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USAF STANDARDIZED 100 PERCENT OXYGEN DELIVERY SYSTEM

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USAF SCHOOL OF AEROSPACE MEDICINE
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Brooks Air Force Base, TX 78235-5301

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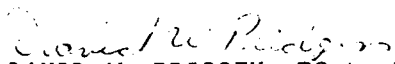
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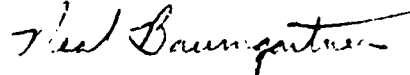
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The Office of Public Affairs has reviewed this report, and it is releasable to the National Technical Information Service, where it will be available to the general public, including foreign nationals.

This report has been reviewed and is approved for publication.


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9. ABSTRACT (Continue on reverse if necessary and identify by block number) The purpose of this report is to provide United States Air Force (USAF) medical treatment facilities with a standardized method of delivering 100% O ₂ via an aviator's oxygen mask to patients suffering from decompression sickness, carbon monoxide poisoning, and other ailments which require the administration of 100% O ₂ . Studies show that administration of 100% O ₂ is the most effective method of treating decompression sickness and carbon monoxide poisoning short of hyperbaric oxygen therapy. However, the options for delivering 100% O ₂ to a patient under present conditions are highly varied and ineffective; very few methods ever deliver 100% O ₂ to the patient. The standardized 100% O ₂ delivery system replaces the standard hospital oxygen equipment with a pressure-demand oxygen system that has the capability of delivering 100% O ₂ uninterrupted from the time of diagnosis in the emergency room to the time the patient arrives at the hyperbaric treatment facility. This report			
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19. ABSTRACT (Continued)

provides the user with all the necessary information to set up and operate the system and includes safety precautions, equipment requirements, assembly procedures, equipment operation, and care and maintenance of the system.

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USAF STANDARDIZED 100 PERCENT OXYGEN DELIVERY SYSTEM

INTRODUCTION

The United States Air Force (USAF) medical treatment facilities may potentially treat patients with decompression sickness, carbon monoxide poisoning, and other illnesses requiring administration of 100% O₂. Studies show that delivery of 100% O₂ via an aviator's mask is the most effective method short of compression hyperbaric therapy. No standard 100% O₂ delivery system exists in the U.S. Air Force. Present methods in the clinical setting are many and varied; very few methods ever deliver 100% O₂ to the patient. These non-standard systems often have inadequate oxygen sources, dilution of the 100% O₂, uncomfortable and leaking masks, or other dysfunctions. This report describes an effective 100% O₂ delivery system which is simple to order, assemble, and operate for all USAF medical treatment facilities. Instructions are detailed for personnel with limited oxygen equipment experience. The appendix contains a parts list with national stock numbers for easy procurement.

Aeromedical and medical maintenance personnel should find all necessary information in this publication for procuring, assembling, and operating this equipment for ground-level administration of 100% O₂. You may address questions or system problems to the Hyperbaric Medicine Division, USAF School of Aerospace Medicine, Brooks AFB, TX 78235-5301, or call AV 240-3281/commercial (512) 536-3281.

I. GENERAL INFORMATION

A. Safety

1. Do not use oil, grease, or other petroleum-based products on or around oxygen equipment.
2. All tools used must be cleaned for use with oxygen equipment and must be designated "for oxygen equipment use only."
3. All high-pressure bottles must be secured to prevent them from falling.
4. When transporting high-pressure bottles, insure the protective top is securely screwed down over the valve.
5. Never use equipment which is designed for a low- pressure system (450 PSI and lower) with a high-pressure system (over 450 PSI).
6. Do not smoke or use open flames around oxygen.

B. Component Parts

1. High-pressure bottle, 244 ft³ capacity, color-coded green, 1800 - 2200 PSI.
2. C-1 pressure-reducing regulator.
3. Low-pressure portable oxygen assembly, Type MA-1, color-coded yellow, 400 - 450 PSI.
4. MBU-12/P aviator's oxygen mask.
5. Low-pressure filler valve.
6. Low-pressure flex hose.

NOTE: For a complete parts list, see appendix.

II. SYSTEM ASSEMBLY PROCEDURES

A. High-Pressure Bottle

1. Secure the high-pressure bottle with a chain fastener and a clip which is securely bolted to the wall; or you may store it on an oxygen bottle cart (Fig. 1).

2. Use a 3/8 in. National Pipe Thread (NPT) male-to-male (3/8 in. NPT) fitting and attach it to the low-pressure side of the C-1 regulator (Fig. 2).

3. Attach a low-pressure flex hose with a low pressure oxygen filler valve to the C-1 regulator (Fig. 2).

4. Secure the C-1 pressure-reducing regulator to the high-pressure cylinder (Fig. 3).

NOTE: Make the flex hose long enough to reach from the high-pressure oxygen bottle to the stretcher. Connect as many flex hoses together as needed to achieve the proper length. Before the flex hoses can be connected, they must first be prepared by using a 3/8 in. NPT male-to-male connector on one end of each hose.



Figure 1. High-pressure cylinder secured to the oxygen bottle cart.

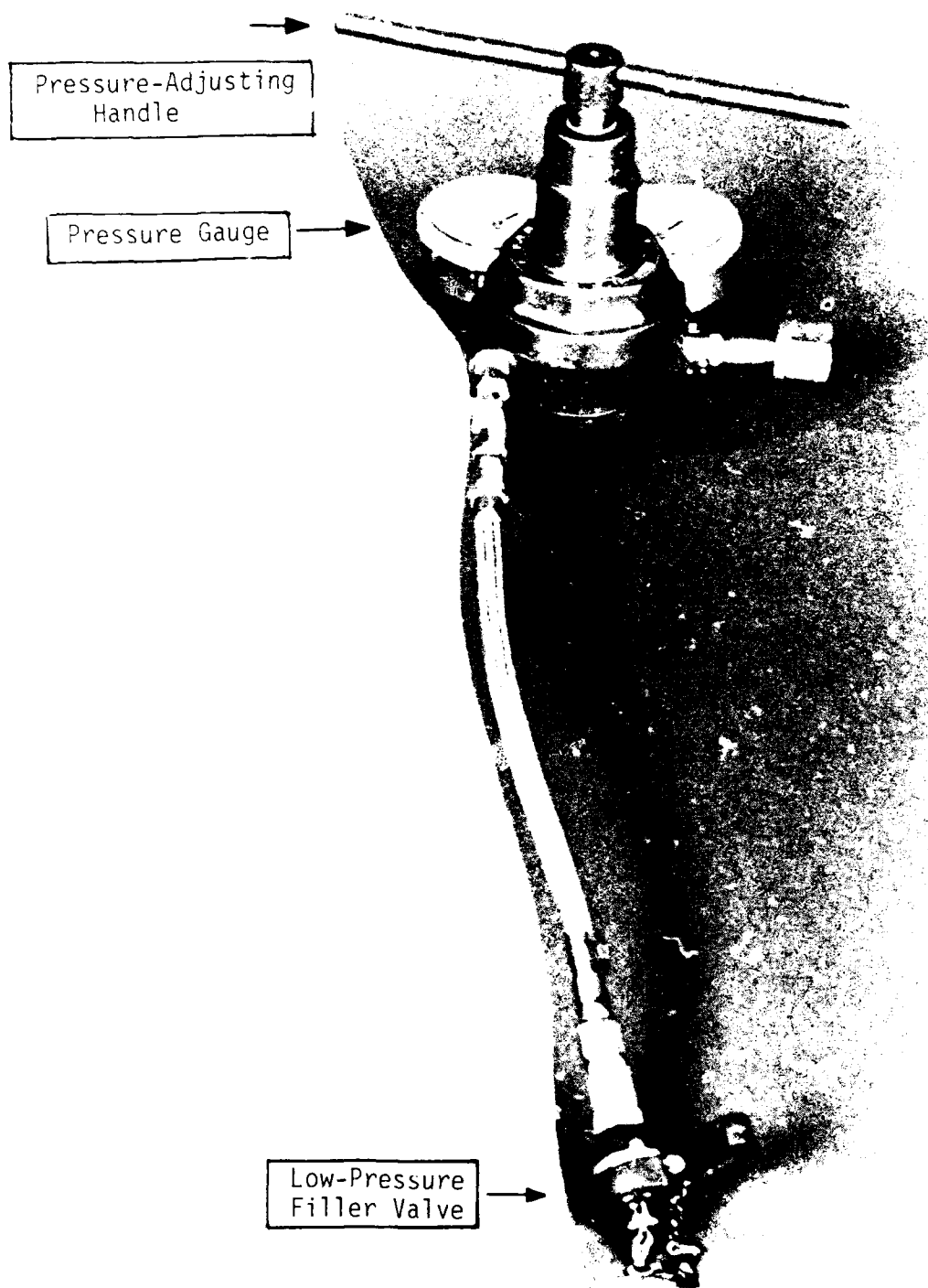


Figure 2. C-1 pressure-reducing regulator.

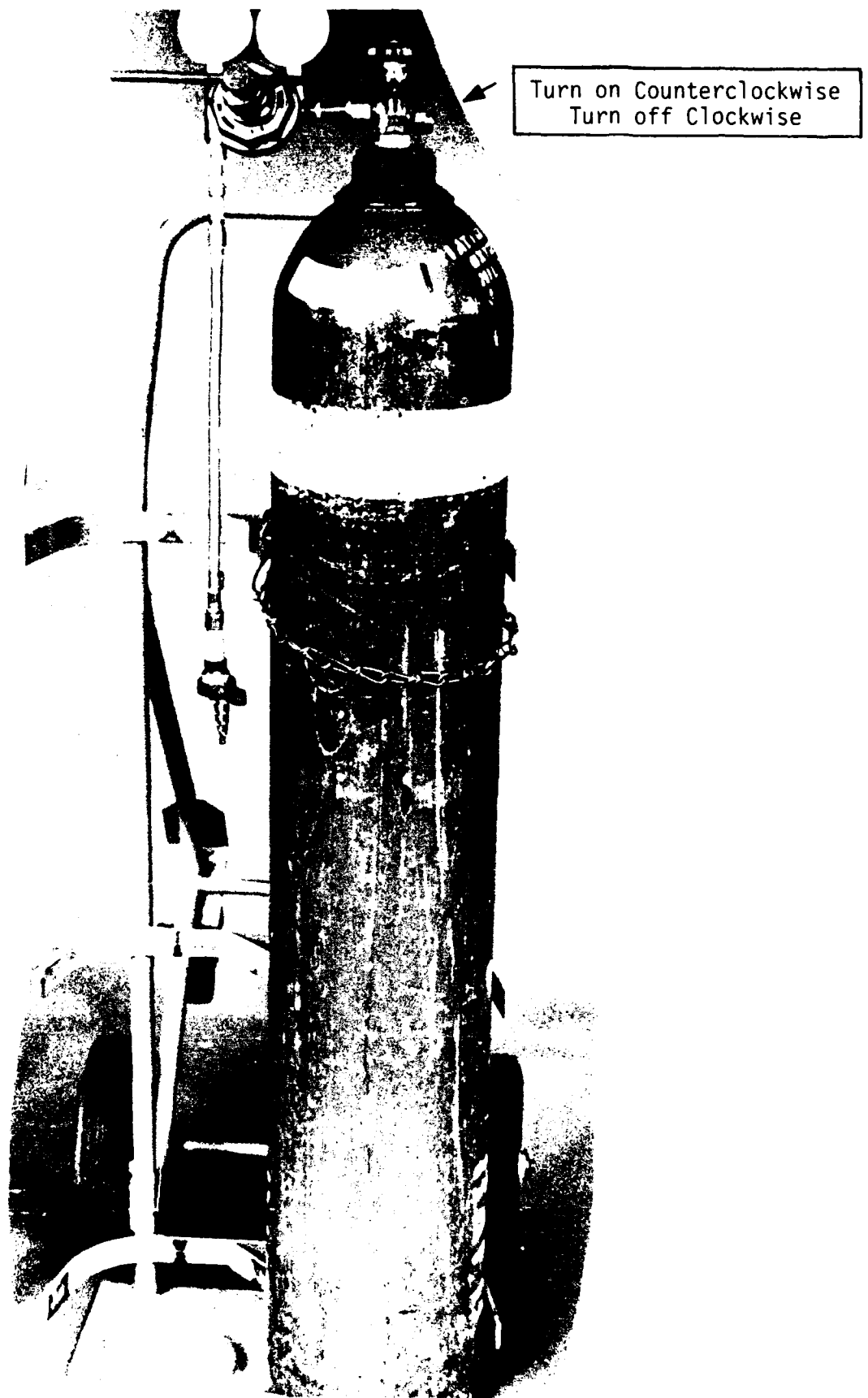


Figure 3. Attachment of the C-1 pressure-reducing regulator to the high-pressure bottle.

B. MBU-12/P Aviator's Oxygen Mask (Fig. 4)

NOTE: The new mask requires slight modification prior to use.

1. Attach connector assembly PN 232-94A to the end of the mask hose.

a. Connect the silver clip hanging from the bottom of the mask hose (Fig. 4: Part 14) to the center cross bar on the inside of the connector.

b. Insert the end of the connector, which has the string attached, into the bottom of the mask hose until it is flush with the main body of the connector.

c. Place the silver clamp (Fig. 4: Part 13) (provided) around the bottom of the mask hose where the connector assembly (PN 232-94A) is attached.

d. Use the special clamp pliers (PN 450-813) to secure the clamp.

NOTE: The mask is shipped with the combination inhalation/exhalation valve nut loose. Therefore, it is necessary to tighten it prior to use.

2. Tighten the combination inhalation/exhalation valve nut. Refer to the blowup in Figure 4 during this procedure.

a. Remove the two small screws from the communications hookup block at the top of the mask (Fig. 4: Part 6).

b. Remove the communications hookup block (Fig. 4: Parts 5 and 7).

NOTE: The communications hookup block is also connected to the microphone bracket on the inside of the mask. When you take off the outer block, the bracket on the inside will also come off. These two pieces will hook back together during reassembly.

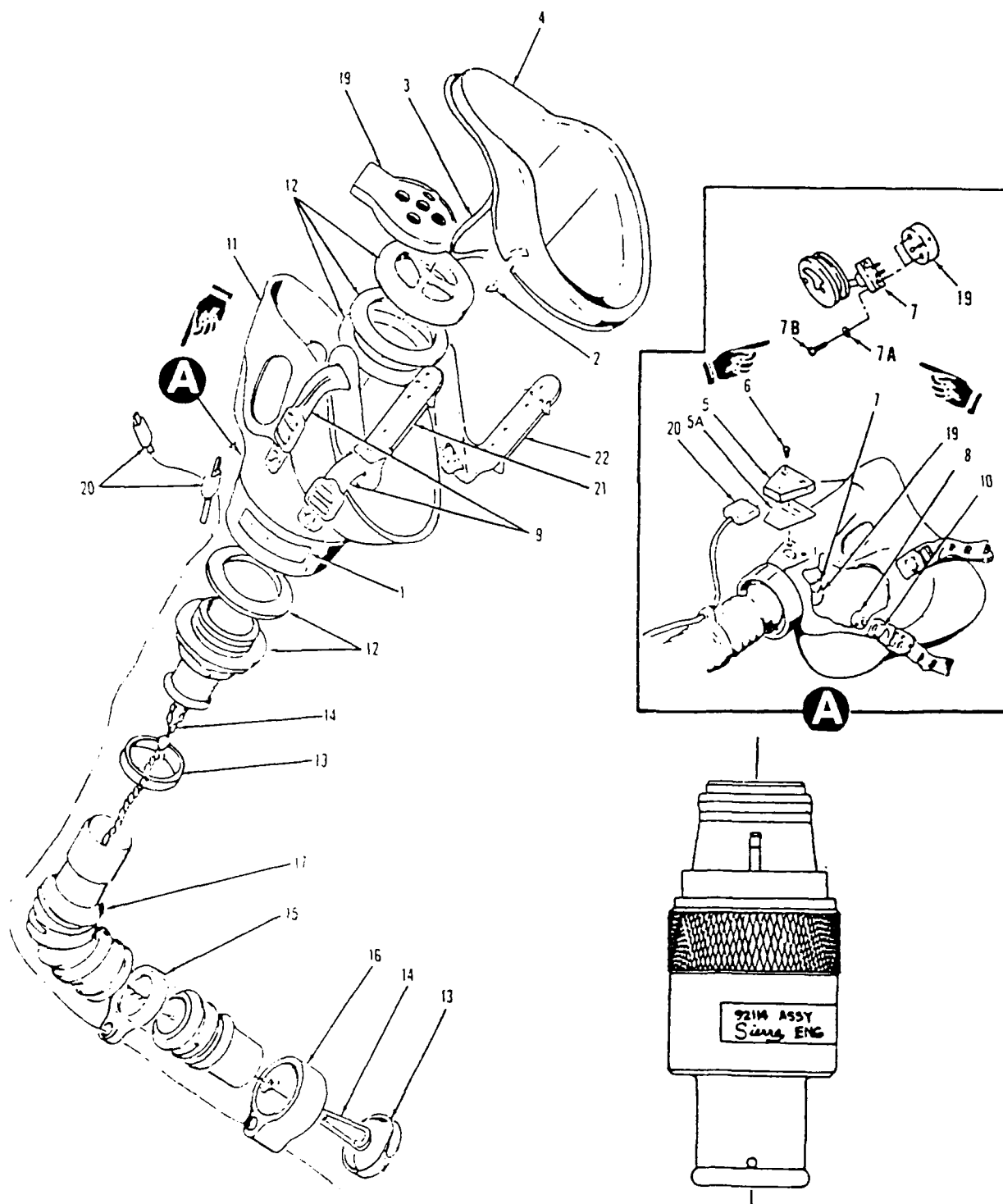
c. Use the valve wrench (PN 211-838-1) to tighten the valve nut. (Hold the oxygen delivery hose with one hand under the face form to keep it from turning while tightening the nut.)

CAUTION: DO NOT OVERTIGHTEN THE VALVE NUT; ONLY TIGHTEN IT UNTIL IT IS SNUG.

d. Reattach the communications hookup block and microphone bracket. Insure the gasket is in place on the underside of the hookup block (Fig. 4: Part 5A). These two pieces will fit together through the hard shell of the mask. Align the pins on the communications hookup block with the holes on the microphone bracket and then snap together.

e. Replace and tighten the two screws until they are snug.

(DO NOT OVERTIGHTEN; THIS MAY CAUSE THE HARD SHELL TO CRACK.)



Connector, Part No. 232-94A

Figure 4. MBU-12/P pressure-demand oxygen mask: parts location.

3. Attach the headstrap assembly (PN 249-363) to the oxygen mask (Fig. 5).

a. Cut the excess webbing from the four buckles on the face form of the mask.

b. Attach the plastic straps of the headstrap assembly to the four buckles on the hard shell of the mask. To do this, first insert the strap through the underside of the large slot on the buckle, then back down through the top of the smaller slot.

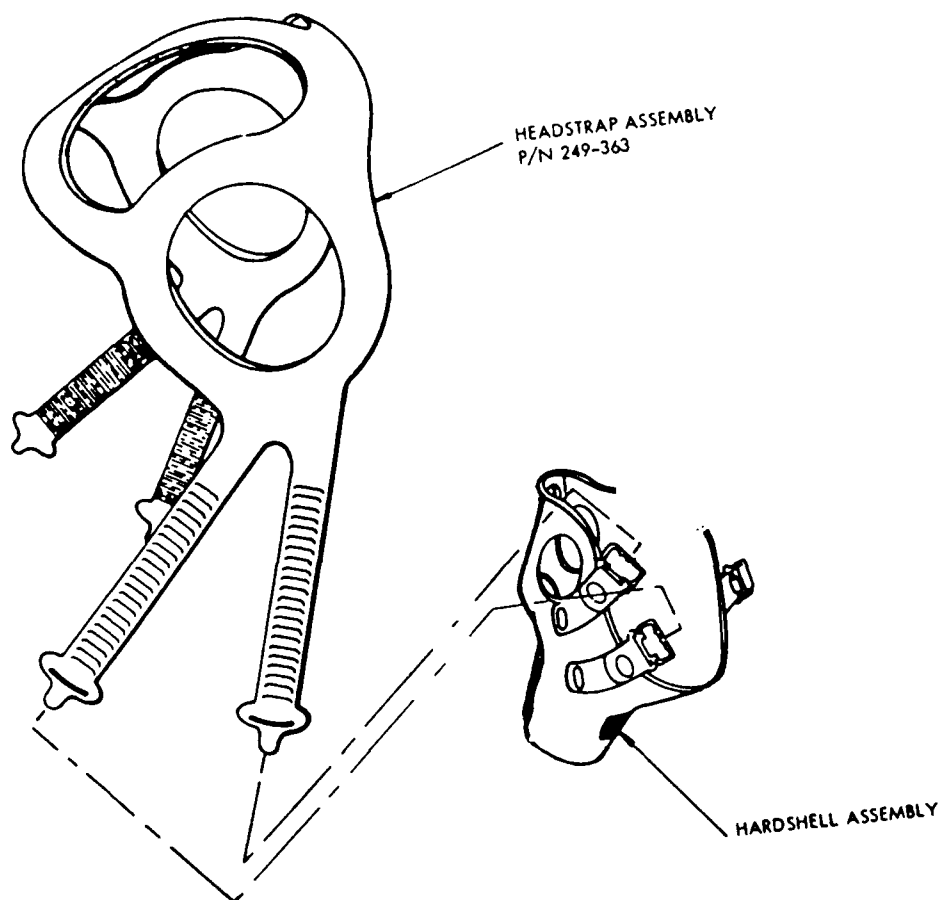


Figure 5. Attachment of the headstrap assembly.

III. OPERATING PROCEDURES (Fig. 6)

A. Turning the System On

1. Insure the pressure-adjusting handle on the C-1 regulator is turned counterclockwise until it is loose. This step will prevent a sudden burst of pressure from damaging the diaphragm of the regulator when the high-pressure bottle is turned on.
2. Turn on the high-pressure bottle. Pressure will indicate on right-hand gauge. Minimum starting pressure is 800 PSI. Bottle is empty at 200 PSI.
3. Use the adjusting handle on the C-1 regulator to adjust the pressure on the low-pressure side to 300 PSI, read on the left-hand gauge.
4. The system is now ready.

WARNING: The A-21 Pressure Demand regulator is designed to operate with a minimum pressure of 55 PSI and a maximum pressure of 450 PSI. Do not exceed this tolerance: if the pressure is too low, the regulator will malfunction; if pressure is too high, it will damage the regulator.

B. Setting Up and Using the System with a Patient

1. Select the proper size mask as described and plug it into the portable oxygen assembly.
2. Place the headstrap assembly and mask over the patient's face and head and have the patient hold them in place while you make any necessary adjustments.
3. Have the patient lie down on the stretcher.
4. Attach the low-pressure refiller valve to the silver recharging nipple on the side of the yellow bottle.
5. Secure the yellow bottle by placing a litter strap around both the patient and bottle.
6. Use other straps as needed to secure the patient.

C. Turning the System Off

1. Disconnect the low-pressure refiller valve.
2. Turn off the high-pressure cylinder.
3. Drain excess pressure by using the blunt end of a pen or other similar object to depress the small, spring-loaded pin on the inside of the refiller valve.
4. Turn the pressure-adjusting handle on the C-1 regulator counterclockwise until loose.

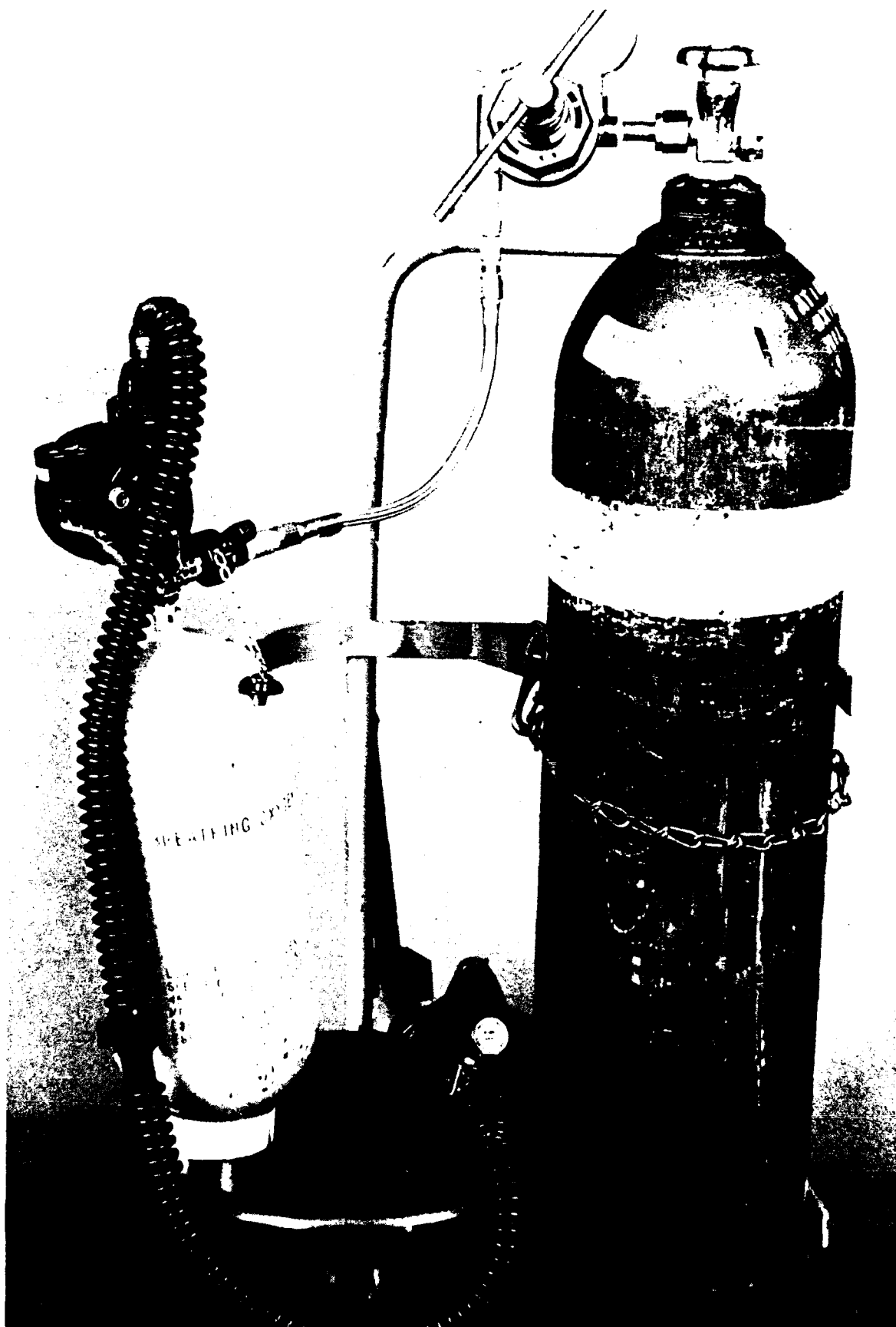


Figure 6. Hookup of equipment to the oxygen delivery system.

IV. INDIVIDUAL EQUIPMENT OPERATION

A. Yellow Walk-Around Assembly (Figs. 7, 8, and 9)

1. The low-pressure portable assembly is a very versatile piece of equipment that can be used for several different applications. It gives you the flexibility of transporting an individual from one point to the next without any interruption in breathing; it has the capability of being refilled easily; and when left attached to a refiller valve, the bottle will last for long periods of time depending on the amount of oxygen in the high-pressure bottle. The assembly consists of an A-21 pressure-demand regulator and low-pressure oxygen bottle. The regulator has no automix lever, thereby supplying strictly 100% O₂, and it has a pressure dial which allows you to manually adjust the delivered pressure. The system also has a pressure gauge and a refiller nozzle which allow it to be recharged when empty. Refiller stations are found on most transport aircraft and one is part of this standardized oxygen delivery system.

2. The bottle has an operating pressure of 100 PSI to 450 PSI and will last a variable amount of time depending on several different factors. With a starting pressure of 450 PSI the bottle may last as long as 20 min; however, this time can vary greatly if using a pressure setting, if there is a mask leak, or if the patient is hyperventilating. Be prepared to refill the bottle in any situation. You can breathe off the bottle at the same time you are refilling it.

NOTE: While transporting an individual from one location to another, it is necessary to insure the walk-around assembly has an adequate supply of oxygen to last through the transfer period. To insure the bottle has an adequate amount of oxygen, always refill it completely (450 PSI) prior to disconnecting from the main line of oxygen. The bottle can be refilled while the patient is breathing off the system.



Figure 7. Type MA-1 portable oxygen assembly (yellow walk-around bottle).



Figure 8. Operational use of the portable assembly.

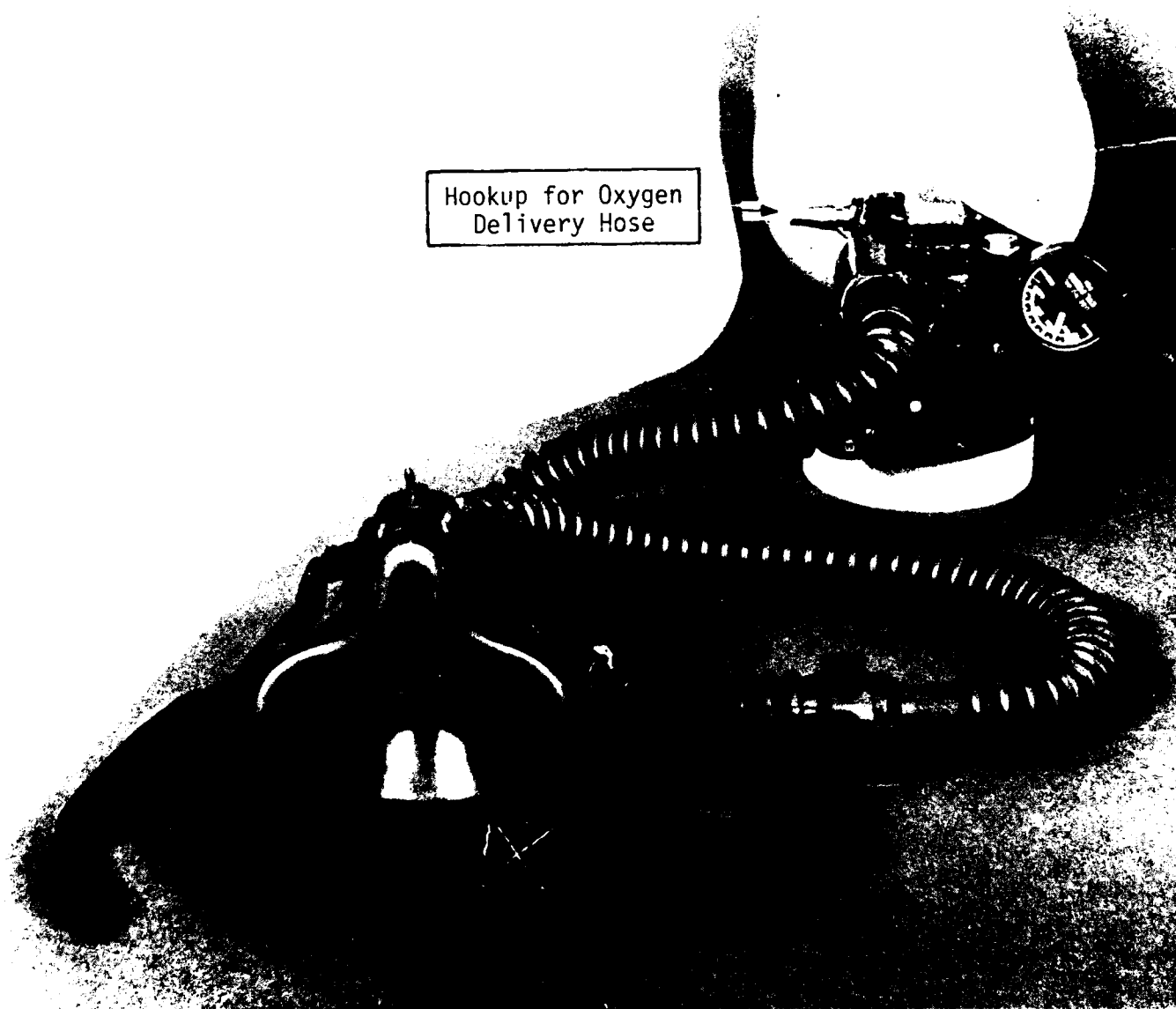


Figure 9. Hookup of the oxygen mask to the portable assembly.

B. Operating the Refiller Valve (Figs. 6 and 7)

1. Refill the bottle when it reaches a pressure of 100 PSI.
2. Turn on the oxygen delivery system as described and adjust the C-1 regulator to 300 - 450 PSI.
3. Use the low-pressure refiller valve and attach it to the silver nipple on the side of the portable assembly and refill the bottle to the pre-set pressure.
 - a. Hold the main body of the refiller valve with one hand and push down on the handle with your thumb to release the dust cover.
 - b. Press firmly into position on the silver nozzle until it clicks; it should now be locked into place. Continue refilling the bottle until you do not hear any more air being forced into it or until the pre-set pressure is attained.
 - c. Again hold the main body of the valve in one hand while pushing down on the handle with your thumb to release the valve.
 - d. Replace the dust cover.

C. Operating the MBU-12/P Aviator's Oxygen Mask

1. Operating Procedure

The MBU-12/P oxygen mask will fit the majority of people. When properly fit, the mask will contain pressure and allow it to be used for pressure breathing. Inside the mask there is a combination inhalation/exhalation valve which allows the user to inhale and exhale through the mask. It takes about 1 mmHg pressure to overcome the valve while breathing, so the mask may seem restrictive at first to the user. When air is exhaled, it will be released through the valve at the point where the oxygen delivery hose attaches to the mask. (When checking for a proper fit of the mask, the expired air being released at that point is not a leak in the system.) When the end of the hose is fitted with the connector assembly (PN 232-94A), it allows for easy hookup into the oxygen supply port on the yellow walk-around bottle. The retention device used to secure the mask to the patient is a head-strap assembly (PN 249-363), which easily attaches to the oxygen mask harness assembly.

2. Fitting Procedure

Proper mask fit is the most important step in administering 100% O₂. If the mask is not sized correctly or is improperly adjusted, it will leak. When fitting an oxygen mask, you can look at the facial features of the person and generally determine which size mask is required, but this usually takes some experience. We recommend that you use the sizing caliper as shown in the parts list to measure the individual's face to determine which size mask to use. The mask comes in four sizes: short, regular, long, and x-long.

3. Measuring Procedure (Fig. 10)

a. Use the sizing caliper to measure from the last indentation on the bridge of the nose to the bottom of the chin; the caliper will indicate which size mask to use.

b. If a measurement falls between two sizes, choose the smaller.

NOTE: Once you have selected the mask, have the individual hold it up to the face; a properly fit mask will rest on the upper bridge of the nose and will fit around the bottom of the chin.

Sizing Chart	
Size	Face Length (inches)
Short	4.0 - 4.4
Regular	4.4 - 4.8
Long	4.8 - 5.1
Extra-Long	5.1 - 5.5



NOTE: For individuals with borderline face lengths, select the mask that feels the most comfortable and most closely follows the contours of the face.

Figure 10. Measuring face length with the sizing caliper.

4. Adjusting Procedure

a. Turn on oxygen system as described in Section III. A.

b. Connect mask hose to the regulator supply port on the yellow bottle.

c. Loosen straps and place the harness over the patient's head. It is helpful if you have the patient hold the mask in place while you make the necessary adjustments.

d. Tighten the straps until the mask is snugly fit. A properly fit mask will stay in place by itself. However, do not overtighten the mask to the point where it is uncomfortable.

e. Test for a good mask seal:

1) Turn the regulator on the yellow walk-around bottle to the 30-M setting.

2) Have the patient take several breaths and then take a deep breath and hold it; there should be no leaks felt around the face form of the mask.

3) If there is a leak, readjust the mask and try again. If a leak persists, try using a different size mask.

V. USE OF THE PORTABLE OXYGEN ASSEMBLY IN AN AMBULANCE

A. Concept of Operation

To get away from logistical problems of having to use several low-pressure oxygen assemblies to transport a patient, you may set up an oxygen system inside the ambulance similar to the one previously described.

This system (Fig. 11) uses the high-pressure oxygen cylinder in the ambulance as the main supply of oxygen. A low-pressure flex hose attached from the cylinder to the portable assembly will continuously supply the portable assembly with oxygen. The system will give you greater flexibility in transporting a patient and will alleviate the need to use several portable oxygen bottles. Personnel can set up and dismantle the system within a few minutes, use it only when needed, and can easily store it, thus allowing the use of the normal ambulance oxygen system.

B. Components Required

1. C-1 Pressure-reducing regulator
2. Low-pressure portable assembly
3. Low-pressure flex hose with 3/8-in. NPT quick-disconnect connectors
4. Aviator's oxygen mask
5. Low-pressure refiller valve

C. Setting Up and Operating Procedures

1. Assembling Low-Pressure Flex Hose (Fig. 12)

a. Determine the required length of flex hose. Use Figure 12 as an example.

b. Connect the lengths of flex hose. At one end attach the low-pressure refiller valve; at the other end connect a 3/8-in. female quick-disconnect fitting.

c. Attach a single length of flex hose to the output side of the C-1 regulator; then connect a 3/8-in. male quick-disconnect fitting to the opposite end.

NOTE: Use of the quick-disconnect fittings is optional. If not used, make a single length of hose with a low-pressure filler valve attached at one end.



Figure 11. Use of the portable assembly in an ambulance.

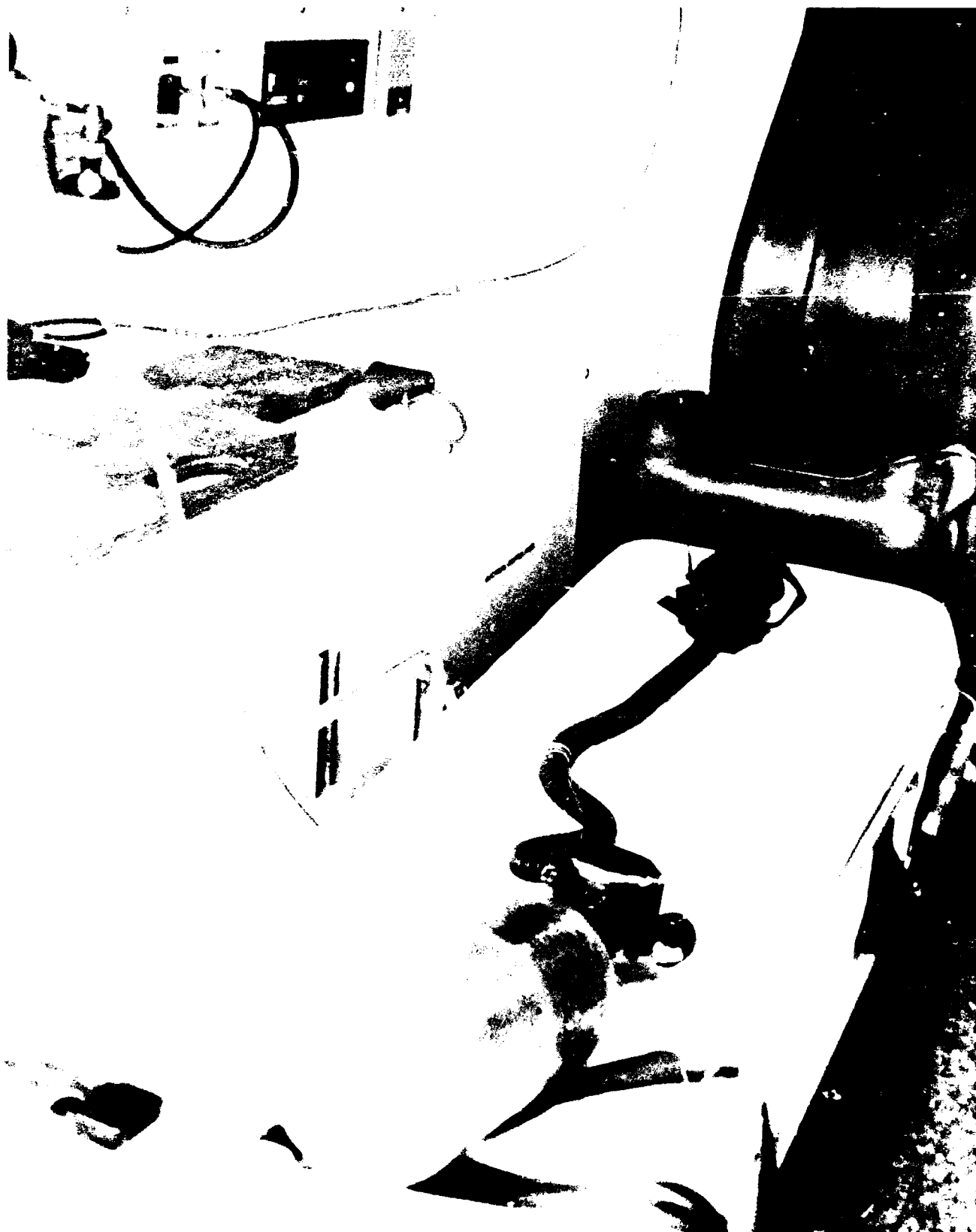


Figure 12. Setup of equipment within the ambulance.

2. Attaching the C-1 Regulator (Fig. 13)

- a. Disconnect the regulator assembly that is in place on the high-pressure cylinder and store it next to the high-pressure bottle.
- b. Attach the C-1 regulator; insure the pressure gauges are facing towards the interior of the ambulance. This step will allow the system to be turned on and monitored from the interior of the ambulance.
- c. Place the flex hose through the opening to the interior of the ambulance and connect the flex hose via the quick-disconnect fittings.

3. Turning the System On

- a. Turn the adjusting handle on the C-1 regulator counter-clockwise until it is loose.
- b. Turn on the high-pressure cylinder.
- c. Adjust the low-pressure side of the C-1 regulator to 300-450 PSI.

4. Operating Procedures

In general, the following procedures will aid you in operating the system (Figs. 12, 13, 14):

- a. Select the proper size mask as previously described and plug it into the portable oxygen assembly.
- b. Place the headstrap assembly and mask over the patient's face and head and have the patient hold them in place while you make any necessary adjustments.
- c. Have the patient lie down on the stretcher.
- d. Attach the low-pressure refiller valve to the silver recharging nipple on the side of the bottle.
- e. Secure the bottle by placing a litter strap around both the patient and bottle.
- f. Use other straps as needed to secure patient.

5. Turning the System Off

- a. Disconnect the low-pressure refiller valve.
- b. Turn off the high-pressure cylinder.
- c. Drain excess pressure by using the blunt end of a pen or other similar object to depress the small, spring-loaded pin on the inside of the refiller valve.

d. Turn the pressure-adjusting handle on the C-1 regulator counterclockwise until the handle is loose.

e. Disconnect the low-pressure flex hoses.

f. Remove the C-1 regulator from the high-pressure cylinder and replace it with the standard ambulance regulator.

6. Storage:

a. When not in use, all equipment items can easily be stored within the ambulance.

b. Store all pieces of equipment (except the portable assembly) in plastic zip-lock bags. Store the oxygen mask separately from the flex hose and the regulator.

c. The portable oxygen assembly may be secured to the stretcher with straps or stored in a similar manner.

VI. CARE AND MAINTENANCE

A. Store all oxygen equipment in a clean, dry area. Excessive moisture or dirt may adversely affect the operation of the equipment. You should store the oxygen masks separately in zip-lock bags.

B. Clean the oxygen mask every 30 days and after each use. To clean the mask, use an alcohol prep pad or a gauze pad soaked in a solution of 70% isopropyl alcohol and wipe the interior and exterior of the mask. Be sure to clean all areas of the face form.

C. Do an operational check of the system every 30 days.



Figure 13. Hookup of the C-1 pressure-reducing regulator to the ambulance oxygen bottle.

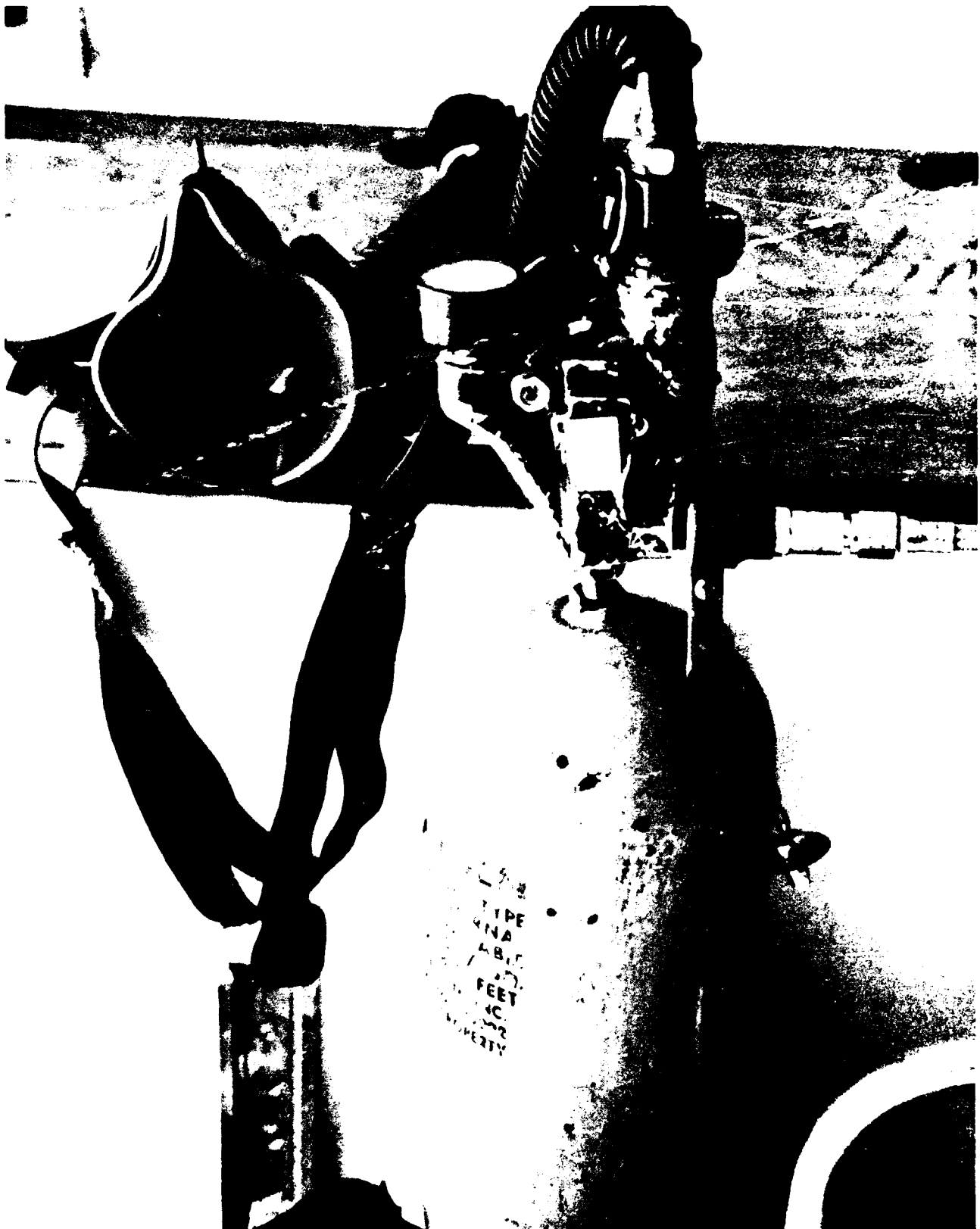


Figure 14. Attachment of the oxygen supply line to the portable assembly.

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1. 15X-1-1, Technical Manual, Oxygen Equipment, Secretary of the Air Force, 1 August 1981.
2. 15X5-3-6-1, Technical Manual, Operation, Fitting, Inspection and Maintenance Instructions with Illustrated Parts Breakdown, MBU-12/P Pressure Demand Oxygen Mask, Secretary of the Air Force, 1 April 1981.
3. 15X5-4-1-101, Technical Manual, Oxygen Mask to Regulator Connector Assemblies, Secretary of the Air Force, 15 January 1976.
4. 15X6-4-3-1, Technical Manual, Operation and Maintenance Instructions Type MA-1 Portable Breathing Oxygen Cylinder and Regulator, Secretary of the Air Force, 26 November 1962.

APPENDIX

PARTS LIST

	QUANTITY REQUIRED	SUPPLY CODE
MBU-12/P Oxygen Mask		
1. Short: 1660-01-081-9157LS	1	XF3
2. Regular: 1660-01-073-7595LS	1	
3. Long: 1660-01-073-7596LS	1	
4. X-Long: 1660-01-081-2368LS	1	
Regulators		
*1. C-1 Regulator: (pressure-reducing regulator) 4820-00-821-2649	1	XD2
2. Type MA-1 portable assembly (yellow walk-around bottle) NSN 1660-00-305-0561.	1	
Hoses		
		XB3
*1. Low-pressure flex hose: 1660-00-055-6795	8 (may vary)	
*2. Low-pressure filler valve: 1660-00-699-0533	1	
Connectors and Special Parts		
		XB3
1. Connector assembly: (mask to regulator) PN 232-94A; 1660-00-959-2150	1 for each mask	
2. Headstrap assembly (oxygen) 1660-00-020-4482	1 for each mask	
3. Mask Sizing Caliper: 1660-01-216-3277	1	

QUANTITY
REQUIRED

Connectors and Special Parts (Continued)

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|--|---|
| 4. Valve Wrench: 5120-01-094-4502 | 1 |
| 5. Upper and Lower Hose Clamp Pliers: 5120-01-073-4187 | 1 |

NOTE: The 3/8-in. male fittings that attach the lengths of flex hose and the quick-disconnect fittings are not available through the normal supply system and you may have to purchase locally.

*NOTE: The quantities shown are for one system only. If you set up two oxygen delivery systems, one in the ambulance and one in the emergency room, double the quantities of the items marked with an asterisk. All items of both systems are interchangeable.