NAVY EXPERIMENTAL DIVING UNIT
Panama City, Florida 32401

EXPERIMENTAL DIVING UNIT REPORT 7-75

TESTING OF BIOMARINE CCR 1000

CLOSED CIRCUIT U.B.A.

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ABSTRACT

Upon request from the U.D.T. and S.E.A.L., Liaison Officer Lt. T. Hawkins, the Test and Evaluation Dept. of NAVXDIVINGU performed breathing resistance and CO_2 scrubber duration tests. The maximum breathing resistance measured at 198 FSW during a breathing rate of 30 breaths per minute with a 2.0 Liter Tidal Volume breathing through a Mk VI mouthpiece was -15 centimeters of H_2O during inhale and +14.5 centimeters of H_2O during exhale. The CO_2 scrubber duration was determined under three conditions; they were all at 200 FSW: first in 32 degree F water with 0.85 SLPM CO_2 add rate with a duration of 2 hours 40 minutes, second in 32 degree F water with a 1.2 SLPM CO_2 add rate and a duration of 1 hour 57 minutes, and finally in 72 degree F H_2O with a 0.85 SLPM CO_2 add rate and a duration of 7 hours, 10 minutes.

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INTRODUCTION

1. In cooperation with the U.D.T. and S.E.A.L. Diving Community N.E.D.U. was asked to perform breathing resistance and canister duration test on the Biomarine CCR 1000. This information is to be used as a portion of data collected to create a MILSPEC for Closed Circuit Mixed Gas Underwater Breathing Apparatus. The testing of the Biomarine CCR 1000 is one third of the technical testing in the MILSPEC effort. The Westinghouse CCM and the General Electric 1500 will also be tested.

METHOD

2. Set up apparatus as in Figure 1. The apparatus is turned on and the chamber is brought to a depth 198 FSW. A pressure transducer is used to monitor differential pressure in the oral cavity of the manikin. Gas sampling lines were installed in both the inhale and exhale hoses. These lines were run to Beckman 315 and LB-1 CO_2 analyzers. Samples were taken at 15 minute intervals until 2.0% surface equivalent was reached. To allow continuous ascending and descending the diluent and oxygen cylinders were replaced by a lead from the B.I.B. System. During compression a stop at 33, 66, 99, 132, 165 and 198 FSW was made for 5 minutes to measure breathing resistance. Upon arrival at 198 FSW the CO_2 was added and CO_2 monitoring was begun. A total of 10 compressions were done to assure reproducibility of data.

RESULTS

3. The results of the 10 runs were averaged and the following tabulation of results is the product of averaging.

-Maximum Breathing Resistance @198 FSW at 60 liters/min
RMV 15.0cm H_2O inhale 14.5cm H_2O exhale.

-Duration of CO_2 scrubber @32 degree F with a 0.85 SLPM CO_2 add rate was 2 hours 40 minutes at 198 FSW.

-Duration of CO_2 scrubber @32 degree F with a 1.2 SLPM CO_2 add rate was 1 hour 57 minutes at 198 FSW.

-Duration of CO_2 scrubber @72 degree F with a 0.85 SLPM CO_2 add rate was 7 hours 10 minutes at 198 FSW.

-Maximum Breathing Resistance @198 FSW at 40 liters/min RMV 10.0cm H_2O inhale 12.0cm H_2O exhale.

It is important to note that the maximum breathing resistance occurred at 198 FSW. At shallower depths the resistance was less. (See Figure 2)

CONCLUSIONS & RECOMMENDATIONS

4. In conclusion the Biomarine CCR 1000 performed as well as any of the closed circuit mixed gas rebreathers tested at N.E.D.U. to date. When subjected to cold water the performance did not deteriorate with the exception of CO_2 scrubber duration. The scrubber performed only 37% as long in cold water as it did in warm water. This is a normal occurrance in baralyme CO_2 scrubbers.

The UBA performed up to the manufacturer's claims entirely.

Further testing is not recommended at this time. The only recommendation as a result of this test is to replace the disposable battery with a rechargeable battery.

FIGURE 2

Breathing Resistance

Depth FSW	40 l/m RMV	60 l/m RMV
0	6.5cm H_2O	9.0cm H_2O
33	10.1cm H_2O	13.0cm H_2O
66	12.3cm H_2O	17.2cm H_2O
99	14.4cm H_2O	21.8cm H_2O
132	18.0cm H_2O	25.6cm H_2O
165	20.5cm H_2O	28.6cm H_2O
198	22.0cm H_2O	29.5cm H_2O

CO_2 Scrubber Duration @198 FSW

Temp F^o	CO_2 add Rate	Duration
32^o	0.85 SLPM	2 hr. 43 min.
32^o	0.85 SLPM	2 hr. 39 min.
32^o	0.85 SLPM	2 hr. 40 min.
32^o	0.85 SLPM	2 hr. 38 min.
32^o	0.85 SLPM	2 hr. 40 min.
32^o	1.20 SLPM	1 hr. 59 min.
32^o	1.20 SLPM	1 hr. 55 min.
72^o	0.85 SLPM	7 hr. 40 min.
72^o	0.85 SLPM	7 hr. 01 min.
72^o	0.85 SLPM	7 hr. 09 min.

Appendix A

The configuration of the Biomarine CCR 1000 as tested was as follows:

Biomarine CCR 1000

a. Baralyme CO_2 scrubber

b. Disposable battery

c. Mark 6 Mod 0 Mouthpiece

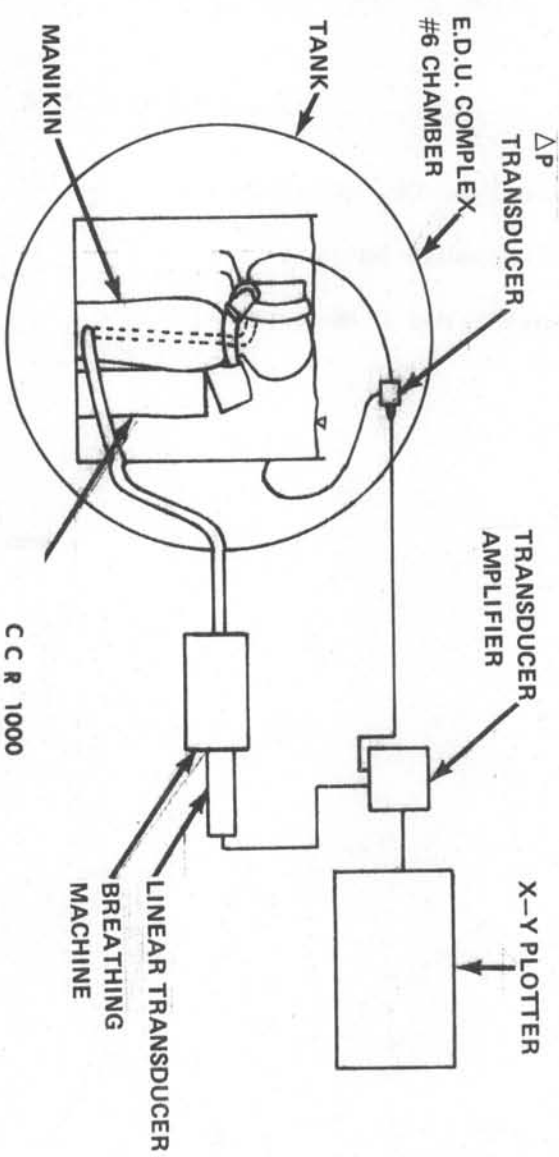

Figure B-1. Biomarine CCR 1000 Front View

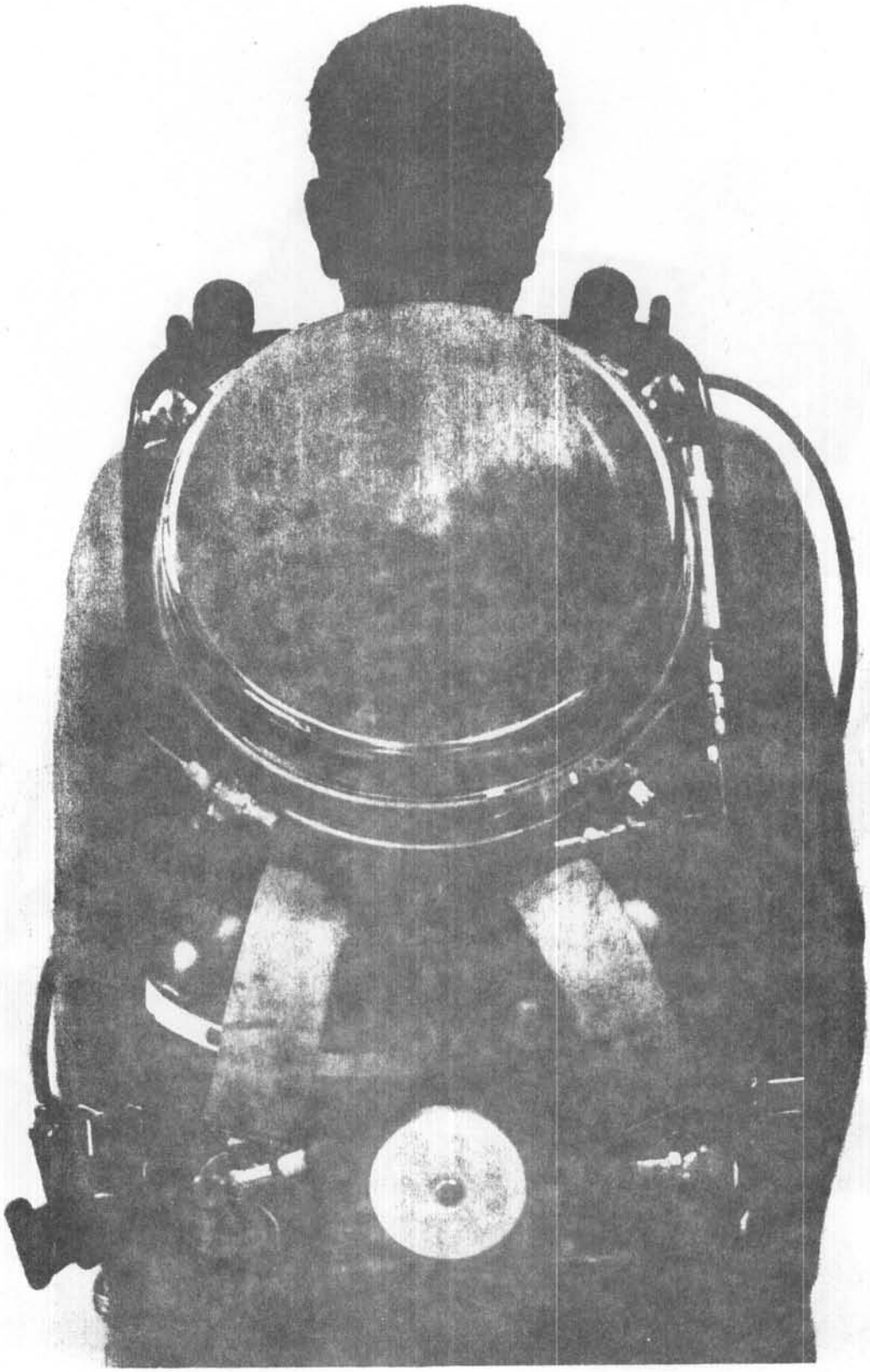

Figure B-2. Biomarine CCR 1000 Back View w/o Shroud

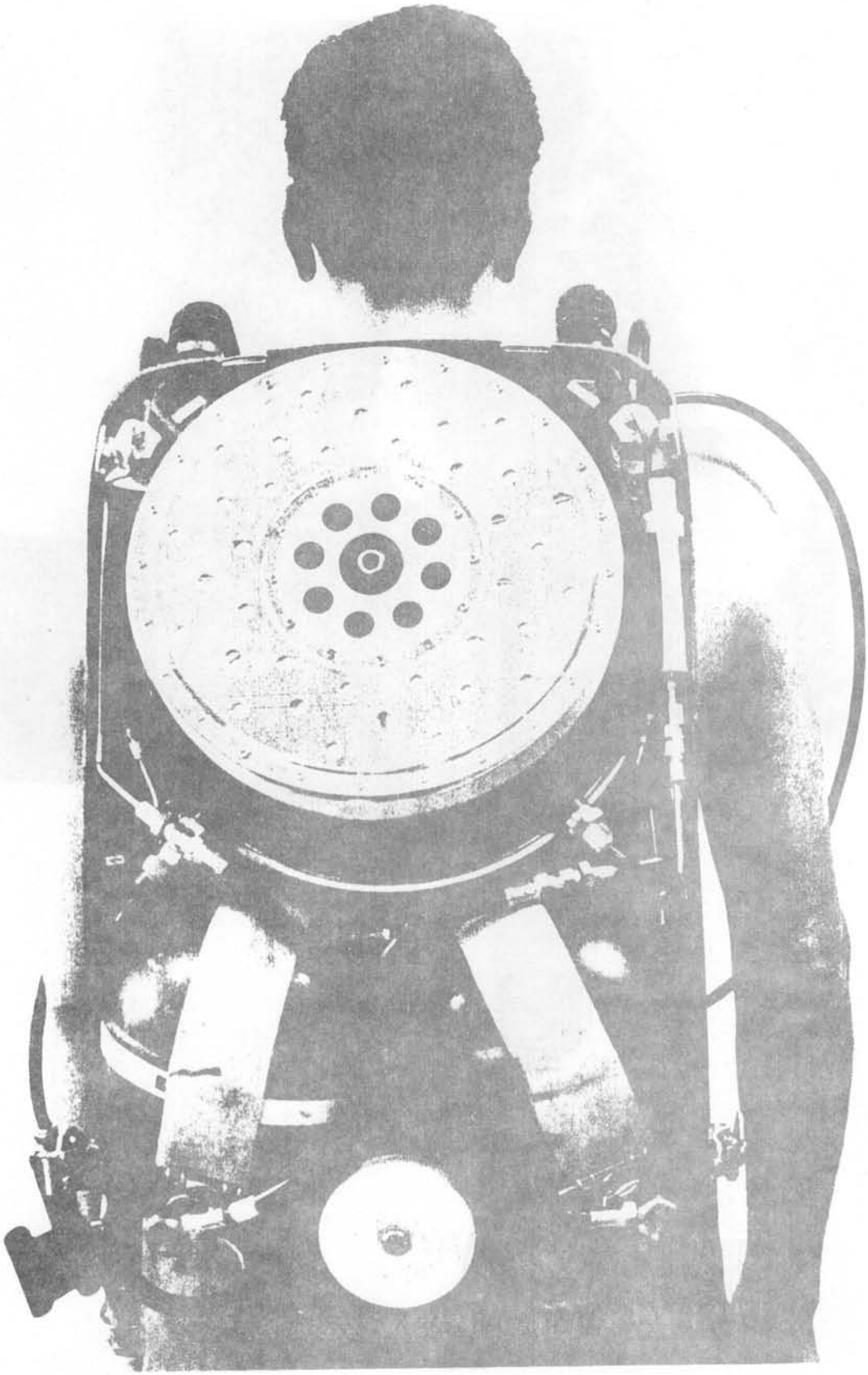

Figure B-3. Biomarine CCR 1000 w/canister uncovered

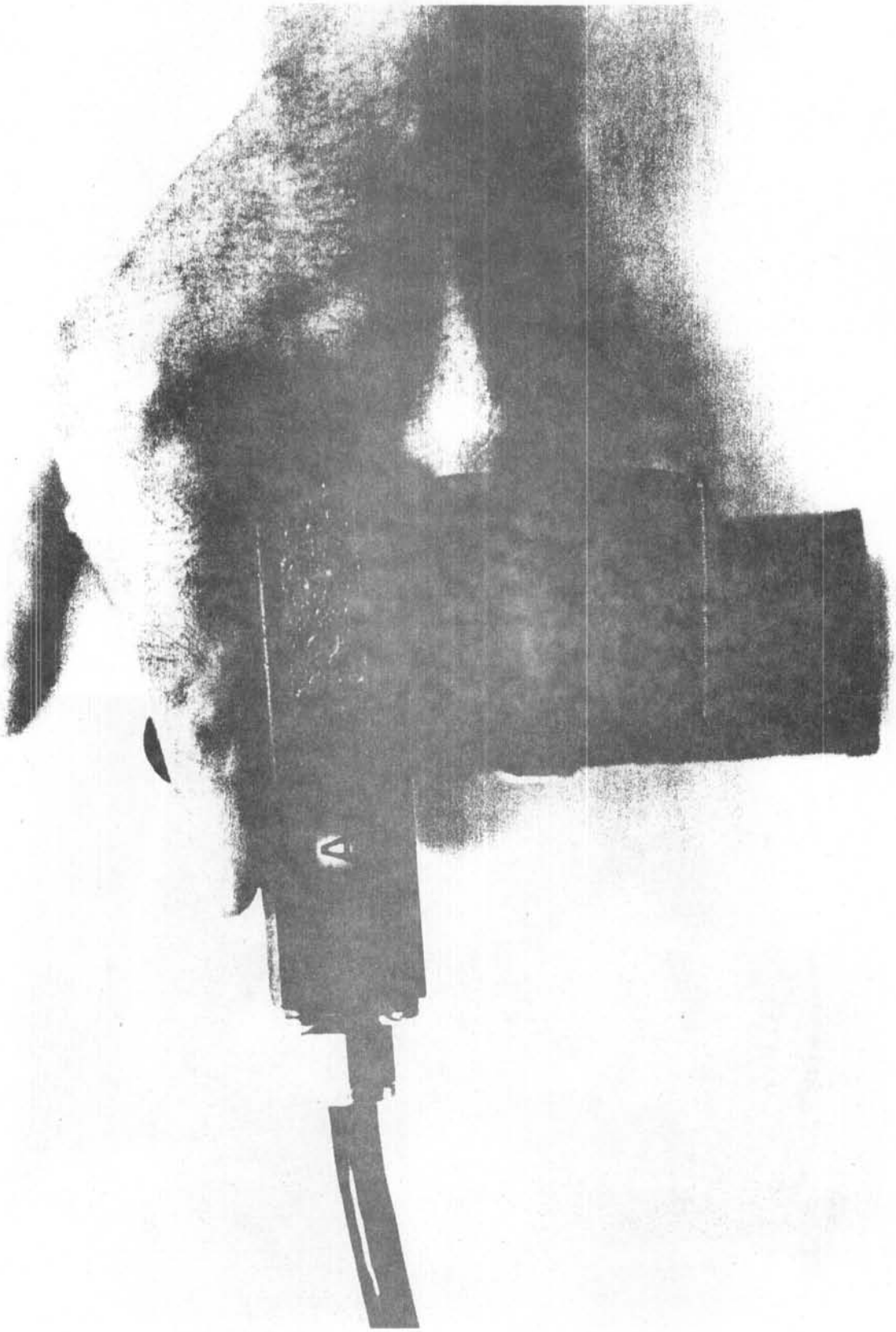

Figure B-4. Wrist Display

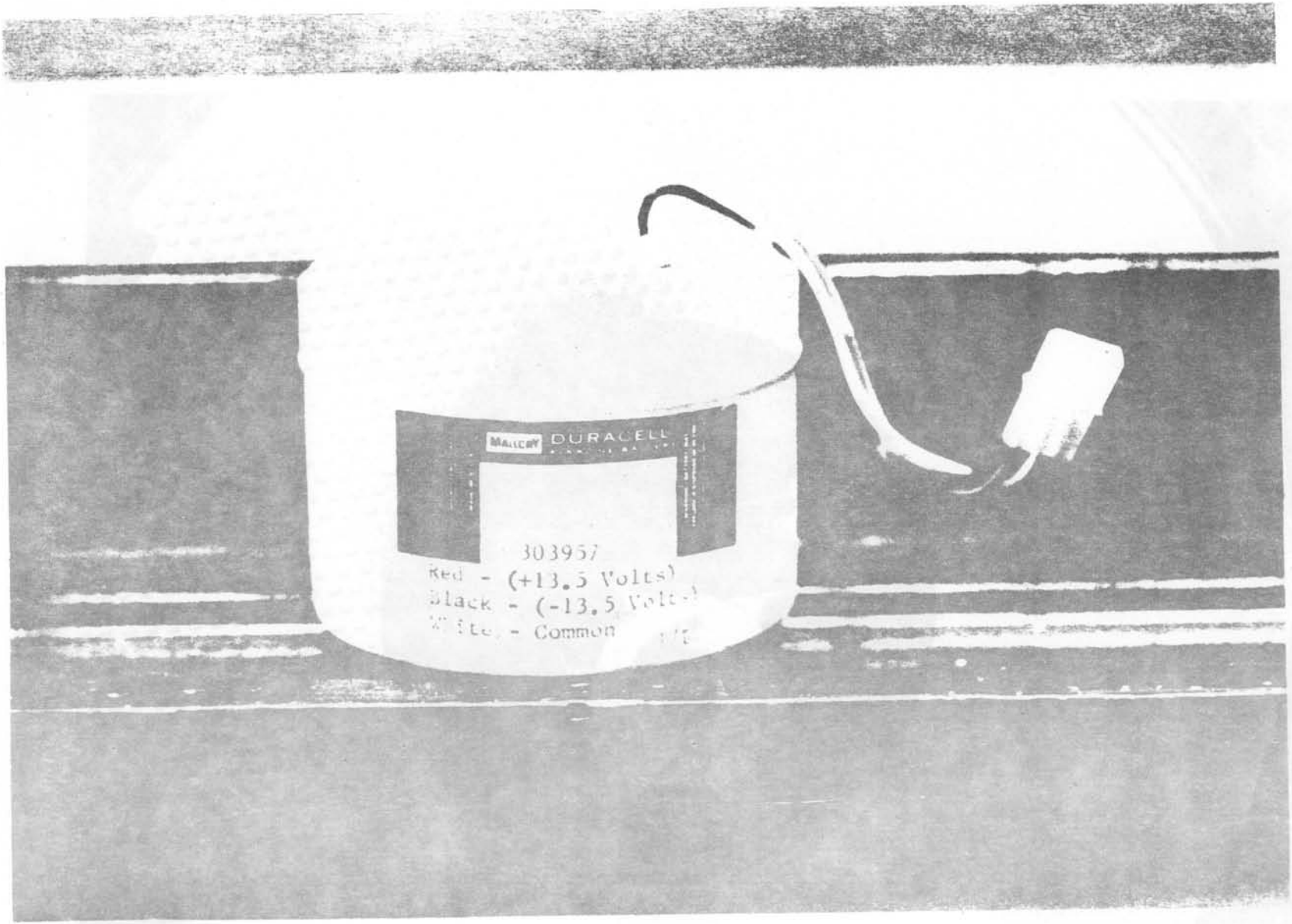

Figure B-5. Battery

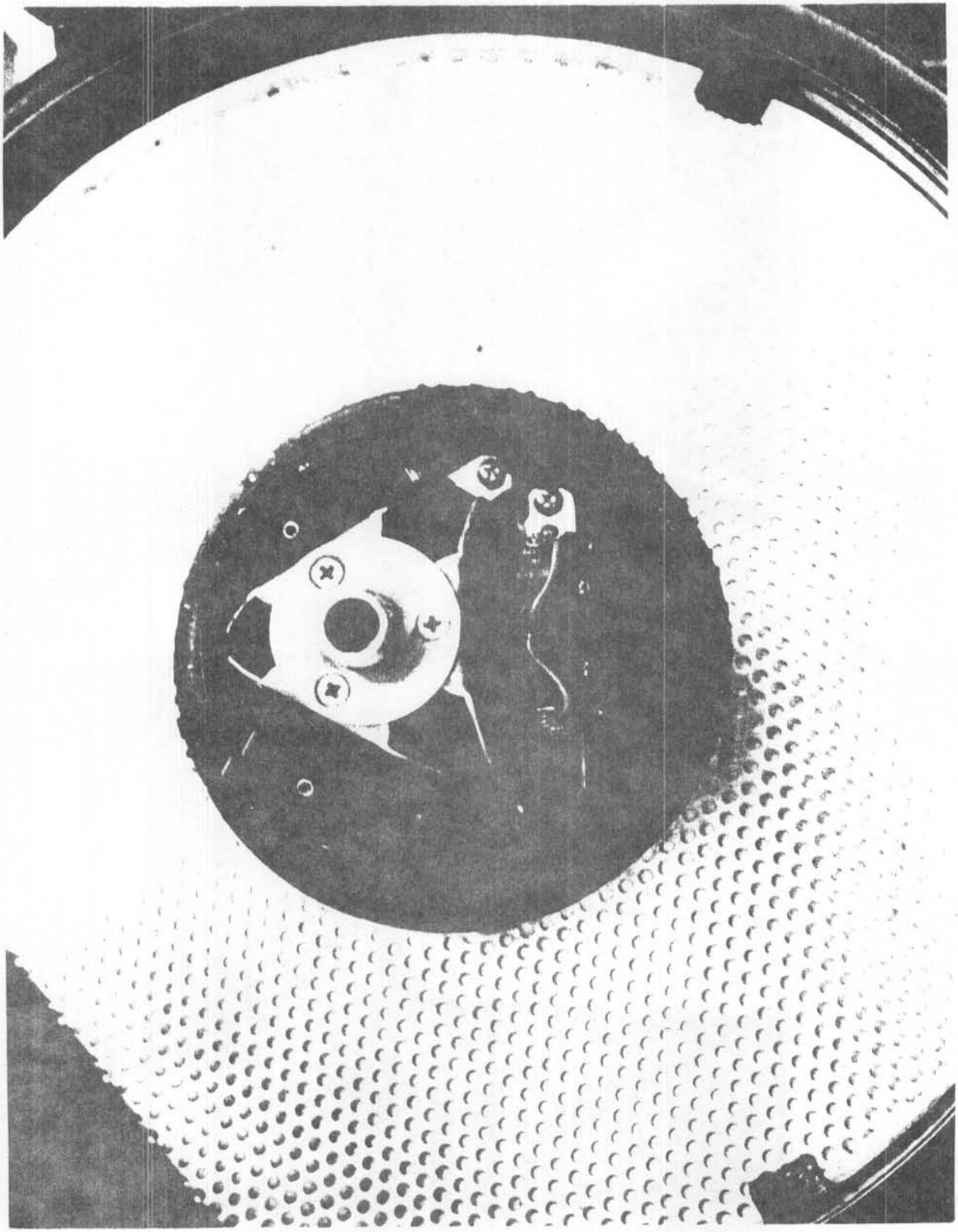

Figure B-6. Oxygen Sensor Plenum

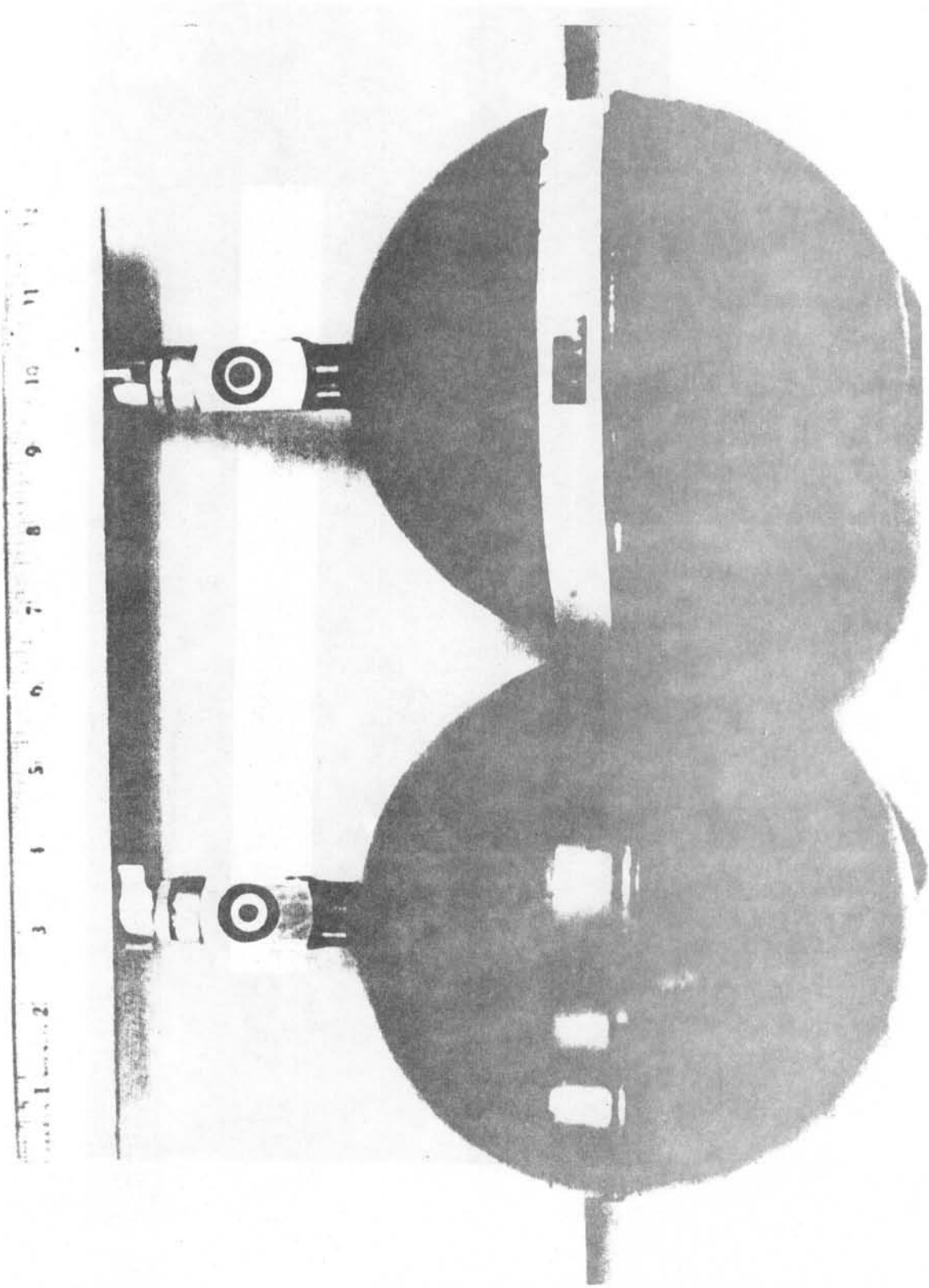

Figure B-7. Oxygen and Diluent Cylinders

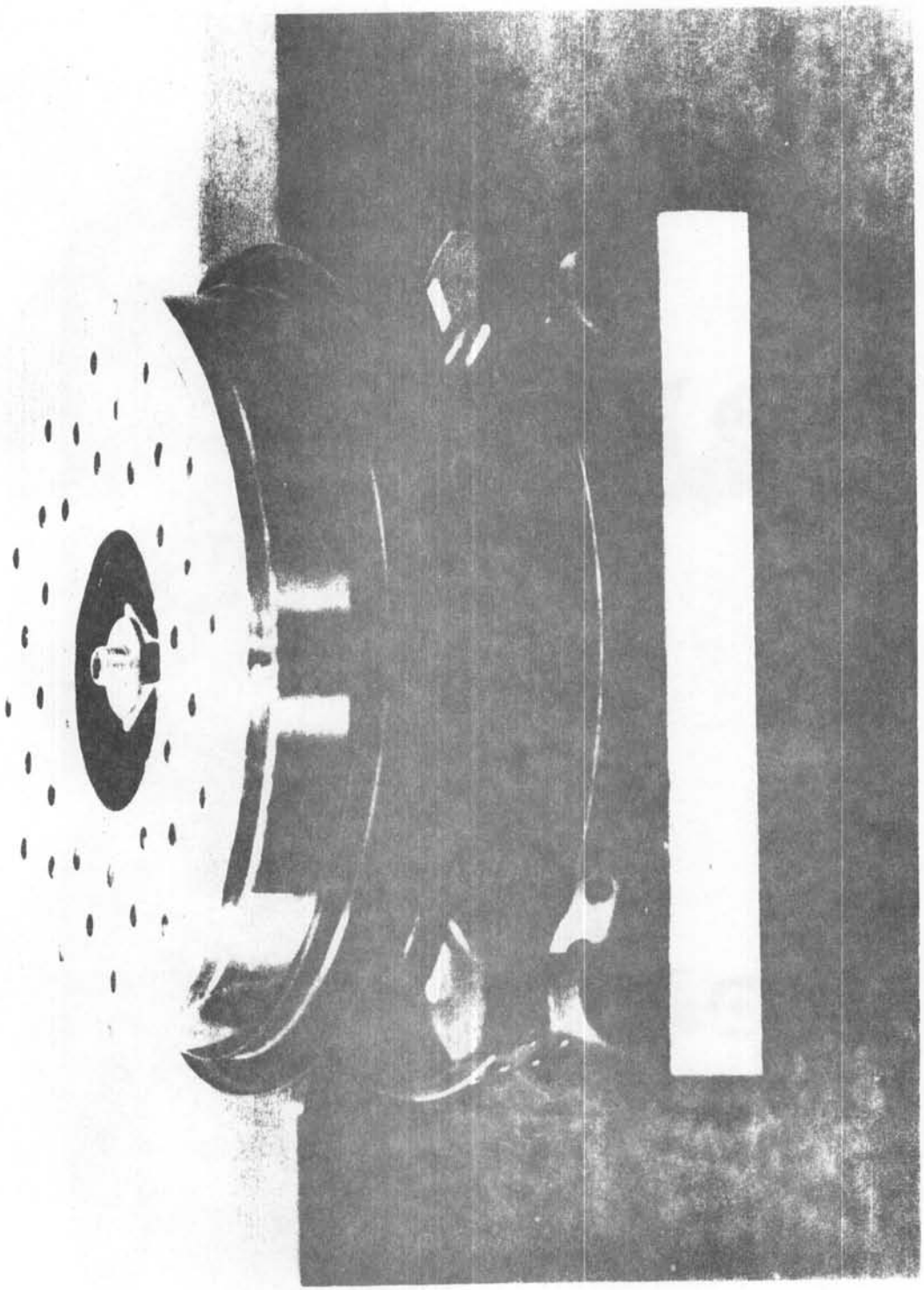

Figure B-3. CO_2 Canister and Diaphragm

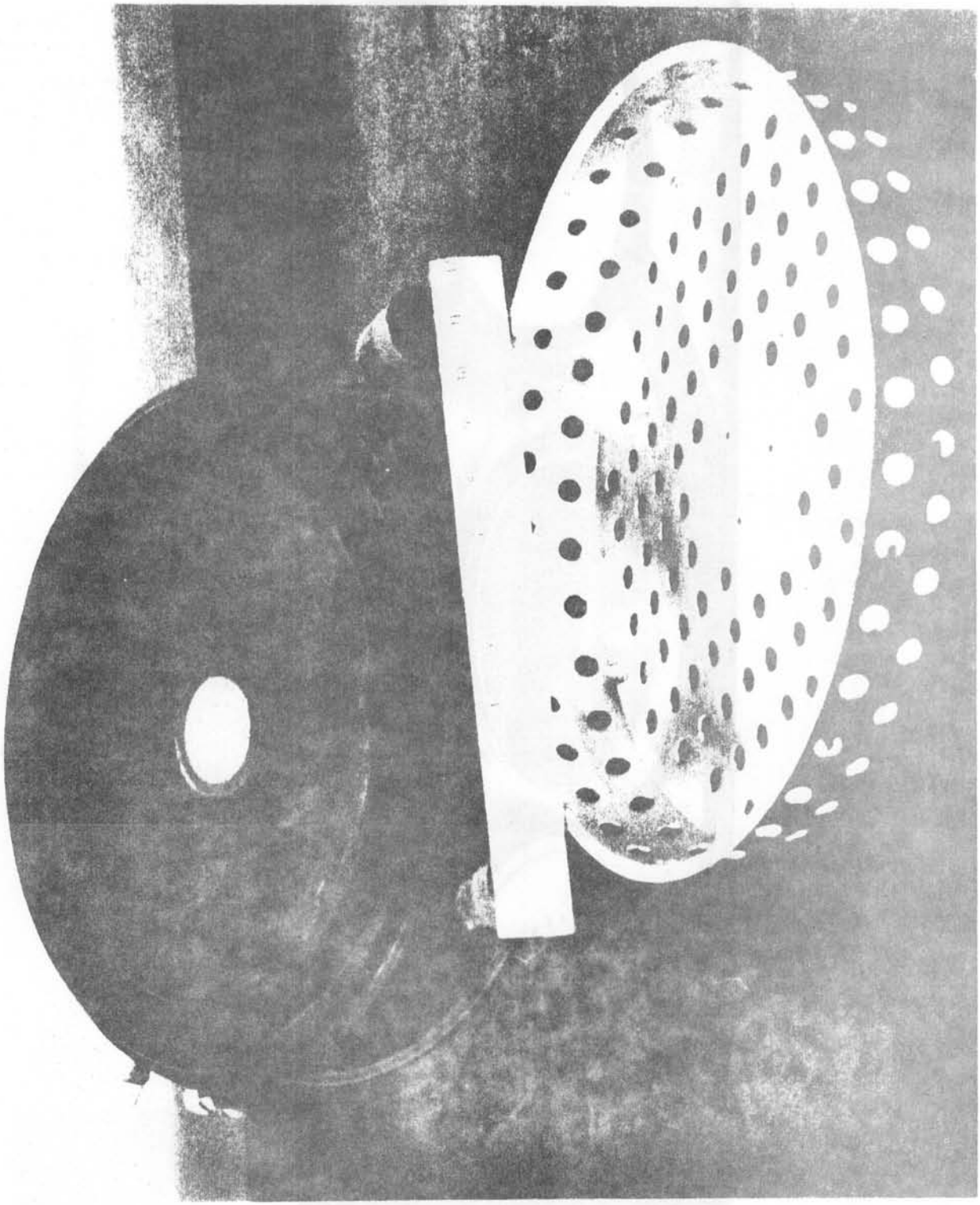

Figure B-9. Diaphragm Disassembled

Figure B-10. CO_2 Canister Disassembled

Appendix B