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CLOSED-CYCLE RESPIRATOR DEVELOPMENT PROGRAM

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FINAL REPORT

PREPARED FOR:

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1.0 SUMMARY

The Closed Cycle Respirator Development Program was begun on 2 June 1969. The original objective of the program was to produce four portable volume controlled prototype respirators. Subsequently, the program was expanded to include the design and construction of a test device to analytically evaluate the performance characteristics of the prototype respirators. This device was appropriately referred to as the lung simulator.

The four prototype units were delivered to the National Naval Medical Center (NNMC) in Bethesda, Md. during March and April, 1970. The lung simulator was delivered to NNMC on August 24, 1970. Operating manuals covering the operation and maintenance procedures for the prototype respirators and the lung simulator were delivered respectively with the equipment. On June 24, 1970, an annual report covering the design, development and fabrication of the four prototype respirator units was issued.

2.0 PROGRAM ANALYSIS

2.1 PROTOTYPE RESPIRATORS

The first prototype unit, designated S/N 6549725, was delivered to NNMC on 20 March 1970. The remaining units, S/N 6549726, 6544727, and 6549728 were delivered on 9 April 1970 and 20 April 1970. All four units had been subjected to component and system tests prior to delivery and in general, had been found to meet system performance specifications. Further tests at NNMC identified several areas in which design modifications were required to improve the reliability of several functions. Most important of these was the flow control valve and the exhale timer circuit. Subsequent to delivery, the flow control valve and exhale timer circuit have been redesigned and prototype components developed and tested. All units have been retrofited with the redesigned components. Details of the respirator design and test program results can be found in the Annual Report (Document RDP-019, June 24, 1970).

2.2 LUNG SIMULATOR

The first evaluation phase of the prototype respirator units consisted of analytically evaluating the performance characteristics of the system. In order to properly evaluate the system, it was necessary to design and build a test device from which meaningful data could be collected. On 16 July 1970, the contract scope was expanded to include manufacture of a lung simulator.

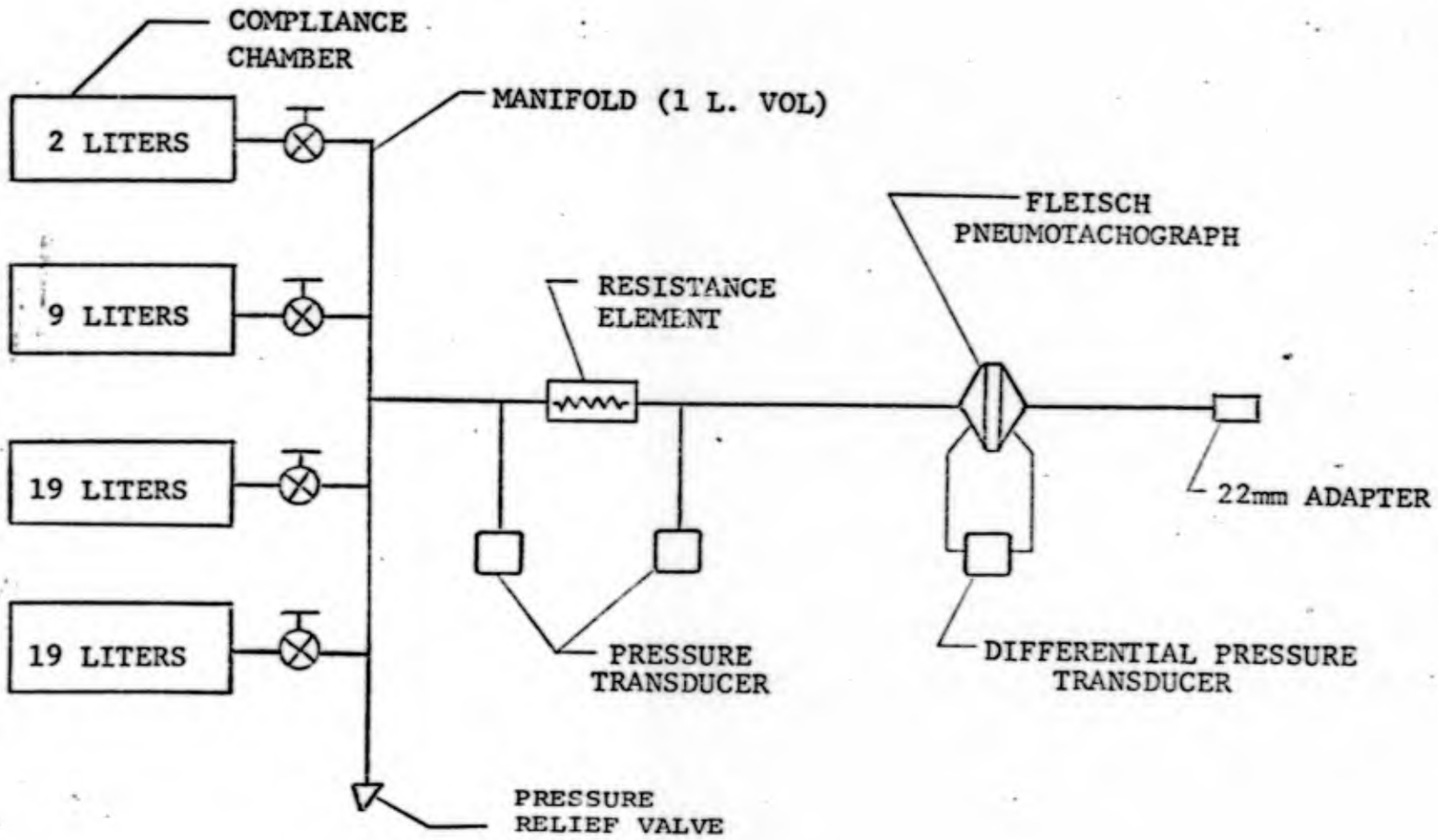
The lung simulator design was based on requirements for such a device established by the American National Standards Institute (Sub committee on Ventilators). It consists of a mechanical device which simulates the compliance of the lung and airway impedence. In the device, compliance is simulated by the compression of gases in fixed volume chambers and the resistance by flow restrictions in the connecting tubing. To simulate patients ranging from neonate to adult, compliance values of .001, .003, .010, .020, and .050 liters/cm H_2O were provided and gas flow resistances of 5, 20, 50, 100, 200 and 1000 cm H_2O/liter/sec were provided. Instrumentation included with the device consists of two pressure transducers to determine pressure levels and a Fleisch Pneumotachograph to measure flow rate. Figure 1 shows the schematic arrangement of the lung simulator and

Figure 2 is a sketch of the system. Prior to delivery, measurements of the compliance values and resistance values were made to determine the degree of accuracy. Tables 1 and 2 summarize the test results obtained.

2.3 DOCUMENTATION

Operating manuals describing manual operation and maintenance procedures for both the prototype respirator units and the lung simulator were delivered with the respective hardware. In addition, an annual report was prepared and issued on June 24, 1970. The annual report covered the complete design, development, fabrication and test effort of the four prototype respirator units.

FIGURE 1. LUNG SIMULATOR SCHEMATIC



A: Compliance Chamber
B: Chamber Selector Valves
C: Pressure Transducer
D: Diff. Pressure Transducer
E: Resistance

F: Fliesh Pneumotachograph
G: 22 mm Adaptor
H: Relief Valve
I: Interconnecting Tubing

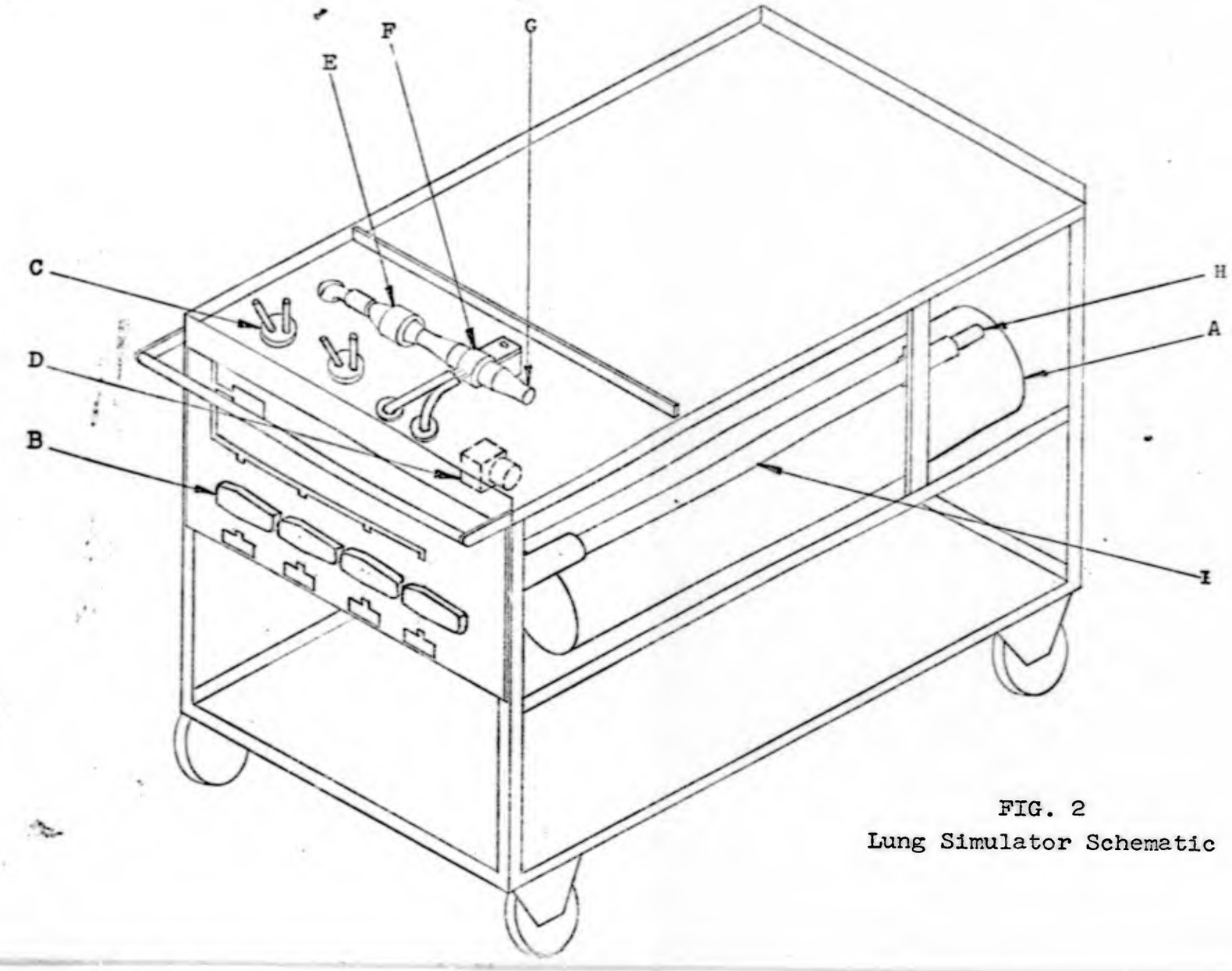


FIG. 2
Lung Simulator Schematic

TABLE I - COMPLIANCE VALUES

Compliance liters/cm H_2O	Required Volume cc	Actual Vol. cc	% Error
.001	1,033	1.024	-1.0
.003	3,099	3,111	+0.3
.010	10,330	10,222	-1.0
.020	20,660	20,684	+0.1
.050	51,650	51,694	+0.1

TABLE 2 - RESISTANCE VALUES

Resistance Value Cm H_2O/liter/sec.	Actual Cm H_2O/liter/sec.	% Error
5	5.2	4.0
20	21.8	9.0
100	102.3	2.3
200	197.0	2.9
1,000	1,020.0	2.0