rotary	S2,S3,S4,S5
10	Plug - 15 Pin	
11	9-Pin Plug	
12	Housing for 15 Pin Plug	
	* When ordering, please be sure to indicate the 9 digit part number and the 5 digit software number located on the white label on the microprocessor.	

ADDENDUM

To ensure proper operation: when using an external controller, the 1290 line switch must be in the ON position before powering up the controller.