E-68556

Printed in U.S.A.

ALPHA-2
AIR SAMPLER

Operating Manual

DUPONT
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NOTICE

The Du Pont Company will not be responsible for any injuries, personal or other, that occur as the result of improper use of this product.

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DU PONT CONSTANT FLOW SAMPLER

The Du Pont Constant Flow Sampler is a personal air-sampling instrument that moves a constant volume airflow through an external collection device. An automatic flow control system maintains the rate within ±5 percent over pressure drop changes up to 25 inches w.c. (See Figure 1.)

Applications for the Sampler include:

- Low flow adsorption tube sampling.
- Charcoal tubes.
- Silica gel tubes.
- Long-term detector tubes.
- Alumina tubes.
- Small air bags.
- Molecular sieves.

The Sampler features two light-emitting diodes (LED's) that show maintenance of constant flow and whether the battery has been charged. The Sampler cover is attached with a 5/64" hex head screw (6-32 x 5/16") that limits accessibility to the controls. (See Figure 2.)

INSTRUMENT AND ACCESSORIES

The Constant Flow Sampler system (see Figure 3) contains:

- 1 Constant Flow Sampler.
- 1 110 volt, 60 Hz battery charger.
- 1 Length of tubing.
- 1 Allen key (5/64").
- 1 Operating Manual.

The Calibrator Pack (see Figure 4) contains:

- 5 Constant Flow Samplers.
- 5 Operating Manuals.
- 1 110 volt Multicharger unit.
- 6 Lengths of tubing.
- 1 Calibrator case.
- 5 Allen keys (5/64").

Each Calibrator Case includes:

- 1 Calibrator panel.
- 1 Bubble tube (100 cc graduated).
- 1 Bubble tube stand.
- 1 Bubble solution jar.

SAMPLER OPERATION INSTRUCTIONS

1. Remove the cover. (See Figure 2.)
2. Turn on Sampler. Before operating for first time, fully charge battery.
3. Check that LED's are lit indicating:
   - Battery has been charged.
   - Flow is controlled.
4. Connect to flow calibration instrument.
5. Adjust pump flow until proper flow is set. (See Sampler Calibration section beginning on page 4.)
6. Attach collection device to the inlet.
7. Replace cover.
8. Attach Sampler on belt of the person to be monitored. (See Figure 5.)
9. Position collection device near user's breathing zone.

CALIBRATION

SAMPLER CALIBRATION

The Sampler flow rate will remain stable for long periods. However, for the most accurate test results, daily calibration is recommended.

The following procedure provides detailed instructions for calibration of the Sampler using the Du Pont Constant Flow Sampler Calibrator Case. This procedure can be adapted to a bubble tube, manometer, and stopwatch calibration system; however, the use of the Du Pont Calibrator Case facilitates the test of the automatic control device.

1. Attach tubing labelled "pump" to the Sampler inlet hose barb. (See Figure 4.) Open the pressure valve ("Simulated Filter Adjustment") during this step. (See Figure 6.) Turn on Sampler.
2. Set the flow rate for the Sampler by setting the flow control adjustment at the desired position.
   - Lower range (5-50 cc/min.)
     a. Open the bypass valve (one turn counterclockwise from the fully closed position).
     b. Turn flow control valve counterclockwise to bring the Sampler within operating range.
   - Higher range (50-200 cc/min.)
     a. Close the bypass valve completely by gently turning it clockwise until it seats.
     b. Turn flow control valve counterclockwise to bring the Sampler within operating range.

   Turn the flow control adjustment clockwise to decrease the flow and counterclockwise to increase the flow. After each adjustment, allow time for the flow control mechanism to respond. If the pump is operating at maximum speed and not responding to flow control changes, the flow control adjustment screw is open too far. See Step No. 2. Once the flow rate has been adjusted, verify the reading with the bubble tube. (See Bubble Tube Use on page 6.)
3. Check the operation of the Sampler's automatic flow control feature by setting the pressure drop adjustment knob to read up to 25 inches w.c. To increase the pressure drop,

move the pressure drop adjustment knob clockwise. The flow will decrease momentarily as the pressure drop increases. A properly functioning flow controller will automatically recover the flow to the original set point.
4. Repeat the bubble tube test after the pressure drop has been set. (See Bubble Tube Use on page 6.) You will note that the needle on the flow rate meter has returned to its original set point position, showing that the constant flow control has operated correctly and compensated for the increased pressure drop.
5. Check to see whether the constant flow Sampler controller is operating properly. The difference between the initial flow rate and the flow rate with pressure drop should be within 5 percent of the 0 pressure drop flow rate.
6. Turn off Sampler.

CALIBRATOR CHECKOUT

1. Place the 100 cc bubble tube, open end down, onto the Calibrator Case with the clip. Connect the top end of the bubble tube to the shorter piece of tubing on the calibrator panel marked "Bubble Tube." (See Figure 7.)
2. Set the pressure drop meter to read 0 inches w.c. during the initial calibration with the bubble tube and flow rate meter. Turn the pressure drop adjustment "Simulated Filter Adjustment" knob counterclockwise until the needle is near 0 to adjust the pressure drop meter reading.
3. Readjust the meters to mechanical zero if the Calibrator Case has been moved or subjected to rough handling. With no flow through the pack, rezero the meters by adjusting the small screw located below the caution label on the meter face. (See Figure 6.)
4. Calibrate the flow rate meter, located at the left side of the calibrator panel, by comparing it to the more accurate flow measuring device, the bubble tube. (See Bubble Tube Use section.) Turn on Sampler. Set the pump at a desired flow rate by adjusting the pump flow rate with the bubble tube. Then, using the flow meter adjustment knob, adjust meter to the same flow rate. To increase the reading, turn flow meter adjustment knob clockwise. Turn off Sampler.
5. Recalibrate the meter once a week or whenever the Calibrator Case is moved to a new location. However, once the flow meter is calibrated against the bubble tube, it does not

have to be checked each time it is used with a pump. The meter is accurate to within ±10 percent over the entire scale. Performing a bubble tube calibration at the flow rate to be used will improve accuracy.

6. Read the flow rate meter for a quick indication of the flow rate in cc/min. For a more accurate determination, use the bubble tube method. (See the Bubble Tube Use section.)

BUBBLE TUBE USE

1. Verify the exact volume flow rate with the bubble tube. To obtain volume flow rate, divide the volume of air sampled by the time it takes for a bubble to traverse that volume.

$$\text{Flow rate} = \frac{\text{Volume}}{\text{Time}}$$

2. Turn on Sampler. (See Figure 8.) Use the bubble tube and solution to wet down the inside of the bubble tube by allowing several bubbles to pass up the full length of the bubble tube. Any soap solution can be used.
3. Use a stopwatch to measure the time for one bubble to rise between any two graduated marks. The volume is the value difference from one mark to another. This volume divided by the elapsed time equals the flow rate. Turn off Sampler.

If time is measured in SECONDS:

$$\text{Flow Rate} = \frac{\text{Bubble Tube Volume (cc)}}{\text{Elapsed Time (sec)}} \times \frac{60 \text{ sec}}{1 \text{ min}} = \frac{\text{cc}}{\text{min}}$$

Stopwatch	Graduation Mark
Start	0 cc
Stop	100 cc
Volume = 100 cc	
Time = 48 sec	

$$\text{Flow rate} = \frac{100 \text{ cc}}{48 \text{ sec}} \times \frac{60 \text{ sec}}{1 \text{ min}} = 125 \text{ cc/min}$$

If time is measured in MINUTES:

$$\text{Flow Rate} = \frac{\text{Bubble Tube Volume (cc)}}{\text{Elapsed Time (min)}}$$

Stopwatch	Graduation Mark
Start	0 cc
Stop	100 cc
Volume = 100 cc	
Time = 0.8 min	

$$\text{Flow Rate} = \frac{100 \text{ cc}}{0.8 \text{ min}} = 125 \text{ cc/min}$$

SAMPLING PROCEDURE

1. Remove Sampler cover.
2. Turn on "on-off" switch.
3. Wait a few seconds until the Sampler flow has stabilized at the preset flow.
4. Check LED's. Battery check LED will light, indicating battery has been charged. Charging time of 14 to 16 hours is required to ensure a fully charged battery.

   The lit flow control LED indicates that the flow control mechanism is operating properly. (Refer to the Theory of Operation beginning on page 10.)
5. Check flow calibration using calibration procedure. Adjust flow if required.
6. Attach collection device to the inlet hose barb.
7. Attach Sampler to user's belt for personal sampling. Position collection device near user's breathing zone. Use Sampler for area monitoring by positioning the collection device appropriately.
8. Record:
   - Date.
   - Start time.
   - Sampler serial no. (located inside case).
   - Flow rate.
   - Unusual conditions (weather, interrupted operation).
   - Employee name.
   - Survey Supervisor.
9. Retrieve pump at the end of sampling time. Observe the flow control LED before turning off pump. If the LED is lit, proceed to Step 10. If the LED is not lit, flow was out of control at some point in the monitoring period, and the sample is invalid.
10. Record end time. Recheck and record flow rate. List any unusual conditions that occurred during sampling period.
11. Prepare collection device for analysis.
12. Set up Sampler to recharge battery in the case for 14 to 16 hours, or
13. Replace used battery with fully charged battery for continuous operation, and charge used battery outside the case. (See Battery Charge and Recharging on page 9.)

CAUTIONS

- Don't short battery.
- Check filter for liquids.
- Don't overcharge.
- Don't introduce solvents or liquids to "rinse out."
- DO NOT fully discharge battery.

BATTERY CHARGE AND RECHARGING

The rechargeable nickel cadmium (Ni-Cd) battery pack can be charged in place within the Sampler or removed from the Sampler case and charged separately. Du Pont sells a battery charger adapter for external recharging.

REMOVING BATTERY

1. Remove Sampler cover.
2. Pull battery up from bottom.
3. Pull battery away from terminal connectors and from battery compartment.

INSTALLING FRESH BATTERY

1. Press battery terminals to engage them with battery connectors.
2. Lower battery into compartment.

RECHARGING BATTERY--IN PLACE

1. Turn the unit to "off."
2. Plug the battery charger into a 110 volt AC wall outlet. Insert the charging plug into the battery charger jack. (See Figure 9.)
3. Allow 14 to 16 hours for fully recharging the Ni-Cd battery; then remove from the charger and return the pump to use.
4. Unplug battery charger when finished.

USING MULTICHARGER

The Sampler Multicharger will charge five Samplers at one time. (See Figure 10.) The batteries are charged for 14 to 16 hours.

Plug the Multicharger into a 110 volt AC wall outlet. Insert the five charging plugs into the Samplers' battery charging jacks.

RECHARGING BATTERY--EXTERNALLY

Use a battery charging adapter (part No. S2400). (See Figure 11.) This device has a battery charger jack and battery connector snaps. Connect the battery charger plug to the adapter. Then connect the adapter to the battery terminals.

THEORY OF OPERATION

The Du Pont Sampler uses simple feedback control to monitor flow through the pump mechanism and to adjust pump speed to maintain constant flow. This control system ensures constant flow regardless of load variations or other factors normally effecting a change in flow rate.

THE PUMP

The diaphragm pump is moved by a DC motor with an eccentric crankshaft. Airflow is smoothed by the accumulator before it passes through the flow control needle valve.

The flow control needle valve creates a pressure drop in the flow passage that varies with the airflow rate and the valve opening.

The differential pressure switch connected across the needle valve is operated by the pressure drop. Thus it operates as a flow switch, opening on low flow rates and closing on high flow rates. The flow point at which the change occurs depends on the needle valve setting and the pressure switch. The normal pressure switch used in this Sampler operates at 3 inches w.c. pressure drop.

THE CONTROL ASSEMBLY

The control assembly has four main sections: integrator, amplifier, flow control light, and battery check circuit. (See Figure 12.)

An advanced integrated circuit chip, hermetically sealed against dirt or humidity damage, performs the electronics functions.

The integrator is a special circuit with an output voltage that varies with time. It continually increases or decreases determined by the condition of the pressure switch connected to it. When the pressure switch opens, the output of the integrator gradually increases. When the pressure switch closes, the output of the integrator gradually decreases.

The amplifier is a circuit that increases the voltage from the integrator and provides enough current to drive the pump

motor. The voltage output of the amplifier increases and decreases exactly with the integrator voltage.

The DC motor, which is connected to the amplifier output, increases its speed as voltage increases. In normal operation at a constant flow, the pump moves air through the needle valve which causes a pressure drop in the vicinity of the pressure switch operating point.

An on-off sensor signal is converted to a constant analog control signal to give smooth, precise control of motor speed and pump flow.

The integrator also drives another circuit called the flow control light. If the pressure switch stays in the open position for approximately 15 to 45 seconds, the output of the integrator will continue to go up beyond the normal operating point. The low flow detector will trigger on this condition and extinguish an LED, showing that the pump could not maintain flow control. The low flow detector circuit will "latch" or stay in this condition even though flow is later reestablished. Thus, the operator has a visual indication that a problem occurred with flow control or that flow was impeded in some way, such as by a pinched collector tube. The flow control circuit will reset when the pump is started for the next test.

The fourth part of the control assembly is the battery check circuit. This circuit is activated when the battery voltage is above 5.16 volts to show that the battery has been charged.

MAINTENANCE

MATERIALS OF CONSTRUCTION

- Parts of black anodized aluminum.
- Valves of Viton® (a Du Pont fluoroelastomer).
- Stainless steel needle.
- Neoprene and Buna-N elastomers.
- ABS case.

Materials are generally unaffected by atmospheres encountered in industrial hygiene monitoring. However, concentrated solvents or liquids should never be used to "rinse out" the Sampler.

STORAGE

When the Sampler is not in use, store it in a safe, cool, dry place. Do not store for an extended period without removing the battery.

BATTERY

The rechargeable battery supplied with the Sampler will provide maximum life if the recharging instructions are followed closely. Continuous recharging for more than 16 hours will shorten the life of the Ni-Cd battery. However, the battery can tolerate weekend charging (Friday p.m. to Monday a.m.).

Self-discharge is a common occurrence with any Ni-Cd battery. It may take months for a battery to completely discharge on the shelf; however, after several days, a battery may discharge so that the "Battery Full Charge" LED does not light. Recharging for approximately an hour will fully recharge the battery.

For safety reasons, the battery contains an internal current limiting resistor. Do not short the battery terminals because this resistor may overheat or burn out.

Some older batteries may not seem to hold a full charge because of a memory developed in the battery. Try a complete discharge by continuous Sampler operation and then complete recharge of the battery. If this procedure does not help, the battery should be replaced.

The battery will normally last 200 to 500 cycles of charge and discharge before replacement is required.

FILTER REPLACEMENT

To protect the internal pump parts, the Sampler contains two filters, a small polyurethane filter behind the inlet hose barb and a larger external filter. These filters will usually last about a year; however, under dusty conditions, more frequent replacement may be necessary. Replace the filters immediately when:

- Liquid is noticed in the filter.
- The Sampler cannot maintain flow for eight hours at its designed flow rate.
- The pressure drop across the filter exceeds 8 inches w.c.

To replace or to install filters:

- Internal -- remove inlet hose barb with an 8mm wrench.
  -- remove and discard the inlet filter inside the pump housing by inserting needle nose pliers into the inlet hose barb opening.
  -- insert fresh filter into inlet port.
  -- replace inlet hose barb in inlet port using mild thread sealer sparingly.
  -- tighten with an 8mm wrench.
- External -- use appropriate lengths of supplied tubing to attach the filter to the pump as shown in Figure 13. Note: Orient the filter so the airflow is in the direction indicated by the arrow on the filter housing.

MAXIMUM FLOW TEST

To ensure that the Sampler is operating at capacity, periodically perform a maximum flow test.

1. Connect calibrator case flow meter to Sampler inlet hose barb, using tubing marked "pump." (See Figure 4.)
2. Remove needle valve by unscrewing counterclockwise. Close bypass valve.
3. Turn on Sampler. Unit should run out of control.

4. Add 29 inches w.c. pressure; wait until the flow is steady. Flow should be equal to or greater than the maximum flow specification of 200 cc/min.
5. Remove pressure.
6. Turn off Sampler.

Lack of flow may indicate a clogged filter. Install a new filter and repeat maximum flow test.

CONTROL FUNCTION

It is normal for a Sampler to take several seconds to start. If the automatic controller does not appear to function properly, review the following:

1. Use the Calibrator Case to verify that the unit is operating within its designed flow and pressure drop range. To determine whether controller is compensating for change in flow, alter the flow by placing a maximum pressure clasp on the pump. If the pump begins to run faster, the controller is functioning.
2. If the flow control light goes out 15 to 45 seconds after the Sampler is started, the flow adjustment is open too far, bypass is open (see bypass range), or the pump lacks capacity. Close the flow adjustment and try again. Perform the "Maximum Flow Test."
3. If any unusual flow changes occur, remove the needle valve and check for possible dirt on the needle. Wipe clean and replace. Be sure to check inlet filter for dirt or liquids.
4. If the pump is operating at maximum speed and not responding to flow control changes, the flow control adjustment screw is open too far. (See Calibration section on page 4.)
5. Return the Sampler to Du Pont for service if the above checks fail to correct the malfunction.

SPECIFICATIONS

Operating Range:	Bypass Valve Open: 5-50 cc/min. Bypass Valve Closed: 50-200 cc/min.
Pressure Drop Capacity:	25 inches w.c. maximum
Pressure Range:	0 to 25 inches w.c.
Flow Control:	Automatically maintained at ±5 percent of set point over 0 to 25 inches w.c.
Flow Control Indicator:	If flow is interrupted for 15 to 45 seconds, the LED will go out, indicating lack of control. The LED is visible through the instrument case.
Battery:	One rechargeable Ni-Cd battery pack capable of eight hours' operation at maximum flow and pressure.
Battery Check Indicator:	An LED lights to indicate that the battery has been charged.
Sampler Controls:	"On-off" switch, flow control adjustment, bypass valve.
Sampler Case:	Durable injection molded ABS plastic--tamperproof.
Dimensions:	1-1/2" x 2-15/16" x 5-1/4" (3.8 cm x 7.5 cm x 13.3 cm).
Weight:	16 ounces.
Operating Temperature and Humidity Range:	$20^{\circ}F$ to $120^{\circ}F$ ($-7^{\circ}C$ to $49^{\circ}C$) 10% to 95% Relative Humidity.
Warranty:	6 months.

Approvals: Underwriters' Laboratory listing No. 973X rated for use in Class I, Groups A, B, C, and D; Class II, Groups E, F, and G. Temperature code T3C. Caution: Approval applies only to pump with battery P/N S2800.

SERVICE

For additional information or assistance, call (800) 344-4900, in Pennsylvania call (215) 444-6800.

For repairs, return the unit with the following information: company name, return shipping address, contact name and telephone number, serial number of pump (inside unit), date of purchase, description of problems. A nominal service charge is based on parts and labor for any service not covered by the warranty. Forward this information with your purchase order and instrument via UPS or insured mail to:

E. I. du Pont de Nemours & Co. (Inc.)
Instrument Systems
N. Walnut Road, P.O. Box 10
Kennett Square, PA 19348
Attn: Repair Service

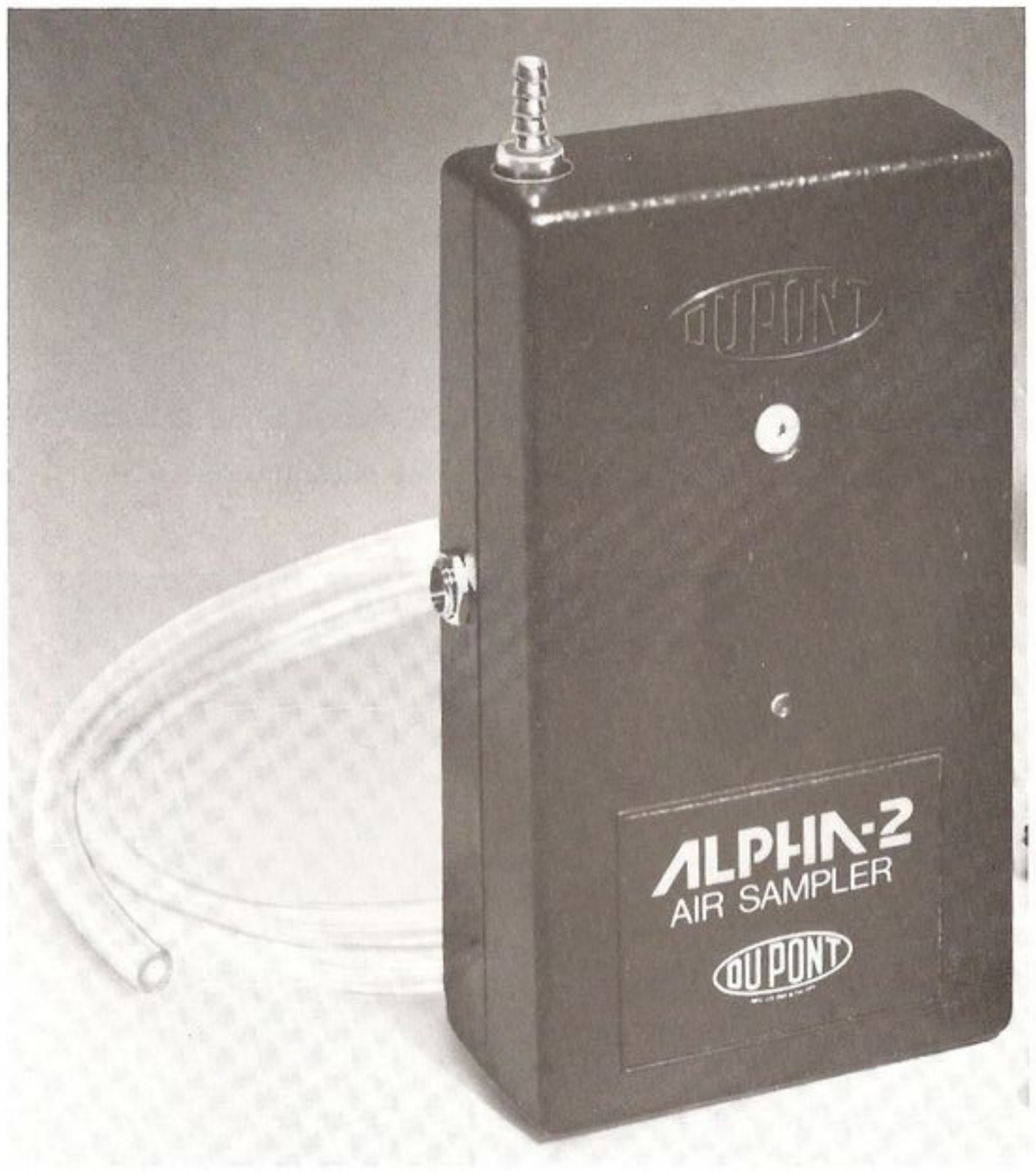

Figure 1. Alpha 2 Constant Flow Sampler.

Figure 2. Sampler with Control Cover Removed.

Figure 3. Alpha 2 System Components.

Figure 4. Calibrator Pack Components.

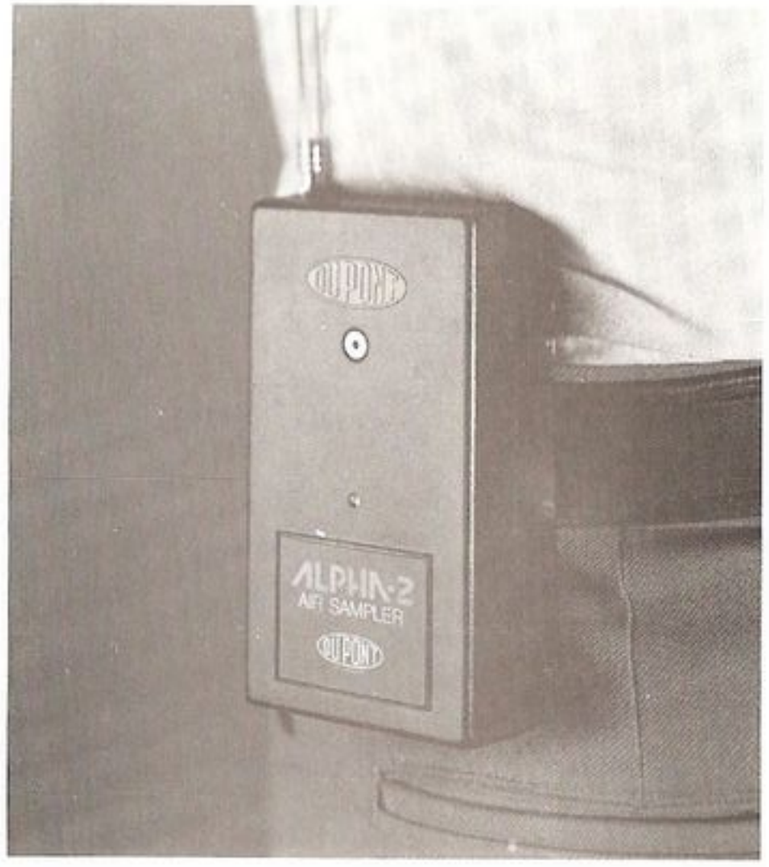

Figure 5. Sampler Attached for Use.

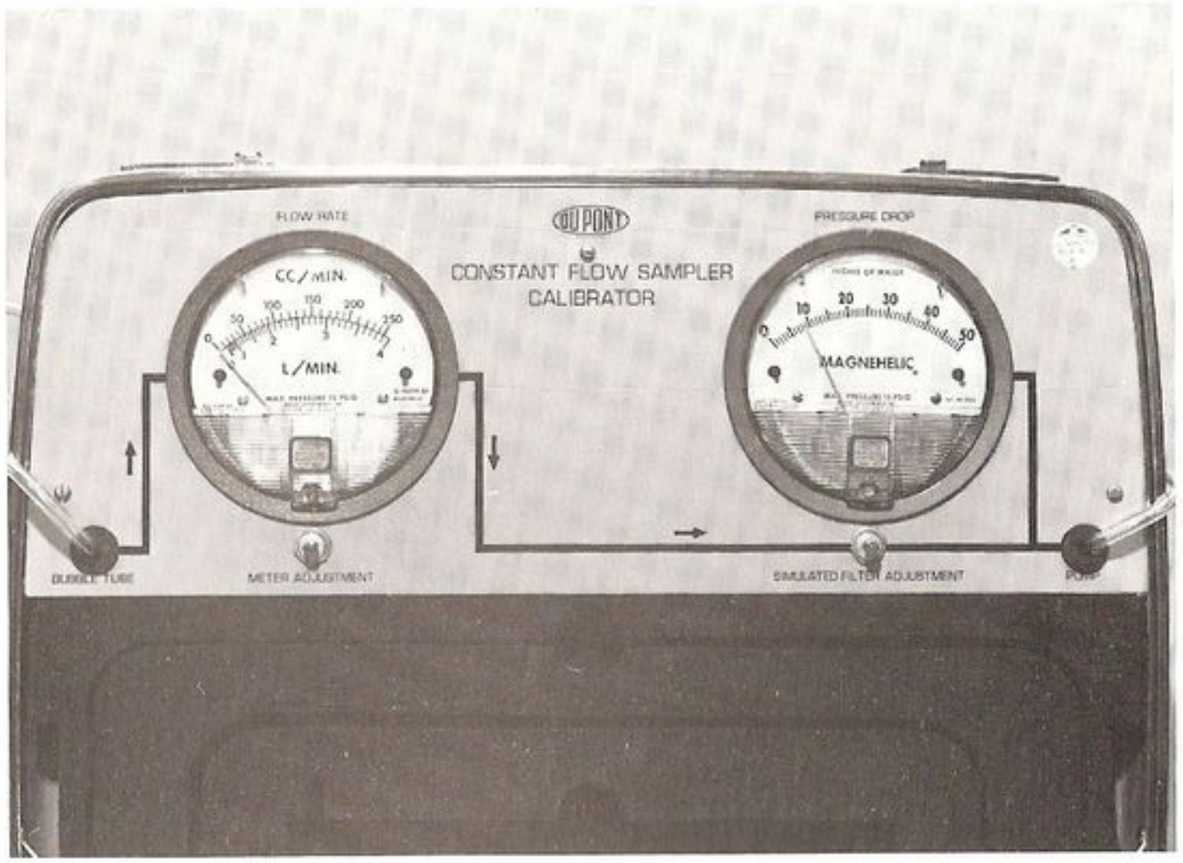

Figure 6. Calibrator Panel.

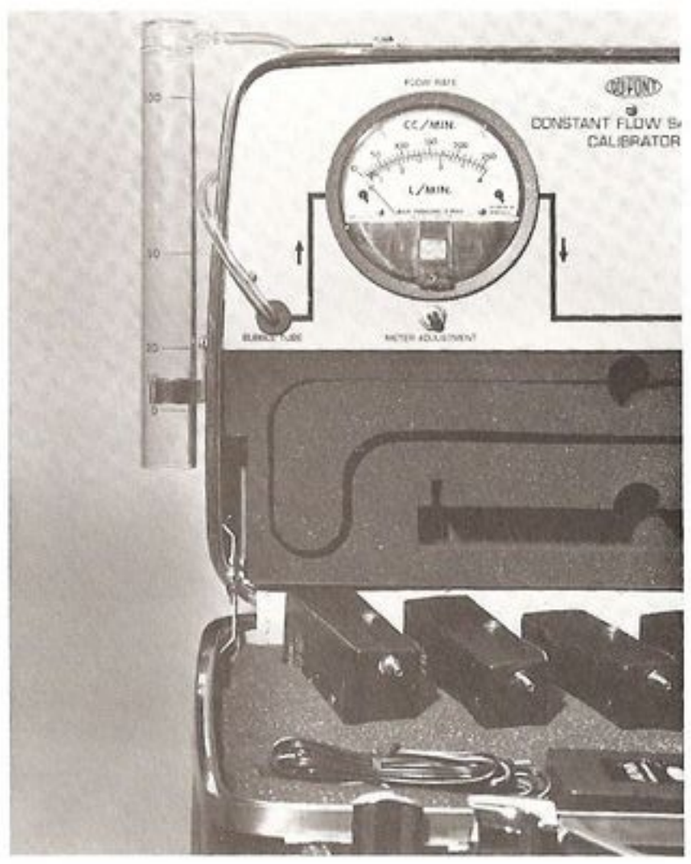

Figure 7. Bubble Tube Connected to Calibrator Panel.

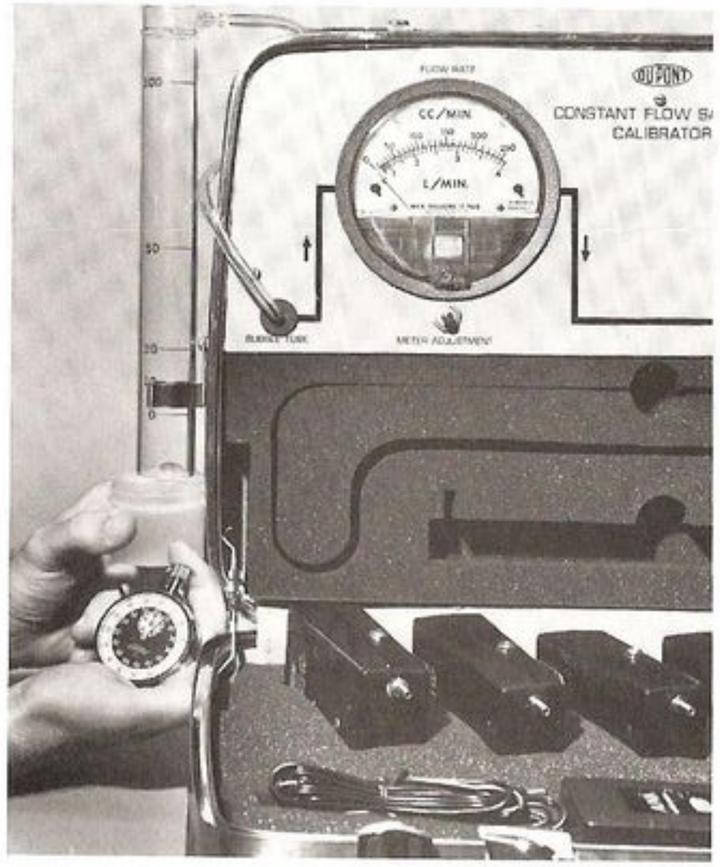

Figure 8. Bubble Tube in Use.

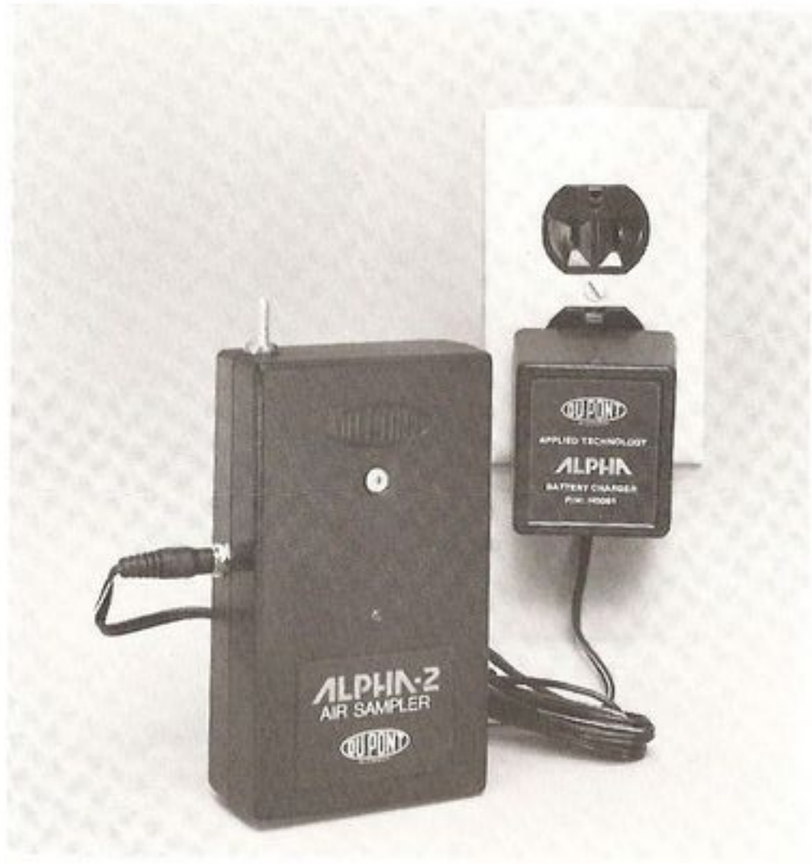

Figure 9. Battery Charger in Use.

Figure 10. Multicharger in Use.

Figure 11. Battery Charging Adapter Used for External Battery Recharging.

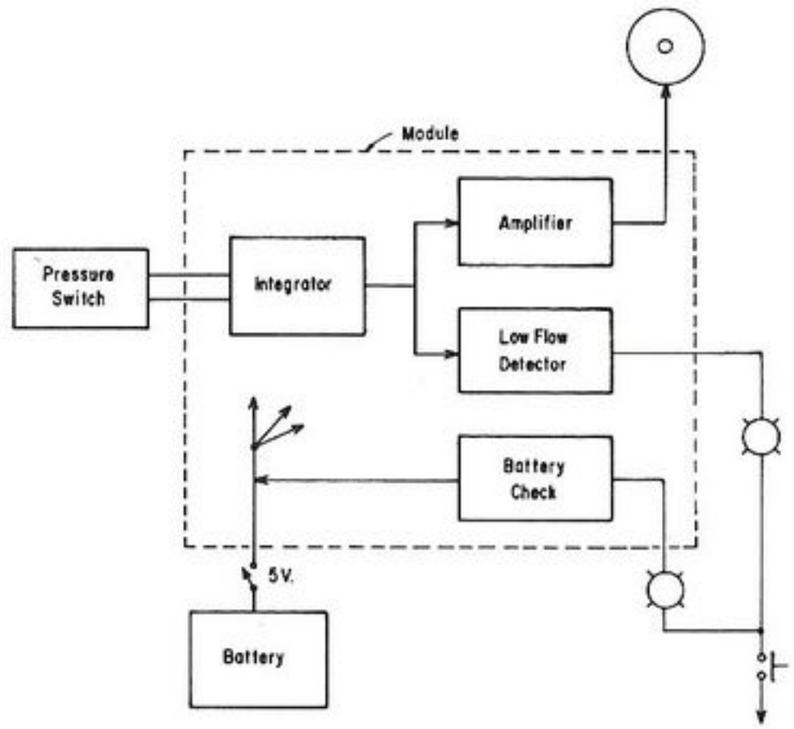

Figure 12. Control Assembly Block Diagram.

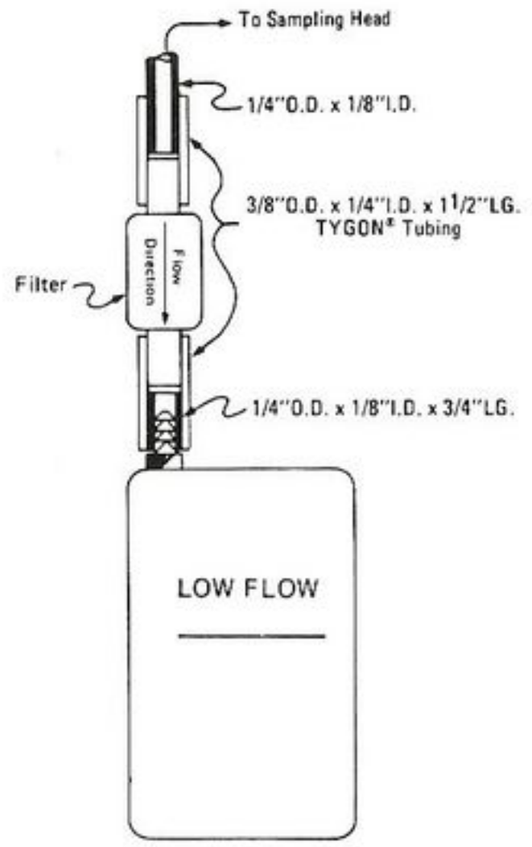

Figure 13. Sampler with External Filter Attached.