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ARROW 2
OXYGEN SYSTEM

REPORT No. 72/SYSTEMS 21/30

ENGINEERING DIVISION

AVRO AIRCRAFT LIMITED

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ARROW 2

OXYGEN SYSTEM

REPORT NO. 72/SYSTEMS 21/30

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This brochure is intended to provide an accurate description of the system(s) or service(s) for purposes of the Arrow 2 Mock-up Conference, and is not to be considered binding with respect to changes which may occur subsequent to the date of publication.

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ENGINEERING DIVISION

AVRO AIRCRAFT LIMITED

MALTON — ONTARIO

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1. INTRODUCTION

1.1 Oxygen System Requirements

The Arrow 2 aircraft is fitted with two oxygen systems; designated Normal and Emergency.

The normal system contains a Lox (liquid oxygen) converter, which converts liquid oxygen into gaseous oxygen for crew members' breathing purposes, and for inflation of the partial pressure suits. Sufficient oxygen will be carried to cover the longest ferry mission with overload tanks, assuming that the Lox converter has been standing by for a maximum of 24 hours after filling. The installation of the system will comply with specification MIL-I-9475 (USAF) where applicable.

The emergency system comprises two separate, 20 minute supply cylinders containing gaseous oxygen, one being mounted on each seat, with provision for manual or automatic selection of the supply; the latter method of selection coming into effect upon ejection of the seat.

1.2 System Design Considerations

It is an inherent feature of Lox converters that a delay of the order of ten minutes is required between filling and the production of gaseous oxygen. It is intended to overcome the effects of this delay, which is unacceptable due to the short turn-around time allowed between missions, by storing filled portable converters

1. INTRODUCTION (Continued)

1.2 System Design Considerations (Continued)

in a building set aside for the purpose. This concept requires that filled converters, which are to be removed from storage as required, be designed for easy installation in the aircraft through the use of plug in features, all connections being made automatically. The gaseous oxygen supply connection will be self sealing both on the aircraft and converter side of the joint.

In the interests of weight saving and portability, the converter weight will be kept to a low figure (28.20 lbs. full) and a carrying handle provided.

2. DESCRIPTION OF NORMAL SYSTEM

2.1 Converter (See Figs. 1 & 4)

The 5.0 litre converter consists of a double walled container, the space between the walls being evacuated to form an insulating vacuum, plus the following items which are connected to it by piping:

- Combined fill, vent, and build up valve
- Pressure closing valve
- Pressure relief valve
- Quick disconnect supply to aircraft
- Quick disconnect overboard vent
- Build up coil
- Evaporating plate.

2. DESCRIPTION OF NORMAL SYSTEM (Continued)

2.1 Converter (See Figs. 1 & 4) (Continued)

In addition, sensing elements, used in the quantity gauging system, are mounted within the container, and are connected by wiring to the electrical disconnect.

The complete assembly is mounted on a base which acts as a reference point between the mounting tray in the aircraft and the disconnect points.

2.2 Operation of Converter (See Fig. 1 & 4)

For filling purposes it is intended that the converter be mounted on a tray similar to the mounting tray in the aircraft. When the supply of liquid oxygen is connected for filling, the combined filler, vent and build-up valve operates in such a manner that the top, or gas side of the converter is vented to atmosphere. Filling is continued until liquid oxygen is seen to be issuing from the vent port.

Removal of the filling connector closes the vent port of the combined filler, vent and build-up valve, and opens the build up portion of the circuit. The liquid then flows out of the container into the build-up tube, where it becomes gaseous, passes through the pressure closing valve, which at this stage is open, and flows back through the build-up valve to the gas side of the container. This cycle continues until the operating pressure of 300 psi is reached, at which point the pressure activated bellows in the pressure closing valve

2. DESCRIPTION OF NORMAL SYSTEM (Continued)

2.2 Operation of Converter (See Figs. 1 & 4) (Continued)

closes. With the build-up tube thus closed, further liquid flow is through the evaporating plate, where the Lox is converted to gas at a usable temperature. At this point, the converter is ready for use; gaseous oxygen being available at the aircraft disconnect. A pressure relief valve connected to the overboard vent quick disconnect prevents excessive pressures being built up in the converter system.

2.3 Operation of Complete System

The full converter is fitted into the aircraft by placing it on its tray and sliding it forward. This automatically couples the supply, overboard vent and electrical connections. The converter is then positively locked to the tray by the operation of two quick acting catches.

Oxygen for crew members use is now available, it flows from the evaporating plate of the converter, through the supply connection into the cockpits where it enters the composite leads disconnect at each crew member's seat.

The composite leads disconnect provides a common attachment point for all the crew members services. There are four outlets, two of them for oxygen (i.e. one mask and one for the partial pressure suit) one for an intercom plug, and one for the anti "g" suit

2. DESCRIPTION OF NORMAL SYSTEM (Continued)

2.3 Operation of Complete System (Continued)

connection. The disconnect is also divided into three parts by self sealing couplings:

Part A - is attached to the crew member's services.

Part B - is attached to the seat.

Part C - is attached to the aircraft.

If the crew member ejects from the aircraft, Part C stays with the aircraft, then when the crew member separates from the seat, Part B stays with the seat and Part A goes with the crew member.

The gaseous oxygen enters the composite leads disconnect at Part C, passes through Part A, and flows from Part B to the dual check valve mounted on the seat.

The dual check valve joins the normal supply system to the emergency supply system to the pressure reducing valve, at the same time preventing any interconnection between the two systems.

From the dual check valve the oxygen flows through the pressure reducing valve to the oxygen regulator, both of which are mounted on the seat. The pressure reducing valve reduces the pressure to 70 psi. The oxygen regulator is a dual outlet, high altitude, pressure demand type regulator (to specification MIL-R-25572).

From the two outlets on the regulator the oxygen flows into two

2. DESCRIPTION OF NORMAL SYSTEM (Continued)

2.3 Operation of Complete System (Continued)

ports on Part B of the composite leads disconnect that is the part attached to the seat, and then into Part A. The oxygen mask and partial pressure suit are attached to two outlet ports on Part A of the composite leads disconnect by the crew member on entering the aircraft.

Note: The single converter supplies gaseous oxygen to both crew members, but each seat has a dual check valve, pressure reducing valve, pressure regulator and combined services disconnect mounted on it. (Fig. 2).

3. EMERGENCY SYSTEM

3.1 Each crew station is equipped with a cylinder containing 53.0 cu.in. of gaseous oxygen charged at 2000 psig. This volume is sufficient for a minimum of 20 minutes supply at a rate of 300 litres per hour. The cylinder is mounted on the crew members' seat. A combined pressure gauge, charging valve and manual and automatic trip valve is provided on each seat.

3.2 Emergency Oxygen for "Bail Out" Case

In the case of crew members' ejection, the emergency supply is automatically connected. A lanyard which is fastened to the floor of the cockpit is attached to the manual and automatic trip valve, so that the valve is operated by the action of the seat leaving the

3. EMERGENCY SYSTEM (Continued)

3.2 Emergency Oxygen for 'Bail Out' Case (Continued)

aircraft. The aircraft part of the composite leads disconnect then stays with the aircraft (Ref. para 2.3) the crew members' part and the seat part leaving the aircraft, being attached to the crew member and the seat respectively. The port on the crew members' part which normally was connected to the aircraft part is automatically closed by the separation of the two parts.

3.3 Emergency Oxygen-Crew Members Remaining with Aircraft

Should either crew member require the use of emergency oxygen due to an inoperative condition of the normal system, it is obtained by pulling the emergency oxygen release knob which is located on the left hand side of each seat. This action connects the emergency supply container to the pressure reducing valve and regulator through the dual check valve.

4. QUANTITY GAUGING SYSTEM (See Figs. 3 & 6)

4.1 The liquid oxygen gauging system comprises the following components:

(a) Indicator

(b) Amplifier

(c) Sensing Element

(d) Circuit Protectors

(e) Connectors

4. QUANTITY GAUGING SYSTEM (See Figs. 3 & 6) (Continued)

4.1 (Continued)

(f.) Wiring Harness

The purpose of the circuit is to measure and indicate the contents of the liquid oxygen container.

The indicator in the pilots cockpit is marked from 0 to 100% of full, and receives signals from the sensing element in the converter. When electrical power to the quantity gauging system fails, a warning flag appears on the indicator dial, informing the pilot of this fact. This warning is necessary because the inertia of the gear train, to which the pointer is attached, is sufficient to prevent the pointer from falling off the scale when the electrical imput to the indicator is removed. There is also a warning light in the navigators cockpit, which is illuminated when the quantity of liquid oxygen in the converter reaches 25% of its full capacity.

Referring to the diagram (Fig. 6), 115 volts 400 cycles are fed into two circuits; namely power rectification and voltage changing. The voltage changing circuit through the transformer T1 reduces the 115 volt supply to 6.3 volts for heating the 6U8 tube. The rectifier circuit converts the 115 volts 400 cycle supply to 115 volts D.C., through the rectifier SR65MA, for plate voltages for each section of the 6U8 tube.

Condensers 7500 MMF and 5 MFD provide ripple filtering for the

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4. QUANTITY GAUGING SYSTEM (See Figs. 3 & 6) (Continued)

4.1 (Continued)

plate voltages; resistor 560 IW provides some smoothing, and tube OB2 regulates the final rectification output. A 4.3 megacycle generator consisting of the triode section of the 6U8 tube, 1 meg OHM 1/2 watt resistor, 4.3 megacycle crystal, 500 MMF condenser, 2.5 millihenry choke is coupled through the 110 MMF condenser to the input of the main amplifier. The main amplifier comprises the 5600 OHM 1/2 watt resistor, the pentode section of the 6U8 tube, a 47 OHM resistor, 1000 OHM 1/2 watt resistor and a 2.5 millihenry choke. The output of the main amplifier is coupled through a 200 MMF condenser to the parallel resonant circuit of the sensing element consisting of a 1500 MMFD condenser, a slug tuned 4.3 megacycle coil and compensator condenser C1. The sensing element is shunt connected across the parallel resonant circuit. The sensing element capacitance varies in relation to the volume and density of the liquid oxygen which in turn varies the load on the output of the main amplifier. The variable load on the main amplifier causes a varying voltage to develop across the input circuit to the IM34 rectifier. The rectifier output is connected in series with a parallel series circuit of resistor of 500 OHM (pot), 56000 OHM 1/2 watt resistor, 1 megohm 1/2 watt resistor and a 500 OHM trim meter shunt pot forming a voltage divider between the rectifier output and the positive D.C. high

4. QUANTITY GAUGING SYSTEM (See Figs. 3 & 6) (Continued)

4.1 (Continued)

voltage. The sensitive 0-200 microampere meter is shunted across the 500 OHM meter trim potentiometer so the meter can be set at an accurate empty or full position when the final check is made on the system in operation.

5. INSTALLATION AND PIPING

5.1 The converter mounting tray is installed in the dorsal on the left hand side of the centre line between STA'S 255.0 and 268.0. It is accessible by removing the detachable portion of the dorsal lying immediately aft of the installation (Ref. Fig. 5). The oxygen supply line and the electrical leads to the quantity gauging system are taken through the navigators' bulkhead. The overboard vent line is taken to a flush outlet point on the skin on the left hand side of the dorsal aft of the navigators' bulkhead.

Piping in the normal system up to the dual check valve, and from the regulator to the composite leads disconnect is of aluminum alloy, using double flared tube ends in accordance with AND10078.

Piping from the emergency container to the double check valve, and from the double check valve to the regulator is of stainless steel, using flared tube ends in accordance with AND10061. Installation is in accordance with MIL-I-9475 (USAF) where applicable.

APPENDIX 1

EQUIPMENT LIST

OXYGEN SYSTEM

DESCRIPTION	QTY	PART No.	SPEC.	MANUFACTURER AND PART No. WHERE APPLICABLE
Bottle - Emergency	2	840287 AN6025AX-53	MIL-C-7095A	Walter Kidde
Converter - 5 Litres	1	Avro 7-2154-14	Avrocan E329	Aro Equip. Corp.
Disconnect - Composite Leads	2	Avro 7-2152-11	Avrocan E269	Aviation Electric
Gauge Quantity	1	Avro 7-2152-12	Avrocan E269	Aro Equip. Corp.
Gauge - Pressure - Normal Supply	1	Avro 7-2152-13	MIL-G-6019A Type M	Norden-Ketay
Gauge - Pressure - Emergency Supply	2	Type L-2	MIL-G-7601A	Aviation Electric
Tray - Mounting	1	Avro 7-2154-15	Avrocan E329	Aro Equip. Corp.
Transmitter - Converter to Quantity Gauge	1	Avro 7-2154-16	Avrocan E329	Aro Equip. Corp.
Valve - Auto and Manual Trip	2	Avro 7-2152-15	Avrocan E286	
Valve - H/P Check	2	AN-6017-1	MIL-V-5027A	Anthony Foster
Oxygen Regulator	2		MIL-R-25572	Firewel
Pressure Reducer	2			Firewel

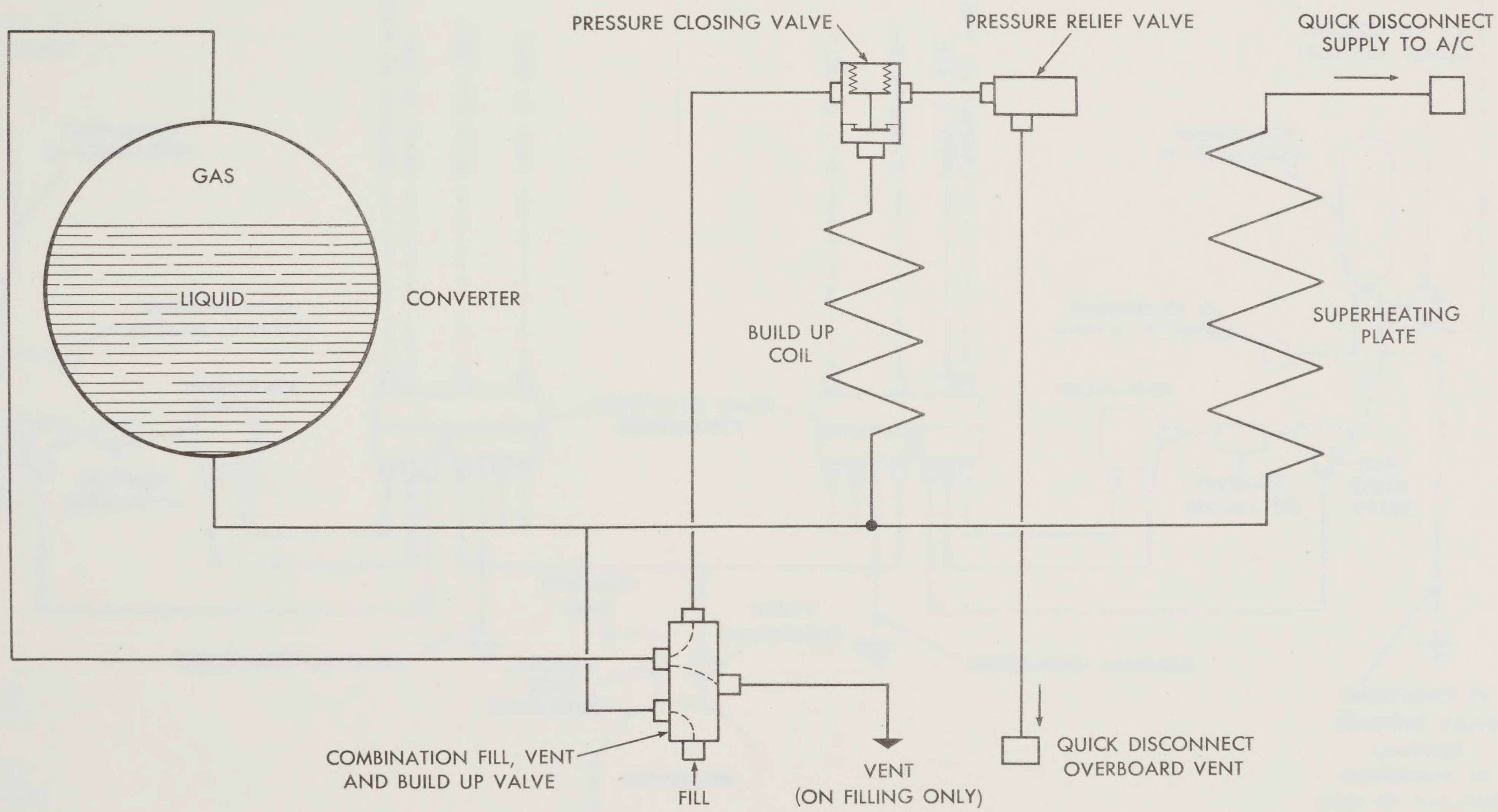


FIG.1 SCHEMATIC - LIQUID OXYGEN CONVERTER

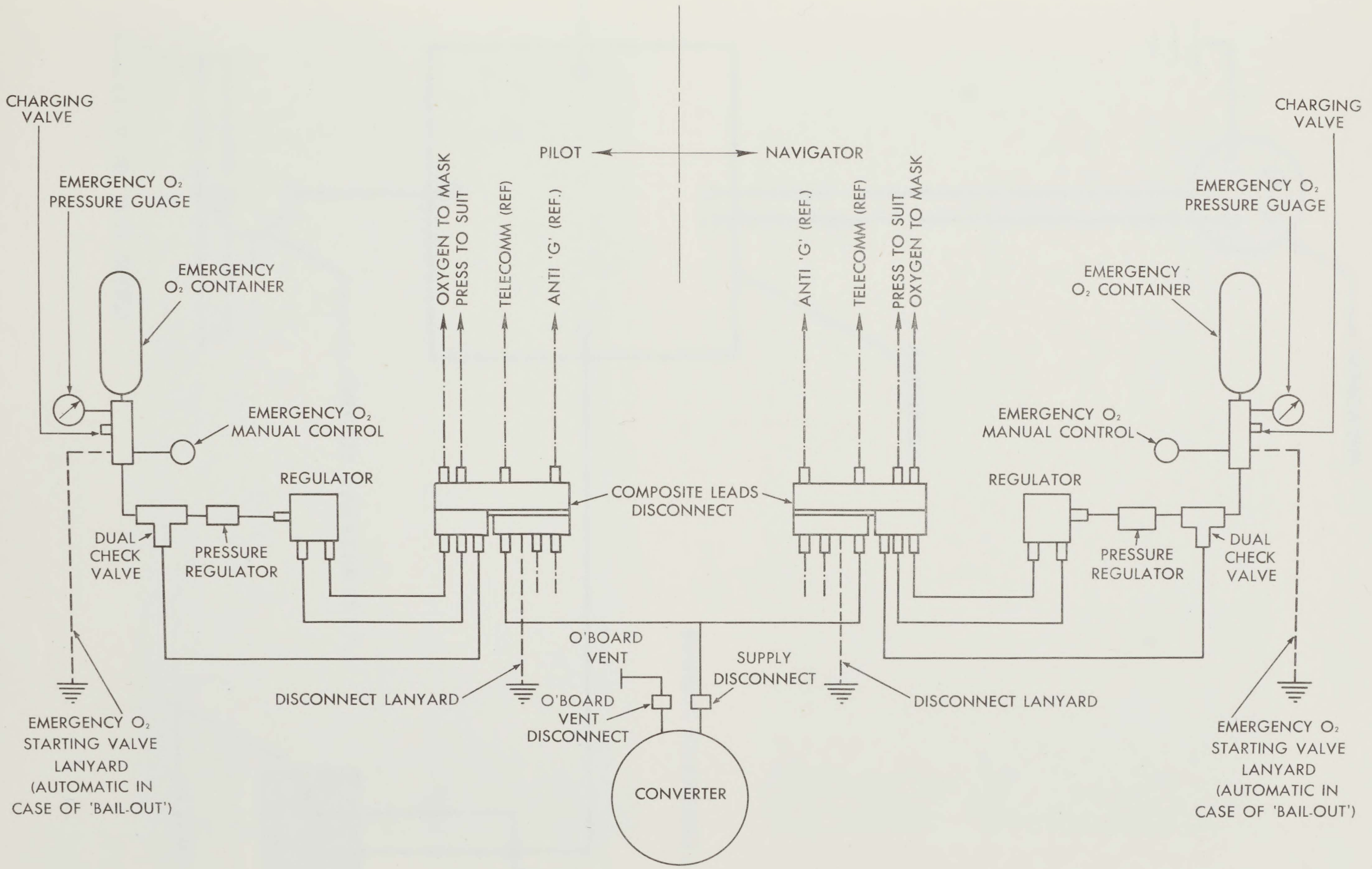
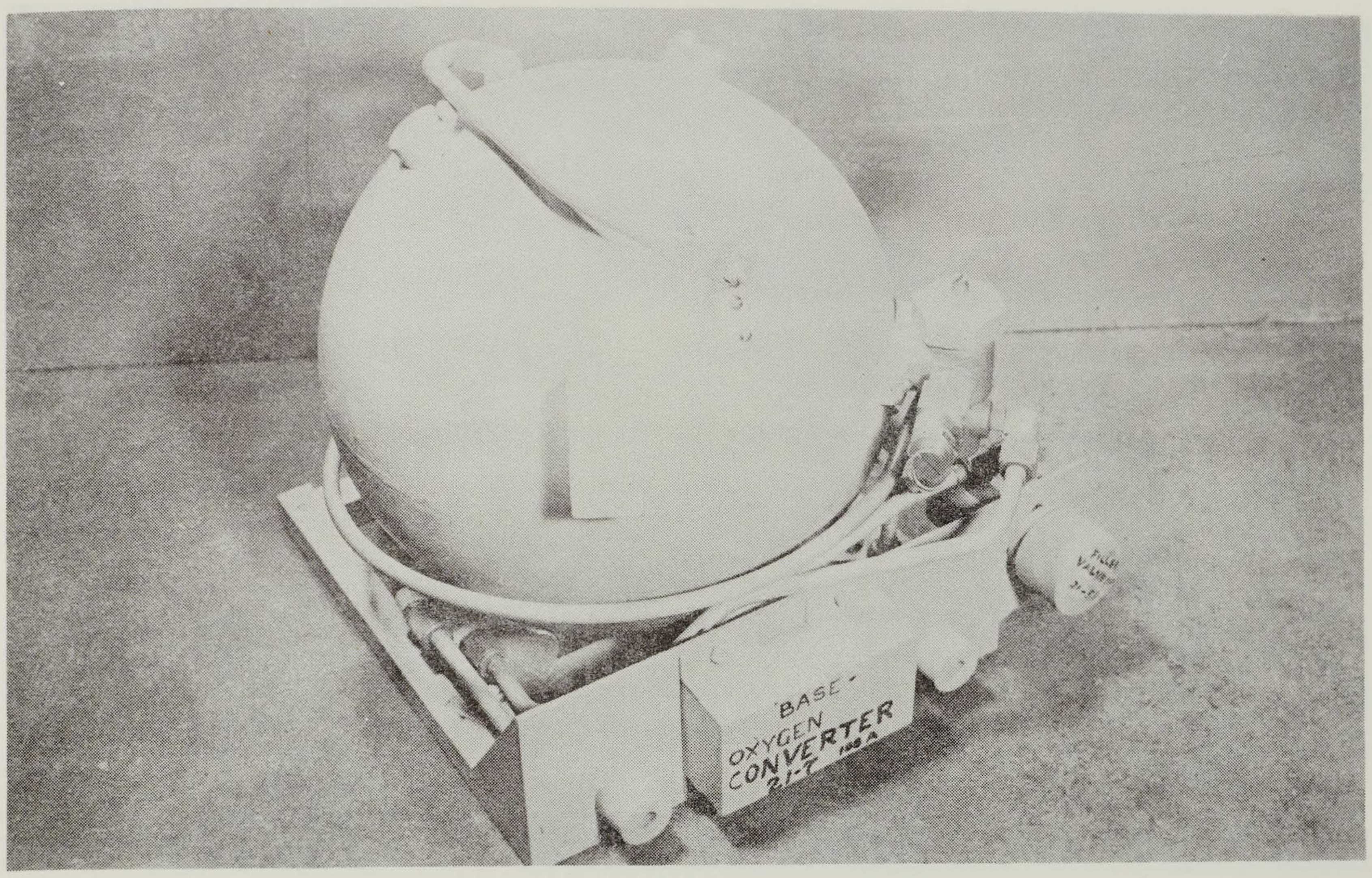
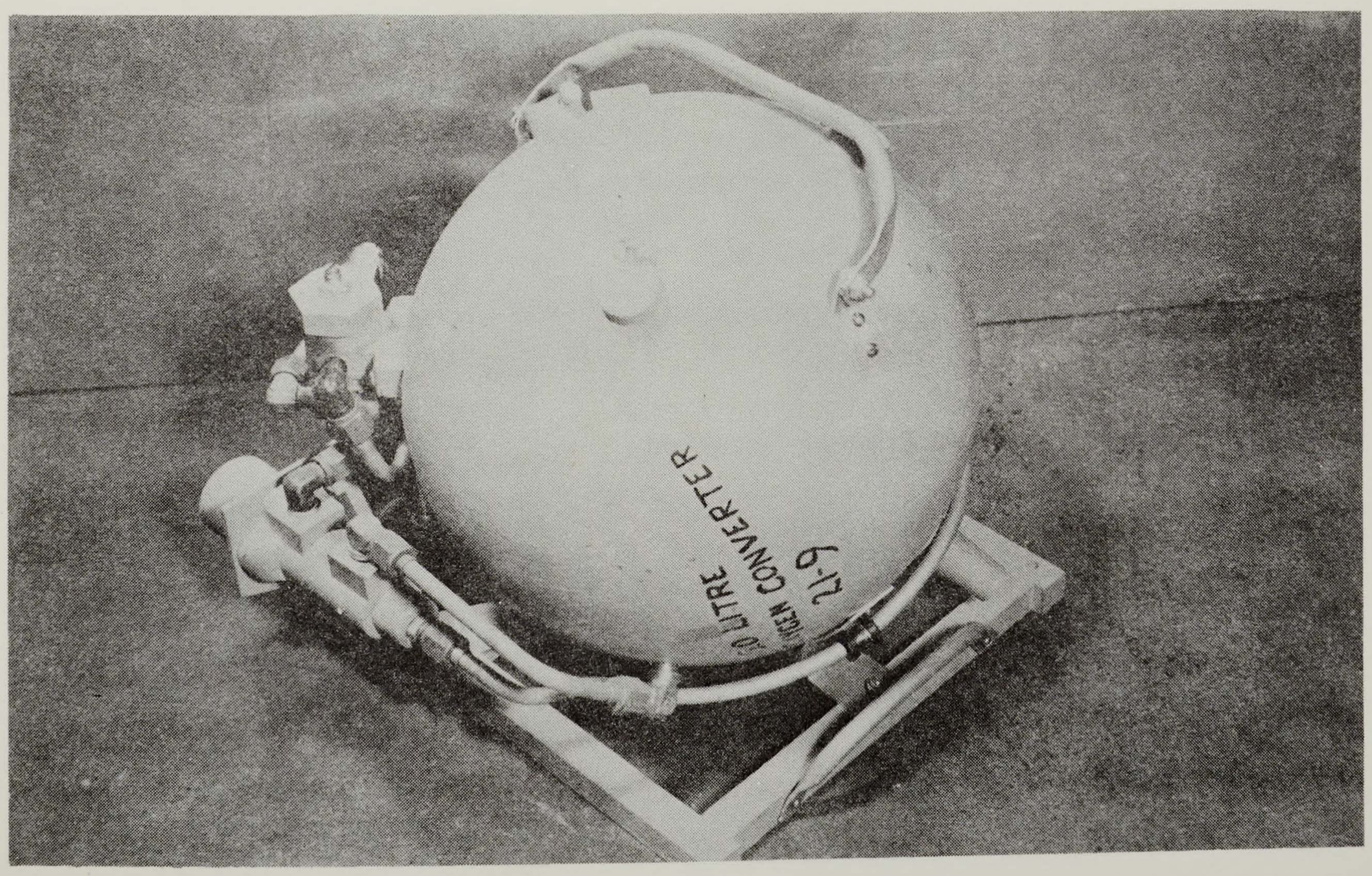


FIG. 2 SCHEMATIC-COMPLETE OXYGEN SYSTEM

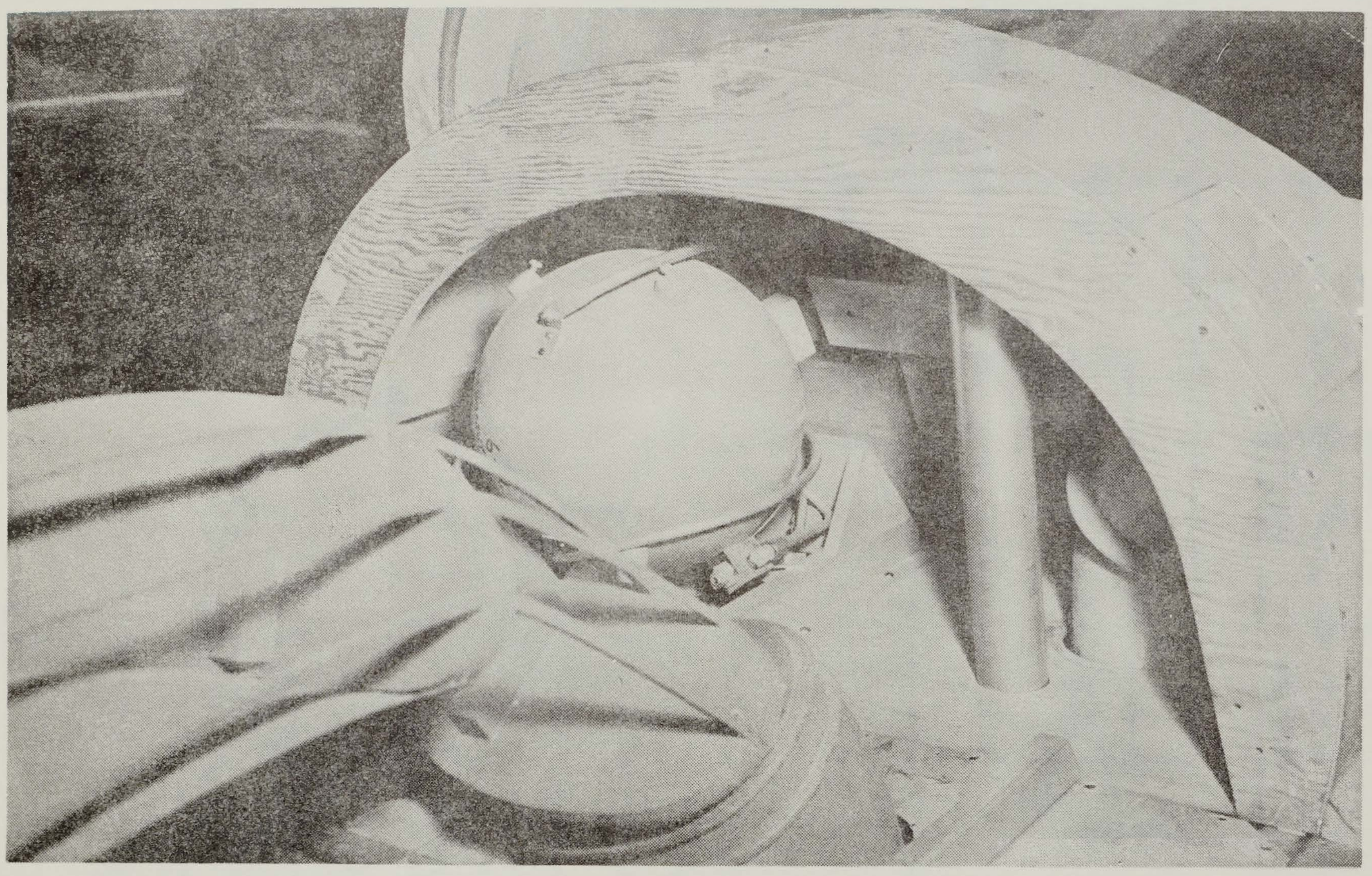


A
5.0 LITRE LIQUID OXYGEN CONVERTER MOCK-UP
3/4 VIEW ON FRONT



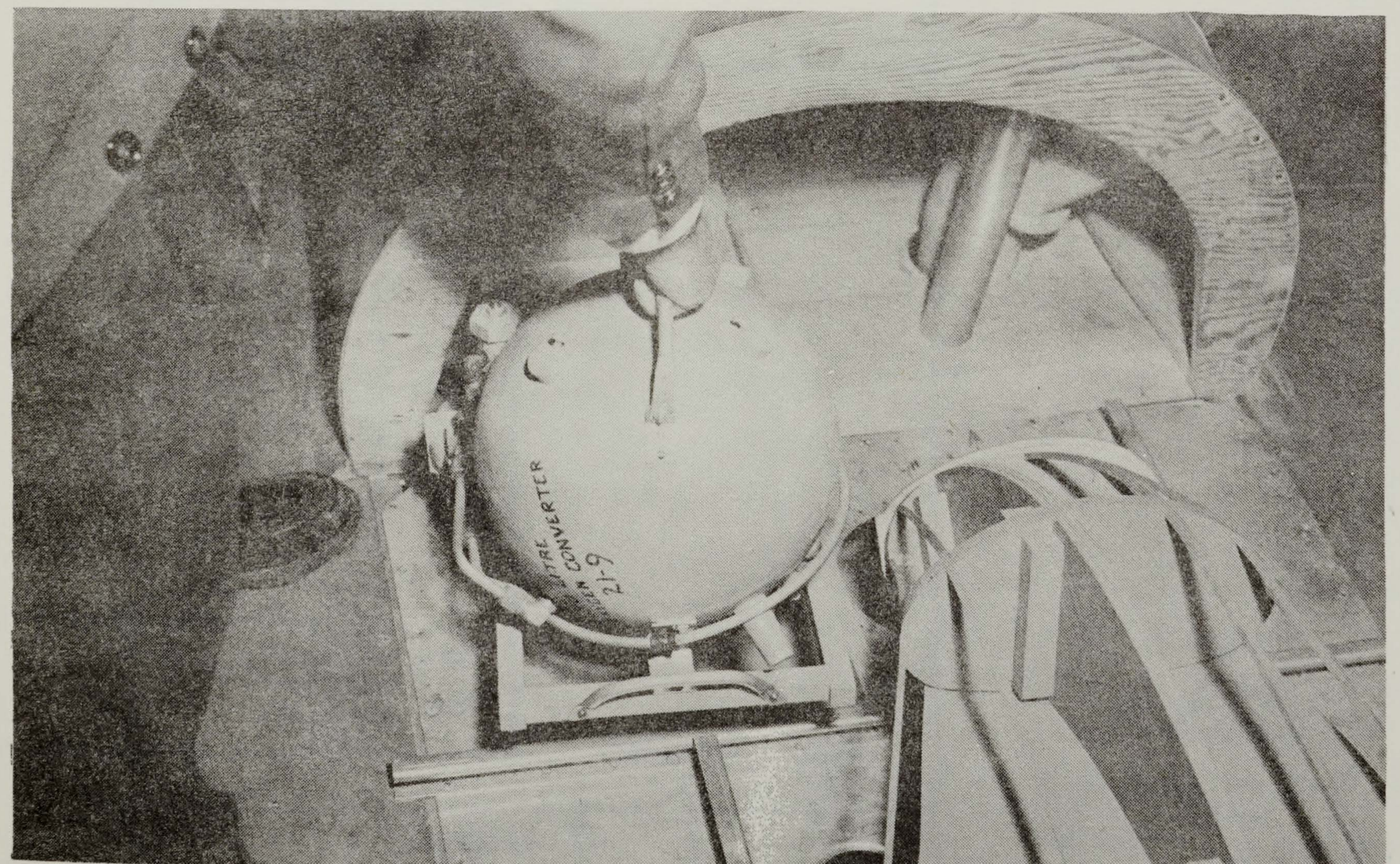
B
5.0 LITRE LIQUID OXYGEN CONVERTER MOCK-UP
3/4 VIEW ON REAR

FIG. 4 5.0 LITRE LIQUID OXYGEN CONVERTER MOCK-UP



A

MOCK-UP OF CONVERTER IN INSTALLED POSITION



B

CONVERTER IN PROCESS OF REMOVAL

FIG. 5 INSTALLATION AND REMOVAL OF CONVERTER

2502-105-1

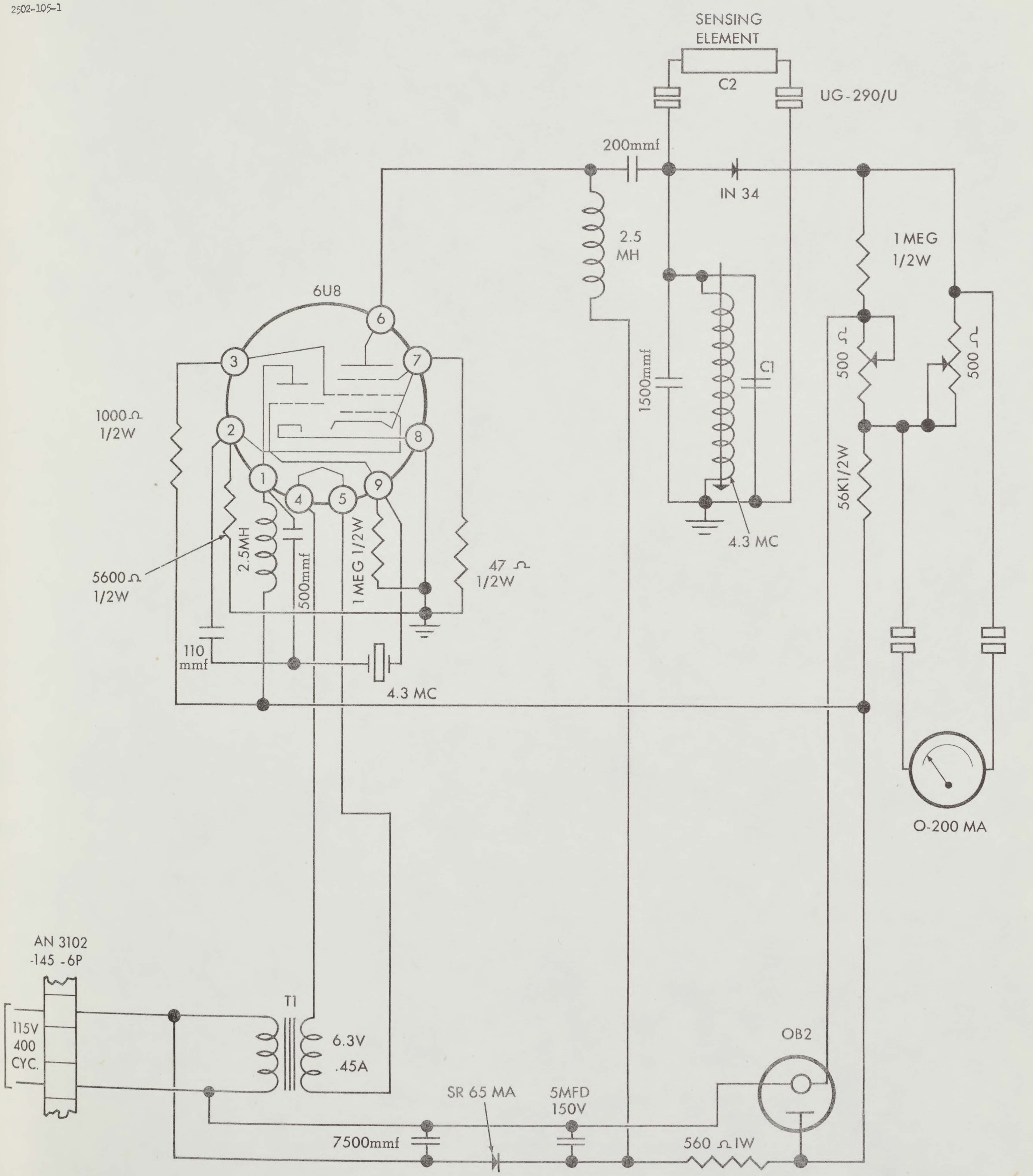


FIG. 6 LIQUID OXYGEN QUANTITY GAUGING SYSTEM