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**Model: 3158**

Single Chamber  
Water Jacketed Incubator

**Manual No. 7003158**

**Important!**

**Read this instruction manual.**

Failure to read, understand and follow the instructions in this manual may result in damage to the unit, injury to operating personnel and poor equipment performance.

***Caution: All internal adjustments and maintenance must be performed by qualified service personnel***

**MANUAL ADDENDUM**

Re: Incubator CO<sub>2</sub> Control

**CAUTION!**

If the incubator sustains a power failure long enough to affect temperature and in turn affect humidity, then the CO<sub>2</sub> readout will be incorrect. The unit will return to NORMAL, indicating correct chamber conditions.

NOTE: PLEASE ALLOW ADEQUATE TIME FOR THE UNIT TO STABILIZE. (Short OFF and ON power failures will not adversely affect the chamber operation.)

**NOTE:**

The material in this manual is for information purposes only. The contents and the product it describes are subject to change without notice. Forma Scientific, Inc. makes no representations or warranties with respect to this manual. In no event shall Forma Scientific, Inc. be held liable for any damages, direct or incidental, arising out of or related to the use of this manual.

<b>MANUAL NO. 7003158</b>			
0		6/82	Original Manual
<b>REV</b>	<b>ECN</b>	<b>DATE</b>	<b>DESCRIPTION</b>

## UNPACKING LIST

Remove the packing box from the incubator. If the unit is to be moved by fork lift leave the incubator on the skid until it has been moved to its designated location. A small box containing the following accessories is packed inside the incubator:

<b>STOCK #</b>	<b>DESCRIPTION</b>	<b>QTY.</b>	<b>PURPOSE</b>
380284	3.8" Hose x 1/4 MPT Adapter	1	Fill & Drain
190028	Decontamination Kit	2	Replace Parts
180001	Polypropylene Funnel	1	Fill & Drain
72017	Vinyl Tubing 3/8" ID	6'	Fill & Drain

## ALSO PACKED WITHIN EACH INCUBATOR

224200	Stainless Steel Shelves	6
505072	Shelf Brackets	12
3113210	Stainless Blower Channel	1
3113220	Stainless Duct Sheet Left	1
3113230	Stainless Duct Sheet Right	1

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## SECTION 1 - INTRODUCTION

### 1.1 THE WATER JACKET: KEY FEATURES

Forma's water jacket design represents the best combination of economy, accuracy and reliability available in today's technology. Some of the salient features include:

- A door heater which adjusts automatically to ambient conditions, providing a condensate-free inner door for unhampered viewing of the product in the chamber without unnecessary door openings, which temporarily disturb temperature, humidity, and CO<sub>2</sub> control.
- Ultra-flat, vibration-free shelves to provide optimal culturing conditions.
- Direct-set CO<sub>2</sub>, temperature, and alarm setpoints.
- Tamper-proof controls to prevent unauthorized or accidental adjustments.
- Digital readout of temperature and CO<sub>2</sub> levels in the chamber surrounding the product.
- A sealed chamber to minimize CO<sub>2</sub> consumption.
- A sealed water jacket to minimize water evaporation.

The water jacket incubator is designed for ease of serviceability by providing:

- Front access to all components so that the unit need not be moved for service, repair, or routine maintenance.
- A slide-out control panel for easy access to electrical components.
- Plug-in CO<sub>2</sub>, and temperature/alarm modules to facilitate servicing or replacement of a particular control module.
- Self-diagnostic switches in the control modules to aid in troubleshooting the system and localizing problems.



The design of the water jacket also allows for ease in disinfecting or autoclaving with a minimum of unit downtime.

- There are no cracks or crevices in, or around, the chamber walls to harbor hidden or hard-to-reach bacterial growth.
- Stainless steel shelves, shelf channels and duct sheets are easily removable without tools for cleaning and disinfecting the entire interior.
- A blower wheel that is disposable and easily replaced.

Careful consideration has been given to the importance of product protection through the addition of:

- An Add Water audible alarm and pilot light to alert the operator when the water level in the water jacket has become too low for efficient operation.
- Audible and visual CO<sub>2</sub> alarms which are activated when the CO<sub>2</sub> percentage in the chamber deviates 1% above or below the CO<sub>2</sub> control setpoint.
- An overtemperature alarm that is activated when the chamber temperature rises above the control setpoint.

## **1.2 AUXILIARY EQUIPMENT**

### **1. Stainless Steel Shelf**

The perforated shelf is square for easy installation. 22 shelf capacity. Minimum order of 1 shelf.      Catalog # 224200

### **2. Shelf Channels**

For mounting extra shelves and a humidity pan. Two needed per shelf or pan. Minimum order of 1.      Catalog # 505072

### **3. Tissue Culture Shelves**

These 11" x 16" stainless steel shelves for culture dishes are designed for stacking to increase incubator storage space. Minimum order of 6 shelves.      Catalog # 500171

4. Multiplex Strip Recorder

This easy-to-install, self-contained strip recorder keeps a permanent record of both temperature and CO<sub>2</sub>. Catalog # 197012

5. Extra Recorder Chart Paper

A one-month supply of chart paper (1 roll) for the multiplex recorder.  
Catalog # 180029

6. FYRITE CO<sub>2</sub> Analyzer Kit

For checking the CO<sub>2</sub> (0-20%) level in the chamber. Connects to the gas sample port on the control panel. Kit comes complete with aspirator, sampling tube, and carrying case. Catalog # 220012

7. Extra FYRITE Fluid

For replacing FYRITE tester fluid. Three bottles per carton.  
Catalog # 220051

8. Digital Thermometer

Hand-held, the size of a pocket calculator, features clear liquid crystal readout of temperature from -99.9°C to +99.9°C. Ideal for general laboratory use.  
Catalog # 853227

9. Two Stage Pressure Regulator

Controls CO<sub>2</sub> cylinder gas pressure. First stage reduces tank pressure to pre-set intermediate level. Second stage reduces pressure to recommended incubator inlet pressure. Permits stable CO<sub>2</sub> flow on high or low demand through the entire cylinder supply. Catalog # 965010

10. CO<sub>2</sub> Gas Guard

For use with automatic CO<sub>2</sub> incubators only. Protects dual tank CO<sub>2</sub> supply by automatically switching to another tank when one supply is exhausted. Audible alarm warns of tank depletion; Reset button silences the alarm. Manual tank switchover included. Model # 3030

11. Replacement CO<sub>2</sub> Filter

Disposable 99.97% microbiological filter to replace the inline CO<sub>2</sub> filter when it becomes clogged. Catalog # 770001

## 12. Disinfection Kit

Includes parts needed for improved disinfection of the incubator. Includes disposable blower wheel, O-ring for the CO<sub>2</sub> sensor and blower shaft seal.

Catalog # 190028

## 13. Laboratory Disinfectant

For use in and around the laboratory. Ideal for cleaning and disinfecting incubators, bio-freezers, glassware washers, baths, circulators, and other equipment. Protects against contamination, reduces chances of infection.

AMPHYL spray absorbs odors, minimizes contamination. Spraying action reaches hard-to-reach places. 12 (14 oz.) aerosol cans per case.

Catalog # 170002

O-SYL Disinfectant Detergent. A combination cleaner and disinfectant with a broad spectrum anti-microbial action. 6 (1 gal.) bottles per case.

Catalog # 170001

ROCCAL II Germicidal Sanitizing Agent. Bactericidal, kills mildew, prevents growth of fungi and bacteria in the water jacket. 4 (1 gal.) bottles per case.

Catalog # 170003

## 14. Humidity Pan

This humidity pan rests on the bottom shelf channels and is easily removable for cleaning. Order an extra set of 2 shelf channels for mounting.

Catalog # 237001

## 15. Hygrometer

For measuring chamber humidity. This instrument has a 4" dial and a range of 0 to 100% RH.

Catalog # 155010

## 13. Glass Thermometer

For independently measuring chamber temperature. Range from 0°C to 100°C.

Catalog # 285722

## SECTION 2 - SPECIFICATIONS

### Capacity

Chamber Capacity	5.7 cu. ft. (0.16 cu. m.)
Water Jacket Volume	10.5 gal. (39.7 liters)
Humidity Reservoir Capacity	1.46 gal. (5.5 liters)
Humidity Pan Capacity	5.28 qt. (5 liters)

### Weights

Net (approximately)	180 lbs. (81.6kg)
Net Operational (approximately)	267.5 lbs. (121.3kg)
Shipping (nominal) Motor	270 lbs. (122kg)

### Dimensions

Exterior	24.6"W x 41.9"H x 23.8"F-B (62.5 cm x 106.4 cm x 60.4 cm)
Interior	18.6"W x 26.8"H x 18.8"F-B (47.2 cm x 68.1 cm x 47.8 cm)

### Construction

Interior	20 ga. stainless steel, type 304, 2B finish
Exterior	18 ga. cold rolled steel
Insulation	1-1/2" fiberglass
Inner Door Gasket	Silicone
Outer Door Gasket	Four sided molded magnetic vinyl
Finish	Polyurethane enamel, Bristol Grey and Windsor Blue trim

### Shelves

Capacity	22 (6 provided) 20 with use of optional humidity pan
Dimensions	17.75"W x 17.75" F-B (45.2 cm x 45.2 cm)
Construction	18 ga. perforated stainless steel, type 304
Surface Area	2.2 sq. ft. (0.2 sq. m) per shelf
Maximum	48.2 sq. ft. (1.36 sq. m)
Flatness	±0.032" off horizontal plane
Clearance	Adjustable on 1" centers

### Alarm/Monitor Module

Sensor	Thermistor
Sensitivity	±0.1°C
Readout	LCD
Setpoint	Digital with screwdriver adjust
Accuracy	±0.2°C
Readability	0.1°C
Alarm Setability	0.1°C

### CO<sub>2</sub> Module

Sensitivity	±0.1% CO <sub>2</sub>
Supply Voltage	±15V
Sensor	Matched thermistors
Controller	Thermal conductivity
Setpoint	Digital with screwdriver adjust
Readout	LCD
Readability	0.1% CO <sub>2</sub>
Setability	0.1% CO <sub>2</sub>
Alarm Differential and Delay	±1.0% (nominal) for longer than approximately 4 minutes.

### Temperature Control

Range	0°C to +60°C
Sensor	Thermistor
Controller	Proportional, zero switching
Sensitivity	±0.05°C

**Heaters**

Chamber	260 Watts
Door	5 Watts continuous, 120 Watts cycled
Top	6 Watts

**Blower**

CFM	7.5
Wheel Material	Polypropylene
Motor	1/200 HP, 1700 RPM, 4 pole, externally mounted, internally removable

**Fittings**

Fill/Drain Port	¼" FPT
Access Port	1.25" (3.17cm), plugged
CO <sub>2</sub> Connection	¼" serrated fitting, ¼" I.D. tubing
Sample Port	¼" OD, ¼" ID tubing

**Electrical Characteristics**

Main	90-130 Volts, 50/60Hz, 1PH, 4 FLA
Circuit Breaker	5 Amps
Power Switch	2 Pole
Line Cord	6', Hospital grade

**Performance Data:**

**Temperature**

Control Tolerance	±0.02°C at +37°C in 22.2°C ambient
Range	+5°C above ambient to +50°C
Uniformity	±0.2°C at 37°C
Recovery Rate after 10 second door opening	*Within 2 minutes, ±0.5°C
Recovery Rate after 20 second door opening	*Within 10 minutes, ±0.5°C
Heat-Up Time from ambient to 37°C	10 hours

\* - to within ½°C

**CO<sub>2</sub>**

Control Tolerance	Better than $\pm 0.1\%$
Range	0 to 20%
Consumption @ 5% CO <sub>2</sub>	1.7 liters/hour +7.2 liters/15 second door opening
Recovery Rate after 10 second door opening	**Within 5 minutes
Recovery Rate after 20 second door opening	**Within 10 minutes

**Humidification**

Range	98% RH @ +37°C
Recovery Rate after 10 second door opening	***Within 25 minutes
Recovery Rate after 20 second door opening	***Within 30 minutes
Energy Consumption @ 37°C in a 25°C ambient	100 Watts per hour/chamber

\*\* to 4.5% CO<sub>2</sub> (setpoint 5% CO<sub>2</sub>)

\*\*\* to 97% rH

## **SECTION 3 – OPERATION OVERVIEW**

### **3.1 OPERATION (See Figure 3-1)**

The water jacket is filled with approximately 10.5 gallons (39.7 liters) of water through the fill port located on the front of the unit. The water is then warmed by the chamber heater, providing very stable heating of the incubator chamber. Not only does the water stay at a constant temperature with a minimum of heater on-time, but it also acts as insulation from ambient temperature conditions.

Temperature control is maintained by a proportional, zero-switching device, which provides temperature uniformity throughout the chamber. A separate and independent overtemperature controller assures product safety by assuming control at the overtemp setpoint if the primary controller malfunctions. Should an overtemp condition develop, the monitor alarm system will alert the operator that a malfunction has occurred.

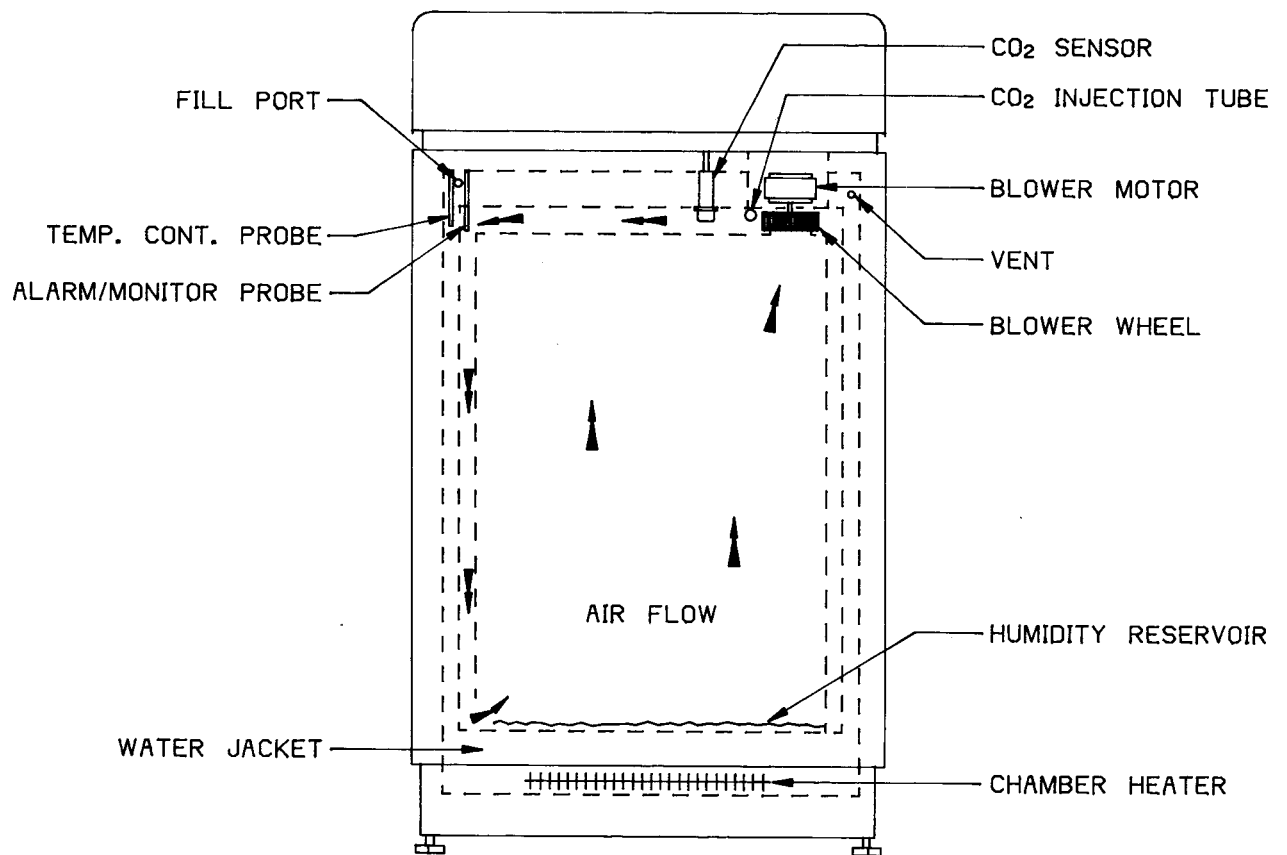
An internal blower gently circulates the air in the chamber to prevent CO<sub>2</sub> stratification while minimizing culture desiccation.

### **3.2 HUMIDIFICATION AND CO<sub>2</sub> (IMPORTANT!)**

Forma has selected the thermal conductivity method of measuring CO<sub>2</sub>, and when properly calibrated, the automatic CO<sub>2</sub> system will provide stable CO<sub>2</sub> control on a long-term basis. The thermal conductivity of the incubator atmosphere is affected by not only the quantity of CO<sub>2</sub> present, but also by the humidity level in the chamber. Since CO<sub>2</sub> control is desired, it is important that the absolute humidity be held constant so any change in thermal conductivity is caused only by a change in the CO<sub>2</sub> concentration. Inadequate humidification can cause the incubator humidity to fluctuate with ambient atmospheric changes and can affect the CO<sub>2</sub> calibration by as much as 1.5%. A special pan that is easy to remove for cleaning can be ordered from Forma (See Section 1). This pan, with the water level maintained between the Add and Full lines, will provide adequate humidification in the incubator.



It should be noted that temperature changes of themselves have little effect on CO<sub>2</sub> calibration, but they do cause large changes in the absolute humidity, and these changes are reflected in changes in the CO<sub>2</sub> calibration. If either the temperature or humidity setpoints are changed, the CO<sub>2</sub> control should be zeroed for the new condition(s).



**Operation of  
Water Jacketed Incubator  
Figure 3-1**



- 1. Fill Port & Vent
- 2. Power Switch
- 3. Circuit Breaker
- 4. Variable/37C Switch, Temp Control, Heat Light
- 5. Gas Sample Port
- 6. Setpoint Adjustment Tool
- 7. CO<sub>2</sub> Power Switch
- 8. CO<sub>2</sub> Controller & Digital Display
- 9. CO<sub>2</sub> Alarm Light
- 10. Set/Silence Button
- 11. Alarm Disable Switch (Not Shown)
- 12. CO<sub>2</sub> Inject Light
- 13. CO<sub>2</sub> Zero Adjustment
- 14. Alarm/Monitor Module
- 15. Overtemp Light
- 16. Add Water Light

**Incubator Controls**  
**Figure 3-2**

### 3.3 CONTROL PANEL (See Figure 3-2)

#### 1) Fill Port and Vent

The fill/drain fitting has been located on the front of the unit to facilitate filling and draining of the water jacket without having to move the unit. When water enters the water jacket during filling, the air that was present in the jacket exits through the vent. Under no circumstances should the vent be plugged.

#### 2) Power Switch and Pilot Light

The main power switch controls the ON/OFF power to the unit. The power pilot light is activated when the power switch is on and the unit is receiving power.

#### 3) Circuit Breaker (Reset)

The 5 amp circuit breaker for the incubator (labeled Reset) can be pushed to reset the incubator power supply within a few seconds after the breaker has tripped. If it trips a second time, the unit should be checked by a qualified electrician.

#### 4) Variable/37C Switch, Temp Control and Heater Pilot Light

When the Variable/37C switch is set to the 37C (up) position, chamber temperature will automatically be maintained at +37°C. If necessary, the 37C control can be calibrated using the calibration screw located at the lower left side of the temperature control dial. See Section 6.4 to calibrate the 37C setting.

When the Variable/37C switch is set to the Variable (down) position, control is assumed by the temperature control potentiometer. The numbers (0 to 60) around the control knob indicate approximate setpoint values in degrees Centigrade. Any value between +5°C above ambient temperature and 50°C may be selected. The heater pilot light will be activated whenever the heater is energized.

#### 5) Gas Sample Port

A sample port for checking CO<sub>2</sub> percentage by independent means (e.g. FYRITE or similar CO<sub>2</sub> measuring device). See Section 6.7-6.9 for details on the proper use of the FYRITE. **Important!** The Sample Port should never be capped as it serves as the vent for the incubator chamber.

#### **6) Setpoint Adjustment Tool**

A small screwdriver, located directly above the sample port, has been provided for setting the CO<sub>2</sub> and overtemp setpoints. Pull out on the knob to release the screwdriver.

### **3.4 CO<sub>2</sub> MODULE (Refer to Figure 3-2)**

#### **7) CO<sub>2</sub> Power Switch**

The CO<sub>2</sub> power switch controls electrical power to the CO<sub>2</sub> system, and it must be On when the incubator is to be operated with CO<sub>2</sub>. The switch should be turned On as soon as power is applied to the unit to allow the CO<sub>2</sub> system to warm up.

#### **8) CO<sub>2</sub> Controller and Digital Display**

The LCD digital readout on the CO<sub>2</sub> module continually displays the percent of CO<sub>2</sub> in the chamber. The setpoint is displayed when the CO<sub>2</sub> SET/SILENCE button is pushed.

The CO<sub>2</sub> setpoint is changed by pushing the CO<sub>2</sub> SET/SILENCE button and rotating the CO<sub>2</sub> setscrew to the desired percentage.

#### **9) Audible CO<sub>2</sub> Alarm and Pilot Light**

The audible CO<sub>2</sub> alarm and pilot light are activated when the percent CO<sub>2</sub> deviates from setpoint by  $\pm 1\%$  (nominal) for longer than approximately four minutes.

#### **10) Set/Silence Push Button**

When pushed, the SET/SILENCE button will silence the CO<sub>2</sub> alarm and de-energize the alarm light. The alarm will remain de-activated until another alarm occurs. This button must be pushed to set or display the CO<sub>2</sub> setpoint.

#### **11) Alarm Disable Switch**

**Note:** It is necessary to pull the CO<sub>2</sub> module out slightly to gain access to the alarm disable switch.

When the alarm switch is in the DISABLE position, the CO<sub>2</sub> alarm is completely disabled. When the switch is set to the NORMAL position, the alarm system is operative and can be silenced by pressing the SET/SILENCE button.

## **12) CO<sub>2</sub> Inject Light**

The CO<sub>2</sub> inject light is activated whenever there is a demand for CO<sub>2</sub> to meet setpoint requirements. Since the CO<sub>2</sub> inject light is independent of the CO<sub>2</sub> alarm, it will continue to signal a need for CO<sub>2</sub> when the CO<sub>2</sub> alarm is set to either the Defeat or Silence position.

## **13) CO<sub>2</sub> Zero Adjustment**

The CO<sub>2</sub> zero adjustment is used for zeroing the CO<sub>2</sub> controller to specific control conditions. It is the *only* user calibration adjustment on the CO<sub>2</sub> module. *All internal adjustments are for qualified service personnel only.*

### **3.5 ALARM/MONITOR MODULE (Refer to Figure 3-2)**

#### **14) Overtemperature Controller and PUSH TO SET Button**

The overtemperature setpoint is displayed when the PUSH TO SET button on the module is pressed. Overtemp control point is adjusted by pressing the SET button and rotating the setscrew on the module to the desired setpoint.

#### **15) Overtemp Alarm and Pilot Light**

The over temperature audible alarm and pilot light are activated in the event of an overtemp condition. Once the alarm has been activated, it can only be silenced by the temperature in the chamber returning to normal or by readjusting the overtemp setpoint to a value above the chamber temperature.

#### **16) Add Water Pilot Light and Audible Alarm**

The ADD WATER audible alarm and pilot light are activated whenever the water level in the water jacket is low. The alarm will be deactivated only when approximately one liter of water has been added through the fill port. See Section 4.9.)

## **SECTION 4 - INSTALLATION AND START-UP**

### **4.1 LOCATION**

Locate the incubator on a firm, level surface capable of supporting the unit filled with water. See weight specifications in Section 2. The incubator should be placed in a somewhat remote area of the laboratory away from any centrifuges, sonicators, doors, windows and air-conditioning or heating ductwork that might produce drafts. To help prevent microbial contamination, the incubator should not be located in areas of high personnel traffic.

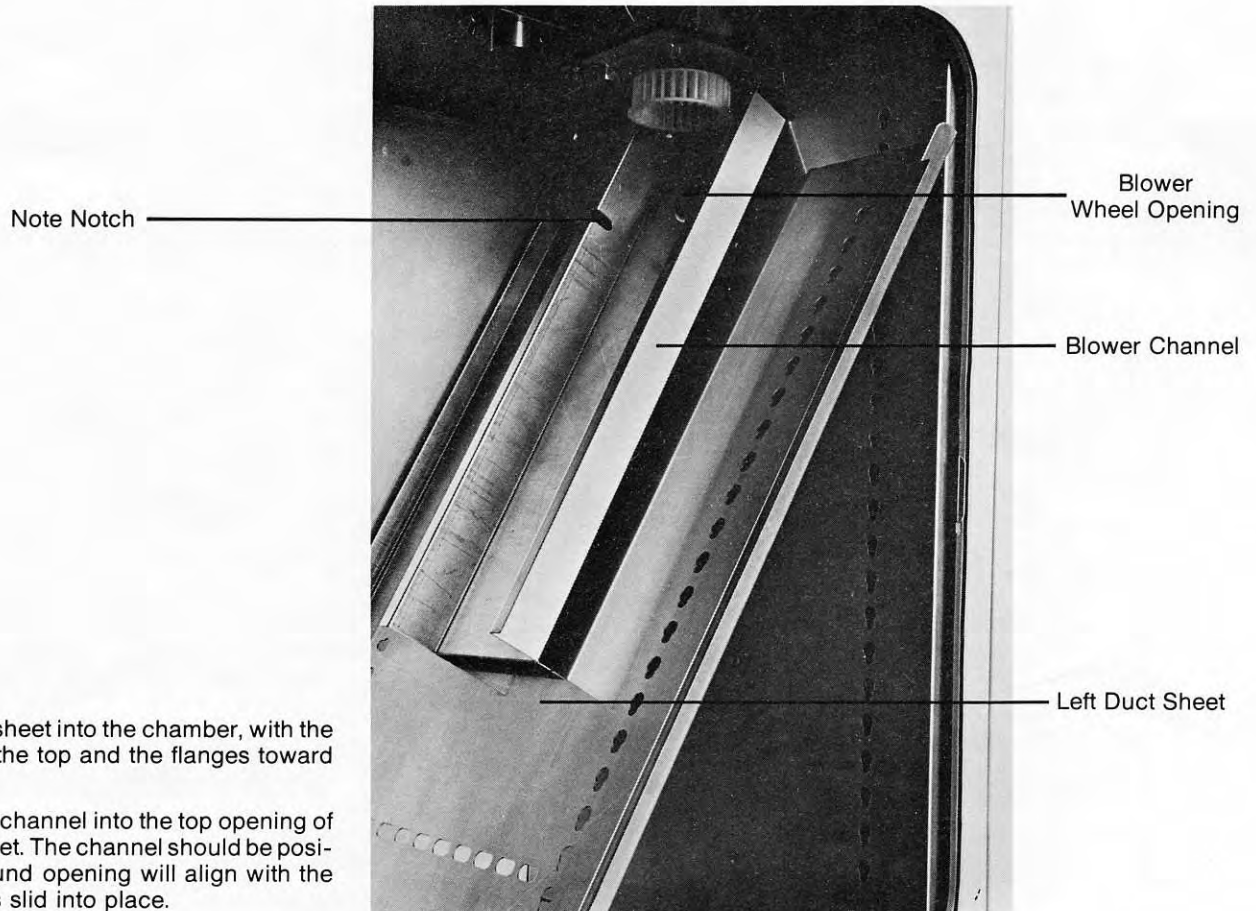
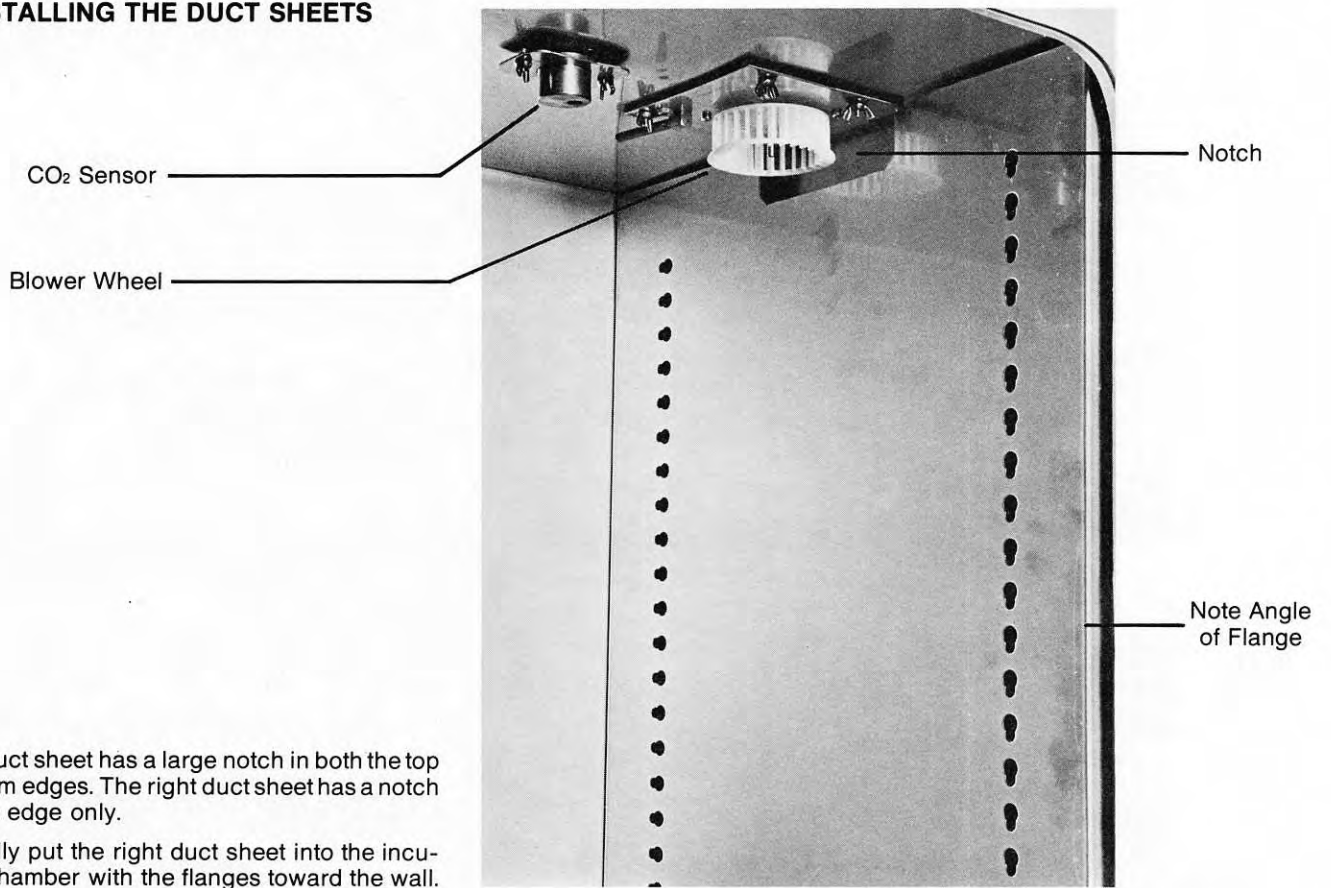
### **4.2 PRELIMINARY DISINFECTING**

Before installing the duct sheets and the shelves, remove the clear plastic film from the shelf brackets and duct sheets. Disinfect all interior surfaces (including both door gaskets) by washing them down with Roccal II (5ml/liter) or an equivalent laboratory disinfectant. Rinse the surfaces with sterile distilled water. Also disinfect the CO<sub>2</sub> sensor and the blower wheel, taking care not to saturate the sensor.

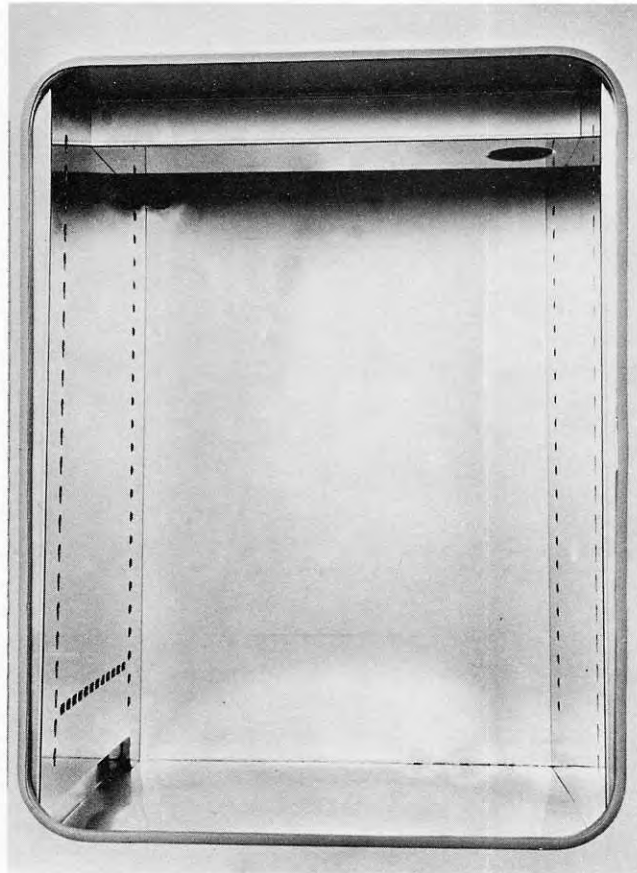
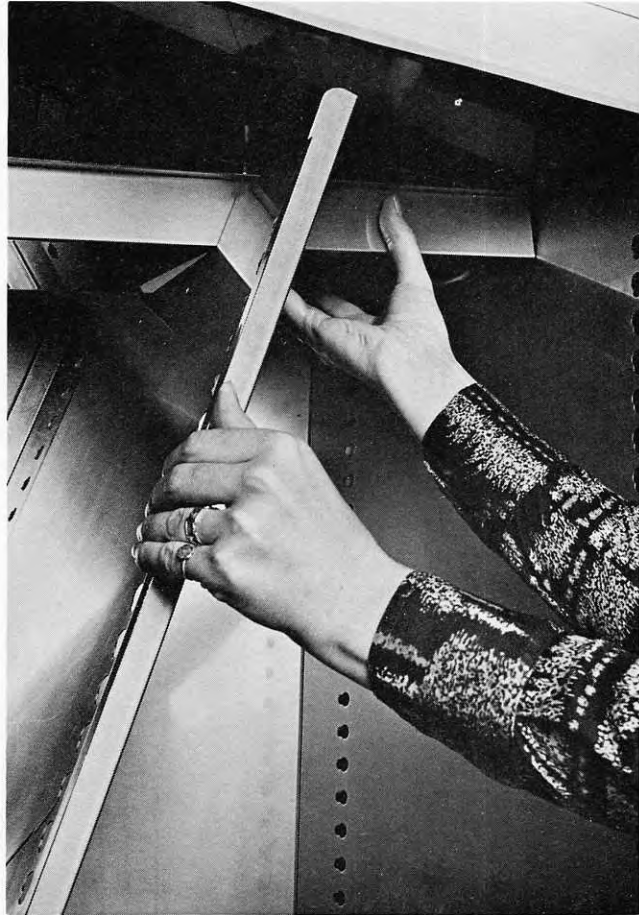
The duct sheets and shelves must be washed with the same disinfectant solution and rinsed with sterile distilled water prior to their installation in the chamber. When all surfaces are clean, proceed with the installation as noted.

For the complete disinfection process, refer to Sections 5.2 and 5.3 of this manual.

### 4.3 INSTALLING THE DUCT SHEETS



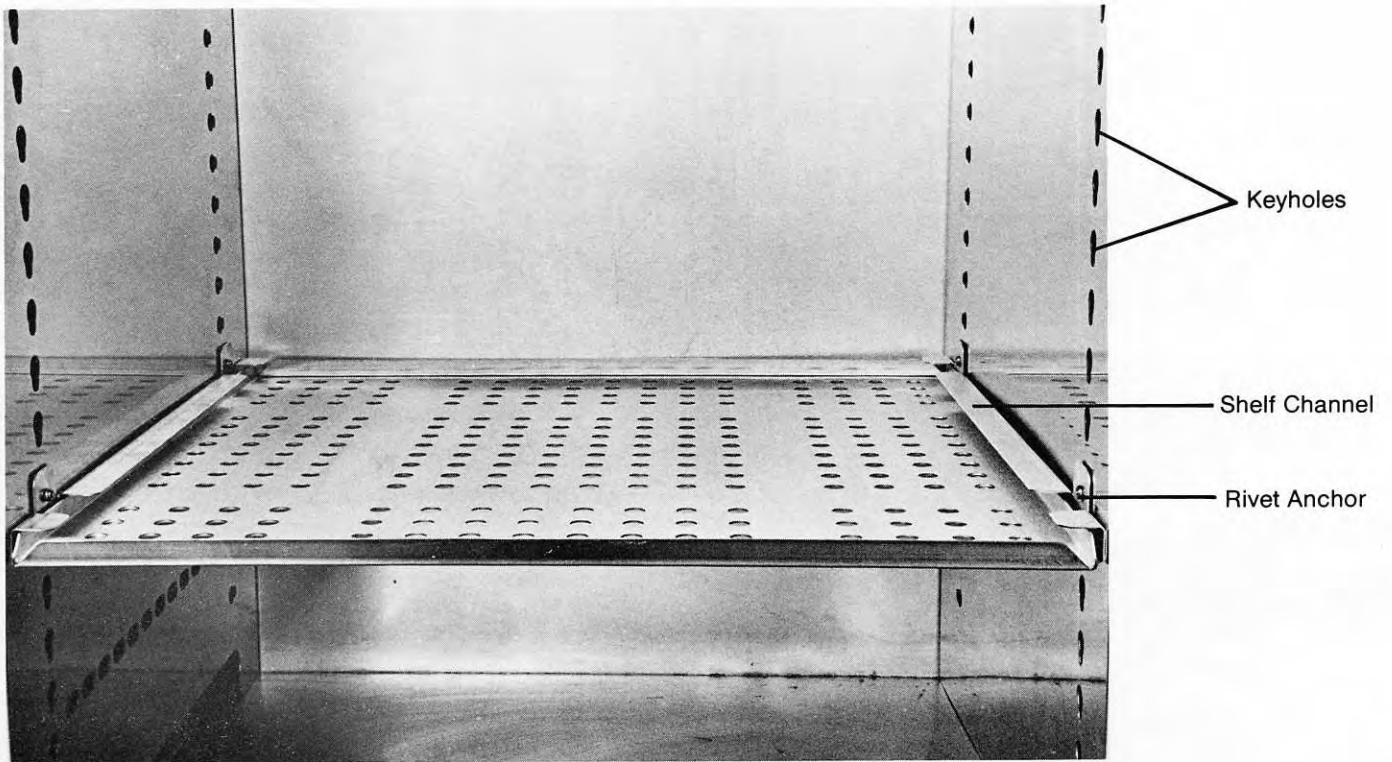
4) While supporting the blower channel, slide the left duct sheet up until it is vertical, making sure that the blower channel lines up into the slot on both duct sheets.



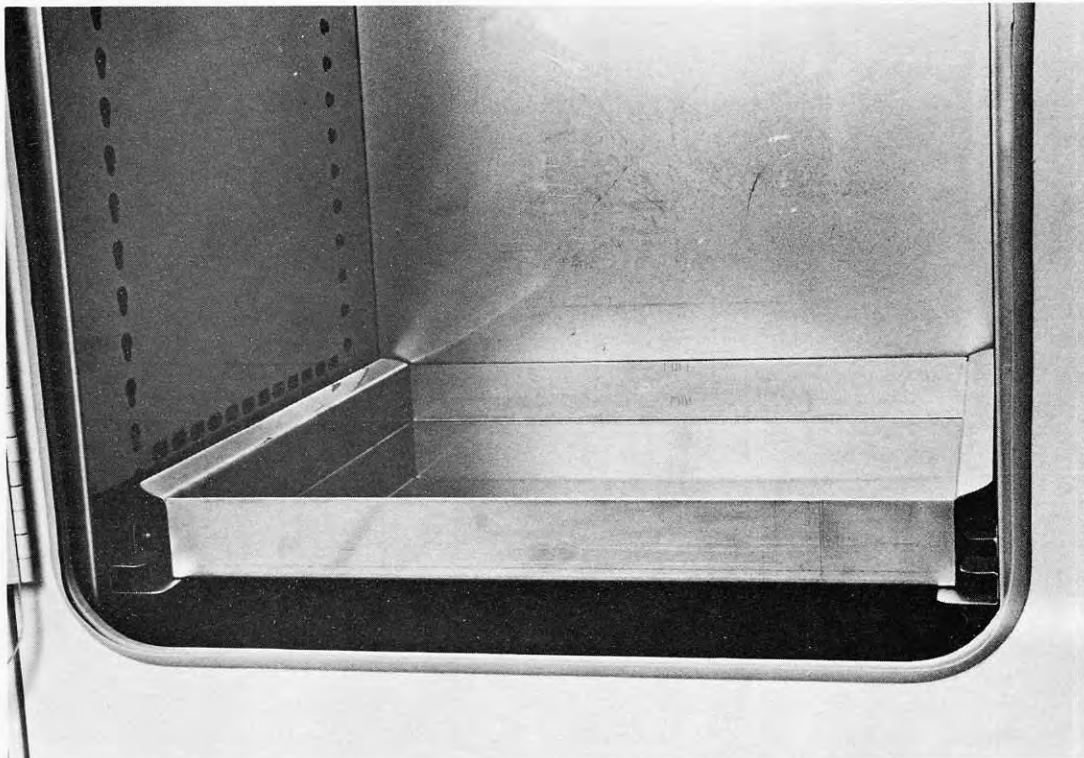
Completed installation of duct sheets and blower channel.



#### 4.4 INSTALLING THE SHELVES



The shelves may be placed at any level in the chamber by installing the shelf channels at the desired levels. The channels are equipped with rivet anchors which fit into the keyholes of the vertical mounting brackets. The shelf is then simply slid into the shelf channels.



**Note:** Do not place the humidity pan on the floor of the incubator.

The optional humidity pan is mounted on the bottom shelf channels.

#### 4.5 LEVELING

Turning the leveling feet counterclockwise will lengthen the leg and raise the unit, or turning them clockwise will shorten the leg and lower the unit. Check leveling by placing a bubble-type level on one of the shelves.

**Note:** Be sure to level the incubator before filling the water jacket.

**Note:** Do not attempt to tilt the incubator without assistance.

**Note:** When tipping the incubator forward, be sure to secure the inner door and hold the outer door to prevent damage to the unit.

#### 4.6 CONNECTING TO POWER

With the incubator power switch OFF, connect the unit to an adequate power source. See Section 2 for specific power requirements.

**Note:** Forma recommends that the incubator be connected to a separate electrical circuit.

#### 4.7 CONNECTING THE CO<sub>2</sub> SUPPLY

For the most economical use of CO<sub>2</sub>, a main supply of liquid CO<sub>2</sub> is recommended. The liquid CO<sub>2</sub> should be supplied from tanks *without siphon tubes* to ensure that only CO<sub>2</sub> gas enters the incubator injection system. It is also recommended that a two-stage pressure regulator with indicating gauges be installed at the supply cylinder outlet. The high pressure gauge should have an indicating range of 0 to 2000 PSIG to monitor tank pressure. The low pressure gauge should have an indicating range of 0 to 30 PSIG to monitor actual input pressure to the incubator injection system. A suitable two-stage pressure regulator is available from Forma Scientific. See Section 2 for additional information.

The CO<sub>2</sub> source must be regulated at a pressure between 5 and 10 PSIG. Higher pressure may damage the CO<sub>2</sub> system. Pressure lower than 5 PSI will not affect the operation of the system, but will increase the CO<sub>2</sub> recovery time.

#### TO CONNECT THE CO<sub>2</sub> SUPPLY:

The CO<sub>2</sub> fitting is located near the top rear of the incubator. Securely attach the vinyl CO<sub>2</sub> line to the serrated fitting and check the connection for leaks. If a metal line is to be used, the serrated fitting can be removed and a 1/8 MPT fitting installed.

### **4.8 PREPARING THE INCUBATOR FOR FILLING**

The access port for the water jacket is located behind the outer incubator door and is sealed with a screw cap.

Remove the cap, check to see that the opening is clear, and attach the threaded fitting and vinyl tubing that were shipped with the unit. Proceed as follows.

1. Set the TEMP SELECT switch to the Variable position and turn the temp control knob completely counterclockwise to keep the heater from coming on before the water jacket is filled.
2. Turn the power switch to the ON position.
3. Push in on the SET button on the Monitor Alarm Module, and adjust the overtemp alarm setpoint to a setting above ambient.
4. Turn On the power to the CO<sub>2</sub> module. Pull out on the module, and temporarily set the alarm switch to the Defeat position to silence the CO<sub>2</sub> alarm. Push the module back in.

### **4.9 FILLING THE WATER JACKET**

1. Forma recommends that you add Roccal II 10%, one part per 15,000 (2.65ml/water jacket) to the water jacket to retard the growth of fungi and bacteria.
2. Use single distilled or demineralized water to fill water jacket to prevent mineral build-up and corrosion.
3. Use only the screw cap provided with the unit to seal the fill port. Use of any other cap or cork could damage or plug the opening and impair its function.

**a. Funnel Method**

1. Fit the funnel into the vinyl tubing provided with the unit.
2. Hold funnel above the level of the fill port and pour the water into the funnel until the ADD WATER alarm and light are deactivated.
3. Add one additional liter of distilled water.
4. Remove the tubing and cap the port finger-tight.

**b. Serrated Tap Method**

1. Fit the tubing to the serrated tap.
2. If the distilled water is supplied from a central system, turn the tap on so that water flows slowly into the incubator.
3. Turn the water off immediately when the ADD WATER alarm and light are deactivated.
4. Add an additional liter of water.
5. Remove the tubing and cap the port finger-tight.

***Caution! As excessive water pressure or overfilling may damage the incubator, do not plug the vent directly above the door! If the jacket is overfilled, water can escape through the vent.***

**4.10 FILLING THE HUMIDITY RESERVOIR OR PAN**

1. Do not use glass or plastic pans for humidification, as they will have an unpredictable effect on humidity and CO<sub>2</sub> levels in the incubator. Use only the floor or optional humidity pan.
2. Add any of the following to the water to retard the growth contaminants:
  - Roccal II 10%, 10 mL
  - 1% Sodiumdodecyl Sulfate (SDS)

***WARNING! Do not use sodium azide as an anti-microbial agent in the humidity reservoir or pan unless it has been boiled immediately prior to use, as it forms a metallic azide that may explode when exposed to pressure.***

***Caution! Do not use demineralized or deionized water in the humidity reservoir or pan unless it has been boiled immediately prior to use, as it may be contaminated with bacteria.***

There are two recommended methods of providing elevated humidity in the chamber.

1. The reservoir in the bottom of the incubator may be filled with at least 3/4" depth of sterile distilled water

**OR**

2. The optional humidity pan (Forma Stock #237001) can be filled to the Full line with sterile distilled water. Mounted on the bottom shelf channels, this pan can be easily removed for filling or cleaning.

***Caution! Do not mount the humidity pan on the incubator floor as it could cause the inner door gasket to tear.***

The water level in the humidity reservoir should be checked frequently. The water should be changed and Roccal II added (6.5mL) weekly to help prevent microbial contamination. It is very important that the water level in the reservoir or pan be kept relatively constant as fluctuations or "dry-outs" will have an adverse effect on the humidity level and CO<sub>2</sub> control in the chamber.

#### **4.11 SETTING THE CHAMBER TEMPERATURE**

Before the initial temperature setting is made, press the PUSH-TO-SET button on the Alarm Monitor Module. Using the screwdriver on the control panel, turn the overtemp setscrew until the display shows a temperature that is 2° above the desired operating setpoint. The overtemp safety may be reset after the chamber temperature has stabilized at setpoint. See Section 4.12.

If a chamber temperature of 37°C is desired, set the Variable/37C switch on the Temperature Control panel to the 37C position.

If a value other than 37°C is desired, set the switch to the Variable position, and set the temperature control knob to the desired setpoint. Any temperature between 5°C above ambient to 50°C may be selected.

#### 4.12 SETTING THE OVERTEMP SAFETY THERMOSTAT

Once the chamber temperature has stabilized (as indicated by the digital display), the Over Temp Safety should be set as follows:

1. Press the PUSH TO SET button on the Alarm Monitor Module.
2. Using the screwdriver mounted on the control panel, turn the overtemp setscrew until the desired overtemp alarm point is shown on the digital display. The overtemp setpoint can be set within 0.1° of the operating setpoint, but it is recommended that it not be set within 0.5° of setpoint.

**Note:** The Overtemp Safety should be checked quarterly to ensure proper operation. To check the overtemp control, press the PUSH TO SET button on the Alarm Monitor Module and turn the setscrew counterclockwise until the overtemp safety light and audible alarm are activated. Reset the Overtemp Safety after the test.

#### 4.13 ZEROING THE CO<sub>2</sub> CONTROLLER

**Important!**

This adjustment is made using the CO<sub>2</sub> gas content of ambient air (0.03%), the most accurate standard available. Never use a Fyrite or other analyzer for this adjustment. The adjustment must be made on initial start-up, and if a change in humidification of the incubator is required.

**Tools Required:** Calibration screwdriver (provided on the panel)

FYRITE CO<sub>2</sub> Analyzer (use only for checking) or other CO<sub>2</sub> measuring device.

**Step 1. Stabilize the incubator at the operating temperature and humidity level with no CO<sub>2</sub> in the interior chamber.**

1. Turn off the CO<sub>2</sub> at the supply.
2. Fill the humidity reservoir or pan.
3. Allow the incubator temperature and humidity to stabilize. This will take a minimum of eight hours. On initial start-up, allow three days.

**Step 2. Adjusting the Zero Set Pot**

1. Using the small screwdriver mounted on the control panel, adjust the CO<sub>2</sub> control zero pot to read 00.0 on the digital display. Wait 5 minutes. Repeat if necessary until the display is stable.
2. Turn on the CO<sub>2</sub> at the supply.
3. Turn the CO<sub>2</sub> setpoint to the desired %.

**Step 3. (Optional) Checking the CO<sub>2</sub> at the Desired Setpoint**

1. Allow the incubator to reach setpoint and control (inject light will cycle) for a minimum of 30 minutes.
2. Check the CO<sub>2</sub> level with a FYRITE until two consecutive readings agree. If the FYRITE and display are not within  $\pm 1.0\%$ , consult the factory. See Section 5.9 for correct FYRITE sampling procedure.

**Note:** After proper zeroing, the CO<sub>2</sub> display will be more accurate than the FYRITE because the zero adjustment was accomplished using absolute atmospheric conditions.

#### **4.14 SETTING THE CO<sub>2</sub> CONTENT**

The following conditions must be satisfied before the CO<sub>2</sub> percentage can be set:

1. Allow the temperature and humidity in the chamber to stabilize. For initial settings of CO<sub>2</sub>, it is recommended that temperature and humidity be allowed to stabilize for three days.
2. Check the CO<sub>2</sub> control zero (See Section 4.13 for detailed instructions).

To set the CO<sub>2</sub> percentage, press the CO<sub>2</sub> Set/Silence button and rotate the CO<sub>2</sub> set screw until the desired percentage is indicated on the digital display.

**Note:** If the unit is in Overtemp and a CO<sub>2</sub> injection occurs, a brief, high CO<sub>2</sub> percentage will appear on the digital display. This is due to the shutdown of the internal fan during Overtemp. The high CO<sub>2</sub> percentage occurs only at the sensor. Average CO<sub>2</sub> throughout the chamber will remain normal.

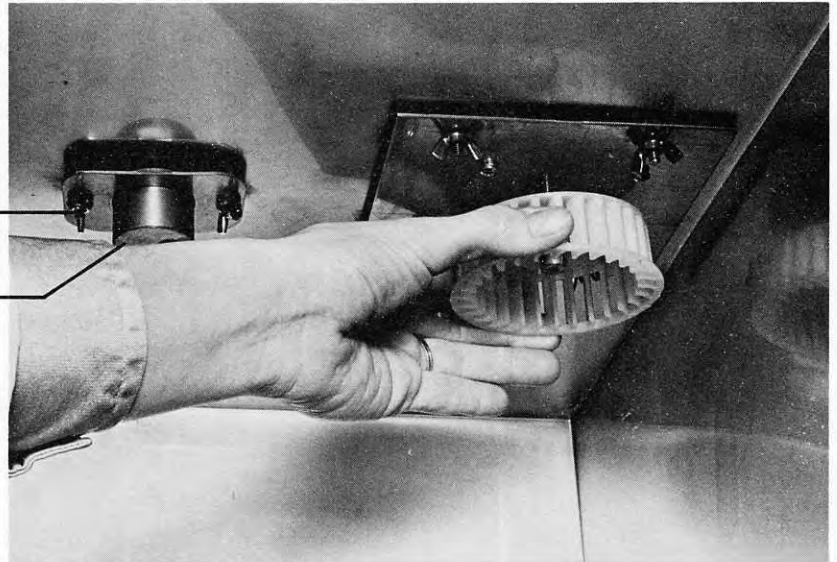


**SECTION 5 - ROUTINE MAINTENANCE**

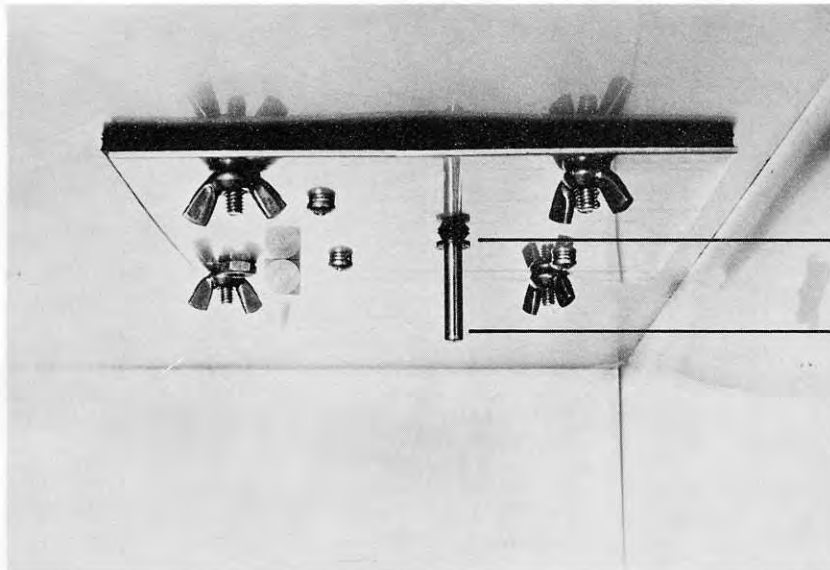
## 5.1 USING THE DECONTAMINATION KIT

Wing Nut

CO<sub>2</sub> Sensor



- 1) Disconnect the unit from the power supply.
- 2) Remove the shelves and duct sheets from the unit.
- 3) Remove the blower wheel by firmly pulling it down.

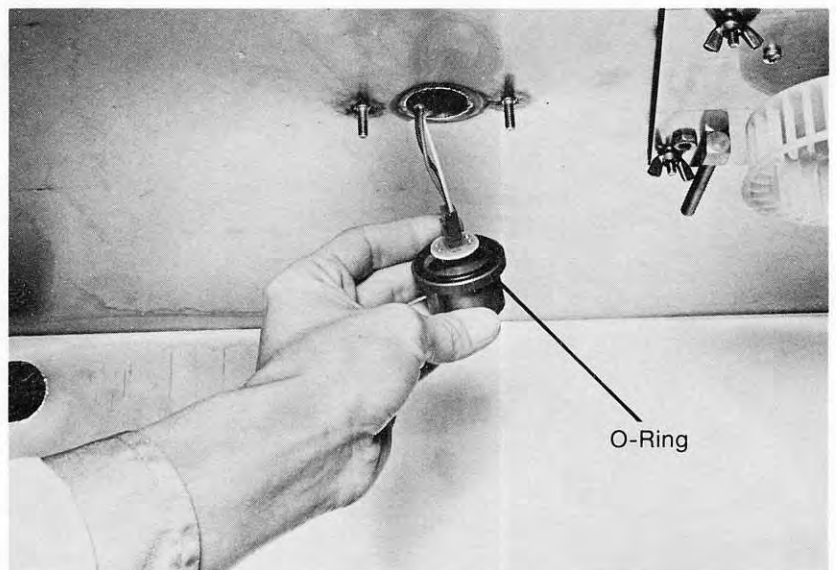


V-Seal

Blower Shaft

- 4) Pull the V-seal off the blower shaft, and replace it with the one in the decontamination kit. Be sure that the V part of the seal is up when the seal is installed on the shaft.
- 5) Replace the blower wheel with the new one in the kit. Be sure that the blower moves freely and does not hit any of the mounting screws.

- 6) Remove the wing nuts securing the CO<sub>2</sub> sensor, and allow the sensor to drop down. The sensor should not be pulled sharply, or damage to the wires could result. Disconnect the sensor.
- 7) Peel the O-ring off of the sensor, and replace it with the O-ring provided in the kit.
- 8) Wipe the sensor clean, taking care not to saturate it. Reconnect the sensor.
- 9) Push the wires back into the opening, and re-install the sensor. Be sure to tighten the wing nuts securely so the O-ring will seal properly.



O-Ring

## 5.2 DISINFECTING THE INCUBATOR INTERIOR

The incubator can be easily disinfected in about 30 minutes. Forma recommends the use of Roccal II, 5 mL/L. Dilute with distilled water.

1. Remove shelves and duct sheets, and clean all interior surfaces, taking care not to saturate the CO<sub>2</sub> sensor.
2. Rinse the surfaces at least twice with sterile distilled water.
3. Thoroughly clean the door gasket. It may be necessary to lift the edge of the gasket.
4. Clean inside of glass door with solution, and rinse with sterile distilled water.
5. Autoclave, or wash the shelves and duct sheets with solution.
6. If desired, all surfaces can then be rubbed or sprayed with 70% alcohol.

***WARNING! Alcohol, even a 70% solution, is volatile and flammable. Use it only in a well ventilated area that is free from open flame. If any component is cleaned with alcohol, do not expose the component to open flame or other possible hazard.***

***CAUTION! Do not use strong alkaline or caustic agents. Stainless steel is corrosion resistant, not corrosion proof.***

***Do not use solutions of sodium hypochlorite (bleach), as they may also cause pitting and rust.***

7. Reinstall the duct sheets and shelves. See Section 4.3 and 4.4.

## 5.3 CLEANING THE CABINET EXTERIOR

The incubator exterior may be cleaned with soap and water and a general-use laboratory disinfectant. Information about disinfectants recommended by Forma Scientific is included as a supplement to this manual.

#### **5.4 DRAINING THE WATER JACKET**

For best results, the water in the water jacket should be changed yearly.

1. Turn off the incubator and disconnect the unit from the power supply.
2. Remove the cap from the fill port and attach the threaded fitting, vinyl tubing and funnel.
3. Prime the water line by holding the tubing straight up and pouring water slowly into the funnel until the tubing is completely filled.
4. Quickly drop the water line to a drain or large bucket. If the tubing has been filled correctly, the water should siphon out of the jacket.
5. See Section 4.9 to fill the water jacket.

#### **5.5 CHANGING THE CO<sub>2</sub> FILTER (For Qualified Service Personnel Only)**

**Note:** Under conditions of normal use, and dependent upon the purity of gas being used, the CO<sub>2</sub> filter should be good for about five years.

If the CO<sub>2</sub> filter becomes clogged, replace it with Forma stock #770001.

1. Disconnect the unit from the power supply.
2. Turn the two 1/4 turn fasteners on the control panel, grasp the CO<sub>2</sub> sample port, and slide the control panel out.
3. Locate the CO<sub>2</sub> filter at the back of the control panel.
4. Replace the filter.

## 5.6 A WORD ABOUT CO<sub>2</sub> TEST INSTRUMENTS

The best standard available for zeroing or calibrating the Forma CO<sub>2</sub> controller is air, which typically contains 0.033% CO<sub>2</sub> by volume. Variations from this figure are insignificant.

It is very important that any Forma automatic CO<sub>2</sub> incubator be zeroed to air (See Section 4.13). CO<sub>2</sub> test instruments should be used as a secondary check or to verify the percentage of CO<sub>2</sub> at operating levels only!

Because sampling technique is so important when using CO<sub>2</sub> test instruments, information follows on the use of the most commonly used test instrument, the FYRITE. The FYRITE should be used for checking purposes only; not for actual zeroing of Forma equipment!

## 5.7 OVERVIEW OF THE FYRITE CO<sub>2</sub> ANALYZER

Many of our customers use FYRITE CO<sub>2</sub> Analyzers as an independent means of checking the CO<sub>2</sub> level in their incubators. We do not want to discourage this practice, but we feel that the safe and correct use of this test instrument is of vital importance to us. In an effort to inform our customers about the use of the FYRITE, we have compiled the following hints and instructions from the FYRITE instruction manual 11-9026, dated January, 1980.

### ***Warning!***

***The fluid used in the fyrite CO<sub>2</sub> analyzer contains potassium hydroxide and is corrosive. It contains poisonous chemicals and should not be taken internally.***

***In the event of body contact:***

### ***Antidotes***

***External: Flood with water, then wash with vinegar.***

***Internal: Give vinegar, or juice of lemon, grapefruit, or orange copiously. Follow with olive oil.***

***Eyes: Flood with water, then wash with a 5% boric acid solution.***

***Call physician***

## 5.8 FYRITE OPERATING PRECAUTIONS

1. DO NOT invert the FYRITE when the plunger is depressed.
2. DO NOT hold the FYRITE near your face when the top plunger is depressed.
3. ALWAYS hold the FYRITE by the fins to prevent heat transfer from your hands.
4. ALWAYS moisten the filter in the sampling tube before taking a sample. Failure to do so will result in inaccurate readings.
5. For maximum accuracy, the FYRITE MUST be at ambient temperature. DO NOT store the FYRITE in a location subject to extreme temperatures, such as the trunk of a car or a windowsill.
6. Check the strength of the FYRITE fluid whenever the instrument is used. See Section 5.10 for instructions on checking the fluid strength.

## 5.9 OPERATING THE FYRITE

1. Hold the FYRITE upright and away from your face. Press the plunger momentarily to vent the tester.
2. Invert the FYRITE to drain the fluid into the top.
3. Turn the FYRITE upright, and allow the fluid to drain to the bottom.
4. Hold the FYRITE at eye level. Loosen the locknut at the rear of the scale. Slide the scale until the top of the fluid column lines up with the zero on the scale. Tighten the locknut.

**Note:** Either the top or the bottom of the meniscus can be used for setting the zero as long as the same point is used when making measurements.

5. Attach the open end of the rubber gas sampler hose to the sample port on the incubator. DO NOT attach the tube to the FYRITE tester at this time. Pump the aspirator bulb a few times to clear the air from the sampler line.
6. Hold the FYRITE upright, and place the rubber connector tip from the sampler tube over the plunger valve, and pump the aspirator bulb at least 18 times. With the bulb still deflated, release the plunger valve during the final squeeze.

7. Invert the FYRITE, and allow all the liquid to drain to the top. Turn upright, and allow all the liquid to drain to the bottom. Repeat once.
8. Momentarily hold the FYRITE at a 45° angle to allow the fluid droplets to drain to the bottom.
9. Hold the FYRITE upright. Allow the fluid a few seconds to stabilize. Determine the percent CO<sub>2</sub> from the level of the fluid column. A delay of 5 to 10 seconds in taking the reading may result in a slight error; a longer delay may result in a substantial error.
10. Repeat steps 6 through 9 until two consecutive readings agree.
11. Remove the FYRITE hose from the sample port to allow the chamber to breathe.

**Note:** When used correctly, the FYRITE is accurate to within +0.5% of actual CO<sub>2</sub> value. Incorrect sampling technique can cause an error of as much as 4%.

## **5.10 CHECKING THE FYRITE FLUID STRENGTH**

After taking a reading with the FYRITE, do not vent the sample. Invert the FYRITE again, and take another reading. If there is an increase of 0.5% or more on the second reading, fluid replacement is necessary.

Fluid strength can also be checked by testing a certified gas sample containing a known CO<sub>2</sub> concentration. Fresh FYRITE fluid should be good for approximately **350** samples.

The dark red fluid floating on the top of the FYRITE solution is normal. It has been added to the solution to prevent excessive foaming at the meniscus and does not indicate defective fluid.

***CAUTION! If replacement of the fluid is necessary, carefully follow the directions on the package. Remember that the fluid is poisonous and caustic.***

## **5.11 RAISING OR LOWERING THE FYRITE FLUID LEVEL**

With the FYRITE vented and in the vertical position, it should be possible to adjust the zero scale to the top of the fluid column. If this is not possible, fluid should be added or removed.

To add fluid, hold the FYRITE upright, and press the plunger. Add clean tap water a few drops at a time.

To remove fluid, refer to the FYRITE instruction manual.



## SECTION 6 - SERVICE

### 6.1 GENERAL TROUBLESHOOTING

<b>Symptom</b>	<b>Possible Cause</b>
<p><b>Problem 1: Pilot lights not on. Readouts are dark. CO<sub>2</sub> power switch is on.</b></p>	<ul style="list-style-type: none"> <li>• Unit unplugged</li> <li>• Circuit breaker tripped.</li> <li>• Outlet overload protection has tripped.</li> <li>• No voltage at outlet.</li> <li>• Defective incubator wiring.</li> <li>• Main power switch not on.</li> </ul>
<p><b>Problem 2: CO<sub>2</sub> system indicator and readout are dark, no control of CO<sub>2</sub> in chamber. Switch is on.</b></p>	<ul style="list-style-type: none"> <li>• Circuit breaker tripped.</li> <li>• Defective switch or wiring.</li> <li>• Defective CO<sub>2</sub> module.</li> </ul>
<p><b>Problem 3: CO<sub>2</sub> setpoint and display agree. FYRITE reads lower.</b></p>	<ul style="list-style-type: none"> <li>• FYRITE not zeroed.</li> <li>• Wool filter in FYRITE is dry.</li> <li>• FYRITE fluid need to be changed.</li> <li>• Chamber absolute humidity has decreased.</li> <li>• Control is incorrectly zeroed.</li> <li>• Defective CO<sub>2</sub> sensor or control.</li> </ul>
<p><b>Problem 4: Alarm sounds periodically, even with the alarm disabled. CO<sub>2</sub> alarm light not activated.</b></p>	<ul style="list-style-type: none"> <li>• Overtemp control set too low.</li> <li>• Shorted heater.</li> <li>• Defective temp control or sensor.</li> </ul>
<p><b>Problem 5: CO<sub>2</sub> alarm and light are on. Alarm can be reset or disabled. If reset, alarm activates again.</b></p>	<ul style="list-style-type: none"> <li>• CO<sub>2</sub> level has deviated more than 1% from setpoint.</li> <li>• CO<sub>2</sub> supply has been interrupted.</li> <li>• CO<sub>2</sub> inject circuit is defective.</li> <li>• CO<sub>2</sub> solenoid is defective.</li> <li>• CO<sub>2</sub> sensor fan is defective.</li> </ul>

Symptom	Possible Cause
<p><b>Problem 6: Digital CO<sub>2</sub> display and FYRITE read more than 1% different from setpoint. CO<sub>2</sub> alarm not activated.</b></p>	<ul style="list-style-type: none"> <li>• Alarm is disabled.</li> <li>• Defective alarm circuit.</li> <li>• Defective CO<sub>2</sub> sampler or control.</li> </ul>
<p><b>Problem 7: CO<sub>2</sub> display and FYRITE read 0% CO<sub>2</sub>. Setpoint is OK. CO<sub>2</sub> alarm is activated. CO<sub>2</sub> inject light is on.</b></p>	<ul style="list-style-type: none"> <li>• Loss of CO<sub>2</sub> supply.</li> <li>• Defective CO<sub>2</sub> solenoid.</li> <li>• Clogged CO<sub>2</sub> in-line filter.</li> </ul>
<p><b>Problem 8: CO<sub>2</sub> display shows some random number or decimal point.</b></p>	<ul style="list-style-type: none"> <li>• Defective readout board.</li> <li>• Defective output to readout board from CO<sub>2</sub> control.</li> <li>• Faulty interconnecting wiring.</li> </ul>
<p><b>Problem 9: CO<sub>2</sub> display will not go to zero no matter how long the door is left open.</b></p>	<ul style="list-style-type: none"> <li>• Improper procedure. Close door and allow temperature and RH to stabilize eight hours.</li> <li>• Defective CO<sub>2</sub> sensor.</li> <li>• Defective CO<sub>2</sub> control.</li> </ul>
<p><b>Problem 10: Display flickers badly or counts up and down three or four digits.</b></p>	<ul style="list-style-type: none"> <li>• Defective readout board.</li> <li>• Excessive electrical interference near the cabinet.</li> <li>• Faulty grounding circuit.</li> <li>• Sampler blower is improperly installed or defective.</li> </ul>

Symptom	Possible Cause
<p><b>Problem 11: CO<sub>2</sub> setpoint cannot be changed.</b></p>	<ul style="list-style-type: none"> <li>• Defective CO<sub>2</sub> control.</li> </ul>
<p><b>Problem 12: Unit cannot be zeroed.</b></p>	<ul style="list-style-type: none"> <li>• Defective CO<sub>2</sub> potentiometer.</li> <li>• Defective zero control.</li> <li>• Defective CO<sub>2</sub> sensor.</li> </ul>
<p><b>Problem 13: CO<sub>2</sub> overshoots setpoint badly.</b></p>	<ul style="list-style-type: none"> <li>• Inoperative CO<sub>2</sub> sampler blower.</li> <li>• Defective CO<sub>2</sub> control.</li> <li>• CO<sub>2</sub> inlet pressure too high.</li> <li>• Unit is in overtemp.</li> </ul>
<p><b>Problem 14: Actual CO<sub>2</sub> is higher than setpoint and readout. Re-zeroing helps for a time, then symptoms return.</b></p>	<ul style="list-style-type: none"> <li>• Defective CO<sub>2</sub> sensor.</li> <li>• Incorrect calibration of CO<sub>2</sub> control.</li> </ul>
<p><b>Problem 15: CO<sub>2</sub> alarm sounds while CO<sub>2</sub> level is controlling at setpoint.</b></p>	<ul style="list-style-type: none"> <li>• Excessive RFI or EMI near unit.</li> <li>• Faulty grounding circuit.</li> <li>• Defective CO<sub>2</sub> control.</li> </ul>
<p><b>Problem 16: CO<sub>2</sub> setpoint changes by itself.</b></p>	<ul style="list-style-type: none"> <li>• Faulty CO<sub>2</sub> potentiometer.</li> <li>• Defective CO<sub>2</sub> control.</li> </ul>

## **6.2 USE OF THE TROUBLESHOOTING FLOWCHARTS**

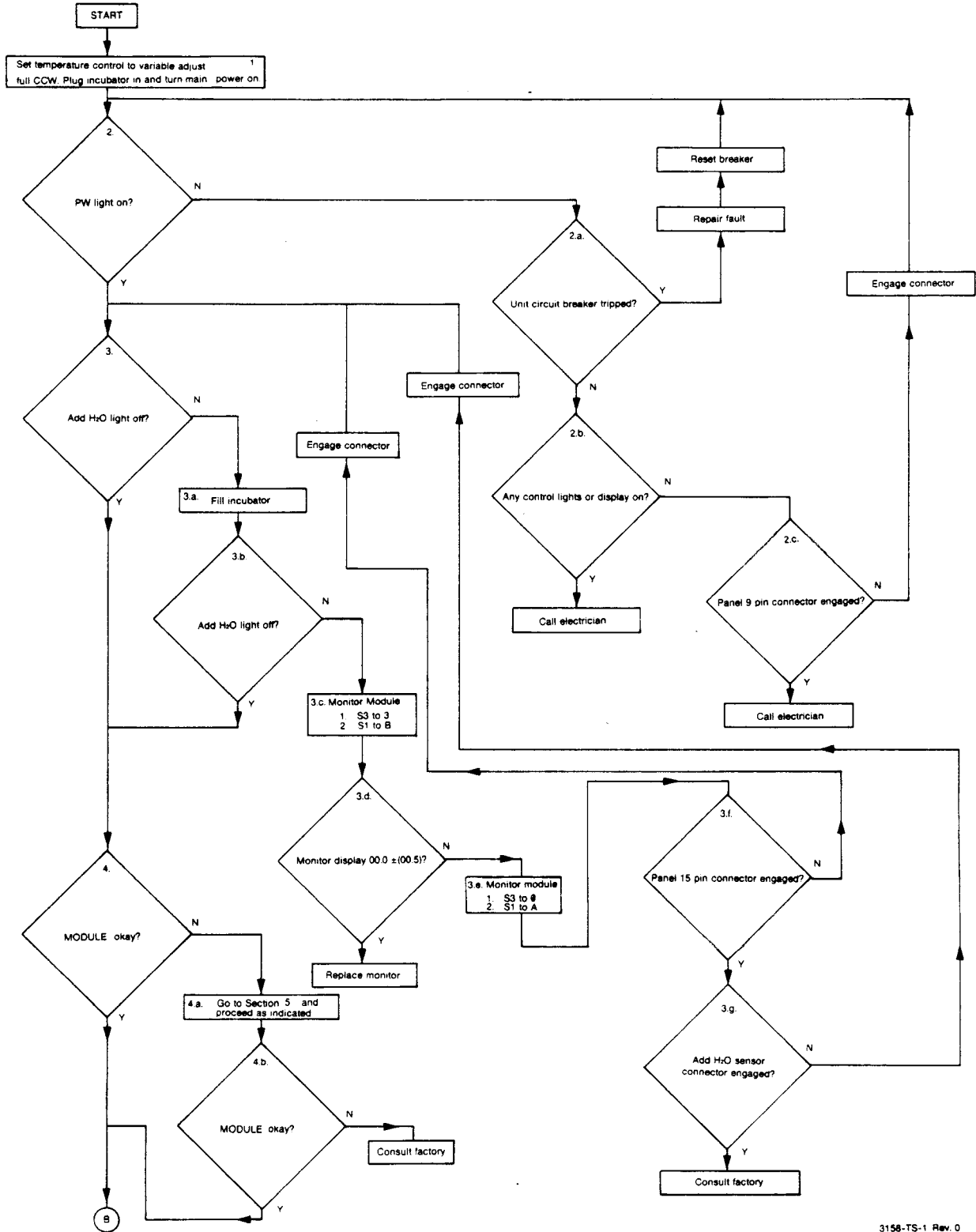
Follow the instructions on the flow charts to diagnose problems with the incubator electrical system and/or the CO<sub>2</sub> and alarm modules. For this diagnostic aid to be effective, all checks must be made in the sequence indicated by the flow chart, and all data must be carefully recorded.

The following two flow charts are for troubleshooting the incubator in general.

Y = Yes            N = No

### GENERAL TROUBLESHOOTING FLOWCHART

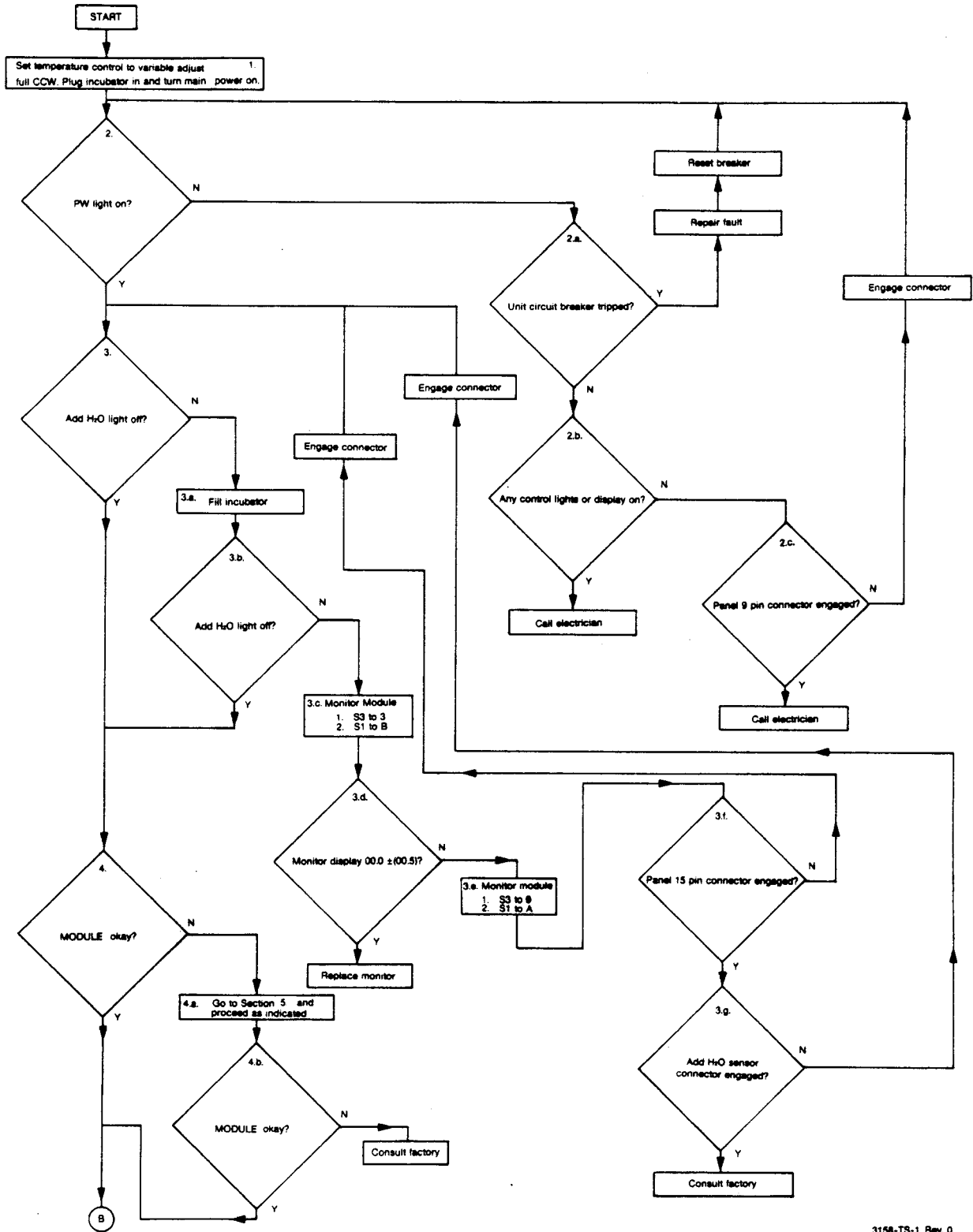
NOTE: Y= YES  
N= NO



Troubleshooting Flowchart, 1 of 2,  
Figure 6-1

### GENERAL TROUBLESHOOTING FLOWCHART

NOTE: Y= YES  
N= NO



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Troubleshooting Flowchart, 2 of 2,  
Figure 6-1

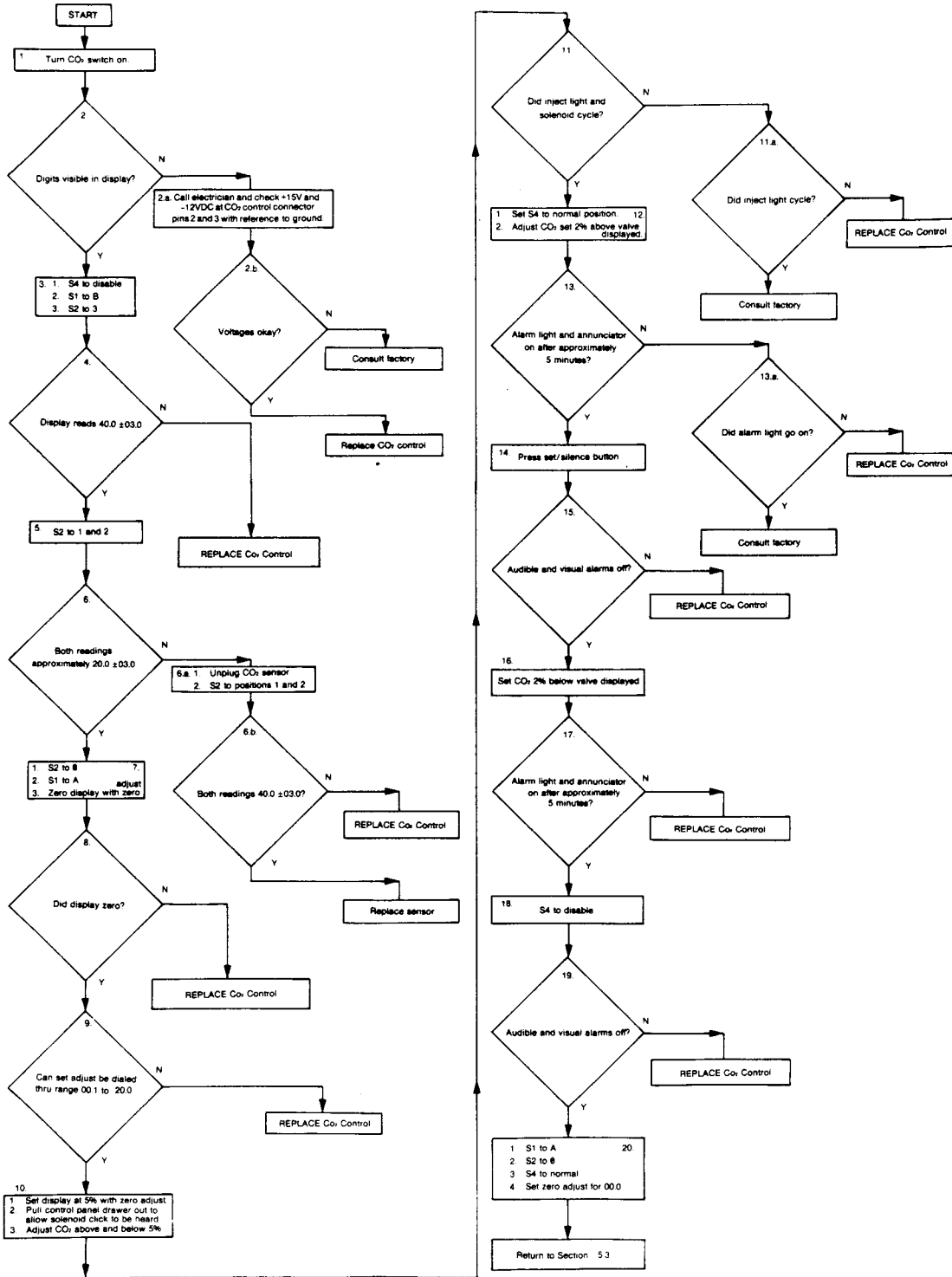
## **6.2B CO<sub>2</sub> MODULE TROUBLESHOOTING – GENERAL NOTES**

- NOTE 1: Before removing the CO<sub>2</sub> control module from the unit, turn the power off to that module.
- NOTE 2: At various times during this procedure, the CO<sub>2</sub> alarm may sound. Unless otherwise noted in the procedure, the alarm may be silenced by pressing the alarm silence switch.
- NOTE 3: Unless otherwise noted in the procedure, the module referred to is the CO<sub>2</sub> module, and the switches referred to are located on the CO<sub>2</sub> module.
- NOTE 4: Switch locations for the CO<sub>2</sub> module are labeled on the module picture.
- NOTE 5: The chamber temperature is stable when the monitor display indicates the interior heater is cycling.
- NOTE 6: Less than 4 hours is insufficient time for calibration, but is adequate for this test.
- NOTE 7: Recalibration of the control may be necessary if replacement is required.
- NOTE 8: When the chart calls for contacting an electrician, your in-house electrical technician should be called.
- NOTE 9: Y = Yes, N = No

### CO<sub>2</sub> MODULE TROUBLESHOOTING FLOWCHART

**Note:** Before using this flow diagram, it is important that the calibration of the CO<sub>2</sub> system has been checked first. The flow chart is to help diagnose problems that may occur other than calibration. It will be necessary to check the calibration of the CO<sub>2</sub> system after using this procedure. Turn CO<sub>2</sub> off at supply, and air out cabinet for 2 minutes. Allow approximately 30 minutes for R/H to recover for this procedure.

**NOTE:** Y= YES  
N= NO



Troubleshooting Flowchart, 1 of 1  
Figure 6-2



## **6.2C MONITOR MODULE TROUBLESHOOTING – GENERAL NOTES**

NOTE 1: Unless otherwise noted in the procedure, the module referred to is the Monitor module, and the switches referred to are located on the Monitor module.

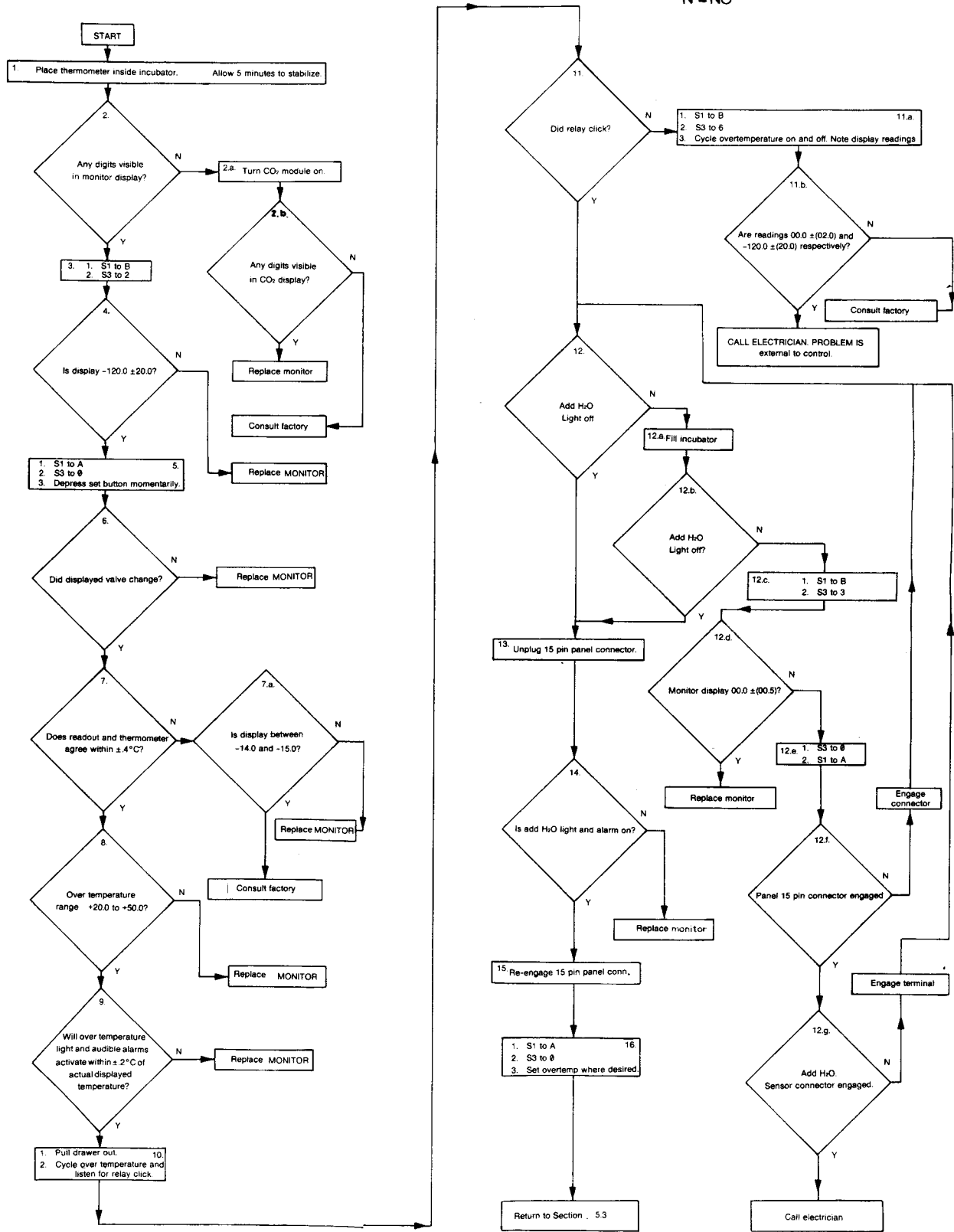
NOTE 2: Switch locations for the Monitor module are labeled on the module picture.

NOTE 3: When the chart called for contacting an electrician, your in-house electrical technician should be called.

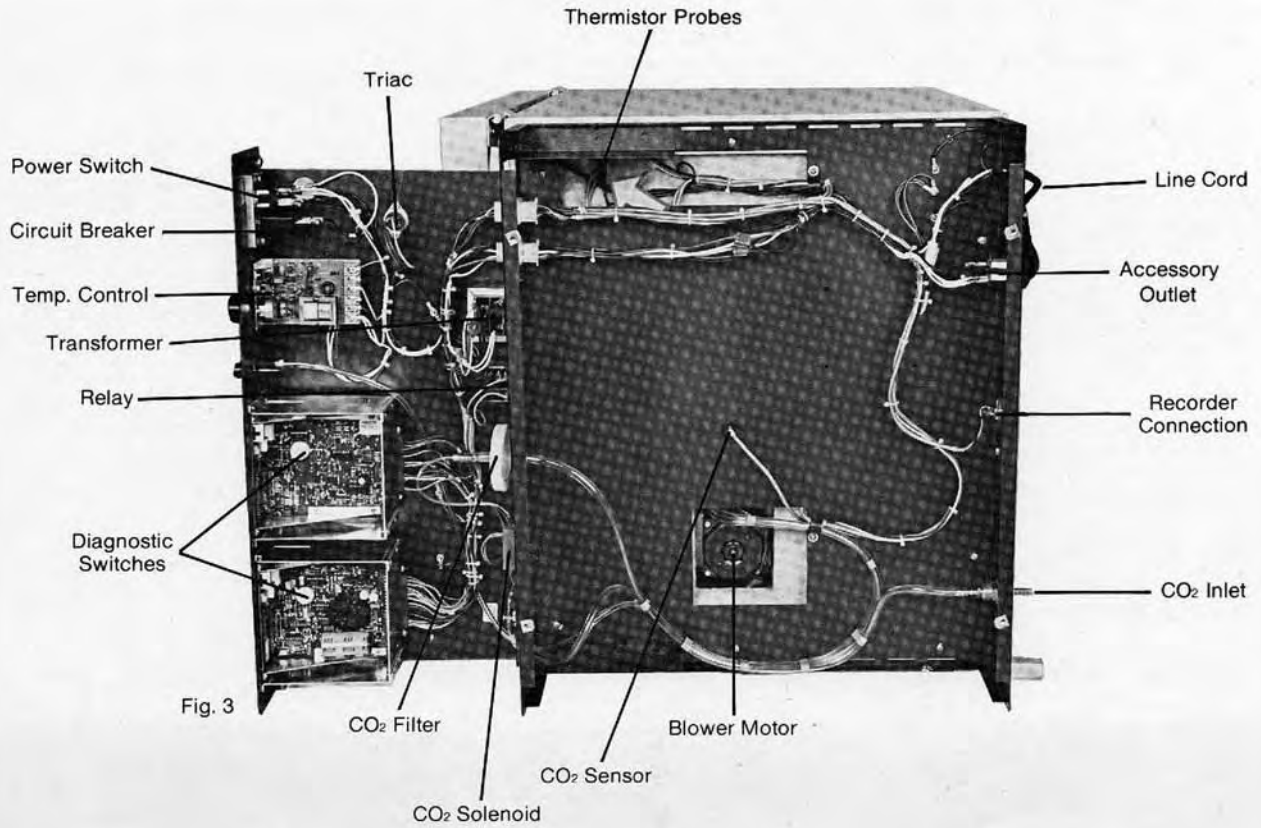
NOTE 4: Y = Yes, N = No

### ALARM MODULE TROUBLESHOOTING FLOWCHART

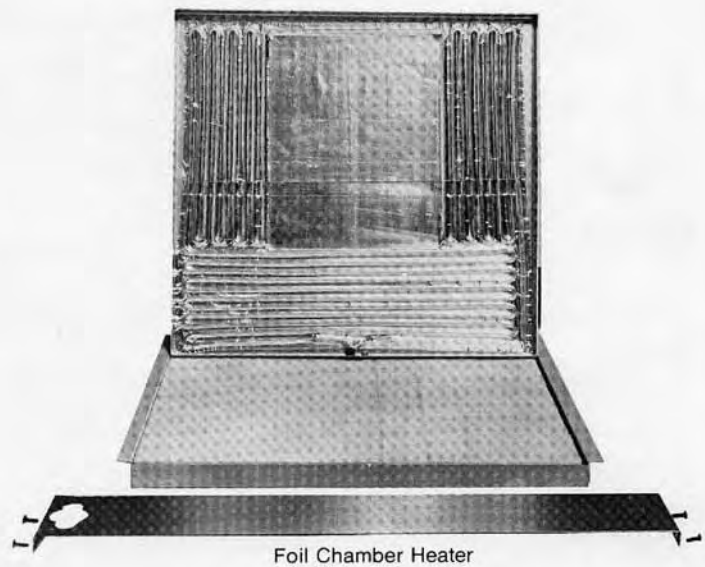
NOTE: Y = YES  
N = NO



Troubleshooting Flowchart, 1 of 1  
Figure 6-3



**Incubator Component Location**  
**1 of 1**  
**Figure 6-4**



### **6.3 CO<sub>2</sub> CONTROL CALIBRATION (See Figure 6-4)**

The adjustment will only be necessary under the following conditions.  
DO NOT recalibrate the incubator for any other reasons!

- After the CO<sub>2</sub> controller is replaced
- After the CO<sub>2</sub> sensor is replaced
- If there is reason to believe that the controller has previously been calibrated incorrectly.

Tools needed:

Calibration screwdriver (provided)

FYRITE CO<sub>2</sub> analyzer (see Sections 5.7 – 5.9 for proper usage)

#### **CALIBRATION PROCEDURE**

**STEP 1: Stabilize the incubator at operating temperature and humidity with no CO<sub>2</sub> in the chamber.**

1. Turn off the CO<sub>2</sub> supply at the source.
2. Fill the humidity pan with sterile distilled water.
3. Allow the chamber temperature and humidity to stabilize. This will take a minimum of eight hours if the temperature setpoint has recently been changed. Allow three days on initial start-up.
4. Turn the span potentiometer counterclockwise 10 turns.

**STEP 2: Adjust the Zero Potentiometer**

1. Using the calibration screwdriver, adjust the CO<sub>2</sub> control zero pot to read 00.0 on the digital display.
2. Wait 5 minutes, and repeat as necessary until the display is stable.

### **STEP 3: Adjust the Span Potentiometer**

1. Turn ON the CO<sub>2</sub> at the supply.
2. Turn the CO<sub>2</sub> setpoint to 10%. Allow the CO<sub>2</sub> to stabilize at 10% on the readout and control (inject light will cycle) for a minimum of 15 minutes.
3. Using a FYRITE or other measuring device, check the CO<sub>2</sub> level in the chamber until two consecutive readings agree.
4. Turn the CO<sub>2</sub> setpoint to 0.0% to prevent CO<sub>2</sub> from being injected into the chamber during the adjustment.
5. Adjust the span pot so the digital display agrees with the FYRITE reading.
6. Turn the setpoint back to 10%, and allow the CO<sub>2</sub> to control and stabilize for a minimum of 15 minutes.
7. Check the CO<sub>2</sub> in the chamber with a FYRITE or similar device until two consecutive readings agree. If the digital display is within  $\pm 1.0\%$  of the FYRITE reading, proceed to Step 4. If the reading is not within  $\pm 1.0\%$ , repeat steps 2 through 6.

### **STEP 4: Re-check the Zero Adjustment**

1. Turn OFF the CO<sub>2</sub> at the supply.
2. Open both doors wide for 45 seconds. Close the doors, and allow a minimum of 15 minutes for the incubator to stabilize and assure a zero CO<sub>2</sub> condition in the chamber.
3. If the readout is greater than 00.4, repeat the door opening for 15 seconds and again allow the incubator to stabilize for a minimum of 15 minutes. If the display is not less than the previous reading, consult the factory. If the display now reads 00.4 or less, re-adjust the zero pot so the display reads 00.0.

### **STEP 5: Check the CO<sub>2</sub> at the desired setpoint**

1. Turn ON the CO<sub>2</sub> at the supply.
2. Turn the CO<sub>2</sub> setpoint to the desired level.
3. Allow the incubator to reach setpoint and control for 30 minutes.
4. Check the CO<sub>2</sub> with a FYRITE or similar device until two consecutive readings agree. If the FYRITE and display are not within 1.0%, consult the factory.

**Note:** After proper calibration, the CO<sub>2</sub> display will be more accurate than the FYRITE because the zero adjustment was made using atmospheric conditions.

## **6.4 37C CONTROL CALIBRATION**

If the digital display indicates a temperature other than 37°C when the chamber temperature has stabilized (temperature select switch set to 37C), it may be necessary to recalibrate the adjustment.

### **To recalibrate:**

1. Make a note of how much the display varies from 37°C.
2. Locate the 37C calibration adjustment on the control panel. (See Figure 1 at the start of Section 3.)
3. Using the calibration screwdriver mounted on the control panel, turn the calibration screw one turn clockwise for every half degree that the display is below 37°C. Turning the screw counterclockwise will lower the temperature.
4. Allow the temperature to stabilize, and check the display again. If it still varies significantly, repeat steps 1 through 3.

***CAUTION! Servicing should be performed by qualified service personnel only. Disconnect the incubator from the power source before starting service procedures.***

### **6.5 REPLACING THE CO<sub>2</sub> SENSOR (See Figure 6-4)**

1. Remove shelves, duct sheets, and blower channel from the chamber.
2. Locate CO<sub>2</sub> sensor, and remove wingnuts. The sensor will drop down. See Section 5.1 photos.
3. There is a clip that connects sensor wiring to incubator wiring. To open the clip, pull out slightly on the clip tab to release the sensor.
4. Remove the O-ring, and place it on the new sensor.
5. Clip the new CO<sub>2</sub> sensor onto the incubator wiring and return the sensor to its original opening. Tighten the wingnuts securely to properly seal the O-ring.
6. After the sensor has been replaced, calibrate the CO<sub>2</sub> controller according to the instructions in Section 6.3.

### **6.6 REPLACING THE CHAMBER HEATER (See Figure 6-4)**

1. Disconnect the unit from the power source and drain the water from the jacket.
2. Locate the heater cover plate at the bottom of the front of the unit.
3. Use a Phillips screwdriver to remove screws that secure the ends of the panel.
4. Pull out the metal heater pan.
5. Open the pan by lifting up on the top piece of metal.
6. Disconnect the electrical connector that joins the heater wiring to the chamber wiring.
7. Grasp the wires that are connected to the heater. Pull up on the wires, and peel them out of the aluminum covering. The covering will remain attached to the heater plate.
8. Smooth the aluminum foil as much as possible.
9. Peel half of the paper backing off the replacement heater. Apply the exposed half of the new heater to the foil remaining from the defective heater. **Be sure to place the new heater in the same configuration as the previous heater.**

10. Peel the remaining paper backing from the heater, and apply it to the remaining area.
11. Connect the wiring from the new heater into the electrical connector on the wiring harness.
12. Reassemble the heater pan by reversing the above procedure.

## **6.7 REPLACING THE DOOR HEATER**

1. Disconnect unit from the power supply, and unplug door heater.
2. Pull back the gasket on the inside of the door to expose the screws securing the interior of the door.
3. Use a Phillips screwdriver to remove the screws. DO NOT remove the screw from lower right corner of door, as it acts as an electrical ground for the heater. (This screw has a star lock washer on it.)
4. Carefully lift off the door interior.
5. Note the configuration of the wiring. Disconnect wires that lead from the heater to the main unit.
6. Grasp the heater wires, and peel them away from aluminum backing. The backing will remain attached to door interior.
7. Smooth out the aluminum foil as much as possible.
8. Remove half of paper backing from new heater.
9. Apply exposed half of heater to remaining foil in same configuration as old heater.
10. Peel off remaining remainder of new heater paper backing, and apply the remainder of new heater.
11. Connect the wiring in the same manner as before.
12. Reassemble door by reversing above procedure. BE SURE THE GROUND WIRE IS PROPERLY INSTALLED.



### **6.8 REPLACING THE TRIAC (See Figure 6-4)**

1. Turn the incubator off and disconnect it from the power supply.
2. Loosen the two 1/4-turn fasteners on the front of the control panel and pull the panel out.
3. Open the incubator outer door to gain access to the triac mounting screws from underneath the control panel.
4. Remove the two mounting screws that secure the triac.
5. Carefully disconnect the wires to the triac and note their configuration to ensure proper connection to the new triac.
6. Remove the triac from the unit. Note the thermal compound between the base of the triac and the floor of the control panel housing. If necessary, reapply more thermal compound before installing the new triac.
7. Install the new triac by reversing the above procedure. Install wiring in the same configuration as the old triac. See Drawing #140018-74-0-D.

### **6.9 REPLACING CO<sub>2</sub> SOLENOID (Refer to Figure 6-4 & Drawing #140018-74-0-D)**

1. Loosen the two 1/4-turn fasteners on the front of the control panel and pull the panel out.
2. Locate the CO<sub>2</sub> solenoid and disconnect the Tygon tubing attached to it. Note how tubing is installed so that it can be attached to new solenoid in same way.
3. Remove the screws that hold the solenoid in place.
4. Disconnect the wiring to the solenoid, making note of its configuration.
5. Remove the solenoid and install the new solenoid by reversing the above procedure. Connect wiring and tubing as noted during removal of the old solenoid. Note the flow direction marked on solenoid.

### **6.10 REPLACING TEMPERATURE CONTROL (See Figure 6-4)**

1. Loosen the two 1/4-turn fasteners on the front of the control panel and pull the panel out.
2. Remove the temperature control knob by loosening the two Allen head screws recessed in the knob.
3. Remove the nut on the shaft, then remove the nut on the back of the panel behind the control knob.
4. Remove the wiring to the temperature control and note its configuration (Drawing #140018-74-0-D).
5. Remove the control and replace it with the new control by reversing the above procedure.

### **6.11 REPLACING PILOT LIGHTS**

1. Loosen the two 1/4-turn fasteners on the front of the control panel and pull the panel out.
2. Disconnect the wiring behind the defective light and break the retaining clip loose. Remove the pilot light and discard.
3. Insert the new pilot light from the front of the panel and install the new retaining clip.
4. Rewire the pilot light in the same configuration as the old light.

### **6.12 REPLACING CIRCUIT BREAKER (See Figure 6-4)**

1. Loosen two ¼ -turn fasteners on the front of the control panel and pull the panel out.
2. Remove the two nuts securing circuit breaker mounting plate to the control panel.
3. Remove the nut securing the circuit breaker to its mounting plate.
4. Remove the wiring and note its configuration.
5. Install the new circuit breaker by reversing the above procedure.

### **6.13 REPLACING THE POWER SWITCH (See Figure 6-4)**

1. Loosen the two 1/4-turn fasteners on the front of the control panel and pull the panel out.
2. Remove the two nuts securing the power switch mounting bracket.
3. Remove the two screws and nuts retaining the power switch on the bracket.
4. Remove the wiring and note its configuration.
5. Install the new power switch by reversing the above procedure.

### **6.14 REPLACING THE THERMISTOR (See Figure 6-4)**

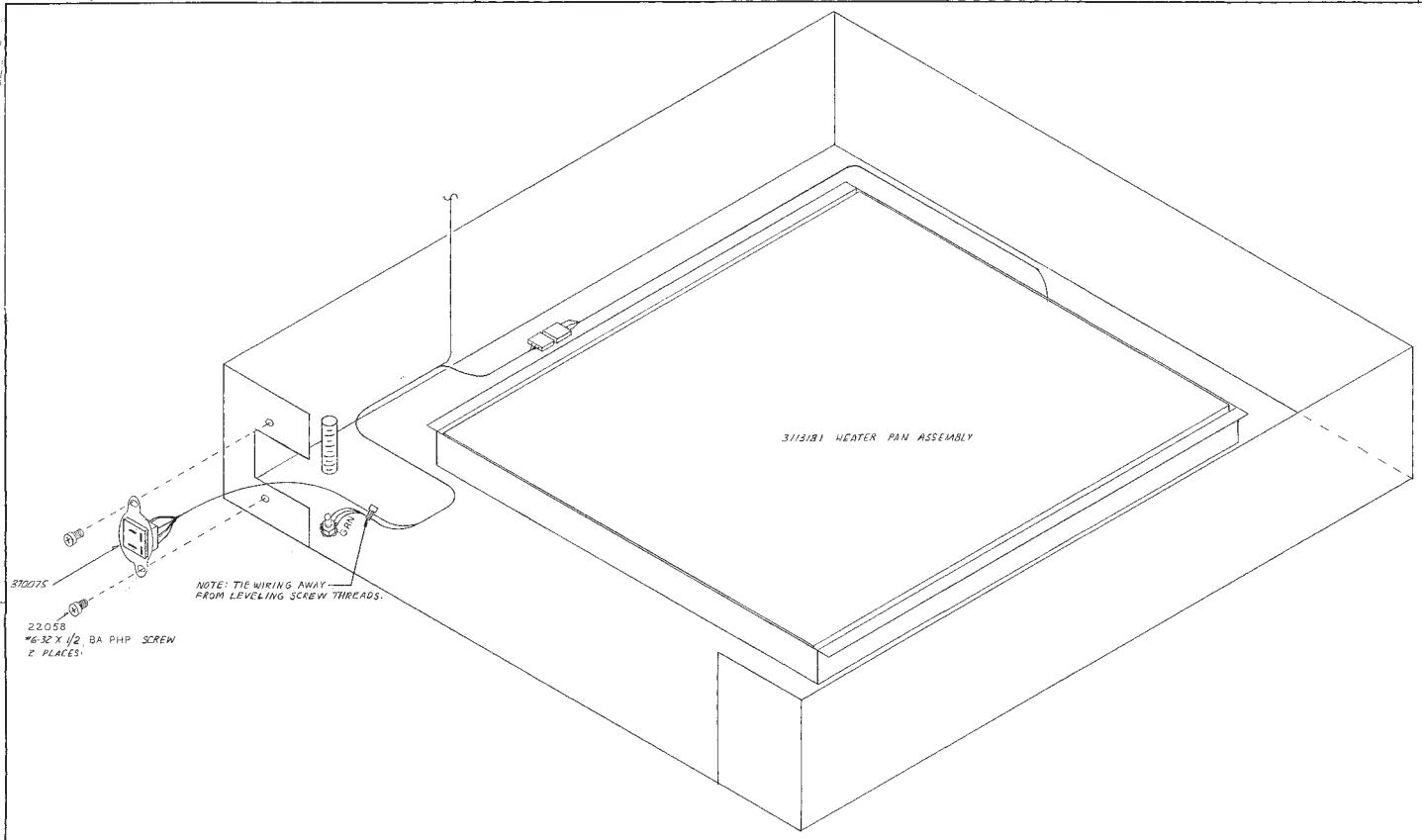
1. Loosen the two 1/4-turn fasteners on the front of the control panel and pull the panel out.
2. Locate the thermistors and remove the Silastic around the thermistor cable.
3. Pull the defective thermistor out of the probe sheath.
4. Cut the wires to the defective thermistor, making note of their configuration.
5. Attach the new thermistor using the electrical in-line connectors.
6. Install the new thermistor by reversing the above procedure. Take care not to damage the probe tip and make sure that the probe is fully extended in the sheath. Reseal the port with Silastic or similar material.

### **6.15 REPLACING THE BLOWER MOTOR (See Figure 6-4)**

1. Disconnect the unit from the power source.
2. Remove the shelves, duct sheets and blower channel from the incubator interior.
3. Remove the four wingnuts that secure the blower mounting plate to the incubator ceiling.
4. Remove the blower wheel and the V-seal by gently but firmly pulling it down.
5. Remove the Tygon tubing from the mounting plate, and disconnect the electrical connector from the motor wiring.
6. Remove the four mounting screws and lockwashers that secure the motor to the mounting plate and remove the motor. Retain the two V-seals from the motor shaft for use on the new motor.
7. Retain the four metal standoffs from the motor mounting screws for use on the new motor. Discard the old motor.
8. Install the new motor by reversing the above procedure, taking care that the wires and tubing are connected in the same configuration as they were before.

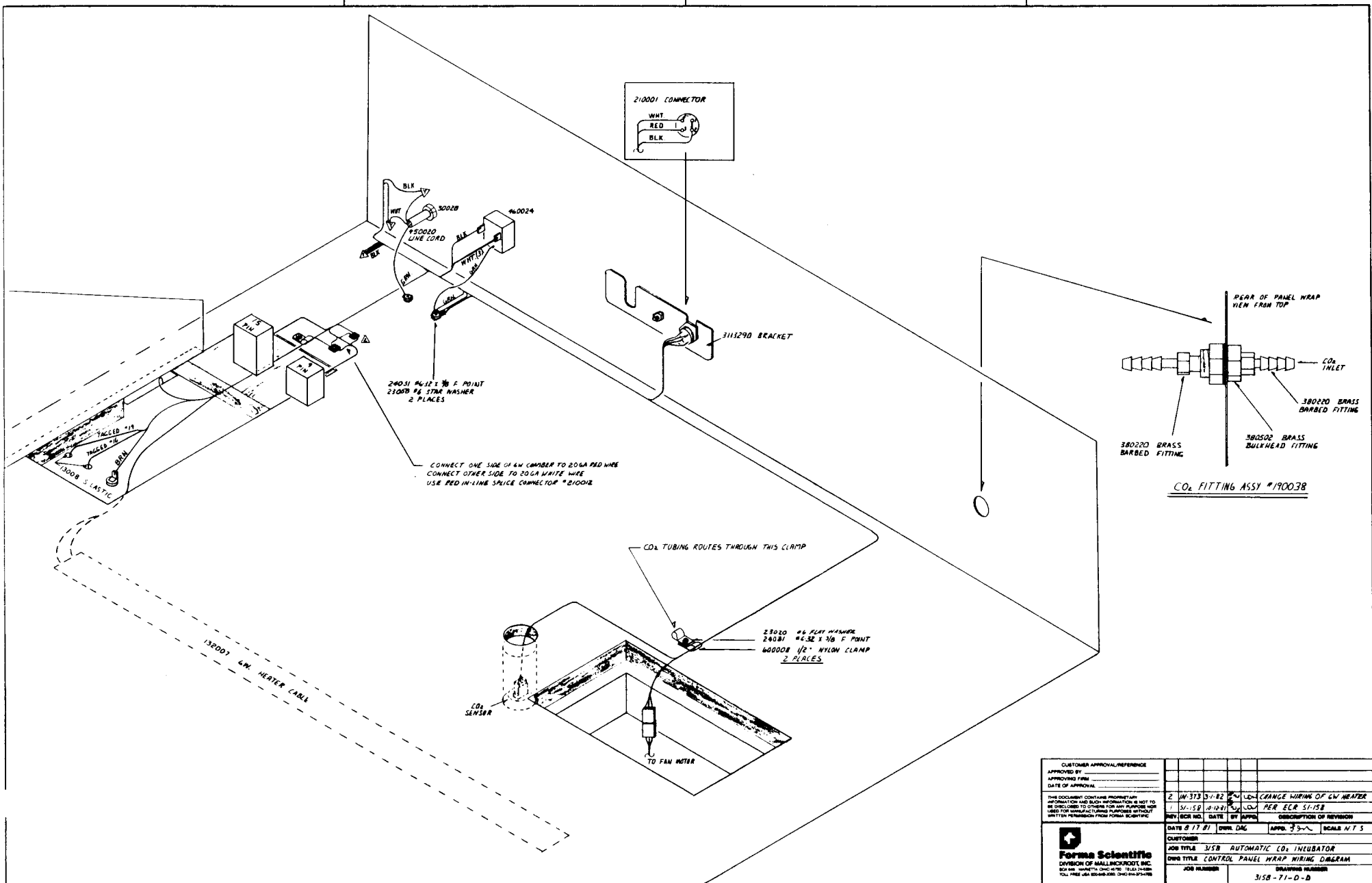
**SECTION 7 - PARTS LIST**

<b><u>QTY</u></b>	<b><u>STOCK</u></b>	<b><u># DESCRIPTION</u></b>
1	116011	Hinge, Interior Door
1	231011	Control Module, Alarm/Monitor
1	231039	Module, CO <sub>2</sub> Control
1	290024	Assembly, CO <sub>2</sub> Sensor
1	505522	Latch Tab, For Incub. Door
1	890155	Door, Glass, Inner
1	260001	Knob, Black, 1/4" Bush, 1/4" Dia.
1	505523	Stud, Latch, For Incubator Door
6	224200	Shelf, Square, Stainless Steel
14	505072	Channel, Shelf
1	460024	Outlet, Electrical, Snap-In
1	950020	Cord Set, 6/3 Sjt, 8 Ft.
1	132004	Heater, Door, 5 Watt, 120v, Foil
1	431142	Gasket, Magnetic, Molded, 4 Side
1	950016	Cord, 4 Wire, 15", W/Special Plug
2	116012	Hinge, Exterior Door
7.2	400296	Gasket, Silicone Feather
1	100008	Wheel, Blower
1	156012	Motor, 2 pole, 115VAC, 50/60 Hz
1	370067	Receptacle, 3 Circuit Mate-N-Lock
1	132007	Cable, Heater, 120V, 6 Watt, Foil
1	132008	Heater, Chamber, 260 Watt, Foil
1	231044	Controller, Temperature
2	235013	Screwdriver, Adjustment, Panel Mount
1	230023	Breaker, Circuit, SP, 5 Amp
1	285379	Triac, 25 Amp
1	880007	Plug, 1/2" Mpt, Nylon (Fill Port)
1	250221	Relay, DPDT, 12V DC, Coil
1	250000	Solenoid, Reed
2	290027	Cable, Thermistor, 1k, 7 Ft.
1	280004	Light, Pilot, Green
1	280005	Light, Pilot, Red
1	280006	Light, Pilot, Amber
2	111008	Clip, Mounting, Pilot Light
1	360054	Switch, Rocker, DPST, On/Off
1	770001	Filter, Line, CO <sub>2</sub>



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DATE OF APPROVAL			
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DATE	BY	DESCRIPTION OF REVISION	
01-13-01	DWN.DAG	APPD.	SCALE N.T.S.
<b>Forma Scientific</b> <small>3000 W. BARNETT, CHICAGO, ILLINOIS 60604          TEL: 773.486.8000 FAX: 773.486.8001</small>			
CUSTOMER			
JOB TITLE	WATER-JACKETED INCUBATOR		
DWG TITLE	BOTTOM BASE WIRING DIAGRAM		
JOB NUMBER	DRAWING NUMBER		
	3152-72-01-D		

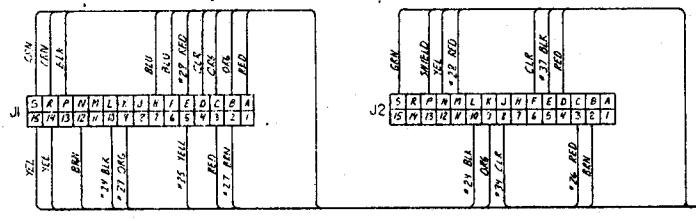
1625 11-10-1197



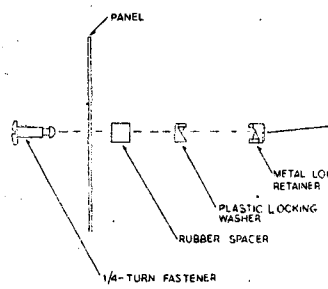
CUSTOMER APPROVAL/REFERENCE					
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DATE OF APPROVAL					
2 JAN 31 3 1982	FORMA	CO <sub>2</sub>	CHANGE WIRING OF LW HEATER		
151-52 (2/1981)	FORMA	CO <sub>2</sub>	PER ECR 51-158		
REV	DATE	BY	DESCRIPTION OF REVISION		
DATE 8/17/81	FORMA	DAG	APPR. 3/5/81	SCALE N.T.S	
<b>Forma Scientific</b> DIVISION OF MALLINCKRODT, INC. 800 HANCOCK SQUARE, PHILADELPHIA, PA 19106 TEL: (215) 381-1000 FAX: (215) 381-1001		CUSTOMER: <b>315B AUTOMATIC CO<sub>2</sub> INEBULATOR</b> DRAWING TITLE: <b>CONTROL PANEL WRAP WIRING DIAGRAM</b> JOB NUMBER: _____ DRAWING NUMBER: <b>315B-71-D-D</b>			

**HARDWARE CHART**

SYM.	STR. NO.	DESCRIPTION
A	23021	*8 FLAT WASHER
B	235013	SCREWDRIIVER
C	710002	STUD RECEIVER
D	232174	NYLON ADAPTER 1/4 HS X 1/2 PPT
E	380503	NYLON BAR CONN. 1/8 NPT X 1/8 HS
F	380256	ADAPTER, 3/16 HS X 1/8 PPT
G	111008	PHOT LIGHT MTG CLIP
H	23002	*6-32 KEPS NUT
I	30001	TIE WRAP ANCHOR
J	22002	*4-40 X 1/2 PHP SCREW
K	23006	*4-40 KEPS NUT
L	22049	*6-32 X 3/8 PHP SCREW
M	23001	*6-32 KEPS NUT
N	23058	*6 EXT. STAR LOCKWASHER
O	840011	BRS. REDUCER, 3/16 HS X 1/16 HS
P	840013	BRS. REDUCER, 1/4 HS X 1/16 HS
Q	22130	*4-40 X 1/4 PHP SCREW
R	124001	CARD GUIDE
S	67000	COUNTERSUNK POP RIVET
T	2285	6-32 X 1/4 PHP SCREW
U	230039	FUSE CLIP
Y	24012	3/8 INTERNAL TOOTH LOCKWASHER

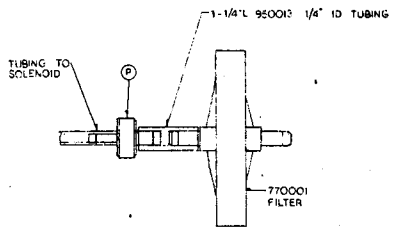


**DETAIL 1**  
CONNECTORS SHOWN AS VIEWED FROM BACK

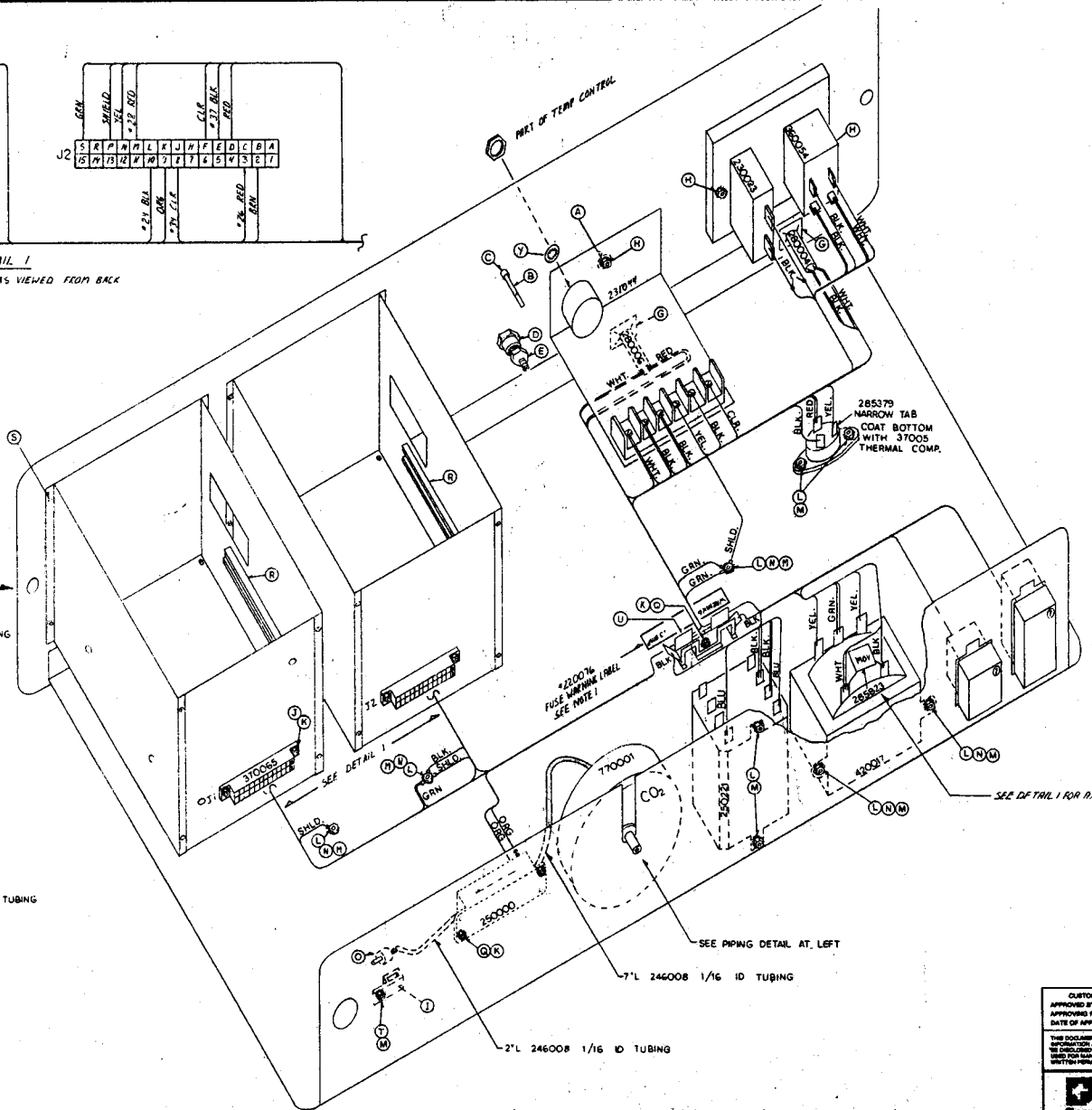


**820002 FASTENER INSTALLATION**

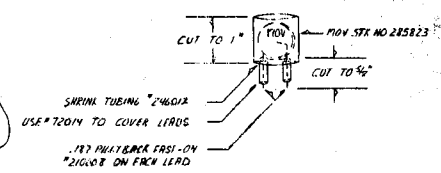
**NOTES:**  
1. USE "MIRING FIB WIRE" AND "FUSE 387P" PORTION OF INFL SET ONLY.



**CO<sub>2</sub> SUPPLY PIPING DETAIL**



**DETAIL 1**



APPROVED BY	DATE OF APPROVAL	APPROVED BY	DATE OF APPROVAL
5 51-381	12-17-51	51	22144 REWIRING DET. UPDATE
7 11-453	1-10-52	51	REV. RECEPTOR 1/35E
3 51-373	2-27-52	51	ADAPTOR UPDATE
2 51-232	1-24-52	51	REC. REV. DETAIL
1 51-625	12-22-51	51	TEMP. CONTROL CHANGE

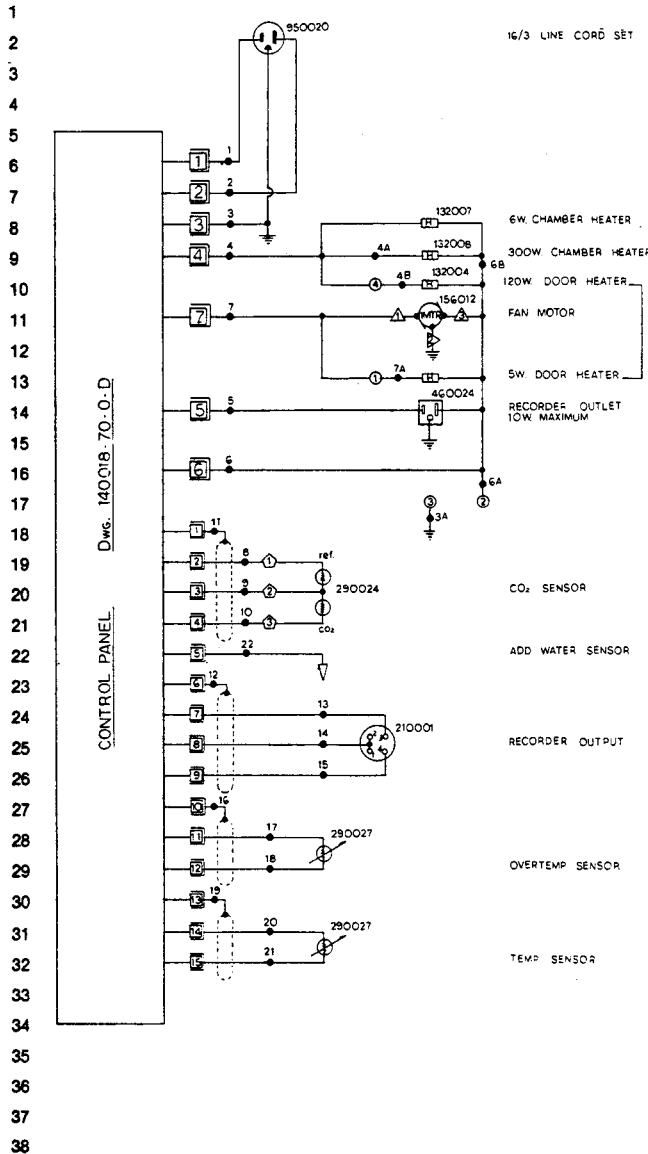
  

REV. (SCR. NO.)	DATE	BY	APPROVED BY	DESCRIPTION OF REVISION
DATE 12-11-51	DRW. DAC.	APPD. L. J. G.	SCALE 8x6x8	

<b>FORNIA Scientific</b>	
DIVISION OF MALL INCORPORATED, INC.	
38500 - MOUNTAIN VIEW, CALIF. 94039	
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FAX 415-961-1001	





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NO	GA	COLOR
1	16	BLK.
2	16	WHT.
3	16	GRN.
3A	18	GRN.
4	20	RED
4A	20	RED
4B	18	RED
5	20	BLK.
6	20	WHT.
6A	18	WHT.
6B	20	WHT.
7	20	BLU.
7A	18	BLK.
8	22	RED
9	22	BLK.
10	22	WHT.
11	22	SHIELD

NO	GA	COLOR
12	22	SHIELD
13	22	RED
14	22	BLK.
15	22	WHT.
16	24	SHIELD
17	24	BLK.
18	24	CLR.
19	24	SHIELD
20	24	BLK.
21	24	CLP.
22	20	BRN.

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NOTES:  
1. Ⓢ DENOTES TERMINAL STRIP CONNECTIONS  
2. Ⓜ DENOTES INTERCONNECTING WIRES  
3. PARTS LIST REFERENCE NUMBERS  
△ PANEL  
○ ASSEMBLY  
□ WIRING  
○ REFRIGERATION

CUSTOMER APPROVAL/REFERENCE  
APPROVED BY \_\_\_\_\_  
APPROVING FIRM \_\_\_\_\_  
DATE OF APPROVAL \_\_\_\_\_

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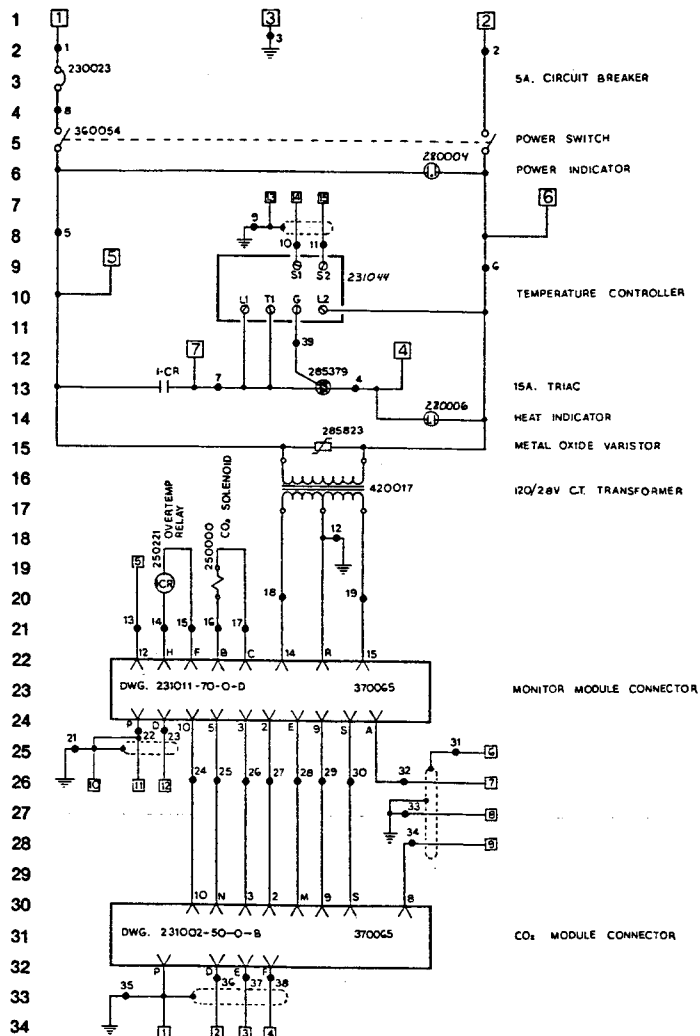
4 Ⓢ DOOR HEATER RECEPTACLE PIN NO.  
5. Ⓜ DENOTES 5-CIRCUIT CONNECTOR PIN NO.

REV	DATE	DESCRIPTION OF REVISION	BY
1	12/21/81	REV PER ECR 51-158	ECR
2	3/1/82	REV PER ACE 11-312	ACE

140018-70-0-D

3/5B AUTOMATIC CO2 INCUBATOR  
ELECTRICAL SCHEMATIC

JOB NUMBER: 3/5B-70-0-D  
DRAWING NUMBER: 3/5B-70-0-D



EXTERNAL CONNECTIONS

- 1 120 VAC (HOT)
- 2 120 VAC (NEUTRAL)
- 3 GROUND
- 4 HEATERS, CYCLED
- 5 OUTLET
- 6 NEUTRAL
- 7 FAN, SW HEATER, GW HEATER
- 8, 9 NOT USED
- 10 CO<sub>2</sub> SENSOR, SHIELD
- 11 REFERENCE CELL
- 12 COMMON
- 13 CO<sub>2</sub> CELL
- 14 ADD WATER SENSOR
- 15 RECORDER, SHIELD
- 16 TEMP. TEMP.
- 17 COMMON
- 18 CO<sub>2</sub>
- 19 OVERTEMP SHIELD SENSOR
- 20 SENSOR
- 21 CONTROL SHIELD SENSOR
- 22 SENSOR

WIRE CHART

NO.	GA.	COLOR	NO.	GA.	COLOR
1	16	BLK	21	24	SHIELD
2	16	WHT.	22	24	BLK.
3	16	GRN.	23	24	CLR.
4	14/20	BLK. YRED	24	20	BLK.
5	14/20	BLK.	25	20	YEL.
6	20	WHT.	26	20	RED
7	20	BLK.	27	20	BRN.
8	20	BLK.	28	20	RED
9	24	SHIELD	29	20	ORG.
10	24	BLK.	30	20	GRN.
11	24	WHT.	31	22	SHIELD
12	20	GRN.	32	22	RED
13	20	BRN.	33	22	BLK.
14	20	BLU.	34	22	WHT.
15	20	BLU.	35	22	SHIELD
16	20	ORG.	36	22	RED
17	20	ORG.	37	22	BLK.
18	20	YEL.	38	22	WHT.
19	20	YEL.	39	20	YEL.

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NOTES:  
 1. Ⓞ DENOTES TERMINAL STRIP CONNECTIONS  
 2. Ⓜ DENOTES INTERCONNECTING WIRES  
 3. PARTS LIST REFERENCE NUMBERS  
 4. Ⓜ DENOTES 9-CIRCUIT CONNECTOR PIN NO.

APPROVED BY _____	CUSTOMER APPROVAL/REFERENCE _____
DATE OF APPROVAL _____	DATE OF REVISION _____
FORM ORG _____	APPROVED BY _____
CURT STOCK NO 140018	DATE: 11-81 SCALE: None
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AUTOMATIC CO <sub>2</sub> CONTROL PANEL ELECTRICAL SCHEMATIC JOB NUMBER _____ DRAWING NUMBER 14-0018-70-0-D	

## CLEANING CHART INFORMATION

THE USE OF PROPRIETARY NAMES IS INTENDED ONLY TO INDICATE A TYPE OF CLEANER AND DOES NOT CONSTITUTE AN ENDORSEMENT, NOR IS OMISSION OF ANY PROPRIETARY CLEANSER TO IMPLY ITS INADEQUACY. IT SHOULD BE EMPHASIZED THAT ALL PRODUCTS SHOULD BE USED IN STRICT ACCORDANCE WITH INSTRUCTIONS ON THE PACKAGE.

IN ALL APPLICATIONS A STAINLESS STEEL WOOL, SPONGE, FIBROUS BRUSH OR PADS ARE RECOMMENDED.

AVOID USE OF ORDINARY STEEL WOOL OR STEEL BRUSHES FOR SCOURING STAINLESS STEEL.

### CAUTION!

DO NOT USE STRONG ALKALINE OR CAUSTIC AGENTS. STAINLESS STEEL IS CORROSION RESISTANT, NOT CORROSION PROOF.

DO NOT USE SOLUTIONS OF SODIUM HYPOCHLORITE (PUREX, CLOROX ETC.), AS THEY MAY CAUSE PITTING AND RUST.

### NOTE:

CLEAR WATER RINSING FOLLOWED BY WIPE-DOWN WITH SOFT CLOTH IS RECOMMENDED AFTER ALL CLEANING PROCEDURES EXCEPT WAXING.

## STAINLESS STEEL CLEANING CHART

	CLEANING AGENT	APPLICATION	EFFECT ON FINISH
<b>ROUTINE CLEANING</b>	Soap, ammonia, or detergent & water.	Sponge with cloth then rinse with clear water and wipe dry.	Satisfactory for use on all finishes.
<b>SMEARS AND FINGERPRINTS</b>	Arcal 20, Lac-O-NU Lumin Wash, O-Cedar Cream Polish, Stainless Steel Shine.	Rub with cloth as directed on the package.	Satisfactory for use on all finishes. Provides barrier film to minimize prints.
<b>STUBBORN SPOTS AND STAINS</b>	Allchem concentrated Cleaner.	Apply with damp sponge or cloth.	Satisfactory for use on all finishes.
<b>BAKED ON SPLATTER, AND OTHER LIGHT DISCOLORATIONS</b>	<p>Samae, Twinkle, or Cameo Copper Cleaner.</p> <p>Grade FFF Italian pumice, whiting, or talc.</p> <p>Liquid NuSteel, Paste NuSteel or DuBois Temp.</p> <p>Copper's Stainless Steel Cleaner, Revere Stainless Steel Cleaner.</p>	<p>Rub with damp cloth.</p> <p>Rub with damp cloth.</p> <p>Rub with damp cloth. Use small amount of cleaner.</p> <p>Apply with damp sponge or cloth.</p>	<p>Satisfactory for use on all finishes if rubbing is light.</p> <p>Rub in direction of polish lines on finish. Use light pressure.</p> <p>Rub in direction of polish lines on finish. May scratch mill or polished finishes.</p> <p>Use in direction of polish lines on finish. May scratch mill or polished finishes.</p>

## STAINLESS STEEL CLEANING CHART (continued)

	CLEANING AGENT	APPLICATION	EFFECT ON FINISH
<b>TENACIOUS DEPOSITS, RUSTY DISCOLORATIONS INDUSTRIAL ATMOSPHERIC STAINS</b>	Oakite #33, Dilac, Texe 12, Texe N.Y., Flash-Klenz, Caddy Cleaner, Turco Scale 4368, Permag 57.	Swab and soak with clean cloth. Let stand 15 minutes or more according to to directions on package. Rinse and dry.	Satisfactory for use on all finishes.
<b>HARD WATER SPOTS AND SCALE</b>	Vinegar  5% Oxalic Acid, 5% Sulfamic Acid, 5% to 10% Phosphoric Acid, Dilac, Oakite #33, Texe 12, Texe N.Y.	Swab or wipe with cloth. Rinse with water and dry.  Swab or soak cloth. Let stand 10-15 minutes. Always follow with neutralizer rinse and dry.	Same as above.  Same as above.
<b>GREASE AND OIL</b>	Organic solvents such as Acetone, Kerosene, Gasoline, and Alcohol.	Rub with cloth. Organic solvents may be flammable and/or toxic. <b>OBSERVE ALL PRE- CAUTIONS AGAINST FIRE. BE SURE AREA IS WELL VENTILATED.</b>	Same as above.

## STAINLESS STEEL CLEANING CHART (continued)

	CLEANING AGENT	APPLICATION	EFFECT ON FINISH
<b>HEAVY TINT OR DISCOLORATION</b>	Penny-Brite or Copper-Brite.	Rub with dry cloth.	Use in direction of polish lines on finish. May scratch mill or polished finishes.
	Paste NuSteel, DuBois or Tarnite.	Rub with dry cloth or stainless steel wool.	Same as above.
	Revere Stainless Steel Cleaner.	Apply with damp sponge or cloth.	Same as above.
	Allen Polish, Steel Brite, Bab-O, Zud, or Wyandotte.	Rub with damp cloth.	Same as above.
<b>BURNT-ON FOODS AND GREASE, FATTY ACIDS MILKSTONE</b>	Easy-Off, DeGrease-It, 4% to 6% hot solution of such agents as trisodium phosphate, sodium tripolyphosphate, or a 5% to 15% caustic soda solution.	Apply generous coating. Allow to stand for 10-15 minutes. Rinse. Repeated applications may be necessary.	Excellent removal. Satisfactory for use on all finishes.