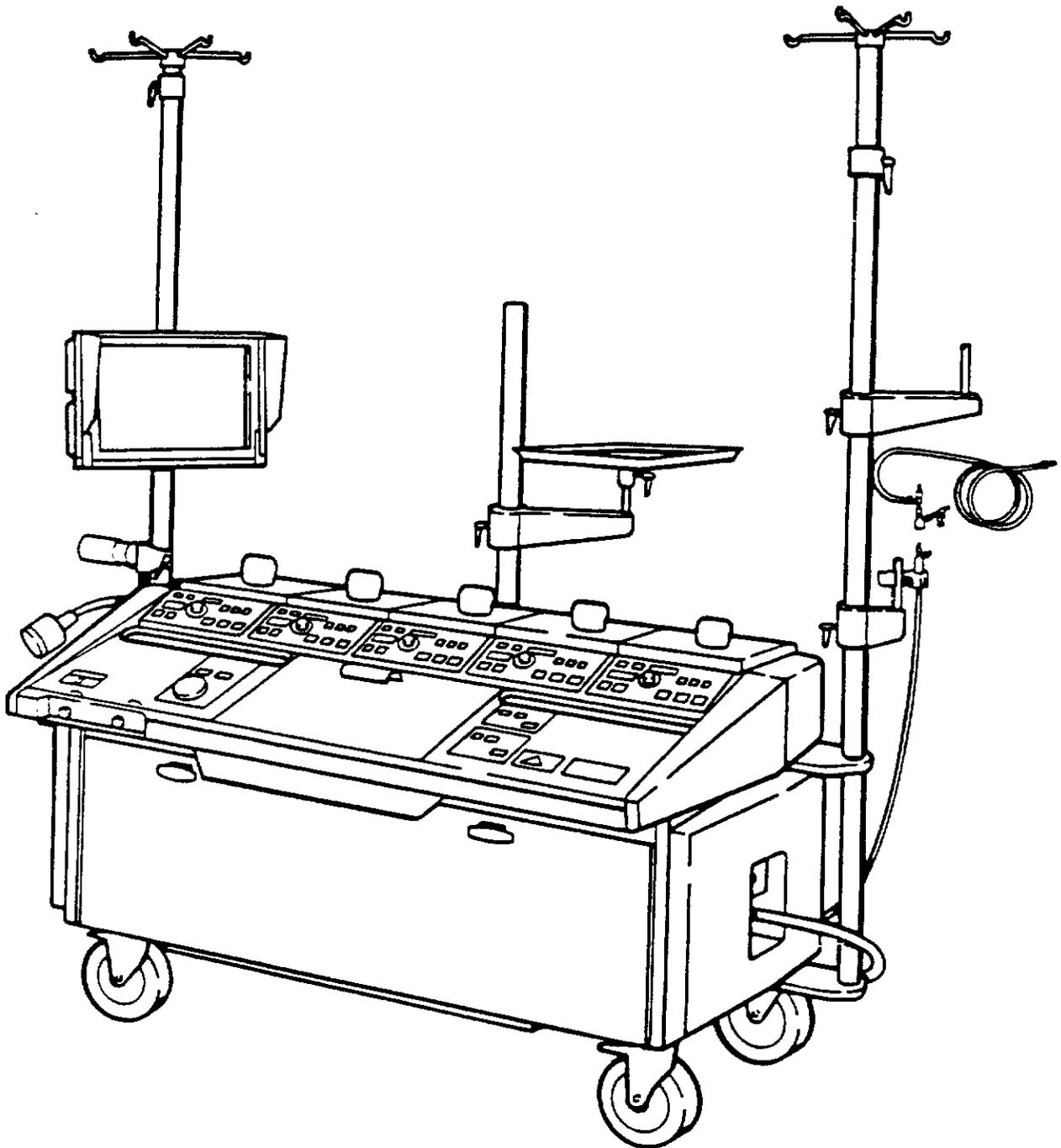


# FIELD SERVICE HANDBOOK

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## Sarns™ 9000 Perfusion System



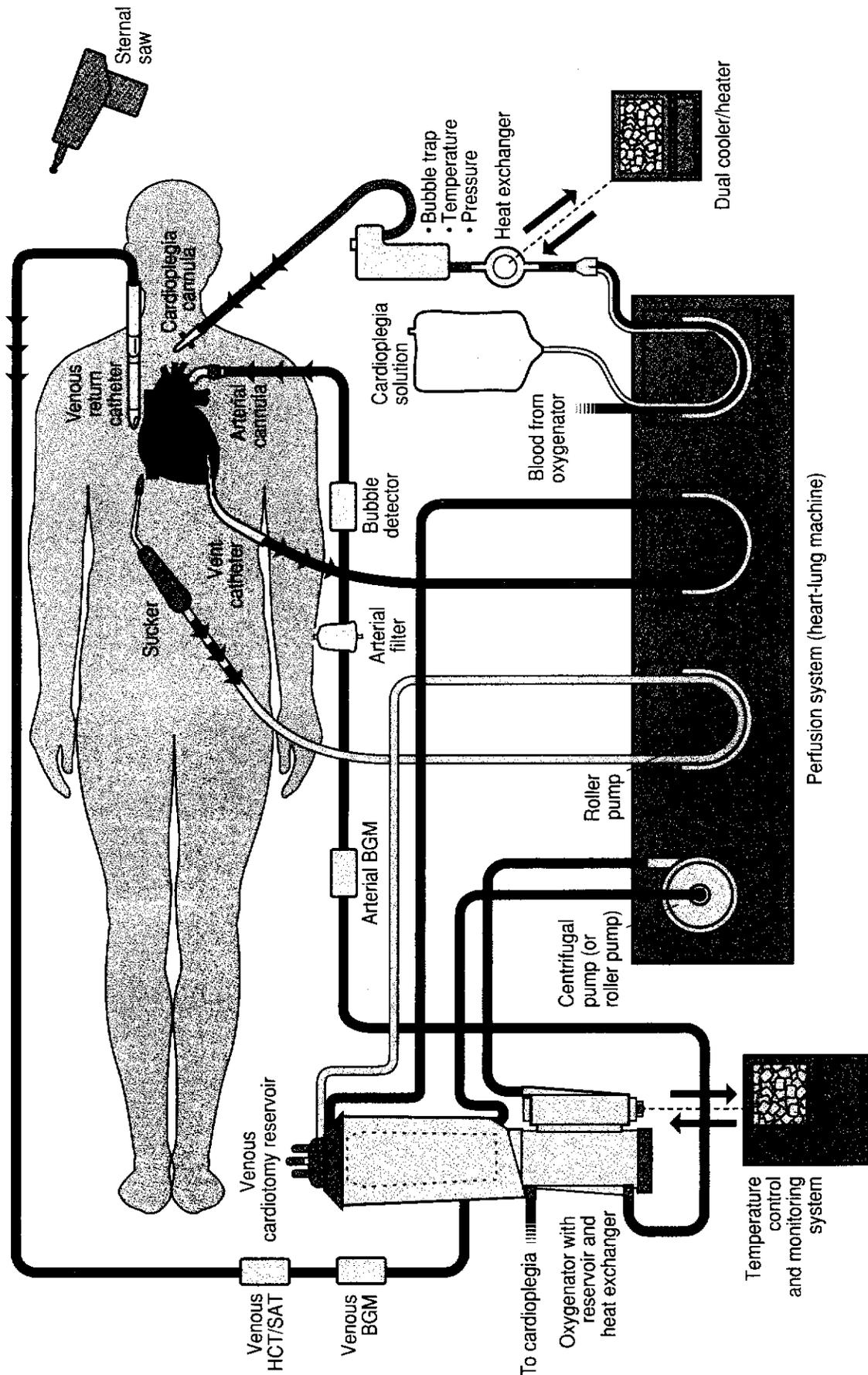
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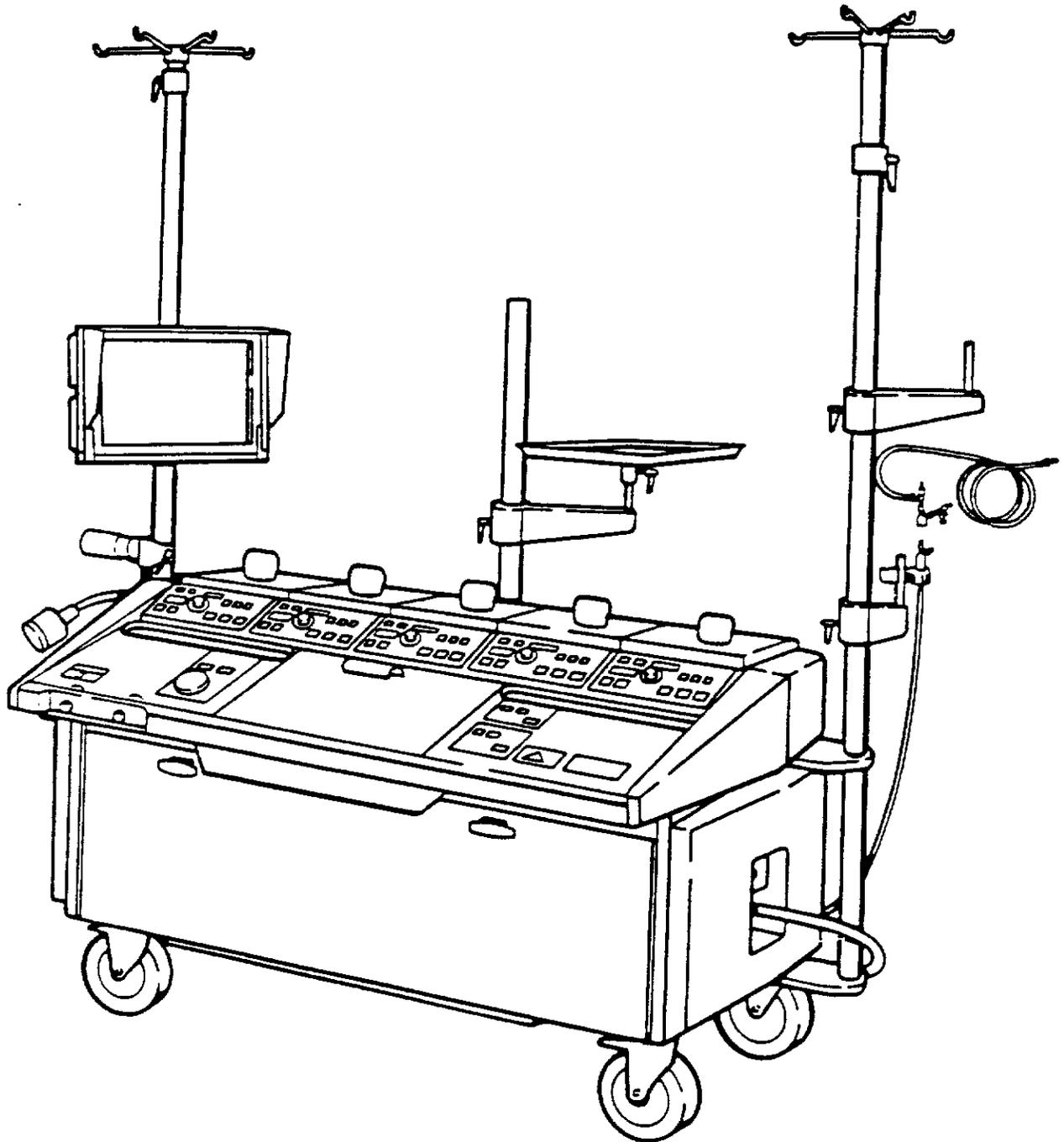
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## Sarns™ 9000 Perfusion System



78-8066-6212-4 R/A

**Sarns**  
**3M Health Care**

6200 Jackson Road  
Ann Arbor, Michigan 48103



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## 2-1. Power Control Board

Performance Specification 16503100

PC Assembly 16464401

See Schematic 16464600

### Functional Description

The Power Control board consists of the logic for controlling the switching of the power supplies, battery, and LED's. It also contains: interfacing of the CPU and Central Display; the -12V DC/DC converter; power distribution from the DC/DC converters to the STD bus and interface Motherboard; power from the battery for the Fixed Panel Display Right Side; and power from the 12V DC/DC converter through a fuse for the Central Display, left and right fans.

### Physical Description

The Power Distribution Board consists of a 6.25" (15.9 cm) by 5.0" (12.7 cm) printed circuit board, double sided, with 2 ounce copper. The card is mounted on a metal plate on top of the interface card cage.

### Electrical Description

The commons of the DC/DC converters are tied together on the Power Control Board. This is the only location that these commons are tied together.

#### Power inputs:

+24VDC (20 to 27 unregulated) "Uninterruptible Power"

+24VDC (20 to 27 unregulated) "Switched Battery"

+12VDC  $\pm$  1%

+5VDC  $\pm$  1%

#### Power outputs:

+24VDC (20 to 27 unregulated) "Uninterruptible Power"

+24VDC (20 to 27 unregulated) "Switched Battery"

+12VDC  $\pm$  1%

+12VDC  $\pm$  1% "+12v Fused"

+5VDC  $\pm$  1%

-12VDC  $\pm$  1% @ 0 to 1.25A

The environmental conditions of the Power Control board are listed as follows:

Operating temperature = 0°C to +60°C

Storage temperature = -55°C to +85°C

Noncondensing relative humidity = 5% to 95%

## 2-1. Power Control Board (continued)

### Interface

The Power Distribution board is mounted atop the interface card cage on the Front Tray assembly. The numerous connectors on the board are summarized as follows:

- J1 to Right Fixed Panel
- J2 to Power Distribution board
- J3 to interface Motherboard
- J4 to STD Card Cage
- J5 to Right Fan
- J6 to Left Fan
- J7 from +12 volt DC-DC converter
- J8 from +5 volt DC-DC converter
- J9 to Central Display
- J10 test points
- J11 to CPU card

### Theory of Operation

The control circuitry on the board is powered by switched battery power. The logic is powered by +5 volts.

The front end of the 5V circuitry is comprised of the voltage comparators (U11). The power-up comparator, U11, pins 2, 4, and 5, is used to provide a power-up reset that resets the circuits and turns on the power system LED's for three seconds.

The other three comparators of U11 compare the voltage of the power supplies to a fixed reference (the voltages of the power supplies are divided by RN2 and RN3). The reference voltage is provided by U12 (1403). This splits the supply voltage (5V) in half to derive 2.5V. When any of the power supplies drop below their threshold voltage,  $19 \pm 1$  volt, the output of the appropriate comparator switches high.

The AC signal is detected by the comparator, U3, pins 1-3, and U10 which is set up to be a retriggerable monostable multivibrator. The square wave from U3 continuously retriggers U10. When the AC fails, the output of U10 (LM556C), pin 5, switches low after 25mS ( $\pm 25\%$ ) from the time it was last retriggered.

The outputs of the comparators and AC detect circuit are the inputs of the logic circuit comprised of U5 (74HC175), U6 (74HCT00, pins 4-6, 8-10), U7 (74HCT10), U8 (74HCT10), and U9 (74HCT00; pin 8-13). This circuit implements the switching scheme described in the functionality section, 11.3.1. The clock for this circuit is provided by the other half of U10 (pins 8-13). This side is set up in an oscillator configuration. Its frequency is approximately 204Hz ( $\pm 25\%$ ).

U1 and U2 ULN2803A high voltage open-collector buffers used by the logic circuit. They are used to turn the coils of the relays on the Power Distribution Board on and off. They are also used to turn the LED's on the Fixed Panel Display Right Side on and off. U6 (74HCT08 pins 1-3, 11-13) is used to turn on the LED's during power-up.

## 2-1. Power Control Board (continued)

### Theory of Operation (continued)

The amount that the battery assists uninterruptible power is controlled by op-amp U4 (LM358). When  $V_{ps}$  (the power supply voltage that is normally supplying uninterruptible power) drops below 20V, the op-amp output (BAT.ON), U4, pin 1, begins to drop in an attempt to make the voltages on its inputs (pins 2 and 3) equal. If  $V_{ps}$  stays below 20V, the op-amp will lower its output to its minimum level (0V). The power FET that separates the battery from UP on the PDB is controlled by the BAT.ON signal. Since it is a P-channel, the lower the BAT.ON signal goes, the more it turns on. The amount of power supplied to UP by the battery is thus proportional to the level of the BAT.ON signal (i.e. the lower BAT.ON goes, the more that UP is supplied by the battery).

When the battery is running the system and its voltage gets below a certain threshold point, a safety circuit shuts down the battery power until the AC power comes back and the level of the battery raises above the threshold. When the battery reaches the threshold point, it is close to being fully discharged. At this point, the battery only has a short time (the exact amount of time depends on the load) before it is completely discharged. Depleting the battery to a completely discharged state will shorten its lifetime and would not do much good anyway, since it could only run the machine for a matter of seconds after the threshold have been reached.

Comparator U3, pins 5-7, detects when the battery drops below the threshold which is set to 20V. When this happens, the output of the comparator switches low. This state causes the output of NAND gate U9 (pin 3) to go high. The output (BAT.OFF) is latched by a D flip-flop in U5 (74HC175) and NAND gate U9, pins 4-6. BAT.OFF causes the output of op-amp U4 (LM358), pin 7, to go high ( $V_{battery}-1.5V$ ), thus turning the BAT.ON signal (U4, pin 1) almost off. When this happens, all of the nodes supplied by UP turn off and thus protect the battery from being deeply discharged. Uninterruptible power will stay off until the AC power returns.

### Calibration Specification

The Power Control board requires no calibration or configuration. The board has a number of test points for monitoring supply voltages and signals.

J10 is a 6-pin MTA-100 header used as a test connector, with the following signals:

- pin 1 5 volts
- pin 2 2.5 volts
- pin 3 CLOCK
- pin 4 POWER-UP RESET\* - -
- pin 5 AC FAILURE\*
- pin 6 POWER SYSTEM COMMON

(Note: The "\*" at the end of a logic signal name indicates a signal that is low when asserted).

Four other test points, for the DC-DC Converters, are on individual pins: +12 volts, -12 volts, +5 volts, and DC-DC Converter Ground.

## 2-2. Power Distribution Board

Performance Specification 16503200  
PC Assembly 16481801  
See Schematic 16480900

### Functional Description

The Power Distribution Board contains the circuitry and connectors for distributing a basic +24 volt power (either from AC mains or from battery) to devices through the circuit breakers. These devices are: pumps, auxiliary outlets, central and auxiliary fans, DC/DC converters, and occluder. A spare connector is also included to power a spare device (through the spare circuit breaker). The board also contains battery charger circuitry, charge status monitor circuitry, and the relays that switch power supplies in the event of one failing.

### Physical Description

The Power Distribution Board consists of a 12" by 5.75" printed circuit board, double sided, with 3 ounce copper. The board is mounted to a metal plate on top of the interface card cage. The board features a fuse (F1), four relays, numerous connectors including two terminal blocks, and three voltage regulators on heat sinks.

### Electrical Description

The operating conditions of the power system are summarized as follows:

Power in: PS 1,2 and 3 = +20-35VDC @ 0-20A

Power in: battery charger transformer = 33-45VDC @ 0-3A

Battery power in: = 20-27VDC @ 0-50A

Battery charging out: 27.2 to 27.6 VDC @ < 205 mA (floating mode)  
2.2 to 3.0 Amp @ < 27.2 VDC (max current mode)  
(Battery voltage is prevented from exceeding 30 volts during charging by an overvoltage shutoff circuit.)

Operating temperature = 0° C to +60° C

Storage temperature = -55° C to +85° C

Noncondensing relative humidity = 5% to 95%

## 2-2. Power Distribution Board (continued)

### Interface

The Power Distribution Board is mounted atop the interface card cage on the Front Tray assembly. The numerous connectors on the board are summarized as follows:

- J1 from Capacitor board
- J2 to negative battery terminal (terminal block)
- J3 to circuit breaker board
- J4 from circuit breaker board (return)
- J5 to occluder
- J6 spare
- J11-J7 to pumps 1-5, respectively
- J12 to auxiliary fan
- J13 central fan
- J14 auxiliary outlets
- J15 +12 volt DC-DC converter
- J16 +5 volt DC-DC converter
- J17 to main circuit breaker
- J18 to power regulator (an LM317HVK)
- J19 to positive battery terminal (terminal block)
- J20 from battery charger transformer
- J21 to Power Control board (26-pin ribbon cable)
- J22 test points

The connectors to the batteries (J2 and J19) are 3-screw barrier strip terminal blocks.

### Theory of Operation

Power from the power supplies comes onto the Power Distribution board and is routed to relays K1 and K2. Relay K1 is used to switch between PS 1 and PS 3. K2 is used to switch between PS 2 and PS 3. PS 1 usually powers Pumps #1 and #2, DC/DC converters, and Uninterruptible Power. PS 2 usually supplies Pumps #4 and #5, Central and Auxiliary fans, Occluder, and Spare. When K1 or K2 switch, PS 3 takes over the loads of the other power supply and its original loads, and Pump #3 and auxiliary outlets, are dropped out. These relays are switched when one of the main power supplies fails.

K3 and K4 are used to switch between the power supplies and the battery. These relays are switched whenever there is a loss of AC power.

The relay-controlling circuitry is located on the Power Control board.

Uninterruptible power is the power to the main computer, displays, and the energizing coils of K1-K4. This power does not get interrupted when power is switched between power supplies or from the power supplies to battery. The power to the other devices are powered through the relays. When a relay switches, there is a glitch of power to those devices powered by the relay. This is the time it takes the relay to flip its contacts.

Uninterruptible power is normally supplied by PS 1 through relay, K1, and power diode, D6 (MR2404F). When K1 has switched, PS 3 provides the power to the uninterruptible supply. This supply voltage is labelled Vps. The battery can also supply uninterruptible power through J17, Q3, and D5. J17 goes to the main circuit breaker and acts like the "on" switch to the switched power battery. Vps is monitored by control circuitry on the Power Control Board. When Vps drops below 20V, the control circuit turns on the power FET, Q3 (MPQ8P08 or IRF9531 or equivalent), and the battery then powers the uninterruptible supply.

## 2-2. Power Distribution Board (continued)

### Theory of Operation (continued)

The battery charger transformer AC voltage is rectified on the PDB by power diodes D11 and D12 (P600D). The voltage is rectified to 33-45VDC and is filtered by capacitors C7 and C8. Two capacitors are needed because of the large surge currents. A 3A fuse (F1) is placed after the capacitors to protect the circuits supplied by this node. This node powers the battery charger control circuit through a resistor programmable voltage regulator (LM317T; TO-220 package). This node powers another resistor programmable voltage regulator (LM317HVM; TO-3 package). This power regulator charges the battery through a relay, K5. This regulator is self-current limiting to about 2.2-3A.

The battery charger is a three-stage charger. Its three stages are: 1) Float; 2) Constant Voltage (low charge rate); and 3) Constant Current (high charge rate). The modes are determined by the amount of current flowing into the battery from the battery charger and the voltage of the power regulator.

Float mode is defined to be when the battery charger current is less than 205mA. The power regulator is set to 27.2-27.6V during this mode. The amount of battery charger current is detected by a 0.2Ω resistor, R13, placed across the battery common and the battery charger common. The voltage drop across this resistor is directly proportional to the current and is amplified by U6. This amplified voltage is compared by the float detect comparator, U5 (LM339), pins 8, 9, and 14, to a 2.5V reference voltage. The reference voltage is provided by U3 (1403). If the voltage across R13 is below approximately 41mV, the float detect comparator output will be high. This state is ANDed with the LED'S OFF\* signal (explained later; the \* indicates active low) through gate, U2 (4081), pins 12 and 13. If the LED'S OFF\* signal is high, the output to U2, pin 11 will be high and the transistor U1 (MPQ2222), pins 12-14, will turn on causing the float LED to light. It also causes another transistor, U1, pins 1-3, to turn on, which programs the output of the power regulator to be 27.2-27.6V.

When the power regulator is supplying its maximum current to the battery, its output voltage will drop to the level of the discharged battery. Thus, when this occurs, the voltage of the regulator will be less than 27.2V and the current will be 2.2-3A. Constant Current mode is defined to be when the voltage drops below 26.3V (3%). This state is detected by the constant current detect comparator, U5, pins 2,4, and 5. The output of the power regulator is divided by R15 (10.0KΩ) and R16 (1.05KΩ), and this voltage is compared with the 2.5V reference. When the output of the comparator is high and the LED'S OFF signal is high, the output of the AND gate, U2, pin 4, will be high and turn on the constant current LED.

Constant Voltage mode is defined to be when the battery charger current is more than 41mA and the output of the regulator is above 27.2V. Therefore, it occurs when the float detect comparator and the constant current detect comparator outputs are both low. When this situation occurs, the output of the NOR gate, U4 (4001), pin 10, goes high. This output is also ANDed with the LED'S OFF\* signal (pins 1 and 2 of U2). If the LED'S OFF\* signal is also high, the transistor, U1, pin 8-10, turn on and the constant voltage LED turns on.

The LED'S OFF\* signal is to turn off the battery charger LED's when there is an over voltage on the output of the power regulator, or there is an AC failure (AC OFF). The battery charger voltage (output of the power regulator) is divided by R5 (52.3KΩ) and RN6, pins 1-2. The over voltage is detected by comparing the divided voltage with the 2.5V reference voltage using U4, pins 10,11, and 13. An over voltage (OVER VOLTAGE\*) is defined to be when the battery charger voltage is greater than 32V (±1V). When an over voltage is detected, the output of the comparator goes low. This signal is buffered through U2, pins 8-10.

## 2-2. Power Distribution Board (continued)

### Theory of Operation (continued)

The rectified AC voltage is divided by R4 (49.9K $\Omega$ ) and RN6, pins 9-10. When the rectified voltage drops below approximately 29V, the output of comparator U4, pin 1, switches high. The AC OFF and over voltage signals are NORed through U3, pin 11-13. This output is then ANDed with the mode signals that turn the LED's on/off. So when the LED' S OFF signal drops low, the battery charger LED's turn off.

Extended periods of time with a battery charge voltage greater than 32V can damage the battery. The OVER VOLTAGE\* Signal, when it goes low, turns off transistor Q4 (ZTX651). The transistor then turns off the coil of relay K5 which separates the battery from the battery charger.

During normal operation, each of the power supplies provides 20-35 volts DC. The battery charger transformer supplies 33-45VDC after being full-wave rectified on the Power Distribution Board.

The battery operates at 20-27 volts during battery operation. A charge voltage of 13.6-13.8V per battery is required for float and 14.6-15.0V per battery during recharge.

The commons of power supplies PS1, PS2, and PS3, and the battery common are tied together on the Power Distribution board. This is the only location that these commons are tied together. The common of the battery charger transformer is separated from the power supply common by a 0.2 $\Omega$  resistor on the Power Distribution Board.

### Calibration Specification

The Power Distribution board has one trimpot, R3, which adjusts the float voltage from the battery charger power regulator (LM317HVK, located off-board).

The board also offers a 6-pin MTA-100 connector providing test points to monitor the following voltages:  
+15v reg, 2.5v ref, \_\_\_\_\_ and common.

33-45v unreg, 27.85v reg.

## 1-1. System Revision History

- Starting with S/N 4148, all units were built with 2.3M system software.
- Any centrifugal pump with "Delphin™ II" on the module cover has directional flow features; field service handbook insert 34-9998-2784-2 provides new information for the Delphin™ II Modules.
- 4.0M system software started with Central Display 9449 (3M I.D. No. 78-8067-5697-5) which has colored screens; field service handbook insert 34-9998-2784-2 provides new display information.

## 1-1. System Revision History

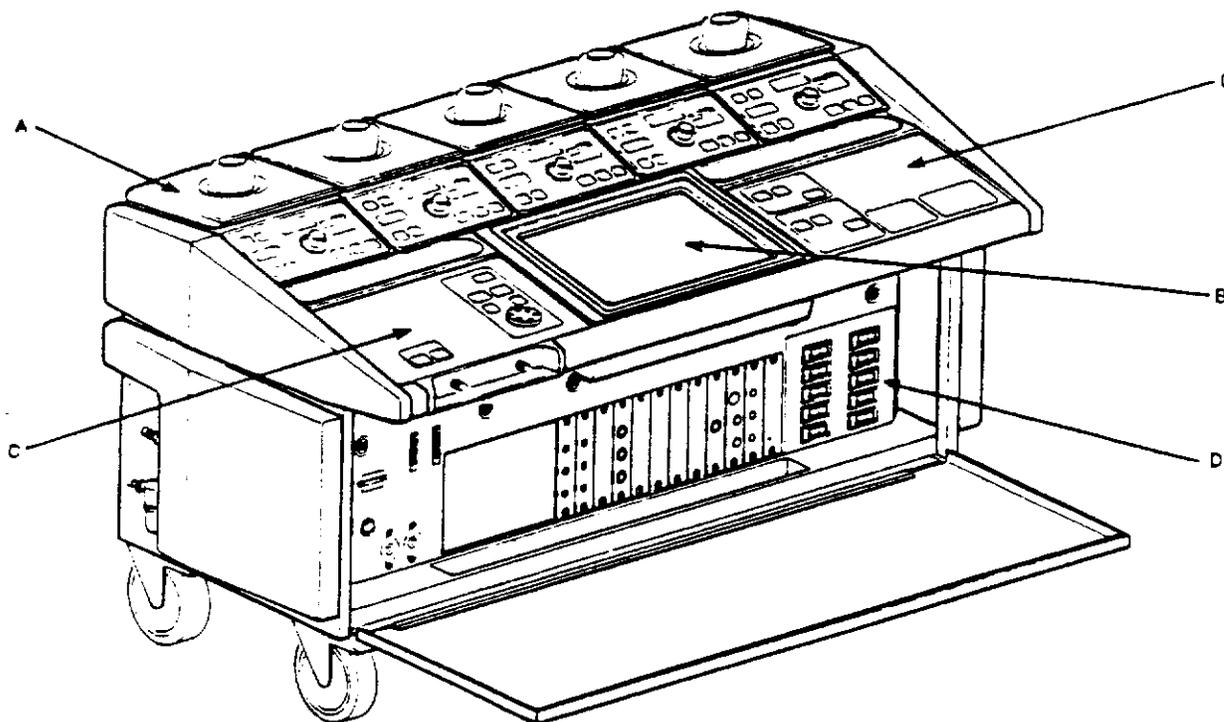
- Starting with S/N 2000, major chassis and electrical changes were implemented to meet TUV requirements.
- All units with serial numbers lower than 3000 that have not been retrofitted with a V-50 upgrade should have version 1.7 system software.
- Starting with S/N 3000, all units were built with the V-50 processor and version 2.1M system software installed.
- Starting with S/N 4000, all units were sent with version 2.21M system software installed. All units with the V-50 processor should be updated per NFC #001-90.
- Starting with S/N 4047, the Level Detector was updated to version 2.3. All others should be updated per NFC #002-90.
- Starting with roller pump S/N 2423, the pump tongue screws were changed from flat head stainless steel screws to Philips oval head zinc plated screws. All other roller pumps should be updated per NFC #003-90.
- Starting with S/N 3058, all units were sent with the new style lamp. All others should be updated per NFC #004-90.
- Starting with S/N 3060, all units were built with a stabilization caster. All others should be updated per NFC #005-90.
- Starting with roller pump S/N 2401, all pumps were built with a snap ring installed in the occlusion knob cap. All other roller pumps should be updated per NFC #006-90.
- Starting with S/N 4005, all units were built with longer bolts for mounting accessories. All others should be updated per NFC #007-90.
- Starting with S/N 3000, all units were built with a modified Air/O<sub>2</sub> mixer bracket. All others should be updated per NFC #008-90.
- Starting with S/N 4006, all units were built with an Improved Communications Adapter printed circuit board (PCB). All other units with the V-50 processor should be updated per NFC #9K-092790.
- Starting with S/N 4053, all units were built with two capacitors removed from the temperature boards. All other units with the V-50 processor should be updated per NFC #9K-100290.
- Level transducers are now built with two guide rings. Check and update all existing level transducers per NFC #9K-100390.

**1-1. System Revision History (continued)**

**This page intentionally left blank to accommodate future updates.**

## 1-2. System Description

### 1-2-1. Product Features



The Sams™ 9000 Perfusion System has 5 pumps and a central display enclosed in a console.

- Each pump (A) has a separate control and display panel, and a safety cover over the roller assembly.
- The central display (B), with both displays and touch controls, is typically mounted on a pole.
- The console exterior panel (C) contains the controls and displays for gases, the line occluder, the air bubble and level detectors, and the battery.
- The console interior panel (D) contains the pump selection controls, circuit breakers, cable connections and the volume control for the audio alarm.
- Accessories mount around the back and sides of the console.

The Sams™ 9000 Perfusion System is designed for versatility and may be easily expanded with additional software or equipment. The system will perform the following functions:

- Pump blood or cardioplegia solutions.
- Blend gases and control their flow rate to the oxygenator.
- Detect gross air bubbles in blood in the arterial line and stop the pump.
- Warn when the reservoir blood level reaches an operator-set minimum.
- Measure temperatures at six sites and pressures at three sites.
- Provide battery power.
- Display the aortic cross-clamp time and perfusion time.
- Send data to the Sams™ Touch and Record Information System.
- Display blood chemistry data from a compatible blood chemistry monitor.
- With the appropriate modules installed, the system allows control of venous blood flow, pulsatile pumping, and delivery of temperature and pressure controlled water to oxygenator and cardioplegia heat exchangers.

## 1-2. System Description (continued)

### 1-2-2. Functional Description

The Sarns™ 9000 Perfusion System allows each pump to be operated independently or as a system with information appearing on the central display. The central display may be mounted in a variety of positions according to the user's preference.

Either a roller or centrifugal pump may be designated for arterial pumping only. Designating a pump as arterial allows the safety features, such as the air bubble detector or the level detector, to stop the "arterial pump". With pulsatile control, the designated arterial pump will produce an asynchronous pulsatile flow according to the speeds, rate, and width time set by the operator.

Designating a roller pump for cardioplegia delivery allows pressure limitation and measurement of the cardioplegia volume delivered. The system may be set so that the safety systems will stop the "cardioplegia pump" whenever they stop an "arterial pump".

Two open channels beneath the console allow cables to be conveniently routed to the front of the console; thus connectors for the temperature and pressure transducers, an air bubble sensor, reservoir level sensors, the console lamp, a line occluder, an external computer and a blood chemistry monitor are easily attached from the front of the console.

The system will blend medical-grades of air (or 95% O<sub>2</sub> and 5% CO<sub>2</sub>) with 100% O<sub>2</sub> to accommodate membrane or bubble oxygenators. It will display the blend and allow adjustment of the gas flow rates. The CO<sub>2</sub> flush rate is preset at 2.5 L/min but may be adjusted by a trained technician.

With an air sensor around the arterial line, the system can detect gross air bubbles in blood in the arterial line, indicate a warning, and stop the arterial pump. With level detector sensors on a rigid reservoir, the system can sense low fluid levels, indicate a low level alert, a low level alarm, and stop the arterial pump.

The system will monitor temperatures of the patient or extracorporeal circuit when a temperature probe is attached to the appropriate system connector. Three connectors are predetermined for arterial, venous, or cardioplegia temperature monitoring; three auxiliary connectors allow the operator to select their use. The temperature readings will appear on the central display.

The system will monitor three pressures: arterial line, cardioplegia line, and an auxiliary pressure. The operator may set pressure limits for the arterial and cardioplegia pumps which will signal an alert or trigger an alarm and stop these pumps. The system will not monitor pressure during pulsatile flow due to extreme pressure variations.

With the line occluder installed, the operator can adjust, rapidly or gradually, the blood flow in the venous line.

With a compatible blood chemistry monitor connected, the system will display blood chemistry information. With the Sarns™ Touch and Record Information System attached, data from the system may be stored and printed.

## 1-2. System Description (continued)

### 1-2-2. Functional Description (continued)

With water mixing installed, hot and cold water from a wall supply is mixed for use with cardioplegia and arterial heat exchangers. The system limits the outlet water to a preset pressure, activates an alert if the temperature exceeds 43°C, and may decrease the outlet flow if there is significant decrease in the cold water supply.

The lamp will illuminate the oxygenator, even when using battery power. All of the wheels swivel and two lock to securely position the console.

The stainless steel, plastic, and membrane surfaces are easily cleaned. Gaskets around the pumps and an internal plate protect the electronics from any spilled fluids. Individual safety covers protect each roller assembly.

The system has many safety features in addition to those already mentioned. The pumps are designed to increase speed gradually - never suddenly. Safety indicators warn the operator when a power supply has failed or the battery is discharging. Separate circuit breakers provide overload protection for the occluder motor, light, battery, the fan and the five pumps. An auxiliary AC-DC power supply is available to supplement either of two main AC-DC power supplies if necessary. The battery pack is constantly being charged when the system is in operation; if an AC power failure occurs, the battery pack will automatically supply power to the system with all the control and display information retained. In case of an electronic failure, the central displays may be lost but the gas blending controls, the pumps, air bubble detector, level detector, and occluder will function.

### 1-2-3. Theory of Operation

Each of the pumps has overcurrent protection from a circuit breaker, and a safety circuit to sense overspeed and stop the pump. The digital and alphanumeric displays of the pump are controlled by the pump's microprocessor. Any pump may be designated for arterial use, allowing safety systems to stop this pump.

The operator sets a number of parameters which the microprocessor-based system uses to adjust the pump speed and to interpret pressures, temperatures, and flow rates. With pulsatile control the system will vary the arterial pump speed over time. The system will interrupt the pump or display messages if pressures, temperatures, flow rates, or other alarm parameters are exceeded.

For temperature monitoring, a thermistor located at the tip of each telethermometer probe senses external temperature. When there is a shift in the external temperature, the electrical resistance of the thermistor changes accordingly. This resistance change is measured by the temperature probe module and transmitted for display.

For pressure monitoring, the transducer senses pressure and converts the pressure signal to an electrical signal; changes in the electrical signal are measured by the pressure module and transmitted for display. The peristaltic action of a roller pump imparts a pressure waveform into the system; the magnitude of this waveform depends upon the tube size, monitoring site, pump flow rate, components (including cannulation) used, line lengths, etc. To minimize the effects of this waveform, pressure channels are sampled several times per second and then the average of nine samples is displayed. Pressure limit alerts are based on the last average reading whereas pressure limit alarms are based on any two consecutive samples.

## 1-2. System Description (continued)

### 1-2-3. Theory of Operation (continued)

To detect gross air bubbles, an infrared light is sent out toward a photodiode receptor. Normally the light is blocked by blood in the arterial line; if air bubbles are present or if clear or low hematocrit (see Specifications) fluid is being pumped, the light will pass through the air to the receptor and trigger an alarm. Extreme care should be taken when pumping such fluids as it is necessary to turn the air detection off.

For gas flow, the inlet pressure of the air (or 95-5) and oxygen are balanced; then these gases are blended by a manually adjusted proportioning valve. Total gas flow is controlled by a manually adjusted needle valve. Three electronic mass flowmeters measure the actual flow before blending and the total flow of blended gas. The values for total flow and  $\text{FiO}_2$  are calculated by the central computer from the flowmeter signals and then transmitted to the central display.  $\text{FiCO}_2$  are calculated and displayed when using 95-5.

For level detection, an ultrasonic sensor is coupled to the outside of the reservoir with an ultrasonic gel. A signal is transmitted through the wall of the reservoir. If fluid is present, most of the transmitted signal is dissipated through the fluid and a small signal returns to the sensor. A large returning signal indicates the presence of air, either inside the reservoir or between the sensor and the reservoir wall. Because the ultrasonic sensor functions regardless of the hematocrit, level detection may be tested during set up of the system.

For the line occluder, the distance the occluder mechanism extends is converted into a percentage of flow for fluid in the line.

For centrifugal pumping, the module controls and provides power to the drive motor, which then turns the pump impeller. The spinning impeller of the pump imparts rotary motion to the incoming blood, containing and directing the blood through the outflow port. Inordinately high outflow resistances, such as clamping the outflow tubing, are not accompanied by high pump pressure increases.

The flow sensor emits an ultrasonic signal from a transmitting transducer; the signal reflects off the red blood cells to the receiving transducer. The Doppler shift of the ultrasonic "echo" relative to the flow velocity determines the blood flow rate.

For water mixing, a valve manually mixes the water and a thermostatic element compensates for small changes in the inlet supply. Pressure regulators limit the outflow pressure.

## 1-3. System Specifications

### Electrical Power Supply

Voltage: 90-110 V~ (100 V, nominal)  
103.5-126.5 V (115 V, nominal)  
198-264 V~ (220-240 V, nominal)

Frequency: 50/60 Hz

Circuit Breaker Protection: 16 Amps (100 or 115 V~)  
8 Amps (220 or 240 V~)

Typical Power Consumption: 7.0 A (100 or 115 V~)  
3.5 A (220 or 240 V~)

Leakage Current: 100  $\mu$  A maximum

Ground Resistance: 0.1 Ohm maximum

### Environmental

Operate at 10° to 40°C, 5 to 95% humidity.

Store in ventilated area, 53°C maximum, up to 100% non-condensing humidity.

### Transportation

Units may be transported up or down an incline of up to 15 degrees without tipping.

### Tubing

Use flexible polyvinyl chloride (PVC) tubing or other medical grade tubing that is appropriately indicated by the tubing manufacturer for use in roller pumps. Select the tubing according to the additional specifications listed for the features.

### Roller Pump

#### Requirements

Tubing with a maximum outer diameter of 3/4 in. (19.0 mm) and wall thickness range of 1/16-3/32 in. (1.6-2.4 mm).

Recommended durometer range is 58-68.

#### Performance

Speed: At 0-200 RPM, display accuracy is +/- 2 RPM; resolution is 1 RPM.

From 200 RPM to a value within 248-258 RPM, display accuracy is +/- 1% of actual speed; resolution is 1 RPM.

Flow Rate: At .00-9.99 L/min and 20-40°C, display accuracy is +/- 8% of actual and resolution is 0.01 L/min. Displays 999 when > 9.99 L/min.

Operating Modes: Continuous or Asynchronous pulsatile.

### 1-3. System Specifications (continued)

#### Centrifugal Pump

##### Requirements

Pump connections use 3/8 in. (9,5 mm) I.D. tubing.

Flow Sensor 164271 needs 3/8 in. (9,5 mm) I.D. x 1/16 in. (1,6 mm) wall tubing.

Flow Sensor 164272 needs 3/8 in. (9,5 mm) I.D. x 3/32 in. (2,4 mm) wall tubing.

##### Performance

Speed display range is 0-9999 RPM.

Actual speed range is 0-3600 RPM.

Flow sensing range is 0.7 - 7.0 L/min.

Flow sensing accuracy is +/- 0.1 L/min within a range of 0.7 - 1.0 L/min and +/- 10% within a range of 1.0 - 7.0 L/min.

Outflow capacity is 0-9.9 L/min.

Outflow pressure is 0-700 mmHg.

Flow display range with a sensor for 3/8 in. (9,5 mm) ID tubing is 0.50 - 9.90 L/min in 0.1 increments. Displays 999 when > 9.90 L/min.

Operating modes: Continuous flow or Asynchronous pulsatile.

#### Pulsatile Control

Base setting is 0-100% of pulse height and resolution is 5%.

Rate with a roller pump is 26-150 BPM; display accuracy is +/- 2 BPM; resolution is 2 BPM .

Rate with centrifugal pump is 60 beats per minute.

Width time with roller pump is 0-100% of pulse time and resolution is 5% .

Width time with a centrifugal pump is 50% of pulse time.

#### Gas Blending

##### Requirements

Gas outlet tubing must have 1/4 in. (6,4 mm ) I.D.

Use medical grade gases (e.g. compressed air, 95% oxygen and 5% CO<sub>2</sub>, 100% CO<sub>2</sub> and 100% oxygen).

Supply pressures must be 50 psi +/- 10 psi (345 kPa +/- 69 kPa).

##### Performance

When operating at room temperature, under normal atmospheric pressure: FiO<sub>2</sub> range is 0.21-1.00 with a display accuracy of +/- 0.03 and 0.01 resolution. FiCO<sub>2</sub> has range of .000-.050 with +/- .005 display accuracy and .001 resolution.

With a gas outlet flow of 0.20-2.00 L/min, the display accuracy is +/- 0.10 L/min and resolution is 0.05 L/min . From 2.00-9.90 L/min, the display accuracy is +/- 0.20 L/min and resolution is 0.10 L/min.

All three displays show zeros when the outlet flow is < 0.20 L/min. The gas display shows "999" when >9.99 L/min. The FiO<sub>2</sub> and FiCO<sub>2</sub> displays are blank when incoming oxygen, air, or 95-5 exceed 20 L/min. Flush rate is preset between 2-10 L/min.

### 1-3. System Specifications (continued)

#### Delphin™ II Module

##### Requirements

Pump connections use 3/8 in. (9,5 mm) I.D. tubing.

Flow Sensor 164271 needs 3/8 in. (9,5 mm) I.D. x 1/16 in. (1,6 mm) wall tubing.

Flow Sensor 164272 needs 3/8 in. (9,5 mm) I.D. x 3/32 in. (2,4 mm) wall tubing.

##### Performance

Speed range: 0-3600 RPM (no load).

Flow display range: 0.00 - 9.90 L/min, positive and negative.

Flow display numbers flash on the module when indicating negative flows.

Display changes in 0.05 increments from 0.0 to  $\pm 1.5$  L/min.

Display changes in 0.10 increments from  $\pm 1.5$  to 9.9 L/min.

9.90 indicates flow rate of magnitude  $\geq 9.90$  L/min.

##### Flow sensing accuracy:

$\pm 0.1$  L/min within a range of 0.3 - 1.0 L/min, positive and negative.

$\pm 10\%$  within a range of 1.0 - 7.0 L/min, positive and negative.

Note: Above performance specifications were obtained using medical grade polyvinylchloride tubing, type S-50-HL. Flow rate accuracy is specified for human blood of hematocrit 10-40%, at  $\leq 38^\circ\text{C}$ , using continuous flow.

Outflow capacity: 0-9.9 L/min. Outflow pressure is 0-700 mmHg.

Modes: Continuous flow or asynchronous, pulsatile flow.

#### Temperature Monitoring

For temperature range, "49.9 °C" should be "50 °C".

#### Pressure Monitoring

Note: Monitoring in units of kPa is not available with system software 4.0.

### 1-3. System Specifications (continued)

#### Temperature Monitoring

##### Requirements

Use YSI (Yellow Springs Instruments) 400 series temperature probes or an equivalent probe so indicated by the manufacturer.

##### Performance

Between 0.0°-49.9°C, monitors with +/- 0.3°C display accuracy and 0.1°C resolution. Displays "- - -" when < 0.0°C or no probe; displays "999" when > 49.9°C or a partially connected probe. Display is blank if an electronic module malfunctions.

#### Pressure Monitoring

##### Requirements

Sarns™ Pressure Transducers, P/N 78-8066-6721-4, are specified because they have a detection range of -50 to 999 mmHg; they may be used with any disposable diaphragm dome which is compatible with the Spectramed P23 XL. If equivalent pressure probes are used and the pressure peaks exceed the probe detection capability, all pressure displays will be inaccurate and the pressure limit warnings will have a restricted range. Alternative probes must meet AAMI standards for physiologic pressure probes and will require an adapter cable from Fogg Systems Co, Aurora CO.

##### Performance

Monitors pressures of -45 to 990 mmHg or -6.7 to 133.2 kPa.

Static conditions: at -45 to 100 mmHg, display accuracy is +/-10 mmHg and resolution is 5 mmHg; at 100 to 500 mmHg, display accuracy is +/- 10 mmHg and resolution is 10 mmHg; at 500 to 990 mmHg, display accuracy is +/- 20 mmHg and resolution is 10 mmHg.

Dynamic conditions: at -45 to 990 mmHg, display accuracy is +/- 40 mmHg with a dynamic variation of 150 mmHg maximum; resolution is the same as for static pressure ranges.

Display shows "- - -" at < -45 mmHg or no probe; it shows "999" at > 990 mmHg. Display is blank if an electronic module malfunctions.

#### Air Detection

1/4 Air Sensor (P/N 15020) requires clear, flexible PVC tubing of 1/4 in. (6,4 mm) I.D. x 1/16 in. (1,6 mm) wall. The 1/4 Air Sensor detects bubbles of 0.5 ml or larger at flow rates up to 3 L/min in blood with a hematocrit of 15-40%.

3/8 Air Sensor (P/N 13540) requires clear, flexible PVC tubing of 3/8 in. (9,5 mm) I.D. x 3/32 in. (2,4 mm) wall. The 3/8 Air Sensor detects bubbles of 1 ml or larger at flow rates up to 6 L/min in blood with a hematocrit of 15-40%.

### 1-3. System Specifications (continued)

#### Level Detection

##### Requirements

Level detection requires that the fluid level in the reservoir be within  $\pm 0.2$  in. (0.5 cm) from the horizontal center line of the level sensor pad.

Functions only with clear hard-shell reservoirs of acrylic, PVC, butadiene styrene or polycarbonate which have a wall thickness of 0.03-0.10 in. (0.8- 2.5 mm).

##### Performance

Alert and alarm signals do not activate when sensing water, priming solutions or blood of any hematocrit. Alert and alarm signals do activate when detecting air, foam and internal blood film.

#### Line Occluder

##### Requirements

Minimum tubing size is 1/4 in. (6.4 mm) I.D. x 1/16 in. (1.6 mm) wall; maximum tubing size is 1/2 in. (12.7 mm) I.D. x 3/32 in. (2.4 mm) wall.

##### Performance

Display range of 0-99%. Display accuracy is  $\pm 12\%$  of maximum possible flow with blood at 20-40°C and a vertical height of 20-36 in. (50.8 - 91.4 cm) from the fluid level in the venous reservoir to the patient. Accuracy requires proper zeroing and no back pressure.

Displays the approximate percent of flow for 3/8-1/2 in. (10.0 - 12.0 mm) I.D. tubing only; displays a reference number only for other tubing sizes.

#### Water Mixing

##### Requirements

Nominal inlet pressure must be 40-80 psi; pressure may fluctuate up to  $\pm 20$  psi but must remain within 40-80 psi. This inlet pressure should be at least 5 psi higher than the setting for the pressure regulators. Both pressure regulators must be set to the same pressure limit, either at or below the pressure rating of the heat exchangers to be used and within 35-75 psi.

Inlet hot water must be 44-65°C. Inlet cold water must be appropriate for arterial and cardioplegia cooling.

Inlet fluctuations beyond  $\pm 20$  psi and  $\pm 5$ °C may affect outlet temperature and flow rate. Water mixing valves must be adjusted for the inlet conditions at each hospital in order to limit output to 42°C.

Minimum flow rate of 10 liters/min is required.

##### Performance

Delivers water flow of 5 liters/min or greater.

Limits water pressure to the preset pressure limit  $\pm 5$  psi.

Activates alert at temperatures  $> 43$ °C (109.4°F).

Capable of delivering water no more than 3°C above the cold inlet temperature and up to 42°C.

Outlet accuracy is  $\pm 1$ °C when the inlet requirements are met.

### 1-3. System Specifications (continued)

#### Emergency Power

Battery Pack (two 12 volt, sealed lead-acid batteries) will power the entire system for 60 minutes, or power the arterial pump and safety systems for 120 minutes.

#### Dimensions

	<u>Console</u>	<u>Pump</u>	<u>Central Display</u>
Height:	25.3 in. (64,3 cm)	8 in. (20,3 cm)	10.5 in. (26,7 cm)
Width:	45.3 in. (115,1 cm)	8-3/4 in. (22,2 cm)	14.1 in. (35,8 cm)
Depth:	24.0 in. (61,0 cm)	14 in. (35,6 cm)	3.2 in. (8,1 cm)

Weight: approximately 31 lbs (14.5 kg) roller pump; 15 lbs (6.8 kg) centrifugal pump; total system 470 lbs (213 kg). Additional 60 lbs. (27.2 kg) with water mixer.

Telescoping Pole: 1.30 in. (3,3 cm) diameter, 6-7 ft. (1,8 - 1,9 m) height.

Water Mixer adds 4 in. (10,2 cm) to the height of the system.

Pump Head Diameter: 6 in. (15,2 cm).

## 2-1. Required Tools, Test Equipment, and Supplies

The following items are required to service the Sarns™ 9000 Perfusion System:

Item	Sarns P/N	3M P/N	Description
1	N/A	26-1008-3763-7	Flowmeter, 1.0 to 10 L/min.
2	N/A	26-1008-3782-7	Oxygen Analyzer, TED 60-J
3	N/A	78-8066-6853-5	Gas Pressure Tester, SVC
4	N/A	78-8066-7139-8	Belt Tension Gauge
5	N/A	78-8066-7954-0	Pressure Simulator
6	13771514	78-8067-7137-2	Occlusion Knob Bearing Insertion Tool
7	N/A	78-8066-1686-2	Pump Calibration Fixture
8	13771518	78-8066-7138-0	Extender Board
9	13771521	78-8066-7140-6	Torx Driver Kit
10	16432901	98-0702-0272-0	Level Sensor Pads (20 per package)
11	N/A	26-1008-0430-6	Current Adapter, Fluke Meter, Y8101
12	10679010	78-8066-6969-9	Tubing Insert Screwdriver
13	13771511	78-8066-8659-4	Ground Leakage Box
14	14837010	78-8066-7253-7	Insulated Screwdriver, Small
15	N/A	26-1008-6116-5	Nut Driver, 3/8"
16	20030031	26-1008-4445-0	Screwdriver, Medium Blade
17	20030032	26-1006-6759-6	Offset Screwdriver
18	20030041	26-1008-5018-4	Fluke 8060A DVM
19	20030044	26-1008-5074-7	Digital Tachometer, DT107
20	20030048	26-1008-5019-2	Soft Face Hammer
21	20030049	26-1008-4061-5	Snap Ring Pliers, Small External
22	N/A	78-8066-7632-2	Snap Ring Pliers, Modified External
23	20030051	26-1007-6794-1	Snap Ring Pliers, Internal
24	20030070	26-1008-5017-6	Allen Hex Key Set
25	20030095	26-1006-6760-4	Ball Driver 3/16"
26	N/A	26-1008-2910-5	Viking Pin Extraction/Insertion Tool
27	13771005	78-8066-7119-0	Deluxe Bushing Driver
28	13771010	78-8066-7121-6	Deluxe Roller Post Punch

## 2-1. Required Tools, Test Equipment, and Supplies (continued)

Item	Sarns P/N	3M P/N	Description
29	13771012	78-8066-7122-4	Adjustment Nut Puller
30	13771014	78-8066-7123-2	Spanner Wrench
31	13771062	78-8066-7128-1	DX Roller Post Punch
32	13771063	78-8066-7129-9	DX Roller Adjustment Tool
33	13771066	78-8066-8655-2	Roller Bearing Insertion Tool
34	13771501	78-8066-7130-7	Torque Wrench Fixture
35	13771502	78-8066-7131-5	Tachometer Fixture
36	13771504	78-8066-7132-3	Custom to Deluxe Adapter
37	13771505	78-8066-7133-1	Roller to Roller Mounting Bar
38	13771507	78-8066-7134-9	DX Casting Runout Fixture
39	13771513	78-8066-8660-2	Water System Test Fixture (if installed)
40	16522201	78-8066-7577-9	Dial Indicator Kit
41	20030045	26-1008-4332-0	Torque Wrench, 0-100 in/lbs
42	20030046	26-0001-7472-7	Reamer
43	20030047	26-1008-5072-1	Torque Screwdriver, 6-26 in/lbs
44	N/A	78-8067-1661-5	Air Sensor Fixture
45	N/A	78-8067-1662-3	3/8 Air Sensor Attenuator
46	N/A	78-8067-1663-1	1/4 Air Sensor Attenuator
47	N/A	78-8066-9340-0	47° Temperature Probe
48	N/A	78-8066-9341-8	25° Temperature Probe
49	N/A	78-8066-6425-0	Centrifugal Pump Drive Motor Fixture

## 2-2. Changing Operating Modes

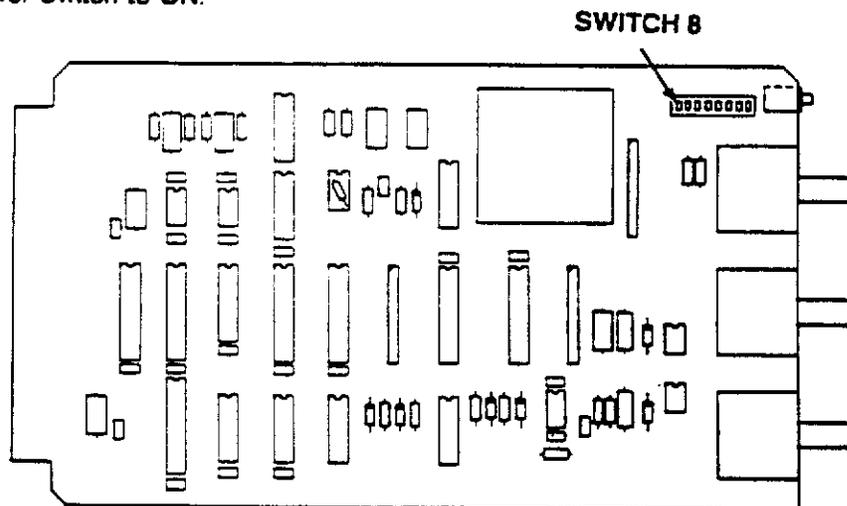
### 2-2-1. Setting the System to Diagnostic Mode

1. Set the Power Switch to OFF.
2. Using static precautions, remove the Digital Interface Board from Slot #11.
3. Remove the black module cover.
4. Set Switch #8 to the closed position.
5. Install the board into Slot #11.
6. Set the Power Switch to ON. After the system completes a normal startup routine, the Service Diagnostics Screen appears on the Central Display.

**Caution:** Never calibrate the Flow Sensors with gas connected. Doing so will result in inaccurate gas flow readings.

### 2-2-2. Returning the System to Normal Operating Mode

1. Set the Power Switch to OFF.
2. Using static precautions, remove the Digital Interface Board from Slot #11.
3. Remove the black module cover.
4. Set Switch #8 to the open position.
5. Replace the black module cover.
6. Install the board into Slot #11.
7. Set the Power Switch to ON.



## 2-3. EM/PM Procedures

### 2-3-1. Preliminary Inspection

**Note:** Fill out an Inspection Report, form number 78-8066-6132-4, to document the inspection.

**Caution:** Start the system using AC power. Starting the system with battery power and then initiating AC power may cause malfunction of the AC/DC service indicators, pump 3, lights, etc.

1. Note any customer comments on the Inspection Report.
2. Record the machine part number, serial number, run hours, and software version.
3. Note the general appearance of the unit. Record any findings, such as broken covers, modifications, missing parts, etc.
4. Measure and record the line voltage. Check the condition of the power cord and strain relief.
5. Measure the system leakage current in normal polarity, then switch off the system, reverse the polarity, and recheck the leakage current. If it is greater than 100 microamps, refer to the troubleshooting section.
6. Power up the unit. Observe that all console LED's light, the dual tone sounds, and then the following occurs:
  - a. The air detector OFF and RESET LED's remain lit.
  - b. The level detector OFF LED remains lit.
  - c. The AC power source LED remains lit.
  - d. One charge status LED remains lit to indicate the charging status as follows:
    - Green indicates fully charged.
    - Yellow indicates constant voltage
    - Red indicates constant current.
  - e. The green LED below the battery symbol remains lit to indicate that battery power is available.
  - f. If an occluder is installed, the manual LED remains lit and the display remains blank.
  - g. All fans are running: three on the console, one in each pump, and one in the central display.
7. The central display lists the pass/fail checks. Note any failures, then turn the unit off, wait ten seconds, and turn it back on. If the fail message reappears, refer to the troubleshooting section.
8. Check the following for each roller pump:
  - a. The stop and manual LED's are lit and the flow rate display is blank.
  - b. The message display shows the following in sequence: Reset (each pump relay clicks once), tube size or RPM, 6-10 second delay, software version, run hours, FAIL 1, FAIL 2, FAIL 3, FAIL 4, FAIL 5, FAIL 6, and then back to tube size or RPM.
  - c. If the message display stops on any fail message, note the message number, then turn the machine off, wait ten seconds, and turn it back on. If the failure repeats, refer to the troubleshooting section.

## 2-3. EM/PM Procedures (continued)

### 2-3-1. Preliminary Inspection (continued)

With software 4.0, check the colors on the screens.

#### 10. Record the existing operator settings:

With 4.0 software check that the following colors appear on the Start-Up Test screen.

Light yellow for the "Warning: Read..." text.

Light aqua for the software "Version..." text.

Dark gray for border around diagnostics.

- a. Touch "Customize" on the Start-Up Test Screen.
- b. Record if "STOP CPG WITH ART" is highlighted on the Selection Screen.  
With 4.0 software, record if "No" appears on the button for "Stop CPG with Arterial"; "yes" is the default.
- c. Touch "CUSTOMIZE DISPLAYS". Record if it is set for mmHg or kPa.  
With 4.0 software the "Customize Displays" button is removed and pressure units are available in mmHg only.
- d. Touch "BLOOD CHEMISTRY" and then "CDI" (if installed).  
With 4.0 software, Blood Chemistry is always installed; record if "CDI" or "Standard" appears on the button.
- e. Touch "TITLE SCREEN" and then "MAIN SCREEN".  
Starting with 2.3 and 4.0 software, touch "Main Screen New Case" or "Main Screen Current Case".
- f. Record the ART pump number from the Pulsatile Screen (if installed), the pump Message Display, or the Digital Interface Board.
- g. Record the CPG pump number from the Cardioplegia Screen, the pump Message Display, or the Digital Interface Board.
- h. Record the tube size or flow constant shown in the Message Display of each Roller Pump.
- i. If a Centrifugal Pump is installed, press the Select switch on the pump and record the calibration number and the minimum flow alert level.
- j. If the pulse option is installed, touch "PULSE" on the Main Screen. Record the rate, width, and base values displayed on the Pulsatile Screen.
- k. Touch "SETUP", then "LIMITS". Record the arterial and cardioplegia alert and alarm limits.
- l. Record the FiO<sub>2</sub> alert limit and the O<sub>2</sub> blend.
- m. Touch "AUX DATA". Record the temperature labels for A, B, and C.
- n. Open the Front Door and locate the Level Detector Board in Slot 10. Record the switch position.
- o. Check to see that all the transducer cables installed in the Front Tray modules are marked. If not, mark them or draw a chart or diagram showing where each transducer is connected.
- p. Extend the Front Tray (refer to Procedure 4-3-1). Connect the negative lead of a DVM to the DC/DC convertor ground test point on the Power Control Board (refer to Page 3-1 for test point location). Connect the positive lead to any metal point on the chassis. The DVM reading must be 250 megohm or greater (with power off, the reading should be stable; with power on, the reading will fluctuate); if not, refer to the troubleshooting section.

**2-3. EM/PM Procedures (continued)****2-3-1. Preliminary Inspection (continued)**

9. Check the battery power:
  - a. Place all the pumps in forward or reverse and turn the flowrate knob fully clockwise.
  - b. Unplug the power cord from the AC source and check that the following occurs:
    - All the pumps continue to operate.
    - The main fan slows.
    - The green LED above the battery symbol lights.
    - The LED bar graph below the battery symbol lights to indicate the amount of battery power available. Refer to the troubleshooting section if only the red LED's light.
  - c. Plug the power cord into the AC source. Check for and note any abnormal operation.

Note: Power interruption may cause the pumps to go through the startup routine and may cause a centrifugal pump to stop.

- d. Stop all the pumps and turn each flowrate knob fully counter-clockwise.
10. Record the existing operator settings:
    - a. Touch "CUSTOMIZE" on the Start-Up Test Screen.
    - b. Record if "STOP CPG WITH ART" is highlighted on the Selection Screen. *Y*
    - c. Touch "CUSTOMIZE DISPLAYS". Record if it is set for mmHg or kPa.
    - d. Touch "BLOOD CHEMISTRY" and then "CDI" (if installed). *Y*
    - e. Touch "TITLE SCREEN" and then "MAIN SCREEN".
    - f. Record the ART pump number, which can be found on the Pulsatile Screen (if installed), the pump Message Display, or the Digital Interface Board. *219*
    - g. Record the CPG pump number, which can be found on the Cardioplegia Screen, the pump Message Display, or the Digital Interface Board.
    - h. Record the tube size or flow constant shown in the Message Display of each Roller Pump. *14*
    - i. If a Centrifugal Pump is installed, press the Select switch on the pump and record the calibration number and the minimum flow alert level.
    - j. If the pulse option is installed, touch "PULSE" on the Main Screen. Record the rate, width, and base values displayed on the Pulsatile Screen. *60 200*
    - k. Touch "SETUP", then "LIMITS". Record the arterial and cardioplegia alert and alarm limits. *300 200 400/120*
    - l. Record the FIO<sub>2</sub> alert limit and the O<sub>2</sub> blend. *20 100*
    - m. Touch "AUX DATA". Record the temperature labels for A, B, and C. *200, 100/80, 100*
    - n. Open the Front Door and locate the Level Detector Board in Slot 10. Record the switch position.
    - o. Check to see that all the transducer cables installed in the Front Tray modules are marked. If not, mark them or draw a chart or diagram showing where each transducer is connected.
    - p. Extend the Front Tray (refer to Procedure 4-3-1). Connect the negative lead of a DVM to the DC/DC convertor ground test point on the Power Control Board (refer to Page 3-1 for test point location). Connect the positive lead to any metal point on the chassis. The DVM reading must be 250 megohm or greater (with power off, the reading should be stable; with power on, the reading will fluctuate); if not, refer to the troubleshooting section.

## 2-3. EM/PM Procedures (continued)

### 2-3-2. System Inspection

1. Replace the air filters. Refer to Procedure 4-5-1.
2. Replace the water trap filter (every six months or as needed). Refer to Procedure 4-2-1. (*Rear of unit*)
3. Check to see that both cable<sup>FOAM</sup> channel plugs are in place. (*front tray*)
4. Start the pump, clamp, and auxiliary timers.
5. Check the cardioplegia delivery recording. This is essentially checking communications between the CPU and the CPG pump:
  - a. Touch "CARDIOPLEGIA" on the Main Screen.
  - b. Select a pump (1 to 5) as the cardioplegia (CPG) pump by turning the CPG switch on the Digital Interface Board. The pump number selected will be displayed at the top of the Cardioplegia Screen, and "CPG" will appear on the pump message display.
  - c. Select a tube size for the CPG pump.
  - d. Press both Forward switches to start the pump; set the speed to 50 RPM.
  - e. Touch "START RECORDING DELIVERY" on the Cardioplegia Screen. The amount of CPG delivered is displayed in cc's.
  - f. Touch "STOP RECORDING DELIVERY". The "TIME SINCE LAST DELIVERY" clock appears.
  - g. Touch "START RECORDING DELIVERY". The cc amount resets to zero briefly and then begins to increase. The "TOTAL VOLUME" increases as the sum of the former and current delivery.
  - h. After verifying the recording of cardioplegia delivery, stop the CPG pump.
6. Check the air bubble detector: (*Infrared Type*)
  - a. Record the air sensor part number and serial number.
  - b. Block the air sensor with an opaque object.
  - c. Press the air detection RESET switch on the right fixed panel until the red LED is no longer lit.
  - d. Press the air detection ON switch.
  - e. Press the Forward switches on the ART and CPG pumps. Turn the speed knobs on both pumps to mid range.
  - f. Remove the opaque object from the air sensor. The ART pump stops, the alarm sounds (and repeats once per minute), and the "AIR DETECTED" message appears on the Main Screen. The CPG pump will also stop if it has been customized to stop with ART.
  - g. Press the air detection OFF switch. The "AIR DETECTED" message disappears, the alarm stops, and the pump(s) can be restarted.
  - h. Check and record the pulse width, period, DC supply, reference voltage, sensor signal voltage, and signal threshold.
    - Install the Air Sensor Fixture.
    - Connect the common lead of the scope to Pin 6. Turn on the air detector. It will alarm during the following four steps.
    - Connect the scope to Pin 5. The pulse width should be 45 - 65 microseconds. The period should be 1250 - 1600 microseconds.
    - Connect the scope to Pin 2. The DC supply should be 7.8 - 8.25 VDC.
    - Connect the scope to Pin 4. The 2.50 VDC reference voltage should be 2.48 - 3.00 VDC.

## 2-3-2 System Inspection

### 6-1. Check the Ultrasonic Air Sensor

Required tools: 50 MHz Oscilloscope and 10x probe

Air Sensor Test Box, 3M ID 78-8067-1661-5

Adapter Cables, 3M ID 78-8067-6710-5,

3M ID 78-8066-6734-7

Tubing, 1-2 feet (0.3 m - 0.6 m): 3/8 in x 3/32 in (9,5 mm x 2,4 mm) for RED air sensor

1/4 in x 3/32 in (6,4 mm x 2,4 mm) for GOLD air sensor

1/4 in x 1/16 in (6,4 mm x 1,6 mm) for BLACK air sensor

Record the part number and serial number of the ultrasonic air sensor.

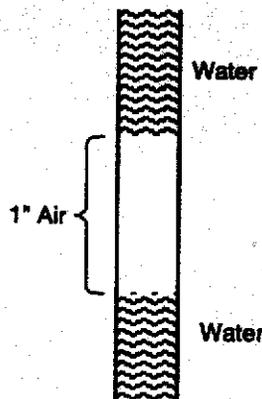
Note: Do not use gel with the ultrasonic air sensor.

- a. Prepare a 1-2 ft. length of water filled tubing. Make sure to entrap a tube-filling bubble of at least 1 inch (2,54 cm) in length. Clamp the ultrasonic air sensor onto the tubing. Do not position the sensor upside down, cover toward floor, as bubbles may go undetected. The tubing must be the appropriate diameter for the sensor.

3/8 in x 3/32 in (9.5 mm x 2.4 mm) for RED air sensor

1/4 in x 3/32 in (6.4 mm x 2.4 mm) for GOLD air sensor

1/4 in x 1/16 in (6.4 mm x 1.6 mm) for BLACK air sensor



Note: This represents a bubble significantly larger than 0.5 ml.

- b. Tilt the tubing and air sensor to force any bubbles out of the sensor area. Insure that the tubing is fluid filled at the air sensor and that no air bubbles are present in this area.
- c. Press and hold the air detection "RESET" switch on the right fixed panel, until the red LED is no longer lit.
- d. Press the air detection ON switch.
- e. Press the forward switches on the ART and CPG pumps and turn the speed knobs to midrange. The ART and CPG pumps are designated by the pump select module.
- f. Tilt the ultrasonic air sensor to force a 0.5 ml or larger air bubble to pass through the sensor.

**2-3-2 System Inspection (continued)****6-1. Check the Ultrasonic Air Sensor (continued)**

- g. The ART pump should stop; the CPG pump should stop if CPG is customized to stop with ART; "Air Detected" message should appear on the main screen; and the audible alarm should sound.
- h. Tilt air sensor to force any air bubbles away from the sensor area. Press and hold the "RESET" switch on the right fixed panel, until the red LED is no longer lit. All messages and alarms should stop. Restart the pumps. Turn air detection system off.
- i. Connect the Air Sensor Test Box to the ultrasonic air sensor and to the air detection module in the front tray.
- j. Tilt the air sensor to force any air bubbles away from the sensor area. Turn the potentiometer on the test box fully counterclockwise. Press and hold the "RESET" switch until the red LED is no longer lit. Press the air detection ON switch.
- k. Connect the scope probe to ground TP6 on the test box. Connect the scope probe to TP2 on the test box. The voltage reading should be  $8.0 \pm 0.2$  VDC. If not, proceed to Step q.  $8V \pm .4V \rightarrow$  This may change in future
- l. Connect the scope probe ground to TP6 on the test box. Connect the scope probe to TP4 on the test box. The voltage reading should be  $2.5 \pm 0.1$  VDC. If not, proceed to Step q.
- m. Measure the pulse width and pulse period. Connect the scope probe ground to TP6 on the test box. Connect the scope probe to TP5 on the test box. The displayed pulse amplitude must be between 2.5 VDC and 8 VDC with a width of 45-65 microseconds. The displayed pulse period should be 1250-1600 microseconds. If not, proceed to Step q.
- n. Connect the scope probe ground to TP6 on the test box. Connect the scope probe to TP1 on the test box. Verify that the potentiometer on the test box is turned fully counterclockwise. Tilt the air sensor to force a 0.5 ml or larger air bubble to pass through the sensor. The air detector should alarm. The displayed voltage level should have a minimum amplitude of 4.4 VDC. If not, proceed to step q. Tilt the air sensor to force the air bubble out of the sensor area. Press the "RESET" switch.
- o. Tilt the air sensor to force all the air bubbles out of the sensor area. With the scope probe ground connected to TP6 and the scope probe connected to TP1, turn the potentiometer on the test box clockwise until the alarm sounds. The voltage reading should be 0.8 VDC - 1.5 VDC. If not, proceed to step q. Turn the potentiometer fully counterclockwise before proceeding to the next step.
- p. Disconnect the test box. Connect the ultrasonic air sensor and the air sensor cord to the air detection module.
- q. If the specified voltages or wave forms are not obtained, check all connections at the air sensor and the air detection module in the safety monitor. Verify that all pins are intact. Systematically replace air sensor cable, the air sensor, then the air detection module. Check for the appropriate voltage or wave form after each replacement. Continue the inspection.

## 2-3. EM/PM Procedures (continued)

### 2-3-2. System Inspection

With software 4.0, check color and two timers.

5. Check the cardioplegia delivery recording. This is essentially checking communications between the CPU and the CPG pump:
  - a. Touch "Cardioplegia" on the Main Screen. Check that the background for the values is purple in color.
  - b. Select a pump (1 to 5) as the cardioplegia (CPG) pump by turning the CPG switch on the Digital Interface Board. The pump number selected will be displayed at the top of the Cardioplegia Screen, and "CPG" will appear on the pump message display.
  - c. Select a tube size for the CPG pump.
  - d. Press both Forward switches to start the pump; set the speed to 50 RPM.
  - e. Touch "Start" and the following should occur:
    - Delivery Duration timer starts.
    - Current volume counter starts recording in mLs.
    - Total volume counter starts recording in mLs.
  - f. Touch "Stop" and the following should occur:
    - Delivery Duration timer stops.
    - The Time Since Last Delivery timer resets and starts.
    - Current and Total volume counters stop with the last values displayed.
  - g. Touch "Start" again. Verify the following:
    - Time Since Last Delivery timer stops with the last values displayed.
    - Delivery Duration timer resets and starts.
    - Current volume counter resets and starts recording in mLs.
    - Total volume increases as the sum of the former and current delivery.
  - h. After verifying the recording of cardioplegia delivery, stop the CPG pump.

**2-3. EM/PM Procedures (continued)****2-3-2. System Inspection (continued)**

8. Check the occluder (if installed):
  - a. Install tubing as described in the Line Occluder section of the 9000 Perfusion System Operators Manual.
  - b. Press the Open switch on the left fixed panel, then press the Close switch. When fully closed, the occluder display reads "0", and the "VENOUS LINE OCCLUDED" message appears on the Main Screen.
  - c. Press the Open switch. The number in the occluder display increases rapidly to 99, and the "VENOUS LINE OCCLUDED" message disappears from the Main Screen.
  - d. Press the Close switch. Fill the tube with water. With a one meter head of water above the occluder, no water should pass through the tube. If it does, perform Procedure 3-4-1 (Occluder Drive Board Calibration).
  - e. Verify that the manual control knob opens and closes the occluder.
9. Check the pressure displays:

**Warning: Pressure transducer cables without transducers attached must be disconnected from the console; cables without transducers act as antennae and may stop the pump.**

- a. Touch "SETUP" on the Main Screen.
- b. Install the Pressure Board Test Fixture into the ART jack on the Pressure Module in Slot 4. Set the fixture to "0" and "+".
- c. Touch "ZERO" on the Setup Screen, then touch "ARTERIAL". "ARTERIAL" should go to reverse video and the arterial pressure display in the upper left corner of the Main Screen should show "0 mmHg". If not, perform Procedure 3-1-3 (Pressure Board Calibration).
- d. Touch "LIMITS" on the Setup Screen, then touch the number displayed as the arterial alert value. Touch the up and/or down arrows until the alert value is 180. Touch "180 mmHg". (On units with Version 2.3M system software, the alarm and alert values are separately adjustable.)
- e. Turn the Test Fixture knob to each setting. The pressure displayed on the Main Screen must be +/- 10 mmHg of the Test Fixture setting. If not, perform Procedure 3-1-3 (Pressure Board Calibration).
- f. Press the Forward or Reverse switches on the ART and CPG pumps. Turn the speed knobs on both pumps to mid range.
- g. Set the Test Fixture to 200 mmHg. The alert sounds and the "CHECK ARTERIAL PRESSURE" message appears on the Main Screen. The pumps continue to run.
- h. Set the Test Fixture to 300 mmHg. The alarm sounds, the "HIGH ARTERIAL PRESSURE" message appears on the Main Screen, and the ART pump stops. The CPG pump will also stop if it has been customized to stop with ART.
- i. Set the Test Fixture to 200 mmHg. The alarm stops and the alert repeats. Restart the pump(s).
- j. Remove the Test Fixture from the ART jack. The arterial pressure display changes to "- - -".
- k. Install the Test Fixture into the CPG jack on the Pressure Module. Repeat steps b through j for the cardioplegia pressure (substitute CARDIOPLEGIA for ARTERIAL where appropriate).
- l. Install the Test Fixture into the AUX jack on the Pressure Module. Repeat steps b, c, e, and j for the auxiliary pressure (substitute AUXILIARY for ARTERIAL where appropriate).

## 2-3. EM/PM Procedures (continued)

### 2-3-2. System Inspection (continued)

- Connect the scope to Pin 1. Adjust the pot to obtain a reading of 0.6 VAC. Insert the optical calibrator into the sensor. The sensor signal should be 0.125 - 0.200 VAC.
- Block the air sensor with an opaque object. Press the air detection RESET switch.
- Adjust the pot until the air detector alarms. The threshold should be 1.2 - 1.5 VDC.
- Remove the test fixture.

#### 7. Check level detection:

**Caution:** Do not drop the level sensors as shock may damage the sensor.

- a. Attach the alarm and alert sensors to a clear plastic container as described in the Level Detection section of the 9000 Perfusion System Operators Manual.
- b. Rotate the switch on the Level Detector Module to position 1 for Alert/Alarm.
- c. Disconnect the alert sensor from the Level Detector Module. Verify that the "LEVEL ALERT SENSOR DISCONNECTED" message appears on the Main Screen and the yellow LED on the right fixed panel lights to indicate that the alert sensor is disconnected.
- d. Fill the container with water until the water level is above both sensors.
- e. Press the Level Detection ON switch.
- f. Press the Forward or Reverse switches on the ART and CPG pumps. Turn the speed knobs on both pumps to mid range.
- g. Tilt the container until the water level is below the alert sensor only. The "CHECK BLOOD LEVEL" message appears on the Main Screen, the alert sounds (and repeats once per minute), and the alert LED on the right fixed panel lights. The pumps continue to run.
- h. Tilt the container until the water level is above both sensors. The "CHECK BLOOD LEVEL" message disappears from the Main Screen, the alert stops sounding, and the alert LED on the right fixed panel goes out.
- i. Tilt the container until the water level is below the alarm sensor only. The "LOW BLOOD LEVEL" message appears on the Main Screen, the alarm sounds (and repeats once per minute), the alarm LED on the right fixed panel lights, and the pump(s) stop.
- j. Tilt the container until the water level is above both sensors. Press the level detection RESET switch. The "LOW BLOOD LEVEL" message disappears from the Main Screen and the alarm stops sounding.
- k. Restart the pumps.
- l. Rotate the switch on the Level Detector Module to position 2 for Alarm only.
- m. Repeat steps i, j, and k.
- n. Rotate the switch on the Level Detector Module to position 4 for Alert only.

**Note:** Position 4 is only functional on machines with Version 2.21M or higher system software. Position 3 is not functional on any machines.

- o. Repeat steps g and h.
- p. Stop the pump(s) and press the level detection OFF switch.

**2-3-2. System Inspection (continued)****Pressure displays check with Software 4.0 (continued)**

- i. Set the Test Fixture to 300 mmHg. The alarm sounds, the "HIGH ARTERIAL PRESSURE" message appears on the Main Screen, and the ART pump stops. The CPG pump will also stop if it has been customized to stop with ART.
- j. Set the Test Fixture to 200 mmHg. The alarm stops and the alert repeats. Restart the pump(s).
- k. Remove the Test Fixture from the ART jack. The arterial pressure display changes to "- - -".
- l. Install the Test Fixture into the CPG jack on the Pressure Module. Repeat steps b through j for the cardioplegia pressure (substitute Cardioplegia for Arterial where appropriate).
- m. Install the Test Fixture into the AUX jack on the Pressure Module. Repeat steps b, c, e, and j for the auxiliary pressure (substitute Auxiliary for Arterial where appropriate).
- n. Starting with 4.0 software, test "not-confirmed" message and border.

Touch "Limits" on the Setup Screen. Touch the arterial alert button and touch the up and/or down arrows until a new value appears on the button. Then exit from the screen without confirming the value.

Check that the message "Set-up value not confirmed" appears, a border appears around the Set-up button, and that both are in the color dark yellow.

Return to the set up screen, select the desired value and confirm it by touching alert button; the "not confirmed" indicators should disappear.

**2-3. EM/PM Procedures (continued)****2-3-2. System Inspection**

With software 4.0, check the colors and "not confirmed" message.

9. Check the pressure displays:

**Warning:** Pressure transducer cables without transducers attached must be disconnected from the console; cables without transducers act as antennae and may stop the pump.

- a. Touch "Setup" on the Main Screen.
- b. Install the Pressure Board Test Fixture into the ART jack on the Pressure Module in Slot 4. Set the fixture to "0" and "+".
- c. Touch "Zero" on the Setup Screen and then touch "Arterial". "Arterial" should become highlighted and the arterial pressure display in the upper left corner of the Main Screen should show "0 mmHg". If not, perform Procedure 3-1-3 (Pressure Board Calibration).
- d. Touch "Limits" on the Setup Screen and then touch the number displayed as the arterial alert value. Touch the up and/or down arrows until the alert value is 180. Touch "180 mmHg". (Starting with Version 2.3M system software, the alarm and alert values are separately adjustable.)
- e. With 4.0 software, check the following colors appear on the screen.

<u>Color</u>	<u>Location</u>
Light gray	"Arterial Line" text on Main Screen,
White	Flow value on Main Screen,
Light red	"Alarms" text on Set-Up Screen,
Light blue	alert and alarm pressure values on Set-Up Screen,
Black	overall background of any screen,
Dark red	background for arterial values on Main Screen,
Dark blue	background for venous values on Main screen,
Green	background for gas values on Main Screen,
Dark yellow	"not confirmed" messages on Main Screen.

- f. Turn the Test Fixture knob to each setting. The pressure displayed on the Main Screen must be +/- 10 mmHg of the Test Fixture setting. If not, perform Procedure 3-1-3 (Pressure Board Calibration).
- g. Press the Forward or Reverse switches on the ART and CPG pumps. Turn the speed knobs on both pumps to mid range.
- h. Set the Test Fixture to 200 mmHg. The alert sounds and the "CHECK ARTERIAL PRESSURE" message appears on the Main Screen. The pumps continue to run.

**2-3. EM/PM Procedures (continued)****2-3-2. System Inspection (continued)**

10. Check the temperature displays:

**Warning:** Use only the specified probes to ensure that the temperature and pressure monitoring function properly (refer to Pressure Monitoring Requirements in Subsection 1-3).

- a. Install a calibrated temperature probe into each of the six temperature jacks. The displayed temperature must be  $\pm 0.2^{\circ}\text{C}$  of the calibrated probe, and each of the six temperatures must be within  $\pm 0.1^{\circ}\text{C}$  of each other. If not, perform Procedure 3-1-4 (Calibrating the Temperature Board).
- b. Install a calibrated  $43.1$  to  $45^{\circ}\text{C}$  probe into each temperature jack. The "TEMPERATURE >  $43^{\circ}\text{C}$ " message is displayed on the Main Screen and the alert sounds.

11. Check the gas flow:

**Warnings:** Use medical grade gases and empty the water trap as liquid water or other contaminants in the gas supplies will cause malfunction of the system.

Always use an oxygen analyzer to verify oxygen content.

Provide inlet gases at a pressure of 50 psi  $\pm 10$  psi (345 kPa  $\pm 69$  kPa). Observe the  $\text{FIO}_2$  display for variation as extreme variation indicates an inadequate gas supply.

**Caution:** The oxygen and air supplies must both be connected (or disconnected) to prevent unequal pressure from damaging the gas blender.

- a. Use the Gas Pressure Test Fixture to verify that the inlet gases are 50  $\pm 10$  psi, and that the gases are within  $\pm 10$  psi of each other.
- b. Connect the gas hoses to the 9000. Connect a 1.0 to 10.0 L/min flowmeter to the output.
- c. Adjust the flow rate from 0.2 L/min to 9.9 L/min. Verify that the flow rate displayed on the Main Screen is the same as that read on the flowmeter. If not, refer to the troubleshooting section.
- d. Set the flow above 9.8 L/min. The flow rate displayed on the Main Screen changes to "999" for overrange.
- e. Adjust the  $\text{FIO}_2$  control knob from .21 to 1.00. Use an oxygen analyzer at the output to verify that the displayed  $\text{FIO}_2$  is  $\pm 3\%$  of the actual output  $\text{FIO}_2$ . If not, refer to the troubleshooting section.
- f. Set the flow rate to 2 L/min. Set the  $\text{FIO}_2$  control knob to .60. Vary the flow rate from 2 to 7 L/min. The displayed  $\text{FIO}_2$  should not change more than  $\pm 20\%$ . If it does, replace the blender.
- g. Set the flow rate to 4 L/min. Vary the  $\text{FIO}_2$  from .21 to 1.00. The total flow should not change more than  $\pm 20\%$ . If it does, replace the blender.
- h. Touch "SETUP" on the Main Screen. Set the  $\text{FIO}_2$  ALERT to .40. Adjust the  $\text{FIO}_2$  control knob to below .40. The alert sounds and the "LOW  $\text{FIO}_2$ " message appears.

**2-3. EM/PM Procedures (continued)****2-3-2. System Inspection (continued)**

- i. Set the FIO<sub>2</sub> BLEND to 95-5. Vary the FIO<sub>2</sub> control knob and verify that the FIO<sub>2</sub> range is from .95 to 1.00 and the FICO<sub>2</sub> range is from .050 to .000.
  - j. Set the flow rate to greater than .2 L/min. Press the CO<sub>2</sub> Flush Start switch on the left fixed panel. The LED lights briefly and then goes out.
  - k. Set the flow rate to less than .2 L/min. Press the CO<sub>2</sub> Flush Start switch on the left fixed panel. The LED remains lit for 3 minutes +/- 12 seconds. (The 3 minute timer is only on machines with system software version 2.21M or lower; version 2.3M has a 15 minute timer.)
  - l. Connect CO<sub>2</sub> to the CO<sub>2</sub> input and verify that the flush rate is from 2 to 10 L/min. Refer to Procedure 3-5-3 (Adjusting the CO<sub>2</sub> Flush Rate) to set the flush rate for the customer's needs.
  - m. With the CO<sub>2</sub> flush on, rotate the gas flow rate knob counter-clockwise. The flush should stop when any other gas is flowing.
12. Check the batteries and power supplies. Refer to Procedure 3-1-1.
13. Check the water module (if installed):

**Note:** Some water modules have been modified with a normally open 24 VDC valve in the hot water supply line to the cardioplegia and/or arterial mixing valves. This valve(s) receives power from J6 on the Power Distribution Board. When energized, the valve(s) cuts off the flow of hot water to the mixing valve(s), allowing for maximum cooling. An activation switch is located next to the control knob(s).

- a. The source hot water supply must be 40-80 psi (with a maximum variation of +/- 20 psi within this range) at 44-65°C (with a maximum variation of +/- 5°C within this range) with a minimum flow of 10 L/min.
- b. The source cold water supply must be 40-80 psi (with a maximum variation of +/- 20 psi within this range) at 2-6°C with a minimum flow of 10 L/min.
- c. Connect the supplies and drains to the water module. Verify that the hot and cold pressure gauges on the water module read 35-75 psi. If not, refer to Procedure 3-6-1 (Setting the Outlet Pressure Limit).
- d. Verify that the maximum output temperature for ART and CPG are 39-42°C. Refer to Procedure 3-6-2 (Checking the Water Temperature). If the temperatures do not meet specification, perform Procedure 3-6-3 (Adjusting the Water Temperature).
- e. If the hot water supply is ≥ 60°C, shut off the cold water supply and verify that the output flow stops. If not, refer to the troubleshooting section.
- f. Verify that an adjustment of +/- 25°C of one knob does not affect the other output by more than 2°C. In no case should the adjustment of one channel cause the other to exceed and maintain a temperature greater than 42°C. If it does, refer to the troubleshooting section.

**2-3. EM/PM Procedures (continued)****2-3-2. System Inspection (continued)**

14. Check the CDIT™ Blood Chemistry Interface (if installed; system software version 2.21M or higher only):
  - a. Connect the RS232 cable from port A on the Front Tray to the CDIT™ Monitor.
  - b. Turn the monitor on and press Setup on the CDIT™ Monitor. Use the Adjust button and Up/Down arrows to set the following:
    - Arterial PH = 1
    - Arterial PCO2 = time of day
    - Arterial PO2 = 4800
    - Arterial BE/HCO3 = 0.1
    - Venous PH = 1
    - Venous PCO2 = 0 (English), 1 (French), 2 (German), 3 (Spanish), or 4 (Italian)
    - Venous PO2 = 0
    - Venous SVO2 = barometric pressure
  - c. Press Operate. Ensure that the Standard Reference Sensors (SRS's) are installed properly.
  - d. The values displayed on the CDIT™ Monitor should be displayed on the Main Screen of the 9000.
  - e. A display of "999" indicates an over-range value; a display of "- - -" indicates an under-range value. Refer to the troubleshooting section if communications cannot be established.

## 2-3. EM/PM Procedures (continued)

### 2-3-3. Roller Pump Inspection

1. Record the part number and serial number for each roller pump.
2. Place each pump in the stop mode and press the scroll switch. Verify that the message display shows the following in sequence: 1/4, 3/8, 1/2, 5/8, 6mm, 8mm, 10mm, 12mm, S4:1, S2:1, S1:1, Fxxx, and RPM.
3. Turn the machine Power Switch to OFF, wait ten seconds, and turn it ON. Verify that the message display on each pump shows the following in sequence: Reset (each pump relay clicks once), tube size or RPM, 6-10 second delay, software version, run hours, FAIL 1, FAIL 2, FAIL 3, FAIL 4, FAIL 5, FAIL 6, and then back to tube size or RPM. Record the software version and run hours for each pump. Note any fail messages that remain on the pumps and refer to the troubleshooting section.

**Note:** To repeat the above sequence of messages, touch "CUSTOMIZE" on the Startup or Title Screen, then touch the blank switch (fourth down from the top) on the Selection Screen as needed. Different messages are displayed for software versions prior to 2.1.

4. Perform the following for each pump:
  - a. Install an emergency hand crank into the pump head.
  - b. Turn the flowrate knob fully counter-clockwise.
  - c. Place the pump in reverse by pressing both Reverse switches for four seconds.
  - d. Hold the hand crank and increase the pump speed until a pump jam occurs. The pump stops and "PUMP JAM" appears in the message display. In the case of the arterial pump, an alarm sounds and the "ARTERIAL PUMP JAM" message appears on the Main Screen.
  - e. Remove the hand crank and press the Forward or Reverse switches to clear the pump jam condition.
  - f. Install the appropriate size tubing in the pump.
  - g. Set the proper occlusion for the pump as described in the Roller Pump section of the 9000 Perfusion System Operators Guide.
  - h. Run the pump in forward and reverse. Note any unusual noises and refer to the troubleshooting section.
  - i. When removing the tubing, be careful not to touch or move the occlusion knob.
5. Check the pump designations:
  - a. Select each pump as arterial by rotating the ART switch on the Digital Interface Board. Verify that when each pump is selected, its message display shows "ART".
  - b. Select each pump as cardioplegia by rotating the CPG switch on the Digital Interface Card. Verify that when each pump is selected, its message display shows "CPG". Note that a centrifugal pump cannot be selected as cardioplegia.
  - c. Select one pump as both ART and CPG. Verify that the "CHANGE PUMP SELECT: ART = CPG" message appears on the Main Screen.
  - d. Return the ART and CPG switches on the Digital Interface Board to their original settings.

## 2-3. EM/PM Procedures (continued)

### 2-3-3. Roller Pump Inspection (continued)

6. Check the pulse mode (if installed) for the arterial pump:
  - a. Touch "PULSE" on the Main Screen. Set the RATE to 60 bpm, the WIDTH to 50%, and the BASE to 50%.
  - b. Press the Forward switches on the pump and turn the flowrate knob fully clockwise (maximum speed). Press the Automatic switches. The message display ramps down from 100 to 50. The pump runs at maximum speed for 1/2 second and then half speed for 1/2 second.
  - c. Set the BASE to 0%. The pump runs at maximum speed for 1/2 second and then stops for 1/2 second.
  - d. Return the RATE, BASE, and WIDTH to their original settings.
  - e. Press the Manual switch to stop the pump.
7. Check the shoulder screws (the location of these screws is shown in the drawing on Page 4-7):
  - a. Set the machine Power Switch to OFF.
  - b. Set the torque screwdriver to 17 in-lbs.
  - c. Verify that all four shoulder screws on each pump are torqued to 17 in-lbs.
8. Check the roller-to-roller. Refer to Procedure 3-2-1 (Roller-To-Roller Adjustment).
9. Check the casting:
  - a. Check the casting runout. Refer to Procedure 3-2-3 (Checking/Adjusting Casting Runout).
  - b. Inspect the casting for any nicks or scratches in the tubing path. As a guide, the casting should be replaced if a nick or scratch is deep enough to catch a fingernail.
10. Check the rollers and roller bearings:
  - a. Spin each roller with your fingers. Each should spin freely; if not, refer to Procedure 4-1-7 (Replacing Roller Bearings).
  - b. Inspect each roller for any nicks or scratches. As a guide, the roller should be replaced if a nick or scratch is deep enough to catch a fingernail.
11. Check the casting bearing. Use a hand crank to spin the roller assembly. It should spin freely and smoothly. If any unusual noises are heard, refer to the troubleshooting section.
12. Check the tube guide rollers (new brown greaseless style):
  - a. Spin each tube guide roller with your fingers. Each roller should spin smoothly. If not, remove the roller and check for a groove worn into the roller post where the tube guide screw shoulder touches the post. If a groove is visible, file it smooth. Re-install the roller and screw. Try to spin the roller again. If it is still hard to spin, replace the tube guide and/or the screw.
  - b. Torque all guide roller screws to 7 in-lbs.

**2-3. EM/PM Procedures (continued)****2-3-3. Roller Pump Inspection (continued)**

13. Check the tube guide rollers (old black style):
  - a. Remove all the tube guide rollers.
  - b. Apply a thin coat of grease to each screw.
  - c. Re-install the greased screws and rollers. Torque the roller screws to 7 in-lbs. Clean off any excess grease.
  - d. Spin each roller with your fingers. Each roller should spin smoothly; if not, refer to Step 12a above.
14. Check the occlusion mechanism:
  - a. Apply a thin coat of grease to the lip of the occlusion mechanism.
  - b. Turn the mechanism back and forth. It should turn smoothly and easily. If not, refer to the troubleshooting section.
  - c. Verify that the four screws securing the gauge ring to the lip are tight.
15. Check the tube clamp mechanisms:
  - a. Remove both tube clamp mechanisms.
  - b. Verify that the screws holding the tubing inserts are tight and that all pins are secure.
  - c. Slide the tube clamp mechanisms back onto the black dovetails. It should require some force to do this; if not, replace the dovetail.
16. Set the machine Power Switch to ON.
17. Check overspeed:
  - a. Insert a hand crank into the pump. Turn the flowrate knob fully counter-clockwise.
  - b. Press the Forward switches on the pump.
  - c. Use the hand crank to rotate the pump counter-clockwise at 20-25 rpm. The message display shows "OVERSPEED 3" and the pump stops. In the case of the arterial pump, the alarm sounds and the "ARTERIAL PUMP OVERSPEED" message appears on the Main Screen.
  - d. Remove the hand crank. Press the Forward switches to clear the OVERSPEED 3 condition.
18. Check the cover interlock:
  - a. Set the pump flow rate to maximum speed.
  - b. Lift the pump cover approximately 1.5 inches (3.81 cm). The pump should stop rotating; if not, see the troubleshooting section.
  - c. Press both Forward switches to restart the pump. Then apply a slight clockwise pressure to the flowrate knob. The maximum RPM should be 250 +/- 2 (use a digital tachometer to verify the RPM reading); if not, refer to Procedure 3-2-4 (Calibrating the Pump Control Board).

## 2-3. EM/PM Procedures (continued)

### 2-3-4. Centrifugal Pump Inspection for Delphin™ II Module

Use the current procedure but with the following exceptions.

#### 13. Install a 3 foot test loop (without cornstarch).

- a. Connect one end of a 3 foot loop of tubing to a disposable pump and fill them with water.
- b. Connect the other end of the tubing to the disposable pump without introducing air as air will affect the test.
- c. Connect the disposable pump to the drive motor.

#### 17. Check both the alert and alarm.

Check the Check Flow alert.

- a. Increase the pump speed to 1600 +/- 20 RPM and adjust the clamp to get a flow of over 3.0 L/min.
- b. Decrease the pump speed to 1400 +/- 20 RPM and verify the message display alternately flashes the chosen motor speed and "CK FLOW". The alert sounds and the "CHECK ARTERIAL PUMP FLOW" message appears on the Main Screen.
- c. Increase the pump speed to 1600 +/- 20 RPM and the Check Flow alert should stop.
- d. Press Stop and then turn the speed knob to minimum.
- e. Start the pump and increase the speed to 1100 +/- 20 RPM. Adjust the clamp to obtain a flow of approximately 3.0 L/min. Turn the speed knob quickly down to 200 RPM +/- 50 RPM. The message display should alternately flash the chosen RPM reading and "CK FLOW" for approximately 5 seconds. The alert sounds and the "CHECK ARTERIAL PUMP FLOW" message appears on the Main Screen.

Check the Backflow alarm.

- a. Install the Flow Sensor around the tubing with the arrow in the direction of flow. Start the pump and increase the pump speed to 2000 RPM. Adjust the clamp for a flow of about 3.0 L/min.
- b. Remove the Flow Sensor and re-install it with the arrow pointing in the direction opposite the flow. The message display should alternately flash 2000 RPM and "IBACKFLW". The alarm sounds and the "ARTERIAL PUMP BACKFLOW" message appears on the Main Screen.

#### 19. This inspection step is not applicable for Delphin™ II Modules.

## 2-3. EM/PM Procedures (continued)

### 2-3-4. Centrifugal Pump Inspection

1. Record the pump part number and serial number.
2. Record the flow sensor part number, serial number, and calibration number.
3. Connect the motor and flow sensor to the pump. Note that early flow sensors and pumps have only two connections. A new three-connector sensor can be used with an old pump and vice versa; just leave the third connector disconnected.
4. Check the pump connector to the 9000 for damage.
5. Check the startup sequence:
  - a. Set the machine Power Switch to ON. Verify that the message display shows the following in sequence: Reset (relay clicks once), 6-10 second delay, software version, run hours, FAIL 1, FAIL 2, FAIL 3, FAIL 4, FAIL 5, FAIL 6, and back to 0000.
  - b. Record the software version and run hours.
  - c. Record any fail messages that remain displayed and refer to the troubleshooting section.
6. After the startup sequence, press the Scroll switch three times. Verify that the message display shows the following in sequence: MNFL number, calibration number, and 0000.
7. Check speed control:
  - a. Press both Forward switches.
  - b. Rotate the speed knob clockwise to increase the speed. Note any unusual noises and refer to the troubleshooting section.
  - c. Verify that the speed knob turns smoothly throughout its range.
8. Check the motor disconnected alert:
  - a. Select the centrifugal pump as arterial by rotating the ART switch on the Digital Interface Board.
  - b. Press the Stop switch on the pump and disconnect the motor.
  - c. Press both Forward switches and turn the speed knob to the 1200 rpm setting. The pump message display alternately flashes "0000" and "MOTOR". The alert sounds and the "CHECK ARTERIAL PUMP MOTOR" message appears on the Main Screen.
  - d. Press the Stop switch. Reconnect the motor and press the Forward switches to clear the alert message.
9. Check motor speed:
  - a. Press the Stop switch. Connect the Drive Motor Tach Fixture to the drive motor, and then connect a digital tachometer to the fixture.
  - b. Press the Forward switches. Turn the speed knob fully clockwise for maximum speed. Verify that the maximum reading on the tachometer is 3600 +/- 100 rpm. If not, refer to Procedure 3-3-1 (Motor Control Board Calibration).

**2-3. EM/PM Procedures (continued)****2-3-4. Centrifugal Pump Inspection (continued)**

10. Check the motor control:
  - a. Press the Stop switch. Turn the speed knob to the 1200 rpm setting.
  - b. Turn the centrifugal pump circuit breaker OFF and back ON. Press both Forward switches immediately. The motor should start while "Reset" is displayed; if not, replace the Motor Control Board.
  - c. Press the Stop switch.
11. Check the minimum flow alert:
  - a. Press the Select switch until "MNFL x.x" is displayed.
  - b. Press the Up/Down arrows to change the minimum flow value to 1.5. Press the Select switch to enter the new value.
  - c. Press both Forward switches. Turn the speed knob to slowly increase the motor speed. When a speed of 1000 rpm or greater is reached, the following occurs: the pump message display alternately flashes the motor speed and "MIN FLOW". The alert sounds and the "BELOW ARTERIAL MINIMUM FLOW" message appears on the Main Screen.
  - d. Turn the speed knob fully counter-clockwise. Verify that the message display shows "0000". Press the Stop switch.
12. Check the calibration number selection:
  - a. Press the Select switch twice to display the calibration number. Press the Up or Down arrow once. An asterisk replaces the C, and the first three digits and the last digit blink. Press the Up/Down arrows to scroll the first three digits through all the values from 020 to 300. Set the first three digits to 112; the last digit changes automatically.
  - b. Press the Select switch once. The last four digits blink. Use the Up/Down arrows to scroll the first three blinking digits through all the values from 270 to 670. Set these three digits to 345; the last digit automatically changes to 6.
  - c. Press the Select switch once to store the value. Turn the centrifugal pump circuit breaker OFF and back ON. After the startup sequence, press the Select switch to verify that the MNFL value is 1.5 and the calibration number is C1123456.
  - d. Enter the calibration number located on the blue tag attached to the sensor.
13. Install a test loop:
  - a. A centrifugal test loop consists of a disposable pump, a two-liter reservoir bag, tubing, and a Roberts tube clamp. Add 0.67 grams of corn starch per one liter of water.
  - b. Connect the test loop to the pump motor. Press both Forward switches. Allow the solution to mix; squeeze and tap on the bag to help mix the solution.
  - c. Put a liberal amount of flow sensor lubricant on the sensor. Connect the sensor to the tubing at least 0.3 meters from the disposable pump or connectors.
14. Check the maximum speed with load. Turn the speed knob fully clockwise (maximum speed). Verify that the speed shown in the message display is between 2800 and 3300 rpm. If not, refer to the Troubleshooting Procedure 5-5-10.

**2-3. EM/PM Procedures (continued)****2-3-4. Centrifugal Pump Inspection (continued)**

15. Check the pulse mode (if installed):
  - a. Touch "PULSE" on the Main Screen. Set the BASE to 50%.
  - b. Press both Forward switches and set the speed to 2400 rpm.
  - c. Press both Pulse switches. The message display ramps down from 100 to 50. The pump pulses once per second, at 2400 rpm for 1/2 second and 1200 rpm for 1/2 second.
  - d. Press the Manual switch. Verify that the pump stops pulsing and continues to run at 2400 +/- 20 rpm.
  
16. Check the flow:
  - a. Set the pump speed to 2000 +/- 20 rpm. Close the tube clamp until the flow reading is 4.0 +/- 0.2 L/min.
  - b. Gently tap on the flow sensor. The flow reading should not change more than 0.1 L/min. If it does, refer to the troubleshooting section.
  
17. Check the backflow alert. Slowly reduce the pump speed to less than 1000 rpm. The message display alternately flashes the motor speed and "BACKFLOW". The alert sounds and the "ARTERIAL BACKFLOW" message appears on the Main Screen. The motor continues to run.
  
18. Check the minimum flow:
  - a. Set the pump speed to 0000 rpm. Completely clamp off the tubing.
  - b. Slowly increase the pump speed to over 1000 rpm. The message display alternately flashes the motor speed and "MIN FLOW". The alert sounds and the "BELOW ARTERIAL MINIMUM FLOW" message appears on the Main Screen.
  - c. Unclamp the tubing and the alert stops sounding.
  
19. Check flow sensing:
  - a. Press the Select switch twice to display the calibration number. Set the second three digits of the number to 270. Adjust the pump speed and clamp until the flow reading is approximately 4.0 L/min.
  - b. Press the Select switch twice. Set the second three digits of the calibration number to 670. Within 10-20 seconds the flow reading should be 1.6 +/- 0.1 L/min. If not, refer to the troubleshooting section.
  - c. Remove the test loop. Set the calibration number back to the number found on the blue tag attached to the sensor.

**2-3. EM/PM Procedures (continued)****2-3-5. Final Inspection**

1. Re-enter all the operator settings that were recorded in Step 10 of the Preliminary Inspection.
2. Turn all pump flowrate knobs fully counter-clockwise.
3. Disconnect the gases from the 9000. Turn the gas flowrate knob fully clockwise.
4. Extend the Front Tray (refer to Procedure 4-3-1). Connect the negative lead of a DVM to the DC/DC convertor ground test point on the Power Control Board (refer to Page 3-1 for test point location). Connect the positive lead to any metal point on the chassis. The DVM reading must be 250 megohm or greater (with power off, the reading should be stable; with power on, the reading will fluctuate); if not, refer to the troubleshooting section.
5. Slide the Front Tray back into the console. Secure the Front Tray. Reconnect all cables to the Front Tray. Leave all circuit breakers on the Front Tray turned ON. Ensure that all cables are clear of the wheels and tied down.
6. Leave the system cleaner than you found it.
7. Measure the system leakage current in normal polarity, then switch off the system, reverse the polarity, and recheck the leakage current.
8. Note on the Inspection Report any additional service that needs to be performed.
9. Place the inspection label on the unit.

## 2-4. Installing Options

### 2-4-1. Installing the Pulse Option and Blood Chemistry

Starting with 2.3 software, the Blood Chemistry feature is automatically on but the Pulsatile Flow feature is still an option requiring service installation. Note: Blood Chemistry may be turned off at the customer's request.

## 2-4. Installing Options

### 2-4-1. Installing the Pulse and Blood Chemistry Options

**Note:** Obtain the machine ID number and option number(s) from Sams Service prior to performing this procedure.

1. Perform Procedure 2-2-1 (Setting the System to the Diagnostic Mode).
2. Touch "System Options Screen".
3. Enter the four-digit machine ID number, then touch "ENTER".
4. Enter the four-digit option number, then touch "ENTER".
5. Touch the "OFF" button to the left of the desired option ("OFF" changes to "ON"), then press "ENTER".
6. Perform Procedure 2-2-2 (Returning the System to Normal Operating Mode).
7. Refer to Procedure 2-3-3 (Roller Pump Inspection) or Procedure 2-3-4 (Centrifugal Pump Inspection) to verify the operation of the Pulse option. Refer to Procedure 2-3-2 (System Inspection) to verify the operation of the Blood Chemistry option.

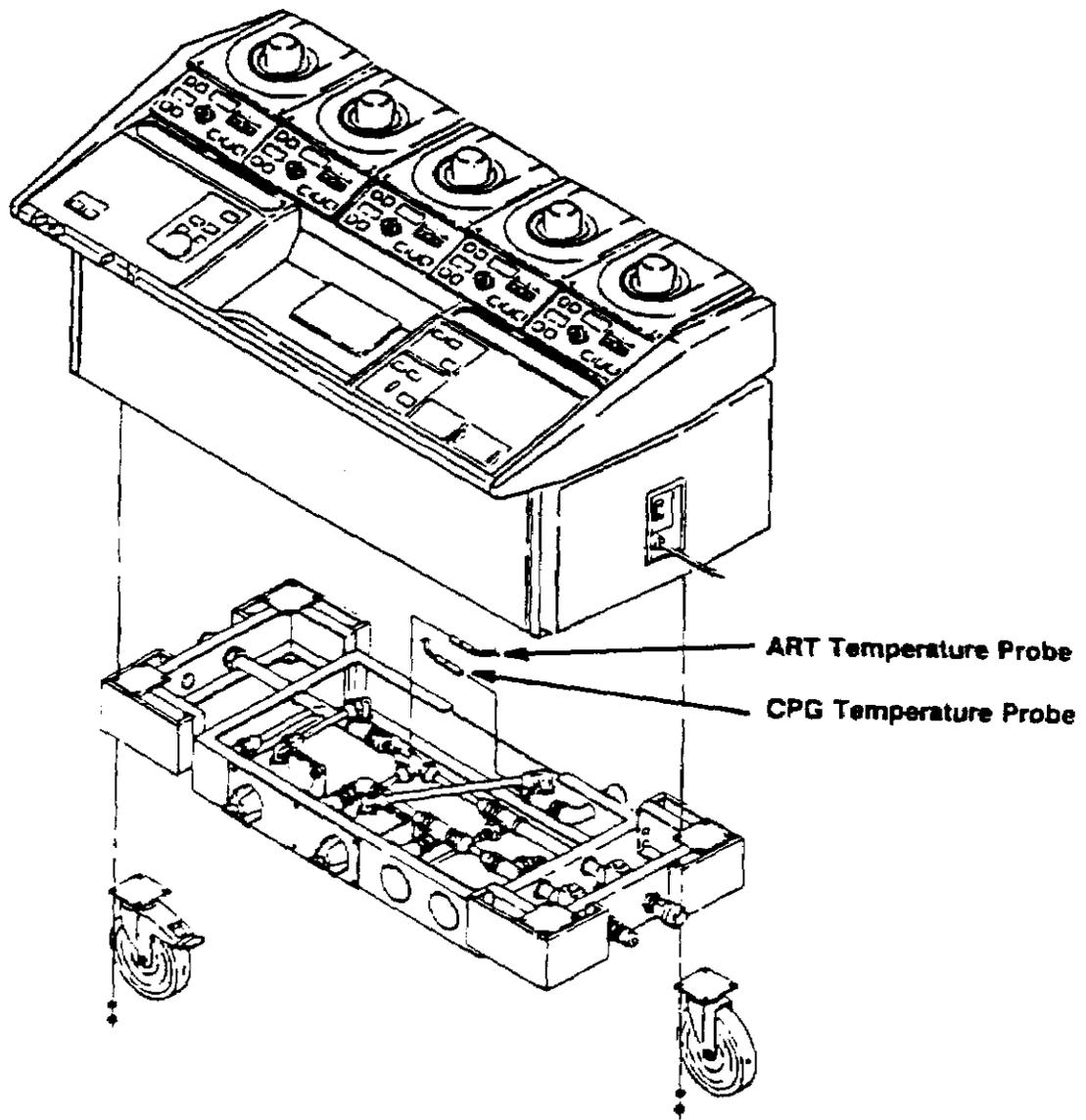
## 2-4. Installing Options (continued)

### 2-4-2. Installing a Water Module

1. Set the Power Switch to OFF and unplug the Power Cord.

**Note:** To ensure that all brackets and accessories are re-installed in the correct positions, draw a picture showing where everything is mounted on the rear of the machine.

2. Remove all items mounted to the Rear Panel. Remove the gas hoses and all loose objects in the storage well. Remove all pumps.
3. Tip the unit on its back onto a 10 to 15 cm platform.



## 2-4. Installing Options (continued)

### 2-4-2. Installing a Water Module (continued)

4. Note the position of each caster (i.e. the corner on which each is mounted). Remove the four casters.
5. Attach the Water Module to the 9000, and then attach the casters to the Water Module. Be certain to install the casters in their original positions. Attach the corner plates to the Water Module.
6. Stand the unit on its wheels.
7. Connect the ART temperature probe to the Water Module. String the cable through the "J" channel to the front of the 9000 and connect it to Jack B on Temperature Module #2.
8. Connect the CPG temperature probe to the Water Module. String the cable through the "J" channel to the front of the 9000 and connect it to Jack C on Temperature Module #2.
9. Install all poles and accessories in their original positions.
10. Plug in the Power Cord and set the Power Switch to ON.
11. Touch "MAIN SCREEN" and then "AUX DATA". Set temperature label B to "MAIN WATER" and temperature label C to "CARDIOPLEG WATER".
12. Refer to Procedure 2-3-2 (System Inspection) to verify the operation of the Water Module.

**2-4. Installing Options (continued)****2-4-3. Installing an Occluder**

1. Set the Power Switch to OFF.
2. Open the Front Door. Remove and discard the cover plate for Slot #12.
3. Slide the Occluder Module into Slot #12. Tighten the securing screws.
4. Mount the Occluder in the position preferred by the operator.
5. String the Occluder cable through the cable brackets mounted along the bottom edge of the Rear Panel, and then through the "J" channel to the front of the 9000. Connect and secure the cable to the Occluder Module in Slot #12.
6. Set the Occluder Circuit Breaker to ON.
7. Refer to Procedure 2-3-2 (System Inspection) to verify the operation of the Occluder.

### 3-1. Miscellaneous Electrical Adjustments

Starting with 4.0 software, there is no calibration for the Touch Screen so step 3-1-2. is unnecessary.

### 3-1. Miscellaneous Electrical Adjustments

#### 3-1-1. Checking Batteries and Power Supplies

1. Unplug the power cord from the wall outlet and set the power switch to OFF.
2. Extend the front tray (refer to Procedure 4-3-1).
3. Check and record the battery voltage level measured at the Power Distribution Board. Connect the negative lead of the DVM to J2 and the positive lead to J19. When fully charged, the voltage should be 26 to 28.5 VDC. If not, let the batteries charge or replace them.

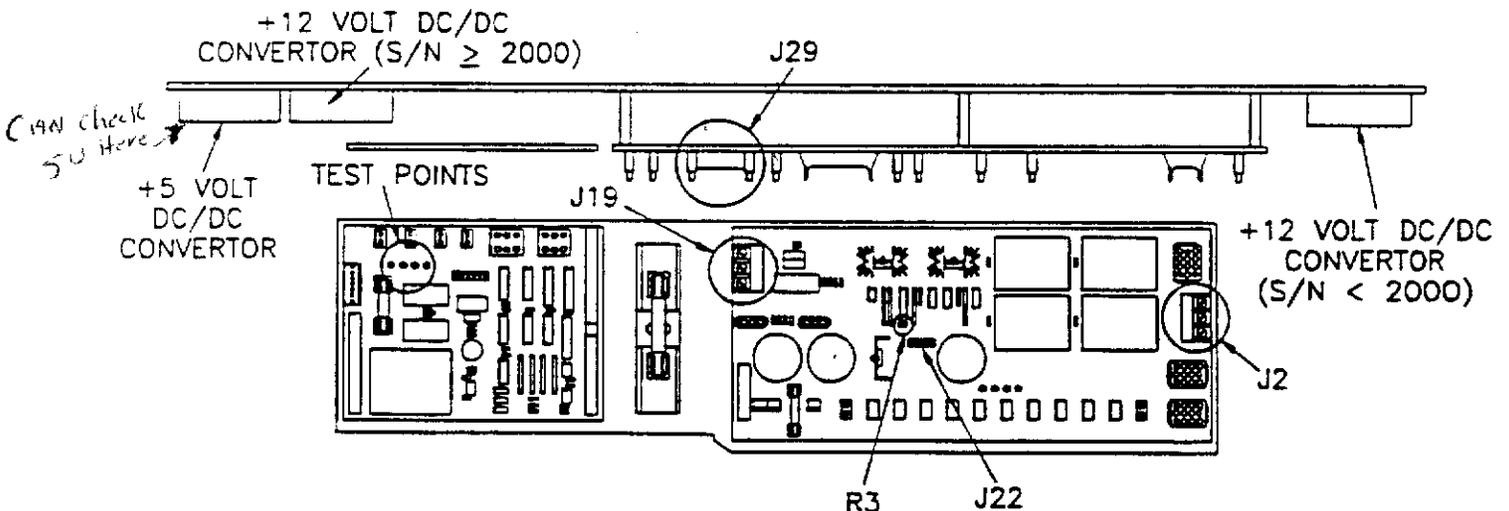
**Caution:** Replace the battery pack every two years OR whenever the battery pack cannot be fully recharged within 13 hours OR whenever a fully charged battery pack will not power the entire system for 60 minutes before lighting the bottom red DC power indicator. Place a label on the machine indicating when the batteries were replaced.

4. Check and record the charging voltage measured at the Power Distribution Board:
  - a. Remove the large 60 amp fuse.
  - b. Plug the power cord into the wall outlet and set the power switch to ON.
  - c. Connect the negative lead of the DVM to Pin 6 of J22 and the positive lead to Pin 5 of J22.
  - d. Adjust R3 as required until the DVM reads 27.85 +/- 0.05 VDC. If the voltage cannot be adjusted to specification, refer to the troubleshooting section.
5. Check the +5 VDC power supply voltage at the Mother Board. Connect the positive lead of the DVM to Pin 4 (red wire) of J29, and the negative lead to Pin 5 (black wire) of J29. The voltage should be 5.00 +/- 0.07 VDC. If not, replace the 5 volt DC/DC convertor.
6. Check the +/- 12 VDC power supplies at the test points on the Power Control Board. The positive voltage should be +12.00 +/- 0.30 VDC. If not, replace the +12 volt DC/DC convertor. The negative voltage should be -12.00 +/- 0.12 VDC. If not, replace the Power Control Board.

+ 12.00 ± .30  
- 12.00 ± .30

**Note:** The +5 VDC power supply is not connected to the test points on the Power Control Board.

7. Set the power switch to OFF. Re-install the 60 amp fuse. Reassemble the machine.



### 3-1. Miscellaneous Electrical Adjustments (continued)

#### 3-1-2. Calibrating the Touch Screen

1. Set the power switch to OFF.
2. Set the system to the Diagnostic Mode (refer to Procedure 2-2-1).
3. Set the power switch to ON.

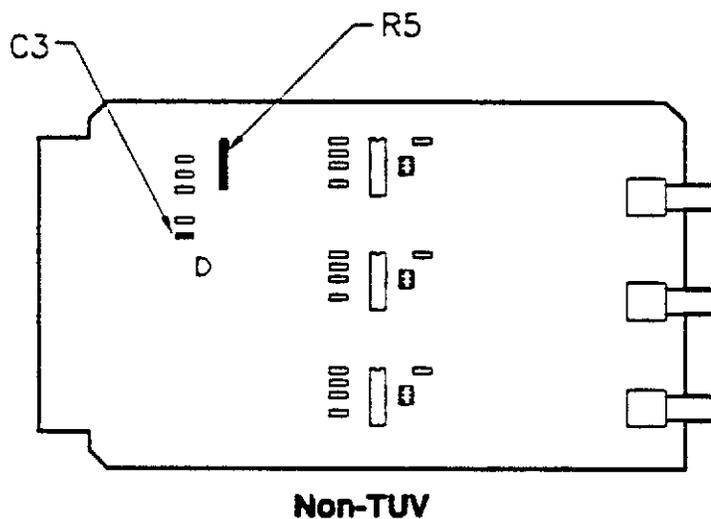
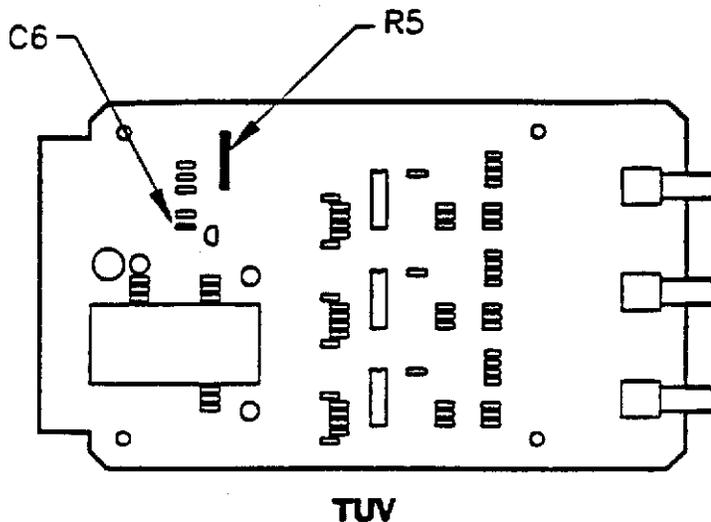
**Caution:** Use only fingers to touch and activate controls. Do not use any sharp instruments on the pump controls, console controls, or display screen as this may damage the device.

4. The Service Diagnostic Menu is displayed on the Main Screen. Touch "Calibrate the Touch Sensor".
5. Touch each circle as it appears on the screen.
6. Set the power switch to OFF.
7. Set the system to the Normal Operating Mode (refer to Procedure 2-2-2).
8. Set the power switch to ON.
9. Check the switch alignment by touching the center of a switch. If the switch does not function as expected, refer to the troubleshooting section.

### 3-1. Miscellaneous Electrical Adjustments (continued)

#### 3-1-3. Calibrating the Pressure Board

1. Convert the Pressure Board to the Extender Card.
2. Connect the DVM across C6 (TUV) or C3 (non-TUV) and observe polarity.
3. Set the power switch to ON; adjust R5 until the DVM reads  $7.50 \pm .05$  VDC. If the voltage cannot be adjusted to specification, replace the Pressure Board.
4. Perform the Pressure Check portion of the System Inspection (refer to Procedure 2-3-2).

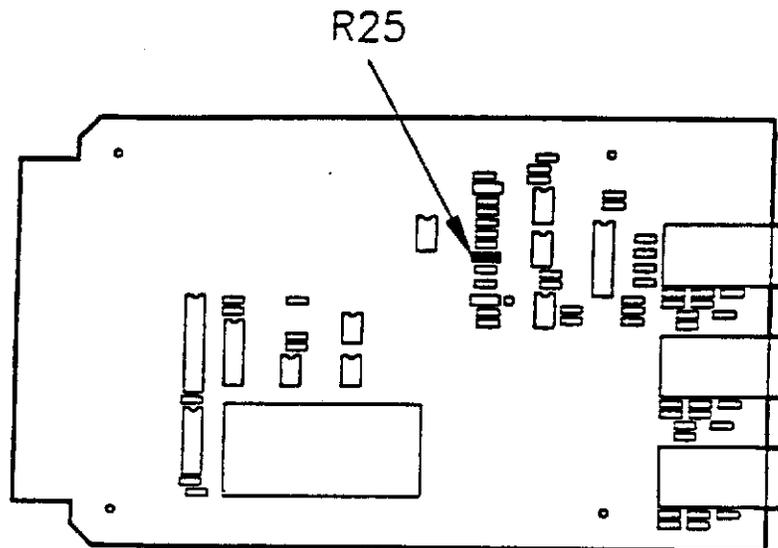


### 3-1. Miscellaneous Electrical Adjustments (continued)

#### 3-1-4. Calibrating the Temperature Board

1. Convert the Temperature Board to the Extender Card.
2. Insert the Sams™ 9000 Temperature Probe into jack A on the Temperature Board.
3. Arterial temperature should read 25.0 +/- 0.1 degrees; if not, adjust R-25 to meet this specification. If the voltage cannot be adjusted to specification, replace the Temperature Board.

Note: R-25 is the only field-adjustable potentiometer on the Temperature Board. All other pots are factory-adjusted.

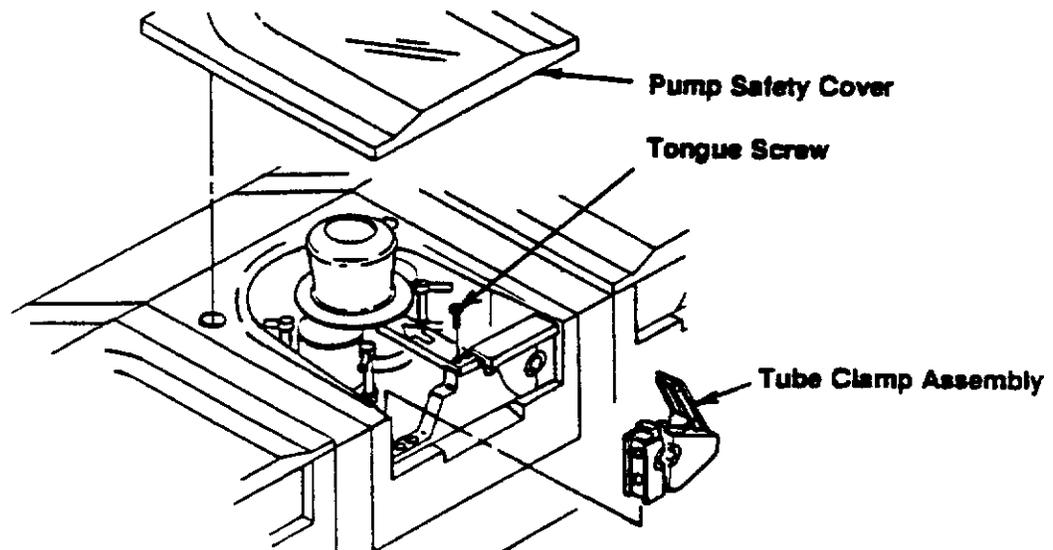


## 3-2. Roller Pump Adjustments

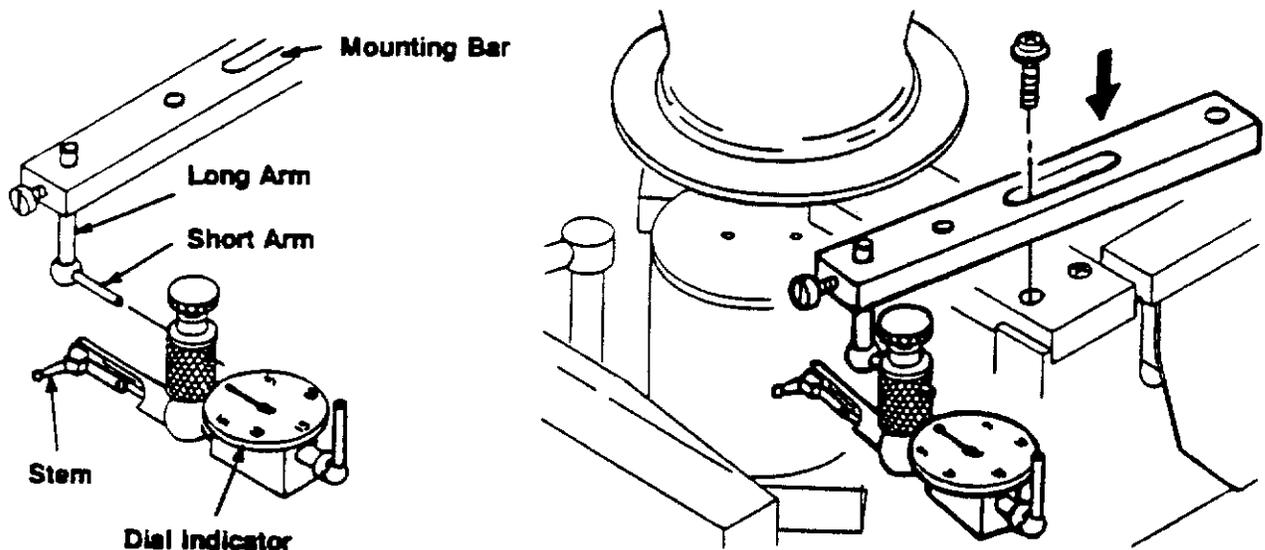
### 3-2-1. Checking Roller-to-Roller

**Warning:** Occlusion must be set by moving the rollers toward the pump race in order to take up any free play in the mechanism. Do not adjust occlusion by moving the rollers away from the race as under-occlusion may result.

1. Set the occlusion (refer to the 9000 Perfusion System Operators Manual for detailed procedures). Note the occlusion adjustment knob's position in reference to the arrow on the tongue. Except where indicated by these instructions, do not move the knob.
2. Remove the pump safety cover, the right tube clamp assembly, and the right screw from the tongue.



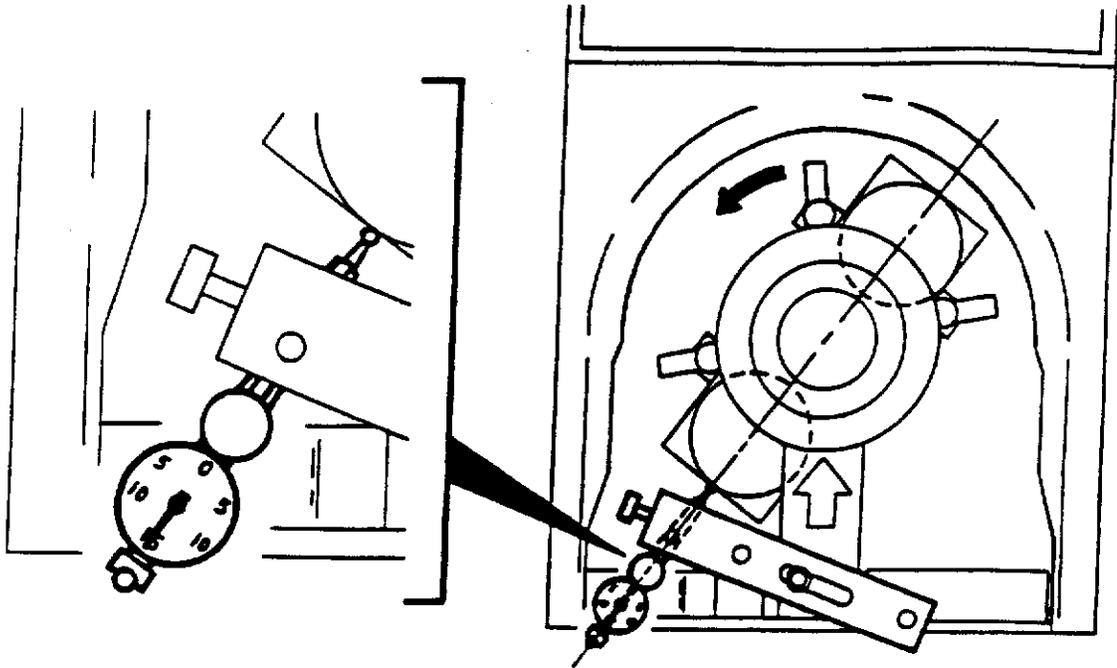
3. Assemble the Dial Indicator Kit and Roller-to-Roller Mounting Bar. Secure the Dial Indicator and Mounting Bar to the tongue as shown below.



### 3-2. Roller Pump Adjustments (continued)

#### 3-2-1. Checking Roller-to-Roller (continued)

4. Adjust the Dial Indicator's position so that the needle deflects to mid-scale when the Stem makes contact with the highest point of one of the Rollers. Make sure that the Stem is at a 45° angle when it contacts the Roller.

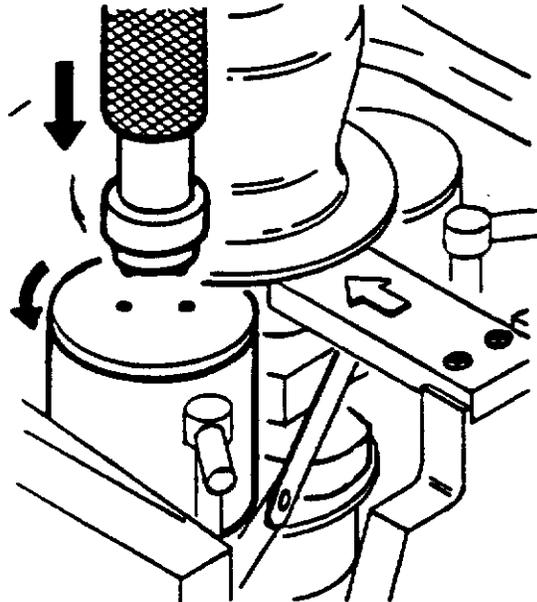


5. Choose one roller as a reference. Rotate the roller arm assembly and observe the maximum dial needle deflection caused by the reference roller. Turn the dial's scale so that the point of maximum deflection is set to zero.
6. Rotate the roller arm assembly and observe the maximum dial needle deflection caused by the non-reference roller.
7. Turn the occlusion adjustment knob in one full turn (clockwise) and then back out (counter-clockwise) to the same point (as noted in Step 1). Repeat Steps 5 and 6.
  - If the difference between deflections is less than 0.0015", continue with Step 8.
  - If the difference between deflections is more than 0.0015", perform Procedure 3-2-2.
8. Remove the Dial Indicator and Mounting Bar.
9. Replace the tongue screw, tube clamp assembly, and pump safety cover.

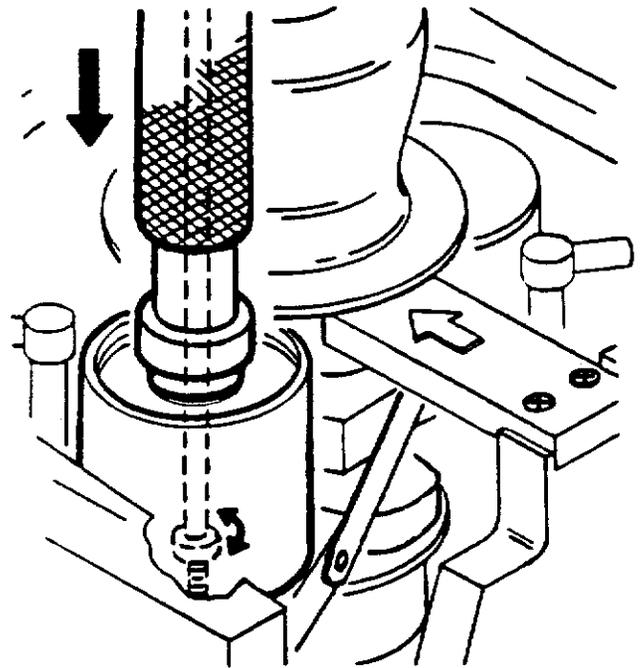
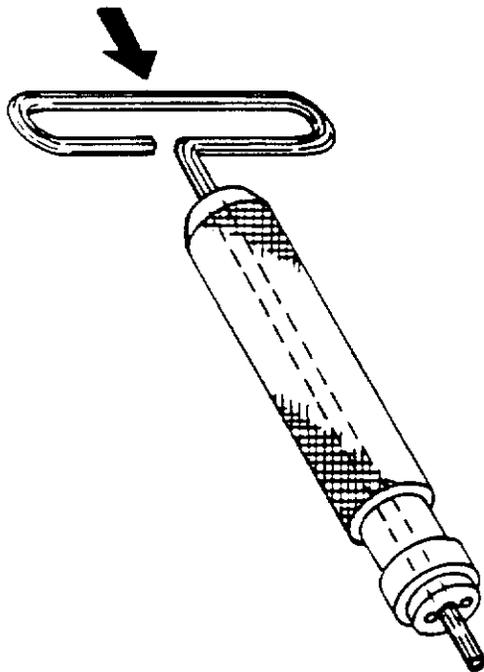
### 3-2. Roller Pump Adjustments (continued)

#### 3-2-2. Adjusting Roller-to-Roller

1. Use the Roller-to-Roller Adjustment Tool to remove the cap from one of the rollers.



2. Insert the special 3/16" hex wrench into the adjustment tool, and then insert both tools into the center of the roller. Loosen the socket head bolt inside the roller post.



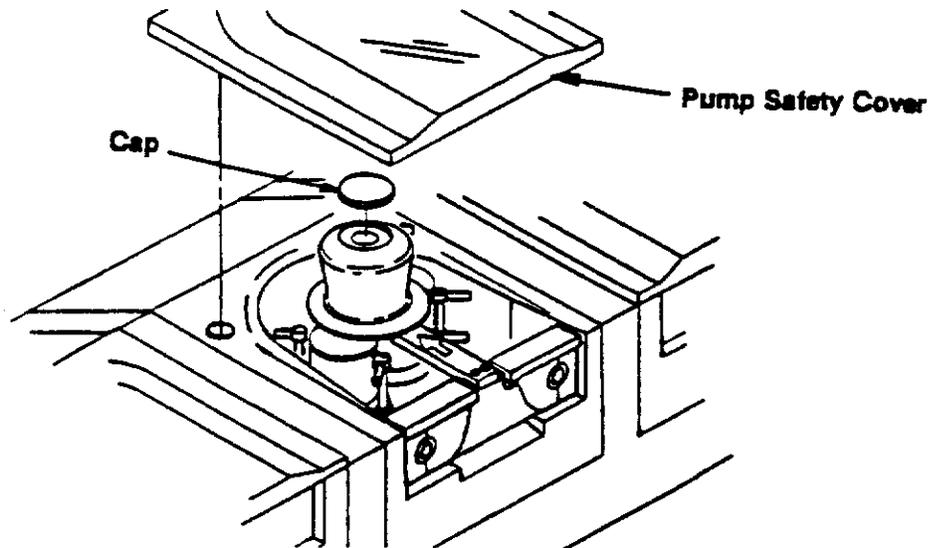
**3-2. Roller Pump Adjustments (continued)****3-2-2. Adjusting Roller-to-Roller (continued)**

3. Turn the occlusion adjustment knob one revolution clockwise, then counter-clockwise to the same point noted in Step 1 of Procedure 3-2-1.
4. Use the roller with the cap as the reference. Adjust the Dial Indicator's position so that the needle deflects to mid-scale when the Stem makes contact with the highest point on the roller.
5. Rotate the roller arm assembly 180° to line up the non-reference roller with the Dial Indicator. Use the adjustment tool to move the roller post and adjust the roller's position (the roller post is shaped like a cam). Move the roller back and forth against the Dial Indicator's stem until the dial needle deflection is the same as the reference roller. When the roller is properly positioned, tighten the socket head bolt inside the roller post.
6. Check the accuracy of the adjustment by rotating the roller arm assembly and observing the maximum dial needle deflection for each roller.
  - If the difference between deflections is less than 0.0015", continue with Step 7.
  - If the difference between deflections is more than 0.0015", repeat Steps 2 through 6.
7. Turn the occlusion adjustment knob one revolution clockwise to draw the rollers in, and then one revolution counter-clockwise to the same point noted in Step 1 of Procedure 3-2-1.
8. Rotate the roller arm assembly until the reference roller lines up with the indicator stem.
9. Repeat Step 4.
10. Rotate the roller arm assembly and observe the maximum deflection for the non-reference roller.
  - If the difference between deflections is less than 0.0015", continue with Step 9 of Procedure 2-3-3.
  - If the difference between deflections is more than 0.0015", repeat this entire procedure.
11. Remove the Dial Indicator and Mounting Bar.
12. Replace the roller cap.
13. Replace the tongue screw, tube clamp assembly, and pump safety cover.
14. Install tubing in the pump (refer to the 9000 Perfusion System Operators Manual). Run the pump with tubing occluded for 20 minutes to ensure normal operation. Repeat Procedure 3-2-1.

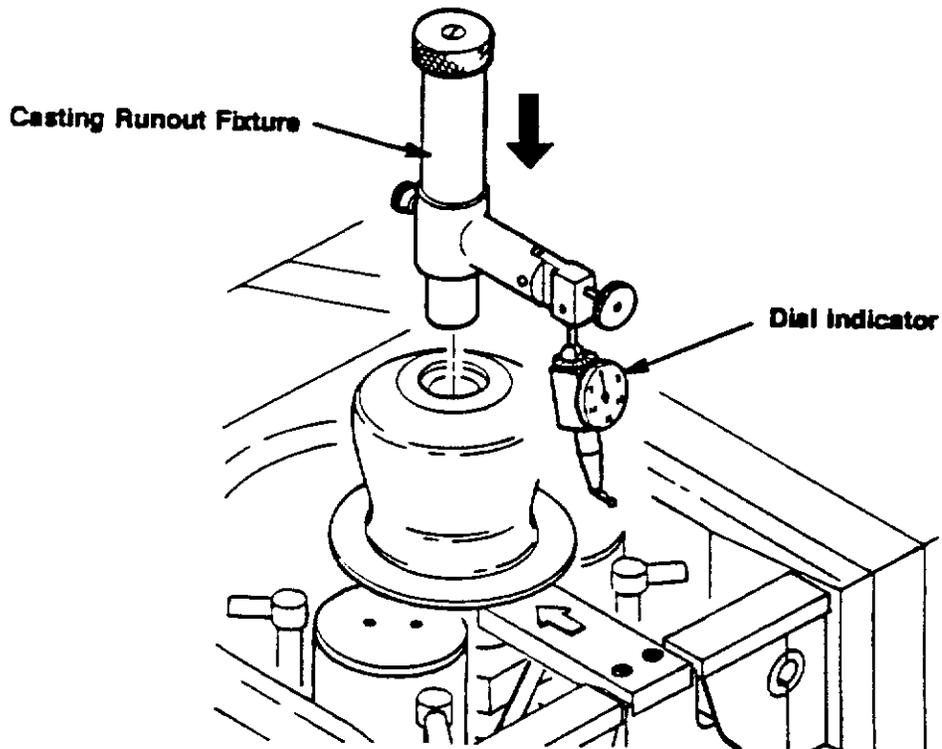
### 3-2. Roller Pump Adjustments (continued)

#### 3-2-3. Checking/Adjusting Casting Runout

1. Remove the pump safety cover and occlusion adjustment knob cap.

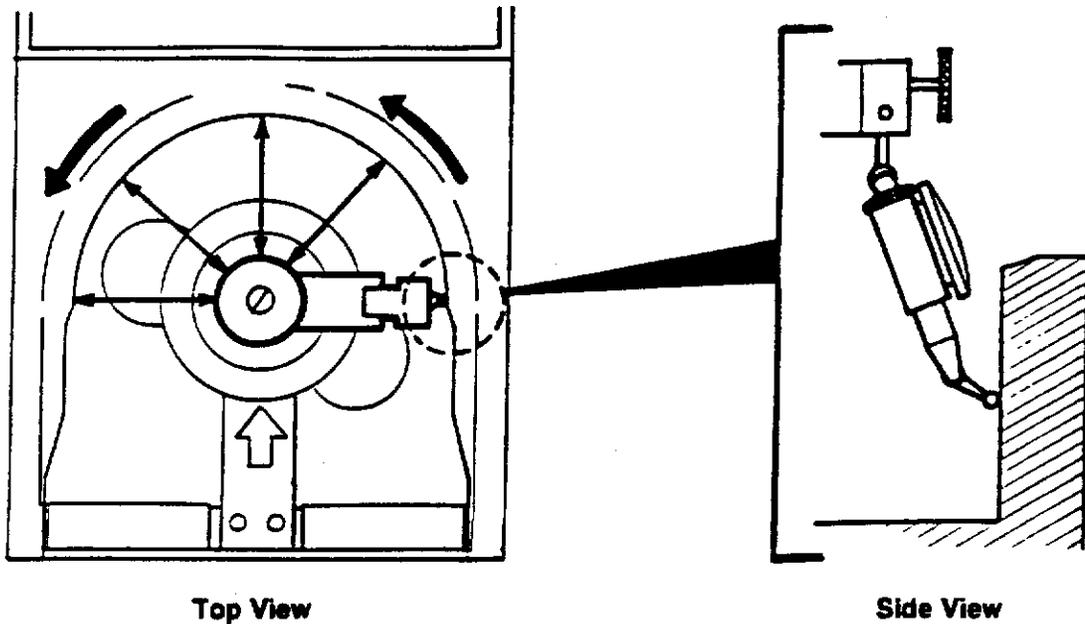


2. Assemble the Dial Indicator Kit and Casting Runout Fixture. Mount the Casting Runout Fixture to the pump shaft assembly as shown below.



**3-2. Roller Pump Adjustments (continued)****3-2-3. Checking/Adjusting Casting Runout (continued)**

3. Adjust the Dial Indicator's position so that the needle deflects to mid-scale when the Stem makes contact with the point on the casting shown below.



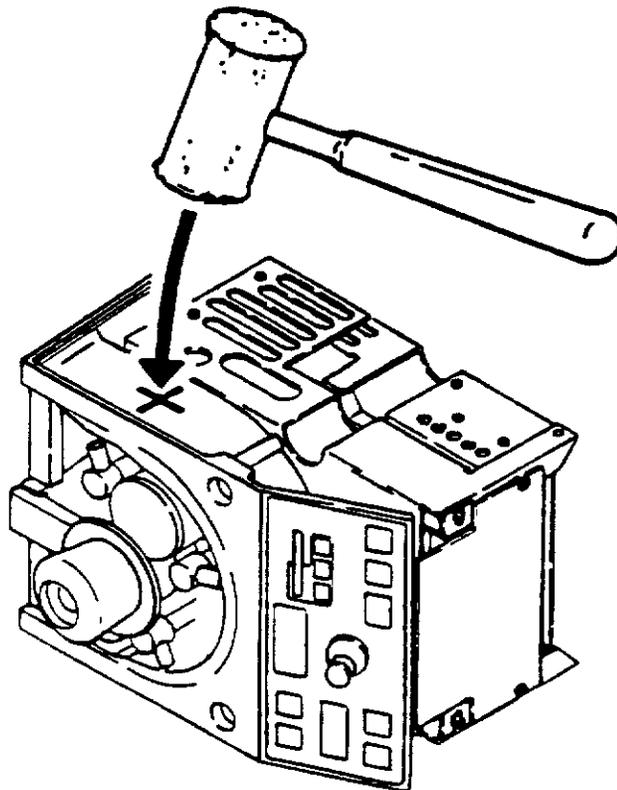
4. Rotate the roller assembly around the casting, monitoring the dial needle deflection.
  - If the needle deflects less than 0.0015" from mid-scale, remove the Casting Runout Fixture. (Loosen the knurled knob, then tap on the top of the fixture to release it.) Continue with Step 9b of Procedure 2-3-3.
  - If the needle deflects more than 0.0015" from mid-scale, continue with Step 5.

### 3-2. Roller Pump Adjustments (continued)

#### 3-2-3. Checking/Adjusting Casting Runout (continued)

5. Adjust the casting as follows:
  - a. Remove the Casting Runout Fixture from the pump shaft assembly. (Loosen the knurled knob, then tap on the top of the fixture to release it.)
  - b. Remove the pump from the console. Lay the pump on its side.
  - c. ~~Use a soft-faced hammer to hit the outside of the casting on the side that caused the greatest deflection of the dial needle.~~
  - d. Recheck the casting runout.
  - e. Repeat Steps 5a through 5d until the casting runout is brought into specification, then continue with Step 6. If the casting cannot be brought into specification, replace the casting/bearing assembly.

IF OUT OF SPEC  
Replace CASTING.



6. Remove the Casting Runout Fixture from the pump shaft assembly. (Loosen the knurled knob, then tap on the top of the fixture to release it.)
7. Replace the pump safety cover and occlusion adjustment knob cap.
8. Check all cable connections to ensure that none were loosened by the pounding.
9. Install tubing in the pump (refer to the 9000 Perfusion System Operators Manual). Run the pump for 20 minutes to ensure normal operation. Repeat Steps 1 through 8.

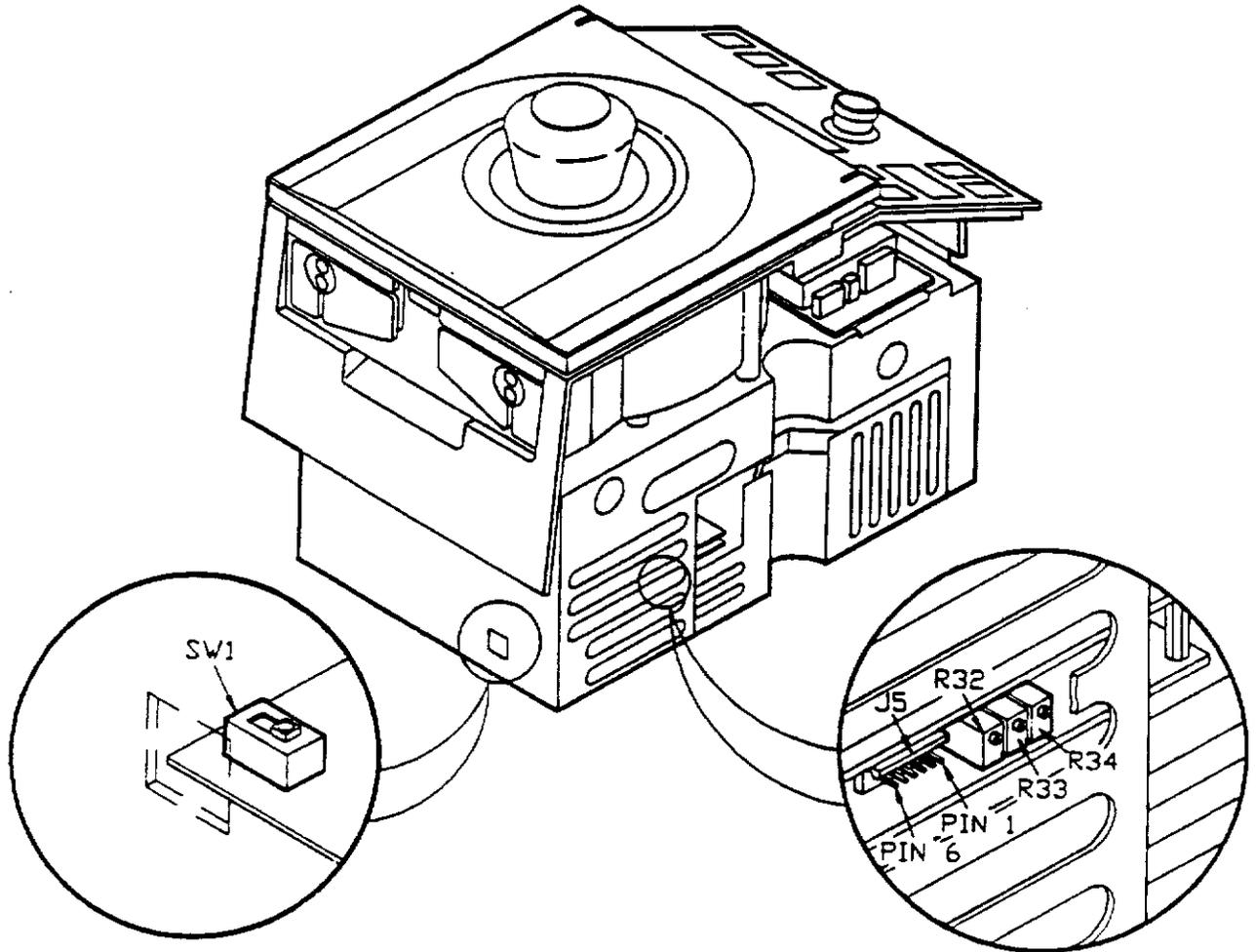
**3-2. Roller Pump Adjustments (continued)**

**3-2-4. Calibrating the Pump Control Board**

1. Remove the roller pump from the 9000 console. Set the pump in front of the 9000; reconnect the pump cable.
2. Press both Forward switches. Turn the speed pot fully clockwise. The rollers should turn counterclockwise at full speed.
3. Perform the following checks at J5 on the Pump Control Board:
  - a. Connect the negative lead of the DVM to Pin 6 and the positive lead to Pin 1. The DVM should read 8.0 +/- 0.2 VDC (reference voltage). If not, perform the following:
    - Check for 24-36 VDC at the appropriate pump connector (J7-J11) on the Power Distribution Board. If not found, refer to the power system troubleshooting (Subsection 5-3).
    - Check for the following voltages at J3 on the Pump Power Supply Board: -12 VDC across Pins 1 and 4 (common), +12 VDC across Pins 2 and 4, +5 VDC across Pins 3 and 4. If any of the voltages are missing, replace the Pump Power Supply Board.
    - Replace the Pump Control Board.
  - b. Turn the demand pot fully clockwise and hold. Connect the positive lead to Pin 2. The DVM should read 5.00 +/- 0.05 VDC; adjust R-34 to meet this specification. If the voltage cannot be adjusted to specification, replace the Pump Control Board.
  - c. Connect the positive lead to Pin 4. The DVM should read -5.00 +/- 0.05 VDC; adjust R-32 to meet this specification. If adjusting R-32 cannot bring the voltage into specification, repeat Steps 3b and 3c as needed until both voltages meet their specifications; if the voltages cannot be adjusted to specification, replace the Pump Control Board.
  - d. Push the switch on the Pump Safety Board toward the forty-pin ribbon cable. The DVM should read 0.00 +/- 0.05 VDC.
  - e. Push the switch toward the outside of the board. The DVM should read -5.00 +/- 0.05 VDC.
  - f. Connect the positive lead to Pin 3. The DVM should read -5.00 +/- 0.05 VDC; if not, replace the Pump Control Board.
  - g. Connect the positive lead to Pin 5. The DVM should read 4.85 +/- 0.15 VDC; if not, replace the Pump Control Board.
4. Stop the pump.
5. Insert the Digital Tachometer into the roller assembly.
6. Press both Forward switches. Turn the speed pot fully clockwise. The maximum RPM should be 250 +/- 2.0 RPM (use a digital tachometer to verify the RPM reading); adjust R-33 to meet this specification.

3-2. Roller Pump Adjustments (continued)

3-2-4. Calibrating the Pump Control Board (continued)



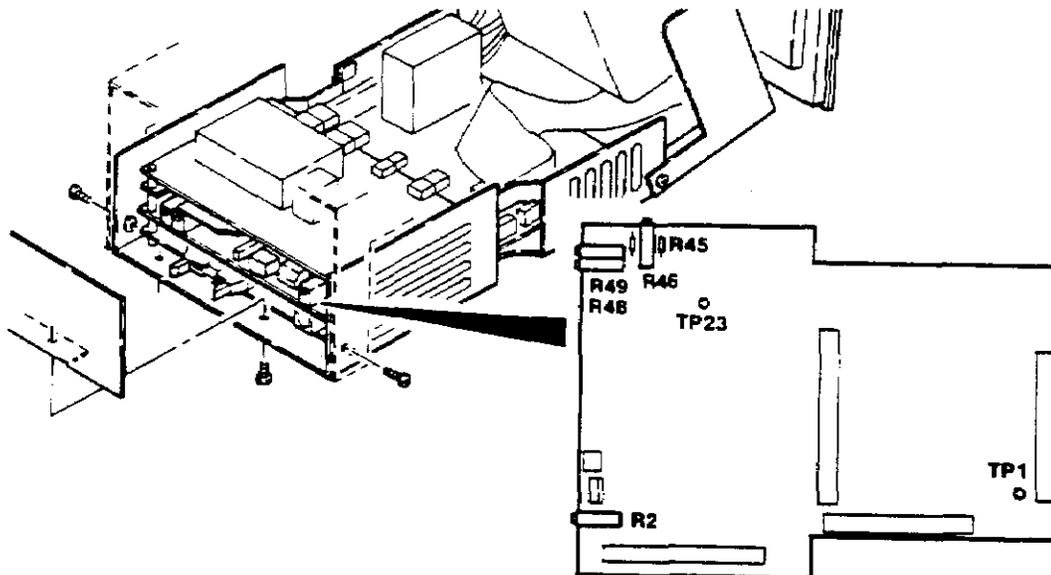
### 3-3. Centrifugal Pump Adjustments

#### 3-3-1. Calibrating the Motor Control Board

1. Remove the centrifugal pump from the 9000 console. Set the pump in front of the 9000.
2. Remove the back panel from the pump.
3. Remove the two securing screws at the rear of the pump assembly, then hinge open the assembly.
4. Connect a drive motor with no load to the pump.
5. Connect the pump cable to the front tray.
6. Set the machine power switch to ON.
7. Press both Forward switches. Turn the speed knob fully clockwise (maximum RPM).
8. Perform the following checks on the Motor Control Board:
  - a. Connect the negative lead of the DVM to TP1, and the positive lead to TP23. The DVM should read  $5.00 \pm 0.01$  VDC; adjust R49 to meet this specification.
  - b. Leave the negative lead of the DVM connected to TP1. Connect the positive lead to R45 (connect to the resistor lead closest to the edge of the PCB). The DVM should read  $4.70 \pm 0.01$  VDC; adjust R45 to meet this specification.

Note: If R45 is a standard resistor, it must be replaced with a 50K ohm potentiometer (P/N 26-1007-7501-9), and then adjusted as stated above.

- c. The speed readout on the front panel should be  $3600 \pm 60$  RPM; adjust R48 to meet this specification.

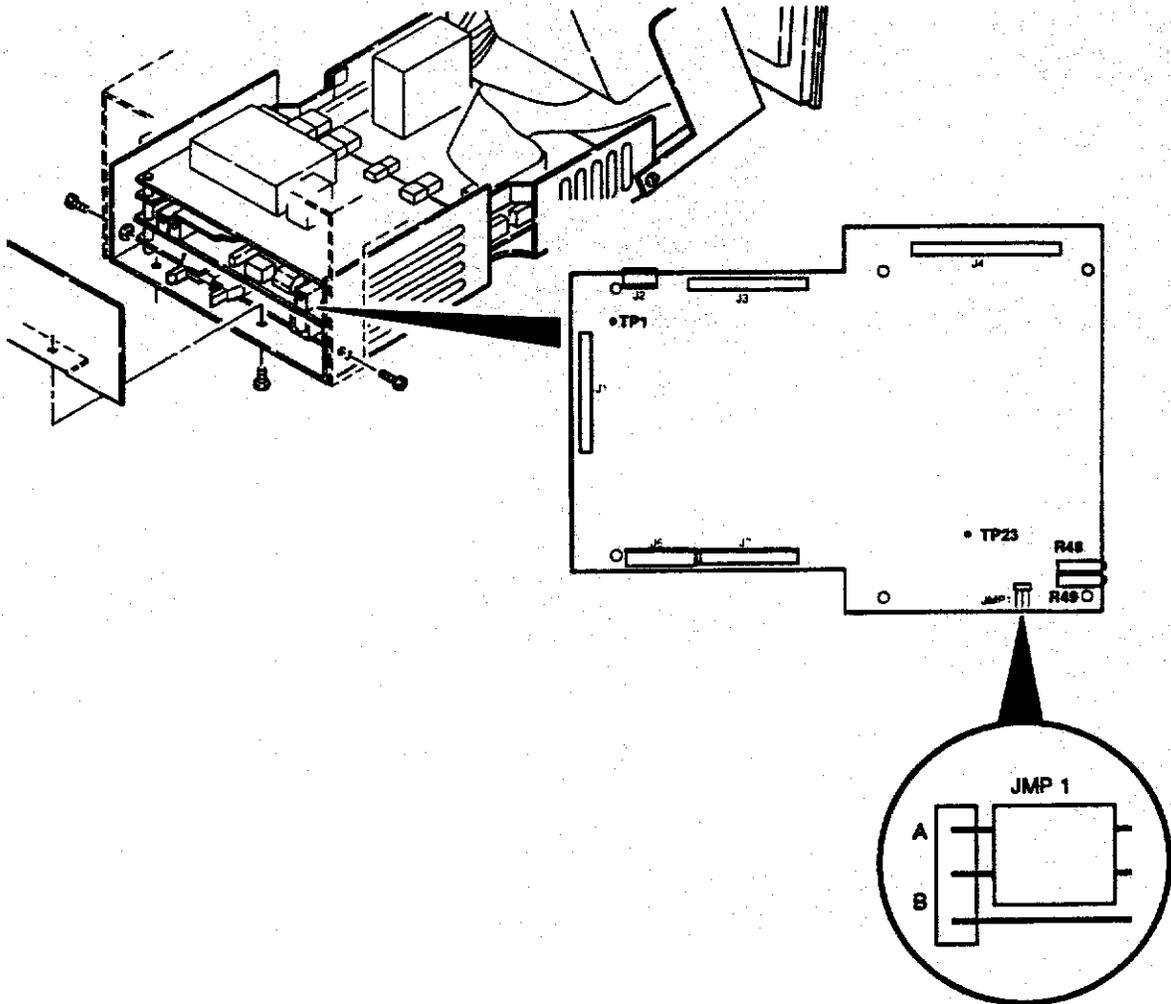


### 3-3. Delphin™ II Module Adjustments

When calibrating the Motor Control Board of a Delphin™ II Module, use the directions below for step 8.b.

**8. Perform the following checks on the Motor Control Board:**

- a. Connect the negative lead of the DVM to TP1, and the positive lead to TP23. The DVM should read 5.00 +/- 0.01 VDC; adjust R49 to meet this specification.
- b. Verify that JMP1 is in position "A" (see new board illustrated below).
- c. The speed readout on the front panel should be 3600 +/- 60 RPM; adjust R48 to meet this specification.



### 3-5. Gas System Adjustments

#### 3-5-1. Calibrating Flow Sensors - Version 2.21 or Higher

1. Set the power switch to OFF.
2. Set the system to the Diagnostic Mode (refer to Procedure 2-2-1).
3. Disconnect the gas supplies.
4. Set the power switch to ON. Allow the machine to stabilize for 15 minutes.
5. Note the offset values displayed on the Central Display.
6. Touch "CALIBRATE FLOW SENSORS". The offset values may change. If any offset value is above 13, replace the appropriate Flow Sensor (refer to Procedure 4-2-4) and re-calibrate. Refer to the gas system troubleshooting (Subsection 5-9) for further detail.

	FLOW	OFFSET
O <sub>2</sub>	X1	Y
AIR/95-5	X2	Y
OUTPUT	X3	Y

X1, X2, and X3 are continually changing numbers. With no gas connected, X1 should not vary more than +/- 8, X2 should not vary more than +/- 15, and X3 should not vary more than +/- 10.  
Y must be a number less than 13 after "CALIBRATE FLOW SENSORS" is touched with no gas flowing.

7. Set the system to Normal Operating Mode (refer to Procedure 2-2-2).

### 3-4. Occluder Adjustments

#### 3-4-1. Calibrating the Occluder Drive Board

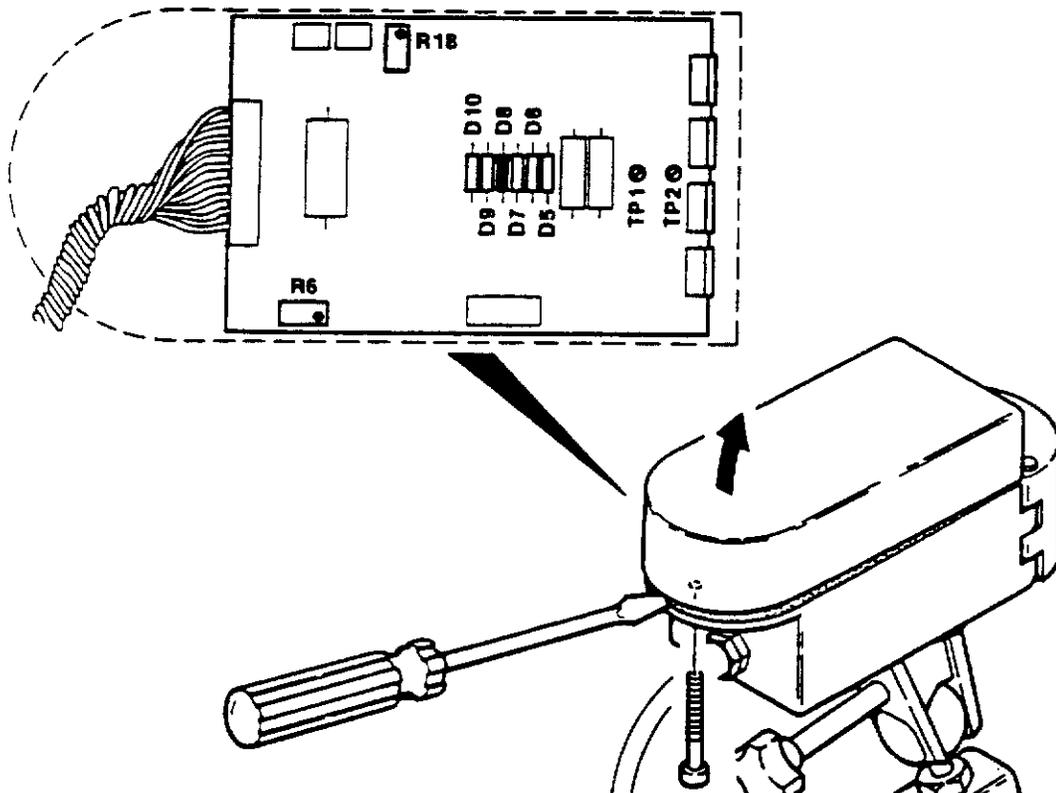
1. Remove the allen screw that secures the occluder cover. Being careful not to damage the conductive seal, pry the cover open at the round end. (The square end of the cover has a lip hinge, so the cover must be opened at the round end.)

**Note:** Be careful not to get a piece of the conductive seal on the Occluder Drive Board.

2. Connect a jumper cable across D8. Also connect the negative lead of the DVM to D8.
3. Ensure that the occluder cable is connected at the front tray and that the occluder circuit breaker is turned on. Set the power switch to ON.

**Note:** For the following steps, note the before and after voltage readings, along with the occluder serial number, on the repair report.

5. Connect the positive lead of the DVM to TP1. Adjust R6 to obtain a reading of 0.40 +/- 0.025 VDC. If this specification cannot be met, replace the Occluder Drive Board.
6. Connect the positive lead of the DVM to TP2. Adjust R18 to obtain a reading of 0.40 +/- 0.025 VDC. If this specification cannot be met, replace the Occluder Drive Board.



### 3-5. Gas System Adjustments

#### 3-5-1. Calibrating Flow Sensors - Version 2.21 or Higher

**Note:** Starting with software 4.0, the result of calibrating the flow sensors is displayed to the right of the button and either "Done" or "Error" will appear.

**3-5. Gas System Adjustments (continued)****3-5-2. Calibrating Flow Sensors - Version 1.7 or Lower**

- Page 2.21*
1. Obtain an Injection Fixture and Test Memory Board from the nearest Service Center.
  2. Set the power switch to OFF.
  3. Disconnect the gas supplies.
  4. Open the front door. Remove the plate (T10 Torx) that covers the STD bus.
  5. Using static precautions, remove the Memory Board and replace it with the Test Memory Board. *close dip switch #8 - reinstall module.* *(Pump selector module)*
  6. Set the power switch to ON. Allow the machine to stabilize for 15 minutes.
  7. A one square inch area in the upper right corner of the Main Screen is active with the Test Memory Board installed. Touch this area of the screen several times until the Gas Flow Test Screen is displayed.
  8. Note the offset values shown for Channel 0 (O<sub>2</sub>), Channel 1 (Air), and Channel 3 (Total). If any offset value is above 18, replace the appropriate flow sensor (refer to Procedure 4-2-4).
  9. Add five to the offset values noted in the previous step. Be certain to keep the O<sub>2</sub>, Air, and Total values separate.
  10. Set the power switch to OFF.
  11. Install the Injection Fixture on Mother Board connectors J6, J7, and J8.
  12. Set the power switch to ON.
  13. Touch the upper right corner of the Main Screen several times to display the Gas Flow Test Screen.
  14. Use the three knobs on the Injection Fixture to dial in the offset values noted in Step 9. Be sure to inject the proper offset for each flow sensor.

**Notes:** Do not touch the knobs once the proper values have been dialed in.

15. Set the power switch to OFF.
16. Using static precautions, remove the Test Memory Board and re-install the standard Memory Board.
17. Set the system to the Diagnostic Mode (refer to Procedure 2-2-1).
18. Set the power switch to ON.

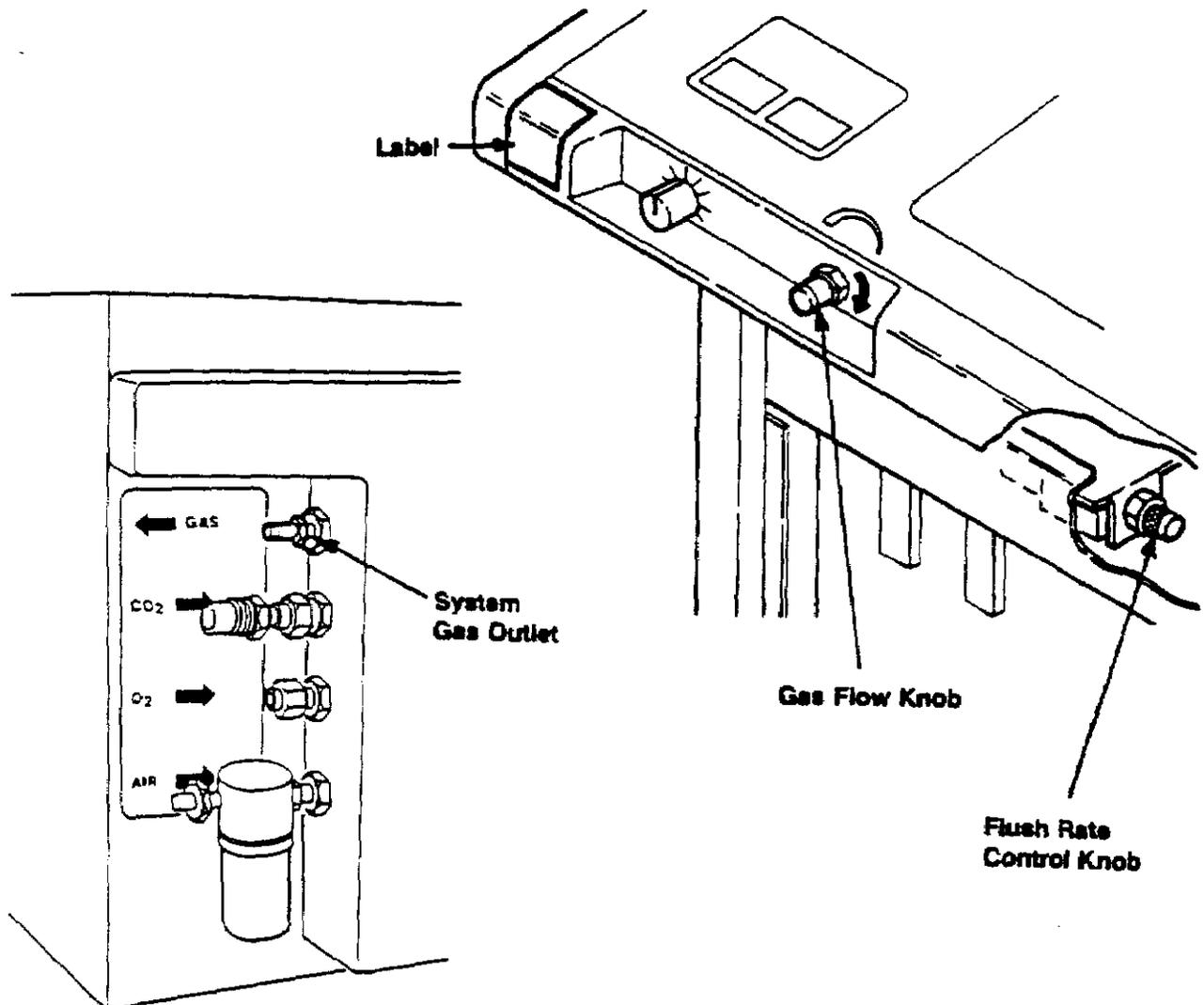
**3-5. Gas System Adjustments (continued)****3-5-2. Callibrating Flow Sensors - Version 1.7 or Lower (continued)**

19. Touch "Callibrate the Flow Sensors".
20. Set the power switch to OFF.
21. Remove the Injection Fixture. Reconnect M-J6, M-J7, and M-J8 to the Mother Board.
22. Replace the plate that covers the STD bus.
23. Set the system to the Normal Operating Mode (refer to Procedure 2-2-2).
24. Connect the gas supplies.
25. Verify the  $\text{FiO}_2$  and Flow Rate as described in the System Inspection (refer to Procedure 2-3-2).

### 3-5. Gas System Adjustments (continued)

#### 3-5-3. Adjusting the CO<sub>2</sub> Flush Rate

1. Turn the gas flow knob fully clockwise (OFF).
2. Connect a flowmeter to the system gas outlet.
3. Start the CO<sub>2</sub> supply to the system.
4. Open the front door. Locate the flush rate control knob at the rear of the left air filter. Turn the knob until the desired flow rate (2 to 10 L/min.) appears on the flowmeter.
5. Clean the label area and apply the correct flow rate label from the accessories kit.



### 3-6. Water Module Adjustments

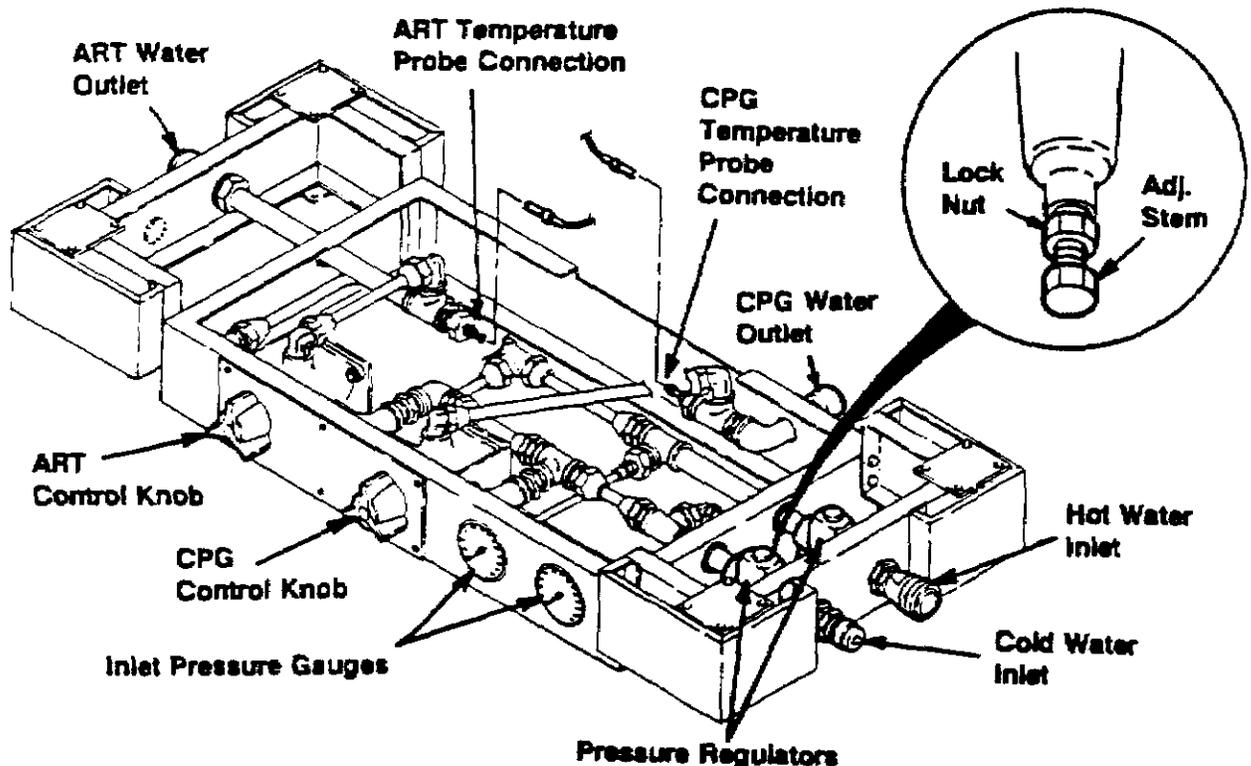
#### 3-6-1. Setting the Outlet Pressure Limit

**Notes:** Input water pressures must be within the range of 35 to 75 p.s.i. Some water modules have been modified with a normally open 24 VDC valve in the hot water supply line to the cardioplegia and/or arterial mixing valves. This valve(s) receives power from J6 on the Power Distribution Board. When energized, the valve(s) cuts off the flow of hot water to the mixing valve(s), allowing for maximum cooling. An activation switch is located next to the control knob(s).

1. Connect the hot and cold water sources to the water module inlets.
2. Turn the CPG and ART control knobs fully clockwise (OFF).
3. Turn on the source water supplies.
4. Perform the following for each pressure regulator:
  - a. Loosen the lock nut on the adjustment stem of the pressure regulator.
  - b. Turn the adjustment stem to change the pressure as desired by the hospital.
  - c. Tighten the lock nut.

**Note:** Both pressure regulators must be set to the same pressure limit, within the range of 35 to 75 p.s.i. Do not adjust the pressure above the rated limit of the heat exchanger to be used.

- a. Loosen the lock nut on the adjustment stem of the pressure regulator.
  - b. Turn the adjustment stem to change the pressure as desired by the hospital.
  - c. Tighten the lock nut.
5. Verify the outlet pressures with an external pressure monitoring device.



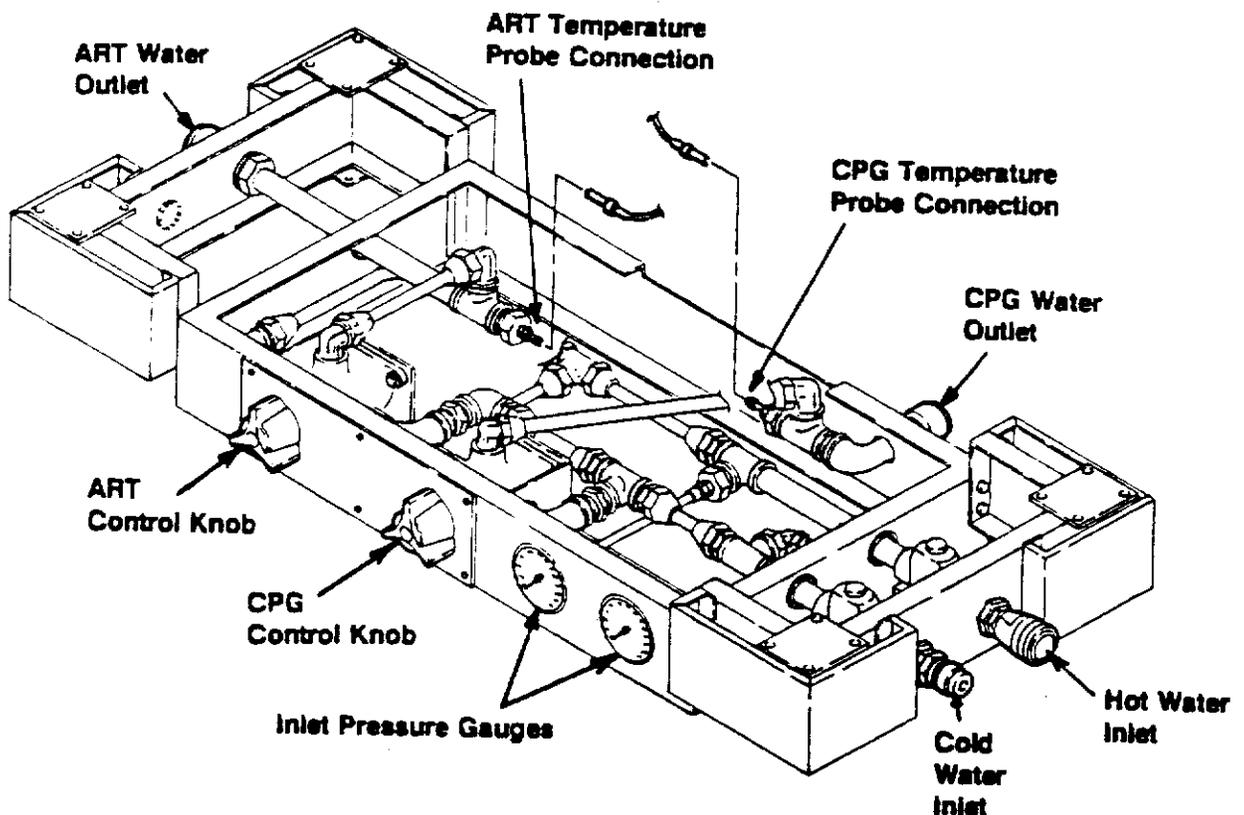
### 3-6. Water Module Adjustments (continued)

#### 3-6-2. Checking the Water Temperature

**Notes:** The source cold water supply must have a maximum temperature of 6°C, at a minimum pressure of 55 p.s.i. The source hot water supply must have a minimum temperature of 44°C, at a minimum pressure of 35 p.s.i.

Some water modules have been modified with a normally open 24 VDC valve in the hot water supply line to the cardioplegia and/or arterial mixing valves. This valve(s) receives power from J6 on the Power Distribution Board. When energized, the valve(s) cuts off the flow of hot water to the mixing valve(s), allowing for maximum cooling. An activation switch is located next to the control knob(s).

1. Set the power switch to OFF.
2. Ensure that the ART and CPG water temperature probes are properly connected.
3. Connect the source water supplies.
4. Connect the drain hoses.
5. Turn the ART and CPG control knobs fully clockwise (OFF).
6. Turn on the source water supplies.
7. Check the pressure gauges to ensure that both inlet pressures are equal. If not, adjust the pressures as described in Procedure 3-6-1.



**3-6. Water Module Adjustments (continued)****3-6-2. Checking the Water Temperature (continued)**

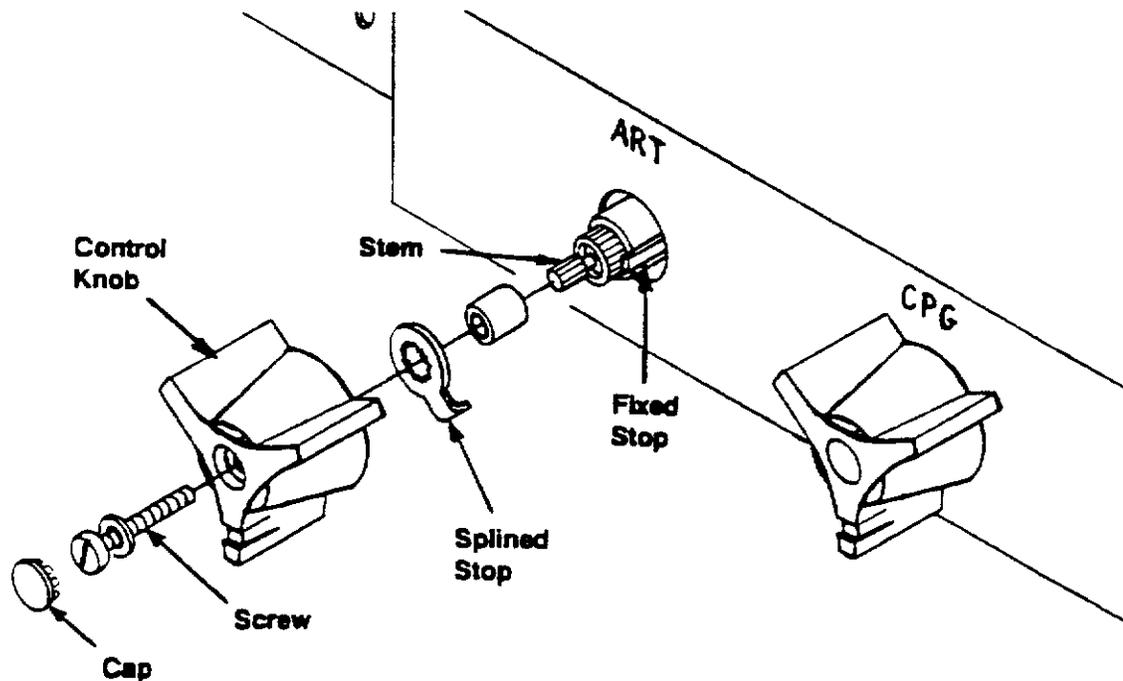
8. Set the power switch to ON.
9. With the Title Screen displayed, touch "Main Screen". With the Main Screen displayed, touch "Auxiliary Screen".
10. Turn the ART control knob fully counter-clockwise. Allow the water temperature to stabilize for several minutes. The maximum output should be  $40.5^{\circ}\text{C} \pm 1.5^{\circ}\text{C}$ . If not, adjust the temperature as described in Procedure 3-6-3.
11. Turn the ART control knob fully clockwise (OFF).
12. Turn the CPG control knob fully counter-clockwise. Allow the water temperature to stabilize for several minutes. The maximum output should be  $40.5^{\circ}\text{C} \pm 1.5^{\circ}\text{C}$ . If not, adjust the temperature as described in Procedure 3-6-3.
13. Turn the CPG control knob fully clockwise (OFF).

### 3-6. Water Module Adjustments (continued)

#### 3-6-3. Adjusting the Water Temperature

**Note:** Adjust only one temperature output at a time; the other output must be OFF (control knob fully clockwise).

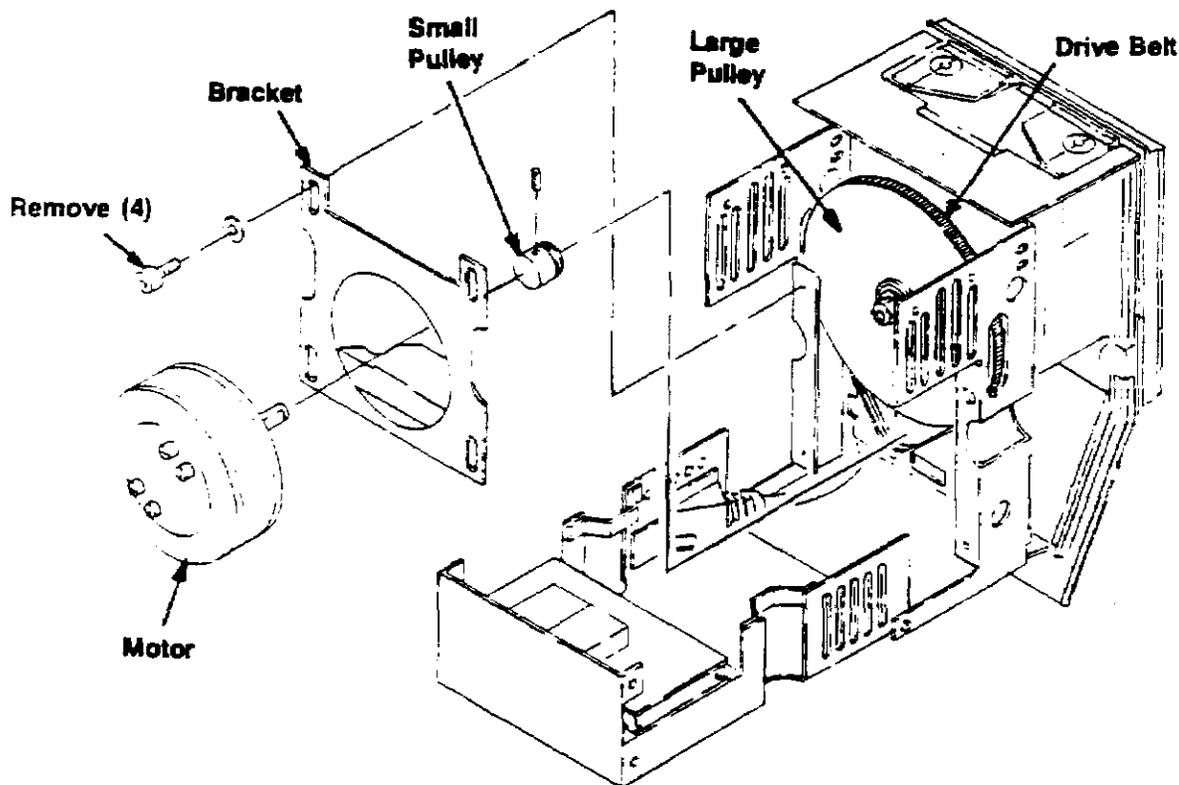
1. Check the water temperature as described in Procedure 3-6-2. Leave the machine powered on, with the Auxiliary Screen displayed.
2. Remove the cap from the center of the appropriate control knob.
3. Remove the screw from the center of the control knob.
4. Remove the control knob and the splined stop.
5. Place the knob on the stem and turn the knob until  $40.5^{\circ}\text{C} \pm 1.5^{\circ}\text{C}$  is displayed on the Auxiliary Screen.
6. Remove the knob and place the splined stop on the stem. Position the splined stop against the fixed stop so that the stem cannot be rotated counter-clockwise.
7. Place the knob on the stem. Turn the knob fully clockwise and check to see that the output flow stops. If not, check to see if the hot water temperature is at least  $44^{\circ}\text{C}$  and that the hot and cold water pressures are equal.
8. Install the screw and cap.



## 4-1. Roller Pumps (continued)

### 4-1-2. Replacing the Pump Drive Motor

1. Perform Steps 1 through 7 of Procedure 4-1-1 (Replacing the Pump Drive Belt).
2. Remove the four bolts (3/16" Allen) that secure the motor bracket assembly to the pump chassis.
3. Disconnect DRV-J4 from the Pump Drive Board and CTRL-J3 from the Pump Control Board. Remove the motor assembly, cutting wire ties as needed.
4. Remove the bracket and small pulley from the old motor and install them on the new motor. When installing the bracket on the new motor, position the bracket so that the side of the motor from which the wires exit will be toward the front of the pump.
5. Mount the new motor assembly to the chassis. Use shrink tubing and solder to splice the new wires.
6. Align the top of the small pulley with the top of the large pulley.
7. Connect DRV-J4 to the Pump Drive Board and CTRL-J3 to the Pump Control Board. Replace any wire ties that were cut when the motor assembly was removed.
8. Perform the replacement steps of Procedure 4-1-1 (Replacing the Pump Drive Belt).
9. Perform all the steps of Procedure 2-3-3 (Roller Pump Inspection).

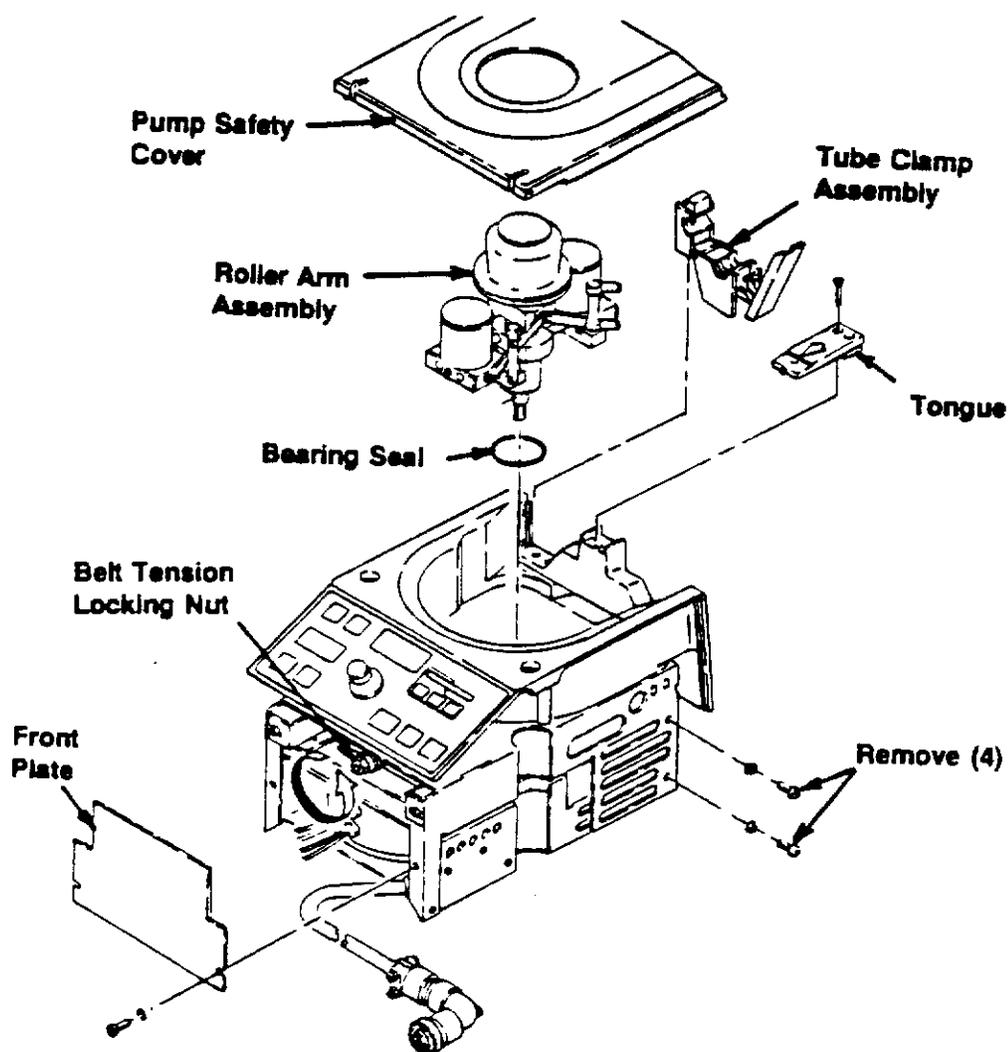


## 4-1. Roller Pumps (continued)

### 4-1-3. Removing the Roller Arm Assembly

#### Disassembly:

1. Remove the pump safety cover.
2. Remove the tube clamp assemblies.
3. Remove the tongue.
4. Remove the front plate.
5. Loosen the belt tension locking nut (9/16").
6. Remove the four screws at the rear of the pump housing.



## 4-1. Roller Pumps (continued)

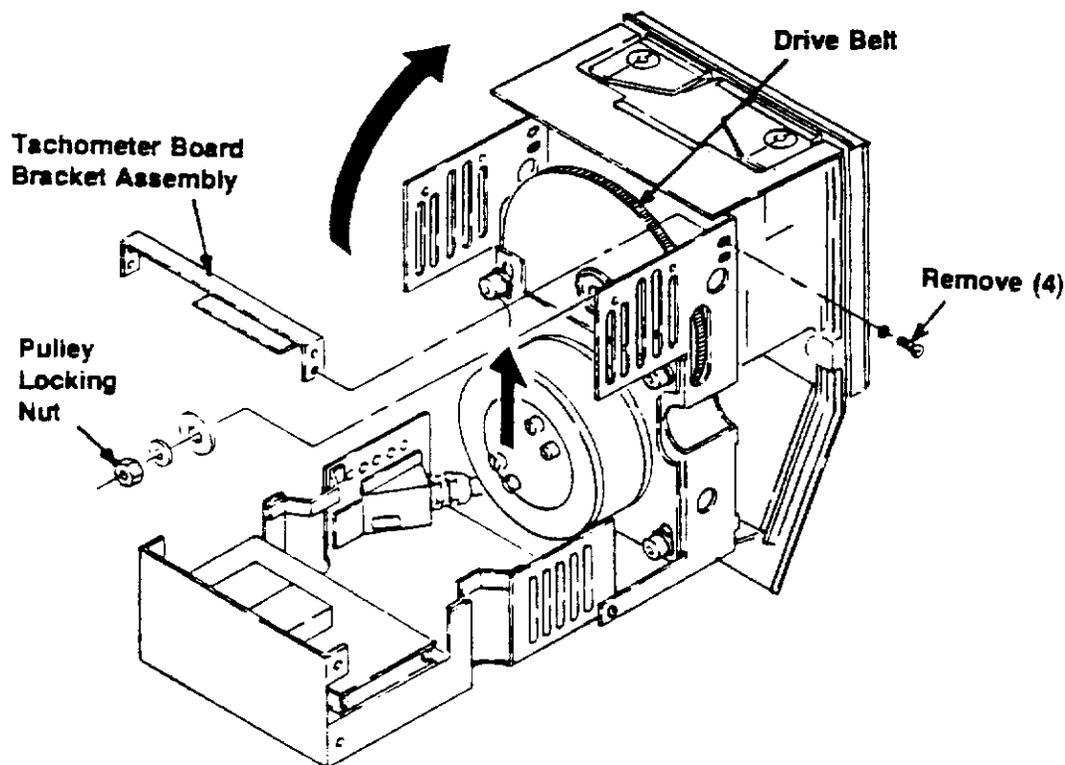
### 4-1-3. Removing the Roller Arm Assembly (continued)

#### Disassembly (continued):

7. Hold down the back of the pump assembly and lift up on the casting to hinge open the assembly.

**Note:** Be careful not to pinch the power cord underneath the casting when the pump assembly is hinged open.

8. Disconnect TACH-J1 from the Tachometer Board.
9. Remove four screws, then remove the Tachometer Board bracket assembly.
10. Lift up on the motor to remove the tension from the drive belt, then slide the drive belt off the pulley and remove it from the pump assembly.
11. Remove the pulley locking nut (9/16").
12. Grasp the occlusion adjustment knob and the casting. Pull the roller arm assembly out of the pump assembly. If necessary, lightly tap the pump shaft with a soft-faced hammer to drive the roller arm assembly out of the casting.
13. Remove the bearing seal.



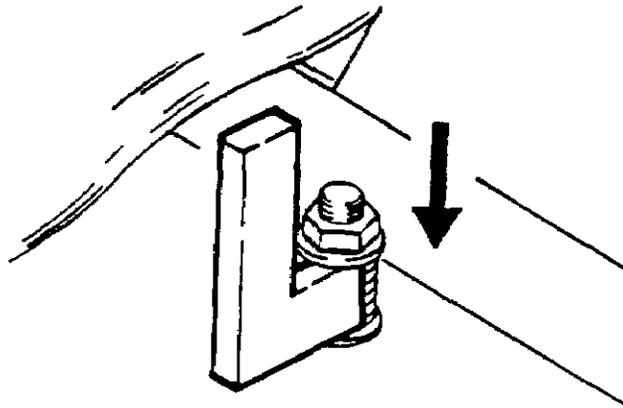
## 4-1. Roller Pumps (continued)

### 4-1-3. Removing the Roller Arm Assembly (continued)

#### Reassembly:

Reassembly is the reverse of disassembly, with the following exceptions:

- Install a new bearing seal. The bearing seal must be replaced whenever the roller arm assembly is removed.
- Be certain that the pin that passes through the pump shaft is seated properly in the groove in the pulley.
- If the pulley locking nut is damaged, replace it.
- When tightening the belt tension locking nut, place the belt tension gauge between the two washers, then tighten the nut until the washers make contact with the gauge. Replace the nut if damaged.



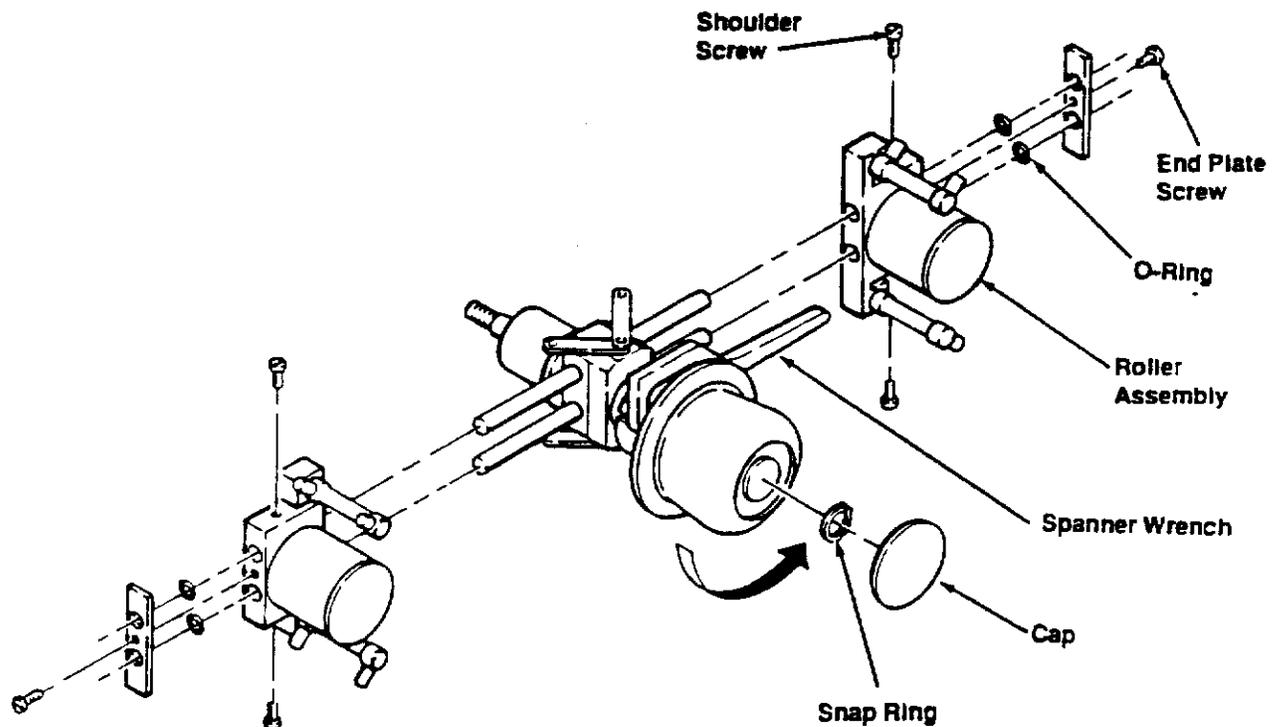
- After completing reassembly, perform the following Adjustment Procedures:
  - 3-2-1. Checking Roller-to-Roller
  - 3-2-3. Checking/Adjusting Casting Runout

## 4-1. Roller Pumps (continued)

### 4-1-4. Disassembling the Roller Arm Assembly

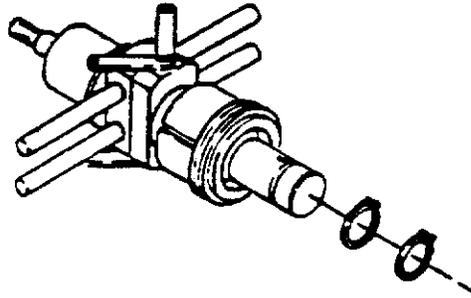
#### Disassembly:

1. Perform Procedure 4-1-3 (Removing the Roller Arm Assembly).
2. Remove the four shoulder screws.
3. Remove and discard the two end plate screws.
4. Remove the end plates and O-rings. Discard the O-rings.
5. Remove the roller assemblies.
6. Remove the black cap from the occlusion adjustment knob.
7. Use the external snap ring pliers to remove the first snap ring from the pump shaft.
8. While holding the adjustment nut with the spanner wrench, unthread the occlusion adjustment knob. Clean off any excess grease.

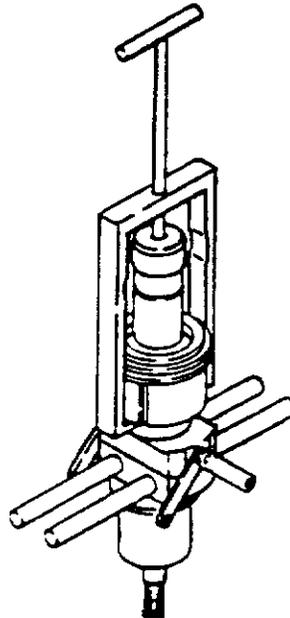


**4-1. Roller Pumps (continued)****4-1-4. Disassembling the Roller Arm Assembly (continued)**

9. Use the External Snap Ring Pliers to remove the second and third snap rings from the pump shaft.



10. Use the Adjustment Nut Puller to remove the adjustment nut from the pump shaft.

**Reassembly:**

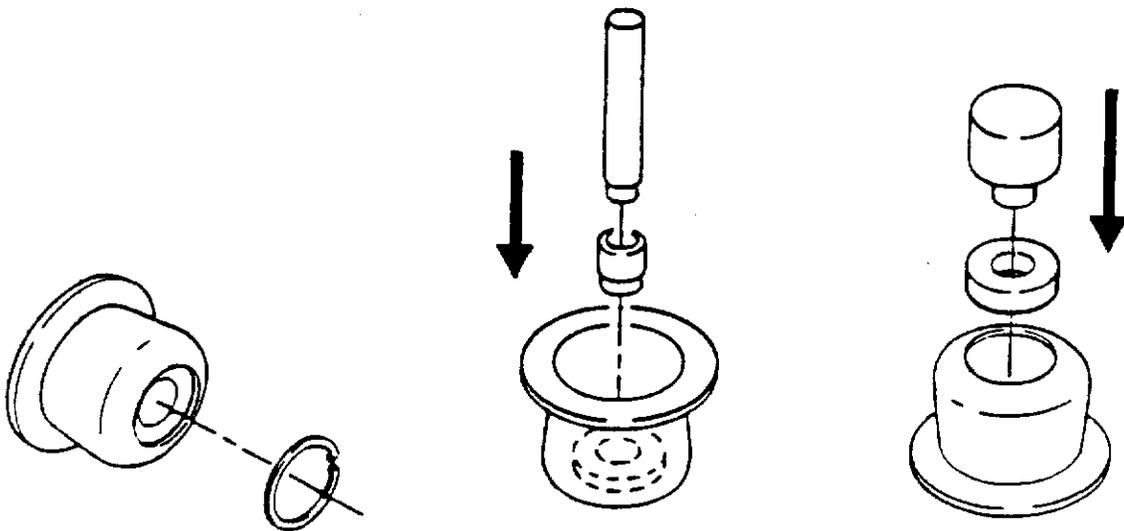
Reassembly is the reverse of disassembly, with the following exceptions:

- Install new end plate screws and O-rings.
- Torque the four shoulder screws to 17 in/lbs.
- After completing reassembly, perform the following Adjustment Procedures:
  - 3-2-1. Checking Roller-to-Roller
  - 3-2-3. Checking/Adjusting Casting Runout

## 4-1. Roller Pumps (continued)

### 4-1-5. Replacing the Occlusion Adjustment Knob Bearing

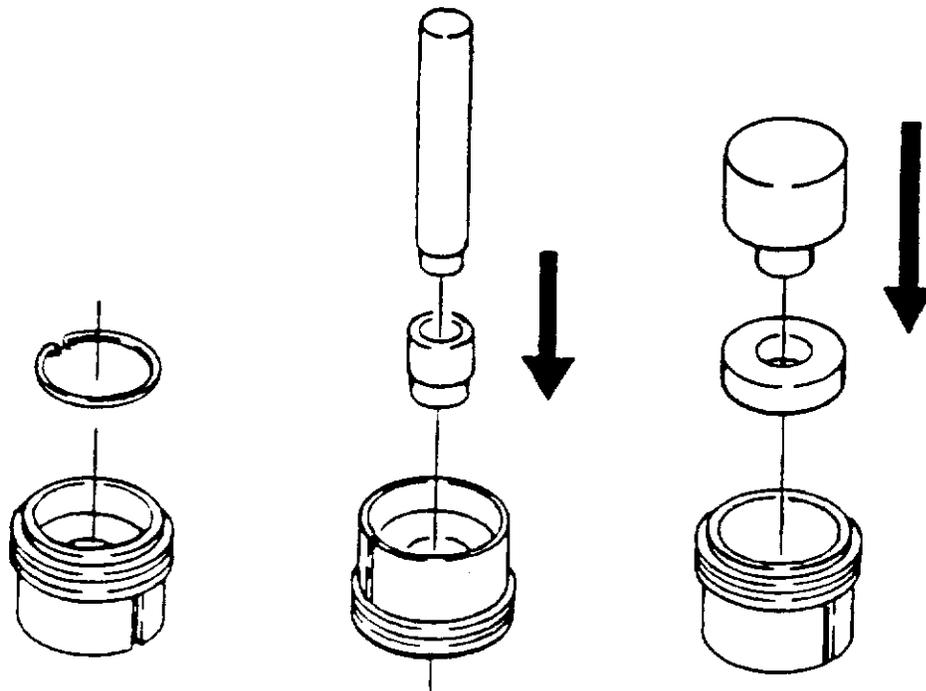
1. Perform Procedure 4-1-3 (Removing the Roller Arm Assembly).
2. Perform Steps 6 and 7 of Procedure 4-1-4 (Disassembling the Roller Arm Assembly).
3. Use the Internal Snap Ring Pliers to remove the snap ring from the occlusion adjustment knob.
4. Use the R-10 Bearing Punch and R-12 Adapter to knock the old bearing out of the knob. Discard the old bearing.
5. Use the 9000 Occlusion Knob Bearing Insertion Tool to install the new bearing in the knob.



## 4-1. Roller Pumps (continued)

### 4-1-6. Replacing the Adjustment Nut Bearing

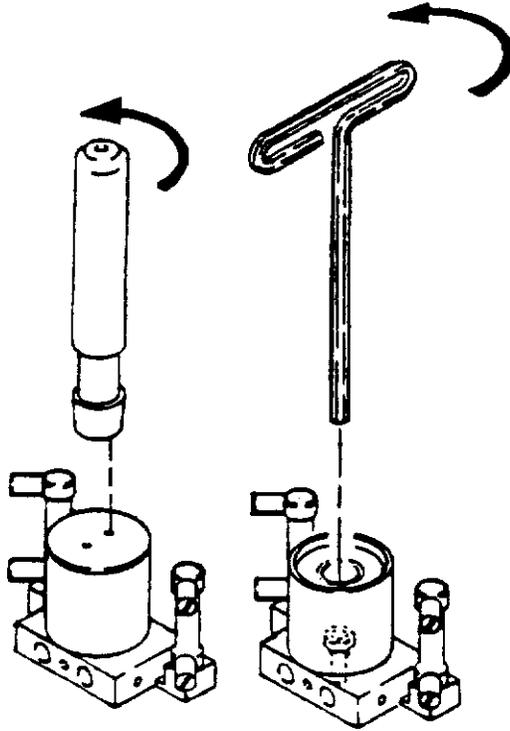
1. Perform Procedure 4-1-3 (Removing the Roller Arm Assembly).
2. Perform Steps 6 through 10 of Procedure 4-1-4 (Disassembling the Roller Arm Assembly).
3. Use the Internal Snap Ring Pliers to remove the snap ring from the adjustment nut.
4. Use the R-10 Bearing Punch and R-12 Adapter to knock the old bearing out of the nut. Discard the old bearing.
5. Use the 9000 Occlusion Knob Bearing Insertion Tool to install the new bearing in the nut.
6. Re-install the snap ring.
7. Reassemble by performing Steps 6 through 10 of Procedure 4-1-4 in reverse order.



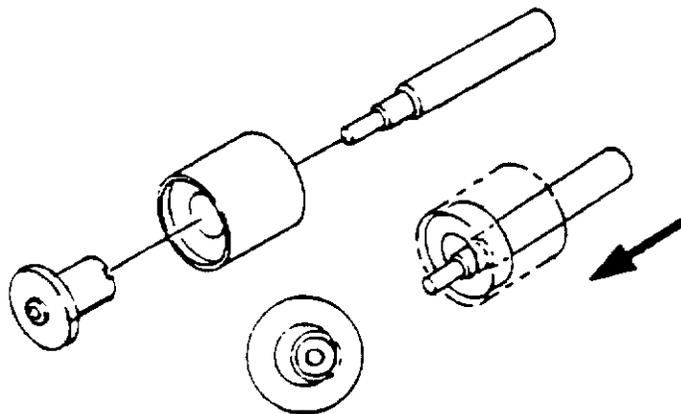
#### 4-1. Roller Pumps (continued)

##### 4-1-7. Replacing Roller Bearings

1. Use the Roller Adjustment Tool to remove the roller cap. Remove the socket head screw from the center of the roller.

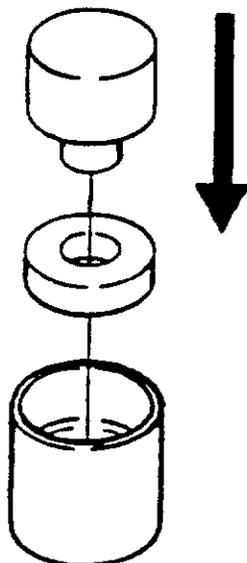


2. Use the Roller Post Punch to remove the roller eccentric post. Use the upper edge of the punch to drive the old bearings out of the roller. Discard the old bearings.



**4-1. Roller Pumps (continued)****4-1-7. Replacing Roller Bearings (continued)**

3. Use the Roller Bearing Insertion Tool to install the new bearings.



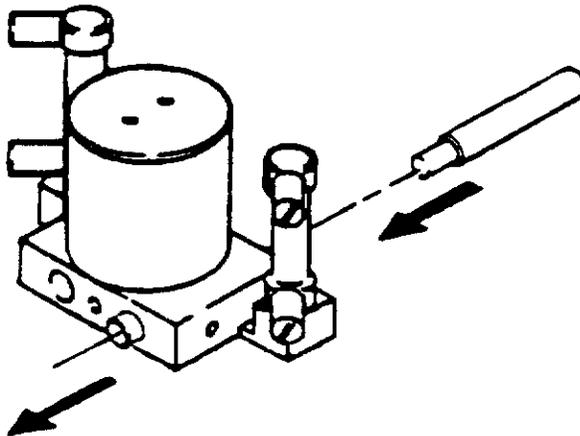
4. Use the Soft-Face Hammer to tap the roller eccentric post back into the roller.
5. Re-install the socket head screw and the roller cap.
6. Perform Procedure 3-2-1 (Checking Roller-to-Roller).

## 4-1. Roller Pumps (continued)

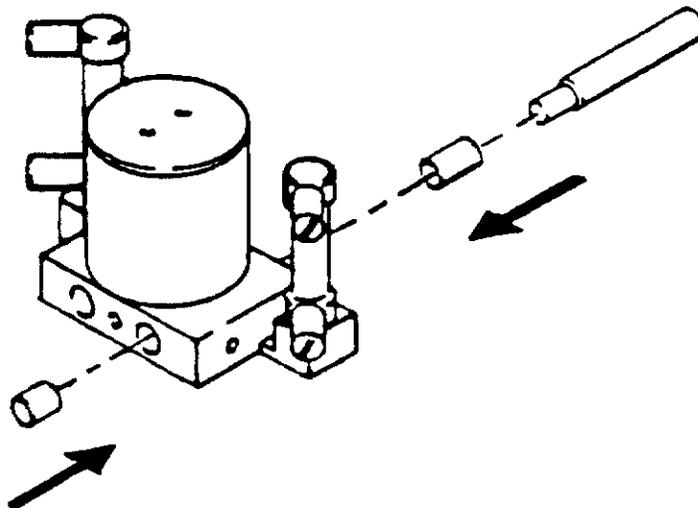
### 4-1-8. Replacing the Roller Slide Bushings

**Note:** It is usually only necessary to replace one set of bushings on each roller slide assembly. Determine which bushings are the most loose on each roller slide and replace them (for a total of two long bushings and two short bushings per roller pump).

1. Perform Procedure 4-1-3 (Removing the Roller Arm Assembly).
2. Perform Steps 1 through 5 of Procedure 4-1-4 (Disassembling the Roller Arm Assembly).
3. Use the Bushing Driver to drive the old bushings out of the roller slide assembly.

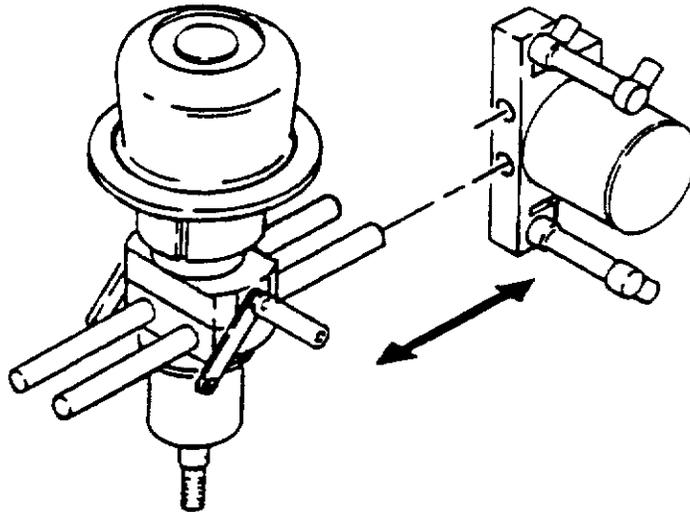


4. Use the Bushing Driver to install the new bushings. Drive the long bushing flush to the bottom of the roller slide. Drive the short bushing flush to the top of the roller slide.

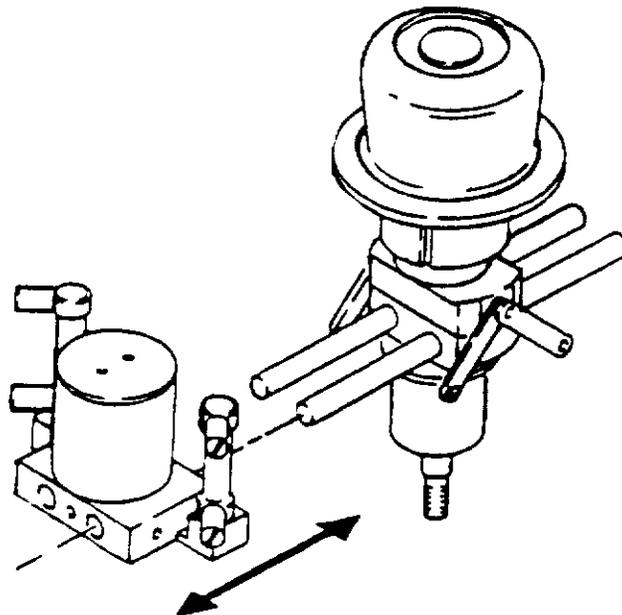


**4-1. Roller Pumps (continued)****4-1-8. Replacing the Roller Slide Bushings (continued)**

5. Align the hole that has new bushings with its respective support rod. Try to ease the roller slide onto the support rod. The slide should move smoothly on the support rod without binding. If the slide doesn't fit on the support rod or does not move smoothly, the bushings have to be reamed (refer to Procedure 4-1-9).



6. When the slide moves smoothly on each individual support rod, align both holes with their respective support rods. Ease the slide onto the support rods. The slide should move smoothly without binding. (If measured with a force gauge, it should require 5 to 7 pounds of force to move the slide.)



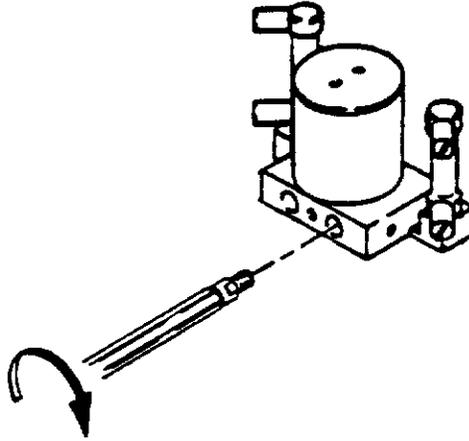
## 4-1. Roller Pumps (continued)

### 4-1-9. Reaming the Roller Slide Bushings

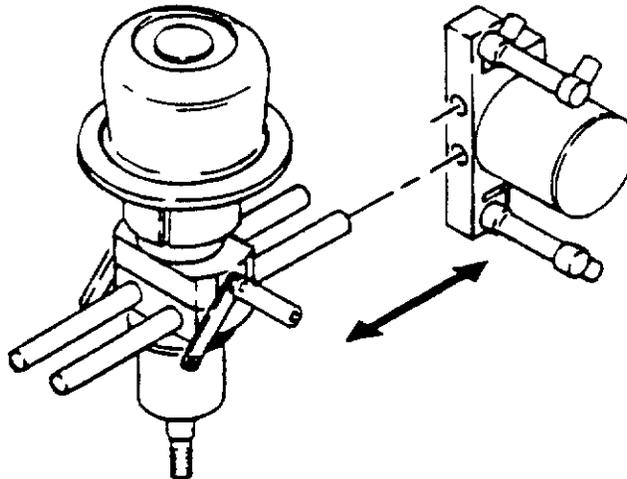
1. Insert the Adjustable Reamer into the roller slide hole that needs adjusting.

**Note:** The Reamer should be adjusted so that the cutting blades apply a small amount of pressure on the bushings.

2. Slowly turn the Reamer clockwise to thread it through the bushings. When the Reamer is completely through the hole and out the other side of the roller slide, continue to turn the Reamer clockwise while withdrawing it from the hole.



3. Align the reamed hole with its respective support rod. Try to ease the roller slide onto the support rod. The slide should move smoothly on the support rod without binding. If the slide doesn't fit on the support rod or does not move smoothly, the bushings require additional reaming. If the slide appears to be too loose on the support rod, the bushings have been reamed too much and have to be replaced (refer to Procedure 4-1-8).



4. Reassemble and perform Procedures 3-2-1 (Checking Roller-to-Roller) and 3-2-3 (Checking/Adjusting Casting Runout).

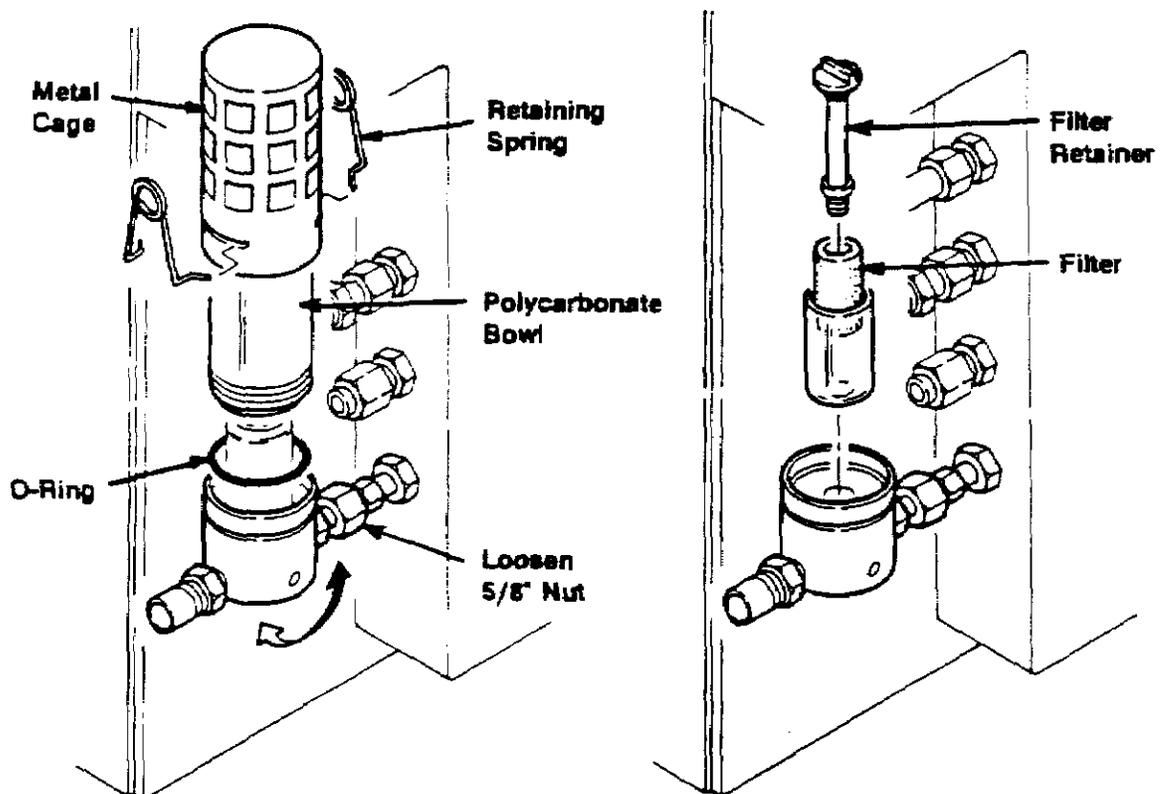
**4-1. Roller Pumps (continued)****4-1-10. Replacing the Casting/Bearing Assembly**

1. Remove the pump drive motor (refer to Procedure 4-1-2).
2. Remove the roller arm assembly (refer to Procedure 4-1-3).
3. Remove the tongue wall support by cutting the two red wires and removing the four screws.
4. Remove the dovetail slides.
5. Remove the card cage assembly by removing the five bolts that secure it to the casting.
6. Remove the display membrane panel (refer to Procedure 4-4-5). Clean off the silastic seal.
7. Place a thin bead of silastic seal on the new casting and secure the display membrane panel.
8. Reassemble the pump using the hardware removed in Steps 1 through 6.
9. Perform a complete System Inspection (refer to Procedure 2-3-2).

## 4-2. Gas Flow System

### 4-2-1. Replacing the Water Trap Filter

1. Squeeze and remove the retaining springs on the metal cage and remove the cage.
2. Press the relief valve on the bottom of the polycarbonate bowl to drain any water.
3. Loosen the 5/8" nut by 1/4 turn. Rotate the filter assembly upwards.
4. Unscrew the polycarbonate bowl (turn counter-clockwise) and remove the O-ring.
5. Unscrew the black filter retainer.
6. Remove the old filter from the filter retainer.
7. Clean and dry all surfaces.
8. Install the new filter on the filter retainer.
9. Re-install the filter retainer, O-ring, and polycarbonate bowl.
10. Re-install the metal cage and retaining springs.
11. Rotate the assembly back down to its original position and tighten the 5/8" nut.

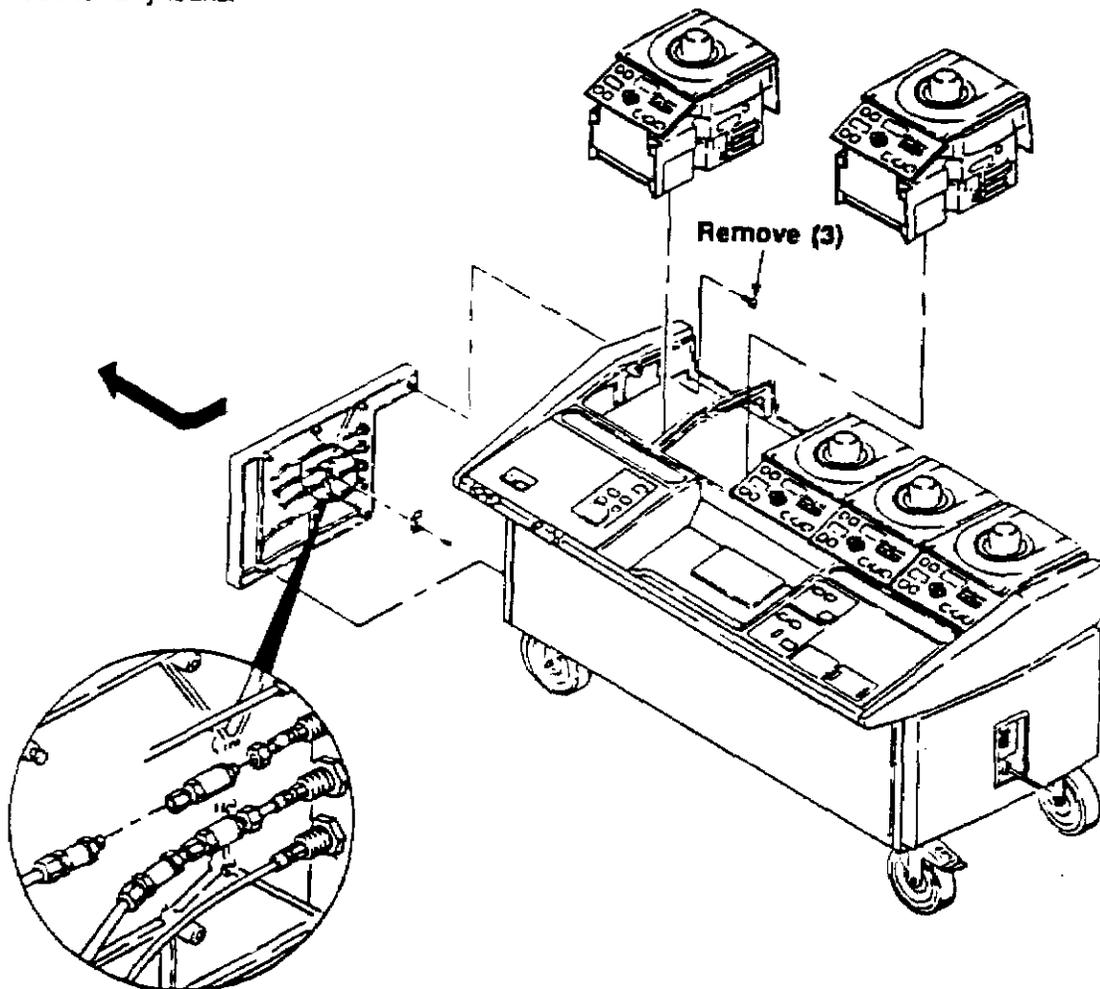


## 4-2. Gas Flow System (continued)

### 4-2-2. Replacing the CO<sub>2</sub> and O<sub>2</sub> Inlet Filters

Note: The inlet filters should be replaced every two years or as needed. Whenever an inlet filter is replaced, the associated check valve must also be replaced.

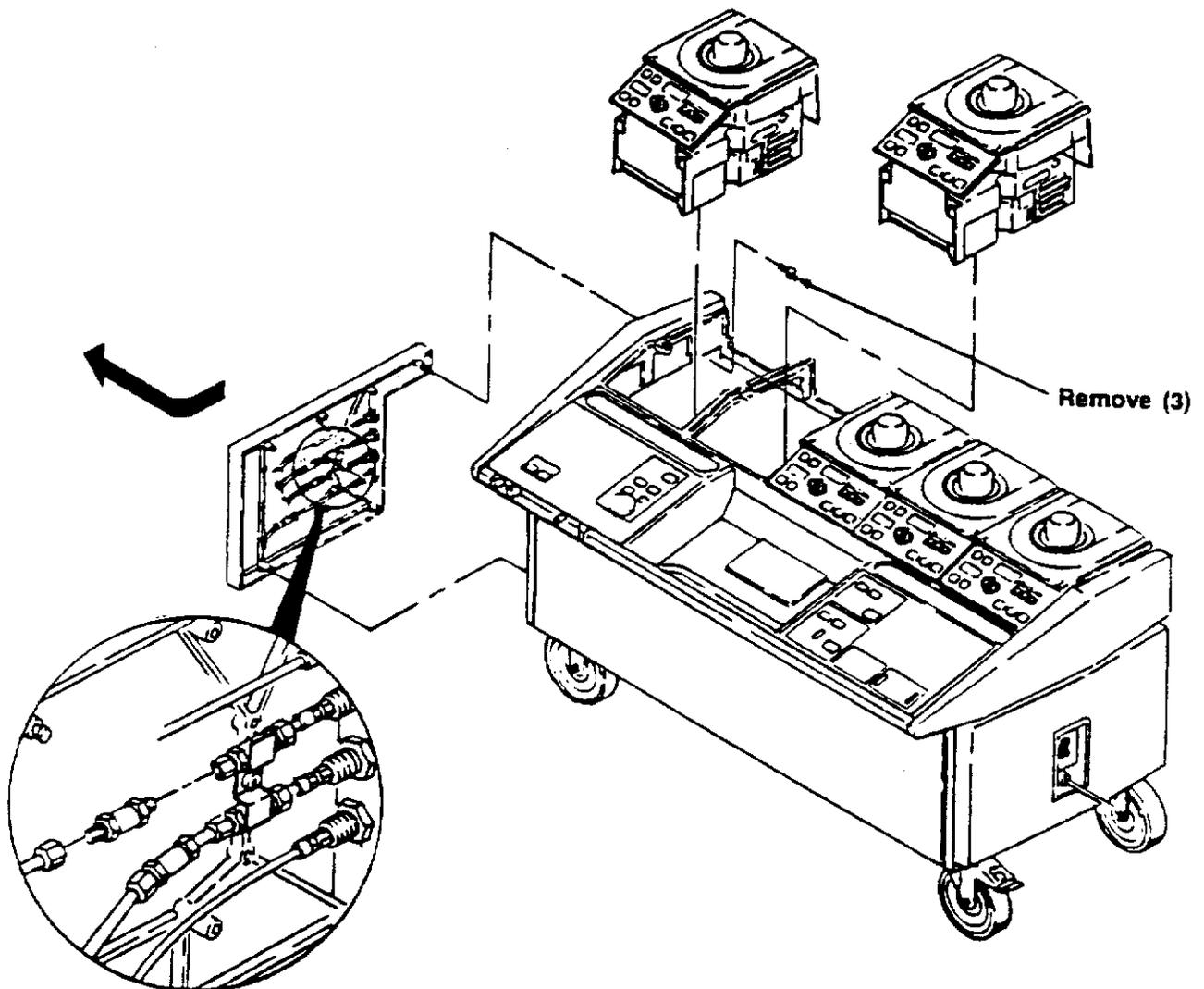
1. Remove pumps 1 and 2.
2. Remove the three screws (T27 Torx) inside the machine that secure the side panel.
3. Remove the side panel by sliding it toward the front of the machine and then pulling it away from the side of the machine.
4. Remove the bracket (T15 Torx) securing the two inlet filters.
5. Remove the appropriate inlet filter.
6. Install the new inlet filter and reassemble the machine.
7. Perform a complete System Inspection (refer to Procedure 2-3-2).
8. Check for any leaks.



## 4-2. Gas Flow System (continued)

### 4-2-3. Replacing the CO<sub>2</sub>, O<sub>2</sub>, and Air Check Valves

1. Remove pumps 1 and 2.
2. Remove the three screws (T27 Torx) inside the machine that secure the side panel.
3. Remove the side panel by sliding it toward the front of the machine and then pulling it away from the side of the machine.
4. Remove the appropriate check valve.
5. Install the new check valve and reassemble the machine.
6. Perform a complete System Inspection (refer to Procedure 2-3-2).
7. Check for any leaks.



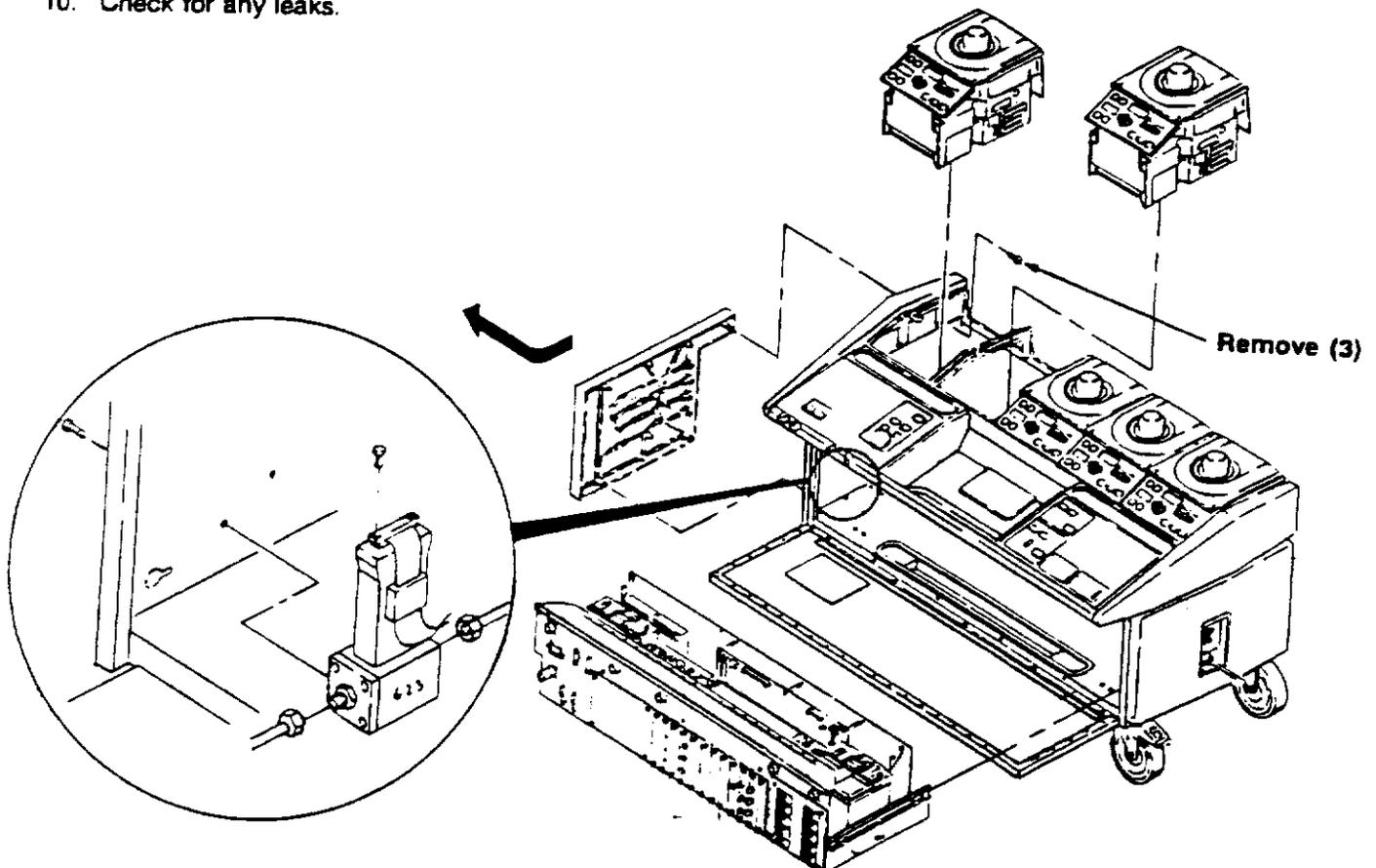
## 4-2. Gas Flow System (continued)

### 4-2-4. Replacing Flow Sensors

1. Remove the front tray (refer to Procedure 4-3-3).

**Note:** Removal of the front tray requires two people. If working alone, access the flow sensors from the rear of the machine instead (refer to Procedure 4-5-2).

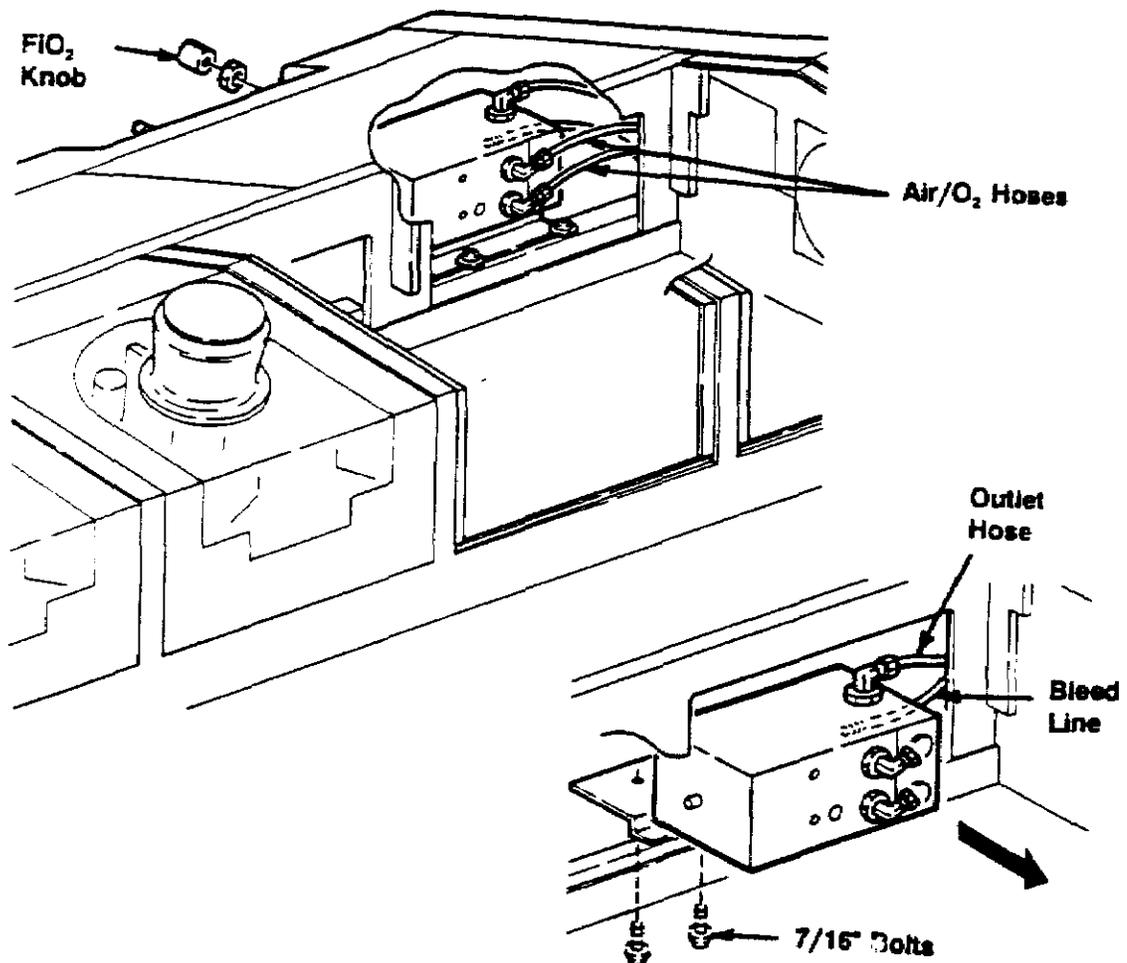
2. Remove pumps 1 and 2.
3. Remove the three screws (T27 Torx) inside the machine that secure the side panel.
4. Remove the side panel by sliding it toward the front of the machine and then pulling it away from the side of the machine.
5. Disconnect the two hoses (9/16" wrench) from the appropriate flow sensor.
6. Remove the two screws (T15 Torx) that secure the flow sensor to the chassis.
7. Remove the two screws (T7 Torx) that secure the cable connector to the flow sensor.
8. Install the new flow sensor. Calibrate the flow sensors (refer to Procedure 3-5-1 or 3-5-2).
9. Reassemble the machine and perform a complete System Inspection (refer to Procedure 2-3-2).
10. Check for any leaks.



## 4-2. Gas Flow System (continued)

### 4-2-5. Replacing the Blender

1. Remove pumps 1 and 2.
2. Remove the black FIO<sub>2</sub> knob (1/16" Allen) and the securing nut (1/2" wrench).
3. Disconnect the Air and O<sub>2</sub> hoses (7/16" wrench) from the rear of the blender.
4. Remove the two bolts (7/16" socket and 3" extension) from the bottom of the blender.
5. Carefully pull the blender out toward the rear of the machine.
6. Disconnect the outlet hose (7/16" wrench) from the top of the blender.
7. Disconnect the bleed line from the side of the blender.
8. Install the new blender and reassemble the machine.
9. Perform a complete System Inspection (refer to Procedure 2-3-2).
10. Check for any leaks.

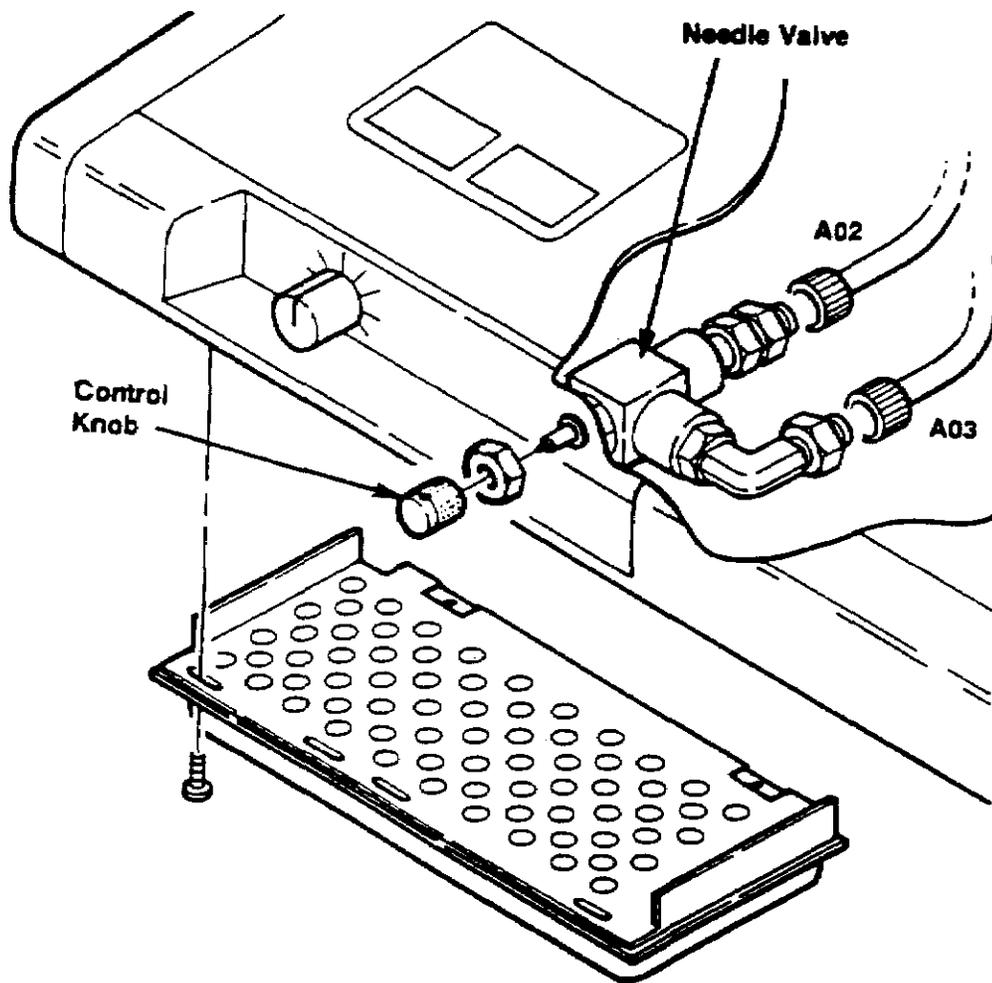


**4-2. Gas Flow System (continued)****4-2-6. Replacing the Gas Flow Needle Valve**

1. Remove the silver control knob (5/64" Allen) and the securing nut (11/16" wrench).
2. Remove the left air filter (refer to Procedure 4-5-1).
3. Disconnect the two gas hoses (7/16" wrench) from the valve. Note the orientation of the hoses, as they are marked the same.
4. Remove the old valve from the machine.
5. Install the new valve and reassemble the machine.

Note: Before re-installing the control knob, ensure that the valve is fully closed (fully clockwise).

6. Perform a complete System Inspection (refer to Procedure 2-3-2).



### 4-3. Front Tray

#### 4-3-1. Extending the Front Tray

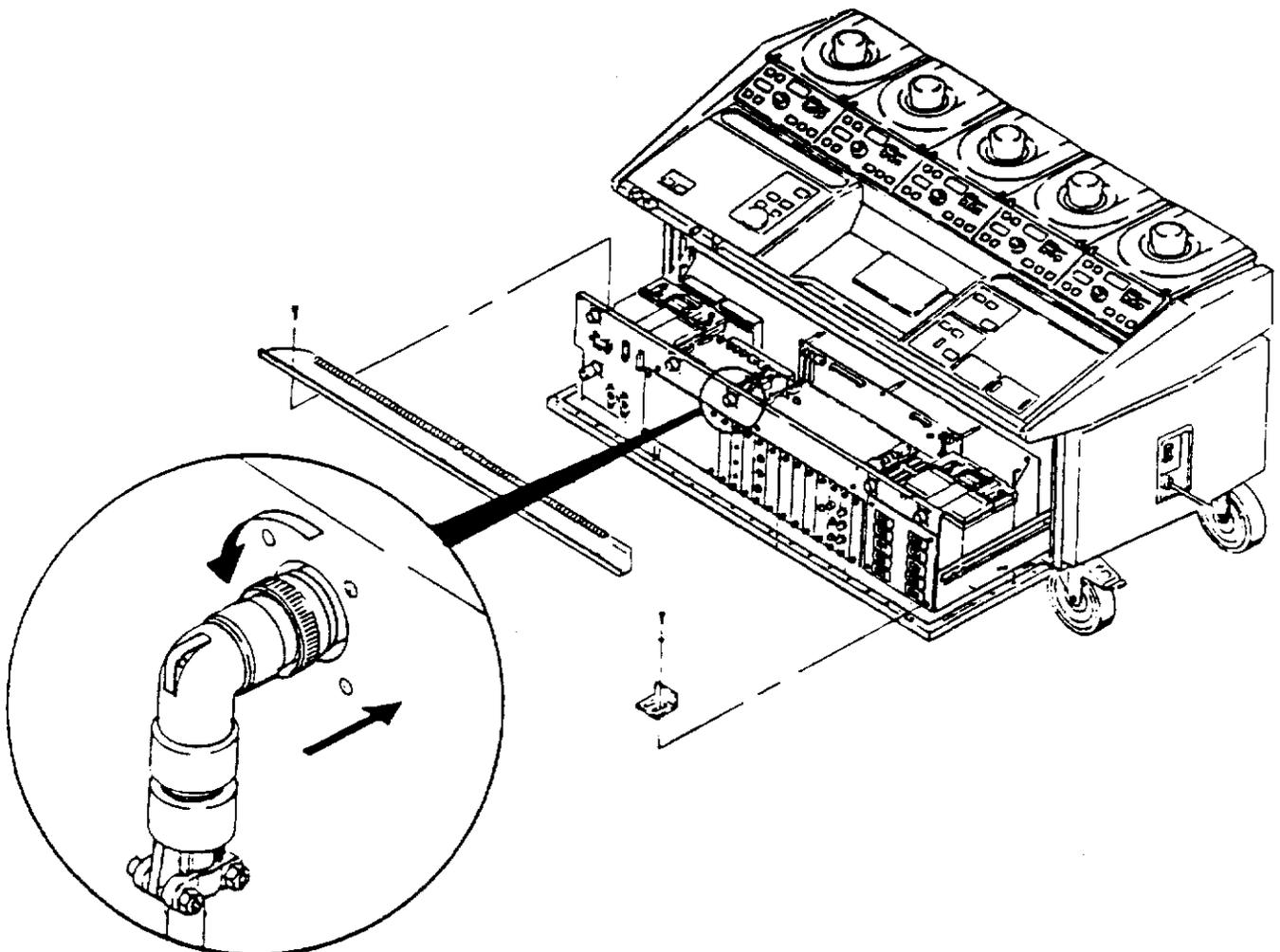
1. Open the front door.

**Note:** Prior to disconnecting any cables from the front tray, ensure that all the cables are marked so that they can be reconnected in the proper positions.

2. Disconnect all the cables from the front of the front tray. To disconnect the pump and central display cables, push in on the connector while turning the large outer ring counter-clockwise.
3. Remove the two stops (T27 Torx).

**Caution:** Take care when sliding the front tray in or out in order to prevent damaging the cables and wiring.

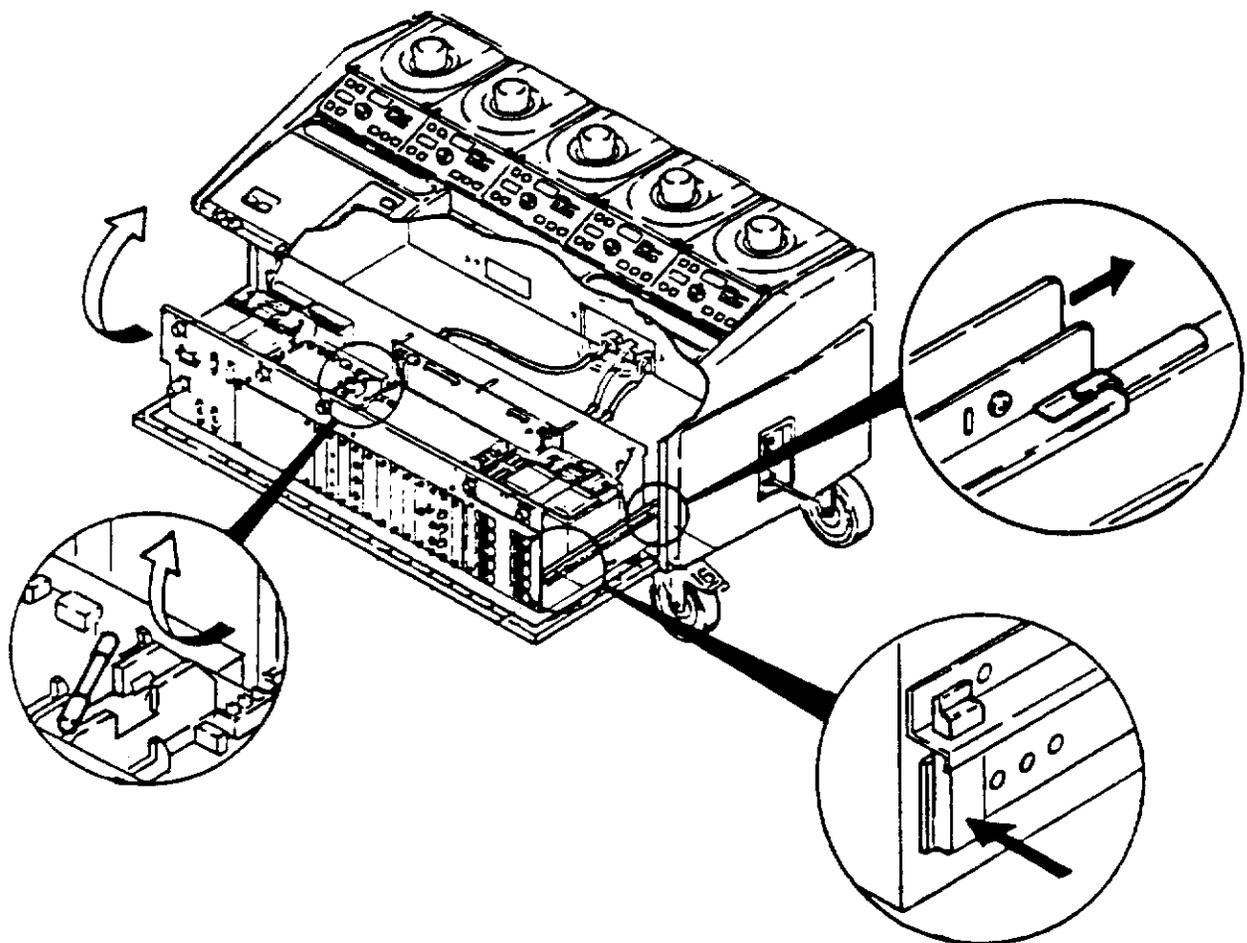
4. Slowly pull the front tray out, being careful not to get hung up on any cabling.
5. Remove the component shield (T15 Torx) from the front tray.



### 4-3. Front Tray (continued)

#### 4-3-2. Removing the Front Tray

1. Set the power switch to OFF and unplug the power cord.
2. Extend the front tray (refer to Procedure 4-3-1).
3. Remove the 60 amp battery power fuse.
4. Disconnect M-J5, M-J6, M-J7, M-J8, M-J28, and M-J29. Remove the cables from their cable hangers.
5. Disconnect M-J26, M-J43, and PC-J1. Remove the cables from their cable hangers.
6. Use a strain relief pliers to remove the middle strain relief from the bottom of the front tray.
7. Disconnect PD-J17 and PC-J5, cut the appropriate cable ties, and remove the cable through the bottom of the front tray.
8. Disconnect the grounding strap at the right rear of the front tray.



### 4-3. Front Tray (continued)

#### 4-3-2. Removing the Front Tray (continued)

**Note:** The following step requires two people.

9. Push in on the black tabs at each end of the front tray. Lift the front tray up and off the slide rails and lay it down on the Front Door. Push the slide rails back into the machine.

**Note:** When replacing the front tray on the slide rails, ensure that the rear edge of the rails attached to the tray fit under the hooks on the side rails.

10. Disconnect the three right-most connectors from the Capacitor Board on the rear tray. Cut the tie wraps that secure the three cables to the chassis.
11. Disconnect the solenoid and fan connectors inside the left end of the chassis.
12. Lift the front tray off the door and away from the 9000.

### 4-3. Front Tray (continued)

#### 4-3-3. Replacing the Batteries

**Warnings:** Turn the system power off before inspection, cleaning, preparation for use, or storage in order to turn off both the battery power and the wall power.

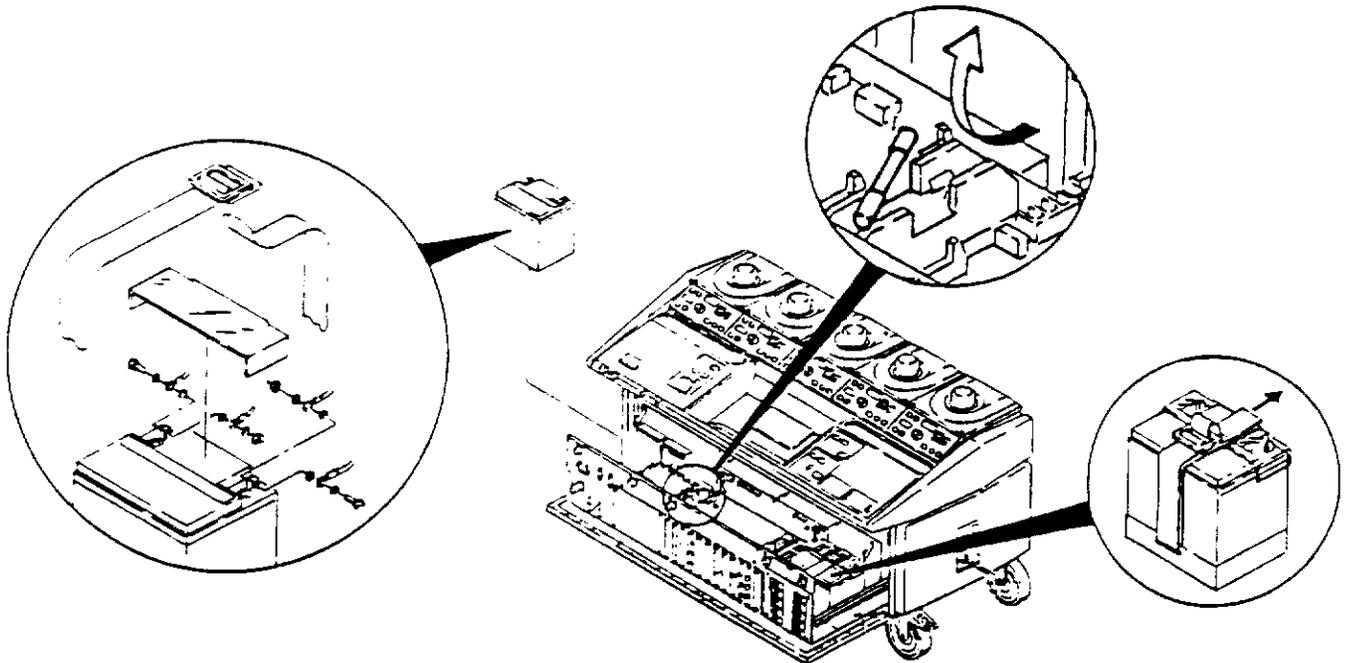
Before servicing the system, disconnect the console from the wall power source.

Disconnect the 60 amp battery fuse when servicing the front tray, rear tray, fuses, or batteries in order to disconnect any battery power.

1. Extend the front tray (refer to Procedure 4-3-1).
2. Remove the 60 amp battery power fuse.
3. Replace the left battery first:
  - a. Unbuckle the battery strap. Slide the strap off the top of the battery, toward the outside of the tray.
  - b. Remove the battery terminal shield. Disconnect the cables from the terminals (5/16" wrench).

**Caution:** Wrap the black (negative) cables with electrical tape to prevent them from shorting against the chassis.

- c. Remove the old battery from the machine. Install the new battery, but do not connect the cables.



### 4-3. Front Tray (continued)

#### 4-3-3. Replacing the Batteries (continued)

4. Replace the right battery:
  - a. Unbuckle the battery strap. Slide the strap off the top of the battery, toward the outside of the tray.
  - b. Remove the battery terminal shield. Disconnect the cables from the terminals (5/16" wrench).
  - c. Remove the old battery from the machine. Install the new battery.
  - d. Reconnect the cables to the battery terminals and replace the battery terminal shield.
  - e. Slide the strap back on top of the battery. Buckle the strap securely.
  
5. Finish installing the left battery:
  - a. Being careful not to allow the black (negative) cables to touch the chassis, reconnect the cables to the battery terminals. Replace the battery terminal shield.
  - b. Slide the strap back on top of the battery. Buckle the strap securely.
  
6. Replace the 60 amp battery fuse.

## 4-3. Front Tray (continued)

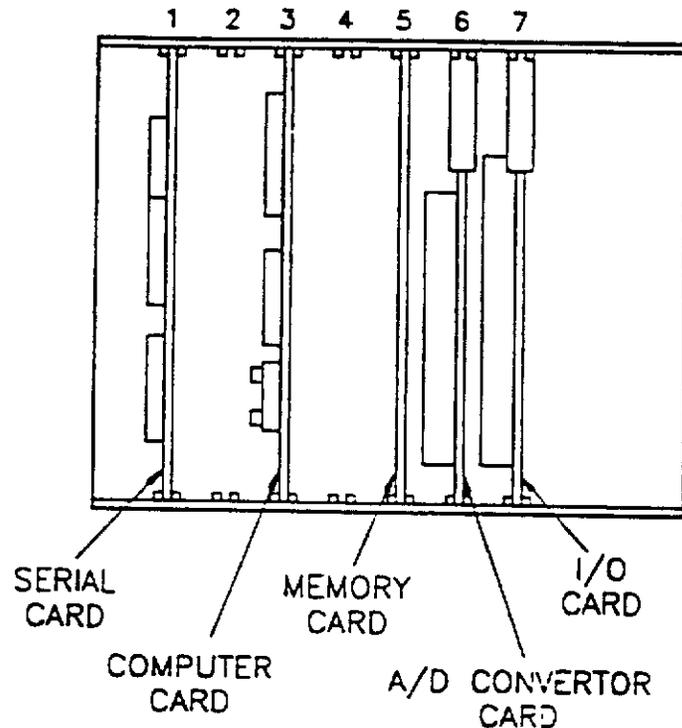
## 4-3-4. Replacing Cards on the STD Bus

Note: If the Computer Card or System Software is to be replaced, obtain the machine ID number from Sams Service prior to performing this procedure.

1. Set the power switch to ON.
2. Note any options that are enabled:
  - a. Touch "CUSTOMIZE" on the Start-Up Test Screen. Note whether or not the "BLOOD CHEMISTRY" option button is displayed.
  - b. Touch "TITLE SCREEN" and then "MAIN SCREEN". Note whether or not the "PULSE" option button is displayed.
  - c. Record the existing operator settings as described in Step 10 of Procedure 2-3-1.
3. Set the power switch to OFF.
4. Open the front door. Remove the plate (T10 Torx) that covers the STD bus.

Caution: Use static precautions whenever handling printed circuit boards or integrated circuit chips.

5. Set up a static mat. Hold down the front edge of the card cage while removing the appropriate card.



### 4-3. Front Tray (continued)

#### 4-3-4. Replacing Cards on the STD Bus (continued)

6. Before installing a new card:
  - a. Verify that all the jumpers on the new card are set the same as the old card.
  - b. If replacing the Computer Card, ensure that jumper J3 is removed from the old card and installed on the new card.
  - c. If replacing the Memory Card and/or Computer Card, either use the software chips from the old card(s) or install new software chips. Refer to Steps 6 and 7 of Procedure 4-3-5 (Replacing System Software).
7. Slide the new card into the card cage. Ensure that it is seated properly.
8. Replace the plate that covers the STD bus.
9. If the Memory Card and/or Computer Card has been replaced, perform Steps 10 through 14 of Procedure 4-3-5 (Replacing System Software).
10. Perform a complete System Inspection (refer to Procedure 2-3-2).

### 4-3. Front Tray (continued)

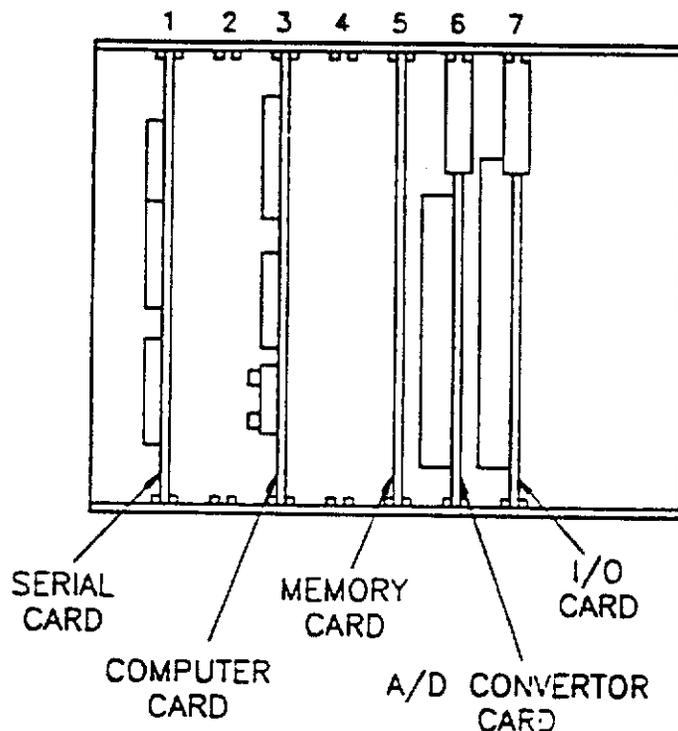
#### 4-3-5. Replacing System Software

**Note:** Obtain the machine ID number from Sams Service prior to performing this procedure.

1. Set the power switch to ON.
2. Note any options that are enabled:
  - a. Touch "CUSTOMIZE" on the Start-Up Test Screen. Note whether or not the "BLOOD CHEMISTRY" option button is displayed.
  - b. Touch "TITLE SCREEN" and then "MAIN SCREEN". Note whether or not the "PULSE" option button is displayed.
  - c. Record the existing operator settings as described in Step 10 of Procedure 2-3-1.
3. Set the power switch to OFF.
4. Open the front door. Remove the plate (T10 Torx) that covers the STD bus.

**Caution:** Use static precautions whenever handling printed circuit boards or integrated circuit chips.

5. Set up a static mat. Hold down the front edge of the card cage while removing the Computer Card and Memory Card. Place the cards on the static mat.



### 4-3. Front Tray (continued)

#### 4-3-5. Replacing System Software

**Note:** Starting with 4.0 software the customize screen no longer offers a choice of displaying pressure in kPa units; also Blood Chemistry is a standard feature with user choice of "CDI" or "Standard" (choices for step 2.a).

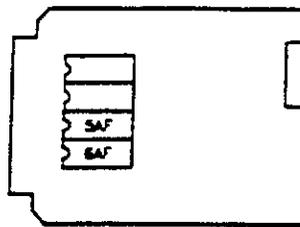
6. Starting with 2.3 software, it is not necessary to replace chips 5AF and 6AF when installing new software. If necessary, remove IC numbers 5AF and 6AF from the Computer Card. Install the new software chips on the card.
7. Remove IC numbers 4A, 5A, 6A, and 7A from the Memory Card. Install the new software chips on the card. Note that pin 1 of the chip actually goes into pin 3 of the socket.

With 4.0 and prior software, calibrate the gas flow sensors and reinstall the operator's settings (see new steps below).

8. Slide both cards back into the card cage. Ensure that they are seated properly.
9. Replace the plate that covers the STD bus.
10. Set the system to the Diagnostics Mode (refer to Procedure 2-2-1).
11. Set the power switch to ON.
12. After the start-up routine is finished, touch "System Options" button. Enter the machine ID number. The system will ask for verification; re-enter the machine ID number.
13. If the Pulse or Blood Chemistry options were enabled in Step 2, re-install them by performing Procedure 2-4-1 (Installing the Pulse and Blood Chemistry Options).
14. Calibrate the gas flow sensors (refer to procedure 3-5-1 or 3-5-2).
15. Return the system to Normal Operating Mode (refer to Procedure 2-2-2).
16. Reinstall the original operators settings.
17. Perform a complete System Inspection (refer to Procedure 2-3-2).

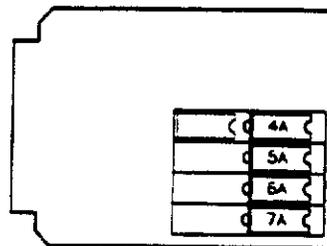
**4-3. Front Tray (continued)****4-3-5. Replacing System Software (continued)**

6. Remove IC numbers 5AF and 6AF from the Computer Card. Install the new software chips on the card.



COMPUTER CARD

7. Remove IC numbers 4A, 5A, 6A, and 7A from the Memory Card. Install the new software chips on the card. Note that pin 1 of the chip actually goes into pin 3 of the socket.



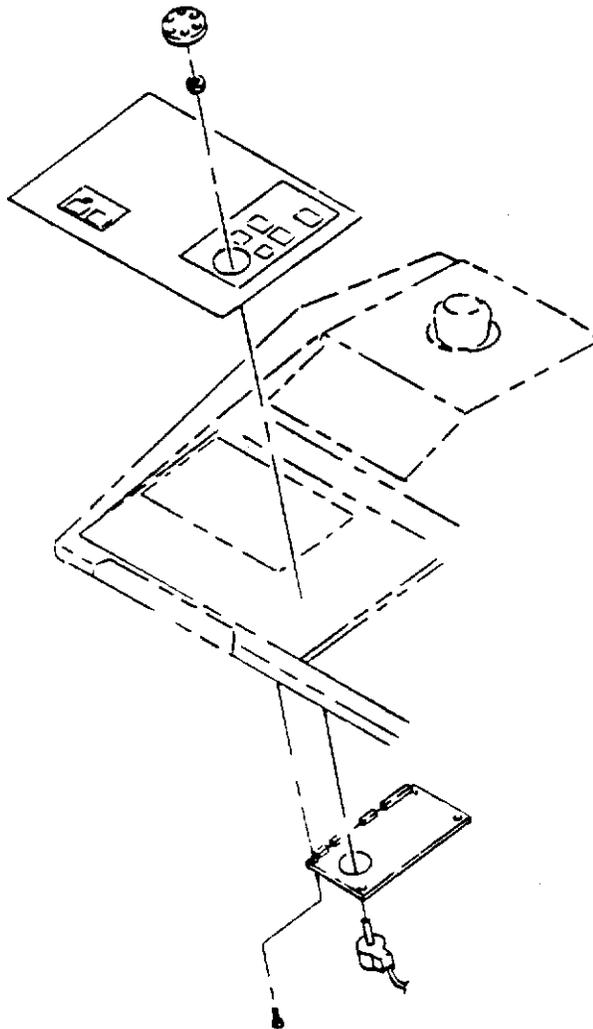
MEMORY CARD

8. Slide both cards back into the card cage. Ensure that they are seated properly.
9. Replace the plate that covers the STD bus.
10. Set the system to the Diagnostics Mode (refer to Procedure 2-2-1).
11. Set the power switch to ON.
12. After the start-up routine is finished, touch "SYSTEM OPTIONS SCREEN". Enter the machine ID number. The system will ask for verification; re-enter the machine ID number.
13. If the Pulse or Blood Chemistry options were enabled in Step 2, re-install them by performing Procedure 2-4-1 (Installing the Pulse and Blood Chemistry Options).
14. Return the system to Normal Operating Mode (refer to Procedure 2-2-2).
15. Perform a complete System Inspection (refer to Procedure 2-3-2).

## 4-4. Membrane Panels

### 4-4-1. Replacing the Left Fixed Membrane Panel - Old Style Glued Down Only

1. Order a Left Fixed Panel Kit.
2. Remove the occluder manual dial by pulling up on it.
3. Remove the left air filter assembly (refer to Procedure 4-5-1).
4. Disconnect the cables from J1, J2, and J4 on the left fixed panel PC board. Remove the four screws securing the PC board, and remove the board.
5. Partially thread the four screws back into the gold colored inserts. Use a soldering iron to heat up the inserts until they can be pulled out of the fixed panel. Discard the screws and inserts.
6. Disconnect the membrane panel ground strap by removing the nut from the ground stud.
7. Peel off the old membrane panel. Clean the old glue off the left fixed panel.



#### **4-4. Membrane Panels (continued)**

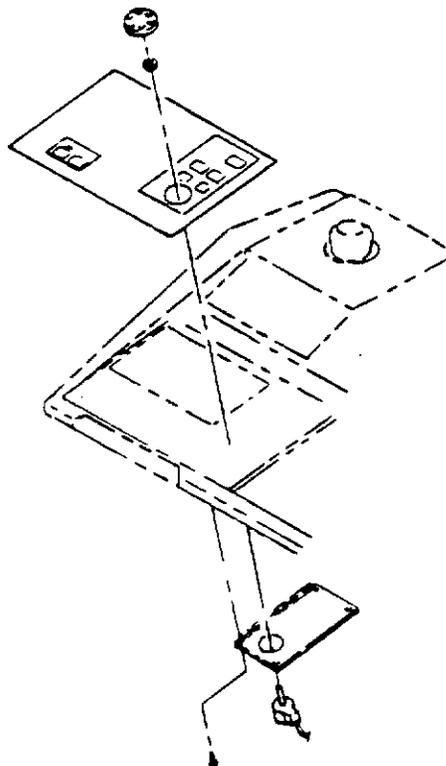
##### **4-4-1. Replacing the Left Fixed Membrane Panel - Old Style Glued Down Only (cont.)**

8. Place the template from the kit over the left fixed panel. Use a 1/4" (6mm) drill bit to drill out the four holes. Remove the template.
9. Remove the paper from the back of the new membrane panel. Route the ribbon cable through the slot in the fixed panel. Align the membrane panel and press it into place.
10. Mount the PC board to the underside of the fixed panel using the keps nuts supplied in the kit. Reconnect the cables to the PC board.
11. Use a flat washer and a keps nut to secure the ground strap to the ground stud.
12. Place a thin bead of silastic sealant around the outer edge of the occluder manual drive well.
13. Re-install the air filter assembly.
14. Perform a complete System Inspection (refer to Procedure 2-3-2).

#### 4-4. Membrane Panels (continued)

##### 4-4-2. Replacing the Left Fixed Membrane Panel - New Style Held Down by Keps Nuts

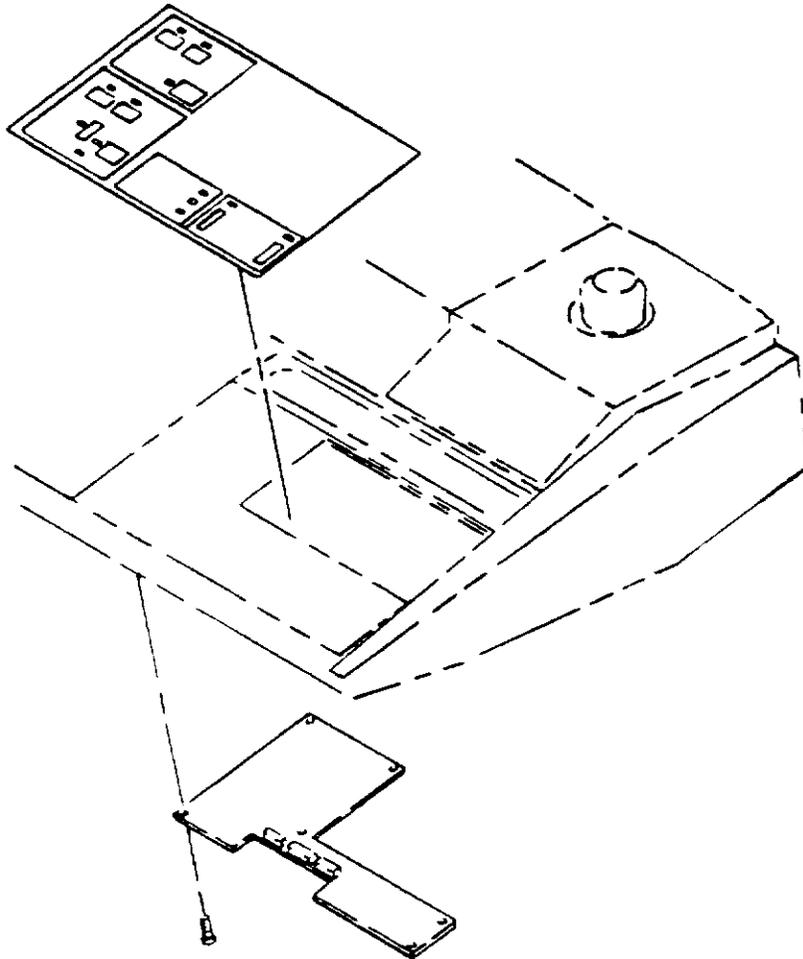
1. Remove the occluder manual dial by pulling up on it.
2. Remove the left air filter assembly (refer to Procedure 4-5-1).
3. Disconnect the cables from J1, J2, and J4 on the left fixed panel PC board. Remove the four keps nuts securing the PC board, and remove the board.
4. Disconnect the membrane panel ground strap by removing the nut from the ground stud.
5. Push up on the pem screws to remove the old membrane panel. Clean the leftover adhesive off the fixed panel.
6. Remove the paper from the back of the new membrane panel. Route the ribbon cable through the slot in the fixed panel. Align the membrane panel and press it into place.
7. Mount the PC board to the underside of the fixed panel. Reconnect the cables to the PC board.
8. Reconnect the ground strap to the ground stud.
9. Place a thin bead of silastic sealant around the outer edge of the occluder manual drive well.
10. Re-install the air filter assembly.
11. Perform a complete System Inspection (refer to Procedure 2-3-2).



#### 4-4. Membrane Panels (continued)

##### 4-4-3. Replacing the Right Fixed Membrane Panel - Old Style Glued Down Only

1. Order a Right Fixed Panel Kit.
2. Remove the right air filter assembly (refer to Procedure 4-5-1).
3. Disconnect the cables from J1, J2, and J3 on the right fixed panel PC board. Remove the six screws securing the PC board, and remove the board.
4. Partially thread the six screws back into the gold colored inserts. Use a soldering iron to heat up the inserts until they can be pulled out of the fixed panel. Discard the screws and inserts.
5. Disconnect the membrane panel ground strap by removing the nut from the ground stud.
6. Peel off the old membrane panel. Clean the old glue off the fixed panel.



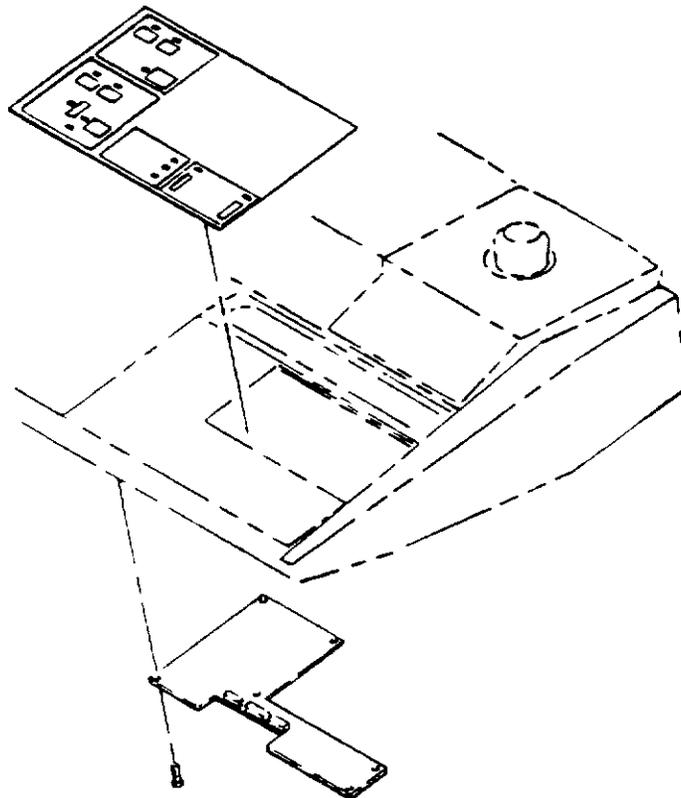
**4-4. Membrane Panels (continued)****4-4-3. Replacing the Right Fixed Membrane Panel - Old Style Glued Down Only (cont.)**

7. Place the template from the kit over the right fixed panel. Use a 1/4" (6mm) drill bit to drill out the six holes. Remove the template.
8. Remove the paper from the back of the new membrane panel. Route the ribbon cable through the slot in the fixed panel. Align the membrane panel and press it into place.
9. Mount the PC board to the underside of the fixed panel using the keps nuts supplied in the kit. Reconnect the cables to the PC board.
10. Use a flat washer and a keps nut to secure the ground strap to the ground stud.
11. Re-install the air filter assembly.
12. Perform a complete System Inspection (refer to Procedure 2-3-2).

#### 4-4. Membrane Panels (continued)

##### 4-4-4. Replacing the Right Fixed Membrane Panel - New Style Held Down by Keps Nuts

1. Remove the right air filter assembly (refer to Procedure 4-5-1).
2. Disconnect the cables from J1, J2, and J3 on the right fixed panel PC board. Remove the six keps nuts securing the PC board, and remove the board.
3. Disconnect the membrane panel ground strap by removing the nut from the ground stud.
4. Push up on the perm screws to remove the old membrane panel. Clean the leftover adhesive off the fixed panel.
5. Remove the paper from the back of the new membrane panel. Route the ribbon cable through the slot in the fixed panel. Align the membrane panel and press it into place.
6. Mount the PC board to the underside of the fixed panel. Reconnect the cables to the PC board.
7. Reconnect the ground strap to the ground stud.
8. Re-install the air filter assembly.
9. Perform a complete System Inspection (refer to Procedure 2-3-2).

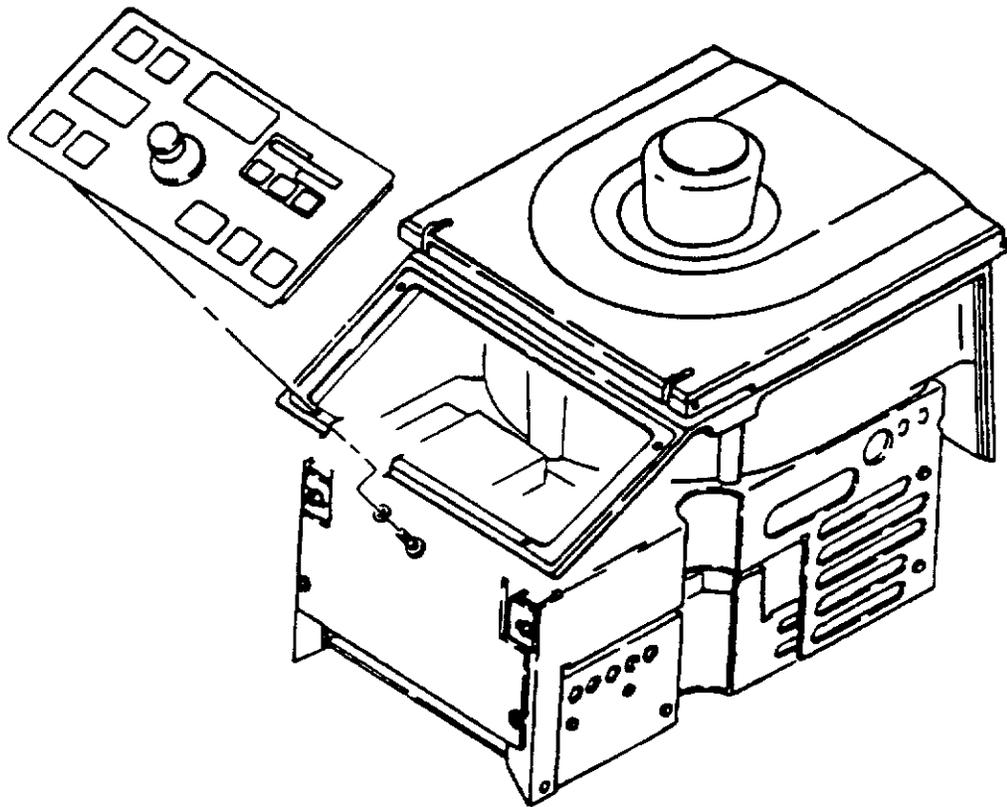


#### 4-4. Membrane Panels (continued)

##### 4-4-5. Replacing Pump Display Membrane Panel Assemblies

**Note:** In order to replace the display board or the membrane panel, both items must be replaced. Order the Pump Display Membrane Assembly.

1. Remove the pump from the console.
2. Remove the four screws that secure the display membrane assembly to the casting. Press the assembly out of the casting. It is held in place by adhesive and elastic.



3. Disconnect DSPL-J1 and DSPL-J3 from the Pump Display Board.
4. Remove the securing screws at the rear of the pump assembly, and then hinge open the assembly.
5. Disconnect CTRL-J4 from the Pump Control Board.
6. Locate and remove the display membrane assembly ground wire from the ground stud.

**4-4. Membrane Panels (continued)****4-4-5. Replacing Pump Display Membrane Panel Assemblies (continued)**

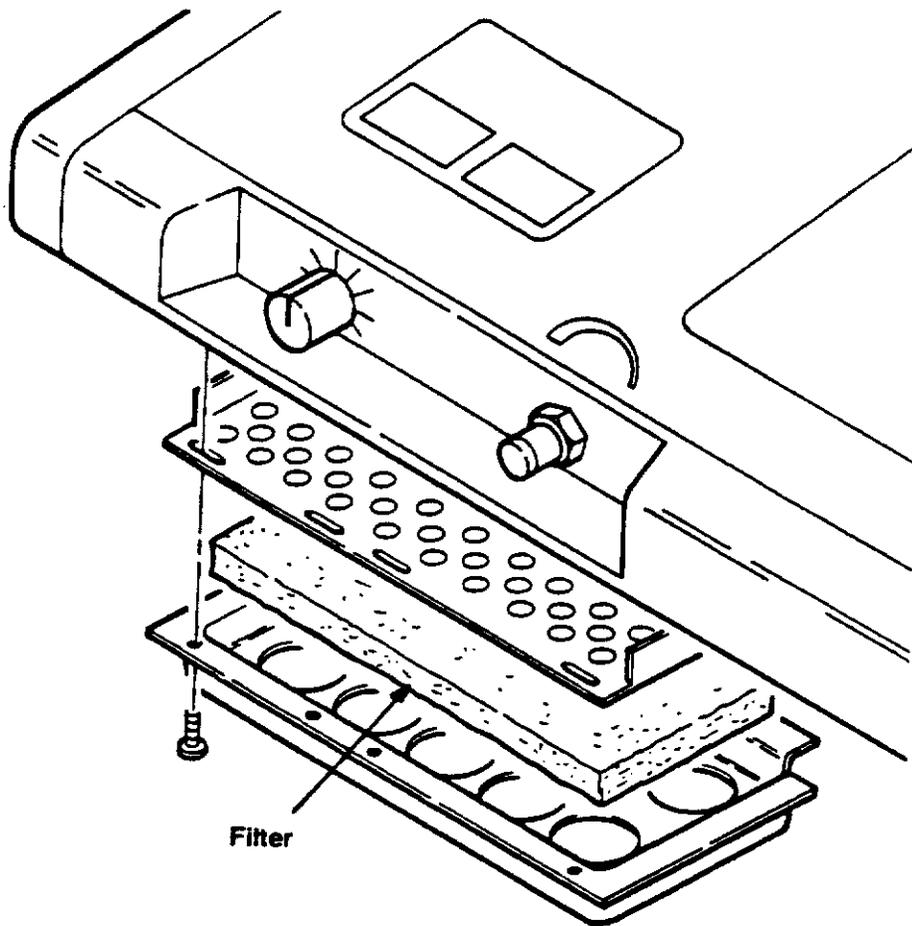
7. Apply a thin bead of clear silastic to the outer edge of the casting where the new display membrane assembly will be mounted.
8. Route the ground wire from the new assembly through the opening in the casting. Remove the paper from the adhesive on the new assembly. Align the new assembly and press it into place.
9. Route the ground wire down to the ground stud. Reconnect the ground wire, CTRL-J4, DSPL-J1, and DSPL-J3.
10. Secure the display membrane assembly to the casting with the screws removed in Step 2.
11. Close the pump and perform a complete pump inspection.

**Note: A "FAIL 4" message may be displayed the first time the pump is powered up. If so, shut the system off and restart it to reset the pump.**

## 4-5. Miscellaneous

### 4-5-1. Replacing the Air Filters

1. Remove the six screws that secure the air filter assembly.
2. Remove the old filter from the assembly.
3. Install the new filter and reassemble the machine.



## 4-5. Miscellaneous (continued)

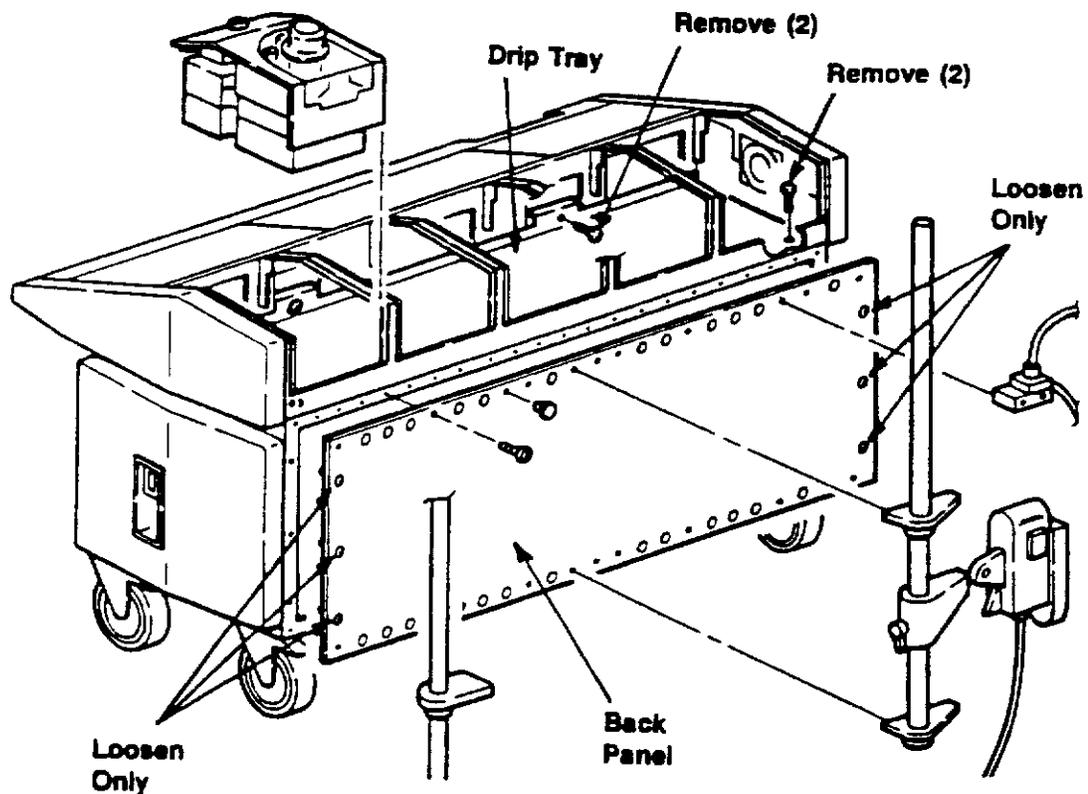
### 4-5-2. Accessing the Rear Tray

**Note:** On machines with serial numbers lower than 2000, the fuses can be accessed by reaching over the front tray.

1. Set the power switch to OFF and unplug the power cord.
2. Remove all five pumps.

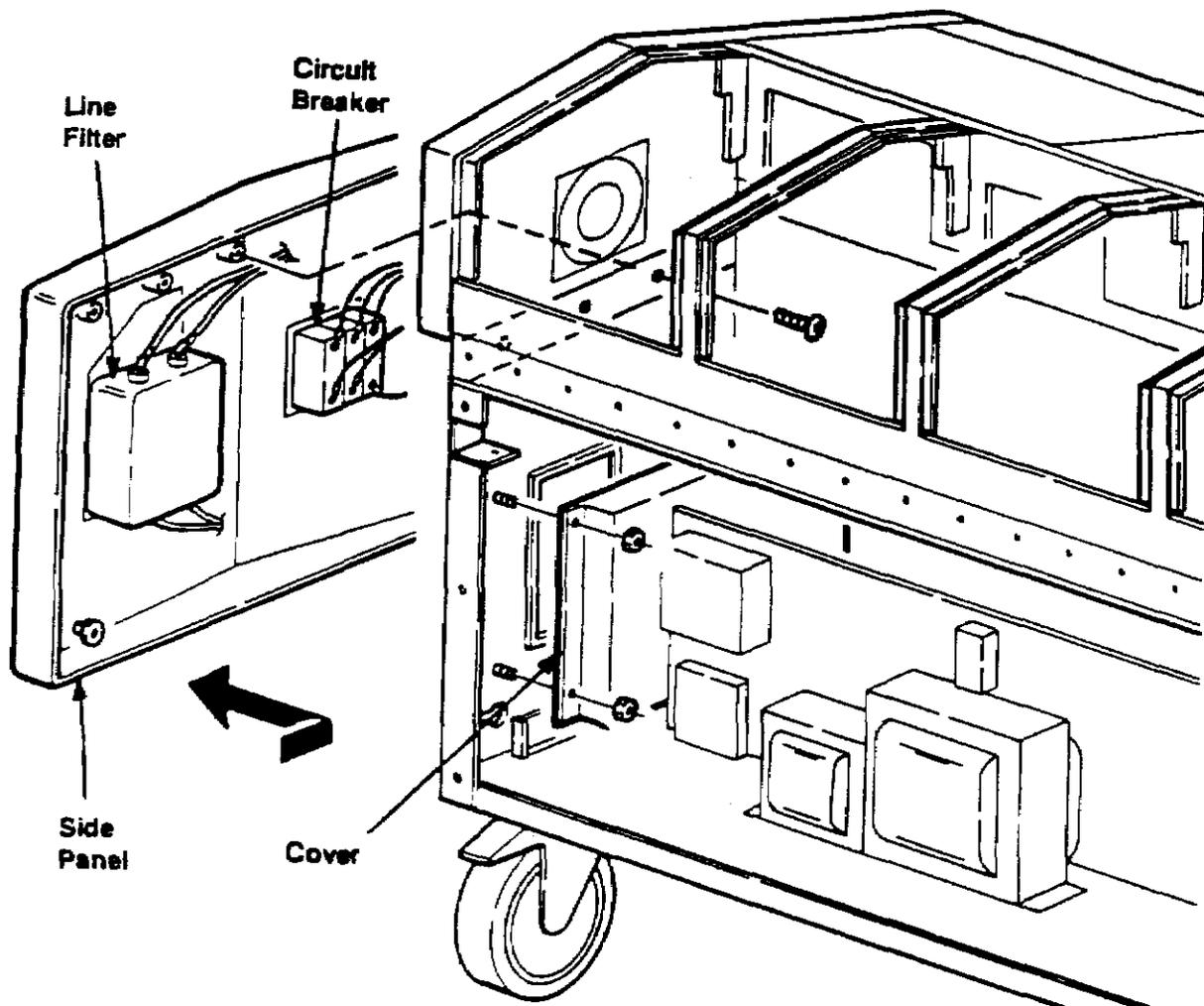
**Note:** To ensure that all brackets and accessories are re-installed in the correct positions, draw a picture showing where everything is mounted on the rear of the machine.

3. Remove all brackets and accessories from the rear of the machine.
4. Remove all the screws along the top and bottom edges of the back panel. Loosen the three screws at each end of the panel (these six screws are captive; they do not get fully removed).
5. Carefully pry off the back panel to unseat the plastic hole plugs in the panel.
6. Remove the two screws (T27 Torx) from the front edge of the gold drip tray. Remove the two screws (T15 Torx) from the rear corners of the tray. Slide the tray out the rear of the machine.



**4-5. Miscellaneous (continued)****4-5-3. Replacing the Circuit Breaker or Line Filter**

1. Access the rear tray (refer to Procedure 4-5-2).
2. Remove the three 11/32" nuts securing the cover over the circuit breaker and Line filter.
3. Remove the three screws (T27 Torx) securing the side panel to the chassis.
4. Remove the side panel by sliding it toward the front of the machine and then pulling it away from the side of the machine.
5. Remove the circuit breaker or line filter from the side panel.
6. Install the new component and reassemble the machine.

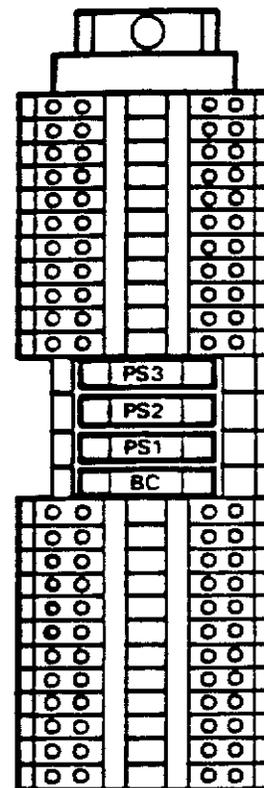


**4-5. Miscellaneous (continued)****4-5-4. Replacing the Battery Charger or Power Supply Fuses**

1. Set the power switch to OFF and unplug the power cord.
2. Gain access to the fuses:
  - For machines with serial numbers less than 2000, perform Procedure 4-3-1 (Extending the Front Tray). The fuses can then be accessed by reaching over the front tray.
  - For machines with serial numbers greater than 2000, perform Procedure 4-5-2 (Accessing the Rear Tray).
3. Plug in the power cord and set the power switch to ON. The fuse that is blown should glow; if not, check each fuse with an ohmmeter.
4. Replace the blown fuse.

**Note:** Check for what caused the fuse to blow. Look for loose connections, defective components, shorts, etc.

	100/115 VAC	220 VAC
Battery Charger (BC)	2.5 amp	1.25 amp
Power Supply 1 (PS1)	8 amp	4 amp
Power Supply 2 (PS2)	8 amp	4 amp
Power Supply 3 (PS3)	8 amp	4 amp



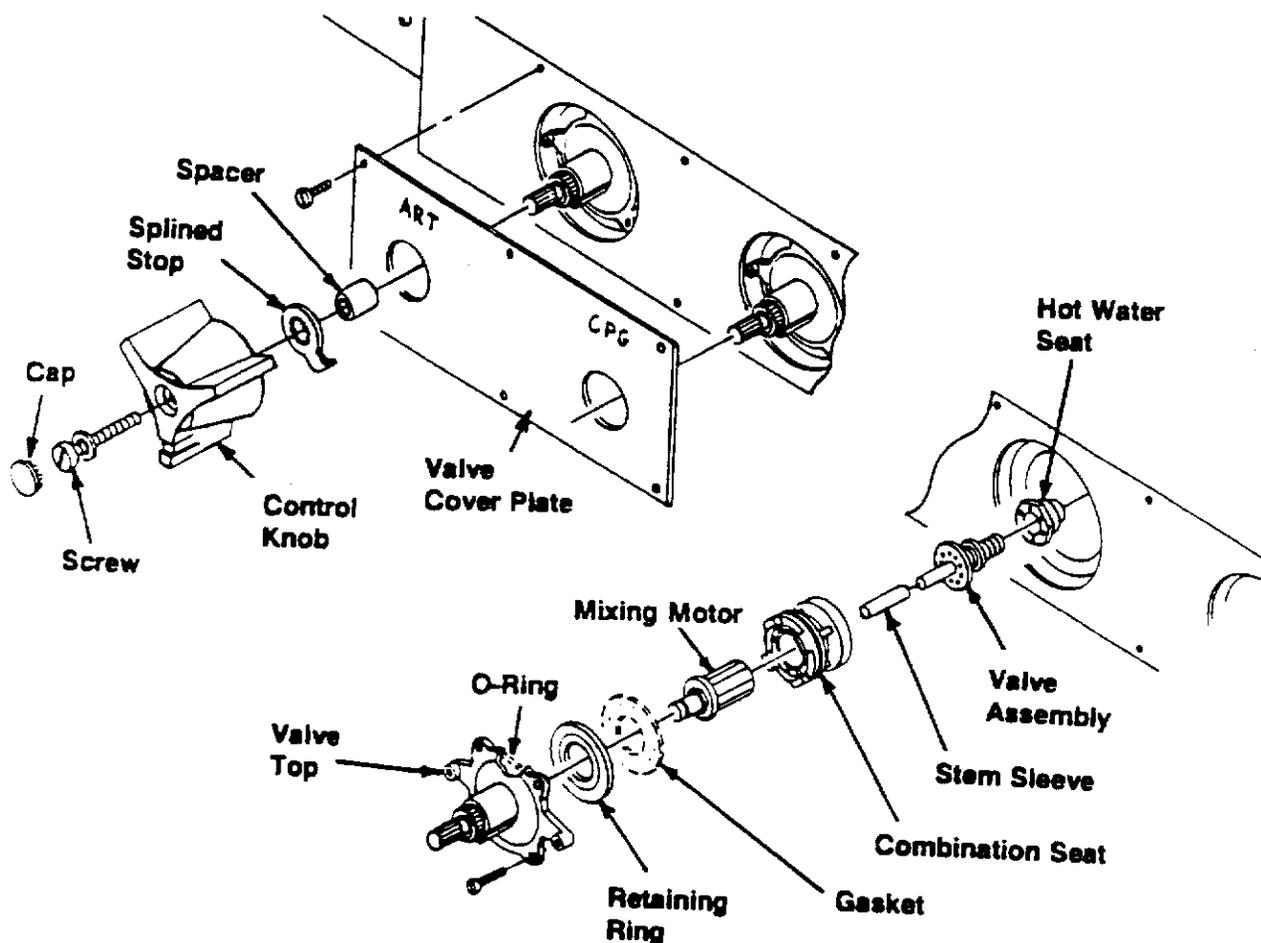
5. Reassemble the machine and perform a complete System Inspection (refer to Procedure 2-3-2). Refer to the troubleshooting section for additional assistance.

## 4-5. Miscellaneous (continued)

### 4-5-5. Replacing the Mixing Motor and Hot Water Seat

1. Disconnect the input water supply.
2. Remove the cap and securing screw from both control knobs, and remove the knobs. Also remove the splined stop and spacer from the valve that is being repaired.
3. Remove the valve cover plate.
4. Remove the four screws that secure the valve top, and remove the top.
5. Remove the white retaining ring, the gasket (if installed), the mixing motor, and the stem sleeve.

Note: The valve assembly is sealed by an O-ring under the valve top or a gasket under the retaining ring.



**4-5. Miscellaneous (continued)****4-5-5. Replacing the Mixing Motor and Hot Water Seat (continued)**

6. Use a pliers to remove the combination seat. This will require some force.
7. Remove the valve assembly.
8. Use a 7/8" socket to remove the hot water seat.
9. Reassemble the valve in reverse order. Replace the following with new parts from the Motor Kit (P/N 26-1006-6570-5) and the Valve/Seat Kit (P/N 26-1006-6571-3): the O-ring or gasket used to seal the assembly, the mixing motor, the stem sleeve, the valve assembly, and the hot water seat. Ensure that the retaining ring is installed so that the side labeled TOP is facing the valve top.
10. Perform Procedure 3-6-3 (Adjusting the Water Temperature).

## 4-5. Miscellaneous

### 4-5-6 Replacing Backlight Bulbs for Color LCD



**Caution:** Use static precautions whenever handling components.

1. Use Backlight Kit 26-1009-7222-8 (2 bulbs per kit).
2. Set up a static mat. Disconnect power to the central display.
3. Using a torx T27 screw driver, remove the six screws securing the display housing and open the display housing.
4. Remove both silver plates (push tabs and slide metal plates out).
5. Lift the black cushions from ends of each bulb.
6. Lift the bulbs out and disconnect them from the LCD Backlight connectors.
7. Replace both bulbs. Reassemble in reverse order. Check that the housing is closed securely.

## 5-1. Service Messages During Startup

### 5-1-1. Operator Settings RESET

**Note:** The prior operator settings may not be saved. This message will appear if new system software has been installed.

1. Switch the system OFF and back ON.
2. If the message repeats check to see that the Computer Card is seated securely.
3. Replace the Computer Card (refer to Procedure 4-3-4).
4. Perform a complete System Inspection (refer to Procedure 2-3-2).

### 5-1-2. System Computer FAIL

**Note:** This message is an indication of trouble with the CPU's real-time clock.

1. Switch the system OFF and back ON.
2. If the message repeats check to see that the Computer Card is seated securely.
3. Replace the Computer Card (refer to Procedure 4-3-4).
4. Perform a complete System Inspection (refer to Procedure 2-3-2).

### 5-1-3. Central Display Comm. FAIL

**Note:** Communications are checked by a loopback test of the appropriate UART channel on the Serial Board.

1. Switch the system OFF and back ON.
2. If the message repeats check to see that the Serial Board (Temp/Serial Board on machines with version 1.7 system software) is seated securely.
3. Replace the Serial Board (Temp/Serial Board on version 1.7 machines). Refer to Procedure 4-3-4.
4. Perform a complete System Inspection (refer to Procedure 2-3-2).

## 5-1. Service Messages During Startup (continued)

### 5-1-4. Pump Comm. FAIL

**Note:** Communications are checked by a loopback test of the appropriate UART channel on the Serial Board.

1. Switch the system OFF and back ON.
2. If the message repeats check to see that the Serial Board (Temp/Serial Board on machines with version 1.7 system software) is seated securely.
3. Replace the Serial Board (Temp/Serial Board on version 1.7 machines). Refer to Procedure 4-3-4.
4. Perform a complete System Inspection (refer to Procedure 2-3-2).

### 5-1-5. S.T.A.R. Comm. FAIL

**Note:** Communications are checked by a loopback test of the appropriate UART channel on the Serial Board.

1. Switch the system OFF and back ON.
2. If the message repeats check to see that the Serial Board (Temp/Serial Board on machines with version 1.7 system software) is seated securely.
3. Replace the Serial Board (Temp/Serial Board on version 1.7 machines). Refer to Procedure 4-3-4.
4. Perform a complete System Inspection (refer to Procedure 2-3-2).

### 5-1-6. Temp. Comm. FAIL (Version 1.7 Software Only)

**Note:** Communications are checked by a loopback test of the appropriate UART channel on the Serial Board.

1. Switch the system OFF and back ON.
2. If the message repeats check to see that the Temp/Serial Board is seated securely.
3. Replace the Temp/Serial Board (refer to Procedure 4-3-4).
4. Perform a complete System Inspection (refer to Procedure 2-3-2).

## 5-1. Service Messages During Startup (continued)

### 5-1-7. Blood Chemistry Comm. FAIL

**Note:** Communications are checked by a loopback test of the appropriate UART channel on the Serial Board.

1. Switch the system OFF and back ON.
2. If the message repeats check to see that the Serial Board (Temp/Serial Board on machines with version 1.7 system software) is seated securely.
3. Replace the Serial Board (Temp/Serial Board on version 1.7 machines). Refer to Procedure 4-3-4.
4. Perform a complete System Inspection (refer to Procedure 2-3-2).

### 5-1-8. Temp. Module 1 (or 2) FAIL

**Notes:** This check is looking for an appropriate reading from a test resistor on the Temperature Board.

False temperature module failures and/or a system reset can occur if the customer is recirculating prime solution while the temperature probes are connected to the tubing and the 9000. This is caused by a piezoelectric charge generated by the roller when it deforms the PVC tubing. This charge can be conducted by the fluid and passed on to the system through the temperature probes. If this charge is great enough, it can saturate the filtering on the temperature module and cause a false temperature module failure and/or a system reset. To eliminate this problem, either disconnect the temperature probes while recirculating, or connect a TCM or Dual Cooler/Heater to the oxygenator water ports and circulate water through the oxygenator heat exchanger (if the heat exchanger is conductive).

**Caution:** Do not replace an electronic module with the power on as the system may be damaged. Do not touch the module connector tabs as static and moisture may damage the module circuitry and tabs.

1. Switch the system OFF and back ON.
2. If the message repeats, switch the system OFF. Wait ten seconds, then swap the location of the two temperature modules. Switch the system back ON.
  - If the fail message changes to indicate that the other temperature module has failed (i.e. the fail message follows one module), calibrate the Temperature Board in that module (refer to Procedure 3-1-4). If the message repeats after calibration, replace the module.
  - If the original fail message repeats, check the cable connections between the I/O Card and J1 and J2 on the Motherboard. Replace the I/O Card.
3. Perform a complete System Inspection (refer to Procedure 2-3-2).

## 5-1. Service Messages During Startup (continued)

### 5-1-9. Pressure and Gas Comm. FAIL

**Note:** This is a check of the A/D Converter Card.

1. Switch the system OFF and back ON.
2. If the message repeats check to see that the A/D Converter Card is seated securely.
3. Replace the A/D Converter Card (refer to Procedure 4-3-4).
4. Perform a complete System Inspection (refer to Procedure 2-3-2).

### 5-1-10. Pressure Module FAIL

**Note:** This is a check for proper excitation voltage on the Pressure Board.

**Caution:** Do not replace an electronic module with the power on as the system may be damaged. Do not touch the module connector tabs as static and moisture may damage the module circuitry and tabs.

1. Switch the system OFF and back ON.
2. If the message repeats, calibrate the Pressure Board (refer to Procedure 3-1-3).
3. If the message repeats after calibration, replace the Pressure Module.
4. Perform a complete System Inspection (refer to Procedure 2-3-2).

### 5-1-11. Comm. with Modules FAIL

**Note:** This is a check of the I/O Card.

1. Switch the system OFF and back ON.
2. If the message repeats, check to see that the I/O Card is seated securely and that the connections from the I/O Card to the Motherboard (MJ-1 and MJ-2) are secure.
3. Replace the I/O Card (refer to Procedure 4-3-4).
4. Perform a complete System Inspection (refer to Procedure 2-3-2).

## 5-1. Service Messages During Startup (continued)

### 5-1-12. Pump Select Module FAIL

**Note:** This is a check of the status bit on the Digital Interface Card.

**Caution:** Do not replace an electronic module with the power on as the system may be damaged. Do not touch the module connector tabs as static and moisture may damage the module circuitry and tabs.

1. Switch the system OFF and back ON.
2. If the message repeats, replace the Digital Interface Module.
3. Perform a complete System Inspection (refer to Procedure 2-3-2).

### 5-1-13. Level Detection Module FAIL

**Note:** This is a check of the status bit on the Level Detection Module.

**Caution:** Do not replace an electronic module with the power on as the system may be damaged. Do not touch the module connector tabs as static and moisture may damage the module circuitry and tabs.

1. Switch the system OFF and back ON.
2. If the message repeats, replace the Level Detection Module.
3. Perform a complete System Inspection (refer to Procedure 2-3-2).

## 5-1. Service Messages During Startup (continued)

### 5-1-14. Air Detection Module FAIL

**Note:** This is a check of the status bit on the Air Detection Module.

**Caution:** Do not replace an electronic module with the power on as the system may be damaged. Do not touch the module connector tabs as static and moisture may damage the module circuitry and tabs.

1. Switch the system OFF and back ON.
2. If the message repeats, replace the Air Detection Module.
3. Perform a complete System Inspection (refer to Procedure 2-3-2).

### 5-1-15. Occluder Module FAIL

**Note:** This is a check of the communications with the Local Processor Board in the Occluder Module.

**Caution:** Do not replace an electronic module with the power on as the system may be damaged. Do not touch the module connector tabs as static and moisture may damage the module circuitry and tabs.

1. Switch the system OFF and back ON.
2. If the message repeats, check connector MJ-20 on the Motherboard.
3. Replace the Occluder Module.
4. Perform a complete System Inspection (refer to Procedure 2-3-2).

## 5-2. Service Messages During Use

### 5-2-1. Cannot Change ART or CPG Pump Now

**Note:** This message will appear while using the system if the system is unable to establish communications with the ART or CPG pumps.

1. Check the RS422 cable connection at each pump connector on the Front Tray. The RS422 cable (orange, brown, and red twisted wires) is daisy chained between each pump, the occluder, and the Serial Card.
2. Disconnect all but one pump. Turn the arterial select switch (on the Digital Interface Module) to select that pump as arterial. Turn the cardioplegia select switch to "0".
  - If this pump can be selected as ART, proceed to Step 3.
  - If this pump cannot be selected as ART, proceed to Step 4.
3. Connect a second pump and select it as ART. Continue connecting pumps until a pump cannot be selected as ART. Open this pump and check that connector LCPR-J1 on the Local Processor Board is properly connected with the orange wire on Pin 1. If LCPR-J1 is properly connected, replace the Local Processor Board. Proceed to Step 5.
4. Disconnect this pump and try another.
  - If this pump can be selected as ART, connect the remaining pumps one at a time, selecting each one as ART. Troubleshoot the first pump per Step 3 of this procedure.
  - If this pump cannot be selected as ART, try each of the remaining pumps. If none of the pumps can be selected as ART, replace the Serial Card (refer to Procedure 4-3-4).
5. Check that all pumps can be selected as ART and CPG.
6. Perform a complete System Inspection (refer to Procedure 2-3-2).

## 5-2. Service Messages During Use (continued)

### 5-2-2. Service Temperature Module

**Note:** V-50 and non V-50 Temperature Modules have different part numbers. Prior to ordering, determine which is needed. Starting with S/N 3000, all units were built with the V-50 processor.

**Caution:** Do not replace an electronic module with the power on as the system may be damaged. Do not touch the module connector tabs as static and moisture may damage the module circuitry and tabs.

1. If a Temperature Module fails during use, the appropriate temperature displays will go blank.
  - If the ARTERIAL, VENOUS, and CARDIOPLEGIA temperature displays are blank, replace Temperature Module 1.
  - If the AUXILIARY A, B, and C temperature displays are blank, replace Temperature Module 2.
3. Check the connections from the I/O Card to J1 and J2 on the Motherboard. Replace the I/O Card (refer to Procedure 4-3-4).
4. Perform a complete System Inspection (refer to Procedure 2-3-2).

### 5-2-3. Service Air Detection Module

**Caution:** Do not replace an electronic module with the power on as the system may be damaged. Do not touch the module connector tabs as static and moisture may damage the module circuitry and tabs.

1. Replace the Air Detection module.
2. Perform a complete System Inspection (refer to Procedure 2-3-2).

### 5-2-4. Service Level Detection Module

**Caution:** Do not replace an electronic module with the power on as the system may be damaged. Do not touch the module connector tabs as static and moisture may damage the module circuitry and tabs.

1. Replace the Level Detection Module.
2. Perform a complete System Inspection (refer to Procedure 2-3-2).

### 5-3. Power Supply System

#### 5-3-1. Batteries Will Not Charge

1. Ensure that the batteries have been replaced within the past two years.
2. Unplug the power cord from the wall outlet and set the power switch to OFF. Extend the Front Tray (refer to Procedure 4-3-1).
3. Measure the battery voltage at the Power Distribution Board. Connect the negative lead of the DVM to J2 and the positive lead to J19. When fully charged, the battery voltage should be 26.3 VDC or greater.
4. Remove the large 60 amp fuse. Plug the power cord into the wall outlet and set the power switch to ON.
5. Measure the charging voltage at the Power Distribution Board. Connect the negative lead of the DVM to Pin 6 of J22 and the positive lead to Pin 5 of J22. Adjust R3 as required until the DVM reads 27.85 +/- 0.05 VDC.
  - If the voltage was already at or adjusted to 27.85 +/- 0.05 VDC, replace the batteries.
  - If the voltage was greater than 20 VDC, and not adjustable, replace the regulator.
  - If the voltage was less than 20 VDC, and not adjustable, proceed to Step 6.
6. Check for 60 +/- 5 VAC between Pin 1 (positive lead) and Pin 3 (negative lead) of J20 on the Power Distribution Board.
  - If the voltage is present, replace the Power Distribution Board.
  - If the voltage is not present, replace the charger transformer.
7. Perform a complete system inspection.

### 5-3. Power Supply System (continued)

#### 5-3-2. Batteries Will Not Power System As Specified

1. Ensure that the batteries have been replaced within the past two years.
2. Extend the Front Tray (refer to Procedure 4-3-1). Remove the large 60 amp fuse. Plug the power cord into the wall outlet and set the power switch to ON.
3. Measure the charging voltage at the Power Distribution Board. Connect the negative lead of the DVM to Pin 6 of J22 and the positive lead to Pin 5 of J22. Adjust R3 as required until the DVM reads 27.85 +/- 0.05 VDC. If the voltage cannot be adjusted to specification, refer to Step 5 of Procedure 5-3-1 (Batteries Will Not Charge).
4. If the red (constant current) charging status LED remains lit for more than 10 hours, replace the batteries.
5. Measure the battery voltage at the Power Distribution Board. Connect the negative lead of the DVM to J2 and the positive lead to J19. If the battery voltage is less than 26 VDC, and the batteries are new, replace the Power Distribution Board.
6. Perform a complete System Inspection (refer to Procedure 2-3-2).

### 5-3. Power Supply System (continued)

#### 5-3-3. Unit Always Powers Up on Battery

1. Check for the appropriate AC power at the source outlet.
2. Extend the Front Tray (refer to Procedure 4-3-1). Remove the large 60 amp fuse. Plug the power cord into the wall outlet and set the power switch to ON.
3. Check for 27.85 +/- 0.05 VDC between Pin 5 (positive lead) and Pin 6 (negative lead) of J22 on the Power Distribution Board.
  - If the voltage is present, proceed to Step 4.
  - If the voltage is not present, proceed to Step 6.
4. Check for 60 +/- 5 VAC between Pin 1 (positive lead) and Pin 3 (negative lead) of J20 on the Power Distribution Board.
  - If the voltage is present, replace the Power Distribution Board.
  - If the voltage is not present, proceed to Step 5.
5. Check for 26 VAC on Pin 26 of J2 on the Power Control Board.
  - If the voltage is present, proceed to Step 6.
  - If the voltage is not present, repair the cable between the Power Control Board and the Power Distribution Board.
6. Check for greater than 20 VDC on Pin 21 of J21 on the Power Distribution Board.
  - If the voltage is greater than 20 VDC, replace the Power Distribution Board.
  - If the voltage is less than 20 VDC, replace the Power Control Board.
7. Access the Rear Tray (refer to Procedure 4-5-2).
8. Check the battery charger fuse.
9. Replace the charger transformer.
10. Perform a complete System Inspection (refer to Procedure 2-3-2).

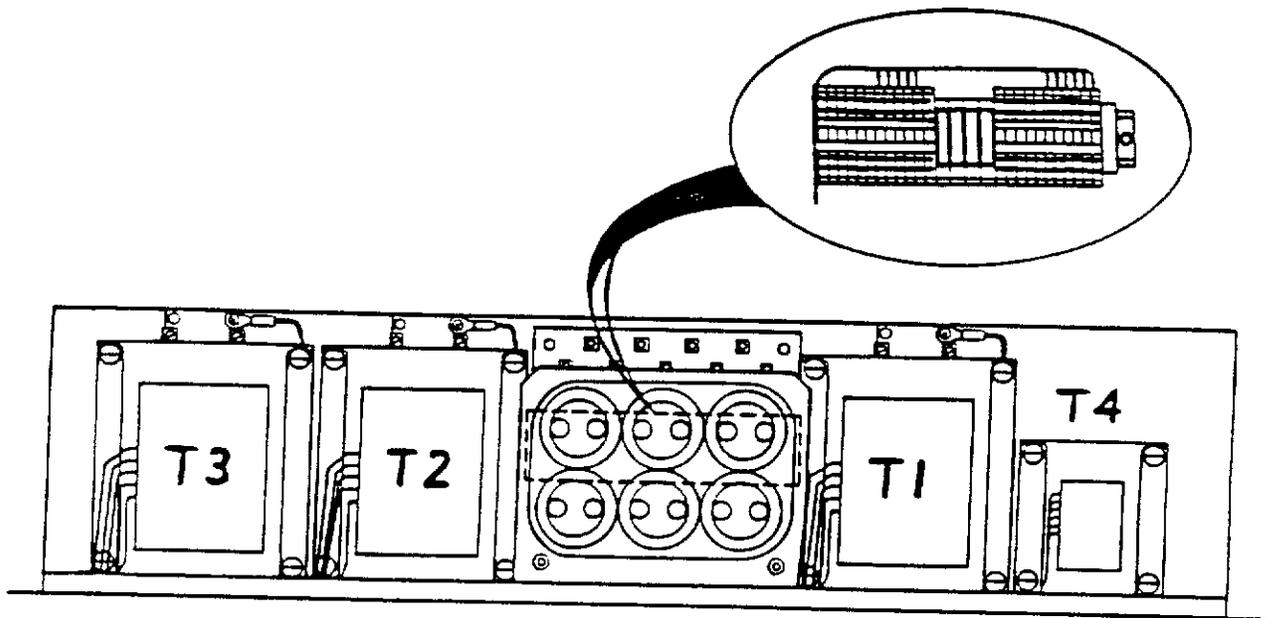
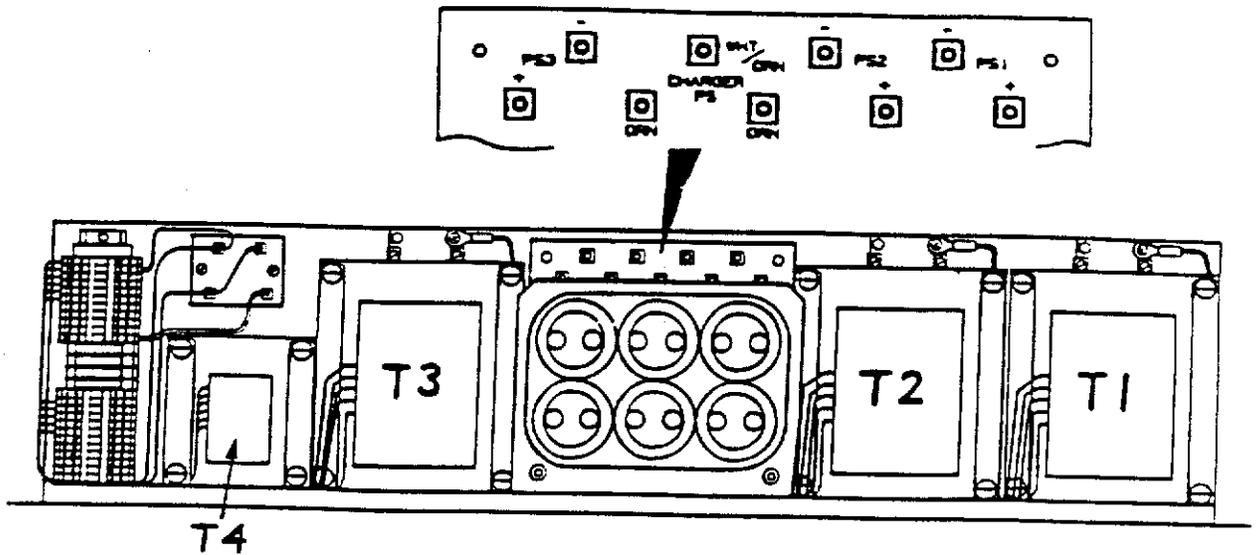
### 5-3. Power Supply System (continued)

#### 5-3-4. AC/DC 1, 2, or 3 LED Lit

1. Extend the Front Tray (refer to Procedure 4-3-1). Plug the power cord into the wall outlet and set the power switch to ON.
2. Check for 24-36 VDC at the appropriate power supply test point on the Power Distribution Board.
  - If the voltage is present, proceed to Step 3.
  - If the voltage is not present, proceed to Step 4.
3. Check the ribbon cable connection between J21 on the Power Distribution Board and J2 on the Power Control Board.
  - If the connection is good, replace the Power Control Board.
  - If the connection is bad, repair the ribbon cable.
4. Check the cable connection between J1 on the Power Distribution Board and J2 on the Capacitor Board.
  - If the connection is good, proceed to Step 5.
  - If the connection is bad, repair the cable.
5. Access the Rear Tray (refer to Procedure 4-5-2).
6. Check the fuse for the appropriate power supply.
7. Check for line voltage across the terminal block (Pins 10 and 7 for PS1, Pins 14 and 17 for PS2, and Pins 22 and 19 for PS3).
  - If the voltage is present, proceed to Step 8.
  - If the voltage is not present, check for a loose connection on the terminal block.
8. Check for approximately 50 VAC across the blue wires on the diode rectifier for the appropriate power supply.
  - If the voltage is present, proceed to Step 9.
  - If the voltage is not present, replace the appropriate power supply transformer.
9. Check for 24-36 VDC between the red (+) and white/blue (-) wire connection points on the Capacitor Board for the appropriate power supply.
  - If the voltage is present, replace the Capacitor Board.
  - If the voltage is not present, replace the diode rectifier for that power supply.
10. Perform a complete System Inspection (refer to Procedure 2-3-2).

5-3. Power Supply System (continued)

5-3-4. AC/DC 1, 2, or 3 LED Lt (continued)



**5-3. Power Supply System (continued)****5-3-5. DC/DC Converter Ground to Chassis Is Less Than 250 Megohm**

1. Touch the DVM leads together to ensure that the meter reads "0".
2. Set the power switch to OFF.

**Note:** In the following steps, replace or repair any component whose removal or disconnection from the 9000 causes the resistance to rise to 250 megohm or greater.

3. Disconnect all the pumps. Check the resistance as described in Step 4 of Procedure 2-3-5. If greater than 250 megohm, connect each pump, one at a time, to find the one causing the problem. Look for shorts, pinched wires, or PCB components touching the pump frame.
4. Disconnect the following, one at a time, checking the resistance each time: the central display, the temperature modules, the pressure module, the level detector module, the bubble detector module, the occluder module, and the digital interface module.

**Note:** Any metal-case component (such as crystals or capacitors) touching the conductive plastic module covers will cause a short between the chassis and DC ground.

5. Disconnect the right fixed panel from the Motherboard (M-J26) and the Power Control Board (PC-J1). Recheck the resistance.
6. Disconnect the left fixed panel from the Motherboard (M-J28). Recheck the resistance.
7. Disconnect each of the flow sensors, one at a time, from the Motherboard (M-J6, M-J7, and M-J8). Recheck the resistance after disconnecting each flow sensor.
8. Disconnect the gas flush solenoid from the Motherboard (M-J27). Recheck the resistance.
9. Remove each card, one at a time, from the STD bus. Recheck the resistance after removing each card.
10. Disconnect all remaining cables from the Power Distribution Board. Recheck the resistance.
11. Disconnect all remaining cables from the Motherboard. Recheck the resistance.
12. If the resistance is still less than 250 megohm, the Power Control Board or the DC/DC converters are the source of the problem.
13. Perform a complete System Inspection (refer to Procedure 2-3-2).

### 5-3. Power Supply System (continued)

#### 5-3-6. Leakage Current Is Greater Than 100 Microamps

1. Check for breaks or cuts in the power cord. Replace if necessary.
2. Access the Rear Tray (refer to Procedure 4-5-2).
3. Remove the three 11/32" nuts securing the cover over the circuit breaker and line filter.
4. Disconnect the light blue and brown wires from the load (bottom) side of the line filter.
5. Check the leakage current.
  - If the leakage current is greater than 3 microamps per meter of power cord (+/- 5 microamps), proceed to Step 6.
  - If the leakage current is less than 3 microamps per meter of power cord (+/- 5 microamps), proceed to Step 8.
6. Set the power switch to OFF and unplug the power cord. Disconnect the light blue and brown wires from the line (top) side of the line filter. Insulate the wires with electrical tape. Recheck the leakage current.
  - If the leakage current is still greater than 3 microamps per meter of power cord (+/- 5 microamps), proceed to Step 7.
  - If the leakage current is now less than 3 microamps per meter of power cord (+/- 5 microamps), replace the line filter.
7. Set the power switch to OFF and unplug the power cord. Disconnect the input power wires from the circuit breaker. Recheck the leakage current.
  - If the leakage current is still greater than 3 microamps per meter of power cord (+/- 5 microamps), replace the power cord.
  - If the leakage current is now less than 3 microamps per meter of power cord (+/- 5 microamps), replace the circuit breaker.
8. If the leakage current measured in Step 5 was less than 3 microamps per meter of power cord (+/- 5 microamps), set the power switch to OFF and unplug the power cord. Reconnect the wires to the line filter.
9. The cause of the high leakage current is a power supply transformer, the terminal block, or the current limiter (220V units only). To isolate the problem to one of the transformers, pull each of the power supply fuses. The leakage current will drop as each fuse is pulled. Look for the one that drops the leakage current the most.
10. Replace the appropriate transformer, terminal block, or current limiter.
11. Perform a complete System Inspection (refer to Procedure 2-3-2).

### 5-3. Power Supply System (continued)

#### 5-3-7. No Power to Pump #3 and the Lamp

1. Is the AC/DC 1, 2, or 3 LED lit? If so, refer to Procedure 5-3-4.
2. Check the circuit breaker on the Front Tray for Pump #3 and the Lamp.
3. Extend the Front Tray (refer to Procedure 4-3-1). Plug the power cord into the wall outlet and set the power switch to ON.
4. Check for 24-36 VDC at each of the power supply test points on the Power Distribution Board.
  - If all the voltages are present, proceed to Step 5.
  - If any of the voltages are not present, refer to Step 2 of Procedure 5-3-4. The right fixed panel PCB may also have to be replaced due to a faulty LED.
5. Check for greater than 20 VDC on Pins 19 and 20 of J21 on the Power Distribution Board.
  - If the voltage is present, replace the Power Control Board.
  - If the voltage is not present, replace the Power Distribution Board.
6. Perform a complete System Inspection (refer to Procedure 2-3-2).

## 5-4. Roller Pump

### 5-4-1. FAIL 1 Displayed (EPROM Test Fail)

1. Switch the system OFF and ON.
2. If the message repeats, switch the pump to a different position. Switch the system OFF and ON.
  - If the message repeats, check for loose connections inside the pump. If none are found, replace the Local Processor Board.
  - If the message does not repeat, check the RS422 line connection to the pump connector that caused the problem, and check the appropriate pump connection at the Motherboard (J21-J25).

### 5-4-2. FAIL 2 Displayed (RAM Test Fail)

1. Switch the system OFF and ON.
2. If the message repeats, switch the pump to a different position. Switch the system OFF and ON.
  - If the message repeats, check for loose connections inside the pump. If none are found, replace the Local Processor Board.
  - If the message does not repeat, check the RS422 line connection to the pump connector that caused the problem, and check the appropriate pump connection at the Motherboard (J21-J25).

### 5-4-3. FAIL 3 Displayed

This test should always pass in a roller pump. If not, replace the Local Processor Board.

### 5-4-4. FAIL 4 Displayed (EEROM Test Fail)

1. Switch the system OFF and ON. If a new Display Board has been installed, this will reset the error.
2. If the message repeats, check the cable connections to the Display Board and the Safety Board.
3. Replace the Display Board and switch the system OFF and ON twice.

### 5-4-5. FAIL 5 Displayed (Stop Test Fail)

1. Switch the system OFF and ON.
2. If the message repeats, switch the pump to a different position. Switch the system OFF and ON.
  - If the message repeats, check for loose connections to the Safety Board and Local Processor Board. If none are found, replace the Safety Board or Local Processor Board.
  - If the message does not repeat, check the RS422 line connection to the pump connector that caused the problem, and check the appropriate pump connection at the Motherboard (J21-J25).

### 5-4-6. FAIL 6 Displayed

This test should always pass in a roller pump. If not, replace the Local Processor Board.

## 5-4. Roller Pump (continued)

### 5-4-7. RESET Displayed Continually

1. Switch the system OFF and ON.
2. If the message repeats, switch the pump to a different position. Switch the system OFF and ON.
  - If the message repeats, check for loose connections to the Safety Board and Local Processor Board. If none are found, replace the Local Processor Board.
  - If the message does not repeat, check the RS422 line connection to the pump connector that caused the problem, and check the appropriate pump connection at the Motherboard (J21-J25).

### 5-4-8. OVRSPD 1 Displayed

1. Use a digital tachometer to measure the actual RPM.
  - If the maximum measured RPM is greater than 250 +/- 2 RPM, calibrate the Pump Control Board (refer to Procedure 3-2-4).
  - If the maximum measured RPM is 250 +/- 2 RPM, replace the Pump Safety Board.

### 5-4-9. OVRSPD 2 Displayed

1. Use a digital tachometer to measure the actual RPM.
  - If the maximum measured RPM is greater than 250 +/- 2 RPM, calibrate the Pump Control Board (refer to Procedure 3-2-4).
  - If the maximum measured RPM is 250 +/- 2 RPM, replace the Pump Safety Board.

### 5-4-10. OVRSPD 3 Displayed

1. Check that the speed control pot is properly connected to J4 on the Pump Control Board.
2. Calibrate the Pump Control Board (refer to Procedure 3-2-4).
3. Replace the Local Processor Board.

### 5-4-11. PUMP JAM Displayed

1. Press the Stop switches. Remove the tubing or any foreign objects from the pump head.
2. Use a hand crank to turn the head.
  - If it is easy to turn, the motor or the Pump Drive Board is the source of the problem. Also check the drive transistor connected to J2 on the Pump Drive Board.
  - If it is difficult to turn, proceed to Step 3.
3. Remove the pump drive belt (refer to Procedure 4-1-1). Use a hand crank to turn the head.
  - If it is easy to turn, replace the motor.
  - If it is difficult to turn, replace the casting/bearing assembly.

## 5-4. Roller Pump (continued)

### 5-4-12. BELT SLIP Displayed

1. Use a digital tachometer to measure the actual RPM.
2. Compare the actual RPM to the displayed RPM.
  - If the actual RPM is greater than the displayed RPM, replace the Tachometer Board. Also check that the plastic encoder wheel has not been damaged.
  - If the actual RPM and displayed RPM are equal, the source of the problem is the Pump Safety Board, the Pump Control Board, or the Local Processor Board. Refer to the schematics for assistance.

### 5-4-13. No Flow Display or Message Display

1. Check for the following voltages at J3 on the Pump Power Supply Board: -12 VDC across Pins 1 and 4 (common), +12 VDC across Pins 2 and 4, +5 VDC across Pins 3 and 4. Also check for the following at J2 on the Pump Power Supply Board: +5 VDC across Pins 1 (common) and 2. If any of the voltages are missing, replace the Pump Power Supply Board.
2. Replace the Display Board.

### 5-4-14. Noisy When Running in Forward or Reverse With Tubing

1. Does the noise stop with the tubing removed? If so, refer to Procedure 5-4-15. Otherwise, proceed to Step 2.
2. Determine whether the noise is coming from the rollers, tube guide rollers, or tube clamps.
  - If the noise is from the rollers, replace the roller bearings (refer to Procedure 4-1-7).
  - If the noise is from the tube guide rollers, grease or replace the rollers per Step 12 or 13 of the Roller Pump Inspection (refer to Procedure 2-3-3).
  - If the noise is from the tube clamps, check for a loose insert screw and/or replace the black dovetail slides.
3. Perform a complete Roller Pump Inspection (refer to Procedure 2-3-3).

## 5-4. Roller Pump (continued)

### 5-4-15. Noisy When Running in Forward or Reverse Without Tubing

1. Check for debris in the pump head.
2. Check to see if the tachometer or something else is rubbing against the pulley.
3. Stop the pump. Remove the two screws that secure the black tongue and remove the tongue. Close the pump safety cover and start the pump.
  - If the noise is no longer heard, replace the occlusion knob bearings (refer to Procedures 4-1-5 and 4-1-6).
  - If the noise is still heard, proceed to Step 4.
4. Remove the pump drive belt (refer to Procedure 4-1-1). Start the pump.
  - If the noise is no longer heard, proceed to Step 5.
  - If the noise is still heard, replace the motor (refer to Procedure 4-1-2).
5. Install a hand crank in the roller assembly and turn it by hand.
  - If the noise is no longer heard, replace the pump drive belt (refer to Procedure 4-1-1).
  - If the noise is still heard, replace the casting/bearing assembly.
6. Perform a complete Roller Pump Inspection (refer to Procedure 2-3-3).

### 5-4-16. Noisy in Reverse Only

Because the motor is normally running in forward, it is typical to hear a different noise when the motor is running in reverse. As long as the motor is running smoothly and steadily, there is no problem. Allow the motor to run in reverse for 10-20 minutes. The motor noise should lessen; if not, replace the motor (refer to Procedure 4-1-2).

### 5-4-17. Knocking Sound Heard When Unoccluding Tubing

1. Check that all shoulder screws are torqued to 17 in/lbs and that the shoulder links are not loose.
2. Replace the roller slide bushings (refer to Procedure 4-1-8).
3. Perform a complete Roller Pump Inspection (refer to Procedure 2-3-3).

## 5-4. Roller Pump (continued)

### 5-4-18. Occlusion Mechanism Hard to Turn

1. Remove the roller arm assembly (refer to Procedure 4-1-3).

**Note:** The following three steps involve disassembly of the roller arm assembly. Refer to Procedure 4-1-4 for assistance.

2. Remove the four shoulder screws.
3. While holding the adjustment nut with the spanner wrench, turn the occlusion adjustment knob back and forth.
  - If it is difficult to turn, replace the occlusion knob bearings (refer to Procedures 4-1-5 and 4-1-6).
  - If it turns smoothly, proceed to Step 4.
4. Remove the roller slide assemblies.
5. Check for corrosion on the support rods; remove any with fine sandpaper.
6. Align each roller slide assembly with its support rods. Push the roller slide assemblies onto the support rods. It should only require 5 to 7 pounds of force to move the slides on the support rods; if more force is required, ream the roller slide bushings (refer to Procedure 4-1-9).
7. Reassemble the pump and perform Procedures 3-2-1 (Checking Roller-to-Roller) and 3-2-3 (Checking/Adjusting Casting Runout).

### 5-4-19. Pump Head Will Not Turn

1. Check for the following voltages at J3 on the Pump Power Supply Board: -12 VDC across Pins 1 and 4 (common), +12 VDC across Pins 2 and 4, +5 VDC across Pins 3 and 4. If any of the voltages are missing, replace the Pump Power Supply Board.
2. Check the transistors connected to J1 and J2 on the Pump Drive Board.
3. Check that the resistance of the speed pot varies from 0 to 10K ohms when measured between Pins 2 and 3 of J4 on the Pump Control Board.
4. Disconnect DRV-J4 from the Pump Drive Board. Check for 24-36 VDC across Pins 1 and 3 of J4.
  - If the voltage is present, replace the motor (refer to Procedure 4-1-2).
  - If the voltage is not present, replace the Pump Drive Board.

## 5-4. Roller Pump (continued)

### 5-4-20. Pump Will Not Power Up

1. Check that the pump circuit breaker is ON.
2. Check for 24-36 VDC at the appropriate pump connector (J7-J11) on the Power Distribution Board.
  - If the voltage is present, proceed to Step 3.
  - If the voltage is not present, refer to the power system troubleshooting (Subsection 5-3).
3. Check for 24-36 VDC across Pins 2 and 3 of J1 on the Pump Power Supply Board.
  - If the voltage is present, proceed to Step 4.
  - If the voltage is not present, check the pump cable.
4. Check for the following voltages at J3 on the Pump Power Supply Board: -12 VDC across Pins 1 and 4 (common), +12 VDC across Pins 2 and 4, +5 VDC across Pins 3 and 4. If any of the voltages are missing, replace the Pump Power Supply Board.
5. Replace the Pump Display Board.

### 5-4-21. Pump Will Not Switch into Forward or Reverse

1. Check that the pump safety cover is closed and that the magnet is in the cover.
2. Short together Pins 2 and 3 of J5 on the Pump Drive Board. If this works, replace the cover interlock switch.
3. Disconnect the cable from J4 on the Pump Safety Board. Check for open circuits between Pins 9 and 11 and Pins 8 and 10. If either are shorted, replace the pump membrane switch panel.
4. Replace the Pump Safety Board.

### 5-4-22. Pump Continues to Run with Cover Open

1. Disconnect DRV-J5 from the Pump Drive Board. Check across the two red wires in the cable for a short circuit.
  - If a short is found, replace the cover interlock switch.
  - If an open is found, replace the Pump Drive Board.

## 5-5. Delphin™ II Module Only

With a Delphin™ II Module, follow the current centrifugal pump checks but with the following exceptions.

### Omit two procedures.

5-5-9. Transmitter Output Voltage Incorrect is not applicable for Delphin™ II Module.

5-5-12. Flow Reading Not 1.6 L/Min During Flow Sensing Check is not applicable for Delphin™ II Module.

In addition, apply the following procedures for Delphin™ II Modules only.

### Flow Reading always 0.00 L/min.

1. Try another Flow Sensor.
2. Measure the voltage between TP9 (AGND) and TP8 (+15 VDC Linear) on the Power Supply Board. If the voltage is not +15 VDC  $\pm$  .2 VDC, replace the Power Supply Board.
3. Measure the voltage between TP9 (AGND) on the Power Supply Board and connector J2 Pin 1 on the Conversion/DSP Board.
  - If the voltage is +15 VDC  $\pm$  .2 VDC, replace the Conversion/DSP Board.
  - If the voltage is not +15 VDC  $\pm$  .2 VDC, replace the RFI Filter assembly.
4. Perform a complete System Inspection (refer to Procedure 2-3-2).

### Flow Readings with No Flow.

1. If flow readings are about 3.0 L/min, check the ground wire and ferrite beads are securely connected to the Lemo connector.
2. Try another Flow Sensor.
3. Measure resistance from chassis ground to TP1 of the Conversion/DSP Board; if it is not infinite, correct the problem.
4. Measure resistance from TP1 of the Conversion/DSP Board to TP1 of the Power Supply Board; if it is not infinite, correct the problem.
5. Connect the drive motor and flow sensor to separate loops. If flow readings are displayed at speeds between 800 to 1000 RPM, the Conversion/DSP Board is detecting low frequency noise from within the module. Check the power and grounds within the module.
6. Replace the Conversion/DSP Board.
7. If flow readings are 9.90 L/min for short periods of time, it could be electrical interference.
8. Perform a complete System Inspection (refer to Procedure 2-3-2).

**5-5. Delphin™ II Module Only (continued)****- -L/min Message.**

1. Check the +5 VDC output on the Power Supply Board (J3 Pin 5, J3 Pin 6) for  $\geq 4.85$  VDC.
2. Check the +5 VDC on the Conversion/DSP Board (J7 Pin 5, J7 Pin 6).
3. Check the ribbon cable between the Conversion/DSP Board and the Motor Control Board.
4. Check the connection between the Local Processor Board and the Motor Control Board.
5. Replace the Conversion/DSP Board; it is not communicating with the Local Processor Board.
6. Perform a complete System Inspection (refer to Procedure 2-3-2).

**Flow Alert Does Not Operate (MIN FLOW, CK FLOW).**

1. Replace the Local Processor Board.

**Note:** With a new Local Processor Board, the start up sequence may stop on FAIL 4. To clear the FAIL message, turn the pump power OFF; wait 10 seconds and then turn the pump power ON.

2. Perform a complete System Inspection (refer to Procedure 2-3-2).

**Backflow Alarm Does Not Operate.**

1. Replace the Conversion/DSP Board.
2. Replace the Local Processor Board.

**Note:** With a new Local Processor Board, the start up sequence may stop on FAIL 4. To clear the FAIL message, turn the pump power OFF; wait 10 seconds and then turn the pump power ON.

3. Perform a complete System Inspection (refer to Procedure 2-3-2).

## 5-5. Centrifugal Pump

### 5-5-1. FAIL 1 Displayed (EPROM Test Fail)

1. Switch the system OFF and ON.
2. If the message repeats, check the connections to the Local Processor Board.
3. Replace the Local Processor Board.
4. Perform a complete System Inspection (refer to Procedure 2-3-2).

### 5-5-2. FAIL 2 Displayed (RAM Test Fail)

1. Switch the system OFF and ON.
2. If the message repeats, check the connections to the Local Processor Board.
3. Replace the Local Processor Board.
4. Perform a complete System Inspection (refer to Procedure 2-3-2).

### 5-5-3. FAIL 3 Displayed (PAL Test Fail)

1. Switch the system OFF and ON.
2. If the message repeats, try using a different motor. Replace the bad motor.
3. Replace the Motor Control Board.
4. If the FAIL 3 message appears while the motor is running, replace the Local Processor Board.
5. Perform a complete System Inspection (refer to Procedure 2-3-2).

### 5-5-4. FAIL 4 Displayed (EEROM Test Fail)

**Note:** This message will appear once when new local processor software is installed.

1. Switch the system OFF and ON.
2. If the message repeats, replace the Pump Display Board.
3. Perform a complete System Inspection (refer to Procedure 2-3-2).

### 5-5-5. FAIL 5 Displayed

This test should always pass in a centrifugal pump. If not, replace the Local Processor Board.

## 5-5. Centrifugal Pump (continued)

### 5-5-6. FAIL 6 Displayed

This test should always pass in a centrifugal pump. If not, replace the Local Processor Board.

### 5-5-7. Motor Will Not Run

1. Check that the motor is securely connected.
2. Try a different motor if available.
3. Hold the motor in your hand. Press the Start switches and turn the speed pot fully clockwise (maximum speed).
4. Twist the motor quickly in your hand.
  - If the motor begins to turn at maximum RPM, replace the Motor Control Board.
  - If no movement of the magnets is seen, repair or replace the motor.
5. Connect the negative lead of a DVM to TP1 on the Motor Control Board. Connect the positive lead to Pin 40 of J5. Press the Stop switches.
6. Press the Start switches. The voltage reading should drop to 0 VDC. If not, replace the pump membrane switch panel.
7. Connect the positive lead of the DVM to TP23 on the Motor Control Board. Leave the negative lead on TP1.
8. Press the Start switches and turn the speed pot fully clockwise with no load on the motor.
9. Adjust R49 on the Motor Control Board until a reading of 5.00 +/- 0.01 VDC is obtained.
  - If the reading was already at 5.00 +/- 0.01 VDC, replace the Motor Control Board.
  - If a reading of 0 VDC is obtained, proceed to Step 10.
10. Move the positive lead to Pin 2 of J2 on the Motor Control Board.
  - If a reading of 5.00 +/- 0.01 VDC is obtained, replace the Motor Control Board.
  - If a reading of 0 VDC is obtained, proceed to Step 11.
11. Move the positive lead to Pin 1 of J2 on the Motor Control Board.
  - If a reading of 5.00 +/- 0.01 VDC is obtained, replace the speed pot.
  - If a reading of 0 VDC is obtained, replace the Motor Control Board.
12. Perform a complete System Inspection (refer to Procedure 2-3-2).

## 5-5. Centrifugal Pump (continued)

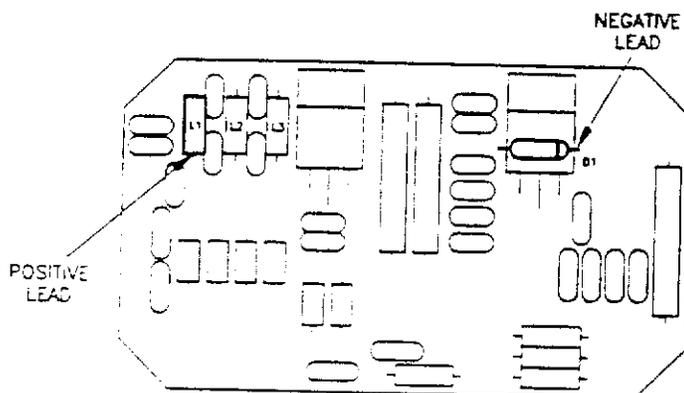
### 5-5-8. Motor Noisy

1. Run the motor at a high RPM (2400 or greater) with no pump attached.
2. Hold your finger just off the surface of the plastic window that covers the magnets. Feel for tiny pieces of metal that may have been attracted by the magnets.
  - If metal pieces are found, use a piece of tape to remove them.
  - If no metal pieces are found, replace the motor bearings.
3. Perform a complete System Inspection (refer to Procedure 2-3-2).

### 5-5-9. Transmitter Output Voltage Incorrect

**Note:** This troubleshooting procedure relates to Step 13 of the Centrifugal Pump Inspection (refer to Procedure 2-3-4).

1. Check for +15 +/- 0.25 VDC at the Transmitter Board. Connect the negative lead of the DVM to the cathode of D1. Connect the positive lead to the lead of L1 closest to the center of the board.
  - If the voltage is +15 +/- 0.25 VDC, replace the Transmitter Board, then perform Step 13 of the Centrifugal Pump Inspection (refer to Procedure 2-3-4).
  - If the voltage is less than +15 +/- 0.25 VDC, replace the Pump Power Supply Board.
2. Perform a complete System Inspection (refer to Procedure 2-3-2).



**5-5. Centrifugal Pump (continued)****5-5-10. Cannot Reach Maximum Speed Under Load**

**Note:** This troubleshooting procedure relates to Step 15 of the Centrifugal Pump Inspection (refer to Procedure 2-3-4).

1. Check all connections to the Motor Control Board.
2. Calibrate the Motor Control Board (refer to Procedure 3-3-1). If it is already calibrated to specification, or cannot be adjusted to specification, replace the Motor Control Board.
3. Perform a complete System Inspection (refer to Procedure 2-3-2).

**5-5-11. Tapping on Sensor Causes Flow Readings to Vary More Than 0.1 L/Min**

**Note:** This troubleshooting procedure relates to Step 17 of the Centrifugal Pump Inspection (refer to Procedure 2-3-4).

1. Disconnect the flow sensor from the pump.
2. Close the sensor.
3. Measure the resistance between the two larger BNC connectors.
  - If the resistance is 0.5 ohms or less, proceed to Step 4.
  - If the resistance is greater than 0.5 ohms, tighten the screws securing the sensor latch and hinges. If this does not lower the resistance to 0.5 ohms or less, replace the flow sensor.
4. Wiggle the sensor wires. If this causes the resistance reading to vary, replace the flow sensor.
5. Perform a complete System Inspection (refer to Procedure 2-3-2).

**5-5-12. Flow Reading Not 1.6 L/Min During Flow Sensing Check**

**Note:** This troubleshooting procedure relates to Step 20 of the Centrifugal Pump Inspection (refer to Procedure 2-3-4).

1. Check that the proper calibration number is entered in the pump.
2. Replace the DSP Conversion Board.
3. Perform a complete System Inspection (refer to Procedure 2-3-2).

## 5-5. Centrifugal Pump (continued)

Additional Troubleshooting Procedures for both Delphin™ Module and Delphin™ II Module

### 5-5-13. Pulse Mode Does Not Function.

1. If the Pulse Mode LED does not illuminate, check the Membrane Panel or the Motor Control Board. Connect negative lead of voltmeter to TP1 and positive lead of voltmeter to J5 Pin 43. With the Pulse switches pressed, check for a ground level (0 VDC).
  - If the voltage reading is not 0 VDC, replace the Membrane Panel.
  - If the voltage reading is 0 VDC, replace the Motor Control Board.
2. If the Pulse Mode LED illuminates, replace the Local Processor Board.
3. Perform a complete System Inspection (refer to Procedure 2-3-2).

### 5-5-14. Motor Alert Displayed.

1. Verify the drive motor cable is secured to the control module.
2. Try another drive motor.
3. Replace the Motor Control Board and check the motor cable from the housing to this board.
4. Perform a complete System Inspection (refer to Procedure 2-3-2).

### 5-5-15. Overcurrent Alert Displayed.

1. Connect negative lead of voltmeter to TP15 and positive lead of voltmeter to TP21 on the Motor Control Board.
  - If the reading is 0.5 VDC or larger, replace the Drive Motor.
  - If the voltage reading is less than 0.5 VDC, replace the Motor Control Board.
2. Check the motor cable from the housing to the Motor Control Board.
3. Replace the Local Processor Board if none of the above steps resolve the problem.
4. Perform a complete System Inspection (refer to Procedure 2-3-2).

### 5-5-16. Underspeed Alert Displayed.

1. If the displayed RPM matches the speed knob setting, replace the Local Processor Board.
2. Set the speed knob to 2400 RPM. If the display shows less than 1680 RPM, press Stop, remove the disposable pump from the drive motor and press Start.
  - If the message disappears, try a different disposable pump.
  - If the message continues, try another drive motor.
3. Check the Motor Control Board calibration (refer to Procedure 3-3-1).
4. Measure the voltage between TP1 (GND) and TP23 (DEMAND) on the Motor Control Board.
  - If the voltage reading is not 3.3 VDC, replace the Speed Pot assembly.
  - If the reading is correct, replace the Motor Control Board.
5. Perform a complete System Inspection (refer to Procedure 2-3-2).

## 5-5. Centrifugal Pump (continued)

### 5-5-17. Overspeed Alert Displayed.

1. Try another drive motor.
2. Replace the Motor Control Board.

### 5-5-18. RESET Displayed Continually.

1. Turn the system OFF and ON.
2. If the message repeats, switch the pump to a different position. Turn the system OFF and ON.
  - If the message repeats again, check for loose connections to the Local Processor Board. If none are found, replace the Local Processor Board.

**Note:** With a new Local Processor Board, the start up sequence may stop on FAIL 4. To clear the FAIL message, turn the pump power OFF, wait 10 seconds and then turn the pump power ON.

- If Reset message does not repeat, check the RS422 line connection to the pump connector that caused the problem and check the appropriate pump connection at the Motherboard (J21-J25).

### 5-5-19. Select Switch Does Not Function.

1. Connect negative lead of voltmeter to TP1 and positive lead of voltmeter to U3 Pin 8 on the Motor Control Board. With the Select switch depressed, check the voltage.
  - If the reading is other than 0 VDC, replace the Membrane Switch Panel.
  - If the reading remained at +5 VDC, proceed to the next step
2. Connect the negative lead of the voltmeter to TP1 and positive lead of voltmeter to U3 Pin 21 on the Motor Control Board. With the Select switch depressed, check the voltage.
  - If the reading is 0 VDC, replace the Local Processor Board.
  - If the reading remains +5 VDC, replace the entire Motor Control Board or try replacing just the PAL in location U3.

### 5-5-20. Up Arrow Switch Does Not Function.

1. Connect the negative lead of voltmeter to TP1 and positive lead of voltmeter to U3 Pin 6 on the Motor Control Board. With the UP Arrow switch depressed, check the voltage.
  - If the reading is other than 0 VDC, replace the Membrane Switch Panel.
  - If the reading remained at +5 VDC, proceed to the next step.
2. Connect the negative lead of voltmeter to TP1 and positive lead of voltmeter to U3 Pin 23 on the Motor Control Board. With the UP Arrow switch depressed, check the voltage.
  - If the reading is 0 VDC, replace the Local Processor Board.
  - If the reading remains +5 VDC, replace the entire Motor Control Board or try replacing just the PAL in location U3.

**5-5. Centrifugal Pump (continued)****5-5-21. Down Arrow Switch Does Not Function.**

1. Connect negative lead of voltmeter to TP1 and positive lead of voltmeter to U3 Pin 7 on the Motor Control Board. With the DOWN Arrow switch depressed, check the voltage.
  - If the reading is other than 0 VDC, replace the Membrane Switch Panel.
  - If the reading remained at +5 VDC, proceed to the next step.
  
2. Connect negative lead of voltmeter to TP1 and positive lead of voltmeter to U3 Pin 22 on the Motor Control Board. With the DOWN Arrow switch depressed, check the voltage.
  - If the reading is 0 VDC, replace the Local Processor Board.
  - If the reading remains +5 VDC, replace the entire Motor Control Board or try replacing just the PAL in location U3.

## 5-6. Bubble Detector

### 5-6-1. Will Not Reset

**Caution:** Do not replace an electronic module with the power on as the system may be damaged. Do not touch the module connector tabs as static and moisture may damage the module circuitry and tabs.

**Note:** The membrane switches on the left and right fixed panels must be held down for at least one second before activation will occur.

1. Ensure that the air sensor cable is properly connected and not damaged. Replace the cable if damaged.
2. Block the air sensor with an opaque object. Press the air detection RESET switch on the right fixed panel. The red LED should go out; if not, check the continuity of the cable.
3. Check the air sensor per Step 6 of the System Inspection (Procedure 2-3-2). Repair/replace the air sensor.
4. Replace the Air Detection Module.
5. Check the cable connection from the Motherboard (J1 and J2) to the I/O Card. Replace the I/O Card (refer to Procedure 4-3-4).
6. Perform a complete System Inspection (refer to Procedure 2-3-2).

### 5-6-2. False Alarm

**Caution:** Do not replace an electronic module with the power on as the system may be damaged. Do not touch the module connector tabs as static and moisture may damage the module circuitry and tabs.

**Note:** The membrane switches on the left and right fixed panels must be held down for at least one second before activation will occur.

1. Block the air sensor with an opaque object. Press the air detection RESET switch on the right fixed panel. The red LED should go out.
2. Wiggle the air sensor cable. If it alarms, check/replace the cable and/or the air sensor connection.

**Note:** Bright lights or EMI interference from another piece of equipment can cause false alarms. Monitor the operating room setting for these causes.

3. If not able to duplicate the false alarm, replace the Air Detection Module.
4. Perform a complete System Inspection (refer to Procedure 2-3-2).

## 5-7. Level Detector

### 5-7-1. False Alarm/Alert

**Caution:** Do not replace an electronic module with the power on as the system may be damaged. Do not touch the module connector tabs as static and moisture may damage the module circuitry and tabs.

1. Check level detection per Step 7 of the System Inspection (Procedure 2-3-2). Be certain that the reservoir meets the following specifications:
  - Clear plastic with a wall thickness of 0.03 - 0.10 inches (0.8 - 2.5 mm).
  - Do not place sensors over labels, painted markings, or surface irregularities.
  - No internal structure can be within 0.39 inches (1.0 cm) of the sensor.
  - Use sufficient gel.
2. If false alarms/alerts occur and are repeatable, switch the position of the sensors. If the false condition follows one sensor, replace it.
3. Replace the Level Detection Module.
4. Check the cable connection from the Motherboard (J1 and J2) to the I/O Card. Replace the I/O Card (refer to Procedure 4-3-4).
5. Perform a complete System Inspection (refer to Procedure 2-3-2).

### 5-7-2. Will Not Reset

**Caution:** Do not replace an electronic module with the power on as the system may be damaged. Do not touch the module connector tabs as static and moisture may damage the module circuitry and tabs.

**Note:** The membrane switches on the left and right fixed panels must be held down for at least one second before activation will occur.

1. The level in the reservoir must be above the alarm sensor before pressing RESET.
2. Try switching the level detector OFF and back ON. If it cannot be turned OFF, switch the system power OFF and back ON.

**Warning:** Do not use the level detection feature until the Level Detection Module has been replaced.

3. Replace the Level Detection Module.
4. Perform a complete System Inspection (refer to Procedure 2-3-2).

## 5-8. Occluder System

### 5-8-1. Occluder Display Blanking

1. If the display shows a number, but blanks as the occluder opens, return the occluder to Sams for repair.
2. If the display blanks after the Close switch is pressed, replace the Left Fixed Panel PCB.
3. Perform a complete System Inspection (refer to Procedure 2-3-2).

### 5-8-2. Occluder Plunger Will Not Move

**Caution:** Do not replace an electronic module with the power on as the system may be damaged. Do not touch the module connector tabs as static and moisture may damage the module circuitry and tabs.

1. Open the occluder per Step 1 of Procedure 3-4-1 (Calibrating the Occluder Drive Board).
2. Check for the following at J2 on the Occluder Drive Board: 24 VDC across Pins 9 and 3, 12 VDC across Pins 11 and 3.
  - If both voltages are present, proceed to Step 4.
  - If either voltage is not present, proceed to Step 3.
3. Check the occluder cable, then check for the following at J2 on the Occluder Interface Board: 24 VDC across Pins 10 and 3, 12 VDC across Pins 14 and 3.
  - If the 24 VDC is not present, check the occluder circuit breaker, then check for 24 VDC across Pins 1 and 2 of J5 on the Power Distribution Board. If the voltage is not present at the Power Distribution Board, refer to the power system troubleshooting (Subsection 5-2).
  - If the 12 VDC is not present, replace the Occluder Module.
4. Replace the Occluder Drive Board. If this does not solve the problem, the motor must be replaced; return the occluder assembly to Sams.
5. Perform a complete System Inspection (refer to Procedure 2-3-2).

### 5-8-3. Manual Dial Will Not Move Plunger

1. Check the cable connection to J3 on the Left Fixed Panel PCB.
2. Replace the control pot.
3. Perform a complete System Inspection (refer to Procedure 2-3-2).

### 5-8-4. Open or Close Switch Does Not Function

1. Check the cable connections to J1 and J2 on the Left Fixed Panel PCB. Check the cable connection to J-28 on the Motherboard.
2. Replace the Left Fixed Panel Membrane Switch per Procedure 4-4-1 or 4-4-2.
3. Perform a complete System Inspection (refer to Procedure 2-3-2).

## 5-9. Gas Flow and Gas Flush System

### 5-9-1. Gas System Verification

**Note:** On systems with version 1.7 or lower system software, prior to performing this procedure, obtain an Injection Fixture and Test Memory Board from the nearest service center

1. Verify that the input O<sub>2</sub> line is 100% oxygen at 50 +/- 10 psi. Verify that the input air line is 21% oxygen at 50 +/- 10 psi. The O<sub>2</sub> and air input pressures must be within 10 psi of each other.
2. Set the system to the Diagnostic Mode (refer to Procedure 2-2-1).
3. Connect the gas inputs.
4. Turn the flowrate knob fully clockwise to turn the gas flow off.
5. Set the Power Switch to ON. Allow the machine to stabilize for ten minutes.
6. Turn the FIO<sub>2</sub> control knob fully counter-clockwise.
7. With stable input gas conditions, the air flow count displayed for Air/Channel:1 should not vary more than 15 counts over any 30 second period. If it does, replace the air flow sensor (refer to Procedure 4-2-4).
8. Turn the FIO<sub>2</sub> control knob fully clockwise.
9. With stable input gas conditions, the O<sub>2</sub> flow count displayed for O<sub>2</sub>/Channel:0 should not vary more than 8 counts over any 30 second period. If it does, replace the O<sub>2</sub> flow sensor (refer to Procedure 4-2-4).
10. With stable input gas conditions, the total flow count displayed for Total/Channel:2 should not vary more than 10 counts over any 30 second period. If it does, replace the total flow sensor (refer to Procedure 4-2-4).
11. If all three flow counts are not remaining stable as noted above, replace the blender.
12. Perform a complete System Inspection (refer to Procedure 2-3-2).

## 5-9. Gas Flow and Gas Flush System (continued)

### 5-9-2. Displayed FIO<sub>2</sub> Not Accurate

**Note:** On systems with version 1.7 or lower system software, prior to performing this procedure, obtain an Injection Fixture and Test Memory Board from the nearest service center or refer to the notes at the end of this procedure.

1. Calibrate the flow sensors per Procedure 3-5-1 (Version 2.21 or higher) or 3-5-2 (Version 1.7 or lower).
2. Verify the gas system operation by performing Procedure 5-9-1.
3. Connect the gas inputs.
4. Set the total flow rate to 6 L/min and turn the FIO<sub>2</sub> control knob for an expected .60 FIO<sub>2</sub>.
5. Verify that the FIO<sub>2</sub> reading on the central display is +/- 3% of the actual FIO<sub>2</sub> as measured with an oxygen analyzer.
6. Set the total flow rate to 0.4 L/min. Repeat Step 5.
7. Set the total flow rate to 10 L/min. Repeat Step 5.
8. Check the accuracy of the total flow by connecting a ball flowmeter to the output. If the total flow display is high and the FIO<sub>2</sub> readings are inaccurate, check to make sure that the flow sensors are isolated per NFC #9K-113090. If the flow sensors are isolated, replace the A/D Converter Card (refer to Procedure 4-3-4).
9. If the output flow (as measured with a ball flowmeter) is less than the displayed flow and the flow sensors passed calibration, check for leaks in the system.
10. Perform a complete System Inspection (refer to Procedure 2-3-2).

**Note:** If the actual FIO<sub>2</sub> output as measured with an external oxygen analyzer is always higher than the displayed FIO<sub>2</sub>, the most likely problem is the O<sub>2</sub> flow sensor.

**Note:** If the actual FIO<sub>2</sub> output as measured with an external oxygen analyzer is always lower than the displayed FIO<sub>2</sub>, the most likely problem is the air flow sensor.

## 5-9. Gas Flow and Gas Flush System (continued)

### 5-9-3. Actual FIO<sub>2</sub> Output Not Accurate

1. Verify that the input O<sub>2</sub> line is 100% oxygen at 50 +/- 10 psi. Verify that the input air line is 21% oxygen at 50 +/- 10 psi. The O<sub>2</sub> and air input pressures must be within 10 psi of each other.
2. Set the flow rate to approximately 6 L/min.
3. Turn the FIO<sub>2</sub> control knob fully counter-clockwise. The central display should read .21 and the O<sub>2</sub> analyzer should read .21 +/- 3%. If not, proceed to Step 6.
4. Turn the FIO<sub>2</sub> control knob fully clockwise. The central display should read 1.00 and the O<sub>2</sub> analyzer should read 1.00 +/- 3%. If not, proceed to Step 6.
5. Turn the FIO<sub>2</sub> control knob to mid-range. The central display should read .60 and the O<sub>2</sub> analyzer should read .60 +/- 3%. If not, proceed to Step 6.
6. Calibrate the flow sensors per Procedure 3-5-1 (Version 2.21 or higher) or 3-5-2 (Version 1.7 or lower). Replace any flow sensor as needed, as described in the calibration procedure.
7. If the flow sensors are accurate, replace the blender per Procedure 4-2-5. Return the old blender to Sarns or the nearest service center for repair.
8. Perform a complete System Inspection (refer to Procedure 2-3-2).

### 5-9-4. Displayed Gas Flowrate Not Accurate

1. Verify that the input O<sub>2</sub> and air are at 50 +/- 10 psi and within 10 psi of each other.
2. Check for leaks in the system.
3. Calibrate the flow sensors per Procedure 3-5-1 (Version 2.21 or higher) or 3-5-2 (Version 1.7 or lower).
  - If the offset value displayed during calibration is higher than 13, replace the output flow sensor (refer to Procedure 4-2-4).
  - If the offset value displayed during calibration is 13 or lower, replace the A/D Converter Card (refer to Procedure 4-3-4).
4. Perform a complete System Inspection (refer to Procedure 2-3-2).

### 5-9-5. Gas Flow Will Not Stop

1. Remove the silver gas flow control knob.
2. Use a pliers to turn the center stem fully clockwise (valve fully closed).
3. If gas still flows with the valve fully closed, replace the gas flow needle valve (refer to Procedure 4-2-6).

**Note:** Before re-installing the control knob, ensure that the valve is fully closed (fully clockwise).

## 5-9. Gas Flow and Gas Flush System (continued)

### 5-9-6. CO<sub>2</sub> Flush Will Not Start

**Caution:** Do not replace an electronic module with the power on as the system may be damaged. Do not touch the module connector tabs as static and moisture may damage the module circuitry and tabs.

1. Verify that no gas is flowing. Disconnect the input gases and press the Start switch. If the solenoid clicks and the LED lights, perform Procedure 5-9-5 (Gas Flow Will Not Stop). Otherwise, proceed to Step 2.
2. Remove the left air filter assembly.
3. Check the cable connections on the Left Fixed Panel PCB.
4. Check the cable connection at J28 on the Motherboard.
5. Replace the Digital Interface Module.
6. Replace the Left Fixed Membrane Panel (refer to Procedure 4-4-1 or 4-4-2) and/or the Left Fixed Panel PCB.
7. Perform a complete System Inspection (refer to Procedure 2-3-2).

### 5-9-7. Output Flow Unstable

1. The gas supply pressures may be fluctuating. Monitor the input gas supplies.
2. Perform Step 4 of Procedure 2-3-5.
3. If the gas supplies are stable, perform Procedure 5-9-1.

### 5-9-8. Output Flow Unstable When Changing the FIO<sub>2</sub>

1. Check for a grossly inadequate oxygen or air supply.
2. Replace the blender (refer to Procedure 4-2-5).

### 5-9-9. FIO<sub>2</sub> Reading Unstable

1. The gas supply pressures may be fluctuating beyond the blender's ability to control them. Monitor the input gas supplies.
2. Perform Step 4 of Procedure 2-3-5.
3. If the gas supplies are stable, perform Procedure 5-9-1.
4. The blender may be erratic. Replace the blender (refer to Procedure 4-2-5).

**5-9. Gas Flow and Gas Flush System (continued)****5-9-10. FIO<sub>2</sub> Reading Unstable When Changing the Total Flow**

1. The gas supplies to the blender may be insufficient. Verify that the input gas supply pressures are high enough. Check for kinked lines. Check/replace the filters and check valves.
2. Replace the blender (refer to Procedure 4-2-5).

**5-9-11. FIO<sub>2</sub> Will Not Reach .21 or 1.00**

1. Calibrate the flow sensors per Procedure 3-5-1 (Version 2.21 or higher) or 3-5-2 (Version 1.7 or lower). Note the new offset values.
2. Use an oxygen analyzer to verify that the source O<sub>2</sub> supply is 100% oxygen and the source air supply is 21% oxygen.
3. Recheck to see if .21 and 1.00 can be reached. If not, replace the blender (refer to Procedure 4-2-5).

## 5-10. Pressure System

### 5-10-1. Inaccurate Pressure Display

1. Calibrate the Pressure Board (refer to Procedure 3-1-3).
2. Check the accuracy of the displayed gas flowrate and  $\text{FIO}_2$ .
  - If these displays are accurate, replace the pressure module.
  - If these displays are also inaccurate, check the cable connection between the A/D Converter Card and J5 on the Motherboard. If this connection is good, replace the A/D Converter Card (refer to Procedure 4-3-4).
3. Perform a complete System Inspection (refer to Procedure 2-3-2).

### 5-10-2. Pressure Will Not Zero

**Caution:** Do not replace an electronic module with the power on as the system may be damaged. Do not touch the module connector tabs as static and moisture may damage the module circuitry and tabs.

1. Try to zero the channel without a probe. If the display now reads "- -", replace the probe.
2. Replace the Pressure Module.
3. Perform a complete System Inspection (refer to Procedure 2-3-2).

## 5-11. Water System

### 5-11-1. General Troubleshooting Tips

1. If a slight ether smell is detected when disassembling a control valve, install a new Motor Kit (refer to Procedure 4-5-5).
2. The system may not function properly if the hot water supply is at the lower end of its specified temperature range and the cold water supply is anywhere within its specified temperature range. Have the hospital raise its hot water temperature. Refer to Step 13 of Procedure 2-3-2.
3. If the customer is having trouble with the system, but it works fine when you check it out, try to determine what else may be happening at the hospital at the time the customer has trouble (i.e. laundry, dishwashing, numerous patient showers).

### 5-11-2. Cannot Set Maximum Output Temperature to 39-42°C

1. Read the troubleshooting tips in Procedure 5-11-1.
2. Verify that the source water supplies are within specification. The cold water supply must be 2-6°C at 40-80 psi; the hot water supply must be 44-65°C at 40-80 psi.
3. Install a new Motor Kit and Valve/Seat Kit in the valve(s) that cannot be adjusted to specification.
4. Set the output temperature (refer to Procedure 3-6-3).
5. Perform a complete System Inspection (refer to Procedure 2-3-2).

### 5-11-3. Output Temperature Hard to Control

1. Read the troubleshooting tips in Procedure 5-11-1.
2. Verify that the source water supplies are within specification. The cold water supply must be 2-6°C at 40-80 psi; the hot water supply must be 44-65°C at 40-80 psi.
3. Install a new Motor Kit in the valve that is hard to control.
4. Perform a complete System Inspection (refer to Procedure 2-3-2).

**5-11. Water System (continued)****5-11-4. Hot Water Continues to Flow After Cold Water Is Shut Off**

**Note:** This safety feature will only work if the hot water supply is  $\geq 60^{\circ}\text{C}$ .

1. Read the troubleshooting tips in Procedure 5-11-1.
2. Disconnect the cold water source.
3. Turn one of the control knobs fully counter-clockwise. If the output flow does not cease and/or the temperature rises above  $50^{\circ}\text{C}$ , install a new Motor Kit (refer to Procedure 4-5-5).
4. Repeat Step 2 for the other control knob.
5. Perform a complete System Inspection (refer to Procedure 2-3-2).

**5-11-5. Adjustment of One Knob Affects the Other Output by More Than  $2^{\circ}\text{C}$** 

1. Read the troubleshooting tips in Procedure 5-11-1.
2. Check that each individual control knob functions properly as described in Step 13 of the System Inspection (refer to Procedure 2-3-2).
3. Check the hot and cold water sources. If both source supplies are good (refer to Step 2 of Procedure 5-11-1), install a new Motor Kit and Valve/Seat Kit in both valves.
4. Set the output temperature (refer to Procedure 3-6-3).
5. Perform a complete System Inspection (refer to Procedure 2-3-2).

## 5-12. Miscellaneous

### 5-12-1. System Clock Resets

1. Record the options installed (I.e. Pulse, Blood Chemistry).
2. Check to see that the Computer Card is seated securely.
3. Replace the Computer Card (refer to Procedure 4-3-4).
4. Perform a complete System Inspection (refer to Procedure 2-3-2).

### 5-12-2. System Clock Cannot Be Set

1. Ensure that all timers are stopped. The AUX, Pump, Clamp, and CPG timers can all be stopped by pressing STOP or shutting the system OFF and ON.
2. If the system clock still cannot be set, calibrate the touch screen (refer to Procedure 3-1-2).

## 5-12. Miscellaneous (continued)

## 5-12-4. Central Display Troubleshooting (continued)

Problem	Check	Possible Action
Many display pixels are out.		Replace LCD panel.
Display slowly turns reddish on power up.	<ul style="list-style-type: none"> <li>Immediately turn off power to display,</li> <li>✓ all cable connections,</li> <li>Disconnect all LCD cabling,</li> <li>Turn display power on,</li> <li>✓ voltages at display video data connector,</li> <li>✓ DOS board data connector.</li> </ul>	<ul style="list-style-type: none"> <li>Replace cables if voltages are not present at both ends,</li> <li>Replace DOS board if data level is steady +5 VDC.</li> </ul>
Display has black lines on power up.	<ul style="list-style-type: none"> <li>✓ all cable connections.</li> </ul>	Replace cables if necessary.
Display shows only a few updated values and screen text missing.	<ul style="list-style-type: none"> <li>✓ all cable connections,</li> <li>✓ for repeatability of the problem by restarting the system,</li> <li>✓ voltage output from DC/DC converter (5 volts <math>\pm</math> 1%).</li> </ul>	<ul style="list-style-type: none"> <li>Replace cable if necessary,</li> <li>Replace display software,</li> <li>Replace DOS board,</li> <li>Replace interconnect board.</li> </ul>
Display shows contrast gradient (in 1/8 screen size sections).	<ul style="list-style-type: none"> <li>✓ all display video data connections.</li> </ul>	<ul style="list-style-type: none"> <li>Replace cable if necessary,</li> <li>Replace LCD panel if necessary.</li> </ul>
Touchscreen does not respond.	<ul style="list-style-type: none"> <li>✓ voltage at touch controller board power input and output,</li> <li>✓ all communication cabling connections,</li> <li>On touch controller board,</li> <li>✓ for jumper W4 pins 3 and 4 and no jumper between pins 1 and 2,</li> <li>✓ W3 for no jumpers.</li> </ul>	<ul style="list-style-type: none"> <li>Replace cable if necessary,</li> <li>Replace touch controller board or touchscreen if power is correct,</li> <li>Place and remove jumpers where necessary.</li> </ul>
Touchscreen is slow to respond.		<ul style="list-style-type: none"> <li>Replace touchscreen,</li> <li>Replace touch controller board.</li> </ul>
System does not boot.	<ul style="list-style-type: none"> <li>✓ DOS board SF-12 for vertical jumpers over top and middle pins,</li> <li>✓ DOS board SF-9 for vertical jumper over top and middle pins.</li> </ul>	<ul style="list-style-type: none"> <li>Place and remove jumpers where necessary,</li> <li>If moving jumpers vertically to top and middle pins, replace software EPROM,</li> <li>If none of the above works, replace DOS board.</li> </ul>
System boots up but no title screen	<ul style="list-style-type: none"> <li>✓ DOS board SF-13 for jumper across lower 2 pins,</li> <li>✓ DOS board SF-6 for no jumper.</li> </ul>	<ul style="list-style-type: none"> <li>Place and remove jumpers where necessary,</li> <li>Replace software,</li> <li>Replace DOS board.</li> </ul>
Display causes front tray display circuit breaker pop.	<ul style="list-style-type: none"> <li>✓ cable connections.</li> </ul>	<ul style="list-style-type: none"> <li>Secure cable connections,</li> <li>Troubleshoot IC board.</li> </ul>
No communication with 9000 console.	<ul style="list-style-type: none"> <li>✓ all communication cable connections.</li> </ul>	Replace cable if necessary.

## 5-12. Miscellaneous

### 5-12-3. Central Display Color Test

1. Set the system to the Diagnostics Mode (refer to Procedure 2-2-1).
2. Turn the power switch ON.
3. After the start-up routine is finished, touch the Screen Test button and verify that the five colors red, green, blue, white and black are each displayed for 10 seconds. If problems, troubleshoot the central display.
4. Return the system to Normal Operating Mode (refer to Procedure 2-2-2).

### 5-12-4. Central Display Troubleshooting

**Warning:** Do not touch pins on connectors J6 and J7 of IC board to prevent 60 VAC electrical shock.

**Cautions:** Use static precautions whenever handling components.

Incorrect positioning of connectors will damage the components on the central display.

Problem	Check	Possible Action
LCD panel is blank (black screen)	<ul style="list-style-type: none"> <li>✓ 60 VAC between pins 1 or 3 and 5 or 7 on display backlight connector,</li> <li>✓ display video data cable connections at DOS board and display,</li> <li>✓ DOS board SF-5 jumpers only on SW2, SW3 and SW8,</li> <li>✓ +5 volt power on data cable.</li> </ul>	Replace backlight bulbs if 60 VAC is reaching LCD panel, Secure cable connections, Place and remove jumpers on DOS board as necessary, Troubleshoot interconnect board.
Display appears dim or half of LCD panel dimmer than the other.	<ul style="list-style-type: none"> <li>✓ 60 VAC between pins 1 or 3 and 5 or 7 on display backlight connector.</li> </ul>	Replace backlight bulbs if 60 VAC is reaching LCD panel, Troubleshoot interconnect board.
Incorrect colors on the display.	<ul style="list-style-type: none"> <li>✓ all cable connections.</li> </ul>	Replace cables if voltages are not present at both ends, Replace the PAL on the interconnect board.
Display flickers.	<ul style="list-style-type: none"> <li>✓ VDD2 voltage at the display video data connector,</li> <li>✓ VCC voltage at the display video data connector,</li> <li>✓ DOS board SF-5 jumpers only on SW2, SW3 and SW8.</li> </ul>	Replace the cable if voltage is not at both ends, If voltage is present, troubleshoot interconnect board, Place and remove jumpers on DOS board as necessary, Replace the LCD panel if flickering persists.
Display only white on power up.	<ul style="list-style-type: none"> <li>✓ display video data cable connections at DOS board and display,</li> <li>✓ DOS board power and data valid signal,</li> <li>✓ power and data at display video data connector.</li> </ul>	Replace cable if correct voltage levels are not at both ends, Replace DOS board if data valid signal is not present, Troubleshoot interconnect board, Replace LCD panel if everything else is correct.

<b>Abbreviation Key</b>	
A/D	A/D Converter Card on STD Bus
+AIN	+ Analog Input
-AIN	-Analog Input
BAT	Battery
BD	Bubble Detector
C	Capactor Board
CA	Communications Adapter Board
CB	Circuit Breaker Board
CD	Central Display
CPU	Computer Card on STD Bus
DI	Digital Interface Board
FSA	Air Flow Sensor
FSO2	O <sub>2</sub> Flow Sensor
FST	Total Flow Sensor
I/O	I/O Card on STD Bus
LD	Level Detector
LF	Left Fan
LFP	Left Fixed Panel Board
LSD	Least Significant Digit
M	Motherboard
MF	Main Fan
MSD	Most Significant Digit
OCC	Occluder
P1	Pump 1 Connector
P2	Pump 2 Connector
P3	Pump 3 Connector
P4	Pump 4 Connector
P5	Pump 5 Connector
PC	Power Control Board
PD	Power Distribution Board
PS	Power Supply
RF	Right Fan
RFP	Right Fixed Panel Board
SC	Serial Card on STD Bus
SOL	Gas Solenoid
TS	Temp/Serial Board (version 1.7 and lower only)

M-J1 is connected to I/O-J1.			
Signal Origin	M-J1	Signal Name	Signal Destination
	Pin 1 ↓ Pin 5	Not Used	
I/O-J1, Pin 6	Pin 6	Address Strobe	M-J31 → M-J41, Pin 51
	Pin 7	Not Used	
I/O-J1, Pin 8	Pin 8	Write Clock	M-J31 → M-J41, Pin 49
	Pin 9	Not Used	
I/O-J1, Pin 10	Pin 10	Read Clock	M-J31 → M-J41, Pin 50
	Pin 11 ↓ Pin 15	Not Used	
I/O-J1, Pin 16	Pin 16	Card Select 11	M-J41, Pin 52
	Pin 17	Not Used	
I/O-J1, Pin 18	Pin 18	Card Select 10	M-J40, Pin 52
	Pin 19	Not Used	
I/O-J1, Pin 20	Pin 20	Card Select 9	M-J39, Pin 52
	Pin 21 ↓ Pin 25	Not Used	
I/O-J1, Pin 26	Pin 26	Card Select 8	M-J38, Pin 52
	Pin 27	Not Used	
I/O-J1, Pin 28	Pin 28	Card Select 7	M-J37, Pin 52
	Pin 29	Not Used	
I/O-J1, Pin 30	Pin 30	Card Select 6	M-J36, Pin 52
	Pin 31	Not Used	
I/O-J1, Pin 32	Pin 32	Card Select 5	M-J35, Pin 52
	Pin 33	Not Used	
I/O-J1, Pin 34	Pin 34	Card Select 4	M-J34, Pin 52
	Pin 35	Not Used	
I/O-J1, Pin 36	Pin 36	Card Select 3	M-J33, Pin 52
	Pin 37	Not Used	
I/O-J1, Pin 38	Pin 38	Card Select 2	M-J32, Pin 52
	Pin 39	Not Used	
I/O-J1, Pin 40	Pin 40	Card Select 1	M-J31, Pin 52

M-J2 is connected to I/O-J2.			
Signal Origin	M-J2	Signal Name	Signal Destination
	Pin 1 ↓ Pin 5	Not Used	
I/O-J2, Pin 6	Pin 6	Auxiliary Bus Signal 8	M-J31 → M-J42, Pin 40
	Pin 7	Not Used	
I/O-J2, Pin 8	Pin 8	Auxiliary Bus Signal 7	M-J31 → M-J42, Pin 39
	Pin 9	Not Used	
I/O-J2, Pin 10	Pin 10	Auxiliary Bus Signal 6	M-J31 → M-J42, Pin 38
	Pin 11	Not Used	
I/O-J2, Pin 12	Pin 12	Auxiliary Bus Signal 5	M-J31 → M-J42, Pin 37
	Pin 13	Not Used	
I/O-J2, Pin 14	Pin 14	Auxiliary Bus Signal 4	M-J31 → M-J42, Pin 36
	Pin 15	Not Used	
I/O-J2, Pin 16	Pin 16	Auxiliary Bus Signal 3	M-J31 → M-J42, Pin 35
	Pin 17	Not Used	
I/O-J2, Pin 18	Pin 18	Auxiliary Bus Signal 2	M-J31 → M-J42, Pin 34
	Pin 19	Not Used	
I/O-J2, Pin 20	Pin 20	Auxiliary Bus Signal 1	M-J31 → M-J42, Pin 33
	Pin 21 ↓ Pin 25	Not Used	
I/O-J2, Pin 26	Pin 26	Multiplexed Address 7	M-J31 → M-J41, Pin 48
	Pin 27	Not Used	
I/O-J2, Pin 28	Pin 28	Multiplexed Address 6	M-J31 → M-J41, Pin 47
	Pin 29	Not Used	
I/O-J2, Pin 30	Pin 30	Multiplexed Address 5	M-J31 → M-J41, Pin 46
	Pin 31	Not Used	
I/O-J2, Pin 32	Pin 32	Multiplexed Address 4	M-J31 → M-J41, Pin 45
	Pin 33	Not Used	
I/O-J2, Pin 34	Pin 34	Multiplexed Address 3	M-J31 → M-J41, Pin 44
	Pin 35	Not Used	
I/O-J2, Pin 36	Pin 36	Multiplexed Address 2	M-J31 → M-J41, Pin 43
	Pin 37	Not Used	
I/O-J2, Pin 38	Pin 38	Multiplexed Address 1	M-J31 → M-J41, Pin 42
	Pin 39	Not Used	
I/O-J2, Pin 40	Pin 40	Multiplexed Address 0	M-J31 → M-J41, Pin 41

M-J3 is connected to TS-J1 (non-V50 units only).			
Signal Origin	M-J3	Signal Name	Signal Destination
	Pin 1 ↓ Pin 4	Not Used	
TS-J1, Pin 5	Pin 5	Transmit Data 3	M-J33, Pin 19
TS-J1, Pin 6	Pin 6	Transmit Source 3	M-J33, Pin 20
TS-J1, Pin 7	Pin 7	Receive Data 3	M-J33, Pin 21
TS-J1, Pin 8	Pin 8	Receive Source 3	M-J33, Pin 22
TS-J1, Pin 9	Pin 9	Transmit Data 2	M-J32, Pin 19
TS-J1, Pin 10	Pin 10	Transmit Source 2	M-J32, Pin 20
TS-J1, Pin 11	Pin 11	Receive Data 2	M-J32, Pin 21
TS-J1, Pin 12	Pin 12	Receive Source 2	M-J32, Pin 22
TS-J1, Pin 13	Pin 13	Transmit Data 1	M-J31, Pin 19
TS-J1, Pin 14	Pin 14	Transmit Source 1	M-J31, Pin 20
TS-J1, Pin 15	Pin 15	Receive Data 1	M-J31, Pin 21
TS-J1, Pin 16	Pin 16	Receive Source 1	M-J31, Pin 22
	Pin 17 ↓ Pin 20	Not Used	

M-J4 is not used. It is intended for general purpose I/O expansion.			
Signal Origin	M-J4	Signal Name	Signal Destination
	Pin 1 ↓ Pin 16	Not Used	M-J33, Pin 1 ↓ M-J33, Pin 16
M-J29, Pin 4	Pin 17	+5 VDC	
M-J29, Pin 4	Pin 18	+5 VDC	
M-J29, Pin 5	Pin 19	Digital Ground	
M-J29, Pin 5	Pin 20	Digital Ground	

M-J5 is connected to A/D-J2.				
Signal Origin	M-J5	Signal Name	Signal Destination	
M-J6, Pin 5	Pin 1	V10+	A/D-J2, Pin 1	Channel 0
M-J6, Pin 3	Pin 2	V10-	A/D-J2, Pin 2	
	Pin 3	Not Used		
M-J7, Pin 3	Pin 4	V11-	A/D-J2, Pin 4	Channel 1
M-J7, Pin 5	Pin 5	V11+	A/D-J2, Pin 5	
	Pin 6	Not Used		
M-J8, Pin 5	Pin 7	V12+	A/D-J2, Pin 7	Channel 2
M-J8, Pin 3	Pin 8	V12-	A/D-J2, Pin 8	
	Pin 9	Not Used		
M-J31 → M-J41, Pin 32	Pin 10	-AIN	A/D-J2, Pin 10	Channel 3
M-J31 → M-J41, Pin 30	Pin 11	+AIN	A/D-J2, Pin 11	
	Pin 12	Not Used		
M-J29, Pin 1	Pin 13	V13+	A/D-J2, Pin 13	Channel 4
M-J29, Pin 2	Pin 14	V13-	A/D-J2, Pin 14	
	Pin 15	Not Used		
M-J10, Pin 2	Pin 16	V14-	A/D-J2, Pin 16	Channel 5
M-J10, Pin 1	Pin 17	V14+	A/D-J2, Pin 17	
	Pin 18	Not Used		
M-J11, Pin 1	Pin 19	V15+	A/D-J2, Pin 19	Channel 6
M-J11, Pin 2	Pin 20	V15-	A/D-J2, Pin 20	
	Pin 21	Not Used		
M-J12, Pin 2	Pin 22	V16-	A/D-J2, Pin 22	Channel 7
M-J12, Pin 1	Pin 23	V16+	A/D-J2, Pin 23	
	Pin 24	Not Used		
M-J34, Pin 2	Pin 25	V1+	A/D-J2, Pin 25	Channel 8
M-J34, Pin 4	Pin 26	V1-	A/D-J2, Pin 26	
	Pin 27	Not Used		
M-J34, Pin 6	Pin 28	V2-	A/D-J2, Pin 28	Channel 9
M-J34, Pin 6	Pin 29	V2+	A/D-J2, Pin 29	
	Pin 30	Not Used		
M-J34, Pin 10	Pin 31	V3+	A/D-J2, Pin 31	Channel 10
M-J34, Pin 12	Pin 32	V3-	A/D-J2, Pin 32	
	Pin 33	Not Used		
M-J34, Pin 18	Pin 34	V4-	A/D-J2, Pin 34	Channel 11
M-J34, Pin 14	Pin 35	V4+	A/D-J2, Pin 35	
	Pin 36	Not Used		
M-J35, Pin 2	Pin 37	V5+	A/D-J2, Pin 37	Channel 12
M-J35, Pin 4	Pin 38	V5-	A/D-J2, Pin 38	
	Pin 39	Not Used		
M-J35, Pin 8	Pin 40	V6-	A/D-J2, Pin 40	Channel 13
M-J35, Pin 6	Pin 41	V6+	A/D-J2, Pin 41	
	Pin 42	Not Used		
M-J35, Pin 10	Pin 43	V7+	A/D-J2, Pin 43	Channel 14
M-J35, Pin 12	Pin 44	V7-	A/D-J2, Pin 44	
	Pin 45	Not Used		
M-J35, Pin 18	Pin 46	V8-	A/D-J2, Pin 46	Channel 15
M-J35, Pin 14	Pin 47	V8+	A/D-J2, Pin 47	
	Pin 48	Not Used		
	Pin 49	Not Used		
	Pin 50	Not Used		

<b>M-J6 is connected to the O<sub>2</sub> Flow Sensor.</b>			
<b>Signal Origin</b>	<b>M-J6</b>	<b>Signal Name</b>	<b>Signal Destination</b>
	Pin 1	Not Used	
	Pin 2	Not Used	
FSO2, Pin 3	Pin 3	V10-	M-J5, Pin 1
	Pin 4	Not Used	
FSO2, Pin 5	Pin 5	V10+	M-J5, Pin 2
M-J29, Pin 3	Pin 6	Analog Ground	FSO2, Pin 6
M-J29, Pin 1	Pin 7	+12 VDC	FSO2, Pin 7
	Pin 8 ↓ Pin 11	Not Used	
M-J29, Pin 2	Pin 12	-12 VDC	FSO2, Pin 12
	Pin 13 ↓ Pin 20	Not Used	

<b>M-J7 is connected to the Air Flow Sensor.</b>			
<b>Signal Origin</b>	<b>M-J7</b>	<b>Signal Name</b>	<b>Signal Destination</b>
	Pin 1	Not Used	
	Pin 2	Not Used	
FSA, Pin 3	Pin 3	V11-	M-J5, Pin 4
	Pin 4	Not Used	
FSA, Pin 5	Pin 5	V11+	M-J5, Pin 5
M-J29, Pin 3	Pin 6	Analog Ground	FSA, Pin 6
M-J29, Pin 1	Pin 7	+12 VDC	FSA, Pin 7
	Pin 8 ↓ Pin 11	Not Used	
M-J29, Pin 2	Pin 12	-12 VDC	FSA, Pin 12
	Pin 13 ↓ Pin 20	Not Used	

<b>M-J8 is connected to the Total Flow Sensor.</b>			
<b>Signal Origin</b>	<b>M-J8</b>	<b>Signal Name</b>	<b>Signal Destination</b>
	Pin 1	Not Used	
	Pin 2	Not Used	
FST, Pin 3	Pin 3	V12-	M-J5, Pin 8
	Pin 4	Not Used	
FST, Pin 5	Pin 5	V12+	M-J5, Pin 7
M-J29, Pin 3	Pin 6	Analog Ground	FST, Pin 6
M-J29, Pin 1	Pin 7	+12 VDC	FST, Pin 7
	Pin 8 ↓ Pin 11	Not Used	
M-J29, Pin 2	Pin 12	-12 VDC	FST, Pin 12
	Pin 13 ↓ Pin 20	Not Used	

<b>M-J9 is not used. It is a spare analog transducer input.</b>			
<b>Signal Origin</b>	<b>M-J9</b>	<b>Signal Name</b>	<b>Signal Destination</b>
	Pin 1	V13+	M-J5, Pin 13
	Pin 2	V13-	M-J5, Pin 14
M-J29, Pin 3	Pin 3	Analog Ground	
M-J29, Pin 1	Pin 4	+12 VDC	
M-J29, Pin 2	Pin 5	-12 VDC	

<b>M-J10 is not used. It is a spare analog transducer input.</b>			
<b>Signal Origin</b>	<b>M-J10</b>	<b>Signal Name</b>	<b>Signal Destination</b>
	Pin 1	V14+	M-J5, Pin 17
	Pin 2	V14-	M-J5, Pin 16
M-J29, Pin 3	Pin 3	Analog Ground	
M-J29, Pin 1	Pin 4	+12 VDC	
M-J29, Pin 2	Pin 5	-12 VDC	

<b>M-J11 is not used. It is a spare analog transducer input.</b>			
<b>Signal Origin</b>	<b>M-J11</b>	<b>Signal Name</b>	<b>Signal Destination</b>
	Pin 1	V15+	M-J5, Pin 19
	Pin 2	V15-	M-J5, Pin 20
M-J29, Pin 3	Pin 3	Analog Ground	
M-J29, Pin 1	Pin 4	+12 VDC	
M-J29, Pin 2	Pin 5	-12 VDC	

<b>M-J12 is not used. It is a spare analog transducer input.</b>			
<b>Signal Origin</b>	<b>M-J12</b>	<b>Signal Name</b>	<b>Signal Destination</b>
	Pin 1	V16+	M-J5, Pin 23
	Pin 2	V16-	M-J5, Pin 22
M-J29, Pin 3	Pin 3	Analog Ground	
M-J29, Pin 1	Pin 4	+12 VDC	
M-J29, Pin 2	Pin 5	-12 VDC	

<b>M-J13 is not used. It is intended for general purpose I/O expansion.</b>			
<b>Signal Origin</b>	<b>M-J13</b>	<b>Signal Name</b>	<b>Signal Destination</b>
	Pin 1 ↓ Pin 10	Not Used	M-J35, Pin 17 ↓ M-J35, Pin 26

<b>M-J14 is not used. It is intended for general purpose I/O expansion.</b>			
<b>Signal Origin</b>	<b>M-J14</b>	<b>Signal Name</b>	<b>Signal Destination</b>
	Pin 1 ↓ Pin 26	Not Used	M-J36, Pin 1 ↓ M-J36, Pin 26

<b>M-J20 is not used. It is intended for general purpose I/O expansion.</b>			
<b>Signal Origin</b>	<b>M-J15</b>	<b>Signal Name</b>	<b>Signal Destination</b>
	Pin 1 ↓ Pin 18	Not Used	M-J36, Pin 1 ↓ M-J36, Pin 18

M-J16 is not used. It is intended for general purpose I/O expansion.			
Signal Origin	M-J16	Signal Name	Signal Destination
	Pin 1 ↓ Pin 26	Not Used	M-J37, Pin 1 ↓ M-J37, Pin 26

M-J17 is not used. It is intended for general purpose I/O expansion.			
Signal Origin	M-J17	Signal Name	Signal Destination
	Pin 1 ↓ Pin 18	Not Used	M-J37, Pin 1 ↓ M-J37, Pin 18

M-J18 is not used. It is intended for general purpose I/O expansion.			
Signal Origin	M-J18	Signal Name	Signal Destination
	Pin 1 ↓ Pin 26	Not Used	M-J38, Pin 1 ↓ M-J38, Pin 26

M-J19 is not used. It is intended for general purpose I/O expansion.			
Signal Origin	M-J19	Signal Name	Signal Destination
	Pin 1 ↓ Pin 18	Not Used	M-J38, Pin 1 ↓ M-J38, Pin 18

M-J20 connects to CA-J103.			
Signal Origin	M-J20	Signal Name	Signal Destination
M-J42, Pin 1 P1 ⇒ P5, Pin F	Pin 1	TXD+ /RXD+	M-J42, Pin 1 P1 ⇒ P5, Pin F
M-J42, Pin 2 P1 ⇒ P5, Pin H	Pin 2	TXD- /RXD-	M-J42, Pin 2 P1 ⇒ P5, Pin H
	Pin 3	Not Used	

<b>M-J21 connects to the Pump 1 connector on the Front Tray.</b>			
<b>Signal Origin</b>	<b>M-J21</b>	<b>Signal Name</b>	<b>Signal Destination</b>
	Pin 1 ↓ Pin 4	Logic Ground	
	Pin 5	Pump 1 ID Number	P1, Pin A
	Pin 6		P1, Pin B
	Pin 7		P1, Pin C
	Pin 8		P1, Pin M
M-J41, Pin 11	Pin 9	DI Pump 1 Stop	P1, Pin D
M-J41, Pin 16	Pin 10	DI Pump Stop	P1, Pin E

<b>M-J22 connects to the Pump 2 connector on the Front Tray.</b>			
<b>Signal Origin</b>	<b>M-J22</b>	<b>Signal Name</b>	<b>Signal Destination</b>
	Pin 1 ↓ Pin 4	Logic Ground	
	Pin 5	Pump 2 ID Number	P2, Pin A
	Pin 6		P2, Pin B
	Pin 7		P2, Pin C
	Pin 8		P2, Pin M
M-J41, Pin 12	Pin 9	DI Pump 2 Stop	P2, Pin D
M-J41, Pin 16	Pin 10	DI Pump Stop	P2, Pin E

<b>M-J23 connects to the Pump 3 connector on the Front Tray.</b>			
<b>Signal Origin</b>	<b>M-J23</b>	<b>Signal Name</b>	<b>Signal Destination</b>
	Pin 1 ↓ Pin 4	Logic Ground	
	Pin 5	Pump 3 ID Number	P3, Pin A
	Pin 6		P3, Pin B
	Pin 7		P3, Pin C
	Pin 8		P3, Pin M
M-J41, Pin 13	Pin 9	DI Pump 3 Stop	P3, Pin D
M-J41, Pin 16	Pin 10	DI Pump Stop	P3, Pin E

M-J24 connects to the Pump 4 connector on the Front Tray.			
Signal Origin	M-J24	Signal Name	Signal Destination
	Pin 1 ↓ Pin 4	Logic Ground	
	Pin 5	Pump 4 ID Number	P4, Pin A
	Pin 6		P4, Pin B
	Pin 7		P4, Pin C
	Pin 8		P4, Pin M
M-J41, Pin 14	Pin 9	DI Pump 4 Stop	P4, Pin D
M-J41, Pin 16	Pin 10	DI Pump Stop	P4, Pin E

M-J25 connects to the Pump 5 connector on the Front Tray.			
Signal Origin	M-J25	Signal Name	Signal Destination
	Pin 1 ↓ Pin 4	Logic Ground	
	Pin 5	Pump 5 ID Number	P5, Pin A
	Pin 6		P5, Pin B
	Pin 7		P5, Pin C
	Pin 8		P5, Pin M
M-J41, Pin 15	Pin 9	DI Pump 5 Stop	P5, Pin D
M-J41, Pin 16	Pin 10	DI Pump Stop	P5, Pin E

<b>M-J26 connects to RFP-J1.</b>			
<b>Signal Origin</b>	<b>M-J26</b>	<b>Signal Name</b>	<b>Signal Destination</b>
RFP-J1, Pin 1	Pin 1	BD ON Switch	M-J39, Pin 1
RFP-J1, Pin 2	Pin 2	BD OFF Switch	M-J39, Pin 2
RFP-J1, Pin 3	Pin 3	BD RESET Switch	M-J39, Pin 3
RFP-J1, Pin 4	Pin 4	BD Switch Common	M-J39, Pin 4
M-J39, Pin 5	Pin 5	BD ON LED	RFP-J1, Pin 5
M-J39, Pin 6	Pin 6	BD OFF LED	RFP-J1, Pin 6
M-J39, Pin 7	Pin 7	BD Air Detect LED	RFP-J1, Pin 7
M-J39, Pin 8	Pin 8	BD LED Common	RFP-J1, Pin 8
RFP-J1, Pin 9	Pin 9	LD ON Switch	M-J40, Pin 1
RFP-J1, Pin 10	Pin 10	LD OFF Switch	M-J40, Pin 2
RFP-J1, Pin 11	Pin 11	LD RESET Switch	M-J40, Pin 3
RFP-J1, Pin 12	Pin 12	LD Switch Common	M-J40, Pin 4
M-J40, Pin 5	Pin 13	LD ON LED	RFP-J1, Pin 13
M-J40, Pin 6	Pin 14	LD OFF LED	RFP-J1, Pin 14
M-J40, Pin 7	Pin 15	LD Low Level Alert LED	RFP-J1, Pin 15
M-J40, Pin 8	Pin 16	LD Probe Disconnected LED	RFP-J1, Pin 16
M-J40, Pin 9	Pin 17	LD Low Level Alert LED	RFP-J1, Pin 17
M-J40, Pin 10	Pin 18	LD LED Common	RFP-J1, Pin 18
M-J41, Pin 20	Pin 19	Bat Power Status LED	RFP-J1, Pin 19
M-J41, Pin 21	Pin 20	Bat Power Status LED	RFP-J1, Pin 20

<b>M-J27 connects to the Gas Solenoid.</b>			
<b>Signal Origin</b>	<b>M-J27</b>	<b>Signal Name</b>	<b>Signal Destination</b>
M-J41, Pin 1	Pin 1	DI Switch 1	
M-J41, Pin 2	Pin 2	DI Switch 1	
M-J41, Pin 3	Pin 3	DI SOL1 Common	SOL, Pin 2
M-J41, Pin 4	Pin 4	+24 VDC	SOL, Pin 1
M-J30, Pin 2	Pin 5	Power System Ground	

<b>M-J28 connects to LFP-J1.</b>			
<b>Signal Origin</b>	<b>M-J28</b>	<b>Signal Name</b>	<b>Signal Destination</b>
LFP-J1, Pin 1	Pin 1	Occ Phase Sense A	M-J42, Pin 5
LFP-J1, Pin 2	Pin 2	Occ Phase Sense B	M-J42, Pin 6
LFP-J1, Pin 3	Pin 3	Occ Open Switch	M-J42, Pin 7
LFP-J1, Pin 4	Pin 4	Occ Close Switch	M-J42, Pin 8
LFP-J1, Pin 5	Pin 5	Occ Manual Switch	M-J42, Pin 9
LFP-J1, Pin 6	Pin 6	Occ Auto Switch	M-J42, Pin 10
M-J42, Pin 11	Pin 7	Occ Manual LED	LFP-J1, Pin 7
M-J42, Pin 12	Pin 8	Occ Auto LED	LFP-J1, Pin 8
M-J29, Pin 4	Pin 9	+5 VDC	LFP-J1, Pin 9
M-J29, Pin 4	Pin 10	+5 VDC	LFP-J1, Pin 10
M-J29, Pin 5	Pin 11	Common	LFP-J1, Pin 11
M-J29, Pin 5	Pin 12	Common	LFP-J1, Pin 12
M-J42, Pin 13	Pin 13	Occ MSD 3	LFP-J1, Pin 13
M-J42, Pin 14	Pin 14	Occ MSD 2	LFP-J1, Pin 14
M-J42, Pin 15	Pin 15	Occ MSD 1	LFP-J1, Pin 15
M-J42, Pin 16	Pin 16	Occ MSD 0	LFP-J1, Pin 16
M-J42, Pin 17	Pin 17	Occ LSD 3	LFP-J1, Pin 17
M-J42, Pin 18	Pin 18	Occ LSD 1	LFP-J1, Pin 18
M-J42, Pin 19	Pin 19	Occ LSD 2	LFP-J1, Pin 19
M-J42, Pin 20	Pin 20	Occ LSD 0	LFP-J1, Pin 20
	Pin 21	Not Used	
LFP-J1, Pin 22	Pin 22	Gas Start Switch	M-J42, Pin 22
LFP-J1, Pin 23	Pin 23	Gas Stop Switch	M-J42, Pin 23
LFP-J1, Pin 24	Pin 24	Gas Switch Common	M-J42, Pin 24
M-J42, Pin 25	Pin 25	Gas ON LED	LFP-J1, Pin 25
M-J42, Pin 26	Pin 26	Gas ON LED Common	LFP-J1, Pin 26

M-J29 connects to PC-J3 and the +5V DC/DC Converter.			
Signal Origin	M-J29	Signal Name	Signal Destination
PC-J3, Pin 1	Pin 1	+12 VDC	M-J31 → M-J42, Pin 29 M-J6 → M-J8, Pin 7 M-J9 → M-J12, Pin 4
PC-J3, Pin 2	Pin 2	-12 VDC	M-J31 → M-J42, Pin 31 M-J6 → M-J8, Pin 12 M-J9 → M-J12, Pin 5
PC-J3, Pin 3	Pin 3	Analog Ground	M-J31 → M-J42, Pins 27 and 28 M-J6 → M-J8, Pin 6 M-J9 → M-J12, Pin 3 M-J43, Pin 1
+5V DC/DC Converter	Pin 4	+5 VDC	M-J31 → M-J42, Pins 53 and 54 M-J4, Pins 17 and 18 M-J28, Pins 9 and 10
+5V DC/DC Converter	Pin 5	Digital Ground	M-J31 → M-J42, Pins 55 and 56 M-J4, Pins 19 and 20 M-J28, Pins 11 and 12
	Pin 6	Not Used	

M-J30 connects to PD-J5.			
Signal Origin	M-J30	Signal Name	Signal Destination
PD-J5, Pin 1	Pin 1	+24 VDC	M-J41, Pin 18 M-J42, Pins 41 → 46 M-J27, Pin 4
PD-J5, Pin 2	Pin 2	Power System Ground	M-J42, Pins 47 → 52 M-J27, Pin 5

M-J31 connects to Temperature Module 1.			
Signal Origin	M-J31	Signal Name	Signal Destination
	Pin 1 ↓ Pin 18	Not Used	
	Pin 19	Transmit Data 1	M-J3, Pin 13
	Pin 20	Transmit Source 1	M-J3, Pin 14
	Pin 21	Receive Data 1	M-J3, Pin 15
	Pin 22	Receive Source 1	M-J3, Pin 16
	Pin 23 ↓ Pin 26	Not Used	
M-J29, Pin 3	Pin 27	Analog Ground	
M-J29, Pin 3	Pin 28	Analog Ground	
M-J29, Pin 1	Pin 29	+12 VDC	
M-J5, Pin 11	Pin 30	+ Analog Input	
M-J29, Pin 2	Pin 31	-12 VDC	
M-J5, Pin 10	Pin 32	- Analog Input	
M-J2, Pin 20	Pin 33	Auxiliary Bus Signal 1	
M-J2, Pin 18	Pin 34	Auxiliary Bus Signal 2	
M-J2, Pin 16	Pin 35	Auxiliary Bus Signal 3	
M-J2, Pin 14	Pin 36	Auxiliary Bus Signal 4	
M-J2, Pin 12	Pin 37	Auxiliary Bus Signal 5	
M-J2, Pin 10	Pin 38	Auxiliary Bus Signal 6	
M-J2, Pin 8	Pin 39	Auxiliary Bus Signal 7	
M-J2, Pin 6	Pin 40	Auxiliary Bus Signal 8	
M-J2, Pin 40	Pin 41	Multiplexed Address 0	
M-J2, Pin 38	Pin 42	Multiplexed Address 1	
M-J2, Pin 36	Pin 43	Multiplexed Address 2	
M-J2, Pin 34	Pin 44	Multiplexed Address 3	
M-J2, Pin 32	Pin 45	Multiplexed Address 4	
M-J2, Pin 30	Pin 46	Multiplexed Address 5	
M-J2, Pin 28	Pin 47	Multiplexed Address 6	
M-J2, Pin 26	Pin 48	Multiplexed Address 7	
M-J1, Pin 8	Pin 49	Data Write Clock	
M-J1, Pin 10	Pin 50	Data Read Clock	
M-J1, Pin 6	Pin 51	Address Strobe	
M-J1, Pin 40	Pin 52	Card Select 1	
M-J29, Pin 4	Pin 53	+5 VDC	
M-J29, Pin 4	Pin 54	+5 VDC	
M-J29, Pin 5	Pin 55	Logic Ground	
M-J29, Pin 5	Pin 56	Logic Ground	

<b>M-J32 connects to Temperature Module 2.</b>			
<b>Signal Origin</b>	<b>M-J32</b>	<b>Signal Name</b>	<b>Signal Destination</b>
	Pin 1 ↓ Pin 18	Not Used	
	Pin 19	Transmit Data 2	M-J3, Pin 9
	Pin 20	Transmit Source 2	M-J3, Pin 10
	Pin 21	Receive Data 2	M-J3, Pin 11
	Pin 22	Receive Source 2	M-J3, Pin 12
	Pin 23 ↓ Pin 26	Not Used	
M-J29, Pin 3	Pin 27	Analog Ground	
M-J29, Pin 3	Pin 28	Analog Ground	
M-J29, Pin 1	Pin 29	+12 VDC	
M-J5, Pin 11	Pin 30	+ Analog Input	
M-J29, Pin 2	Pin 31	-12 VDC	
M-J5, Pin 10	Pin 32	- Analog Input	
M-J2, Pin 20	Pin 33	Auxiliary Bus Signal 1	
M-J2, Pin 18	Pin 34	Auxiliary Bus Signal 2	
M-J2, Pin 16	Pin 35	Auxiliary Bus Signal 3	
M-J2, Pin 14	Pin 36	Auxiliary Bus Signal 4	
M-J2, Pin 12	Pin 37	Auxiliary Bus Signal 5	
M-J2, Pin 10	Pin 38	Auxiliary Bus Signal 6	
M-J2, Pin 8	Pin 39	Auxiliary Bus Signal 7	
M-J2, Pin 6	Pin 40	Auxiliary Bus Signal 8	
M-J2, Pin 40	Pin 41	Multiplexed Address 0	
M-J2, Pin 38	Pin 42	Multiplexed Address 1	
M-J2, Pin 36	Pin 43	Multiplexed Address 2	
M-J2, Pin 34	Pin 44	Multiplexed Address 3	
M-J2, Pin 32	Pin 45	Multiplexed Address 4	
M-J2, Pin 30	Pin 46	Multiplexed Address 5	
M-J2, Pin 28	Pin 47	Multiplexed Address 6	
M-J2, Pin 26	Pin 48	Multiplexed Address 7	
M-J1, Pin 8	Pin 49	Data Write Clock	
M-J1, Pin 10	Pin 50	Data Read Clock	
M-J1, Pin 6	Pin 51	Address Strobe	
M-J1, Pin 38	Pin 52	Card Select 2	
M-J29, Pin 4	Pin 53	+5 VDC	
M-J29, Pin 4	Pin 54	+5 VDC	
M-J29, Pin 5	Pin 55	Logic Ground	
M-J29, Pin 5	Pin 56	Logic Ground	

M-J33 is not used. It is intended for general purpose I/O expansion.			
Signal Origin	M-J33	Signal Name	Signal Destination
	Pin 1 ↓ Pin 56	Not Used	

M-J34 connects to the Pressure Module.			
Signal Origin	M-J34	Signal Name	Signal Destination
M-J29, Pin 3	Pin 1	Analog Ground	
	Pin 2	V1+	M-J5, Pin 25
M-J29, Pin 3	Pin 3	Analog Ground	
	Pin 4	V1-	M-J5, Pin 26
M-J29, Pin 3	Pin 5	Analog Ground	
	Pin 6	V2+	M-J5, Pin 29
M-J29, Pin 3	Pin 7	Analog Ground	
	Pin 8	V2-	M-J5, Pin 28
M-J29, Pin 3	Pin 9	Analog Ground	
	Pin 10	V3+	M-J5, Pin 31
M-J29, Pin 3	Pin 11	Analog Ground	
	Pin 12	V3-	M-J5, Pin 32
M-J29, Pin 3	Pin 13	Analog Ground	
	Pin 14	V4+	M-J5, Pin 35
M-J29, Pin 3	Pin 15	Analog Ground	
	Pin 16	V4-	M-J5, Pin 34
	Pin 17 ↓ Pin 26	Not Used	
M-J29, Pin 3	Pin 27	Analog Ground	
M-J29, Pin 3	Pin 28	Analog Ground	
M-J29, Pin 1	Pin 29	+12 VDC	
M-J5, Pin 11	Pin 30	+ Analog Input	
M-J29, Pin 2	Pin 31	-12 VDC	
M-J5, Pin 10	Pin 32	- Analog Input	
M-J2, Pin 20	Pin 33	Auxiliary Bus Signal 1	
M-J2, Pin 18	Pin 34	Auxiliary Bus Signal 2	
M-J2, Pin 16	Pin 35	Auxiliary Bus Signal 3	
M-J2, Pin 14	Pin 36	Auxiliary Bus Signal 4	
M-J2, Pin 12	Pin 37	Auxiliary Bus Signal 5	
M-J2, Pin 10	Pin 38	Auxiliary Bus Signal 6	
M-J2, Pin 8	Pin 39	Auxiliary Bus Signal 7	
M-J2, Pin 6	Pin 40	Auxiliary Bus Signal 8	
M-J2, Pin 40	Pin 41	Multiplexed Address 0	
M-J2, Pin 38	Pin 42	Multiplexed Address 1	
M-J2, Pin 36	Pin 43	Multiplexed Address 2	
M-J2, Pin 34	Pin 44	Multiplexed Address 3	
M-J2, Pin 32	Pin 45	Multiplexed Address 4	
M-J2, Pin 30	Pin 46	Multiplexed Address 5	
M-J2, Pin 28	Pin 47	Multiplexed Address 6	
M-J2, Pin 26	Pin 48	Multiplexed Address 7	
M-J1, Pin 8	Pin 49	Data Write Clock	
M-J1, Pin 10	Pin 50	Data Read Clock	
M-J1, Pin 6	Pin 51	Address Strobe	
M-J1, Pin 34	Pin 52	Card Select 4	
M-J29, Pin 4	Pin 53	+5 VDC	
M-J29, Pin 4	Pin 54	+5 VDC	
M-J29, Pin 5	Pin 55	Logic Ground	
M-J29, Pin 5	Pin 56	Logic Ground	

M-J35 is not used. It is intended for general purpose I/O expansion.			
Signal Origin	M-J35	Signal Name	Signal Destination
	Pin 1 ↓ Pin 56	Not Used	

M-J36 is not used. It is intended for general purpose I/O expansion.			
Signal Origin	M-J36	Signal Name	Signal Destination
	Pin 1 ↓ Pin 56	Not Used	

M-J37 is not used. It is intended for general purpose I/O expansion.			
Signal Origin	M-J37	Signal Name	Signal Destination
	Pin 1 ↓ Pin 56	Not Used	

M-J38 is not used. It is intended for general purpose I/O expansion.			
Signal Origin	M-J38	Signal Name	Signal Destination
	Pin 1 ↓ Pin 56	Not Used	

<b>M-J39 connects to the Air Detection Module.</b>			
<b>Signal Origin</b>	<b>M-J39</b>	<b>Signal Name</b>	<b>Signal Destination</b>
M-J26, Pin 1	Pin 1	BD ON Switch	
M-J26, Pin 2	Pin 2	BD OFF Switch	
M-J26, Pin 3	Pin 3	BD Reset Switch	
M-J26, Pin 4	Pin 4	BD Switch Common	
	Pin 5	BD ON LED	M-J26, Pin 5
	Pin 6	BD OFF LED	M-J26, Pin 6
	Pin 7	BD Air Detected LED	M-J26, Pin 7
	Pin 8	BD LED Common	M-J26, Pin 8
	Pin 9 & Pin 26	Not Used	
M-J29, Pin 3	Pin 27	Analog Ground	
M-J29, Pin 3	Pin 28	Analog Ground	
M-J29, Pin 1	Pin 29	+12 VDC	
M-J5, Pin 11	Pin 30	+ Analog Input	
M-J29, Pin 2	Pin 31	-12 VDC	
M-J5, Pin 10	Pin 32	- Analog Input	
M-J2, Pin 20	Pin 33	Auxiliary Bus Signal 1	
M-J2, Pin 18	Pin 34	Auxiliary Bus Signal 2	
M-J2, Pin 16	Pin 35	Auxiliary Bus Signal 3	
M-J2, Pin 14	Pin 36	Auxiliary Bus Signal 4	
M-J2, Pin 12	Pin 37	Auxiliary Bus Signal 5	
M-J2, Pin 10	Pin 38	Auxiliary Bus Signal 6	
M-J2, Pin 8	Pin 39	Auxiliary Bus Signal 7	
M-J2, Pin 6	Pin 40	Auxiliary Bus Signal 8	
M-J2, Pin 40	Pin 41	Multiplexed Address 0	
M-J2, Pin 38	Pin 42	Multiplexed Address 1	
M-J2, Pin 36	Pin 43	Multiplexed Address 2	
M-J2, Pin 34	Pin 44	Multiplexed Address 3	
M-J2, Pin 32	Pin 45	Multiplexed Address 4	
M-J2, Pin 30	Pin 46	Multiplexed Address 5	
M-J2, Pin 28	Pin 47	Multiplexed Address 6	
M-J2, Pin 26	Pin 48	Multiplexed Address 7	
M-J1, Pin 8	Pin 49	Data Write Clock	
M-J1, Pin 10	Pin 50	Data Read Clock	
M-J1, Pin 6	Pin 51	Address Strobe	
M-J1, Pin 20	Pin 52	Card Select 9	
M-J29, Pin 4	Pin 53	+5 VDC	
M-J29, Pin 4	Pin 54	+5 VDC	
M-J29, Pin 5	Pin 55	Logic Ground	
M-J29, Pin 5	Pin 56	Logic Ground	

M-J40 connects to the Level Detection Module.			
Signal Origin	M-J40	Signal Name	Signal Destination
M-J26, Pin 9	Pin 1	LD ON Switch	
M-J26, Pin 10	Pin 2	LD OFF Switch	
M-J26, Pin 11	Pin 3	LD Reset Switch	
M-J26, Pin 12	Pin 4	LD Switch Common	
	Pin 5	LD ON LED	M-J26, Pin 13
	Pin 6	LD OFF LED	M-J26, Pin 14
	Pin 7	LD Low Level Alert LED	M-J26, Pin 15
	Pin 8	LD Probe Disconnected LED	M-J26, Pin 16
	Pin 9	LD Low Level Alarm LED	M-J26, Pin 17
	Pin 10	LD LED Common	M-J26, Pin 18
	Pin 11 ↓ Pin 26	Not Used	
M-J29, Pin 3	Pin 27	Analog Ground	
M-J29, Pin 3	Pin 28	Analog Ground	
M-J29, Pin 1	Pin 29	+12 VDC	
M-J5, Pin 11	Pin 30	+ Analog Input	
M-J29, Pin 2	Pin 31	-12 VDC	
M-J5, Pin 10	Pin 32	- Analog Input	
M-J2, Pin 20	Pin 33	Auxiliary Bus Signal 1	
M-J2, Pin 18	Pin 34	Auxiliary Bus Signal 2	
M-J2, Pin 16	Pin 35	Auxiliary Bus Signal 3	
M-J2, Pin 14	Pin 36	Auxiliary Bus Signal 4	
M-J2, Pin 12	Pin 37	Auxiliary Bus Signal 5	
M-J2, Pin 10	Pin 38	Auxiliary Bus Signal 6	
M-J2, Pin 8	Pin 39	Auxiliary Bus Signal 7	
M-J2, Pin 6	Pin 40	Auxiliary Bus Signal 8	
M-J2, Pin 40	Pin 41	Multiplexed Address 0	
M-J2, Pin 38	Pin 42	Multiplexed Address 1	
M-J2, Pin 36	Pin 43	Multiplexed Address 2	
M-J2, Pin 34	Pin 44	Multiplexed Address 3	
M-J2, Pin 32	Pin 45	Multiplexed Address 4	
M-J2, Pin 30	Pin 46	Multiplexed Address 5	
M-J2, Pin 28	Pin 47	Multiplexed Address 6	
M-J2, Pin 26	Pin 48	Multiplexed Address 7	
M-J1, Pin 8	Pin 49	Data Write Clock	
M-J1, Pin 10	Pin 50	Data Read Clock	
M-J1, Pin 6	Pin 51	Address Strobe	
M-J1, Pin 18	Pin 52	Card Select 10	
M-J29, Pin 4	Pin 53	+5 VDC	
M-J29, Pin 4	Pin 54	+5 VDC	
M-J29, Pin 5	Pin 55	Logic Ground	
M-J29, Pin 5	Pin 56	Logic Ground	

M-J41 connects to the Digital Interface Module.			
Signal Origin	M-J41	Signal Name	Signal Destination
	Pin 1	DI Switch 1	M-J27, Pin 1
	Pin 2	DI Switch 2	M-J27, Pin 2
	Pin 3	DI Solenoid	M-J27, Pin 3
	Pin 4	+24 VDC	M-J27, Pin 4
	Pin 5 Pin 6	Not Used	
	Pin 9	DI External Alarm	M-J43, Pin 2
	Pin 10	Not Used	
	Pin 11	DI Pump 1 Stop	M-J21, Pin 9
	Pin 12	DI Pump 2 Stop	M-J22, Pin 9
	Pin 13	DI Pump 3 Stop	M-J23, Pin 9
	Pin 14	DI Pump 4 Stop	M-J24, Pin 9
	Pin 15	DI Pump 5 Stop	M-J25, Pin 9
	Pin 16	DI Pump Stop	M-J21 = M-J25, Pin 10
	Pin 17	Not Used	
M-J30, Pin 1	Pin 18	+24 VDC	
	Pin 19	Not Used	
	Pin 20	DI Battery Power LED Source	M-J26, Pin 19
	Pin 21	DI Battery Power LED Sink	M-J26, Pin 20
M-J28, Pin 22	Pin 22	DI Gas Start Switch	
M-J28, Pin 23	Pin 23	DI Gas Stop Switch	
M-J28, Pin 24	Pin 24	DI Gas Switch Common	
	Pin 25	DI Gas LED	M-J28, Pin 25
	Pin 26	DI Gas LED Common	M-J28, Pin 26
M-J29, Pin 3	Pin 27	Analog Ground	
M-J29, Pin 3	Pin 28	Analog Ground	
M-J28, Pin 1	Pin 29	+12 VDC	
M-J5, Pin 11	Pin 30	+ Analog Input	
M-J29, Pin 2	Pin 31	-12 VDC	
M-J5, Pin 10	Pin 32	- Analog Input	
M-J2, Pin 20	Pin 33	Auxiliary Bus Signal 1	
M-J2, Pin 18	Pin 34	Auxiliary Bus Signal 2	
M-J2, Pin 16	Pin 35	Auxiliary Bus Signal 3	
M-J2, Pin 14	Pin 36	Auxiliary Bus Signal 4	
M-J2, Pin 12	Pin 37	Auxiliary Bus Signal 5	
M-J2, Pin 10	Pin 38	Auxiliary Bus Signal 6	
M-J2, Pin 8	Pin 39	Auxiliary Bus Signal 7	
M-J2, Pin 6	Pin 40	Auxiliary Bus Signal 8	
M-J2, Pin 40	Pin 41	Multiplexed Address 0	
M-J2, Pin 38	Pin 42	Multiplexed Address 1	
M-J2, Pin 36	Pin 43	Multiplexed Address 2	
M-J2, Pin 34	Pin 44	Multiplexed Address 3	
M-J2, Pin 32	Pin 45	Multiplexed Address 4	
M-J2, Pin 30	Pin 46	Multiplexed Address 5	
M-J2, Pin 28	Pin 47	Multiplexed Address 6	
M-J2, Pin 26	Pin 48	Multiplexed Address 7	
M-J1, Pin 8	Pin 49	Data Write Clock	
M-J1, Pin 10	Pin 50	Data Read Clock	
M-J1, Pin 6	Pin 51	Address Strobe	
M-J1, Pin 16	Pin 52	Card Select 11	
M-J29, Pin 4	Pin 53	+5 VDC	
M-J29, Pin 4	Pin 54	+5 VDC	
M-J29, Pin 5	Pin 55	Logic Ground	
M-J29, Pin 5	Pin 56	Logic Ground	

M-J42 connects to the Occluder Module.			
Signal Origin	M-J42	Signal Name	Signal Destination
	Pin 1	TXD+ /RXD+	
	Pin 2	TXD- /RXD-	
	Pin 3	Not Used	
	Pin 4	Not Used	
M-J28, Pin 1	Pin 5	Occ Phase Sense A	
M-J28, Pin 2	Pin 6	Occ Phase Sense B	
M-J28, Pin 3	Pin 7	Occ Open Switch	
M-J28, Pin 4	Pin 8	Occ Close Switch	
M-J28, Pin 5	Pin 9	Occ Manual Switch	
M-J28, Pin 6	Pin 10	Occ Auto Switch	
	Pin 11	Occ ON LED	M-J28, Pin 7
	Pin 12	Occ OFF LED	M-J28, Pin 8
	Pin 13	Occ MSD 3	M-J28, Pin 13
	Pin 14	Occ MSD 2	M-J28, Pin 14
	Pin 15	Occ MSD 1	M-J28, Pin 15
	Pin 16	Occ MSD 0	M-J28, Pin 16
	Pin 17	Occ LSD 3	M-J28, Pin 17
	Pin 18	Occ LSD 2	M-J28, Pin 18
	Pin 19	Occ LSD 1	M-J28, Pin 19
	Pin 20	Occ LSD 0	M-J28, Pin 20
	Pin 21 ↓ Pin 32	Not Used	
M-J2, Pin 20	Pin 33	Auxiliary Bus Signal 1	
M-J2, Pin 18	Pin 34	Auxiliary Bus Signal 2	
M-J2, Pin 16	Pin 35	Auxiliary Bus Signal 3	
M-J2, Pin 14	Pin 36	Auxiliary Bus Signal 4	
M-J2, Pin 12	Pin 37	Auxiliary Bus Signal 5	
M-J2, Pin 10	Pin 38	Auxiliary Bus Signal 6	
M-J2, Pin 8	Pin 39	Auxiliary Bus Signal 7	
M-J2, Pin 6	Pin 40	Auxiliary Bus Signal 8	
M-J30, Pin 1	Pin 41	+24 VDC	
M-J30, Pin 1	Pin 42	+24 VDC	
M-J30, Pin 1	Pin 43	+24 VDC	
M-J30, Pin 1	Pin 44	+24 VDC	
M-J30, Pin 1	Pin 45	+24 VDC	
M-J30, Pin 1	Pin 46	+24 VDC	
M-J30, Pin 2	Pin 47	Power System Common	
M-J30, Pin 2	Pin 48	Power System Common	
M-J30, Pin 2	Pin 49	Power System Common	
M-J30, Pin 2	Pin 50	Power System Common	
M-J30, Pin 2	Pin 51	Power System Common	
M-J30, Pin 2	Pin 52	Power System Common	
M-J29, Pin 4	Pin 53	+5 VDC	
M-J29, Pin 4	Pin 54	+5 VDC	
M-J29, Pin 5	Pin 55	Logic Ground	
M-J29, Pin 5	Pin 56	Logic Ground	

M-J43 connects to the Sonalert.			
Signal Origin	M-J43	Signal Name	Signal Destination
M-J29, Pin 3	Pin 1	Analog Common	Sonalert
M-J41, Pin 9	Pin 2	External Alarm Power	Sonalert
	Pin 3	Not Used	

M-J44 is not used.			
Signal Origin	M-J44	Signal Name	Signal Destination
	Pin 1 ↓ Pin 5	Not Used	

Signal Origin	PD-J1	Signal Name	Signal Destination
C-J2, Pin 3	Pin 1	Power Supply 1 Common	
C-J1, Pin 1	Pin 2	Power Supply 2 Common	
C-J1, Pin 8	Pin 3	Power Supply 3 Common	
C-J2, Pin 6	Pin 4	Power Supply 1 Common	
C-J1, Pin 2	Pin 5	Power Supply 2 Common	
C-J1, Pin 9	Pin 6	Power Supply 3 Common	
C-J2, Pin 1	Pin 7	24-36 VDC	
C-J1, Pin 3	Pin 8	24-36 VDC	
C-J1, Pin 4	Pin 9	24-36 VDC	
C-J2, Pin 4	Pin 10	24-36 VDC	
C-J1, Pin 6	Pin 11	24-36 VDC	
C-J1, Pin 7	Pin 12	24-36 VDC	

Signal Origin	PD-J2
Negative lead of right-hand battery.	Pin 1
	Pin 2
	Pin 3

Signal Origin	PD-J3	Signal Name	Signal Destination
	Pin 1	24-36 VDC	CBIN, Pin 1
	Pin 2	24-36 VDC	CBIN, Pin 2
	Pin 3	24-36 VDC	CBIN, Pin 3
	Pin 4	24-36 VDC	CBIN, Pin 4
	Pin 5	Not Used	
	Pin 6	24-36 VDC	CBIN, Pin 6
	Pin 7	24-36 VDC	CBIN, Pin 7
	Pin 8	Not Used	
	Pin 9	24-36 VDC	CBIN, Pin 9
	Pin 10	24-36 VDC	CBIN, Pin 10
	Pin 11	24-36 VDC	CBIN, Pin 11
	Pin 12	24-36 VDC	CBIN, Pin 12

Signal Origin	PD-J4	Signal Name	Signal Destination
CBOUT, Pin 1	Pin 1	24-36 VDC	
CBOUT, Pin 2	Pin 2	24-36 VDC	
CBOUT, Pin 3	Pin 3	24-36 VDC	
CBOUT, Pin 4	Pin 4	24-36 VDC	
	Pin 5	Not Used	
CBOUT, Pin 6	Pin 6	24-36 VDC	
CBOUT, Pin 7	Pin 7	24-36 VDC	
	Pin 8	Not Used	
CBOUT, Pin 9	Pin 9	24-36 VDC	
CBOUT, Pin 10	Pin 10	24-36 VDC	
CBOUT, Pin 11	Pin 11	24-36 VDC	
CBOUT, Pin 12	Pin 12	24-36 VDC	

Signal Origin	PD-J5	Signal Name	Signal Destination
	Pin 1	24-36 VDC	M-J30, Pin 1
	Pin 2	Power Common	M-J30, Pin 2

Signal Origin	PD-J6	Signal Name	Signal Destination
	Pin 1	24-36 VDC	Not Used
	Pin 2	Power Common	Not Used

Signal Origin	PD-J7	Signal Name	Signal Destination
	Pin 1	24-36 VDC	P5, Pin J
	Pin 2	Power Common	P5, Pin K

Signal Origin	PD-J8	Signal Name	Signal Destination
	Pin 1	24-36 VDC	P4, Pin J
	Pin 2	Power Common	P4, Pin K

Signal Origin	PD-J9	Signal Name	Signal Destination
	Pin 1	24-36 VDC	P3, Pin J
	Pin 2	Power Common	P3, Pin K

Signal Origin	PD-J10	Signal Name	Signal Destination
	Pin 1	24-36 VDC	P2, Pin J
	Pin 2	Power Common	P2, Pin K

Signal Origin	PD-J11	Signal Name	Signal Destination
	Pin 1	24-36 VDC	P1, Pin J
	Pin 2	Power Common	P1, Pin K

Signal Origin	PD-J12	Signal Name	Signal Destination
	Pin 1	24-36 VDC	Not Used
	Pin 2	Power Common	Not Used

Signal Origin	PD-J13	Signal Name	Signal Destination
	Pin 1	24-36 VDC	
	Pin 2	Power Common	

Signal Origin	PD-J14	Signal Name	Signal Destination
	Pin 1	24-36 VDC	Auxiliary Outlet and Lamp
	Pin 2	Power Common	

Signal Origin	PD-J15	Signal Name	Signal Destination
	Pin 1	24-36 VDC	+12V DC/DC Convertor
	Pin 2	Power Common	

Signal Origin	PD-J16	Signal Name	Signal Destination
	Pin 1	24-36 VDC	+5V DC/DC Convertor
	Pin 2	Power Common	

PD-J17	Signal Destination
Pin 1	Shorted to Pin 2 when Main Breaker is ON.
Pin 2	Shorted to Pin 1 when Main Breaker is ON.

Signal Origin	PD-J18	Signal Name	Signal Destination
	Pin 1	Regulator In	Battery Charger Regulator
	Pin 2	Regulator Out	
	Pin 3	Regulator Adjust	

PD-J19	Signal Destination
Pin 1	Main Battery Fuse.
Pin 2	
Pin 3	

Signal Origin	PD-J20	Signal Name	Signal Destination
	Pin 1	AC Line (60 VAC +/- 5 VAC)	Battery Charger Transformer
	Pin 2	Battery Charger Ground	
	Pin 3	AC Return	

Signal Origin	PD-J21	Signal Name	Signal Destination
	Pin 1	24-36 VDC Uninterruptible Power	PC-J2, Pin 1
	Pin 2	24-36 VDC Uninterruptible Power	PC-J2, Pin 2
	Pin 3	Power System Ground	PC-J2, Pin 3
	Pin 4	24-36 VDC DC/DC Converter Power	PC-J2, Pin 4
	Pin 5	Power System Ground	PC-J2, Pin 5
	Pin 6	24-36 VDC DC/DC Converter Power	PC-J2, Pin 6
	Pin 7	Power System Ground	PC-J2, Pin 7
	Pin 8	Power System Ground	PC-J2, Pin 8
	Pin 9	24-36 VDC Switched Battery Power	PC-J2, Pin 9
	Pin 10	Power System Ground	PC-J2, Pin 10
	Pin 11	24-36 VDC Switched Battery Power	PC-J2, Pin 11
	Pin 12	Power System Ground	PC-J2, Pin 12
	Pin 13	24-36 VDC Switched Battery Power	PC-J2, Pin 13
	Pin 14	Power System Ground	PC-J2, Pin 14
	Pin 15	24-36 VDC PS1 Reference Voltage	PC-J2, Pin 15
	Pin 16	24-36 VDC PS2 Reference Voltage	PC-J2, Pin 16
	Pin 17	24-36 VDC PS3 Reference Voltage	PC-J2, Pin 17
	Pin 18	24-36 VDC PS Reference Voltage	PC-J2, Pin 18
	Pin 19	24-36 VDC PS1 Auxiliary Switch	PC-J2, Pin 19
	Pin 20	24-36 VDC PS2 Auxiliary Switch	PC-J2, Pin 20
	Pin 21	24-36 VDC PS Battery Switch	PC-J2, Pin 21
	Pin 22	Battery ON Signal	PC-J2, Pin 22
	Pin 23	Battery Charger Float LED	PC-J2, Pin 23
	Pin 24	Battery Charger Constant Voltage LED	PC-J2, Pin 24
	Pin 25	Battery Charger Constant Current LED	PC-J2, Pin 25
	Pin 26	30 VAC +/- 5 VAC Battery Charger Voltage	PC-J2, Pin 26

PD-J22	Signal Name
Pin 1	+15 VDC
Pin 2	2.5 VDC Reference Voltage
Pin 3	Not Used
Pin 4	Power Regulator Input: 40 VAC
Pin 5	Power Regulator Output: 27.85 VDC +/- 0.05 VDC with 60 VAC fused out
Pin 6	Battery Charger Ground

Signal Origin	PC-J1	Signal Name	Signal Destination
	Pin 1	24-36 VDC	RFP-J2, Pin 1
	Pin 2	PS1 Fail LED	RFP-J2, Pin 2
	Pin 3	24-36 VDC	RFP-J2, Pin 3
	Pin 4	PS2 Fail LED	RFP-J2, Pin 4
	Pin 5	24-36 VDC	RFP-J2, Pin 5
	Pin 6	PS3 Fail LED	RFP-J2, Pin 6
	Pin 7	24-36 VDC	RFP-J2, Pin 7
	Pin 8	Battery Power Status LED	RFP-J2, Pin 8
	Pin 9	24-36 VDC	RFP-J2, Pin 9
	Pin 10	AC Power Status LED	RFP-J2, Pin 10
	Pin 11	24-36 VDC	RFP-J2, Pin 11
	Pin 12	Charger Float LED	RFP-J2, Pin 12
	Pin 13	24-36 VDC	RFP-J2, Pin 13
	Pin 14	Charger Constant Voltage LED	RFP-J2, Pin 14
	Pin 15	24-36 VDC	RFP-J2, Pin 15
	Pin 16	Charger Constant Current LED	RFP-J2, Pin 16
	Pin 17	24-36 VDC	
	Pin 18	24-36 VDC	
	Pin 19	Power System Common	
	Pin 20	Power System Common	

Signal Origin	PC-J2	Signal Name	Signal Destination
PD-J21, Pin 1	Pin 1	24-36 VDC Uninterruptible Power	
PD-J21, Pin 2	Pin 2	24-36 VDC Uninterruptible Power	
PD-J21, Pin 3	Pin 3	Power System Ground	
PD-J21, Pin 4	Pin 4	24-36 VDC DC/DC Converter Power	
PD-J21, Pin 5	Pin 5	Power System Ground	
PD-J21, Pin 6	Pin 6	24-36 VDC DC/DC Converter Power	
PD-J21, Pin 7	Pin 7	Power System Ground	
PD-J21, Pin 8	Pin 8	Power System Ground	
PD-J21, Pin 9	Pin 9	24-36 VDC Switched Battery Power	
PD-J21, Pin 10	Pin 10	Power System Ground	
PD-J21, Pin 11	Pin 11	24-36 VDC Switched Battery Power	
PD-J21, Pin 12	Pin 12	Power System Ground	
PD-J21, Pin 13	Pin 13	24-36 VDC Switched Battery Power	
PD-J21, Pin 14	Pin 14	Power System Ground	
PD-J21, Pin 15	Pin 15	24-36 VDC PS1 Reference Voltage	
PD-J21, Pin 16	Pin 16	24-36 VDC PS2 Reference Voltage	
PD-J21, Pin 17	Pin 17	24-36 VDC PS3 Reference Voltage	
PD-J21, Pin 18	Pin 18	24-36 VDC PS Reference Voltage	
PD-J21, Pin 19	Pin 19	24-36 VDC PS1 Auxiliary Switch	
PD-J21, Pin 20	Pin 20	24-36 VDC PS2 Auxiliary Switch	
PD-J21, Pin 21	Pin 21	24-36 VDC PS Battery Switch	
PD-J21, Pin 22	Pin 22	Battery ON Signal	
PD-J21, Pin 23	Pin 23	Battery Charger Float LED	
PD-J21, Pin 24	Pin 24	Battery Charger Constant Voltage LED	
PD-J21, Pin 25	Pin 25	Battery Charger Constant Current LED	
PD-J21, Pin 26	Pin 26	30 VAC +/- 5 VAC Battery Charger Voltage	

Signal Origin	PC-J3	Signal Name	Signal Destination
	Pin 1	+12 VDC	M-J29, Pin 1
	Pin 2	-12 VDC	M-J29, Pin 2
	Pin 3	Analog Ground	
	Pin 4	Not Used	
	Pin 5	Not Used	
	Pin 6	Not Used	

Signal Origin	PC-J4	Signal Name	Signal Destination
	Pin 1	+12 VDC	STD Bus
	Pin 2	-12 VDC	STD Bus
	Pin 3	Analog Ground	
	Pin 4	Not Used	
	Pin 5	Not Used	
	Pin 6	Not Used	

Signal Origin	PC-J5	Signal Name	Signal Destination
	Pin 1	+12 VDC	Right Fan
	Pin 2	Analog Ground	

Signal Origin	PC-J6	Signal Name	Signal Destination
	Pin 1	+12 VDC	Left Fan
	Pin 2	Analog Ground	

Signal Origin	PC-J7	Signal Name	Signal Destination
+12V DC/DC Convertor	Pin 1	+12 VDC	
	Pin 2	Analog Ground	

Signal Origin	PC-J8	Signal Name	Signal Destination
	Pin 1	Not Used	
	Pin 2	Not Used	

Signal Origin	PC-J9	Signal Name	Signal Destination
	Pin 1	Signal Ground	CD, Pin A
PC-J11, Pin 5	Pin 2	Transmitted Data to Display	CD, Pin G
CD, Pin H	Pin 3	Received Data from Display	PC-J11, Pin 3
	Pin 4	+12 VDC	CD, Pin J
	Pin 5	+12 VDC	CD, Pin K
	Pin 6	Logic Common	CD, Pin L
	Pin 7	Logic Common	CD, Pin M

PC-J10	Signal Name
Pin 1	+5 VDC
Pin 2	2.5 VDC Reference Voltage
Pin 3	Clock
Pin 4	Power Up Reset (Active Low)
Pin 5	AC Failure (Active Low)
Pin 6	Power System Common

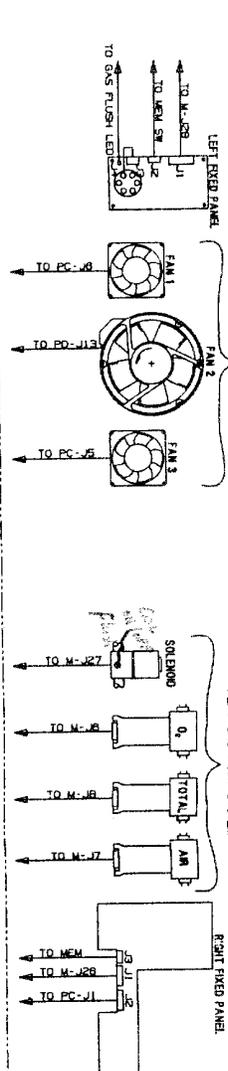
Signal Origin	PC-J11	Signal Name	Signal Destination
	Pin 1	Not Used	
	Pin 2	Not Used	
	Pin 3	Received Data from Display	CPU-J1, Pin 3
	Pin 4	Not Used	
CPU-J1, Pin 5	Pin 5	Transmitted Data to Display	
	Pin 6 ↓ Pin 12	Not Used	
	Pin 13	Signal Ground	CPU-J1, Pin 13
	Pin 14 ↓ Pin 24	Not Used	

Signal Origin	CA-P103	Signal Name	Signal Destination
SC-J2, Pin 1	Pin 1	TXD+ /RXD+	SC-J2, Pin 1
SC-J2, Pin 2	Pin 2	TXD-/RXD-	SC-J2, Pin 2
	Pin 3 ↓ Pin 12	Not Used	
SC-J2, Pin 13	Pin 13	TXD-/RXD-	SC-J2, Pin 13
SC-J2, Pin 14	Pin 14	TXD+ /RXD+	SC-J2, Pin 14

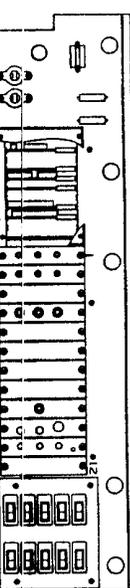
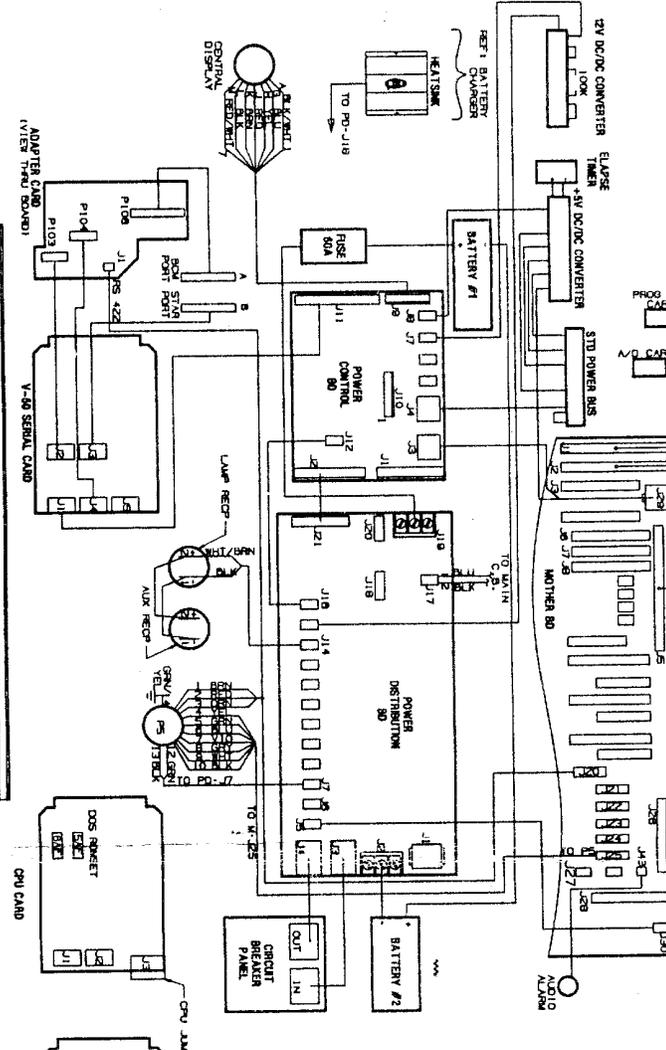
Signal Origin	CA-P104	Signal Name	Signal Destination
	Pin 1	Not Used	
	Pin 2	Not Used	
	Pin 3	Blood Gas Data	SC-J4, Pin 3
	Pin 4	Not Used	
	Pin 5	Not Used	
	Pin 6	+12 VDC	SC-J4, Pin 6
	Pin 7 ↓ Pin 12	Not Used	
	Pin 13	Signal Return	
	Pin 14	Not Used	

Signal Origin	CA-P105	Signal Name	Signal Destination
	Pin 1	Not Used	
P1 → P5, Pin F M-J20, Pin 1	Pin 2	TXD+ /RXD+	P1 → P5, Pin F M-J20, Pin 1
P1 → P5, Pin H M-J20, Pin 2	Pin 3	TXD-/RXD-	P1 → P5, Pin H M-J20, Pin 2
	Pin 4	Not Used	

**CHASSIS**



**FRONT TRAY**



NOTE:  
 M MOTHERBOARD  
 PD POWER DISTRIBUTION BOARD  
 PC POWER CONTROL BOARD  
 MEM MEMORANE SWITCH PANEL

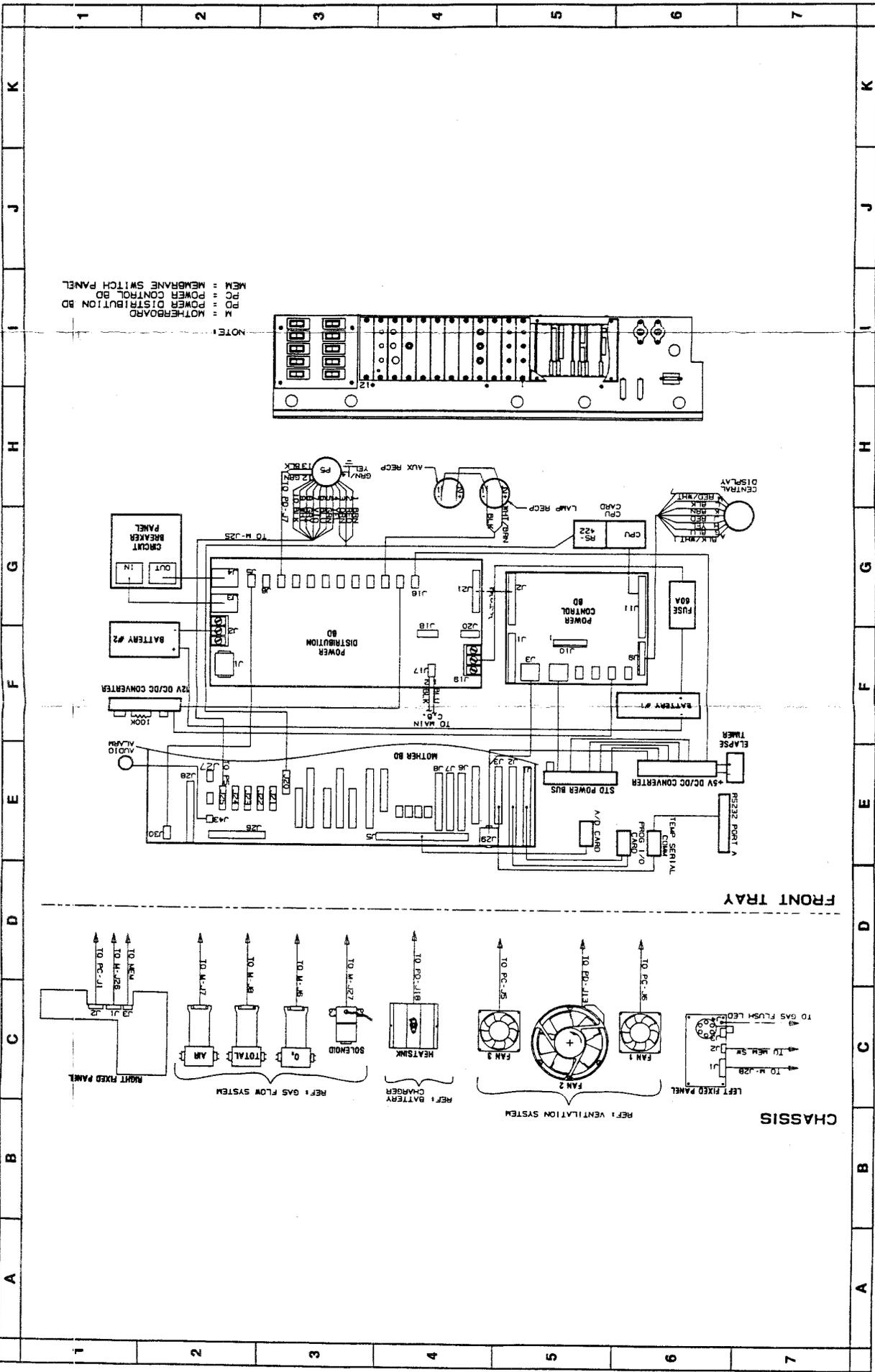
THIS EQUIPMENT CONTAINS...  
 UNLESS OTHERWISE SPECIFIED...  
 THE FOLLOWING INFORMATION IS FOR INFORMATIONAL PURPOSES ONLY...  
 THE USER SHOULD CONSULT THE USER MANUAL FOR THE LATEST REVISIONS...  
 THE USER SHOULD CONSULT THE USER MANUAL FOR THE LATEST REVISIONS...  
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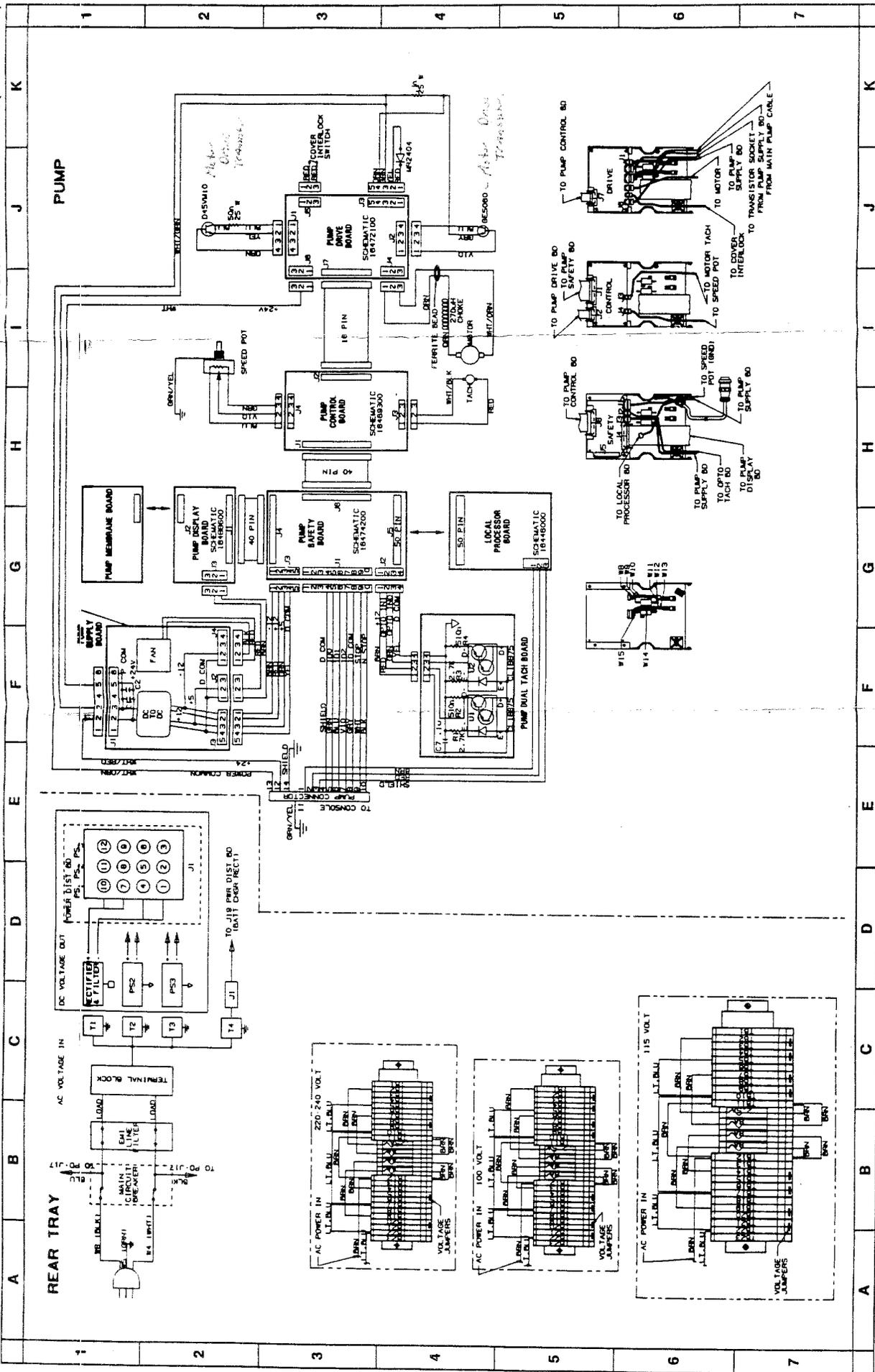
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 THE USER SHOULD CONSULT THE USER MANUAL FOR THE LATEST REVISIONS...  
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REV	DATE	DESCRIPTION	BY	CHKD
1	10/1/78	INITIAL		
2	10/1/78	REVISION		
3	10/1/78	REVISION		

REV	DATE	DESCRIPTION	BY	CHKD
1	10/1/78	INITIAL		
2	10/1/78	REVISION		
3	10/1/78	REVISION		







# Additional Information

## 3M™ Sarns™ Perfusion System 9000 Field Service Handbook Troubleshooting - Color Screen

This insert contains technical information regarding the color and monochrome display screens for a 3M™ Sarns™ Perfusion System 9000.

Insert these pages at the end of Section 5 - Troubleshooting in the 3M™ Sarns™ Perfusion System 9000 Field Service Handbook.



Health Care

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(800) 262-5504 (313) 663-4111

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## 5-12 Miscellaneous (continued)

## 5-12-4 Central Display Troubleshooting (color and monochrome)

Problem	Check	Action
Display blank, no cursor.	<ul style="list-style-type: none"> <li>✓ isolated +12 VDC on power control board</li> <li>✓ for +12 VDC at the front tray screen connector, pins J and K, use L or M for ground.</li> <li>✓ for +12 VDC inside screen, connector CB J4, Pins 1 and 2; Pins 4 and 5.</li> </ul>	<p>Replace power control board.</p> <p>Replace 12 volt DC/DC converter in front tray.</p> <p>Replace main twist lock cable. Replace the screen power board, (color screen). Return screen to 3M service.</p>
Display blank with cursor.	<ul style="list-style-type: none"> <li>✓ connectors at J9 and J11 on the power control board.</li> <li>✓ isolated -12 VDC on power control board</li> </ul>	<p>Secure all connectors. Replace power control board. Re-seat the serial comm. board. Re-seat the console CPU board. Replace the boards in the order above, checking operation between each replacement. Return screen to 3M service.</p>
(Color Screens only) Half of display blank or dim	<ul style="list-style-type: none"> <li>✓ back light connectors</li> <li>✓ back light tubes for discoloration</li> </ul>	<p>Replace backlight tubes</p> <p>Replace power board in screen, (TUV screen only). Return screen to 3M service.</p>
Display continually recycles boot messages. Title screen never appears.	<ul style="list-style-type: none"> <li>✓ jumper J3 on front edge of console (front tray) CPU board.</li> <li>✓ screen internal connectors.</li> </ul>	<p>Re-seat jumper J3. Re-seat serial comm., memory and CPU board in console. Replace jumper J3 on console CPU.</p> <p>Replace the boards in the above order, checking operation between each replacement.</p> <p>Return screen to 3M service.</p>
Display recycles, then locks up.	<ul style="list-style-type: none"> <li>✓ screen internal connectors.</li> </ul>	<p>Secure all connections. Replace DOS board in screen, (color only). Return screen to 3M service.</p>
Blank display, then image or pieces of image slowly return.	<ul style="list-style-type: none"> <li>✓ connectors at serial comm. board.</li> </ul>	<p>Re-seat the serial comm. board. Replace the serial comm. board. Replace DOS board in screen, (color only). Return screen to 3M service.</p>

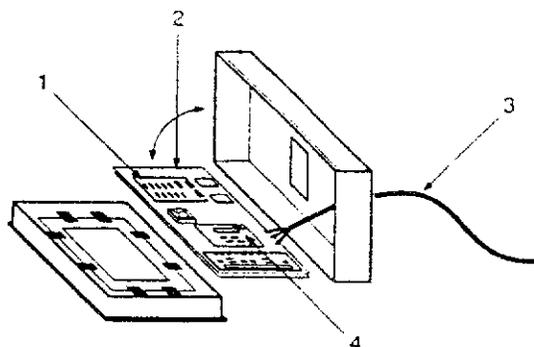
## 5-12 Miscellaneous (continued)

## 5-12-4 Central Display Troubleshooting (color and monochrome)

**Monochrome Touchscreen**

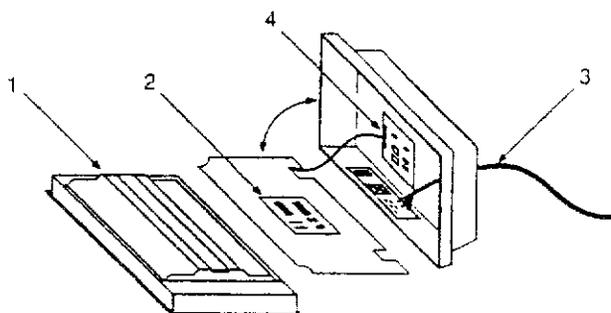
3M ID 78-8067-6731-3

1. 26-1008-0615-2 PC Graphics Board
2. 78-8067-0895-0 PC Graphocs Power Bd.
3. 78-8066-6000-3 Cable Central Display
4. 26-1008-0619-4 PC Touch Controller

**Color Screen Non-TUV**

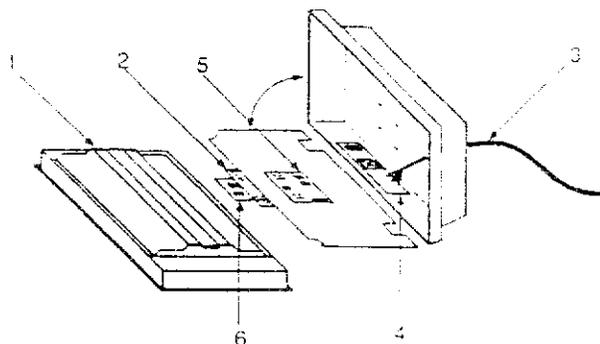
3M ID 78-8067-4581-2

1. 26-1009-7222-8 Back Light Kit
2. 78-8067-5393-1 DOS/Controller Board
3. 78-8067-6000-3 Cable Central Display
4. 26-1009-6634-5 Touch Controller

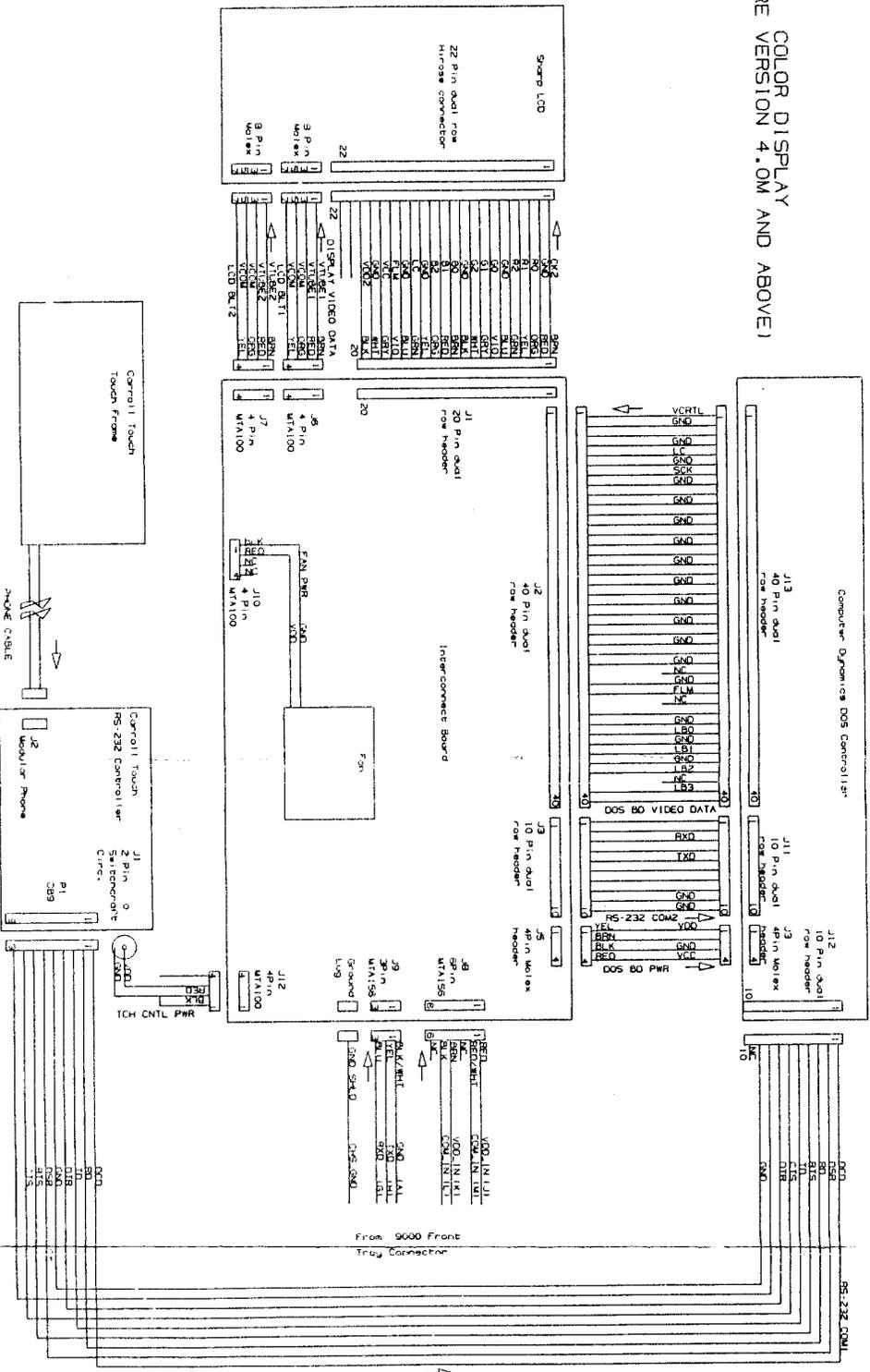
**Color Screen TUV**

3M ID 78-8067-6615-6

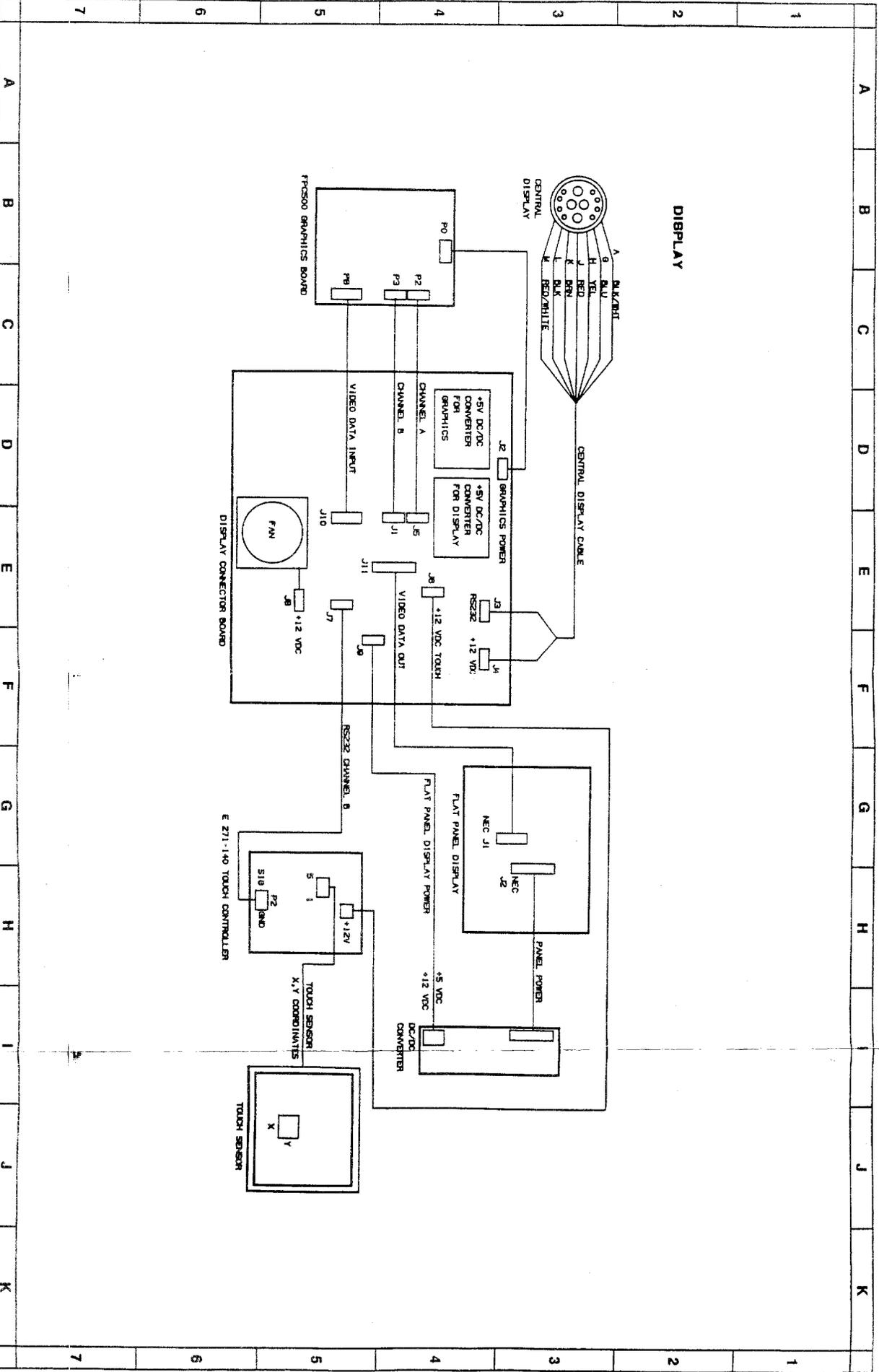
1. 26-1009-7222-8 Back Light Kit
2. 78-8067-5393-1 DOS/Controller Board
3. 78-8067-6807-9 Cable Main Display
4. 78-8067-6576-0 PC Power Board
5. 26-1009-6634-5 Touch Controller
6. 78-8067-6572-9 Color Select Board

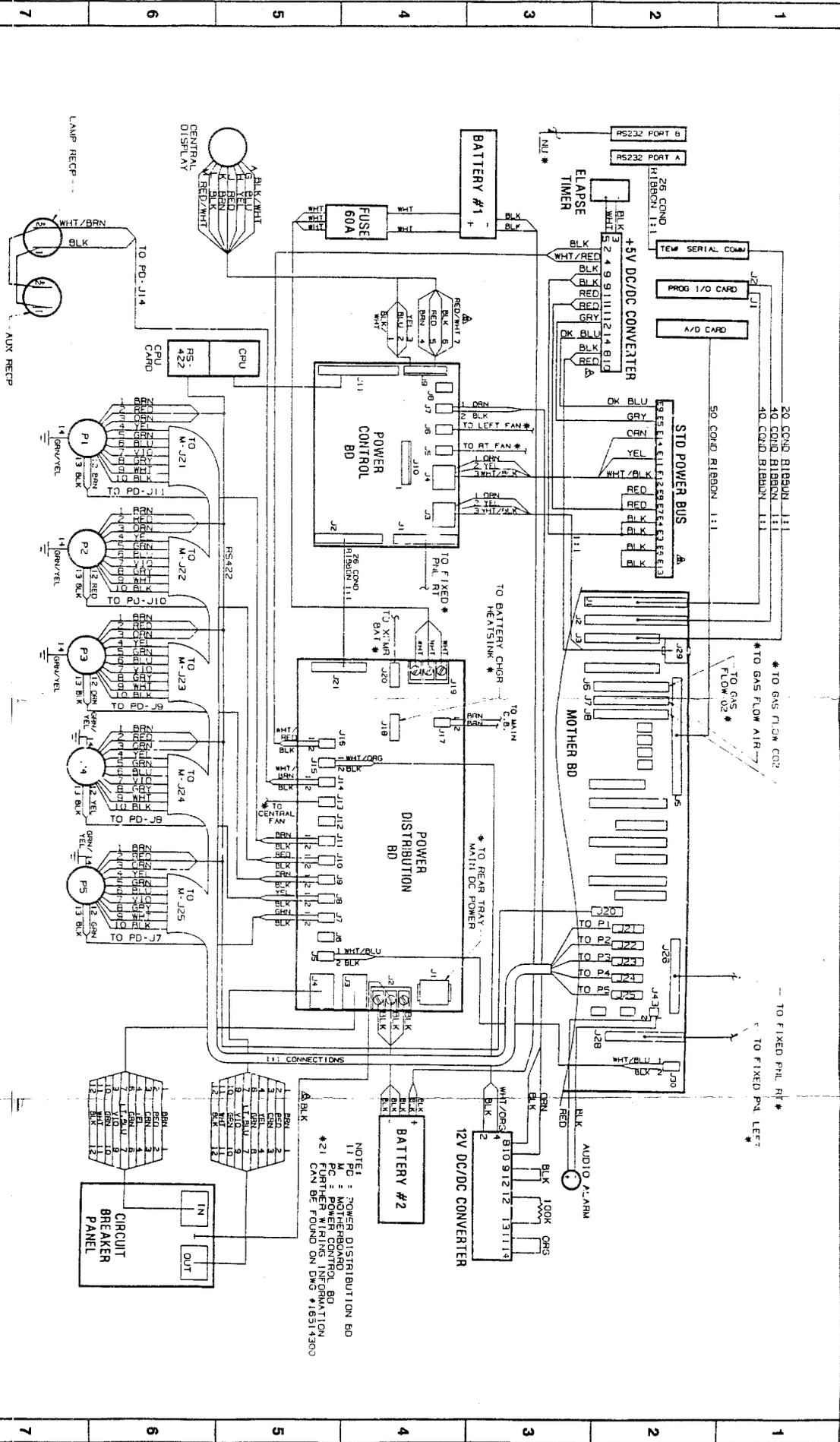


COLOR DISPLAY  
(SOFTWARE VERSION 4.0M AND ABOVE)



Part No.	Description	Quantity	Notes
1	Sharp LCD	1	
2	Control Touch Touch Frame	1	
3	Control Touch PS-232 Controller	1	
4	Control Touch Modular Phone	1	
5	Interconnect Board	1	
6	Computer Dynamics DOS Controller	1	

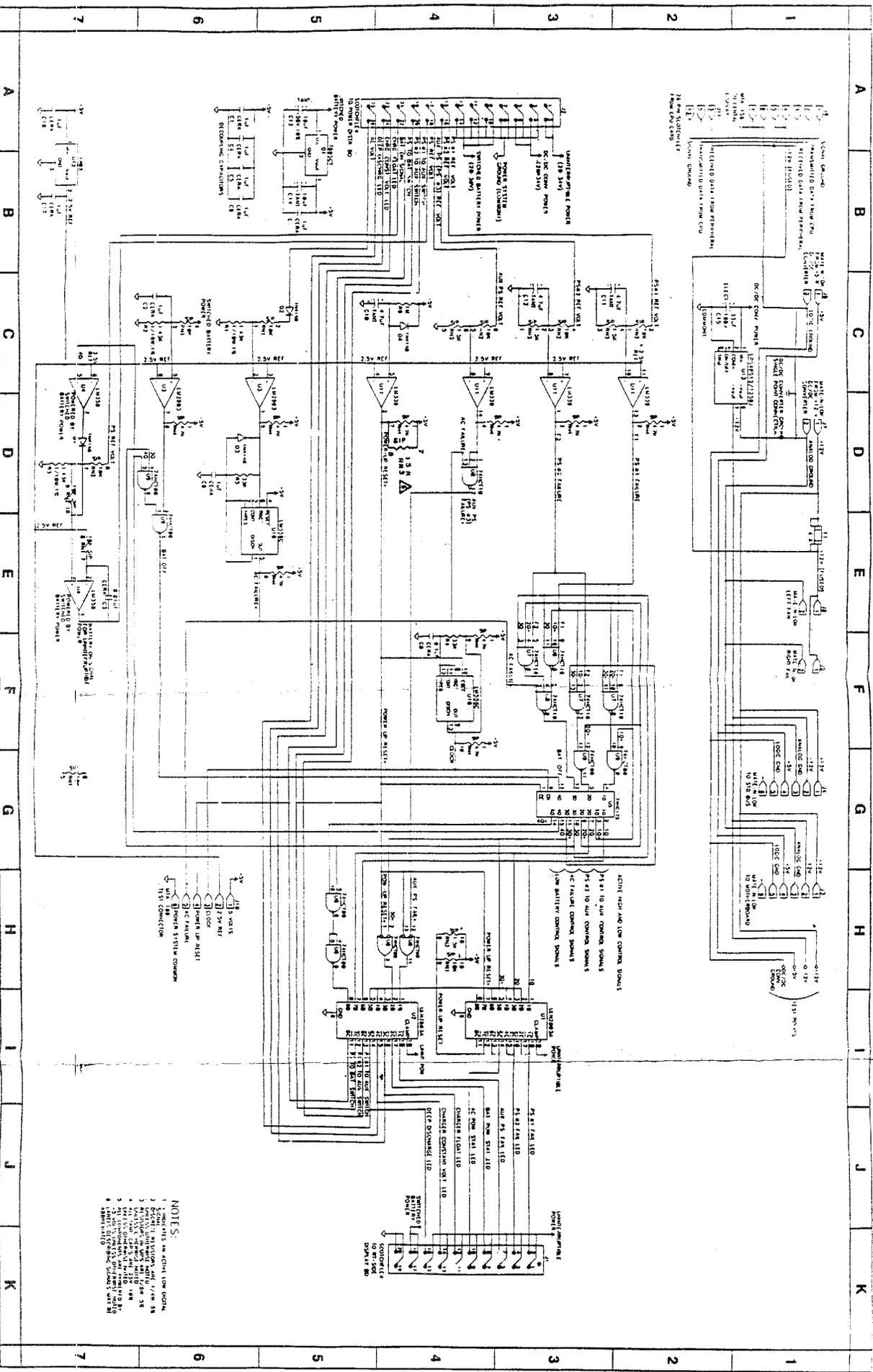




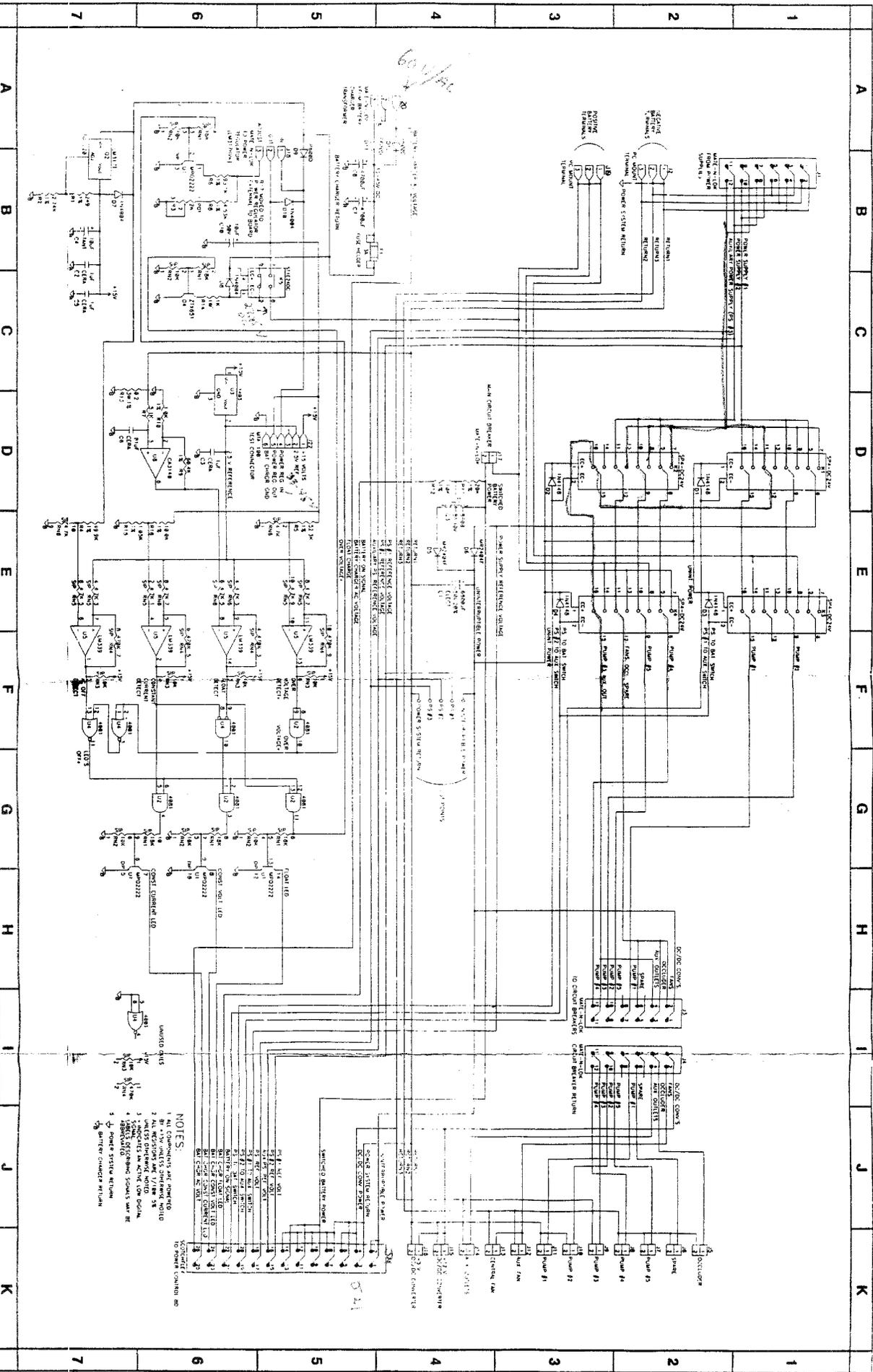




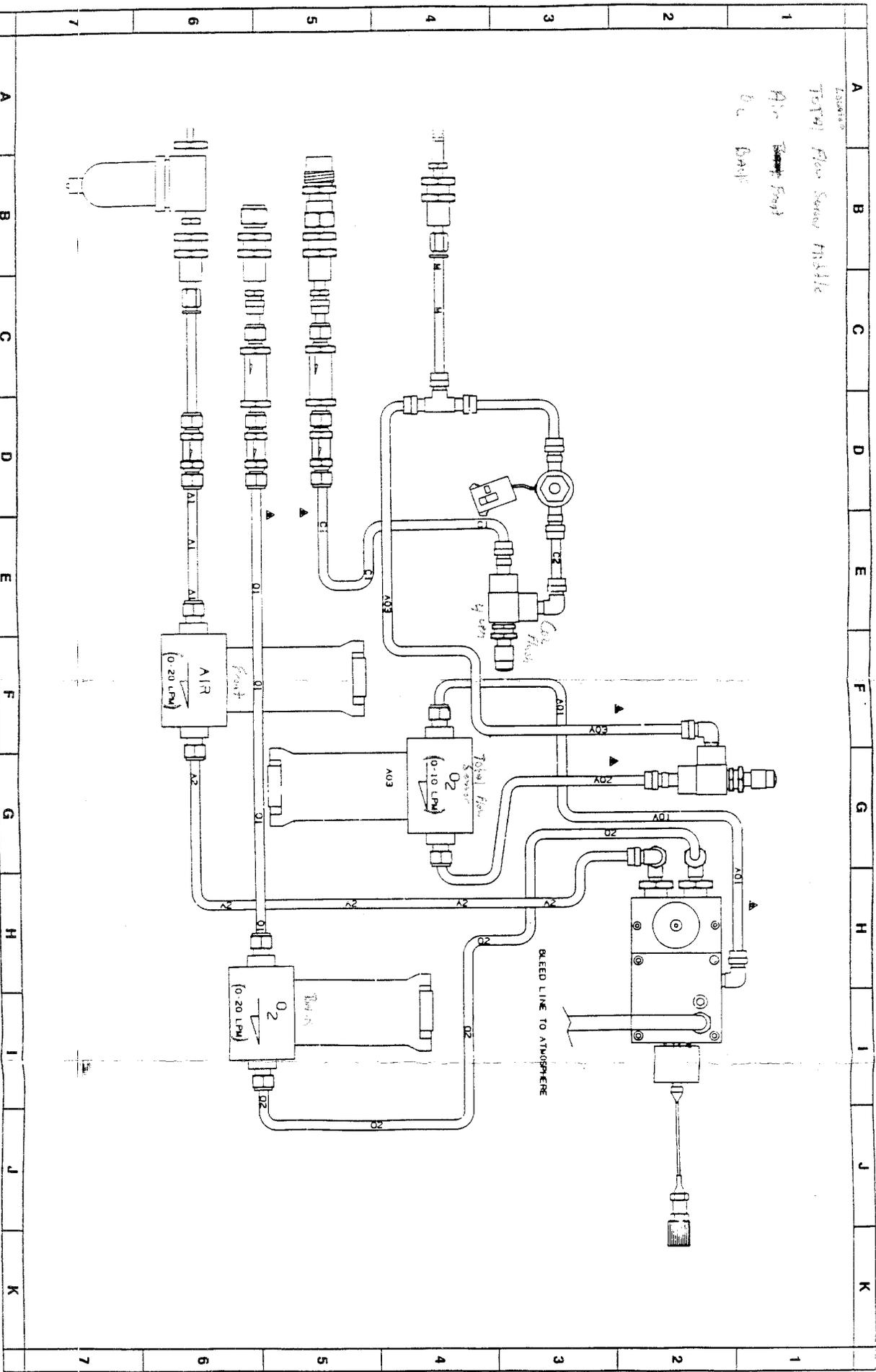




- NOTES:
1. INDICATES AN ACTIVE LOW SIGNAL.
  2. SIGNAL IS INVERTED AND NOT INVERTED.
  3. SIGNAL IS NOT INVERTED AND NOT INVERTED.
  4. SIGNAL IS NOT INVERTED AND NOT INVERTED.
  5. SIGNAL IS NOT INVERTED AND NOT INVERTED.
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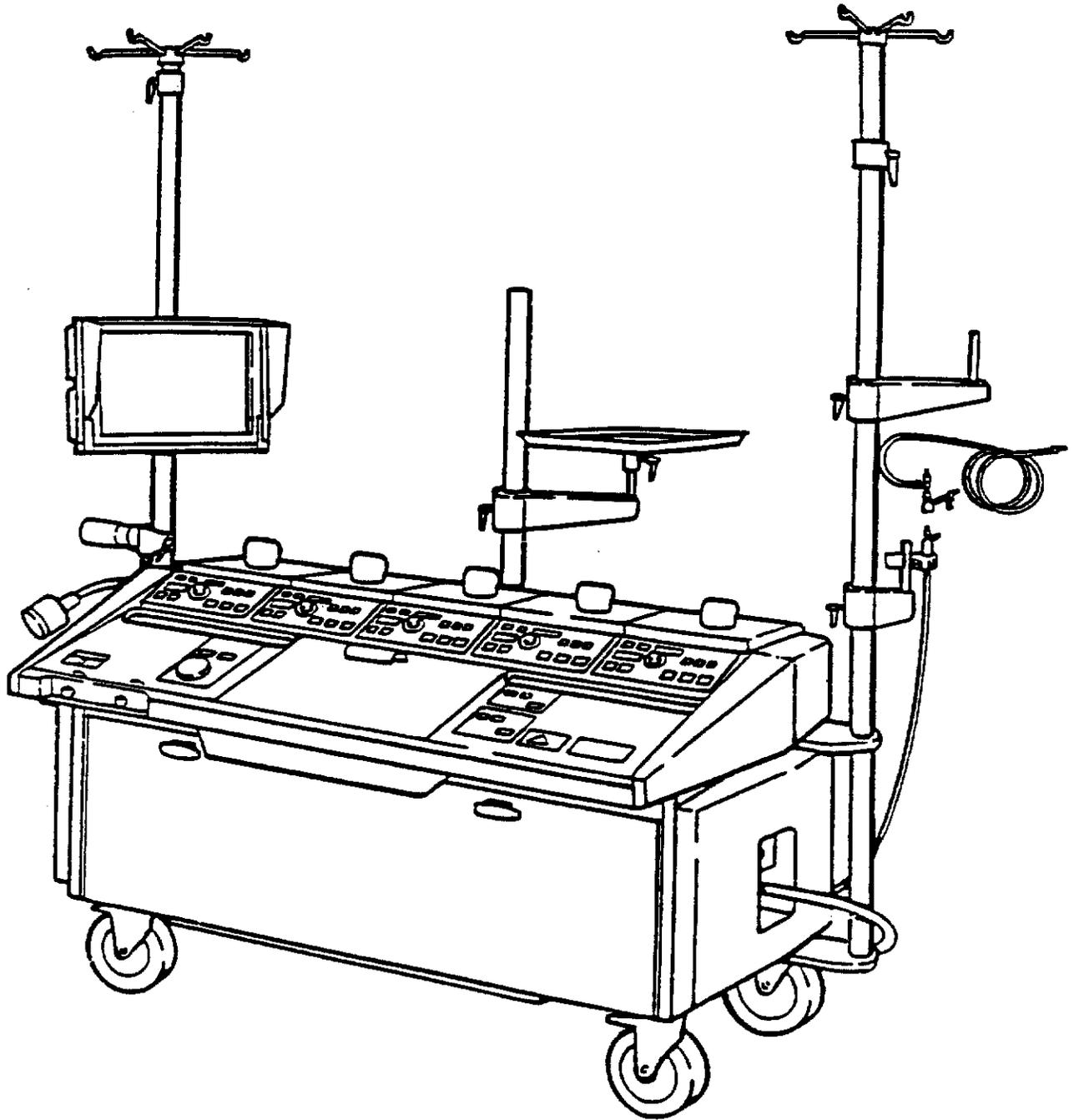
- NOTES:**
- 1 All components are numbered
  - 2 R.V. UNLESS SHOWN W/OUT
  - 3 UNLESS SHOWN W/OUT
  - 4 UNLESS SHOWN W/OUT
  - 5 UNLESS SHOWN W/OUT
  - 6 UNLESS SHOWN W/OUT
  - 7 UNLESS SHOWN W/OUT



# Illustrated Parts Breakdown

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## Sarns™ 9000 Perfusion System



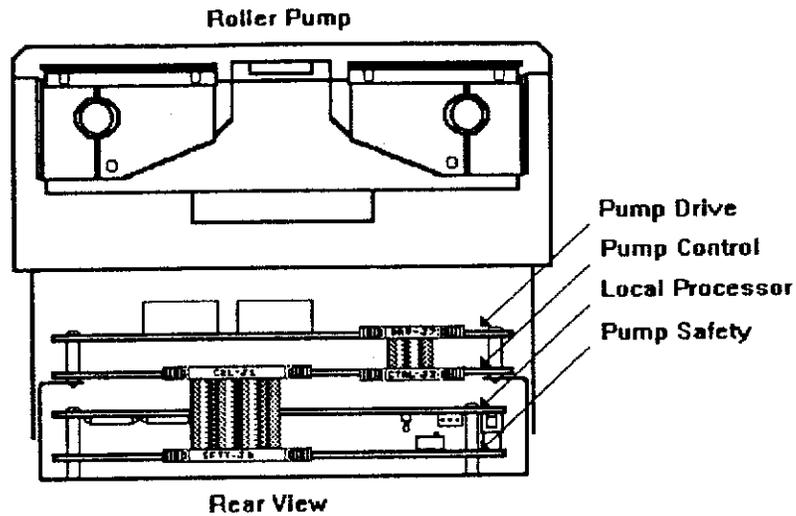
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78-8067-1352-1

Sarns  
3M Health Care Group

6200 Jackson Road  
Ann Arbor, Michigan 48103 U.S.A.





#### **Pump Drive Board:**

- Drive circuit for the motor power transistor
- Forward and Reverse switch relays
- Motor speed voltage circuitry:
- Motor current circuitry:

#### **Pump Control Board:**

- This board provides the motor control circuitry minus the motor drive circuitry.
- Speed control error amplifier
- Pulse width modulator
- Conditioning circuits for the demand potentiometer and motor tach.
- Speed comparators for the safety circuit

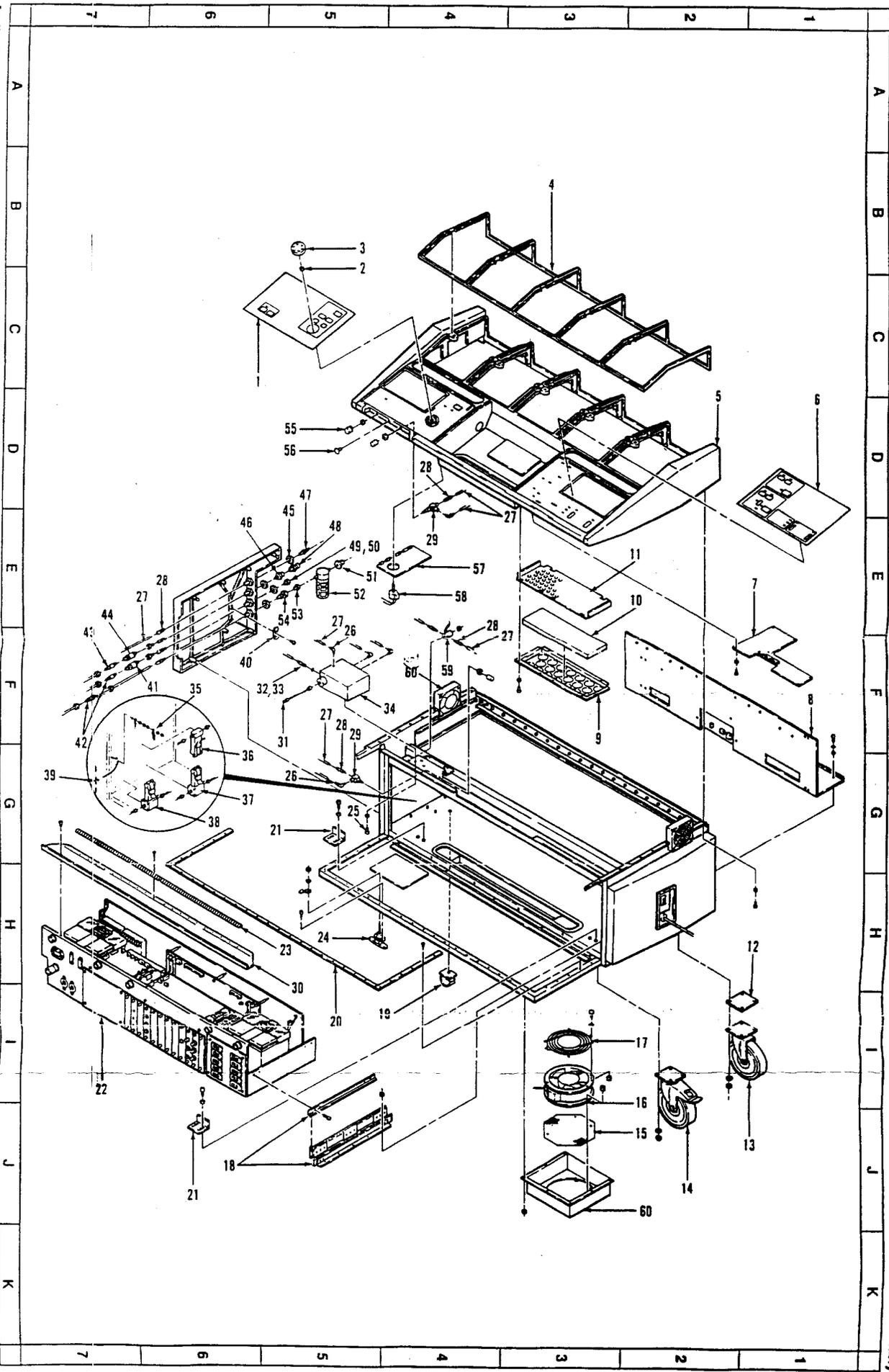
#### **Pump Safety Board:**

- This board provides safety circuitry and much of the digital interface with the local processor. Including:
- Stop switch membrane panel
- Air bubble detector
- Latches and driver for the front panel switches and LED's
- Decoding local processor signals used by the pump control and pump drive boards.
- Conditioning of the dual tach signals
- Overspeed signal
- Belt slip signal
- Loss of tach signal
- Pump jam signal

- Section 1. Main Machine Assembly**
- Section 2. Chassis Assembly**
- Section 3. Front Tray Assembly**
- Section 4. Rear Tray Assembly**
- Section 5. System Options**
- Section 6. Central Display Assembly**
- Section 7. Roller Pump Assembly**
- Section 8. Roller Pump Display/Membrane Panel Assembly**
- Section 9. Roller Pump Guts Assembly**
- Section 10. Centrifugal Pump Assembly**
- Section 11. Centrifugal Pump Display/Membrane Panel Assembly**
- Section 12. Centrifugal Pump Drive Motor Assembly**
- Section 13. Occluder Assembly**
- Section 14. Lamp Assembly**
- Section 15. Water Module Assembly**
- Section 16. Air Sensor Assembly**







2. Chassis Assembly

Item No.	Sams P/N	3M P/N	Description	Qty.
1	16456401	78-8066-7517-5	PANEL, Left Membrane Switch	1
2	23890040	26-1008-0613-7	SEAL, APM, 1/4 Shaft, N-9030	1
3	16471401	78-8066-7530-8	KNOB, Occluder Control	1
4	16445901	78-8066-6725-5	GASKET, Molded, Pump Rest	1
5	16446001	78-8066-9999-3	TOP, Foam, Molded	1
6	16456601	78-8072-1469-3	PANEL, Right Membrane Switch	1
7	16455301	78-8066-6727-1	PC ASY, Fixed Panel, Right Side	1
8	16592801	78-8067-0894-3	REAR TRAY ASY (See Section 4)	1
9	16467201	78-8067-0032-0	ACCESS PANEL, Vacuum Formed	1
10	16467401	78-8066-6277-7	FILTER, Air Media	2
11	16467301	78-8066-7525-8	RETAINER, Screen, Air Filter	2
12	N/A	78-8066-6921-0	SPACER, Caster	2
13A	N/A	26-1008-2696-0	CASTER, 6" Dia. without Brake (S/N < 4200)	2
13B	N/A	26-1008-6651-1	CASTER, Steer Lock (S/N ≥ 4200)	2
14A	20104120	26-1006-8107-6	CASTER, Conductive, 6" Dia. (S/N < 4200)	2
14B	N/A	26-1008-6650-3	CASTER, Steer and Wheel Lock (S/N ≥ 4200)	2
15	16431201	78-8066-9895-3	GUARD, Fan	1
16	25130012	26-1008-0622-8	FAN, Brushless, 24-56 VDC	1
17	23890201	26-1004-2615-9	GUARD, Fan, 6.25 Diameter	1
18	21090001	26-1008-0986-7	DRAWER, Slides, 14 in travel	1
19	23850101	26-1007-6502-8	CLIP, Wire, 1 in Diameter, Pushmount	2
20	16565101	78-8067-0740-8	GASKET, EMI Shielding	1
21	16598201	78-8067-0926-3	STOP, Front Tray	2
22	16594601	78-8067-0904-0	FRONT TRAY ASY (See Section 3)	1
23	N/A	26-1007-5156-4	GASKET, EMI Shield, with Rivets	2
24	20330020	26-1003-1657-3	LATCH, T-Handle, Half Turn	2
25	22162506	26-1002-5397-5	SCREW, Hex Head, 1/4-20 X 3/8	2
26	25320031	26-1007-5043-4	ELBOW, 1/8 MNPT - 1/4 OD, Brass	5
27	N/A	26-1008-3795-9	TUBING, Teflon, .25 OD .17 ID	16
28	25321130	26-1007-5044-2	MALE, 1/8 MNPT - 1/4 OD, Brass	8
29	25501030	26-1007-7476-4	VALVE, Gas, Panel Mounted, Chrome Plate	2
30	1659201	78-8067-0887-7	SHIELD, Component Drawer	1
31	21310050	26-1008-0993-3	SHAFT, Flexible, Remote Control, 5 in	1
32	25390025	?	COUPLING, Hose, Barb, 7/16-20 X 1/4	1

## 2. Chassis Assembly

Sarna™ 9000 Perfusion System Illustrated Parts Breakdown

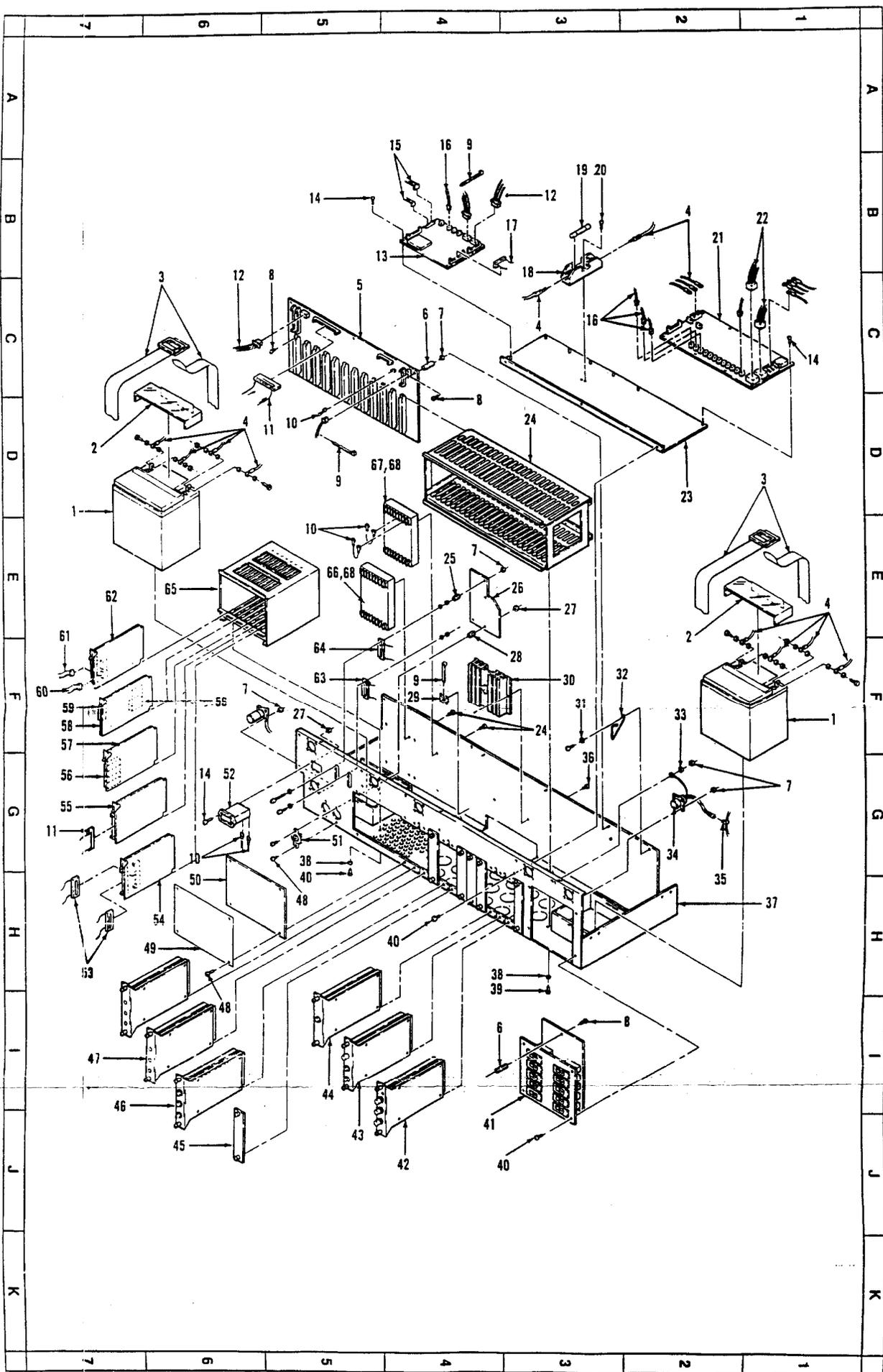
Item No.	Sarna P/N	3M P/N	Description	Qty.
33	20050081	26-1008-4288-4	TAPE, Teflon, 1/2 X 600 inches	.125
34	16570101	78-8066-5745-3	BLENDER, Air/O2, Modified, Sechrist	1
35	16554601	78-8067-0665-7	CLIP, Cable, Spring Wire, SS <del>Foot</del>	6
36	25510003	26-1007-7547-2	FLOWMETER, O2 Porter 111 FSVC <i>Tota/</i>	1
37	25510001	26-1007-7545-6	FLOWMETER, O2 Porter 112 FSVC	1
38	25510002	26-1007-7546-4	FLOWMETER, Air Porter 112 FSU	1
39	25322030	26-1007-7466-5	UNION, Tubing, T, 1/4 OD, Brass	1
40	16480301	78-8067-0102-1	HOLDER, Gas Filter, Side Panel	1
41	N/A	26-1008-3402-2	FILTER, Gas, 7 Micron, SS	1
42	N/A	26-1008-3403-0	VALVE, Check, Gas, 1 PSI, SS	2
43	25502010	26-1007-7541-5	VALVE, Check, Gas, 1 PSI	1
44	25700035	26-1007-8632-1	FILTER, Gas, 7 Micron, SS	1
45	25651030	26-1008-1163-2	BULKHEAD, 1/8 F/F NPT, Chrome Plated	4
46	25690022	26-1007-8629-7	ADAPTER, 1/4 FNPT - 1/8 MNPT	1
47	25690020	26-1008-1579-9	ADAPTER, 1/8 NPT - 1/4 Hose	1
48	25690040	26-1008-1157-3	CONNECTOR, CO2 Diss, Male, 1/4 MNPT	1
49	25690030	26-1007-8630-5	NIPPLE, O2 Diss, Female, 1/8 MNPT	1
50	25690031	26-1008-1166-5	NUT, O2 Diss, Female	1
51	25690050	26-1008-1168-1	CONNECTOR, Air Diss, Male, 1/8 MNPT	1
52	25700030	26-1007-8631-3	FILTER, Air Inlet, .1 Micron	1
53	N/A	12-7992-7476-1	ADAPTER, Tube, 1/8 MNPT - 3/8 OD, SS	1
54	N/A	26-1008-3428-7	ADAPTER, Tube, 1/8 MNPT - 3/8 OD, SS	1
55	23800099	26-1006-6874-3	KNOB, .75 diameter for .25 shaft	1
56	20040058	26-1002-4730-8	PLUG, .562 diameter, Heyco 2653, Black	1
57	16460901	78-8066-5729-7	PC ASY, Fixed Panel, Occluder, Left Side	1
58	23250196	26-1008-4333-8	POTENTIOMETER, Digital, Panel Mounted	1
59	25503030	26-1007-7544-9	VALVE, Solenoid, N.C., 24VDC	1
60	N/A	78-8066-6393-2	HOUSING, Fan	1
61	25130011	26-1008-0621-0	FAN, Brushless, 8-28 VDC	2

Item No.	Sarns P/N	3M P/N	Description	Qty.
1	16456401	78-8066-7517-5	PANEL, Left Membrane Switch	1
2	23890040	26-1008-0613-7	SEAL, APM, 1/4 Shaft, N-9030	1
3	16471401	78-8066-7530-8	KNOB, Occluder Control	1
4	16445901	78-8066-5725-5	GASKET, Molded, Pump Rest	1
5	16446001	78-8066-9999-3	TOP, Foam, Molded	1
6	16456601	78-8072-1469-3	PANEL, Right Membrane Switch	1
7	16455301	78-8066-5727-1	PC ASY, Fixed Panel, Right Side	1
8	16592801	78-8067-0894-3	REAR TRAY ASY (See Section 4)	1
9	16467201	78-8067-0032-0	ACCESS PANEL, Vacuum Formed	1
10	16467401	78-8066-5277-7	FILTER, Air Media	2
11	16467301	78-8066-7525-8	RETAINER, Screen, Air Filter	2
12	N/A	78-8066-6921-0	SPACER, Caster	2
13A	N/A	26-1008-2696-0	CASTER, 6" Dia. without Brake (S/N < 4200)	2
13B	N/A	26-1008-6651-1	CASTER, Steer Lock (S/N ≥ 4200)	2
14A	20104120	26-1006-8107-6	CASTER, Conductive, 6" Dia. (S/N < 4200)	2
14B	N/A	26-1008-6650-3	CASTER, Steer and Wheel Lock (S/N ≥ 4200)	2
15	16431201	78-8066-9895-3	GUARD, Fan	1
16	25130012	26-1008-0522-8	FAN, Brushless, 24-56 VDC	1
17	23890201	26-1004-2615-9	GUARD, Fan, 6.25 Diameter	1
18	21090001	26-1008-0986-7	DRAWER, Slides, 14 In travel	1
19	23850101	26-1007-6502-8	CLIP, Wire, 1 in Diameter, Pushmount	2
20	16565101	78-8067-0740-8	GASKET, EMI Shielding	1
21	16598201	78-8067-0926-3	STOP, Front Tray	2
22	16594601	78-8067-0904-0	FRONT TRAY ASY (See Section 3)	1
23	N/A	26-1007-5156-4	GASKET, EMI Shield, with Rivets	2
24	20330020	26-1003-1657-3	LATCH, T-Handle, Half Turn	2
25	22162506	26-1002-5397-5	SCREW, Hex Head, 1/4-20 X 3/8	2
26	25320031	26-1007-5043-4	ELBOW, 1/8 MNPT - 1/4 OD, Brass	5
27	N/A	26-1008-3795-9	TUBING, Teflon, .25 OD .17 ID	16
28	25321130	26-1007-5044-2	MALE, 1/8 MNPT - 1/4 OD, Brass	8
29	25501030	26-1007-7476-4	VALVE, Gas, Panel Mounted, Chrome Plate	2
30	1659201	78-8067-0887-7	SHIELD, Component Drawer	1
31	21310050	26-1008-0993-3	SHAFT, Flexible, Remote Control, 5 in	1
32	25390025	?	COUPLING, Hose, Barb, 7/16-20 X 1/4	1

## 2. Chassis Assembly

Sams™ 8000 Perfusion System Illustrated Parts Breakdown

Item No.	Sams P/N	3M P/N	Description	Qty.
33	20050081	26-1008-4288-4	TAPE, Teflon, 1/2 X 600 inches	.125
34	16570101	78-8066-6745-3	BLENDER, Air/O2, Modified, Sechrist	1
35	16554601	78-8067-0665-7	CLIP, Cable, Spring Wire, SS <del>Foot</del>	6
36	25510003	26-1007-7547-2	FLOWMETER, O2 Porter 111 FSVC <i>Toto</i>	1
37	25510001	26-1007-7545-6	FLOWMETER, O2 Porter 112 FSVC	1
38	25510002	26-1007-7546-4	FLOWMETER, Air Porter 112 FSU	1
39	25322030	26-1007-7466-5	UNION, Tubing, T, 1/4 OD, Brass	1
40	16480301	78-8067-0102-1	HOLDER, Gas Filter, Side Panel	1
41	N/A	26-1008-3402-2	FILTER, Gas, 7 Micron, SS	1
42	N/A	26-1008-3403-0	VALVE, Check, Gas, 1 PSI, SS	2
43	25502010	26-1007-7541-5	VALVE, Check, Gas, 1 PSI	1
44	25700035	26-1007-8632-1	FILTER, Gas, 7 Micron, SS	1
45	25651030	26-1008-1163-2	BULKHEAD, 1/8 F/F NPT, Chrome Plated	4
46	25690022	26-1007-8629-7	ADAPTER, 1/4 FNPT - 1/8 MNPT	1
47	25690020	26-1008-1579-9	ADAPTER, 1/8 NPT - 1/4 Hose	1
48	25690040	26-1008-1167-3	CONNECTOR, CO2 Diss, Male, 1/4 MNPT	1
49	25690030	26-1007-8630-5	NIPPLE, O2 Diss, Female, 1/8 MNPT	1
50	25690031	26-1008-1166-5	NUT, O2 Diss, Female	1
51	25690050	26-1008-1168-1	CONNECTOR, Air Diss, Male, 1/8 MNPT	1
52	25700030	26-1007-8631-3	FILTER, Air Inlet, .1 Micron	1
53	N/A	12-7992-7476-1	ADAPTER, Tube, 1/8 MNPT - 3/8 OD, SS	1
54	N/A	26-1008-3428-7	ADAPTER, Tube, 1/8 MNPT - 3/8 OD, SS	1
55	23800099	26-1006-6874-3	KNOB, .75 diameter for .25 shaft	1
56	20040058	26-1002-4730-8	PLUG, .562 diameter, Heyco 2653, Black	1
57	16460901	78-8066-6729-7	PC ASY, Fixed Panel, Occluder, Left Side	1
58	23250196	26-1008-4333-8	POTENTIOMETER, Digital, Panel Mounted	1
59	25503030	26-1007-7544-9	VALVE, Solenoid, N.C., 24VDC	1
60	N/A	78-8066-6393-2	HOUSING, Fan	1
61	25130011	26-1008-0621-0	FAN, Brushless, 8-28 VDC	2



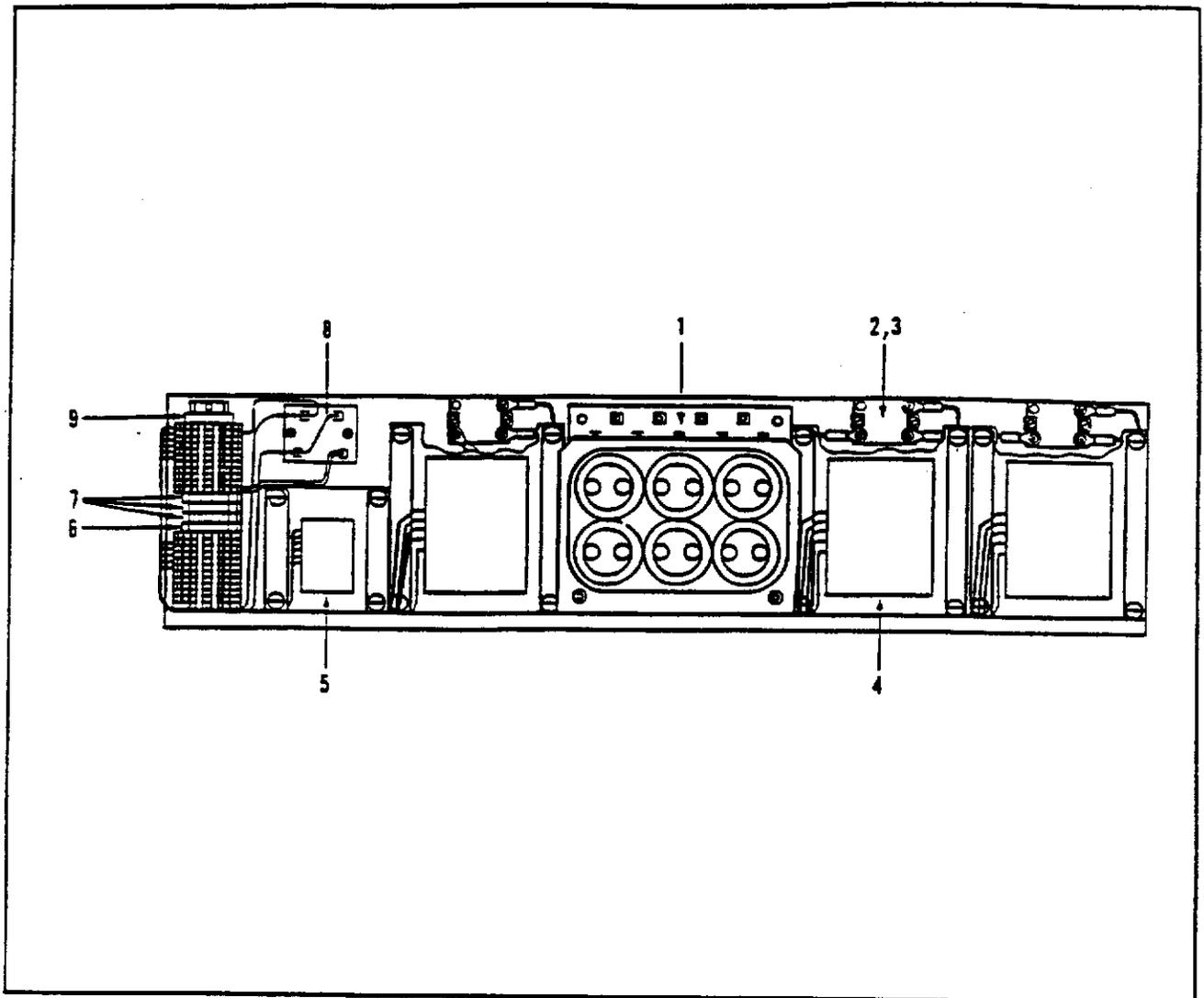
Item No.	Sarns P/N	3M P/N	Description	Qty.
1	24300015	26-1008-0617-8	BATTERY, Lead Acid, 12V, 24A	2
2	16594001	78-8067-0898-4	SHIELD, Battery Terminal	2
3	16472201	78-8066-7531-6	STRAP, Battery Retaining	2
4	16596601	78-8067-0920-6	CABLE ASY, Battery	1
5	16455201	78-8072-1463-6	PC ASY, Motherboard	1
6	22978120	26-1006-9288-3	STANDOFF, F 1.25 Nylon 4-40 Hex	4
7	22723001	26-1003-4052-5	NUT, Keps, 4-40, Steel, Zinc Plated	33
8	22197106	26-1008-8041-3	SCREW, Button Head Torx, 4-40	24
9	23850076	26-1008-4315-5	TIE-WRAP, Tyton #T18R	25
10	16506901	78-8067-0238-3	CABLE ASY, Miscellaneous	1
11	16508801	78-8067-0267-2	CABLE ASY, Analog/Digital, 50 Pin	1
12	16506701	78-8067-0236-7	CABLE ASY, Power Control/Motherboard	1
13	16464401	78-8066-6276-9	PC ASY, Power Control Board	1
14	22197208	26-1008-8045-4	SCREW, Button Head Torx, 6-32 X .50	14
15	16594401	78-8067-0903-2	CABLE ASY, Front Tray/Display	1
16	16595401	78-8067-0910-7	CABLE ASY, Power Distribution (set of 5)	1
17	16510401	78-8067-0273-0	CABLE ASY, Power Control/Distribution	1
18	23430025	26-1008-8135-3	FUSEBLOCK, 35-60A, Buss	1
19	23422501	26-1006-6714-1	FUSE, 60 Amp, Buss SC-60	1
20	22197308	26-1008-8048-8	SCREW, Button Head Torx, 6-32 X .50	2
21	16481801	78-8066-6281-9	PC ASY, Power Distribution	1
22	16506401	78-8067-0234-2	CABLE ASY, Circuit Breaker	1
23	16452801	78-8072-1447-9	SHELF, Power Control	1
24	23890108	26-1007-6511-9	CARD CAGE, 24 Slot	1
25	N/A	26-1008-0322-5	STANDOFF, M/F, 4-40, 7/16 X 3/16	2
25	N/A	78-8066-6500-2	PC ASY, Communications Adapter	1
27	22723002	26-1001-7983-2	NUT, Keps, 6-32, Steel, Zinc Plated	2
28	N/A	26-1008-0321-7	STANDOFF, M/F, 6-32, 7/16 X 3/16	2
29	23850080	26-1008-0845-5	CABLE MOUNT, Adhesive, Small	10
30	16594201	78-8067-0901-6	CABLE ASY, Heat Sink, Chassis	1
31	22743003	26-1008-1921-3	WASHER, Flat, #8, Zinc Plated	3
32	16554601	78-8067-0665-7	CABLE CLIP, Spring Wire, Stainless Steel	3
33	22743001	26-1008-1919-7	WASHER, Flat, #4, Zinc Plated	5
34	16594501	78-8066-6750-3	CABLE ASY, Pump Connectors	1

### 3. Front Tray Assembly

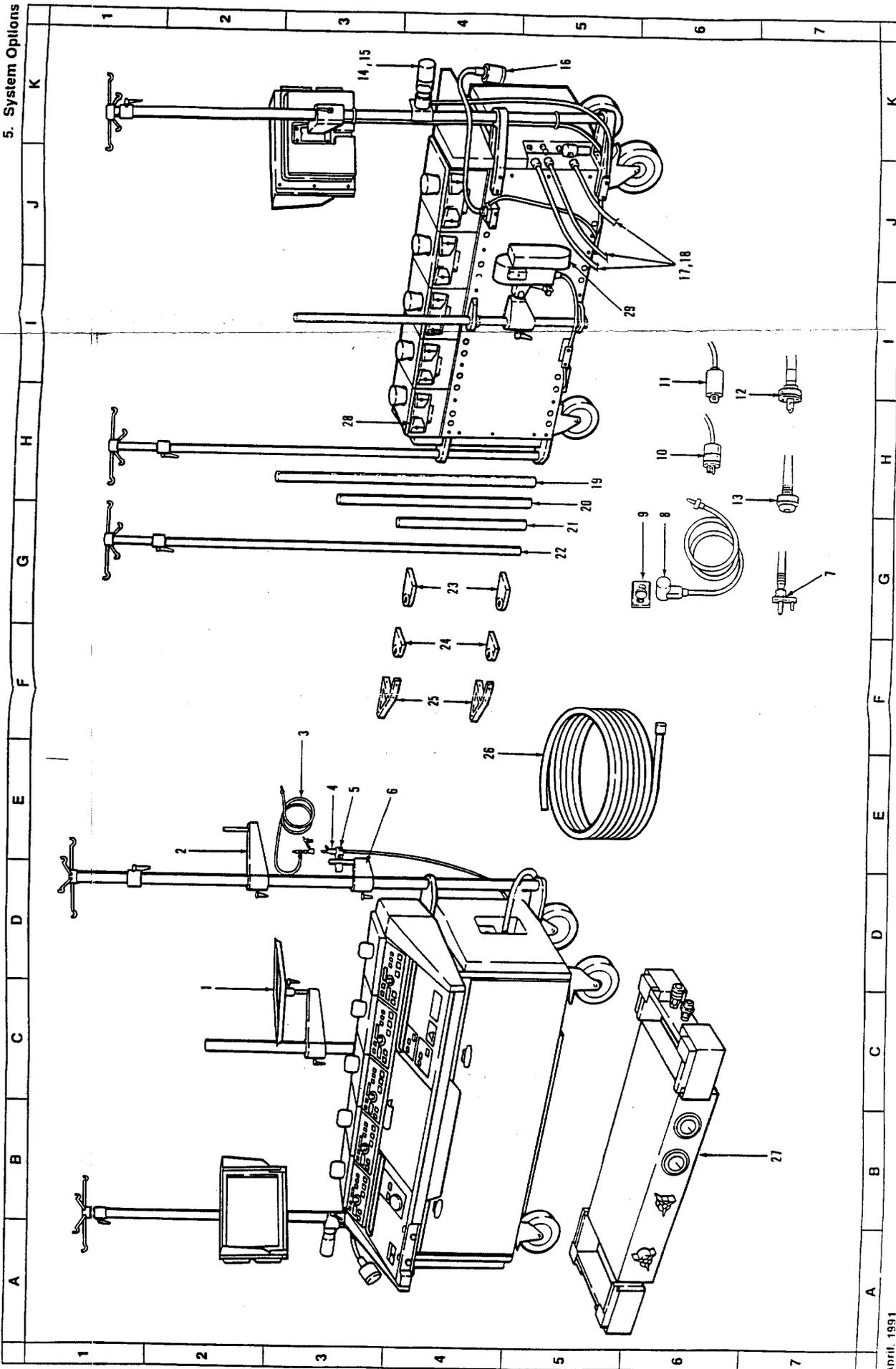
Sams™ 9000 Perfusion System Illustrated Parts Breakdown

Item No.	Sams P/N	3M P/N	Description	Qty.
35	16528201	78-8066-6379-1	CABLE ASY. RS422/Comm V50	1
36	22197206	26-1008-8044-7	SCREW, Button Head Torx, 6-32 x .38	2
37	16592301	78-8067-0890-1	COMPONENT DRAWER	1
38	22745003	26-1008-1928-8	WASHER	8
39	22197309	26-1008-8049-6	SCREW, Button Head Torx, 8-32 x .62	8
40	22197306	26-1008-8047-0	SCREW, Button Head Torx, 8-32 X .38	8
41	16470101	78-8066-7529-0	PC ASY, Circuit Breaker	1
42	16462201	78-8066-6275-1	PC ASY, Digital Interface	1
43	N/A	78-8066-7955-7	PC ASY, Level Detector	1
44	16593101	78-8066-6748-7	PC ASY, Bubble Detector	1
45	16450301	78-8072-1437-0	FILLER PANEL	6
46	16592901	78-8066-6747-9	PC ASY, Pressure Interface	1
47	N/A	78-8066-6331-2	PC ASY, Temperature Probe Interface	1
48	22197204	26-1008-8043-9	SCREW, Button Head Torx, 6-32 x .25	8
49	16494901	78-8067-0188-0	LABEL, Legend	1
50	16450401	78-8072-1438-8	BLANK, Front Tray Door	1
51	23004011	26-1006-9320-4	RECEPTACLE, 2 Pin, TRW S-302-FD	2
52	23720022	26-1006-6865-1	METER, Time, 4 to 40 VDC	1
53	16508301	78-8067-0263-1	CABLE ASY, Prog I/O, 40 Pin	2
54	16513801	78-8066-6286-8	CARD ASY, Prog I/O, TTL	1
55	16513601	78-8066-6284-3	CARD ASY, Analog/Digital Converter	1
56	N/A	78-8066-6408-8	ROM SET, Programmable, V2.21	1
57	N/A	26-1007-5679-5	MEMORY BOARD, ZT8825, V50	1
58	N/A	26-1007-5678-7	COMPUTER, Single Board, ZT8817, V50	1
59	N/A	78-8066-8060-5	CABLE ASY, CPU Jumper	1
60	N/A	78-8066-6380-9	CABLE ASY, RS232/Display	1
61	N/A	78-8066-6501-0	CABLE ASY, RS422/CDI, V50	1
62	N/A	26-1007-5677-9	SERIAL BOARD, 4 Channel, ZT8841, V50	1
63	N/A	78-8066-6381-7	CABLE ASY, RS232/STAR, V50	1
64	N/A	78-8066-6382-5	CABLE ASY, RS232/CDI, V50	1
65	N/A	78-8066-6391-6	CARD CAGE ASY, Standard Bus, V50	1
66	24300043	26-1007-7429-3	DC/DC CONVERTER, 24V in, 5V @ 10 Amp	1
67	24300037	26-1007-7423-6	DC/DC CONVERTER, 24V in, 12V @ 5 Amp	1
68	20050092	26-1006-7082-2	COMPOUND, Thermalcote, #251	0.05

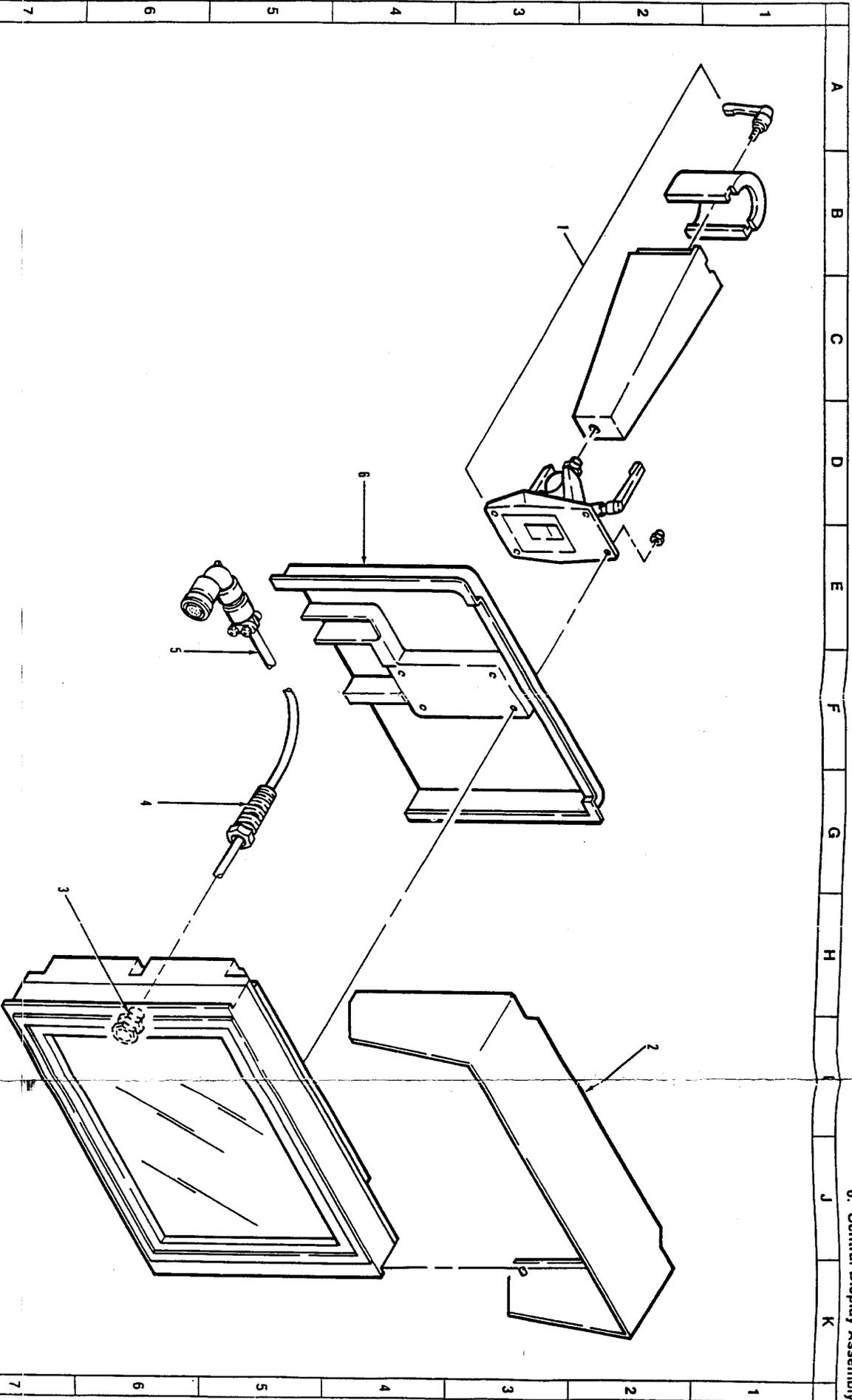




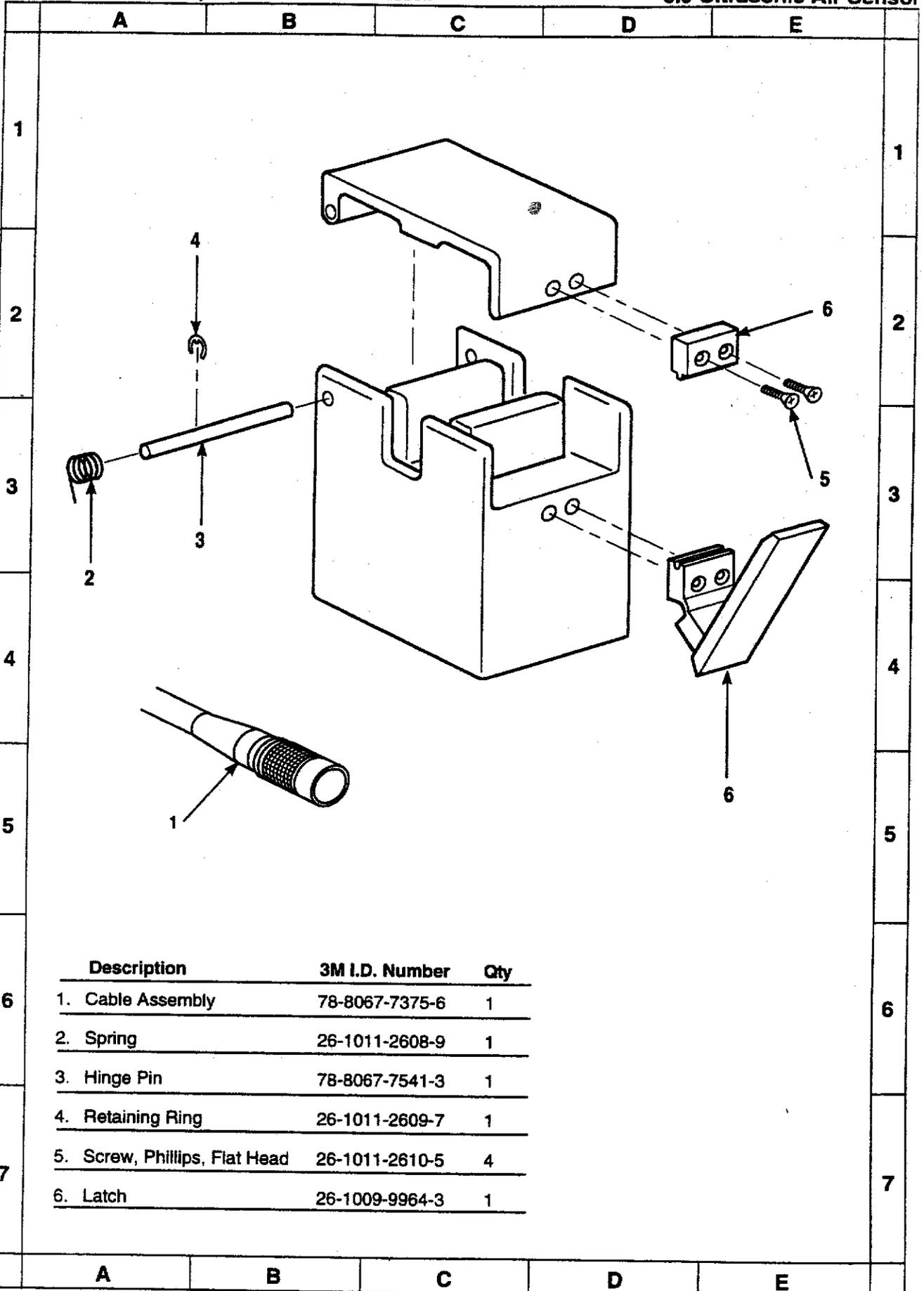
Item No.	Sarna P/N	3M P/N	Description	Qty.
1	16604801	78-8067-0940-4	PC ASY, Capacitor Board	1
2	24110050	26-1008-1071-7	RECTIFIER, Diode, Modified, 1200V @ 70A	3
3	20050092	26-1006-7082-2	COMPOUND, Thermacote, 251	.100
4	23360038	26-1006-7484-0	TRANSFORMER, Power, 100/115/230, 46 VCT	3
5	23360037	26-1006-7485-7	TRANSFORMER, Power, 100/115/230, 60 VCT	1
6A	23420402	26-1006-6716-6	FUSE, Slo-Blo, 2.5 Amp, Glass (100/115V)	1
6B	23420401	78-8005-3889-0	FUSE, Slo-Blo, 1.25 Amp, Glass (220/240V)	1
7A	23420408	26-1006-6715-8	FUSE, Slo-Blo, 8 Amp, Ceramic (100/115V)	3
7B	23420405	26-1008-2354-6	FUSE, Slo-Blo, 4 Amp, Ceramic (220/240V)	3
8	23300011	26-1008-1052-7	LIMITER, Current, 16A (220/240V)	1
9	16470201	78-8067-0045-2	B' OCK, Terminal	1



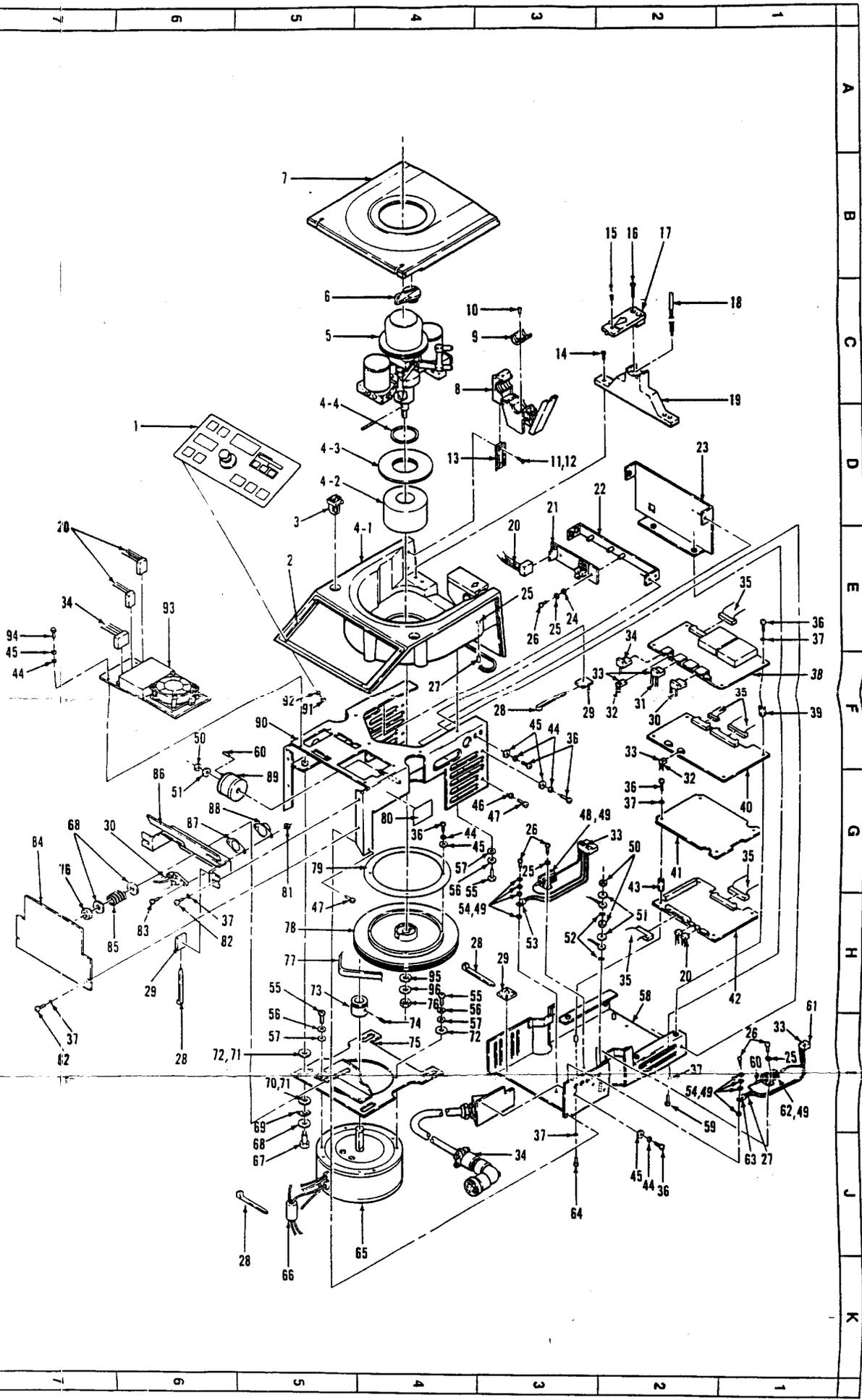
Item No.	Sarns P/N	3M P/N	Description	Qty.
1	16434101	98-0702-0275-3	Instrument Tray & Long Mounting Arm	-
2	16505901	98-0702-0305-8	Long Mounting Arm with 5/8 in Pole	-
3	16066100	98-0702-0211-8	Pressure Transducer Monitoring Kit	-
4	16433301	78-8066-6721-4	Pressure Transducer, Wide Range	-
5	22300030	98-0702-0353-8	Holder, Pressure Transducer	-
6	16505801	98-0702-0304-1	Short Mounting Arm with 5/8 in Pole	-
7	N/A	78-8066-6027-6	Hose Adapter Set, NCG	-
8	16458601	78-8066-6728-9	Level Sensor Transducer	-
9	16432901	98-0702-0272-0	Level Sensor Pads (20 pairs)	-
10	23008035	26-1008-4360-1	Wall Plug, Three Prong	-
11	23001029	26-1006-8315-4	Wall Plug, Twist Lock	-
12	N/A	78-8066-6029-2	Hose Adapter Set, OH Diamond	-
13	N/A	78-8066-6028-4	Hose Adapter Set, D.I.S.S. Hand Tight	-
14	15020	98-0702-0111-0	Air Sensor, 1/4	-
15	13540	98-0702-0066-6	Air Sensor, 3/8	-
16	16434701	98-0702-0276-1	Lamp	-
17	N/A	78-8066-6026-8	Hose Kit, US, 3 hoses (also order 7,12, or 13)	-
18	N/A	78-8066-6025-0	Hose Kit, OUS, 3 hoses	-
19	16553401	98-0702-0332-2	Pole, 4 feet long x 1.3 OD	-
20	16548101	98-0702-0326-4	Pole, 3 feet long	-
21	16553301	98-0702-0331-4	Pole, 2 feet long x 1.3 OD	-
22	16431701	98-0702-0271-2	Telescoping Pole, 5 to 7 ft., with Solution Rack	-
23	16553101	98-0702-0329-8	Extended Pole Bracket Kit, Console Side	-
24	16553001	98-0702-0328-0	Standard Pole Bracket Kit, Console Rear	-
25	16553201	98-0702-0330-6	Corner Pole Bracket Kit, Console Corner	-
26	164595	98-0702-0286-0	Gas Hose, 95% Oxygen, 5% Carbon Dioxide	-
27	164575	98-0702-0285-2	Water Module Asy (See Section 11)	-
28	16462401	78-8066-7520-9	Tube Clamp Asy	-
29	164560	98-0702-0283-7	Occluder Asy (See Section 9)	-
	16551701		level sensor transducer spring	
		78-8066-6067-8	transducer mount assembly	







Description	3M I.D. Number	Qty
1. Cable Assembly	78-8067-7375-6	1
2. Spring	26-1011-2608-9	1
3. Hinge Pin	78-8067-7541-3	1
4. Retaining Ring	26-1011-2609-7	1
5. Screw, Phillips, Flat Head	26-1011-2610-5	4
6. Latch	26-1009-9964-3	1



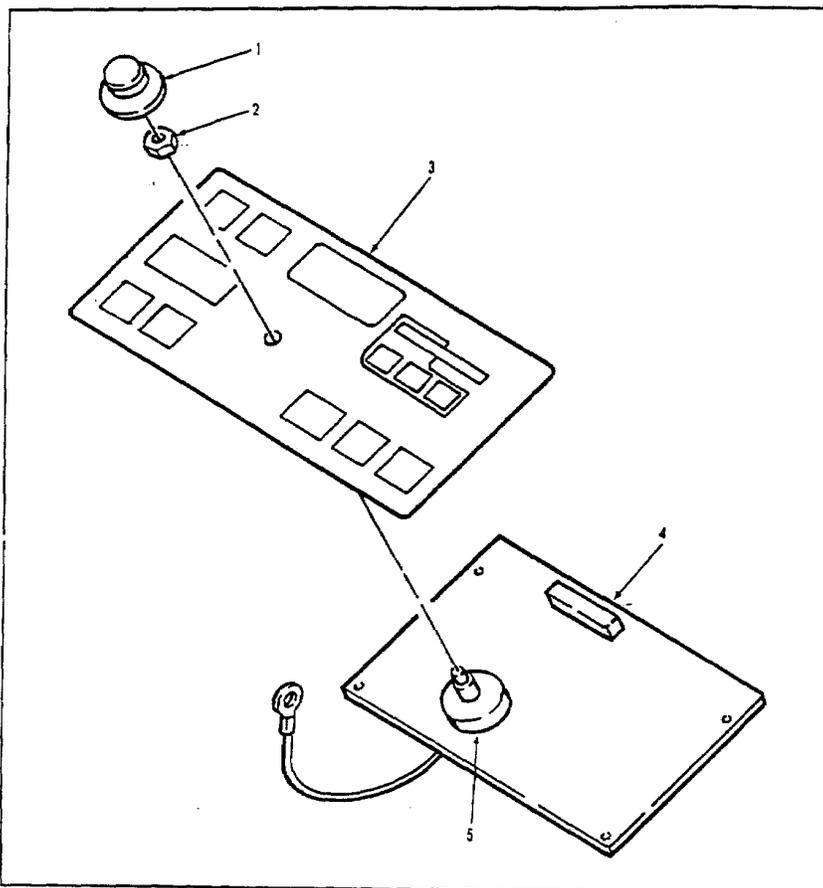
Item No.	Sams P/N	3M P/N	Description	Qty.
1	16565201	78-8066-6289-2	PANEL ASY, Display/Membrane (See Sect. 8)	1
2	22510021	78-8005-0601-2	SEAL, Silastic, Clear UL	.040
3	22192906	26-1006-9168-7	LATCH, 1/4 Turn, .182 - .271 Grip	2
4	N/A	78-8067-1688-8	CASTING/BEARING ASY, incl. 4-1 through 4-4	-
4-1	16425501	78-8066-7466-5	PUMPHEAD, Machined	1
4-2	21011200	26-1008-0599-8	BALL BEARING, 2 Row, 1.2 ID X 2.8 OD	1
4-3	16549601	78-8066-7587-8	CAP, Bearing, Machined, Aluminum	1
4-4	22869152	26-1008-2123-5	SEAL, Oil, Rotating Shaft, Teflon	1
5	16431301	78-8066-7470-7	GUTS ASY, Roller Pump (See Section 9)	1
6	16455401	78-8066-6269-4	HINGE, Cover	2
7	16490001	78-8066-6733-9	COVER ASY, Roller Pump	1
8	16462401	78-8066-7520-9	CLAMP ASY, Tube	2
9	4467013	78-8066-7723-9	INSERT, Tubing, 11/16	4
10	22114105	12-7996-6665-1	SCREW, Flat Head, 4-40 X 5/16	4
11	22114205	70-7023-4040-0	SCREW, Flat Head, 6-32 X 5/16	4
12	20050012	26-1008-1633-4	LOCTITE, 242, 50 ml	.002
13	16460601	78-8066-6271-0	SLIDE, Dovetail, Tube Clamp	2
14	22114308	12-7997-9109-5	SCREW, Flat Head, 8-32 X 1/2	4
15	14875010	78-8066-6248-8	INSERT, Drag, BUNA N, Delux Head	1
16	N/A	26-1008-4686-9	SCREW, Phillips Oval Head, 8-32 X 1	2
17	16436301	78-8066-9919-1	TONGUE, Molded Roller Pump	1
18	23688051	26-1008-9049-5	SENSOR, Magnetic Proximity	1
19	16460701	78-8072-1495-8	TONGUE, Roller Pump Wall Support	1
20	16508201	78-8067-0262-3	CABLE ASY, Roller Pump MTAS	1
21	16484601	78-8066-6282-7	PC ASY, Dual Tachometer Board	1
22	16431101	78-8066-9894-6	BRACKET, Encoder Board Mounting	1
23	16588401	78-8067-0869-5	BRACKET, Roller Pump Back	1
24	22746006	26-1008-9069-3	WASHER, 5710-15-30 SS	3
25	22755001	26-1000-3349-2	WASHER, Split, #4, SS	7
26	22197104	26-1008-8040-5	SCREW, Button Head Torx, 4-40 X .25	9
27	23119039	26-1006-7179-6	TUBING, Shrink, 1/8, Clear, UL	.750
28	23850076	26-1008-4315-5	TIE-WRAP, Tyton #T18R	13
29	23850080	26-1008-0845-5	MOUNT, Cable, Adhesive	6
30	16507801	78-8067-0259-9	CABLE ASY, Trans Socket, Roller Pump	1

## 7. Roller Pump Assembly

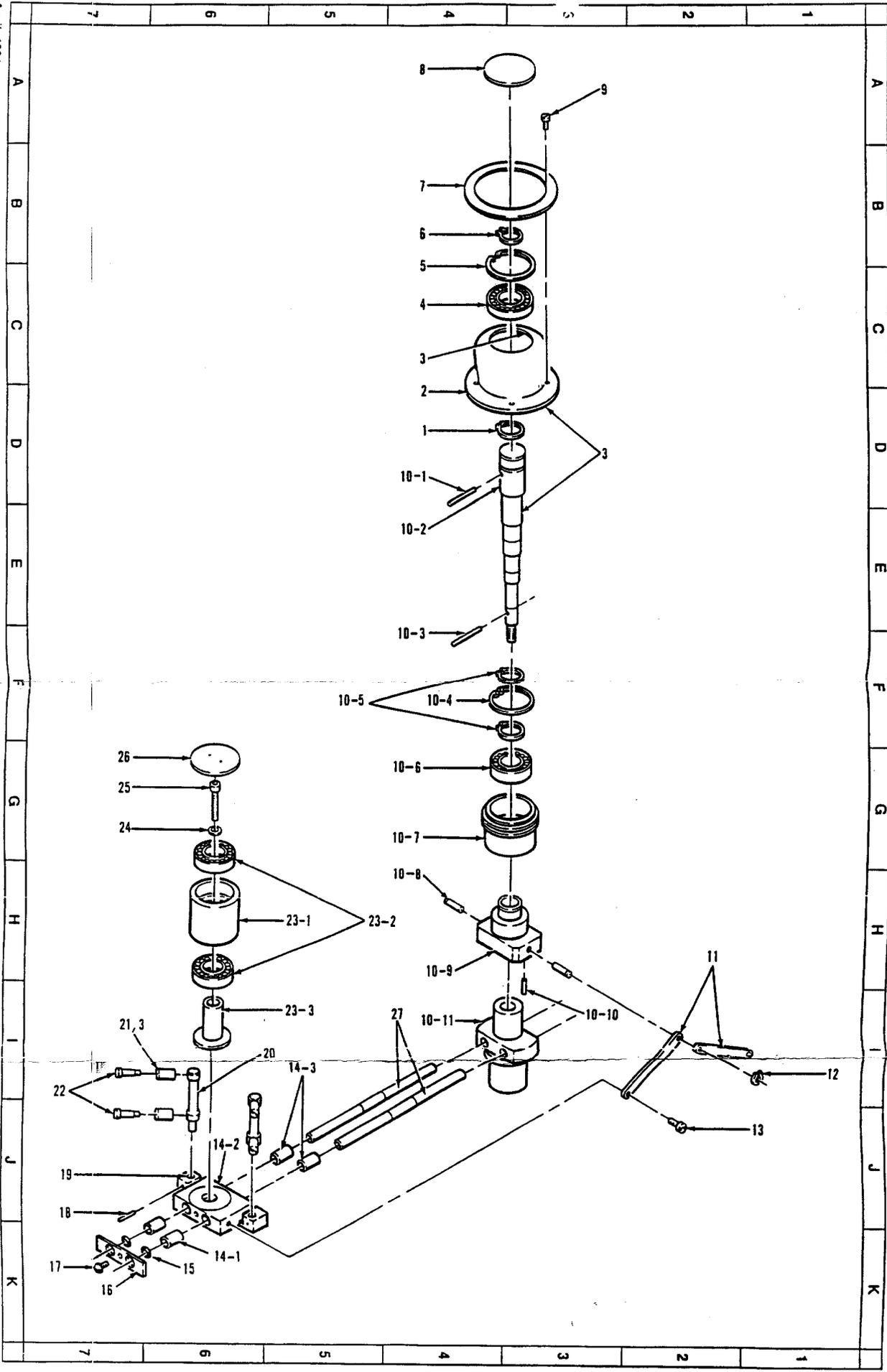
Sarna™ 9000 Perfusion System Illustrated Parts Breakdown

Item No.	Sarna P/N	3M P/N	Description	Qty.
31	23006062	26-1008-2032-8	CONNECTOR, MTA Housing, 3 Pin, 18 Gage	1
32	23006130	26-1004-0455-2	CONNECTOR, MTA Housing, 3 Pin, 22 Gage	2
33	26000010	26-1007-8560-2	Label, .65 X .20, Polyester, White	5
34	16590401	78-8066-6746-1	CABLE ASY, Roller Pump	1
35	16508101	78-8067-0261-5	CABLE ASY, Roller Pump Ribbons	1
36	22197206	26-1008-8044-7	SCREW, Button Head Torx, 6-32 X .38	21
37	22763002	18-9851-0603-0	WASHER, Lock, #6 External Tooth	18
38	16471901	78-8066-6278-3	PC ASY, Roller Pump Drive	1
39	23810036	26-1007-5718-9	STANDOFF, 6-32 X .5, M/F, Aluminum	4
40	16468301	78-8066-6278-5	PC ASY, Roller Pump Control	1
41	16446501	78-8066-6268-6	PC ASY, Local Processor Board	1
42	16474101	78-8066-6280-1	PC ASY, Roller Pump Safety	1
43	22978212	26-1006-8292-5	STANDOFF, 6-32 X 3/4, Nylon, Hexagonal	4
44	22773002	26-1000-0078-0	WASHER, Split, #6, SS	17
45	22745002	18-9813-0675-8	WASHER, Flat, #6, SS	17
46	22773003	18-9832-0875-4	WASHER, Split, #8, SS	2
47	22197306	26-1008-8047-0	SCREW, Button Head Torx, 8-32 X .38	4
48	23230024	26-1008-1038-6	RESISTOR, .1 ohm, 25 watt, 1%	1
49	20050092	26-1006-7082-2	COMPOUND, Thermancote, 251	.001
50	22723003	26-1000-6654-2	KEPS NUT, 8-32, Steel	3
51	22743003	26-1008-1921-3	WASHER, Flat, #8	3
52	22763003	18-9851-0803-6	WASHER, Lock, #8 External Tooth	2
53	24110014	26-1008-0735-8	RECTIFIER, Diode, MR2404F	1
54	23890062	26-1008-0809-1	KT, Insulation Mounting, TO-220	2
55	22197409	26-1008-8051-2	SCREW, Button Head Torx, 10-32 X .50	9
56	22755004	77-8007-6245-0	WASHER, Split, #10, SS	9
57	22745004	26-1008-1929-6	WASHER, Flat, #10, SS	9
58	16591001	78-8067-0884-4	ENCLOSURE, Roller Pump Bracket Bottom	1
59	22197204	26-1008-8043-9	SCREW, Button Head Torx, 6-32 X .25	2
60	23119040	26-1006-7180-4	TUBING, Shrink, 3/16, Clear, UL	.500
61	23006075	26-1008-2009-6	CONNECTOR, MTA Housing, 4 Pin, 22 Gage	1
62	23230041	26-1008-1041-0	RESISTOR, 50 ohm, 25 watt, 1%	1
63	24131005	26-1008-1097-2	TRANSISTOR, Power, PNP, 8 amp, 50 watt	1
64	22197210	26-1008-8046-2	SCREW, Button Head Torx, 6-32 X .63	4

Item No.	Sams P/N	3M P/N	Description	Qty.
65	21770011	26-1008-0601-2	MOTOR/TACHOMETER, U12M4T, Heavy Duty	1
66	23029902	26-1007-5202-6	BEAD, Ferrite, .25 ID X 1.1 Long	1
67	22195669	26-1008-2419-7	SCREW, Shoulder, 5/16 Thread X .375	4
68	22745009	26-1008-1891-8	WASHER, .75 OD X .318 ID X .075, SS	6
69	22793007	26-1005-7759-7	SPRING	4
70	22745010	26-1008-1892-6	WASHER, .75 OD X .720 ID X .105	4
71	20050093	26-1008-4062-3	LUBRICAM, SL2	.050
72	22746009	26-1008-1895-9	WASHER, .12T X .315 ID	6
73	16428201	78-8066-6720-6	PULLEY, Small Machined	1
74	22187504	18-3414-5015-5	SCREW, Set, 1/4 -20 X 1/4, Black	1
75	16448101	78-8072-1425-5	MOUNT, Motor, Roller Pump Bracket	1
76	22733007	26-1008-4384-1	NUT, Stop, El, 3/8-16, 90566D	2
77	21230560	26-1006-6708-3	BELT, Polyflex Joined	1
78	16549801	78-8066-6740-4	PULLEY, Large Flat Machined	1
79	16472701	78-8067-0059-3	ENCODER, Roller Pump Wheel	1
80	16487301	78-8067-0156-7	LABEL, Nameplate, 1.5 X 1.0	1
81	22723001	26-1003-4052-5	NUT, Keps, 4-40, Steel	2
82	22144206	78-8005-5342-8	SCREW, Truss Head, 6-32 X 3/8, SS	4
83	22197108	26-1008-8042-1	SCREW, Button Head Torx, 4-40 X .50	2
84	16588301	78-8067-0868-7	BRACKET, Front, Roller Pump	1
85	20000023	26-1008-2134-2	SPRING, Compression, .61 OD X .75L X .091	1
86	16448201	78-8072-1426-3	BRACKET, Roller Pump Spring	1
87	23890101	26-1008-0823-2	INSULATOR, Mica, TO-3	1
88	24130012	26-1008-0700-2	TRANSISTOR, Power, NPN	1
89	23300010	26-1008-4134-0	CHOKE, Power, Line, 270 microhenry, 11 amp	1
90	16591101	78-8067-0761-4	BRACKET, Roller Pump Top Enclosure	1
91	22144103	12-7996-8598-2	SCREW, Truss Head, 4-40 X 3/16	4
92	22746200	26-1008-1896-7	WASHER, FLAT, 3/16, Nylon	6
93	16485101	78-8066-6283-5	PC ASY, Roller Pump Supply Board	1
94	22162006	26-1002-5367-8	SCREW, Hex Head, 6-32 X 3/8	4
95	22743007	18-9832-2403-3	WASHER, Flat, 3/8	1
96	22753007	12-7991-1789-5	WASHER, Split, 3/8	1

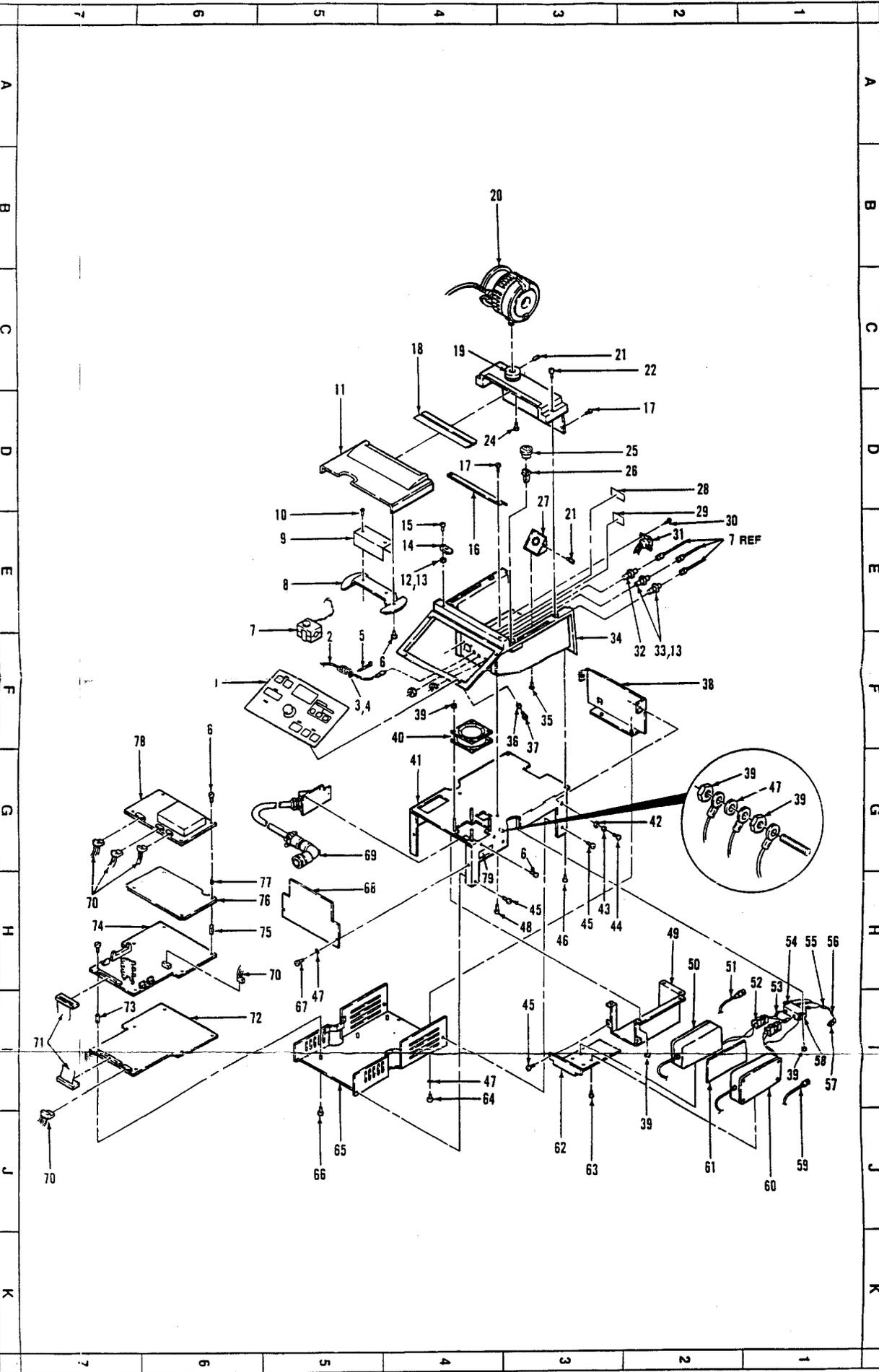


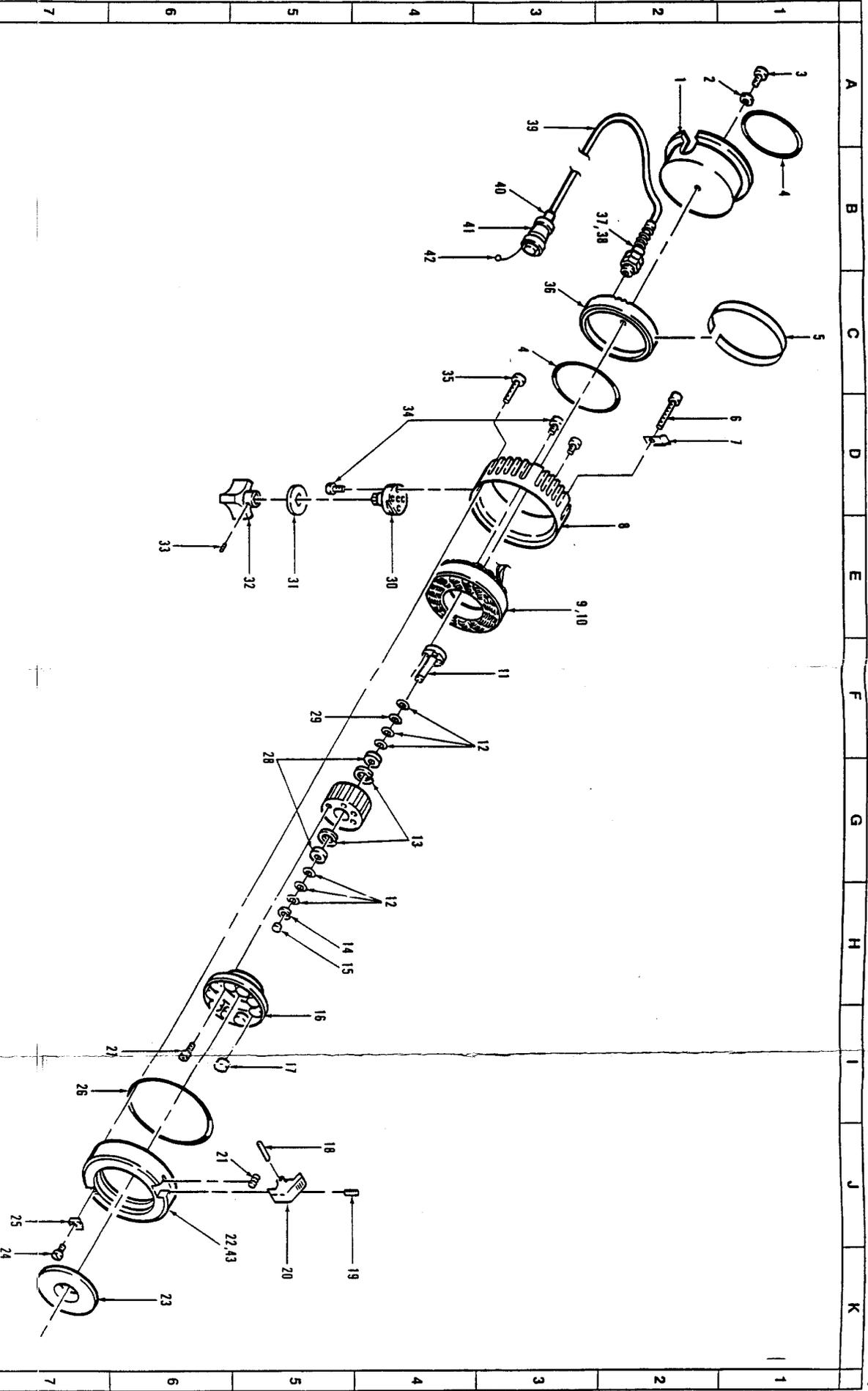
Item No.	Sarna P/N	3M P/N	Description	Qty.
1	23890040	26-1008-0613-7	SEAL, APM, 1/4 Shaft, N-8030	1
2	23800091	26-1006-6870-1	KNOB, 1.25 Diameter, Black	1
3	<del>16445401</del>	<del>78-8066-7516-7</del>	MEMBRANE, Roller Pump Switch Panel	1
4	16445401	78-8066-7501-9	PC ASY, Roller Pump Display Board	1
5	16507901	78-8066-8951-5	POTENTIOMETER AND CABLE ASY	1



Item No.	Sams P/N	3M P/N	Description	Qty.
1	22204078	26-1006-6722-4	SNAP RING, .78 ID, 5101	1
2	16531101	78-8067-0380-3	KNOB, Adjustable, Acme Thread	1
3	20050090	26-1008-4423-7	LUBRICANT, Distributor Cam	.100
4	21011180	26-1006-6720-8	BALL BEARING, Deep Groove, .79 ID	1
5	22203145	26-1006-6721-6	SNAP RING, Bow/Internal 1.45 Housing	1
6	22202078	26-1006-6723-2	SNAP RING, External, .781 ID	1
7	16472601	78-8067-0058-5	DIAL, Roller Pump Indicator	1
8	N/A	78-8066-7958-1	CAP ASY, Adjustment Knob	1
9	22134002	78-8005-9317-6	SCREW, Pan Head, 2-56 X 1/8, SS	4
10	16431401	78-8066-9896-1	ROLLER PUMP SHAFT ASY	1
10-1	22412075	26-1002-4557-5	PIN, Roll, 1/8 X 3/4	1
10-2	16429501	78-8066-9889-6	SHAFT, Roller Pump Main	1
10-3	22412110	26-1000-3216-3	PIN, Roll, 1/8 X 1.0, SS	1
10-4	22204078	26-1006-6722-4	SNAP RING, .78 ID, 5101	2
10-5	22203145	26-1006-6721-6	SNAP RING, Bow/Internal 1.45 Housing	1
10-6	21011180	26-1006-6720-8	BALL BEARING, Deep Groove, .79 ID	1
10-7	16531201	78-8067-0381-1	STUB, Adjustable Screw, Acme Thread	1
10-8	4318051	78-8066-7711-4	PIN	2
10-9	16429201	78-8066-9888-8	BLOCK, Roller Pump Guide Bar	1
10-10	22412050	26-1005-0955-8	PIN, Roll, 1/16 X 1/2	2
10-11	16429101	78-8066-9887-0	COLLAR, Support	1
11	14304001	78-8066-6233-0	LINK, Shoulder	4
12	22202018	26-1008-3139-0	SNAP RING, 5100 18	2
13	14322010	78-8066-7182-8	SCREW, Machined Shoulder	4
14	16519301	78-8067-0336-5	ROLLER PUMP SLIDE/BUSHING ASY	2
14-1	21000039	26-1006-6669-7	BUSHING, Oilube, .3145 X .4405 X 1/2	2
14-2	16519201	78-8067-0335-7	SLIDE, Roller Pump Machined	1
14-3	21000040	26-1006-6668-9	BUSHING, Oilube, .3145 X .4405 X 5/8	2
15	22804375	26-1006-6667-1	O-RING, Nitrile, .375 ID	4
16	14299001	78-8066-7178-6	PLATE, Slide Drag	2
17	22144313	26-1008-2179-7	SCREW, Truss Head, 8-32 X .38 with lock	2
18	22409625	18-9260-5815-9	PIN, Roll, 3/32 X 5/8	4
19	N/A	26-1004-6165-1	LOCTITE, Super Bond 420	.010
20	164_8801	78-8066-9886-2	POST, Roller Pump Guide	4







Item No.	Sarns P/N	3M ID	Description	Qty.
35	22114208	12-7996-8116-3	SCREW, Flat Head, 6-32 X 1/2, SS	2
36	N/A	26-1008-6546-3	WASHER, Shoulder, Nylon, .192 ID	4
37	N/A	78-8067-0539-4	NUT, Slotted Panel	4
38	16588401	78-8067-0869-5	BRACKET, Back, Centrifugal Pump	1
39	22723002	26-1001-7983-2	NUT, Keps, 6-32, Steel, Zinc Plated	13
40	16565401	78-8067-0741-6	CABLE ASY, Cooling Fan	1
41	N/A	78-8067-3526-8	ENCLOSURE, Electrical, Upper, Delphin II	1
42	22745002	18-9813-0675-8	WASHER, Flat, #6, SS	2
43	22773002	26-1000-0078-0	WASHER, Split, #6, SS	2
44	22197206	26-1008-8044-7	SCREW, Button Head Torx, 6-32 X .38	2
45	22132306	18-4702-7803-9	SCREW, Pan Head, 8-32 X 3/8	2
46	22114408	12-7997-9188-9	SCREW, Flat Head, 10-32 X 1/2, SS	4
47	22763002	18-9851-0603-0	WASHER, Lock, External Tooth, #6	5
51	N/A	78-8066-9988-6	CABLE SMB/BNC F/M	1
58	N/A	78-8066-9987-8	CABLE, Line Filter	1
59	N/A	78-8066-9988-6	CABLE SM B/BNC F/M	1
64	22197204	26-1008-8043-9	SCREW, Button Head Torx, 6-32 X .25	2
65	N/A	78-8067-3527-6	ENCLOSURE, Electrical, Lower, Delphin II	1
66	22134208	12-7995-0779-8	SCREW, Pan Head, 6-32 X 1/2, SS	6
67	22144206	78-8005-5342-8	SCREW, Truss Head, 6-32 X 3/8, SS	2
68	N/A	78-8066-6432-8	BRACKET, Front	1
69	16601201	78-8067-0931-3	CABLE ASY, Pump/Front Tray	1
70	16556901	78-8066-7595-1	CABLE ASYS	1
71	N/A	78-8066-7304-8	CABLE ASY, Motor Control/Display	1
72	N/A	78-8066-9966-2	PC ASY, Conversion/DSP Board	1
73	23810102	26-1007-5730-6	STANDOFF, F/F, Hexagonal, 6-32 X .62, SS	6
74	N/A	78-8067-1840-5	PC ASY, Motor Control	1
75	23810100	26-1007-5729-8	STANDOFF, M/F, Hexagonal, 6-32 X .75, SS	4
76	N/A	78-8067-1680-5	PC ASY, Local Processor Board	1
77	23810103	26-1007-5731-4	STANDOFF, M/F, Hexagonal, 6-32 X .25, SS	4
78	16525301	78-8066-6738-8	PC ASY, Power Supply	1
79	16487301	78-8067-0156-7	LABEL, Nameplate, 1.50 X 1.0	1

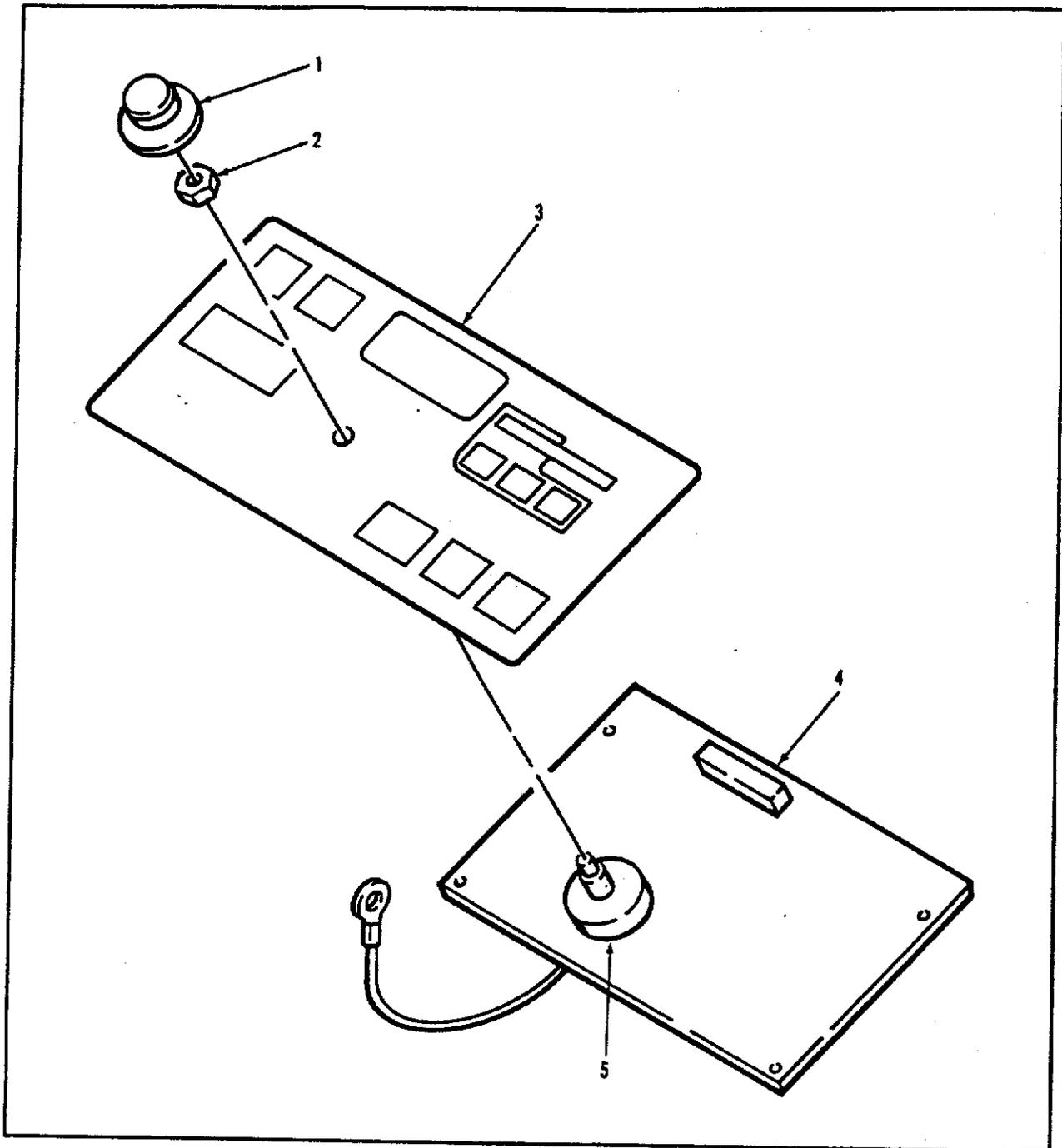
Item No.	Sams P/N	3M P/N	Description	Qty.
1	16587001	78-8066-8954-9	PANEL ASY, Display/Membrane (See Sect. 11)	1
2	N/A	78-8066-6774-3	GROUND WIRE ASY, #18 AWG	1
3	23119042	26-1006-7182-0	TUBING, Shrink, 3/8, Clear	1
4	N/A	26-1004-4334-5	BEAD, Ferrite, .18 ID x .40	2
5	23850076	26-1008-4315-5	TIE-WRAP, Tyton #18	4
6	22134204	26-1000-0197-8	SCREW, Pan Head, 6-32 X 1/4, SS	6
7	164272	98-0702-0060-9	FLOW SENSOR ASY	1
8	16509001	78-8067-0269-8	SPOOL, Centrifugal Pump	1
9	16585901	78-8067-0857-0	SENSOR CLIP, Centrifugal Pump	1
10	22020003	26-1008-2191-2	RIVET, Semitubular	2
11	16579801	78-8067-0821-6	LID, Centrifugal Pump Enclosure	1
12	22746695	26-1006-9205-7	WASHER, .150 X .478 Dia, Neoprene	2
13	20050017	26-1008-1636-7	LOCTITE, 271, 50 ml	.100
14	20040065	26-1006-6769-5	CLIP, Insert, Black	2
15	22134206	78-8005-8615-4	SCREW, Pan Head, 6-32 X 3/8, SS	2
16	16509501	78-8067-0271-4	ROOF, Connector, Centrifugal Pump	1
17	22134104	77-8007-5129-7	SCREW, Pan Head, 4-40 X 1/4, SS	4
18	20300028	26-1006-8109-2	HINGE, Slip-Over, Panel, .012	6.2in
19	16508501	78-8067-0265-6	PUMP MOUNT, Centrifugal Pump	1
20	164267	98-0702-0259-7	DRIVE MOTOR, Cent. Pump (See Section 12)	1
21	22030000	26-1008-0998-2	BALL PLUNGER, Nylon, 1/4-20	2
22	22134312	26-1000-0705-8	SCREW, Pan Head, 8-32 X 3/4	2
23	16585501	78-8067-0855-4	TOP, Machined, Centrifugal Pump Enclosure	1
24	22134212	26-1003-5292-6	SCREW, Pan Head, 6-32 X 3/4, SS	2
25	20040070	26-1006-3612-0	PLUG, Hole, .75 Diameter, Black, Nylon	2
25	22192906	26-1006-9168-7	LATCH, 1/4 Turn, .182 - .271 Grip	2
27	16585801	78-8067-0856-2	MOTOR MOUNT, Internal, Centrifugal Pump	1
28	16607301	78-8067-0945-3	LABEL Connector, Centrifugal Pump	1
29	N/A	78-8066-7860-9	LABEL Transmitter/Sensor Hook-Up	1
30	22134108	26-1000-3175-1	SCREW, Pan Head, 4-40 X 1/2, SS	4
31	16567701	78-8067-0754-9	CABLE ASY, Motor Control/Motor	1
32	N/A	26-1006-7340-4	CONNECTOR, 2 Pin, Receptacle Lemo	1
33	N/A	26-1008-3396-6	RECEPTACLE, Bulkhead, BNC, Stetco	2
34	16585401	78-8067-0854-7	BASE, Machined, Centrifugal Pump Enclosure	1

# 10. Centrifugal Pump Assembly

Sams™ 9000 Perfusion System Illustrated Parts Breakdown

Item No.	Sams P/N	3M P/N	Description	Qty.
35	22114208	12-7996-8116-3	SCREW, Flat Head, 6-32 X 1/2, SS	2
36	22746200	26-1008-1896-7	WASHER, Flat, Nylon, 3/16	4
37	22144103	12-7996-8598-2	SCREW, Truss Head, 4-40 X 3/16	4
38	16588401	78-8067-0869-5	BRACKET, Back, Centrifugal Pump	1
39	22723002	26-1001-7983-2	NUT, Keps, 6-32, Steel, Zinc Plated	13
40	16565401	78-8067-0741-6	CABLE ASY, Cooling Fan	1
41	16596101	78-8067-0917-2	ENCLOSURE, Electrical, Upper	1
42	22745002	18-9813-0675-8	WASHER, Flat, #6, SS	2
43	22773002	26-1000-0078-0	WASHER, Split, #6, SS	2
44	22197206	26-1008-8044-7	SCREW, Button Head Torx, 6-32 X .38	2
45	22132306	18-4702-7803-9	SCREW, Pan Head, 8-32 X 3/8	4
46	22114408	12-7997-9188-9	SCREW, Flat Head, 10-32 X 1/2, SS	2
47	22763002	18-9851-0603-0	WASHER, Lock, External Tooth, #6	5
48	22132408	70-7023-2840-5	SCREW, Pan Head, 10-32 X 1/2	2
49	N/A	78-8066-6924-4	ENCLOSURE, Transmitter/Receiver Boxes	1
50	16606401	78-8066-8955-6	TRANSMITTER ASY	1
51	N/A	78-8066-6655-4	CABLE ASY, Transmitter	1
52	N/A	78-8066-7329-5	PLUG ASY, Transmitter/Receiver Power	1
53	23119034	26-1006-7185-3	TUBING, Shrink, 1/8, Black	.20ft
54	23022029	26-1008-0889-3	TERMINAL 8 Ring, 22 -18 Gage	1
55	23119036	26-1006-7183-8	TUBING, Shrink, 1/4, Black	.10ft
56	N/A	26-1008-2899-0	CABLE, 2 Conductor, Shielded, 22 AWG	1.3ft
57	23006130	26-1004-0455-2	CONNECTOR, Housing, MTA, 3 Pin, 22 Gage	1
58	23300040	26-1008-8870-5	FILTER, RFI, 1 amp	1
59	N/A	78-8066-6655-4	CABLE ASY, Receiver	1
60	16606501	78-8066-8956-4	RECEIVER ASY	1
61	N/A	78-8066-6923-3	INSULATORS, Polyester Film Matte	1
62	N/A	78-8066-6925-1	SLIDE, Lexan, Transmitter/Receiver	1
63	22114206	12-7996-6649-5	SCREW, Flat Head, 6-32 X 3/8, SS	4
64	22197204	26-1008-8043-9	SCREW, Button Head Torx, 6-32 X .25	2
65	16596001	78-8067-0916-4	ENCLOSURE, Electrical, Lower	1
66	22134208	12-7995-0779-8	SCREW, Pan Head, 6-32 X 1/2, SS	6
67	22144206	78-8005-5342-8	SCREW, Truss Head, 6-32 X 3/8, SS	2
68	N/A	78-8066-6431-8	BRACKET, Front	1



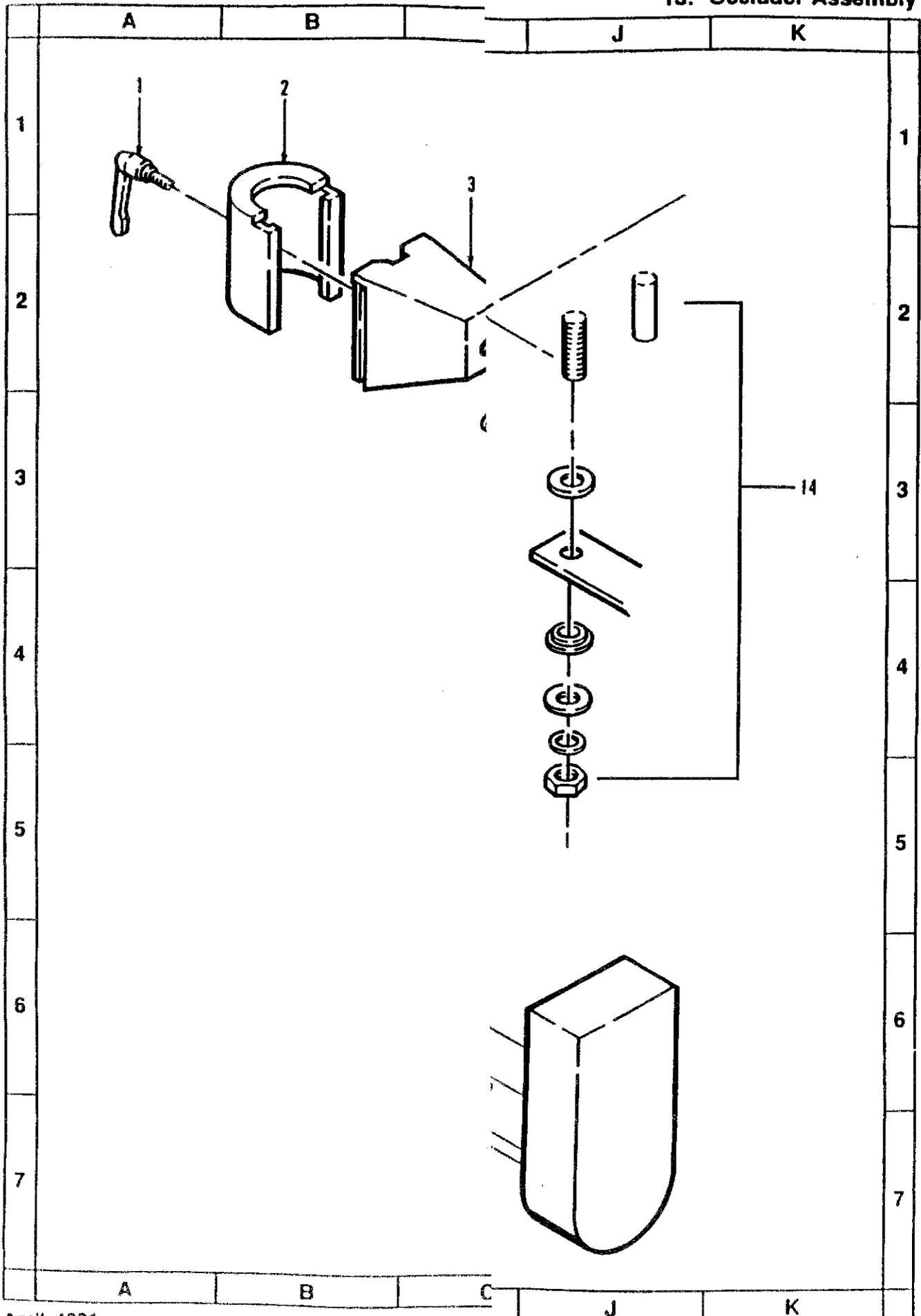


Item No.	Sams P/N	3M ID	Description	Qty.
1	23890040	26-1008-0613-7	SEAL, APM, 1/4 Shaft, N-9030	1
2	23800091	26-1006-6870-1	KNOB, 1.25 Diameter, Black	1
3	N/A	78-8066-6700-8	MEMBRANE, Roller Pump Switch Panel D2	1
4	16445401	78-8066-7501-9	PC ASY, Centrifugal Pump Display Board	1
5	N/A	78-8067-0989-1	POTENTIOMETER AND CABLE ASY	1

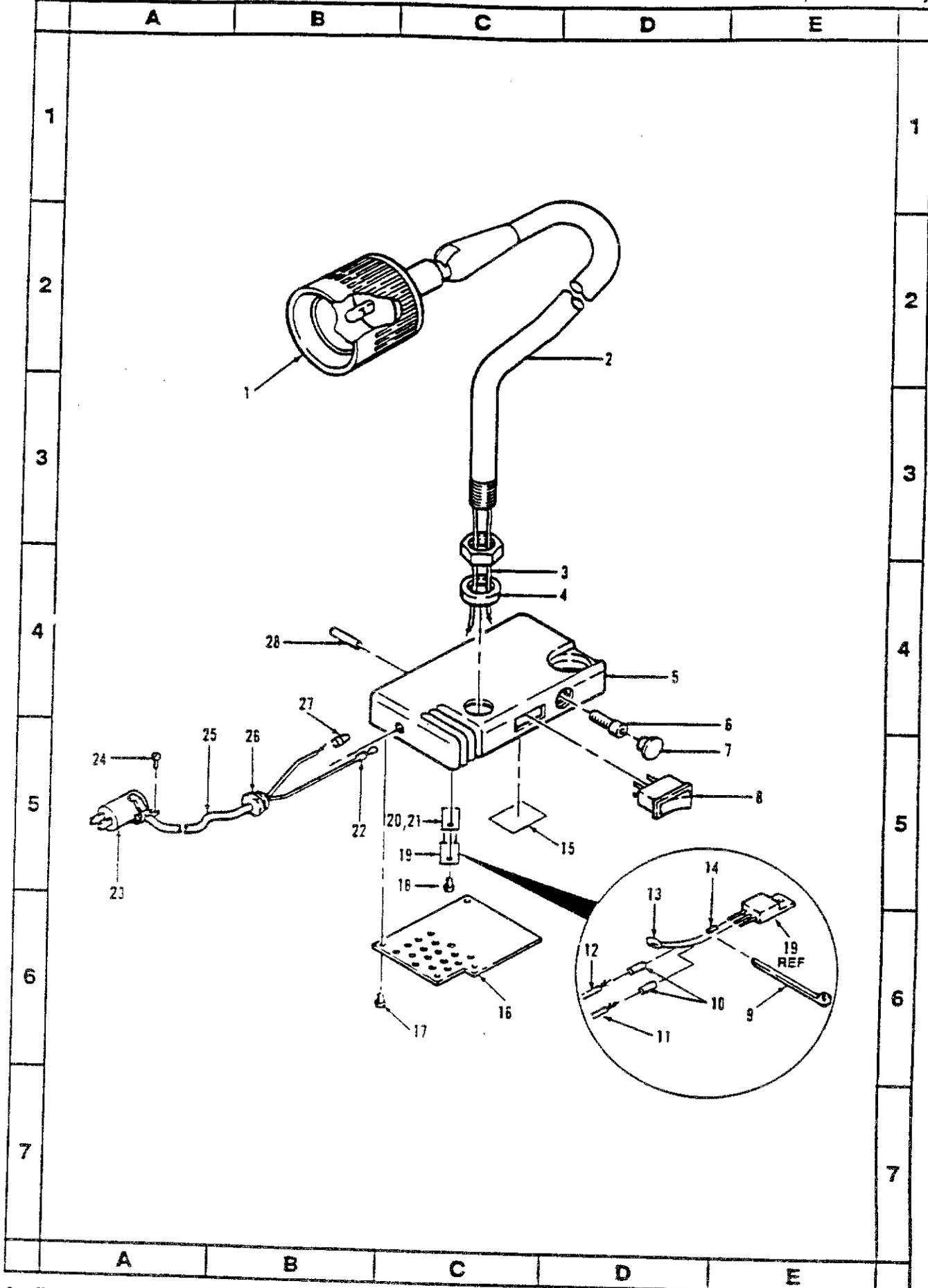
Item No.	Sams P/N	3M P/N	Description	Qty.
1	16577501	78-8067-0809-1	SPOOL, Cord, Drive Motor	1
2	22746691	26-1008-9060-2	WASHER, .141 ID X .625 D X .060 Thick, Nylon	1
3	22197210	26-1008-8046-2	SCREW, Button Head Torx, 6-32 X .63	1
4	22802156	26-1006-9214-9	O-RING, 2.38 ID X 2.50 OD X .06 Thick	2
5	16440101	78-8066-7485-5	NAMEPLATE, Drive Motor	1
6	22170221	26-1008-6353-4	SCREW, Socket Head Cap, 6-32 X 1 1/2, SS	1
7	16588901	78-8067-0870-3	CLIP, Drive Motor Cord Spool	1
8	16442801	78-8066-9947-2	HOUSING, Drive Motor Rear	1
9	21740000	26-1008-2171-4	MOTOR, Inland, RBE-01801-D02	1
10	20050092	26-1006-7082-2	COMPOUND, Thermalcote #251	.001
11	16443101	78-8066-7493-9	SHAFT, Drive Motor Rotor	1
12	22791002	26-1008-8897-8	SPACER, .315 X .500 X .002 Thick, SS	AR
12	22791004	26-1008-8898-6	SPACER, .315 X .500 X .004 Thick, SS	AR
12	22791006	26-1008-8896-0	SPACER, .315 X .500 X .006 Thick, SS	AR
12	22791008	26-1008-8899-4	SPACER, .315 X .500 X .008 Thick, SS	AR
12	22791010	26-1008-8895-2	SPACER, .315 X .500 X .010 Thick, SS	AR
12	22791012	26-1008-8900-0	SPACER, .315 X .500 X .012 Thick, SS	AR
12	22791016	26-1008-8901-8	SPACER, .315 X .500 X .016 Thick, SS	AR
12	22791030	26-1008-8894-5	SPACER, .315 x .500 X .030 Thick, SS	AR
13	22202065	78-8656-3669-6	SNAP RING, Internal, .694	2
14	22202031	26-1008-1596-3	SNAP RING, Truarc 5100-31	1
15	20020026	26-1008-0596-4	PAD, Felt, 3/8 Diameter X 3/32 Thick	1
16	16443001	78-8066-9948-0	HUB, Drive Motor Magnet	1
17	16437201	78-8066-9925-8	MAGNET, Pump Drive Motor	10
18	22420062	26-1008-1613-6	PIN, Dowel, .0625 Diameter X .750 Long, SS	1
19	22187205	12-7996-4105-0	SCREW, Set, 6-32 X 5/16, SS	2
20	16436901	78-8066-6722-2	LATCH, Window, Pump Drive Motor	1
21	20000074	26-1006-6744-8	SPRING, Compression, .25 D X .50 L X .035 W	1
22	16442701	78-8066-9946-4	HOUSING, Front Drive Motor	1
23	16437001	78-8066-6723-0	WINDOW, Pump Drive Motor	1
24	22144108	26-1008-4285-0	SCREW, Truss Head, 4-40 X 1/2, SS	1
25	16437101	78-8066-7478-0	RETAINER, Pump Drive Motor Window	1
26	22803562	26-1006-9215-6	O-RING, 3.50 ID X 3.62 OD X .06 Thick	1
27	22170205	78-8657-3284-2	SCREW, Socket Head Cap, 6-32 X 3/8, SS	5



13. Occluder Assembly



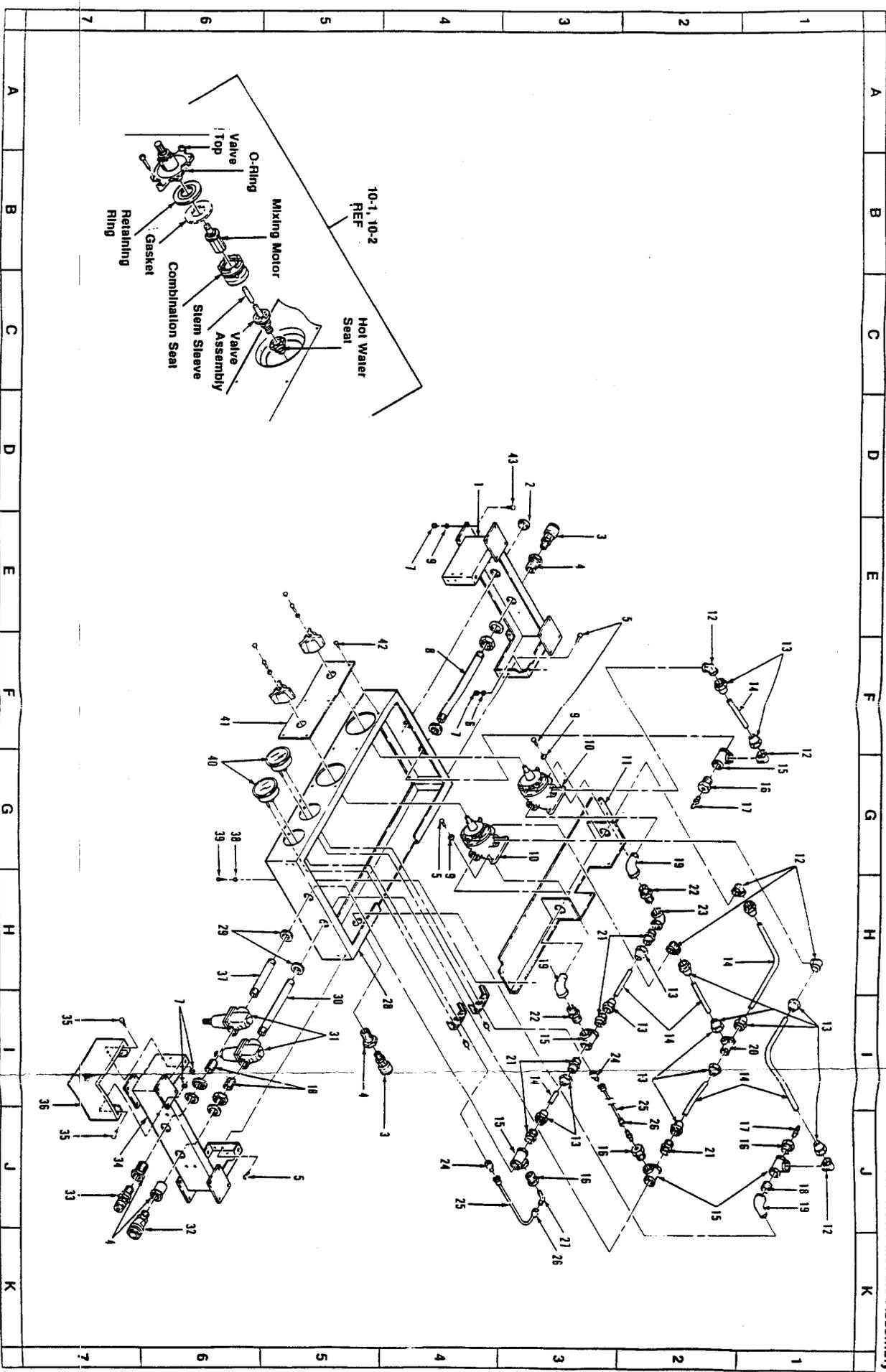




# 14. Lamp Assembly

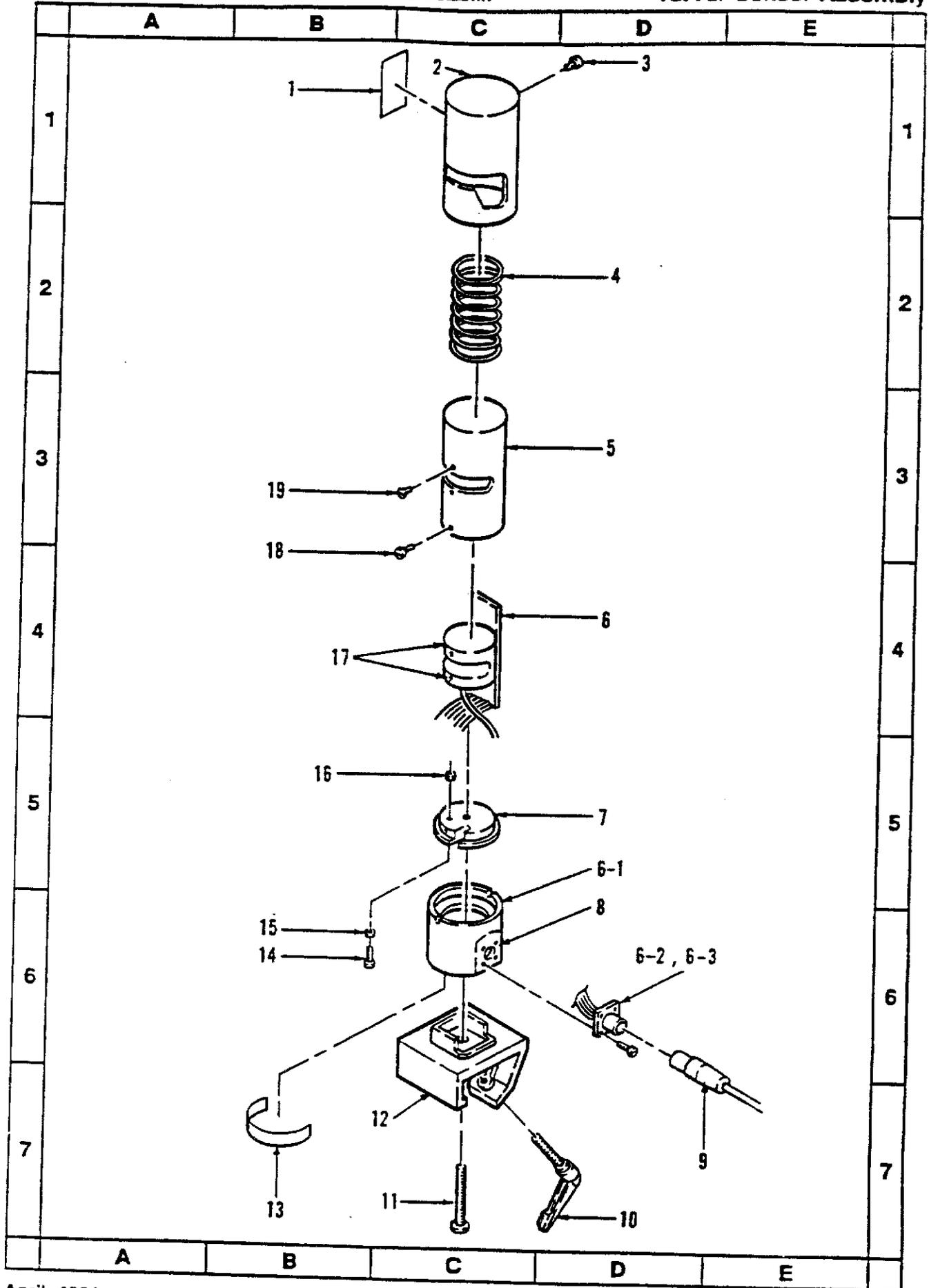
Item No.	Sams P/N	3M P/N	Description	Qty.
1	23702008	26-1006-6710-9	BULB, Halogen, 24V, 20W	1
2	N/A	26-1006-7466-7	ARM, Flexible	1
3	20050017	26-1008-1636-7	LOCTITE, 271, 50ml	.002
4	N/A	78-8066-6919-4	SPACER, Lamp Collar	1
5	N/A	78-8066-6703-2	BRACKET, Lamp Mounting	1
6	22172512	26-1006-6711-7	SCREW, Socket Head Cap, 1/4-20 X 3/4	1
7	20040057	26-1008-4280-1	PLUG, Hole, White	1
8	N/A	26-1006-7464-2	SWITCH, Rocker, SPST	1
9	23850076	26-1008-4315-5	TIE-WRAP, Tyton #T18R	1
10	23119039	26-1006-7179-6	SHRINK TUBING, Clear, 1/8	.200
11	23111225	26-1008-1498-2	WIRE, Black, #22	.250
12	23111234	26-1008-1507-0	WIRE, White, #22	.250
13	24263950	26-1008-2297-7	CAPACITOR, Mono Ceramic, .1M/50/20%	1
14	23119040	26-1006-7170-4	SHRINK TUBING, Clear, 3/16	.010
15	16487301	78-8067-0156-7	LABEL, Nameplate, 1.50 X 1.0	1
16	N/A	78-8066-6496-3	COVER, Lamp Base	1
17	22114104	12-7996-8113-0	SCREW, Flat Head, 4-40 X 1/4	3
18	22134104	77-8007-5129-7	SCREW, Pan Head, 4-40 X 1/4	1
19	N/A	26-1008-0448-8	IC, 7824, +24V Reg, TO-220	1
20	23890062	26-1008-0809-1	KIT, Insulating Mounting, TO-220	1
21	20050092	26-1006-7082-2	COMPOUND, Thermalcote, #251	.100
22	23022027	26-1008-0887-7	TERMINAL, .250 Receptacle, Insulated	2
23	N/A	26-1006-7465-9	PLUG, 2 Pin, TRW P-302-CCE	1
24	22144103	12-7996-8598-2	SCREW, Truss Head, 4-40 X 3/16	2
25	23113062	26-1002-3315-9	CABLE, 2 Conductor, Belden 8461	6ft
26	23830040	78-8003-9076-3	STRAIN RELIEF, Heyco SR-5P-4	1
27	23022009	26-0000-3939-1	NUT, Wire, Stacon RB44	1
28	22418075	26-1000-0050-9	ROLL PIN, .188 Diameter X .750 Long	1

15. Water Module Assembly



Item No.	Sams P/N	3M P/N	Description	Qty.
1	16569701	78-8067-0774-7	RISER, Left Water Module	1
2	20040005	26-1006-6761-2	PLUG, Hole, 1.125 Diameter Steel	1
3	8760010	78-8066-7799-9	SOCKET, Hansen, Nickel Plated	2
4	15990010	78-8066-7405-3	COUPLING, 1/2-14 X 1.5 long	4
5	22190020	26-1008-2155-7	SCREW, SEMS, 1/4 X 3/4	12
6	22743005	26-1008-1923-9	WASHER, Flat, 1/4, Zinc Plated	4
7	22723004	26-1000-0468-3	NUT, Keps, 1/4-20, Cadmium Plated	36
8	25600033	26-1007-8602-4	NIPPLE, 1/2 NPT, 10 long, Brass	1
9	22743010	26-1008-1924-7	WASHER, Flat, #12, Zinc Plated	36
10	16580201	78-8067-0824-0	VALVE, Hydroguard, Water Mixer	2
10-1	25505060	26-1006-6670-5	KT, Motor, includes: O-Ring (Valve Top) Gasket Mixing Motor Stem Sleeve O-Ring (Combination Seat)	-
10-2	25505070	26-1006-6671-3	KT, Valve/Seat, includes: O-Ring (Valve Top) Gasket Stem Sleeve O-Ring (Combination Seat) Valve Assembly Hot Water Seat	-
11	16569501	78-8067-0772-1	BRACKET, Water Module Mixing Valve	1
12	25300010	?	ELBOW, 1/2 Flare X 1/2 MPT long, 49FF	6
13	25303010	?	NUT, Flare, 1/2 Tube, 41F	14
14	25210050	26-0000-6418-3	TUBING, Soft Copper, 1/2 OD X .032 wide	5
15	25610001	26-1008-0547-7	TEE, Brass, 1/2	5
16	25321135	26-1007-7464-0	BUSHING, Pipe, 1/8 to 1/2 NPT	4
17	31006123	98-0702-0360-3	PROBE, 416 Sams 1203	2
18	25600032	26-1007-8601-6	NIPPLE, 1/2 NPT, 1 1/8 long, Brass	3
19	25622775	26-1007-8605-7	ELBOW, Street 90, 1/2, Brass	3
20	25300012	26-1008-1160-8	TEE, 1/2	1
21	25300011	?	CONNECTOR, 1/2 X 1/2 MPT, 48FF	5
22	25602005	26-1008-0544-4	NIPPLE, Hexagonal, 1/2 MPT, Brass	2
23	25622011	12-7992-5684-2	ELBOW, 1/2, Brass	1
24	25321136	26-1007-7465-7	CONNECTOR, Female, 1/2, Polytite	2
25	25220015	26-1007-7458-2	TUBING, 1/4 O/D, Polyethylene	1







# Additional Service Information for Central Display with Colored Screens, System Software 4.0 and Delphin™ II Module 4402

The Sarns™ 9000 Perfusion System Field Service Handbook 78-8066-6212-4/A (with pages dated April 1991) discusses system software 2.3, the monochromatic display and the Delphin™ Module.

This insert packet (with pages dated January, 1993.) contains information regarding system software 4.0, the central display with colored screens and the Delphin™ II Module ("Delphin™ II" on the module cover).

- Keep this introductory page at the front of the manual.
- Insert the new instruction pages into the manual as directed by the third unit of the page number.

For example, insert page 1-1.0 before page 1.1.,  
but insert page 5-26A and 5-26B after page 5.26.

This insert also contains information for the Sarns™ 9000 Perfusion System Illustrated Parts Breakdown 78-8067-1352-2.

- Add the Delphin II Module Assembly in front of the Centrifugal Pump Assembly.
- Replace the Page 11-1 with the new page dated January, 1993.

Sarns  
3M Health Care  
6200 Jackson Road  
Ann Arbor, Michigan 48103 U.S.A.  
(313) 663-4145 or (800) 262-3304  
Telex: 4930456 SARINC

34-9998-2784-2 R/A  
January, 1993  
© 3M 1993

The 3M logo, consisting of the letters '3' and 'M' in a bold, sans-serif font, with the '3' being significantly larger than the 'M'.

### 1-1. System Revision History

- Starting with S/N 4148, all units were built with 2.3M system software.
- Any centrifugal pump with "Delphin™ II" on the module cover has directional flow features; field service handbook insert 34-9998-2784-2 provides new information for the Delphin™ II Modules.
- 4.0M system software started with Central Display 9449 (3M I.D. No. 78-8067-5697-5) which has colored screens; field service handbook insert 34-9998-2784-2 provides new display information.

### 1-3. System Specifications (continued)

#### Delphin™ II Module

##### Requirements

Pump connections use 3/8 in. (9,5 mm) I.D. tubing.

Flow Sensor 164271 needs 3/8 in. (9,5 mm) I.D. x 1/16 in. (1,6 mm) wall tubing.

Flow Sensor 164272 needs 3/8 in. (9,5 mm) I.D. x 3/32 in. (2,4 mm) wall tubing.

##### Performance

Speed range: 0-3600 RPM (no load).

Flow display range: 0.00 - 9.90 L/min, positive and negative.

Flow display numbers flash on the module when indicating negative flows.

Display changes in 0.05 increments from 0.0 to  $\pm 1.5$  L/min.

Display changes in 0.10 increments from  $\pm 1.5$  to 9.9 L/min.

9.90 indicates flow rate of magnitude  $\geq 9.90$  L/min.

Flow sensing accuracy:

$\pm 0.1$  L/min within a range of 0.3 - 1.0 L/min, positive and negative.

$\pm 10\%$  within a range of 1.0 - 7.0 L/min, positive and negative.

Note: Above performance specifications were obtained using medical grade polyvinylchloride tubing, type S-50-HL. Flow rate accuracy is specified for human blood of hematocrit 10-40%, at  $\leq 38^\circ\text{C}$ , using continuous flow.

Outflow capacity: 0-9.9 L/min. Outflow pressure is 0-700 mmHg.

Modes: Continuous flow or asynchronous, pulsatile flow.

#### Temperature Monitoring

For temperature range, "49.9 °C" should be "50 °C".

#### Pressure Monitoring

Note: Monitoring in units of kPa is not available with system software 4.0.

## 2-3. EM/PM Procedures (continued)

### 2-3-1. Preliminary Inspection (continued)

With software 4.0, check the colors on the screens.

10. Record the existing operator settings:

With 4.0 software check that the following colors appear on the Start-Up Test screen.

Light yellow for the "Warning: Read..." text.

Light aqua for the software "Version..." text.

Dark gray for border around diagnostics.

- a. Touch "Customize" on the Start-Up Test Screen.
- b. Record if "STOP CPG WITH ART" is highlighted on the Selection Screen.  
With 4.0 software, record if "No" appears on the button for "Stop CPG with Arterial"; "yes" is the default.
- c. Touch "CUSTOMIZE DISPLAYS". Record if it is set for mmHg or kPa.  
With 4.0 software the "Customize Displays" button is removed and pressure units are available in mmHg only.
- d. Touch "BLOOD CHEMISTRY" and then "CDI" (if installed).  
With 4.0 software, Blood Chemistry is always installed; record if "CDI" or "Standard" appears on the button.
- e. Touch "TITLE SCREEN" and then "MAIN SCREEN".  
Starting with 2.3 and 4.0 software, touch "Main Screen New Case" or "Main Screen Current Case".
- f. Record the ART pump number from the Pulsatile Screen (if installed), the pump Message Display, or the Digital Interface Board.
- g. Record the CPG pump number from the Cardioplegia Screen, the pump Message Display, or the Digital Interface Board.
- h. Record the tube size or flow constant shown in the Message Display of each Roller Pump.
- i. If a Centrifugal Pump is installed, press the Select switch on the pump and record the calibration number and the minimum flow alert level.
- j. If the pulse option is installed, touch "PULSE" on the Main Screen. Record the rate, width, and base values displayed on the Pulsatile Screen.
- k. Touch "SETUP", then "LIMITS". Record the arterial and cardioplegia alert and alarm limits.
- l. Record the  $FI_{O_2}$  alert limit and the  $O_2$  blend.
- m. Touch "AUX DATA". Record the temperature labels for A, B, and C.
- n. Open the Front Door and locate the Level Detector Board in Slot 10. Record the switch position.
- o. Check to see that all the transducer cables installed in the Front Tray modules are marked. If not, mark them or draw a chart or diagram showing where each transducer is connected.
- p. Extend the Front Tray (refer to Procedure 4-3-1). Connect the negative lead of a DVM to the DC/DC convertor ground test point on the Power Control Board (refer to Page 3-1 for test point location). Connect the positive lead to any metal point on the chassis. The DVM reading must be 250 megohm or greater (with power off, the reading should be stable; with power on, the reading will fluctuate); if not, refer to the troubleshooting section.

## 2-3. EM/PM Procedures (continued)

### 2-3-2. System Inspection

With software 4.0, check color and two timers.

5. Check the cardioplegia delivery recording. This is essentially checking communications between the CPU and the CPG pump:
  - a. Touch "Cardioplegia" on the Main Screen. Check that the background for the values is purple in color.
  - b. Select a pump (1 to 5) as the cardioplegia (CPG) pump by turning the CPG switch on the Digital Interface Board. The pump number selected will be displayed at the top of the Cardioplegia Screen, and "CPG" will appear on the pump message display.
  - c. Select a tube size for the CPG pump.
  - d. Press both Forward switches to start the pump; set the speed to 50 RPM.
  - e. Touch "Start" and the following should occur:
    - Delivery Duration timer starts.
    - Current volume counter starts recording in mLs.
    - Total volume counter starts recording in mLs.
  - f. Touch "Stop" and the following should occur:
    - Delivery Duration timer stops.
    - The Time Since Last Delivery timer resets and starts.
    - Current and Total volume counters stop with the last values displayed.
  - g. Touch "Start" again. Verify the following:
    - Time Since Last Delivery timer stops with the last values displayed.
    - Delivery Duration timer resets and starts.
    - Current volume counter resets and starts recording in mLs.
    - Total volume increases as the sum of the former and current delivery.
  - h. After verifying the recording of cardioplegia delivery, stop the CPG pump.

## 2-3. EM/PM Procedures (continued)

### 2-3-2. System Inspection

With software 4.0, check the colors and "not confirmed" message.

9. Check the pressure displays:

**Warning:** Pressure transducer cables without transducers attached must be disconnected from the console; cables without transducers act as antennae and may stop the pump.

- a. Touch "Setup" on the Main Screen.
- b. Install the Pressure Board Test Fixture into the ART jack on the Pressure Module in Slot 4. Set the fixture to "0" and "+".
- c. Touch "Zero" on the Setup Screen and then touch "Arterial". "Arterial" should become highlighted and the arterial pressure display in the upper left corner of the Main Screen should show "0 mmHg". If not, perform Procedure 3-1-3 (Pressure Board Calibration).
- d. Touch "Limits" on the Setup Screen and then touch the number displayed as the arterial alert value. Touch the up and/or down arrows until the alert value is 180. Touch "180 mmHg". (Starting with Version 2.3M system software, the alarm and alert values are separately adjustable.)
- e. With 4.0 software, check the following colors appear on the screen.

<u>Color</u>	<u>Location</u>
Light gray	"Arterial Line" text on Main Screen,
White	Flow value on Main Screen,
Light red	"Alarms" text on Set-Up Screen,
Light blue	alert and alarm pressure values on Set-Up Screen,
Black	overall background of any screen,
Dark red	background for arterial values on Main Screen,
Dark blue	background for venous values on Main screen,
Green	background for gas values on Main Screen,
Dark yellow	"not confirmed" messages on Main Screen.

- f. Turn the Test Fixture knob to each setting. The pressure displayed on the Main Screen must be +/- 10 mmHg of the Test Fixture setting. If not, perform Procedure 3-1-3 (Pressure Board Calibration).
- g. Press the Forward or Reverse switches on the ART and CPG pumps. Turn the speed knobs on both pumps to mid range.
- h. Set the Test Fixture to 200 mmHg. The alert sounds and the "CHECK ARTERIAL PRESSURE" message appears on the Main Screen. The pumps continue to run.

## 2-3. EM/PM Procedures (continued)

### 2-3-4. Centrifugal Pump Inspection for Delphin™ II Module

Use the current procedure but with the following exceptions.

13. Install a 3 foot test loop (without cornstarch).

- a. Connect one end of a 3 foot loop of tubing to a disposable pump and fill them with water.
- b. Connect the other end of the tubing to the disposable pump without introducing air as air will affect the test.
- c. Connect the disposable pump to the drive motor.

17. Check both the alert and alarm.

Check the Check Flow alert.

- a. Increase the pump speed to 1600 +/- 20 RPM and adjust the clamp to get a flow of over 3.0 L/min.
- b. Decrease the pump speed to 1400 +/- 20 RPM and verify the message display alternately flashes the chosen motor speed and "CK FLOW". The alert sounds and the "CHECK ARTERIAL PUMP FLOW" message appears on the Main Screen.
- c. Increase the pump speed to 1600 +/- 20 RPM and the Check Flow alert should stop.
- d. Press Stop and then turn the speed knob to minimum.
- e. Start the pump and increase the speed to 1100 +/- 20 RPM. Adjust the clamp to obtain a flow of approximately 3.0 L/min. Turn the speed knob quickly down to 200 RPM +/- 50 RPM. The message display should alternately flash the chosen RPM reading and "CK FLOW" for approximately 5 seconds. The alert sounds and the "CHECK ARTERIAL PUMP FLOW" message appears on the Main Screen.

Check the Backflow alarm.

- a. Install the Flow Sensor around the tubing with the arrow in the direction of flow. Start the pump and increase the pump speed to 2000 RPM. Adjust the clamp for a flow of about 3.0 L/min.
- b. Remove the Flow Sensor and re-install it with the arrow pointing in the direction opposite the flow. The message display should alternately flash 2000 RPM and "!BACKFLW". The alarm sounds and the "!ARTERIAL PUMP BACKFLOW" message appears on the Main Screen.

19. This inspection step is not applicable for Delphin™ II Modules.

## 2-4. Installing Options

### 2-4-1. Installing the Pulse Option and Blood Chemistry

Starting with 2.3 software, the Blood Chemistry feature is automatically on but the Pulsatile Flow feature is still an option requiring service installation. Note: Blood Chemistry may be turned off at the customer's request.

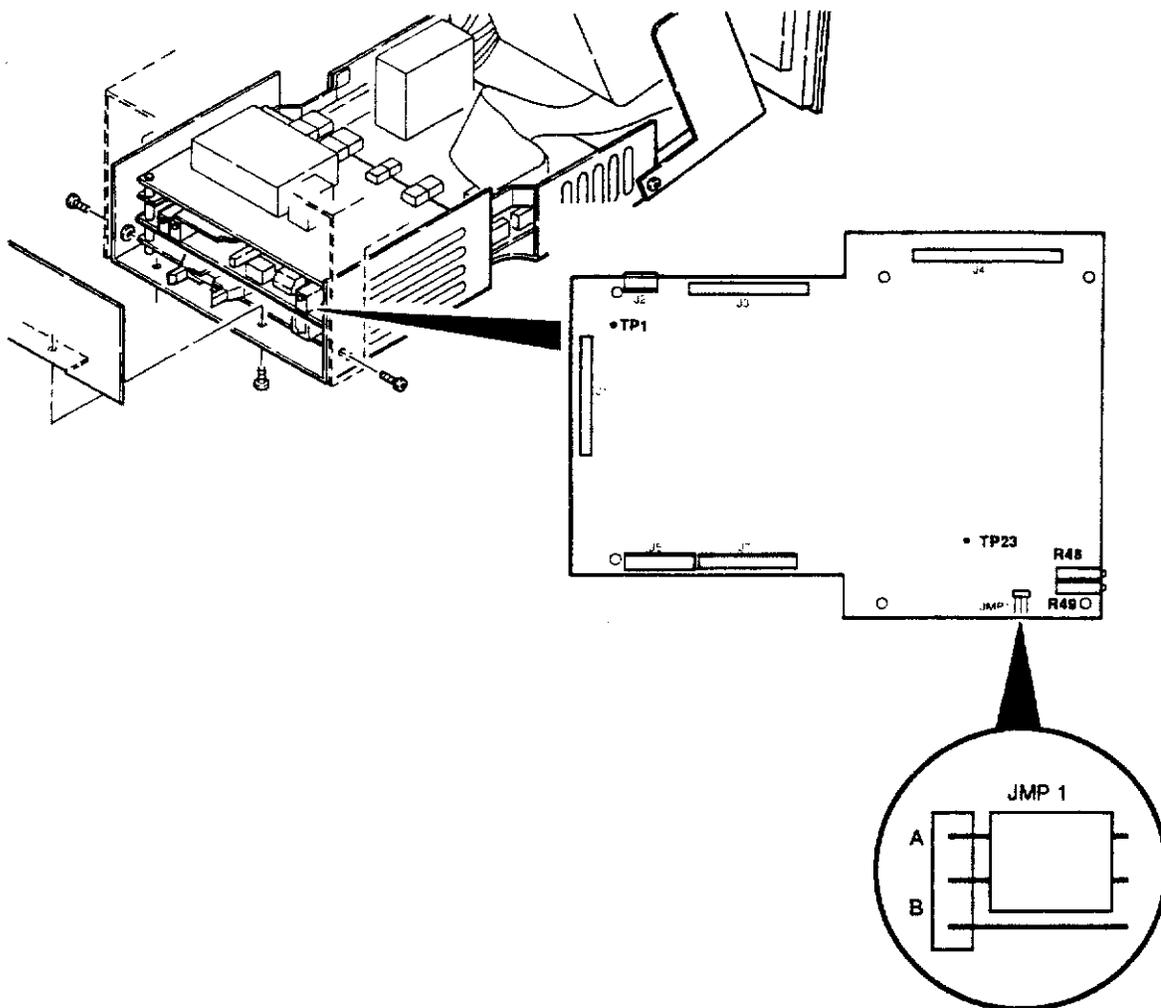
### 3-1. Miscellaneous Electrical Adjustments

Starting with 4.0 software, there is no calibration for the Touch Screen so step 3-1-2. is unnecessary.

### 3-3. Delphin™ II Module Adjustments

When calibrating the Motor Control Board of a Delphin™ II Module, use the directions below for step 8.b.

8. Perform the following checks on the Motor Control Board:
  - a. Connect the negative lead of the DVM to TP1, and the positive lead to TP23. The DVM should read 5.00 +/- 0.01 VDC; adjust R49 to meet this specification.
  - b. Verify that JMP1 is in position "A" (see new board illustrated below).
  - c. The speed readout on the front panel should be 3600 +/- 60 RPM; adjust R48 to meet this specification.



### 3-5. Gas System Adjustments

#### 3-5-1. Calibrating Flow Sensors - Version 2.21 or Higher

**Note:** Starting with software 4.0, the result of calibrating the flow sensors is displayed to the right of the button and either "Done" or "Error" will appear.

### 4-3. Front Tray (continued)

#### 4-3-5. Replacing System Software

**Note:** Starting with 4.0 software the customize screen no longer offers a choice of displaying pressure in kPa units; also Blood Chemistry is a standard feature with user choice of "CDI" or "Standard" (choices for step 2.a).

6. Starting with 2.3 software, it is not necessary to replace chips 5AF and 6AF when installing new software. If necessary, remove IC numbers 5AF and 6AF from the Computer Card. Install the new software chips on the card.
7. Remove IC numbers 4A, 5A, 6A, and 7A from the Memory Card. Install the new software chips on the card. Note that pin 1 of the chip actually goes into pin 3 of the socket.

With 4.0 and prior software, calibrate the gas flow sensors and reinstall the operator's settings (see new steps below).

8. Slide both cards back into the card cage. Ensure that they are seated properly.
9. Replace the plate that covers the STD bus.
10. Set the system to the Diagnostics Mode (refer to Procedure 2-2-1).
11. Set the power switch to ON.
12. After the start-up routine is finished, touch "System Options" button. Enter the machine ID number. The system will ask for verification; re-enter the machine ID number.
13. If the Pulse or Blood Chemistry options were enabled in Step 2, re-install them by performing Procedure 2-4-1 (Installing the Pulse and Blood Chemistry Options).
14. Calibrate the gas flow sensors (refer to procedure 3-5-1 or 3-5-2).
15. Return the system to Normal Operating Mode (refer to Procedure 2-2-2).
16. Reinstall the original operators settings.
17. Perform a complete System Inspection (refer to Procedure 2-3-2).

## 4-5. Miscellaneous

### 4-5-6 Replacing Backlight Bulbs for Color LCD

**Caution:** Use static precautions whenever handling components.

1. Use Backlight Kit 26-1009-7222-8 (2 bulbs per kit).
2. Set up a static mat. Disconnect power to the central display.
3. Using a torx T27 screw driver, remove the six screws securing the display housing and open the display housing.
4. Remove both silver plates (push tabs and slide metal plates out).
5. Lift the black cushions from ends of each bulb.
6. Lift the bulbs out and disconnect them from the LCD Backlight connectors.
7. Replace both bulbs. Reassemble in reverse order. Check that the housing is closed securely.

## 5-5. Delphin™ II Module Only

With a Delphin™ II Module, follow the current centrifugal pump checks but with the following exceptions.

**Omit two procedures.**

5-5-9. Transmitter Output Voltage Incorrect is not applicable for Delphin™ II Module.

5-5-12. Flow Reading Not 1.6 L/Min During Flow Sensing Check is not applicable for Delphin™ II Module.

In addition, apply the following procedures for Delphin™ II Modules only.

### Flow Reading always 0.00 L/min.

1. Try another Flow Sensor.
2. Measure the voltage between TP9 (AGND) and TP8 (+15 VDC Linear) on the Power Supply Board. If the voltage is not +15 VDC +/- .2 VDC, replace the Power Supply Board.
3. Measure the voltage between TP9 (AGND) on the Power Supply Board and connector J2 Pin 1 on the Conversion/DSP Board.
  - If the voltage is +15 VDC +/- .2 VDC, replace the Conversion/DSP Board.
  - If the voltage is not +15 VDC +/- .2 VDC, replace the RFI Filter assembly.
4. Perform a complete System Inspection (refer to Procedure 2-3-2).

### Flow Readings with No Flow.

1. If flow readings are about 3.0 L/min, check the ground wire and ferrite beads are securely connected to the Lemo connector.
2. Try another Flow Sensor.
3. Measure resistance from chassis ground to TP1 of the Conversion/DSP Board; if it is not infinite, correct the problem.
4. Measure resistance from TP1 of the Conversion/DSP Board to TP1 of the Power Supply Board; if it is not infinite, correct the problem.
5. Connect the drive motor and flow sensor to separate loops. If flow readings are displayed at speeds between 800 to 1000 RPM, the Conversion/DSP Board is detecting low frequency noise from within the module. Check the power and grounds within the module.
6. Replace the Conversion/DSP Board.
7. If flow readings are 9.90 L/min for short periods of time, it could be electrical interference.
8. Perform a complete System Inspection (refer to Procedure 2-3-2).

## 5-5. Centrifugal Pump (continued)

Additional Troubleshooting Procedures for both Delphin™ Module and Delphin™ II Module

### 5-5-13. Pulse Mode Does Not Function.

1. If the Pulse Mode LED does not illuminate, check the Membrane Panel or the Motor Control Board. Connect negative lead of voltmeter to TP1 and positive lead of voltmeter to J5 Pin 43. With the Pulse switches pressed, check for a ground level (0 VDC).
  - If the voltage reading is not 0 VDC, replace the Membrane Panel.
  - If the voltage reading is 0 VDC, replace the Motor Control Board.
2. If the Pulse Mode LED illuminates, replace the Local Processor Board.
3. Perform a complete System Inspection (refer to Procedure 2-3-2).

### 5-5-14. Motor Alert Displayed.

1. Verify the drive motor cable is secured to the control module.
2. Try another drive motor.
3. Replace the Motor Control Board and check the motor cable from the housing to this board.
4. Perform a complete System Inspection (refer to Procedure 2-3-2).

### 5-5-15. Overcurrent Alert Displayed.

1. Connect negative lead of voltmeter to TP15 and positive lead of voltmeter to TP21 on the Motor Control Board.
  - If the reading is 0.5 VDC or larger, replace the Drive Motor.
  - If the voltage reading is less than 0.5 VDC, replace the Motor Control Board.
2. Check the motor cable from the housing to the Motor Control Board.
3. Replace the Local Processor Board if none of the above steps resolve the problem.
4. Perform a complete System Inspection (refer to Procedure 2-3-2).

### 5-5-16. Underspeed Alert Displayed.

1. If the displayed RPM matches the speed knob setting, replace the Local Processor Board.
2. Set the speed knob to 2400 RPM. If the display shows less than 1680 RPM, press Stop, remove the disposable pump from the drive motor and press Start.
  - If the message disappears, try a different disposable pump.
  - If the message continues, try another drive motor.
3. Check the Motor Control Board calibration (refer to Procedure 3-3-1).
4. Measure the voltage between TP1 (GND) and TP23 (DEMAND) on the Motor Control Board.
  - If the voltage reading is not 3.3 VDC, replace the Speed Pot assembly.
  - if the reading is correct, replace the Motor Control Board.
5. Perform a complete System Inspection (refer to Procedure 2-3-2).

## 5-5. Centrifugal Pump (continued)

### 5-5-21. Down Arrow Switch Does Not Function.

1. Connect negative lead of voltmeter to TP1 and positive lead of voltmeter to U3 Pin 7 on the Motor Control Board. With the DOWN Arrow switch depressed, check the voltage.
  - If the reading is other than 0 VDC, replace the Membrane Switch Panel.
  - If the reading remained at +5 VDC, proceed to the next step.
2. Connect negative lead of voltmeter to TP1 and positive lead of voltmeter to U3 Pin 22 on the Motor Control Board. With the DOWN Arrow switch depressed, check the voltage.
  - If the reading is 0 VDC, replace the Local Processor Board.
  - If the reading remains +5 VDC, replace the entire Motor Control Board or try replacing just the PAL in location U3.

## 5-12. Miscellaneous

### 5-12-3. Central Display Color Test

1. Set the system to the Diagnostics Mode (refer to Procedure 2-2-1).
2. Turn the power switch ON.
3. After the start-up routine is finished, touch the Screen Test button and verify that the five colors red, green, blue, white and black are each displayed for 10 seconds. If problems, troubleshoot the central display.
4. Return the system to Normal Operating Mode (refer to Procedure 2-2-2).

### 5-12-4. Central Display Troubleshooting

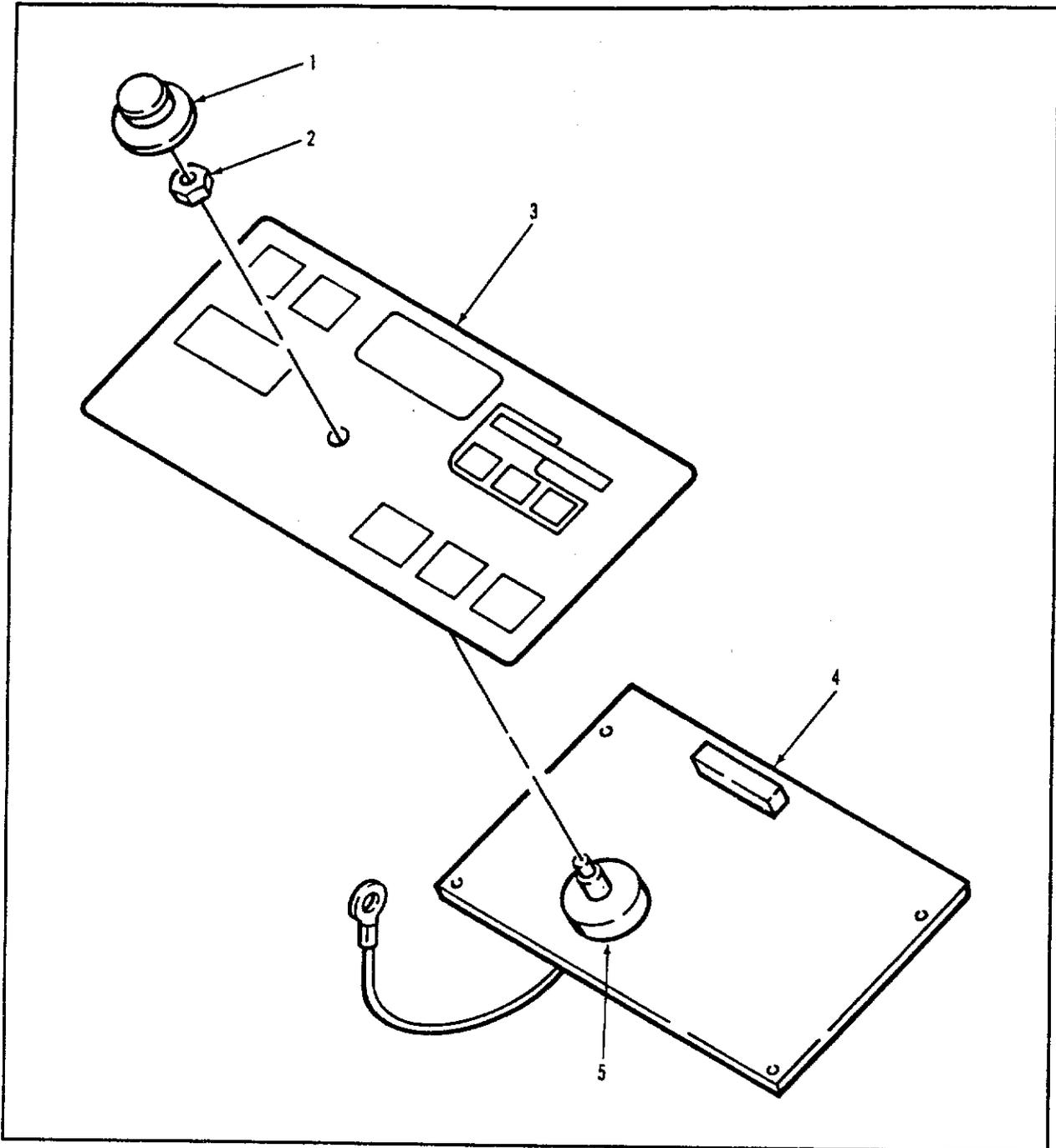
**Warning:** Do not touch pins on connectors J6 and J7 of IC board to prevent 60 VAC electrical shock.

**Cautions:** Use static precautions whenever handling components.

Incorrect positioning of connectors will damage the components on the central display.

Problem	Check	Possible Action
LCD panel is blank (black screen)	<ul style="list-style-type: none"> <li>✓ 60 VAC between pins 1 or 3 and 5 or 7 on display backlight connector,</li> <li>✓ display video data cable connections at DOS board and display,</li> <li>✓ DOS board SF-5 jumpers only on SW2, SW3 and SW8,</li> <li>✓ +5 volt power on data cable.</li> </ul>	Replace backlight bulbs if 60 VAC is reaching LCD panel, Secure cable connections, Place and remove jumpers on DOS board as necessary, Troubleshoot interconnect board.
Display appears dim or half of LCD panel dimmer than the other.	<ul style="list-style-type: none"> <li>✓ 60 VAC between pins 1 or 3 and 5 or 7 on display backlight connector.</li> </ul>	Replace backlight bulbs if 60 VAC is reaching LCD panel, Troubleshoot interconnect board.
Incorrect colors on the display.	<ul style="list-style-type: none"> <li>✓ all cable connections.</li> </ul>	Replace cables if voltages are not present at both ends, Replace the PAL on the interconnect board.
Display flickers.	<ul style="list-style-type: none"> <li>✓ VDD2 voltage at the display video data connector,</li> <li>✓ VCC voltage at the display video data connector,</li> <li>✓ DOS board SF-5 jumpers only on SW2, SW3 and SW8.</li> </ul>	Replace the cable if voltage is not at both ends, If voltage is present, troubleshoot interconnect board, Place and remove jumpers on DOS board as necessary, Replace the LCD panel if flickering persists.
Display only white on power up.	<ul style="list-style-type: none"> <li>✓ display video data cable connections at DOS board and display,</li> <li>✓ DOS board power and data valid signal,</li> <li>✓ power and data at display video data connector.</li> </ul>	Replace cable if correct voltage levels are not at both ends, Replace DOS board if data valid signal is not present, Troubleshoot interconnect board, Replace LCD panel if everything else is correct.

Item No.	Sarns P/N	3M ID	Description	Qty.
35	22114208	12-7996-8116-3	SCREW, Flat Head, 6-32 X 1/2, SS	2
36	N/A	26-1008-6546-3	WASHER, Shoulder, Nylon, .192 ID	4
37	N/A	78-8067-0539-4	NUT, Slotted Panel	4
38	16588401	78-8067-0869-5	BRACKET, Back, Centrifugal Pump	1
39	22723002	26-1001-7983-2	NUT, Keps, 6-32, Steel, Zinc Plated	13
40	16565401	78-8067-0741-6	CABLE ASY, Cooling Fan	1
41	N/A	78-8067-3526-8	ENCLOSURE, Electrical, Upper, Delphin II	1
42	22745002	18-9813-0675-8	WASHER, Flat, #6, SS	2
43	22773002	26-1000-0078-0	WASHER, Split, #6, SS	2
44	22197206	26-1008-8044-7	SCREW, Button Head Torx, 6-32 X .38	2
45	22132306	18-4702-7803-9	SCREW, Pan Head, 8-32 X 3/8	2
46	22114408	12-7997-9188-9	SCREW, Flat Head, 10-32 X 1/2, SS	4
47	22763002	18-9851-0603-0	WASHER, Lock, External Tooth, #6	5
51	N/A	78-8066-9988-6	CABLE SMB/BNC F/M	1
58	N/A	78-8066-9987-8	CABLE, Line Filter	1
59	N/A	78-8066-9988-6	CABLE SM B/BNC F/M	1
64	22197204	26-1008-8043-9	SCREW, Button Head Torx, 6-32 X .25	2
65	N/A	78-8067-3527-6	ENCLOSURE, Electrical, Lower, Delphin II	1
66	22134208	12-7995-0779-8	SCREW, Pan Head, 6-32 X 1/2, SS	6
67	22144206	78-8005-5342-8	SCREW, Truss Head, 6-32 X 3/8, SS	2
68	N/A	78-8066-6432-8	BRACKET, Front	1
69	16601201	78-8067-0931-3	CABLE ASY, Pump/Front Tray	1
70	16556901	78-8066-7595-1	CABLE ASYS	1
71	N/A	78-8066-7304-8	CABLE ASY, Motor Control/Display	1
72	N/A	78-8066-9966-2	PC ASY, Conversion/DSP Board	1
73	23810102	26-1007-5730-6	STANDOFF, F/F, Hexagonal, 6-32 X .62, SS	6
74	N/A	78-8067-1840-5	PC ASY, Motor Control	1
75	23810100	26-1007-5729-8	STANDOFF, M/F, Hexagonal, 6-32 X .75, SS	4
76	N/A	78-8067-1680-5	PC ASY, Local Processor Board	1
77	23810103	26-1007-5731-4	STANDOFF, M/F, Hexagonal, 6-32 X .25, SS	4
78	16525301	78-8066-6738-8	PC ASY, Power Supply	1
79	16487301	78-8067-0156-7	LABEL, Nameplate, 1.50 X 1.0	1



Item No.	Sarns P/N	3M ID	Description	Qty.
1	23890040	26-1008-0613-7	SEAL, APM, 1/4 Shaft, N-9030	1
2	23800091	26-1006-6870-1	KNOB, 1.25 Diameter, Black	1
3	N/A	78-8066-6700-8	MEMBRANE, Roller Pump Switch Panel D2	1
4	16445401	78-8066-7501-9	PC ASY, Centrifugal Pump Display Board	1
5	N/A	78-8067-0989-1	POTENTIOMETER AND CABLE ASY	1

# Additional Information

## SMT Universal Roller Pump

This insert contains technical information related to the surface mount technology (SMT) style universal roller pump.

Insert these pages into the Sarns™ 8000 Perfusion System Field Service Handbook or the Sarns™ 9000 Perfusion System Field Service Handbook as directed.

Use the appropriate Table of Contents for the handbook you are updating. Discard the unused Table of Contents pages.

### Table of Contents

8000 Perfusion System Field Service Handbook	Add page iii
9000 Perfusion System Field Service Handbook	Replace page v
SMT Roller Pump section	
8000 Perfusion System Field Service Handbook	Insert as Section 8
9000 Perfusion System Field Service Handbook	Insert as Section 7



### Health Care

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Calibration .....	5
Replacement Procedures .....	6
Troubleshooting .....	14

**Section 6. System Diagrams**

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**Section 7. SMT Universal Roller Pump**

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**SMT Universal Roller Pump**

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## System Description

**Power Requirements:** 28 VDC (23.5-35.5) 8.5 A, used with 10.0 A circuit breaker.

### Functional Description, Printed Circuit Boards

#### Pump Display Board

The pump display board contains the following indicators and displays:

- Five individual LED indicators which represent the pump operating mode, such as forward, reverse, stop, manual and automatic.
- A numerical display which indicates the pump's flow rate derived from pump rotation speed and tube size, in liters per minute (LPM), or pump rotation speed in revolutions per minute (RPM).
- An alphanumeric display indicates operator selections for the pump, tube size, LPM/RPM display and system alert messages which pertain to the pump.

The pump display board also contains three board-to-board connectors; one accepts inputs from the membrane switch assembly J2 (12 pin), another accepts inputs and outputs from the CPU/control board J1 (40 pin), and the third handles power from the pump drive/power board assembly J4 (14 pin).

- Connector J1 mates directly with J3 on the pump CPU/control board. This connector carries the following signals:
  1. Bi-directional communication to the display board
  2. LEDs and seven segment communication
  3. EERam communication
  4. Switch commands
  5. Reverse switch 5V DC
  6. Reset signals
  7. Ground

- J1 Pin Arrangement

Pin No.		Pin No.	
1	AUTOLED	21	AS1
2	MANLED	22	DS0
3	+5 VDC	23	DS1
4	STOPLED	24	DS2
5	FWDLED	25	ALPHAAL
6	REVLED	26	DATASTRB
7	FWDSW	27	EECLK
8	STOPSW	28	EECS
9	STOPSW	29	EERD
10	GND	30	NC
11	GND	31	RESET
12	REVS	32	NC
13	MANSW	33	IO7
14	AUTOSW	34	IO6
15	UPSW	35	IO5
16	DOWNSW	36	IO4
17	SELSW	37	IO3
18	GND	38	IO2
19	RESET	39	IO1
20	AS2	40	IO0

## System Description (Continued)

- J2 on the pump display board mates directly with J2 on the membrane switch. This connector carries the control signals from the switches.

- J2 Pin Arrangement

Pin No.		Pin No.	
1	GND	7	MANUAL
2	AUTO	8	UP
3	REVERSE	9	DOWN
4	GND	10	SELECT
5	GND	11	STOP
6	FORWARD	12	STOP

- J3 mates directly with J4 on the pump drive/ power supply board. This connector carries the power from the drive/power board.

- J3 Pin Arrangement

Pin No.		Pin No.	
1	+ 5V DC	8	NC
2	+ 5V DC	9	GND
3	+ 5V DC	10	GND
4	+ 5V DC	11	GND
5	+ 5V DC	12	GND
6	+ 5V DC	13	GND
7	+ 5V DC	14	GND

### Pump CPU/Control Board

The CPU/control board assembly is composed of three separate modules performing different functions. Each one of these modules performs unique independent tasks, while interfacing with one another. The functional modules are:

Microprocessing - This module performs five major functions:

- Monitors the pump safety systems
- Controls the displays
- Controls the stop command in the event of a safety system failure
- Pulsatile control
- Speed reduction

Motor control - This module provides analog control over the motor utilizing a PWM (pulse width modulator) driven by a demand voltage. Part of the control is accomplished by the use of the feedback voltage generated by the analog tach of the motor.

Pulse control is accomplished by the use of DAC (digital-to-analog converter) when the pump is placed in "AUTO" mode.

Safety system - This module controls the pump's mode and respective LEDs based on the inputs from the membrane switches, and stops the pump whenever a safety parameter is activated either from an internal safety circuit (excessive speed, excessive current draw) or external source (cover interlock switch, stop line).

The pump CPU interfaces with the cover interlock switch, the speed potentiometer, the Opto tach, the motor, the front plate assembly, the pump display board and the pump drive/power supply. There are also two auxiliary connectors used for reading the communications lines, and test points.

## System Description (Continued)

### Pump Drive/Power Supply Board

The pump drive/power supply board consists of two separate modules performing different functions. Each one of these modules performs unique independent tasks, while interfacing with one another. The functional modules are:

**Pump Drive** - The pump drive section consists of circuits that perform the following tasks:

**Speed fault detector** - This disables the motor if it continues to run while a stop condition has been met.

**Motor drive** - This circuit drives the motor in either direction, forward or reverse.

**Safety** - This circuit detects when the motor exceeds the speed and current limits.

**Power Supply Section** - This provides the following power stages for use in the SMT pump.

**Voltage limiter** - Limits the voltage to the DC converter

**15V DC** - Powers the safety and the drive circuits

**5V DC and  $\pm$  12V DC** - Powers the logic and analog circuits

The pump drive/power supply board interfaces with the DC motor, the cooling fan, the main input power, the display board and the CPU/control board.

- Connector J1 handles the interface signals between the motor and the pump drive/power supply board. This connector carries the forward and reverse polarity signals.

Pin No.

- 1 Forward polarity
- 2 Reverse polarity

- Connector J2 supplies power to the cooling fan. This connector carries the following signals:

Pin No.

- 1 -12V DC
- 2 GND
- 3 GND

- Connector J3 is a 20 pin connector that handles the interface signals between the pump CPU/control board and the pump drive/power supply board. This connector carries the following signals:

Pin No.

- 1 + 12V DC Isolated power supply
- 2 + 12V DC Isolated power supply
- 3 SPDFLT Speed fault
- 4 + 5V DC Isolated power supply
- 5 + 5V DC Isolated power supply
- 6 + 5V DC Isolated power supply
- 7 + 5V DC Isolated power supply
- 8 FWDPWM Forward pulse width mod
- 9 REV Reverse direction
- 10 FWD Forward direction

Pin No

- 11 REVPWM Reverse pulse width modulator
- 12 OVRCUR Overcurrent
- 13 OVRSPD Overspeed
- 14 GND Isolated power ground
- 15 GND Isolated power ground
- 16 GND Isolated power ground
- 17 GND Isolated power ground
- 18 GND Isolated power ground
- 19 -12V DC Isolated power supply
- 20 -12V DC Isolated power supply

## System Description (Continued)

- Connector J4 is a 14 pin interconnect that handles the interface signals between the display board and the pump drive/power supply board. The connector carries the following signals:

Pin No.			Pin No.		
1	+ 5V DC	Isolated power	8	NC	No Connection
2	+ 5V DC	Isolated power	9	GND	Isolated power ground
3	+ 5V DC	Isolated power	10	GND	Isolated power ground
4	+ 5V DC	Isolated power	11	GND	Isolated power ground
5	+ 5V DC	Isolated power	12	GND	Isolated power ground
6	+ 5V DC	Isolated power	13	GND	Isolated power ground
7	NC	No connection	14	GND	Isolated power ground

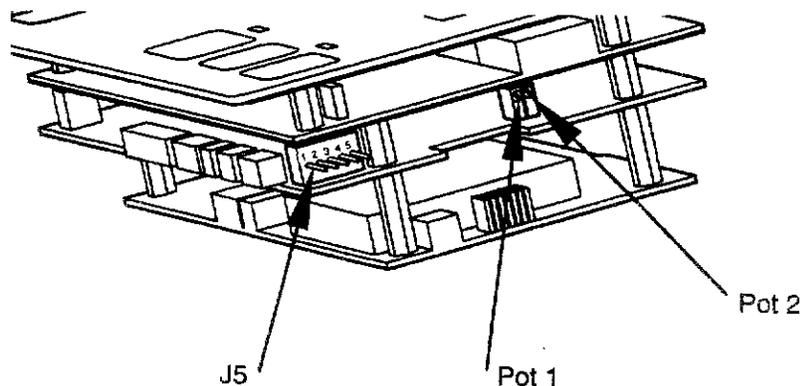
- Connector J5 handles the interface signal between the main power (input) and the pump drive/power supply board. This connector carries the following signals:

Pin No.		
1	+ 24V DC	Unregulated power
2	GND	Unregulated power return

## Calibration

### Calibrating the Pump CPU/Control Board

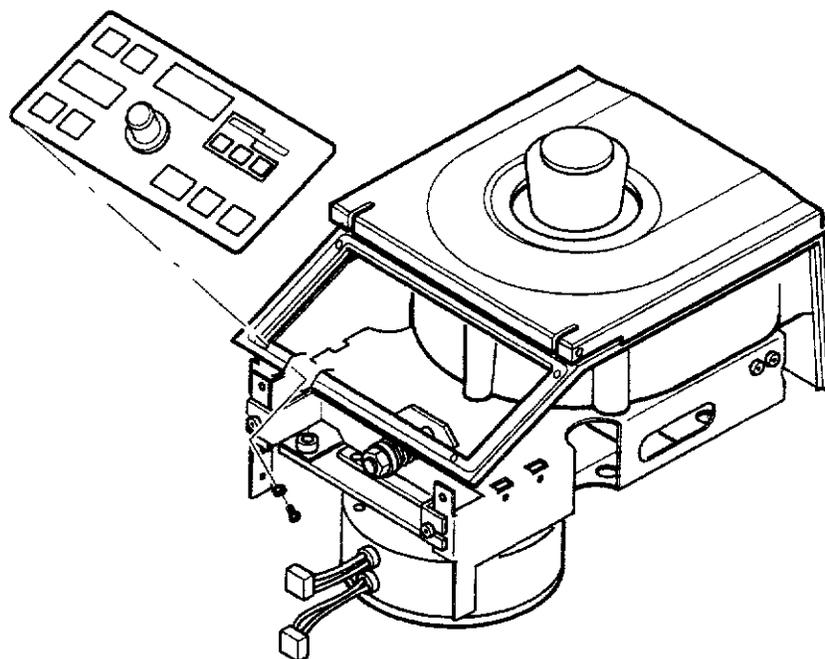
- Remove the roller pump from the parent housing (8000/9000). Set the pump adjacent to the 8000 housing / 9000 console and reconnect the pump cable.
- With the power applied to the roller pump, depress both forward switches. Turn the speed pot fully clockwise; the rollers should rotate counter clockwise at full speed.
- Perform the following checks at J5 on the pump CPU/control board:
  - Connect the positive lead of the DVM to pin 4 and the negative lead to pin 6. Adjust Pot 1 to obtain a reading of -5.0VDC.
  - Connect the positive lead to pin 5, adjust Pot 2 to obtain 250 max RPM as measured by an external tachometer.
  - If either of these adjustments cannot be achieved refer to the troubleshooting section.



## Replacement Procedures

### Pump Membrane Panel/PC Boards

1. Remove the pump from the base.
2. Remove the front plate assembly and disconnect J2 & J5 on the pump drive/power board and J1 on the pump CPU/control board.
3. Using a driver with a gapped screwdriver bit installed, remove the four screws that secure the display membrane panel assembly to the casting.
4. Lift the assembly out of the casting (slight pressure may be required to break the silicon seal).
5. Once the membrane panel assembly is removed it can be disassembled to replace the individual boards or membrane panel.



6. Reassemble in the reverse order. If the silicon seal is damaged, remove it from the membrane panel assembly and replace it.

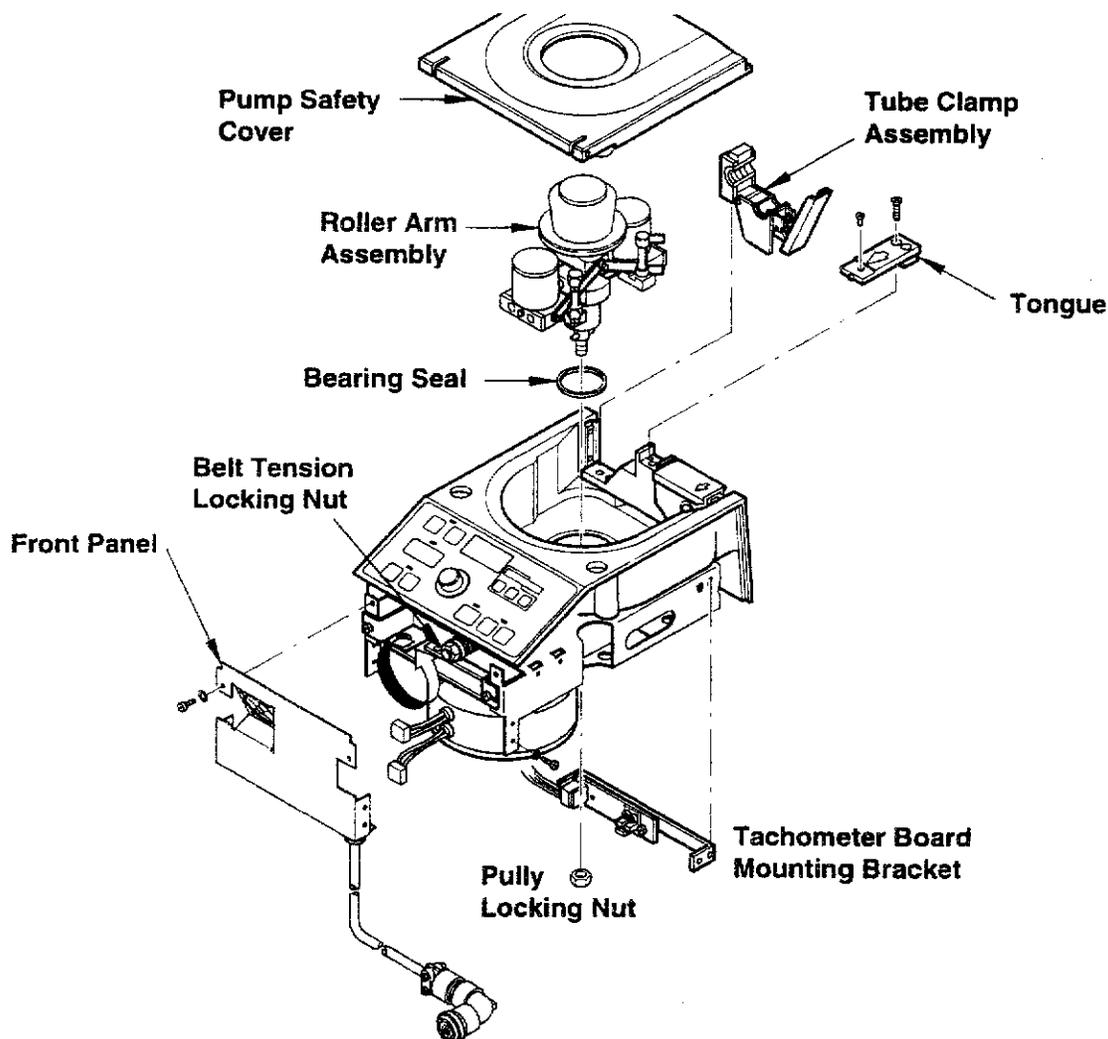
Note: When replacing the silicon seal, coat the casting with a thin film of liquid soap. This will allow the silicon to cure and form a gasket without adhering to the casting.

## Replacement Procedures (Continued)

### Removing the Roller Arm Assembly

#### Disassembly:

1. Remove the pump from the parent housing (8000/9000).
2. Remove the pump safety cover.
3. Remove the tube clamp assemblies.
4. Remove the tongue.
5. Remove the front plate assembly. Refer to Replacing the Front Plate Assembly, in this section.
6. Loosen the belt tension locking nut (9/16").
7. Remove the four screws that secure the tachometer board mounting bracket. Remove the mounting bracket.
8. Remove the pulley locking nut (9/16").
9. Grasp the occlusion adjustment knob and the casting. Pull the roller arm assembly out of the pump assembly. If necessary, lightly tap the pump shaft with a soft-faced hammer to assist the roller arm assembly out of the casting.
10. Remove the bearing seal.



## Replacement Procedures (Continued)

### Reassembly:

- Reassemble in the reverse order of disassembly, with the following exceptions:
- Install a new bearing seal. The bearing seal must be replaced whenever the roller arm assembly is removed.
- Be certain that the pin that passes through the pump shaft seats properly in the groove on the pulley.
- If the pulley locking nut is damaged, replace it.
- When tightening the belt tension locking nut, place the belt tension gauge between the two washers, then tighten the nut until the washers make contact with the gauge. Replace the nut if it is damaged.
- After completing reassembly, perform the following Adjustment Procedures:

Roller to Roller  
Casting Runout

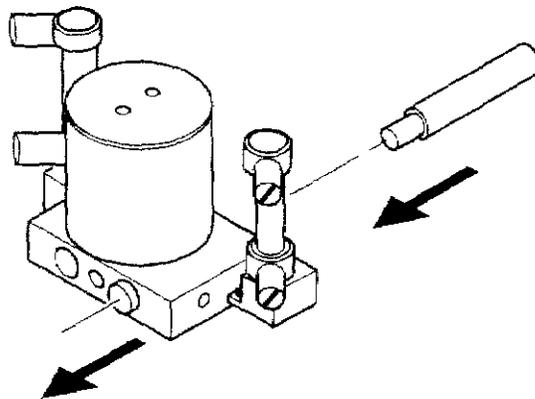
### Replacing Roller Slide Bushings

#### Removal:

Remove the roller arm assembly. Refer to Replace the Roller Arm Assembly.

Disassemble the roller arm assembly. Perform Steps 1 through 5 of Disassembling the Roller Arm Assembly, in the replacement procedures section in the main text of the handbook.

Use a bushing driver to drive the old bushings out of the roller slide assembly.



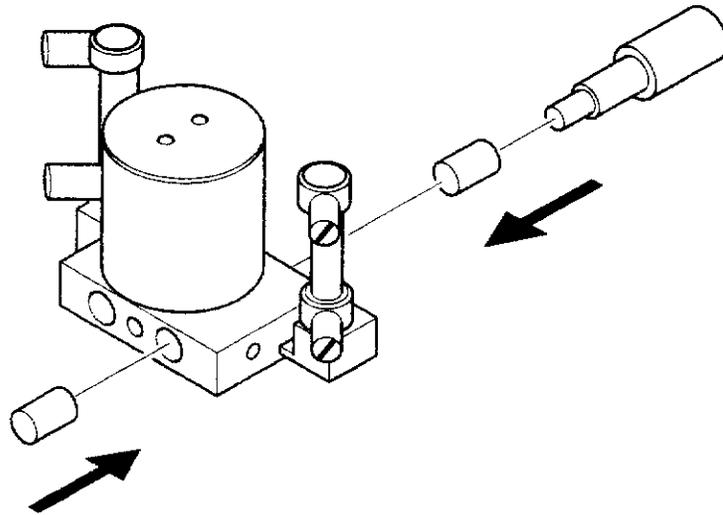
Clean the slide assembly and rails with alcohol or cleaning solvent to remove oil deposits from the brass bushings.

## Replacement Procedures (Continued)

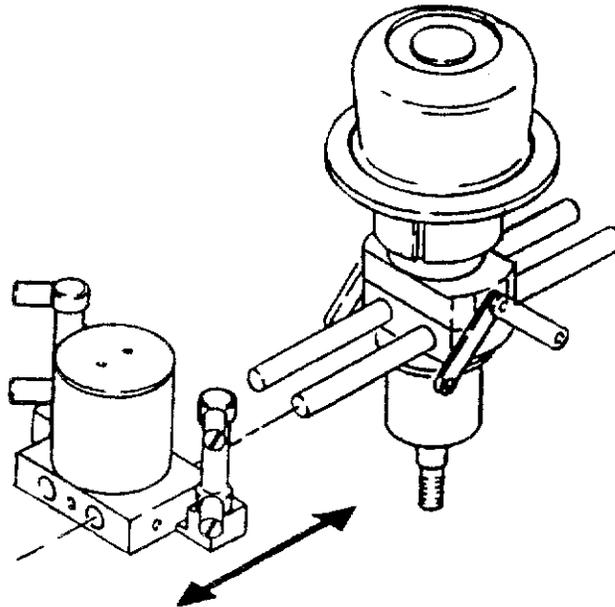
### Installation:

Use a bushing mandrel press to insert the Delrin bushing into the slide assembly. A hammer is not required. Manual pressure should be sufficient to install the bushings.

Note: Do NOT attempt to ream the bushing, as this will damage the new Delrin bushing.



Align both holes with their respective support rails. Ease the slide onto the support rails. The slide should move smoothly without binding. If measured with a force gauge, it should require a minimum of 10 pounds of force to move the slide.



Install a new locking screw and o-rings in the end plate. Install the end plate.

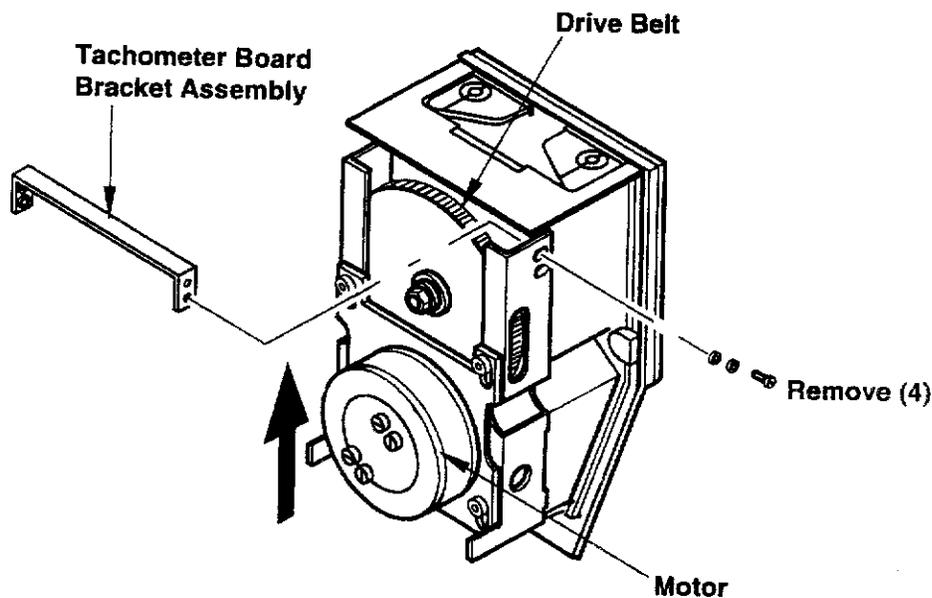
Check the pump gut operation and roller to roller setting.

## Replacement Procedures (Continued)

### Replacing the Pump Drive Belt

#### Removal:

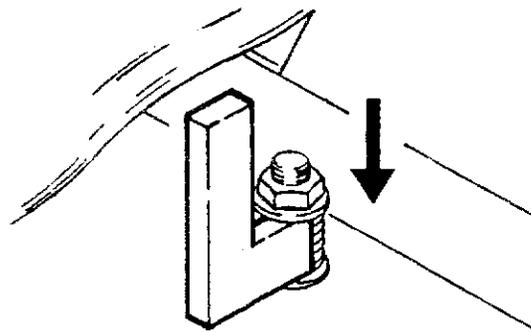
1. Remove front plate.
2. Disconnect the fan at J2 on pump drive/power supply board; disconnect the pump power cord from J1 on the CPU/control board and J5 on the drive/power supply board.
3. Loosen the belt tension locking nut (9/16").
4. Disconnect J1 from the tachometer board.
5. Remove the 4 screws that secure the tachometer board bracket assembly and remove the assembly.
6. Lift up on the motor to remove the tension from the drive belt; slide the drive belt off the pulley and remove it from the pump assembly.



#### Installation:

Installation is the reverse order of removal with the following exceptions:

1. When tightening the belt tension locking nut, place the belt tension gauge between the two washers, then tighten the nut until the washers make contact with the gauge. Replace the nut if it is damaged.
2. Using HL grade tubing in raceway, fully occlude tubing and check for belt slip page.

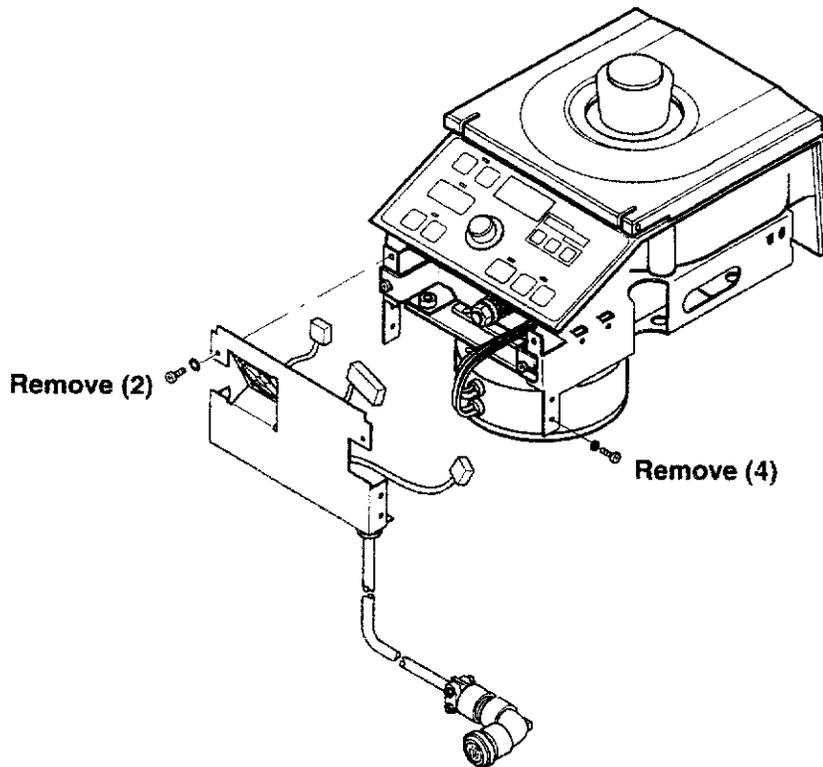


## Replacement Procedures (Continued)

### Replacing the Front Plate Assembly (Main Cable)

Removal:

1. Remove the roller pump from the parent 8000/9000 housing.
2. Remove the six screws that secure the front plate assembly to the roller pump. Two screws are located on the front of the assembly and two on each side.
3. Disconnect J2 & J5 on the pump drive/power supply board and J1 on the pump CPU/control board. Remove the front plate assembly.



Installation:

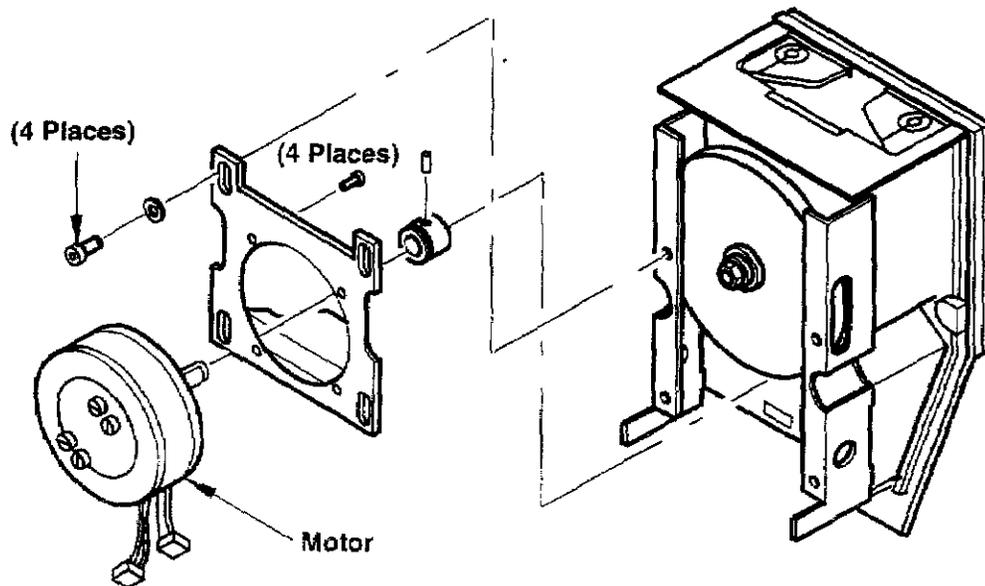
1. Connect J2 & J5 on the pump drive/power supply board and J1 on the CPU/control board to the new front plate assembly. Secure the front plate assembly by inserting the 6 screws removed during the removal process.

## Replacement Procedures (Continued)

### Replacing the Pump Drive Motor

Removal:

1. Remove the pump drive belt as described in Replacing the Pump Drive Belt.
2. Disconnect J5 from the drive/power supply board and J6 from the CPU/control board.
3. Remove the four bolts (3/16" Allen) that secure the motor bracket assembly to the pump and remove the drive motor.
4. Remove the bracket and small pulley from the old motor.



Installation:

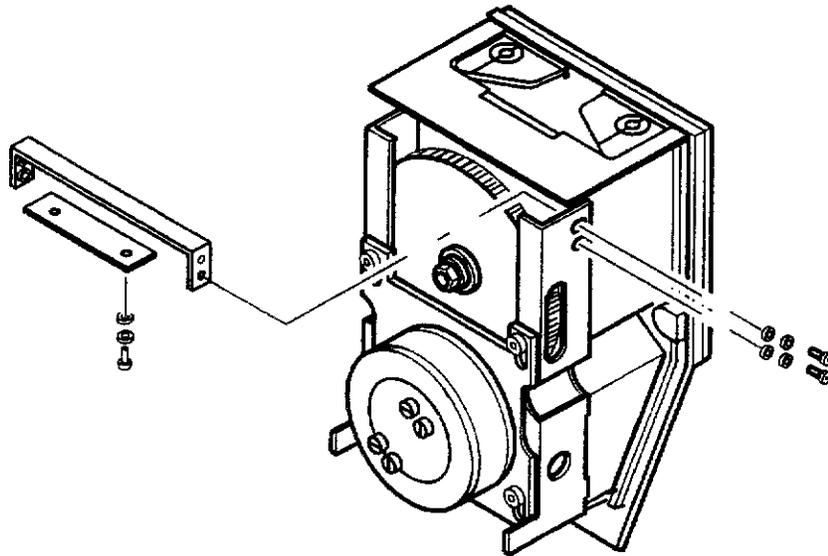
1. Install bracket and small pulley on the new motor. When installing the bracket on the new motor, position the bracket so that the side of the motor from which the wires exit will be toward the front of the pump.
2. Mount the new motor to the chassis. Splice the connector from the old motor onto the new motor cable assembly. Solder the splice connections and cover with heat shrink.
3. Align the top of the small pulley with the top of the large pulley.
4. Reconnect J5 to the drive/power supply board and J6 to the CPU/control board.
5. Install the pump drive belt as described in Replacing the Pump Drive Belt.
6. Perform a complete roller pump inspection.

## Replacement Procedures (Continued)

### Replacing the Dual Tachometer Board

1. Remove the roller pump from the parent housing (8000/9000).
2. Remove the four screws that secure the tachometer mounting bracket to the pump.
3. Remove J1 from the tachometer board and remove the tachometer bracket.
4. Remove torx screws that secure the tachometer board to the bracket and remove the tachometer board.

Installation is the reverse of removal.



## Troubleshooting

### Fail 1 Displayed (EPROM test fail)

1. Switch the system power off and on. If the message repeats replace the CPU/control board.

### Fail 2 Displayed (RAM test fail)

1. Switch the system power off and on. If the message repeats replace the CPU/control board.

### Fail 3 Displayed (PAL test fail - Centrifugal only)

1. This test should always pass on a roller pump. If it fails replace CPU/control board.

### Fail 4 Displayed (EEPROM test fail)

1. Switch system power off and on, if a new display board has been installed this will reset the error. If the message repeats, replace the display board.

### Fail 5 Displayed (STOP test fail)

1. Ensure there are no active alarm conditions on the system. This test will fail if an active alarm condition is present at boot.
2. Switch the system power off and on. If the message repeats replace the CPU/control board.

### Fail 6 Displayed (MOTOR test fail)

1. This test should always pass on a roller pump. If it fails replace the CPU/control board or the drive/power supply board.

### RESET Displayed Continually

1. Check the main connector or cable assembly. Switch the system power off and on. If the message repeats replace the CPU/control board.

### PUMP JAM Displayed

1. Check to make sure the pump is not over-occluded.
2. Remove the tubing. Check for any foreign objects obstructing pump head movement.
3. Remove power. Use a handcrank to turn the pump head.
  - If it is easy to turn, the pump drive/power supply board or the motor is the likely problem.
  - If it is difficult to turn, remove the pump drive belt and turn the pump head with the hand crank. If the pump head turns easily, replace the motor. If it is difficult to turn, replace the casting assembly.

### BELT SLIP Displayed

1. Use an external tachometer to measure the actual RPM.
2. Compare the actual RPM to the displayed RPM.
  - If the actual RPM is greater than the displayed RPM, replace the tachometer board. Also check that the plastic encoder wheel has not been damaged.
  - If the actual RPM and displayed RPM are equal, tighten or replace the belt, or replace the CPU/control board.

### OVERSPEED Displayed

1. Replace the CPU/control board.

## Troubleshooting (Continued)

### No Flow or Message Display

1. Check for the following voltages:
  - +24VDC on P1 across pins 1 and 2 for the pump drive/power supply board.
  - -12 VDC on J2 across pins 2 and 3.
  - + 5.0 VDC on J8 across pins 2 and 3.
2. If all voltages are present, replace the pump display board.

### Pump Will Not Power Up

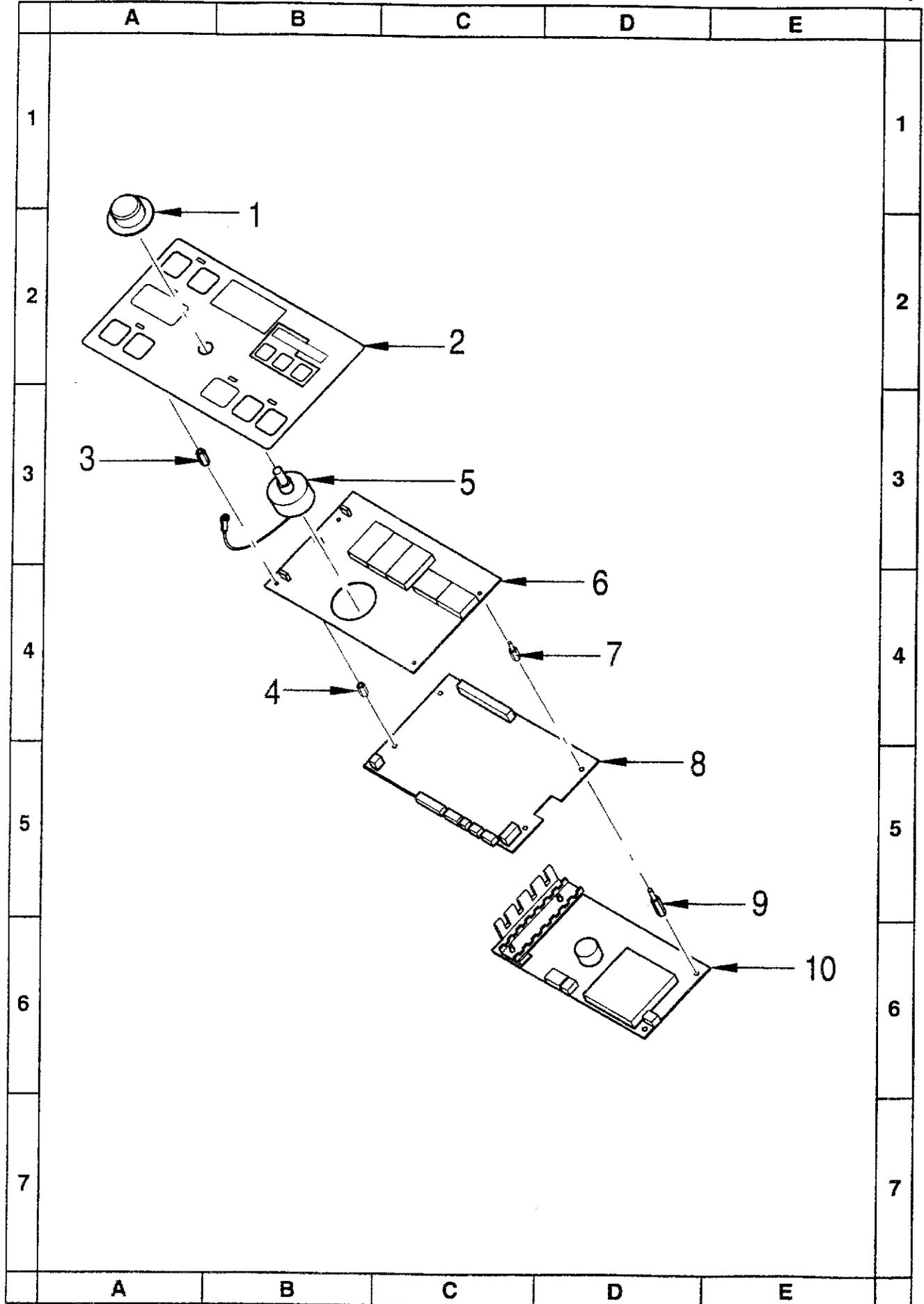
1. Check that the pump circuit breaker is ON.
2. Check for 24-36 VDC across pins 1 and 9 on connector J1 of the pump drive/power supply board.
  - If the voltage is present, proceed to step 3.
  - If the voltage is not present, replace the pump drive/power supply board.
3. Check for 24-36 VDC across pins 1 and 2 of P1 connecting to the pump drive/power board.
  - If the voltage is present proceed to step 4.
  - If voltage is not present, check the pump cable.
4. Check for the following voltages:
  - +24VDC on P1 across pins 1 and 2 for the pump drive/power supply board.
  - -12VDC on J2 across pins 2 and 3.
  - + 5.0VDC on the CPU/control board across pins 2 and 3 on J8.
5. If all voltages are present replace the pump display board.

### Pump Will not Switch into Forward or Reverse

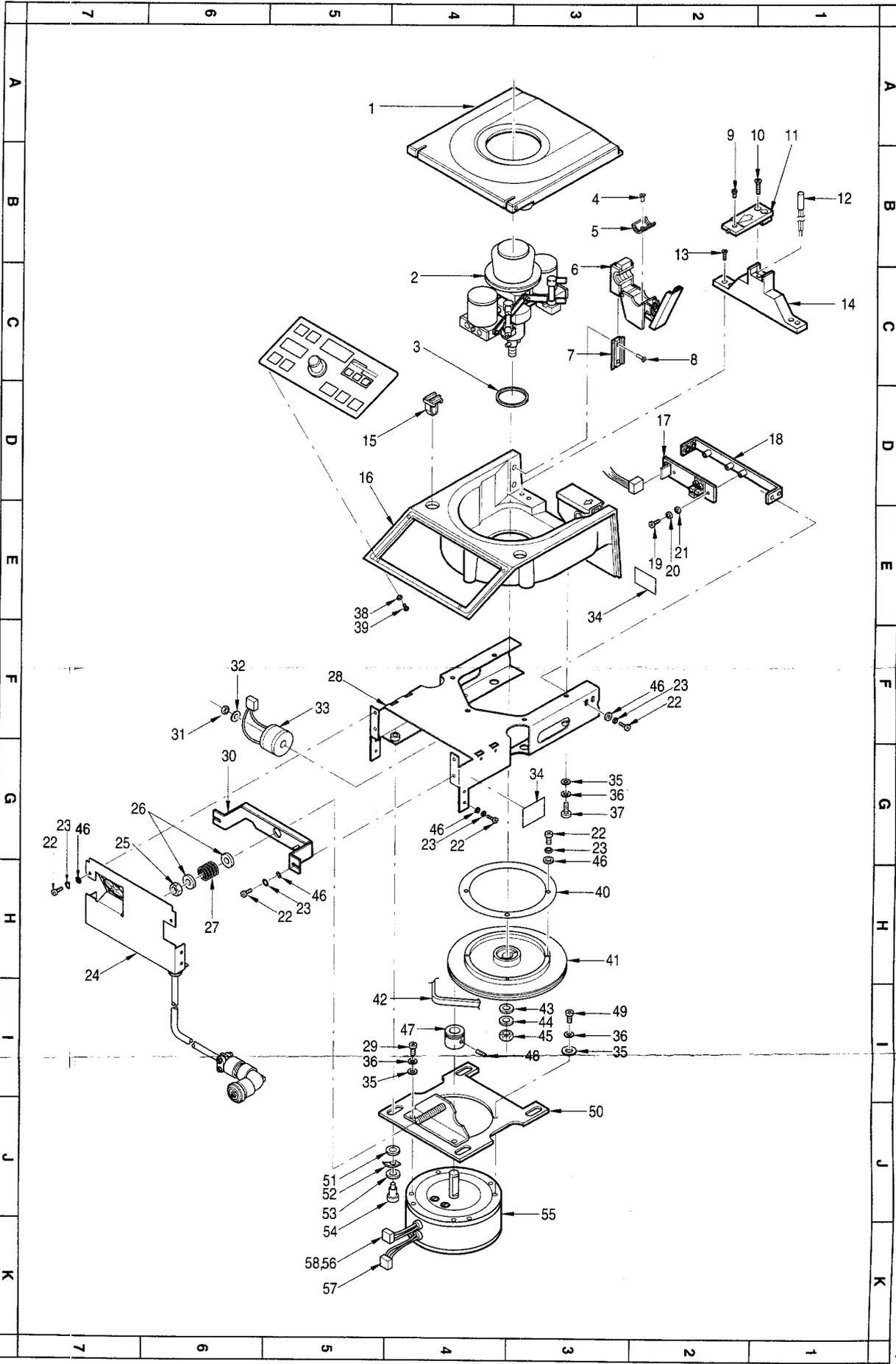
1. Check that the pump safety cover is closed and the magnet is in the cover.
2. Check the stop switch for a collapsed membrane switch.
3. Short together pins 2 and 3 on J9 on the pump CPU/control board.
  - Try to start the pump, if the pump runs, replace the cover interlock switch.
4. Replace the pump membrane panel.
5. Replace the pump drive/power supply board.

### Pump latches in either Forward or Reverse with no pumphead movement when the control knob is in a clockwise position.

1. Check the connection at J3 on the CPU/control board. Make sure the connection is clean and seated properly.
2. Replace the CPU/control board.







Item No.	3M ID	Description	Qty.
1	78-8066-6733-9	Cover Assembly Pump	1
2	78-8066-7470-7	Guts Assembly Pump	1
3	26-1008-2123-5	Oil Seal shaft rotating	1
4	12-7996-6665-1	Screw flathead, 4-40 x 5-16	2
5	98-0702-0384-3	Insert, 11/16 OD, color aluminum	4
6	78-8066-7520-9	Tube clamp assembly	2
7	78-8066-6271-0	Dovetail slide tube clamp	2
8	70-7023-4040-0	Flat HD SS screw, 6/32 x 5/16	4
9	78-8066-6248-8	Drag Insert	1
10	26-1008-4686-9	Philips oval HD zinc pl, 8/32 x 1	2
11	78-8066-9919-1	Tongue molded pump	1
12	26-1008-9049-5	Magnetic Sensor	1
13	12-7997-9109-5	Flat HD ss, 8/32 x 1/2	4
14	78-8072-1495-8	Tongue support wall	1
15	26-1006-9168-7	1/4 turn latch	2
16	78-8066-7466-5	Pumphead machined	1
17	78-8066-6282-7	PC Dual Tach Board	1
18	78-8066-9894-6	Encoder mounting bracket	1
19	26-1008-8040-5	4-40 x .25 but HD torx zinc PL	3
20	26-1000-3349-2	#4 split washer ss	3
21	26-1008-9069-3	Washer, stainless steel 5710-15-30	3
22	26-1008-8044-7	6-32 x .38 But HD Torx zinc pl	8
23	26-1000-0078-0	#6 split washer stainless steel	16
24	78-8067-7754-2	Cable assembly pump SMT	1
25	26-1008-4384-1	Stop nut 3/8 x 16	2
26	26-1008-1891-8	Washer .750D x .318D x .075 ss	6
27	26-1008-2134-2	Compression Spring	1
28	78-8067-7610-6	Enclosure Pump Motor	1
29	12-7996-1458-6	10/32 x 1/2 pan HD	2
30	78-8067-7612-2	Tension Bracket TCM	1
31	26-1000-6654-2	8-32 keps nut zinc plate	1
32	26-1008-1921-3	#8 Flat washer zinc plate	1
33	26-1011-2997-6	Power inductor 270 UH 11 amps	1
34	78-8067-0156-7	Nameplate Label	2

