NAVY EXPERIMENTAL DIVING UNIT

DEPARTMENT OF THE NAVY
NAVY EXPERIMENTAL DIVING UNIT
PANAMA CITY FLORIDA 32401

NAVXDIVINGU REPORT 11-75

EVALUATION OF THE DRAEGER LAR V PURE OXYGEN SCUBA

By

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8 OCTOBER 1975

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The Draeger LAR V scuba is a pure oxygen self contained underwater breathing apparatus designed and manufactured in the Federal Republic of Germany. The scuba is completely closed circuit and incorporates a demand type oxygen supply. Gas purification is accomplished by means of a refillable CO2 absorbant canister. The LAR V works on pure oxygen, and is, therefore, depth and time limited as defined in the U.S. Navy Diving Manual. A maximum diving time of three and one half hours

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can be expected depending on the oxygen consumption and work rate of the individual diver.

This evaluation was conducted to determine safe operational capabilities and limitations of the LAR V with respect to training and operational use by Naval Special Warfare Divers. It was found that the LAR V is equal to, and in many respects superior to the U.S. Navy Emerson scuba. The Draeger incorporates many inherent design features which makes it easier to pre/post dive and to maintain than the Emerson closed circuit scuba.

Test were conducted by the Navy Experimental Diving Unit, Special Operations Department during the period of July 1975 through September 1975.

Unmanned testing was conducted at the Navy Experimental Diving Unit, Panama City, Florida and the manned test at the U.S. Naval Station, Roosevelt Roads, Puerto Rico and U.S. Naval Amphibious Base, Little Creek, Virginia. LTJG Howard N. PAULSEN, USN, Project Officer and BT1(DV) Ronald E. JARVI, USN of the NAVXDIVINGU. Operations were conducted using services of Commanding Officer, Underwater Demolition Team TWENTY-ONE, Commanding Officer, Underwater Demolition Team ELEVEN, Commanding Officer, Underwater Demolition Team TWELVE, Commanding Officer SEAL Team TWO, and Officer in Charge, Naval Special Warfare Group TWO, Task Unit - Caribbean.

ABSTRACT

The Draeger LAR V is a pure oxygen self contained underwater breathing apparatus designed and manufactured in the Federal Republic of Germany. The scuba is completely closed circuit and incorporates a demand type oxygen supply. Gas purification is accomplished by means of a refillable CO2 absorbant canister. The LAR V works on pure oxygen and is, therefore, depth and time limited as defined in the U.S. Navy Diving Manual. A maximum diving time of three and one half hours can be expected depending on the oxygen consumption and work rate of the individual diver.

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LIST OF REFERENCES

(a) U.S. Navy Diving Manual, NAVSHIPS 0994-001-9010

(b) NEDU ltr Ser 415 of 21 July 1972 (NOTAL)

(c) NAVSEA ltr 3960/2000/2 Ser 531/00C of 25 April 1975

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SECTION 1

DESCRIPTION OF "DRAEGER LAR V" CLOSED CIRCUIT OXYGEN SCUBA

101. General

The Draeger LAR V is a closed oxygen scuba which provides oxygen to the diver via a demand valve or a manual bypass valve. Carbon dioxide is removed from the breathing system when it passes through the CO2 absorbent canister which holds approximately 5.95 lbs. of baralyme or 5.56 lbs. of sodasorb. The Draeger LAR V when fully charged with gas and CO2 absorbent, weighs approximately 25.5 lbs. When fully charged and installed in its carrying case, it weighs approximately 37 lbs. (figures 1, 2 and 3). Dimensionally, the Draeger unit is 16.9 inches long, 11.8 inches wide, and 6.7 inches thick. The Draeger LAR V is secured to the divers chest by a belt buckle type harness arrangement and is able to be rigged for quick disconnect. The Draeger LAR V is manufactured by:

Draegerwerk, Lubeck
24 Lubeck, P.O. Box 1139
Moislinger Allee 53/54

102. Major Components

The major components of the Draeger LAR V are the equipment case housing, the pneumatic assembly, the CO2 scrubber assembly and the breathing system.

103. Equipment Case Housing

The rebreather is enclosed in the equipment case housing, a single outer shell of fiber-glass reinforced polyester to which the components are secured (figure 4).

104. Pneumatic Assembly

The high pressure gas for the unit is contained in a 1.5 liter galvanized steel cylinder, which has a working pressure of 200 BAR or 2940 psi (approximately 300 liters) (figure 5). A pressure reducing regulator reduces the high pressure gas to a constant 66.15 psi over bottom pressure. The working pressure side of the regulator is protected by a pressure relief valve which is designed to relieve excessive pressure. A pressure gauge is encased on the top of the equipment case housing (figure 6) which indicates from 0-300 Kp/cm2 (0-4410 psig). An illuminative material is provided on the gauge needle, between 0-514.5 psig and at the 2940 psig mark, which provides the diver with a night-time gas supply read out (figure 6). Regulated gas is piped from the regulator to

the demand valve, located in the equipment case housing. Integral to the demand valve are the bypass gas valve and the sensativity adjustment, which can be adjusted from 10 to 30 CM H20 by the diver during the pre-dive set up (figures 2 and 4).

105. CO2 Scrubber Assembly

The CO2 canister assembly located in the lower portion of the equipment case housing contains approximately 5.95 lbs. of baralyme or 5.56 lbs. of sodasorb. It consists of; canister securing wing nut, a water trap, canister main body and canister cover. Water seals are effected by a flat gasket and "0" rings (figures 7 and 8).

106. Breathing System

The breathing system is composed of the mouthpiece T-tube assembly, the inhalation/exhalation hoses, the inhalation/exhalation check valves and the breathing bag (figures 9 and 10).

The mouthpiece T-tube assembly is composed of a plastic housing, a surface and dive valve, a vent opening for surface purging and a rubber keeper worn in the back of the head or neck for security.

The inhalation/exhalation hoses contain the check valves and necessary metal and plastic fittings for closing the breathing loop.

The breathing bag contains 8.2 liters of gas when fully inflated. It is made from a fabric type material rubberized on both sides. Its location, when installed, is shown in figure 10.

107. Functional Description

The functional description of the Draeger LAR V is illustrated in figure 11. From the oxygen cylinder, (1) the high pressure oxygen passes through the cylinder on/off valve (2) to the pressure reducing regulator (3) where the high pressure gas is reduced to a working pressure of 66 psig over bottom setting and then piped to the demand regulator which is adjustable from 10-30 CM H20 (4). High pressure gas is also piped to the 0-300 BAR pressure gauge where the diver can monitor his gas pressure. The demand regulator is secured to the equipment case housing and is fitted to the breathing bag and functions each time the bag is emptied on inhalation. On inhalation, the inhalation check valve opens (7) and the diver receives gas from the CO2 scrubber, if insufficient gas is available for the divers requirements, the demand valve actuates, adding more oxygen to the system. As the diver exhales, the exhalation check valve opens, the inhalation check valve closes and the exhaled gas flows through the exhalation hose (9) to the breathing bag, it is then filtered through the CO2 scrubber with tne next inhalation. During descent or if the diver is purging his unit, the diver merely depresses the demand bypass valve (figure 2).

SECTION 2

PREVIOUS WORK AND BACKGROUND

201. The oxygen shallow water diving apparatus model LAR V scuba is manufactured by Draegerwerk Lubeck, 24 Lubeck, P.O. Box 1339, Moislinger Allee 53/54, Federal Republic of Germany.

202. Historically, the U.S. Navy has had relatively little knowledge concerning the use or design of foreign produced scubas. There are two primary reasons for this. First, as a general rule, there has almost always been domestic equipment capable of meeting the needs of the navy. Secondly, the "Buy American Act" makes it very difficult to buy foreign made equipment, especially when similar (but not necessarily equal) and more costly equipment of domestic manufacture is available. U.S. Navy experience with Draeger equipment has been generally limited to the LT LUND 2 and LAR III closed circuit oxygen scuba. The LT LUND 2 oxygen scuba was used in quantity at one time by U.S. Navy UDT Teams. It was superceded by the standard USN closed circuit oxygen scuba (the Emerson) beginning about 1963. The LAR III was tested successfully by the Navy Experimental Diving Unit and the results are given in NAVXDIVINGU REPORT 11-74 dated 5 May 1974.

203. General USN views regarding Draeger equipments have been summarized as follows.

a. Draeger is one of the few diving equipment manufacturers who supplies a complete line of diving equipment, from swim fins to complete saturation diving systems.

b. Draeger equipment is generally characterized by "close attention to engineering details, optimum selection of materials, and excellent quality control". Draeger equipment is also generally of simple mechanical design without the multiplicity of back-up systems found in much U.S. gear. Draeger's simple mechanical designs and care in manufacture result in generally highly reliable equipment at reasonable prices.

c. Draeger equipment is designed to contemporary European design standards and consequently it does not meet many U.S. Military Specification Standards, particularly the standard requiring monel in oxygen systems.

d. Although not available from one single supplier, there is available domestic equipment equivalent to almost every item in the Draeger line. In particular, Draeger and U.S. Deep Sea gear are almost identical.

NOTE: Paragraphs 202 and 203 above are excerpts of information contained in NEDU ltr Ser 415 of July 21 1972 (NOTAL) to the CNO, Attention

CAPT Wendell E. WEBBER (OP-324). This letter had heavy reference to "A Survey of Heavy Duty Deep Sea Diving Equipment", USN Supervisor of Diving Research Report No. 12-70, 15 November 1970 (NOTAL).

204. The evaluation discussed within this report was requested by the Commander, Naval Sea Systems Command ltr Ser 531/OOC of 25 April 1975. NAVSEA Code OOC specifically requested that NEDU conduct an evaluation of the LAR V scuba to determine parameters for its safe use by UDT and SEAL Teams personnel in joint cross training operations with combat swimmers of foreign navies.

205. Two units of the Draeger LAR V oxygen scuba were purchased by NAVSEA OOC from Draegerwerk, Lubeck.

206. As a point of interest, it may be beneficial to record the usuage and distribution of the Draeger oxygen scubas in Europe. Table 2-1 sets forth a listing provided by Draegerwerk.

TABLE 2-1

Greece	60 units
Turkey	40 units
Cyprus	20 units
Iran	40 units
Norway	10 units
Netherlands	50 units
Germany (FRG)	50 units
U.S. Army, DET A, Special Forces	10 units

SECTION 3

PURPOSE OF THE PROJECT

301. The primary purpose of the project was to conduct an evaluation of the LAR V scuba to determine parameters for its safe use by Naval Special Warfare Divers. The LAR V was not tested for service approval nor was the test program so structured since COMOPTEVFOR had no participation.

302. Due to present Naval Special Warfare commitments in Europe, they are frequently exposed to and have opportunity to train with the LAR V through cross/joint efforts. For such reasons, it was the desire of UDT and SEAL Teams to have the LAR V on its material allowance list, thereby affording Naval Special Warfare divers the opportunity to become more familiar with the LAR V prior to European deployments. An additional purpose of the project, therefore, was to evaluate the LAR V for possible limited procurement by UDT and SEAL Teams.

303. In general, tests of the Draeger LAR V oxygen scuba were conducted to objectively and subjectively:

a. Assess operational performance of the units when utilized by various teams of divers in the open-sea environment.

b. Assess the performance of the units by means of controlled bench breathing tests.

c. Determine and list operational parameters for safe use of the equipment by USN Special Warfare divers.

304. Specific objectives of the tests were to:

a. Conduct a minimum of 40 hours open-sea bottom time on each of the two units available, a total of 80 hours being the final objective.

b. Conduct wet pot breathing tests at the Navy Experimental Diving Unit, Panama City, Florida.

c. Assess primarily through subjective means, the reliability and maintainability of the LAR V.

SECTION 4

CONDUCT OF THE TESTS, RESULTS, AND DISCUSSION

401. General

The NAVXDIVINGU evaluation of the Draeger LAR V scuba was conducted during the period 23 July through 26 September 1975. Tests were conducted at the U.S. Naval Station, Roosevelt Roads, Puerto Rico and at the Navy Experimental Diving Unit, Panama City, Florida. Two units of the Draeger LAR V oxygen scuba were available for evaluation. Both units were evaluated in their marketable configuration and no modifications were incorporated. The single variable was that both baralyme and sodalime was utilized as the CO2 abosorbent. Sodalime is in common usage throughout Europe but not yet authorized for U.S. Navy use.

402. Throughout the course of the evaluation series the LAR V was, at least subjectively, considered superior to the U.S. Navy closed circuit oxygen scuba (i.e. the Emerson). No specific test dive team was utilized during the conduct of this project. Deployed Underwater Demolition and SEAL Team platoons were utilized to obtain many of the desired tests. A very broad cross-section was, therefore, able to utilize and subjectively compare the LAR V with the Emerson. Evaluation and testing was accomplished by both objective and subjective means.

403. Design and operational criteria concerning the Draeger LAR V oxygen scuba are set forth in Table 4-1.

TABLE 4-1

CHARACTERISTICS

Weight in Air w/Baralyme	25.45 lbs.
Weight when housed in carrying case	37 lbs.
Length	16 3/4"
Width	11 3/8"
Thickness	6 1/2"
Buoyancy	Neutral
02 Cylinder contains	1.5 liter/.05 cu. ft.
Fill pressure	200 BAR/2,940 psi
Material	Steel
Type canister	Refillable
Baralyme required	5.95 lbs. APPROX
Sodasorb	5.56 lbs. APPROX
Canister Duration 70° water	3.5 hrs. (plus)
Canister Duration 35° water	1.55 hrs. (plus)
Pre-dive Time (est)	10 min.
Post-dive Time (est)	10 min.

Breathing Bag Volume	8.2 LITERS
Type Gas Supply to Diver	Demand

404. Summary of Tests

A summary of the test phases accomplished is provided in Table 4-2.

TABLE 4-2

SUMMARY OF TESTS

TEST	DATES	LOCATION
Open-sea Swims	04 AUG - 21 AUG 1975	NAVSTA, Roosevelt Roads, Puerto Rico
Breathing Resistance and CO2 Analysis	23 JUL - 25 JUL 1975 15 SEP - 19 SEP 1975	NAVXDIVINGU Panama City, FL

405. Open-sea Tests

a. Purpose. To complete a minimum of 40 hours total operational bottom time on each of the two units, a combined total of 80 hours being the test objective. To evaluate the equipment in the natural environment to determine the parameters for safe use.

b. Procedure. Much of the testing was accomplished by various UDT and SEAL personnel who were on operational or training deployment. Classroom instruction preceded the in-water phase and included functional description and pre-dive/post dive set up methods. A controlled in-water training period was conducted inside a flooded dry dock to allow the divers to trim and become familiar with the units. All at sea swims were conducted at a selected water sight in proximity of the test facilities. Water depths varied between 10 and 29 feet. Maximum test and dive depth was 25 feet. Each diver wore a U.S. Navy MK III life jacket, compass, depth gauge, and watch. Wet suit tops were optional. A swimmer buddy line was utilized to join the swim pair with a swimmer buoy attached to assist the safety boat in monitoring the swimmers. Tests conducted were planned objectively on a daily basis.

c. Analysis. It is safe to state that from a subjective point of view, every diver who used the Draeger LAR V indicated a preference over the USN oxygen scuba (i.e. Emerson). The design characteristics of the LAR V make it inherently easy to maintain. Meteric tools are required and a kit is supplied with each unit. The reliability was exceptional if judged by the percentage of successful missions (tests) completed. Only one of the 62 dives was aborted. This was caused by a unit flood out do to diver pre-dive error rather than equipment malfunction. It was the opinion of the test director and supervisors that the Draeger LAR V was,

in most instances, a superior diving apparatus. However, a more objective analysis does show some small short comings which must be considered and which are not always readily visible to the operator. A total project analysis will be provided in Section 6.

d. Results and Discussions. The overall test indicated that the Draeger LAR V oxygen scuba is both a safe and reliable diving apparatus.

Although the NAVXDIVINGU was not testing the LAR V for modification and/or improvements, many of the comments below are set forth for record purposes.

(1) The breathing flow cycle in the LAR V is the direct reverse of USN scubas (i.e. inhale from left - exhale to right).

(2) All check valves in the LAR V are integral to the hoses.

(3) Disimilar hose fittings prevent incorrect connection of hoses.

(4) It was discovered that divers who jocked-into the LAR V very tightly had breathing resistance problems. By having the breathing bag too tight against the chest, the bag becomes depressed thereby reducing total volume and inducing exhalation resistance. Divers should allow the LAR V to hang loose.

(5) The oxygen gas cylinder is not Department of Transportation (DOT) approved. This did not have an adverse impact on the conduct of the tests but is set forth as a matter of record that the bottles have no blowout plug/disc.

(6) The U.S. Navy MK III life jacket is useable with the LAR V, however it is awkward. The standard UDT life jacket is not at all useable with the LAR V. The Draeger buoyancy compensator was utilized on many of the dives and was satisfactory, but needs further test and evaluation.

(7) Divers exhibited some minor problems acclimating to a chest worn unit vice a back worn unit. This was considered a training and familiarization problem.

(8) The LAR V does not have a pressure relief valve to protect the closed breathing system from rupture during pre-dive dip testing. If the unit is inadvertently over inflated during the pre-dive, damage could occur. The USN Emerson scuba does incorporate such a system. Divers using the LAR V should be cautioned about over inflation of the scuba.

(9) A test kit should be provided to enable the diver to check and adjust the regulator over bottom pressure and the demand valve cracking pressure.

(10) A high pressure oxygen charging fitting is needed to adapt the Draeger LAR V meteric bottle threads to U.S. national pipe thread.

408. Swimmer Delivery Vehicle Operations

a. Due to the almost identical size and configuration of the Draeger LAR III to the LAR V, we are concurrent with opinion that the LAR V is acceptable for usage with current fleet SDV models.

409. Wet Pot Tests(Unmanned)

a. Purpose. To measure the ΔP required to give the diver adequate ventilation under varied respiratory minute volumes (RMV's). To determine CO2 scrubber canister duration at 10 - FSW while packaged with baralyme in warm water (75°F) and cold water (35°F).

b. Procedure. Tests were conducted by Mr. T. W. CETTA, the resident NAVXDIVINGU Test Engineer and the NAVXDIVINGU Test and Evaluation Department. The LAR V was set up in Chamber "C" and secured in the prone position to simulate the normal diving position. The apparatus was then taken to the desired depth. A pressure transducer was used to monitor differential pressure in the mouth piece. Gas sampling lines were installed in both the mouth piece and the exhalation hose. The lines were joined to a Beckman LB1 CO2 analyzer. Samples were taken and recorded at 30 minute intervals until a 1.0% CO2 surface equivalent was reached.

SECTION 5

HUMAN FACTORS

501. No specific tests were originally established in the area of human factors, however, several obvious characteristics inherent to the Draeger LAR V were noted during the evaluation which are not common to USN equipments.

a. Purpose. To assess and set forth human factor characteristics which must be recognized by all U.S. Navy personnel using the LAR V scuba.

b. Procedure. This assessment was conducted by means of interviews and observation throughout the test series and also by questionnaire.

c. Results and Discussion. Some of the results and discussion areas were set forth in Section 4 and are repeated for amplification purposes only.

(1) All personnel diving the Draeger LAR V must be CAUTIONED that the INHALATION/EXHALATION flow is the direct REVERSE of USN scuba.

(2) Some divers had difficulty working with equipment and viewing auxillary equipments. This is primarily a training problem. The LAR V scuba is worn on the divers chest whereas all USN scuba are worn on the divers back. Continuous use and familiarization with the LAR V would resolve these types of problems.

(3) The U.S. Navy standard MK III life jacket is awkward when utilized with the LAR V. This problem cannot be corrected with U.S. Navy equipments. Draeger does manufacture a life vest which is compatible with the LAR V and utilized by the German UDT. Tests were conducted on this life jacket but further tests are needed and will be ran.

(4) The see-view type pressure gauge does not indicate pounds per square inch (psi). Due to the use of the Metric System in Europe, pressure is listed in Kilopons per square centimeter (kp/cm2). Personnel diving the apparatus should be instructed on the proper reading of this vital gauge. A conversion factor of 14.22 x actual gauge reading equals psig.

SECTION 6

PROJECT SUMMARY AND ANALYSIS

601. It is the NAVXDIVINGU position that the Draeger LAR V scuba is a safe and reliable diving apparatus and by operational comparison is equal to and in some instances has design features which make it superior to the U.S. Navy Emerson scuba. However, this in no way detracts from the fact that the Emerson scuba is also a safe and reliable oxygen breathing apparatus.

602. The NAVXDIVINGU did not conduct a running side-by-side comparison of the Emerson with the Draeger LAR V, however, with the existing knowledge base, the following objective and subjective factors were noted:

a. The in-water time and depth limits are equal.

b. The pre-dive and post dive procedure on the LAR V is more simplified and less time consuming than the Emerson scuba.

c. The LAR V has no positive reserve valve whereas the Emerson scuba does incorporate such a feature. LAR V divers must rely on a see-view pressure gauge which is reliable. The Emerson has no see-view gauges.

d. During normal operation and maintenance, the Draeger LAR V requires meteric tooling which is provided with each unit. All fittings are designed for hand operation. The Emerson is very similar in this respect.

e. The Emerson is completely supportable at all maintenance levels within the SPECWAR organizational structure. The Draeger LAR V is equally supportable provided Draeger supplies test kit for testing and adjusting the regulator over bottom pressure and the demand valve cracking pressure. Also needed is a firm logistic support agreement with Draeger.

f. The Draeger LAR V incorporates a demand oxygen supply whereas the Emerson is designed for constant but variable controlled gas flow.

603. All factors being equally weighed, it is considered that the Draeger LAR V has inherent design features which make it superior to the U.S. Navy Emerson scuba. This is undoubtedly due to the fact that the LAR V is produced and marketed by a commercial manufacturer for commercial purposes and is continually subject to design improvement. By comparison, the Draeger scubas fall into the same design

philosophy as the Volkswagen automobiles, i.e. to continually improve the same basic product. The Emerson on the other hand has seen very little improvement since its introduction to the fleet in 1963.

604. The Emerson has not seen the benefit of major improvement primarily because there has been no such indication for the need and/or a requirement addressed from the fleet. This may be due, in part, to the fact that the SPECWAR developmental program, Technical Development Plan, S38-02 "Swimmer Support System" (promulgated on 1 April 1966) recognized the need for the development of a new closed circuit oxygen scuba (i.e. Type II scuba in TDP). Design and operating characteristics were not identified in the SOR (Specific Operational Requirement, i.e. 38-02) and the TDP simply identified that; "The Life Support Subsystem can be viewed as consisting of the basic equipment required by the swimmer to survive in his operational environment along with his self-contained communications equipments". The major performance characteristics of the Type II closed circuit scuba are marginally defined on page 8-7 of TDP S38-02 dated 15 February 1969. The specific characteristics are listed in paragraph 8.2.1.2 and classified CONFIDENTIAL.

605. The SPECWAR developmental program has not yet produced a new oxygen scuba nor is a new unit now in the immediate planning. This factor is due in part to management priority and funding considerations although the summary is much more complex. The Navy did contract the design of the Type II scuba to the Scott Aviation Corporation in 1967 and some limited work was accomplished prior to a program termination in 1971. The knowledge base both within the U.S. Navy and in the American industrial community has the capability to produce a much improved oxygen scuba allowing for necessary time and funding. It must be realized that the S38-02 Type II closed circuit oxygen scuba development was much broader in scope and design than either the Emerson and/or Draeger scubas. The Type II scuba included other major diver carried sub-systems above and beyond the basic life support function.

606. It is considered that the Draeger LAR V oxygen closed circuit scuba is acceptable for inclusion into the UDT and SEAL Special Warfare Unit inventories.

SECTION 7

SPECIFIC SAFETY PARAMETERS

701. The specific objectives of the Navy Experimental Diving Unit evaluation series was to assess and determine parameters for safe use of the Draeger LAR V scuba by SEAL Team personnel. In light of the fact that Navy Special Warfare Teams now represent the only faction of the total U.S. Navy diving community utilizing pure oxygen scuba (i.e. Emerson), it is considered that basic parameters for safe use of the LAR V scuba are now established.

702. General guidance for use of the LAR V scuba shall encompass the following.

a. All Draeger LAR V diving operations shall be conducted in strict adherence to the U.S. Navy Diving Manual NAVSHIPS 0994-001-9010 dated September 1973. Table 13-1 on page 13-2 sets forth the basic criteria involving pure oxygen closed circuit scuba time and depth limits.

b. Draeger LAR V scuba operations may include additional guidance now established at the organizational level.

c. The Draeger LAR V scuba shall be operated and maintained only by qualified divers, specifically divers qualified in the use of closed circuit pure oxygen scuba, (i.e. Emerson scuba or equivalent).

703. Specific guidance for use of the LAR V scuba, especially for supervisory and instructor personnel, shall include the following.

a. Sodalime as to CO2 absorbent is not authorized. Baralyme will be used in the CO2 absorbent canister.

b. CAUTION: The LAR V has no positive reserve. Gas supply must be monitored via a see-view gauge provided for this purpose.

c. CAUTION: The LAR V see-view gauge is calibrated in kilopons per square centimeter (kp/cm2) NOT psig. Divers must assess remaining gas supply by multiplying the actual gauge reading by 14.22, (i.e. 14.22 x actual gauge reading equals psig).

d. CAUTION: Only the U.S. Navy MK III life jacket shall be used with the LAR V. UDT type life jackets are not compatible with the apparatus.

e. CAUTION: The breathing flow loop of the Draeger LAR V is the direct reverse of U.S. Navy scubas. This statement is reiterated for diver indoctrination only as hose fitting size differences preclude incorrect assembly.

f. CAUTION: The LAR V has no pressure relief valve to prevent damage from excess gas when the breathing loop is closed. Divers must guard against over inflation, especially during pre-dive dip testing.

g. Divers should be instructed to jock into the LAR V in a loose but comfortable position otherwise breathing exhalation resistance may result.

h. CAUTION: Special attention must be given while charging the high pressure oxygen cylinder is to the lack of a blow out plug/disc.

SECTION 8

CONCLUSIONS

801. It has been concluded by the Navy Experimental Diving Unit that:

a. The Draeger LAR V scuba is a safe and reliable diving apparatus for use by Special Warfare UDT and SEAL Teams.

b. Reliability and maintainability of the LAR V was subjectively satisfactory.

c. Special Warfare operators can acquire the basic skills to operate and maintain the Draeger LAR V with less than one hour instruction.

d. The Draeger LAR V is compatible for use with SPECWAR submersible vehicles.

e. The Draeger LAR V does not provide and improved depth/time operational capability over the U.S. Navy Emerson scuba.

SECTION 9

RECOMMENDATIONS

901. It is recommended that:

a. The Draeger LAR V pure oxygen scuba be considered a safe, reliable and satisfactory diving apparatus for use by Special Warfare divers.

b. Specific recognition be given to the fact that the limited tests conducted by the Navy Experimental Diving Unit were objective and subjective in scope and were in no way intended to be an evaluation for service approval nor were tests so structured.

c. Prior to purchase of any quantity of the LAR V scuba that logistic provisioning and supply policy be firmly established with the manufacturer.

ANNEX A

SUMMARY OF OPERATIONS

ANNEX A

SUMMARY OF OPERATIONS

I. PHASE	UNIT #1	UNIT #2	TOTALS
Training	8 hours	8 hours	16 hours
Swims	31 hours	31 hours	62 hours

II. EVENT	UNIT #1	UNIT #2	TOTALS
Training/Balance Dives	8 hours	8 hours	16 hours
30 min. Swims	8 hours	8 hours	16 hours
1 hour Swims	6 hours	6 hours	12 hours
2 hour Swims	6 hours	6 hours	12 hours
3 hour Swims	3 hours	3 hours	6 hours

DATA SHEET - DRAEGER LAR V

DEPTH	RMV	ΔP IN CM H2O		CO2 INJECTION RATE L.P.M.	CO2 LEVELS - %			WATER TEMP.	CO2 ABSORBENT
		INHALE	EXHALE		INHALE HOSE	EXHALE HOSE	EXHALE BOX		
0'	22.5	+22	+18	.9	.6	.6	3.4	70°F	Baralyme
25'	40.0	+28	+21	1.6	.8	.8	3.4	70°F	Baralyme
25'	62.5	+28	+15	2.5	.8	.8	3.4	70°F	Baralyme
25'	75.0	+27	+ 8	2.5	.8	.85	3.4	70°F	Baralyme
*10'	40.0	+28	+ 6	.9	1.0	1.4-2.5	2.5	70°F	Baralyme
**10'	40.0	+25	+ 7	.9	1.2	1.2-2.4	2.5	35°F	Baralyme

* Canister Breakthrough T.T.D. 3 hrs. 30 min.

** Canister Breakthrough T.T.D. 1 hr. 30 min.

TAB A

DRAEGER LAR V PRE/POST DIVE
CHECK LIST AND QUESTIONNAIRE

DRAEGER LAR V
PRE/POST DIVE CHECK LIST

NAME _____ RATE _____ DATE _____

RIG # _____ CO2 ABSORBANT _____ EVOLUTION _____

PRE-DIVE

Initials

_____ 1. Inspect all parts for dirt, deterioration, damage.
_____ 2. Inspect all "O" rings for lubrication.
_____ 3. Fill canister and secure cover.
_____ 4. Attach breathing bag to canister.
_____ 5. Install canister and attach breathing bag to demand valve.
_____ 6. Assemble breathing hoses and mouthpiece, install.
_____ 7. Install cylinder, gauge and check bypass. O2 PSIG _____
_____ 8. Breath rig to check non-return valve function and insure demand valve actuation.
_____ 9. Dip test rig.

PRE-DIVE TIME _____ SIGNATURE _____

POST DIVE

Initials

_____ 1. Dip rig in fresh water.
_____ 2. Gauge cylinder, secure cylinder, bleed down via bypass. O2 PSIG _____
_____ 3. Remove hoses, mouthpiece and bag; disinfect, rinse well and hang to dry.
_____ 4. Dump canister; rinse if necessary.

POST-DIVE TIME _____ SIGNATURE _____

COMMENTS

TAB B

DRAEGER LAR V DIVER COMMENT SHEET

DIVER COMMENT SHEET DRAEGER LAR V

NAME _____ DATE _____

1. DID YOU ENCOUNTER ANY PROBLEMS SETTING UP THIS SCUBA UNIT FOR DIVING? YES _____ NO _____. IF YES, EXPLAIN: _____

2. DID YOU HAVE ANY PROBLEMS DURING YOUR SWIMS? YES _____ NO _____. IF YES, EXPLAIN: _____

3. DID YOU HAVE ANY BREATHING PROBLEMS SUCH AS RESISTANCE? OVER-PRESSURIZATION? YES _____ NO _____. IF YES, EXPLAIN: _____

4. WERE YOU ABLE TO MAINTAIN DEPTH? YES _____ NO _____. IF NO, EXPLAIN: _____

5. WAS THE SCUBA UNIT COMFORTABLE IN THE WATER: YES _____ NO _____. IF NO, EXPLAIN: _____

6. DO YOU FEEL THIS SCUBA UNIT COULD BE MAINTAINED BY THE PERSONNEL IN YOUR UNIT? YES _____ NO _____. IF NO, EXPLAIN: _____

7. WHAT FEATURES DO YOU LIKE ABOUT THIS SCUBA? EXPLAIN: _____

8. WHAT FEATURES DO YOU DISLIKE ABOUT THIS SCUBA? EXPLAIN: _____

9. HOW DO YOU COMPARE THIS UNIT TO OTHER CLOSED CIRCUIT/SCUBA'S YOU HAVE USED? EXPLAIN: _____

10. ADDITIONAL COMMENTS OR REMARKS ENTER BELOW.

_____

FIGURE 1 DRAEGER LAR V

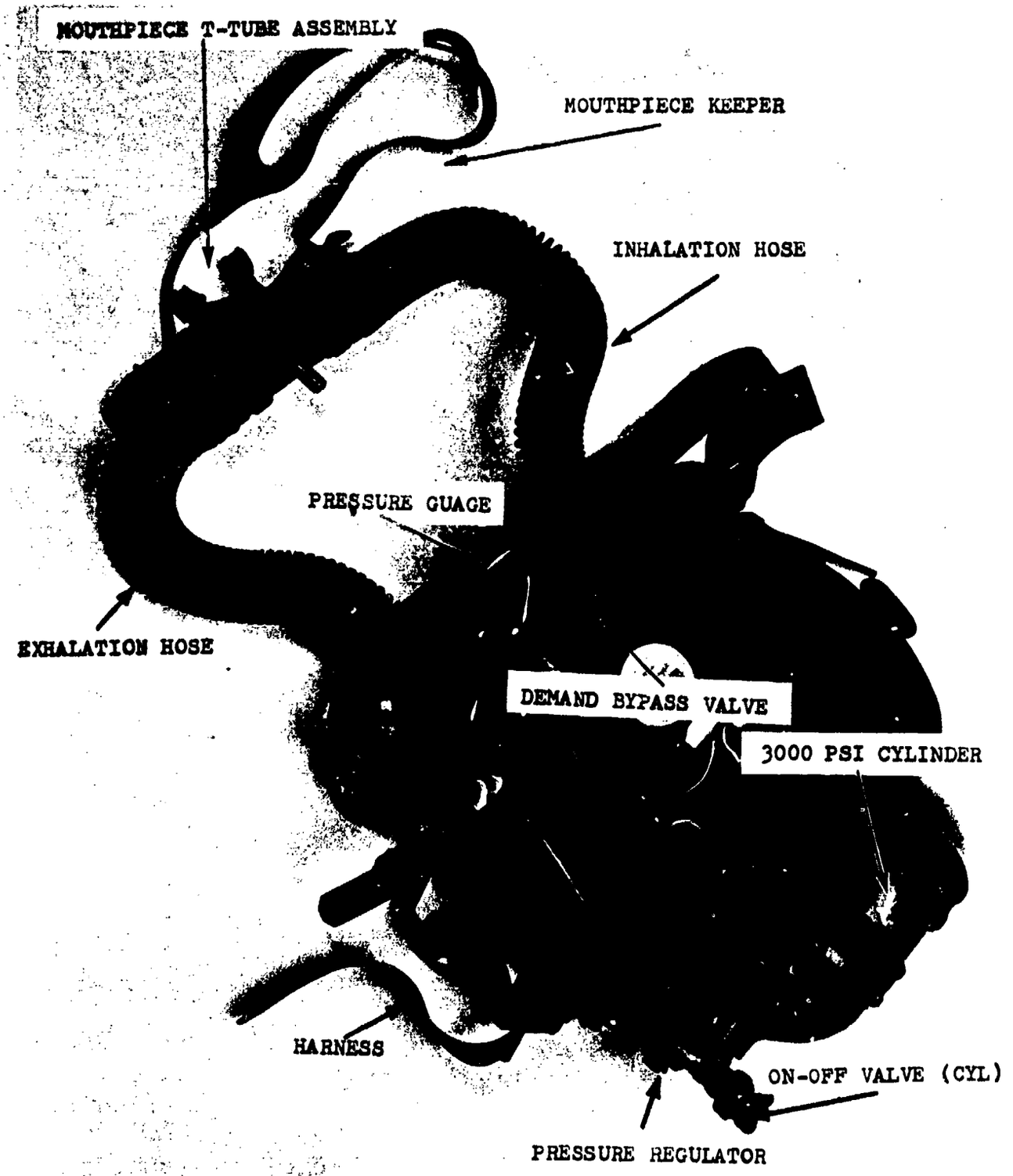

MOUTHPIECE T-TUBE ASSEMBLY
MOUTHPIECE KEEPER
INHALATION HOSE
PRESSURE GUAGE
EXHALATION HOSE
DEMAND BYPASS VALVE
3000 PSI CYLINDER
HARNESS
ON-OFF VALVE (CYL)
PRESSURE REGULATOR

FIGURE 2

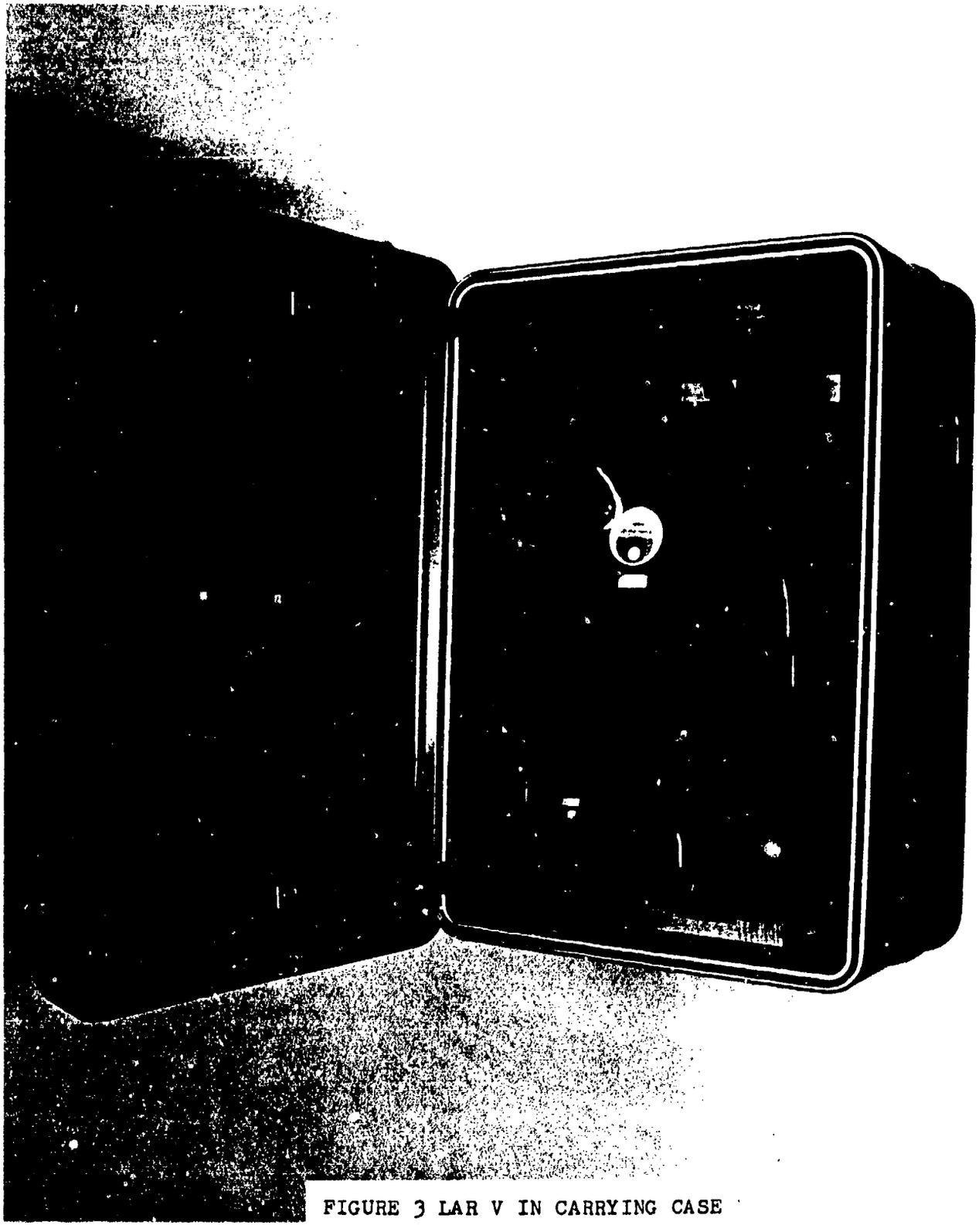


FIGURE 3 LAR V IN CARRYING CASE

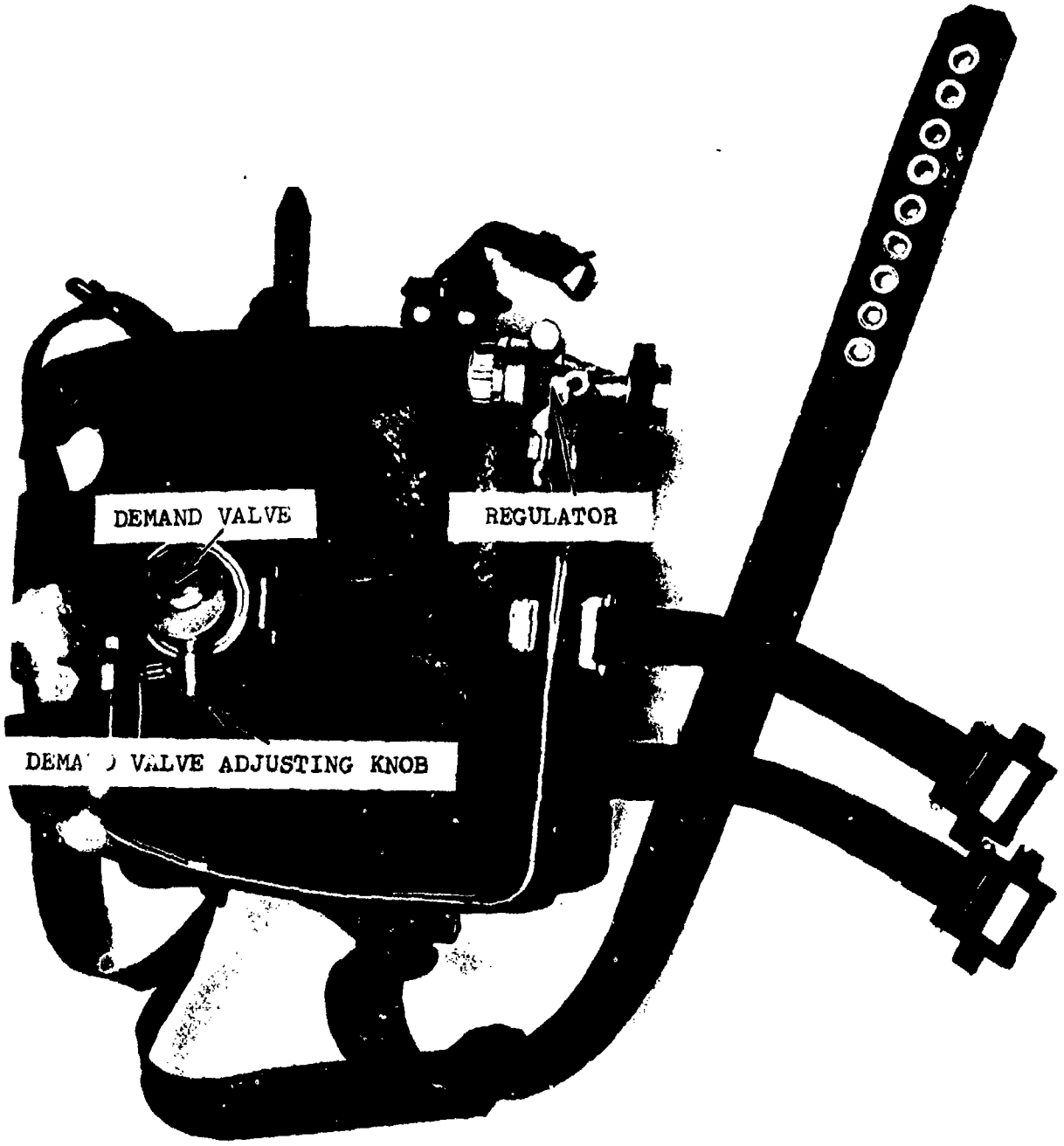


FIGURE 4 EQUIPMENT CASE HOUSING

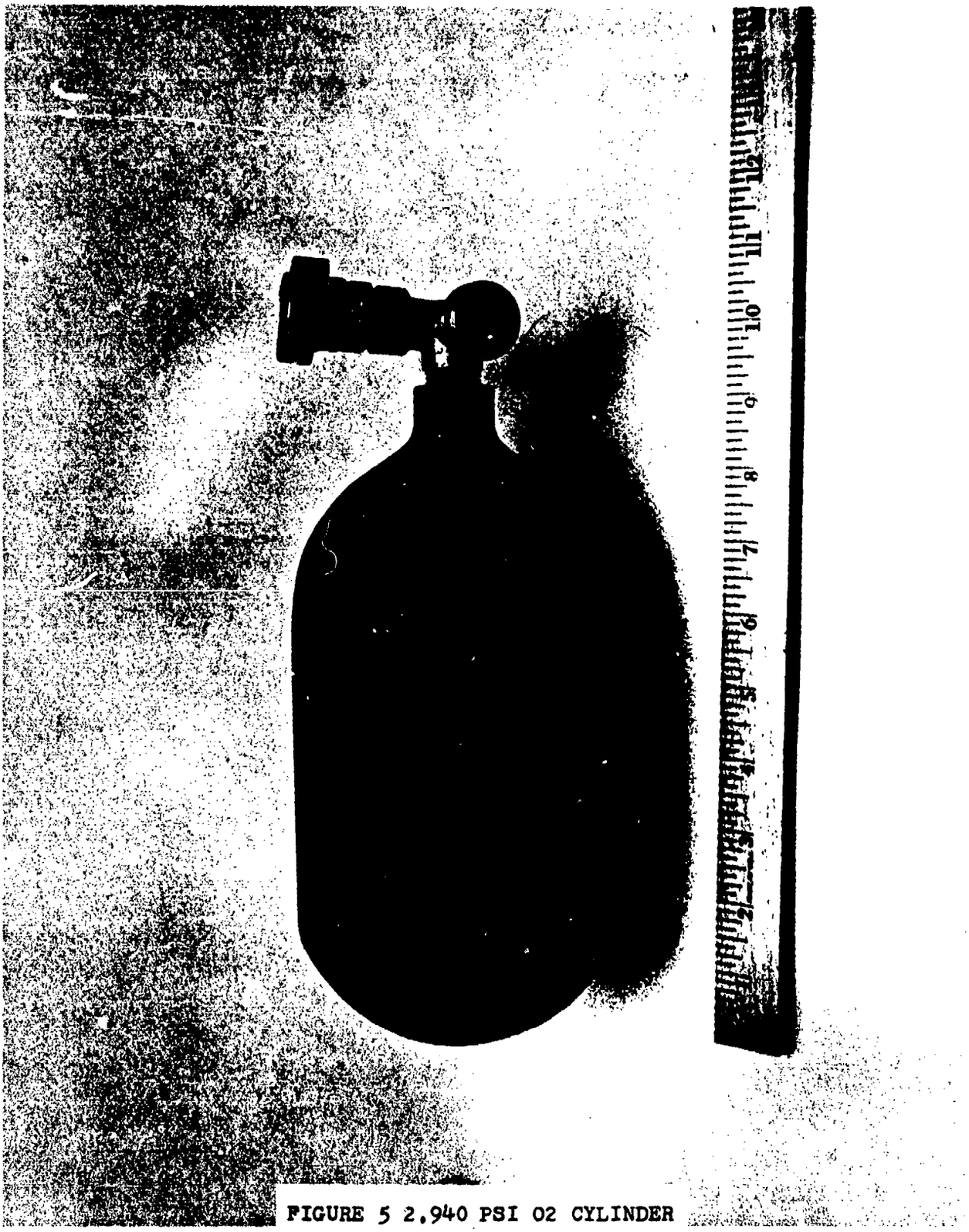


FIGURE 5 2,940 PSI O2 CYLINDER

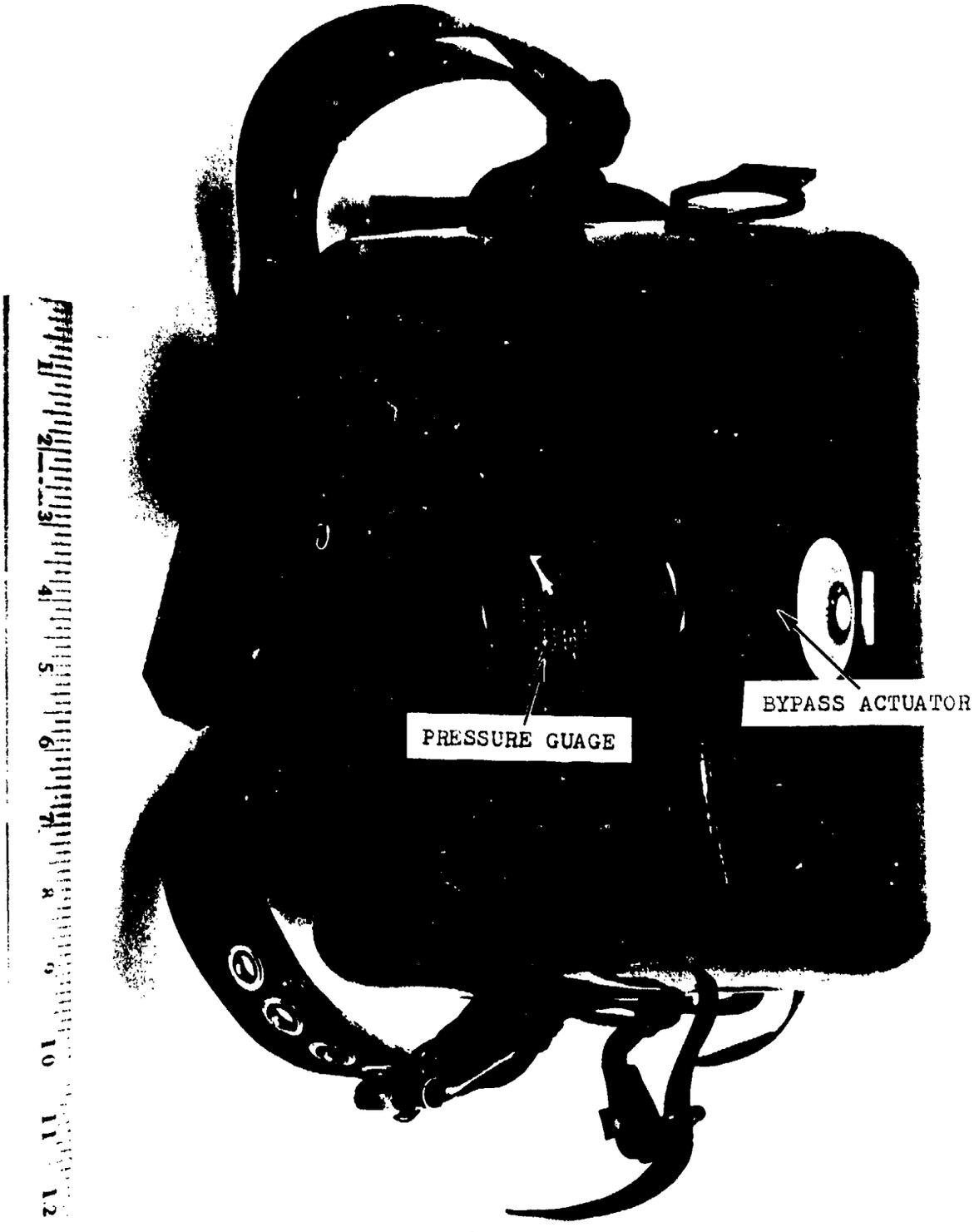


FIGURE 6

FIGURE 7 CO2 CANISTER

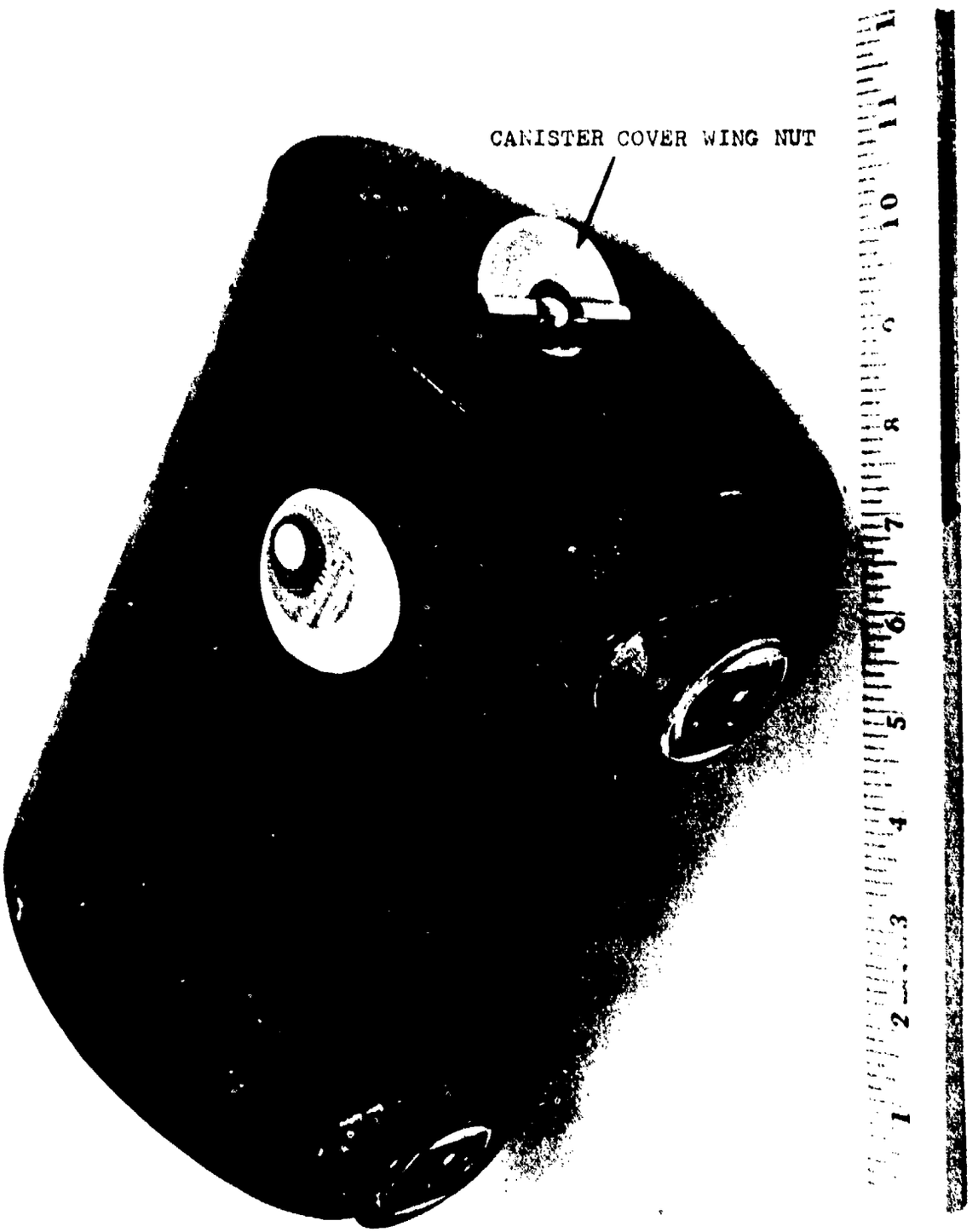


FIGURE 8 CO2 CANISTER ASSEMBLED

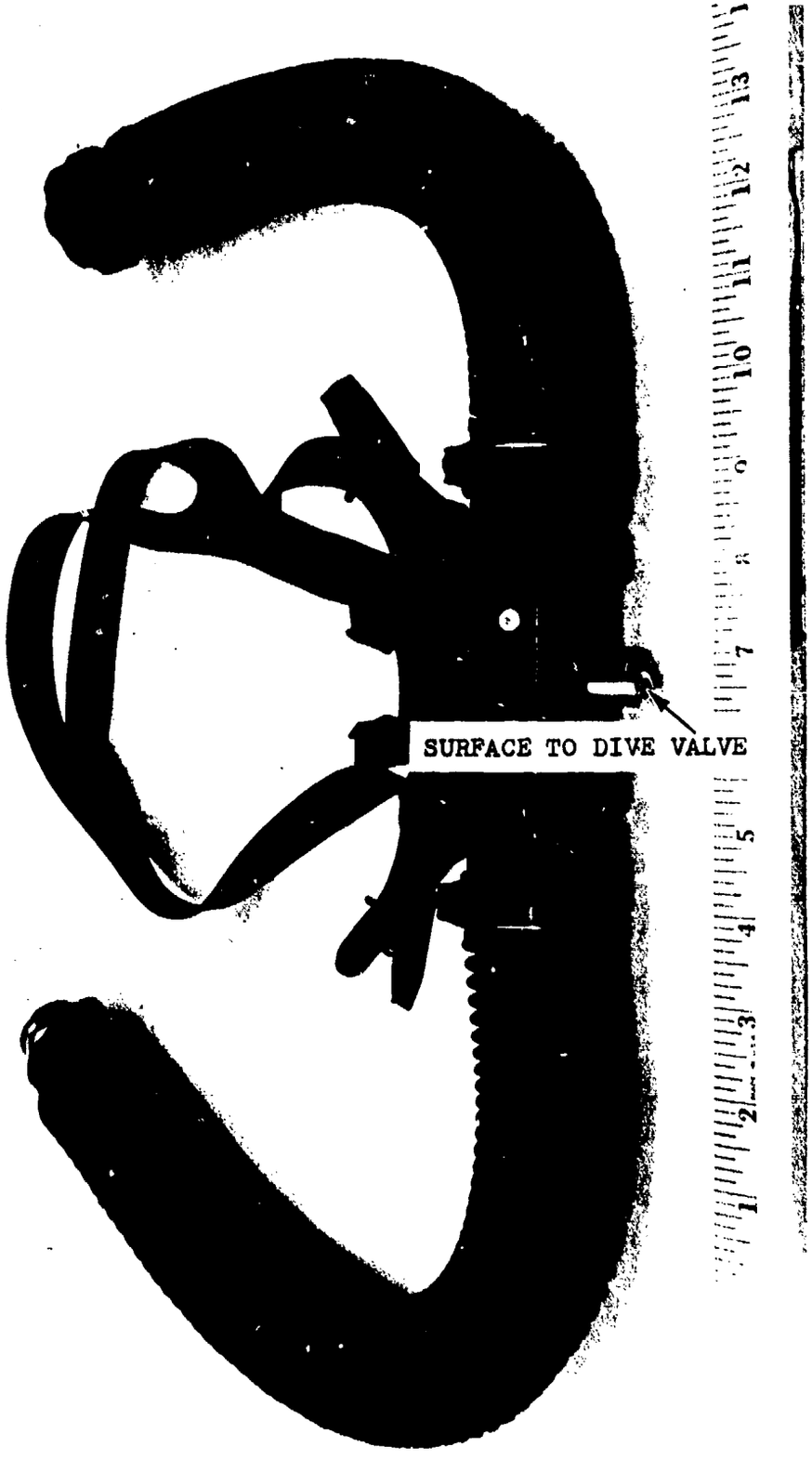


FIGURE 9 MOUTHPIECE/BREATHING HOSE ASSEMBLY

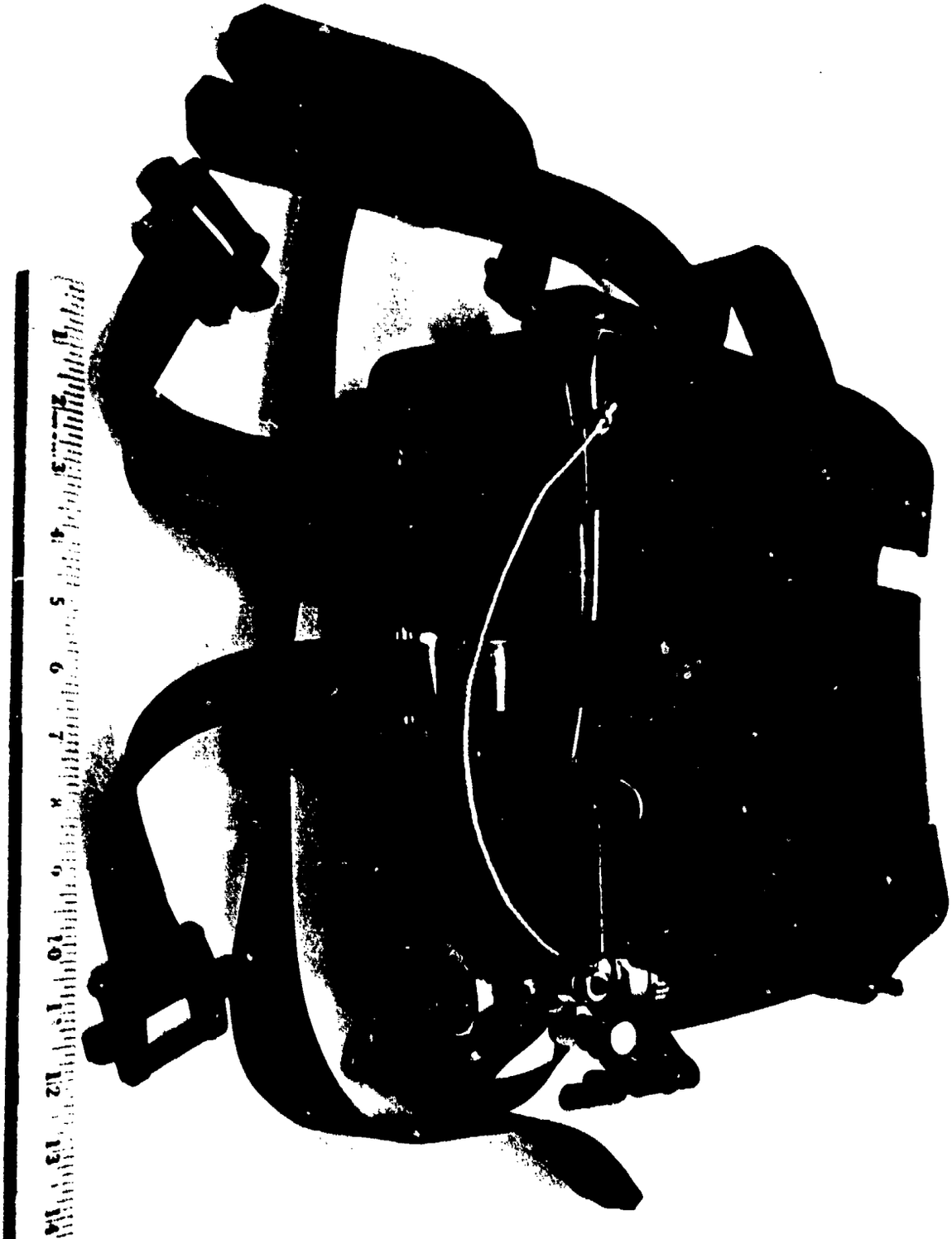
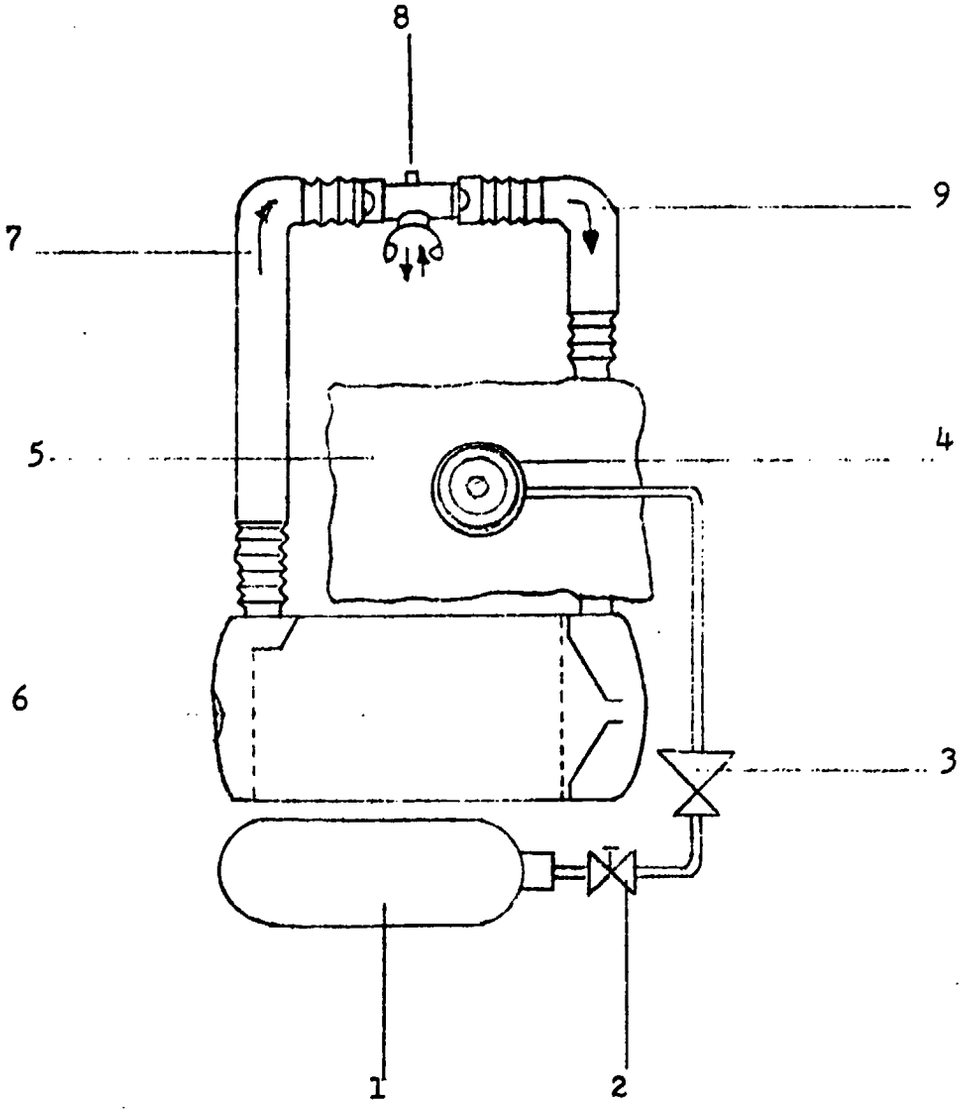


FIGURE 10 BREATHING BAG



1. O^2 FLASK
2. FLASK VALVE
3. PRESSURE REGULATOR
4. DEMAND REGULATOR
5. BREATHING BAG
6. CO_2 SCRUBBER
7. INHALATION HOSE
8. MOUTHPIECE
9. EXHALATION HOSE

(FIG.11)

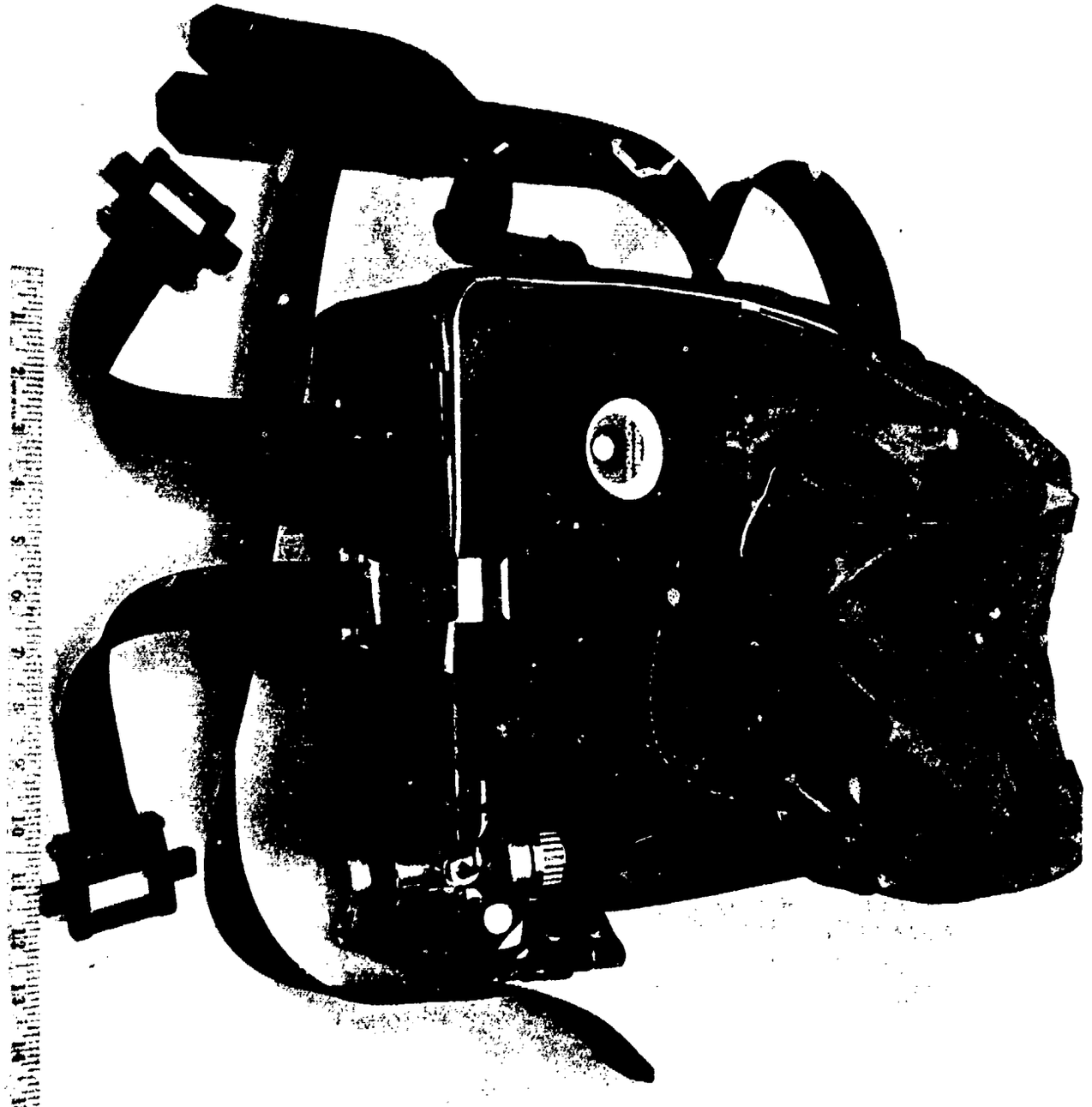


FIGURE 12 CO2 CANISTER INSTALLED

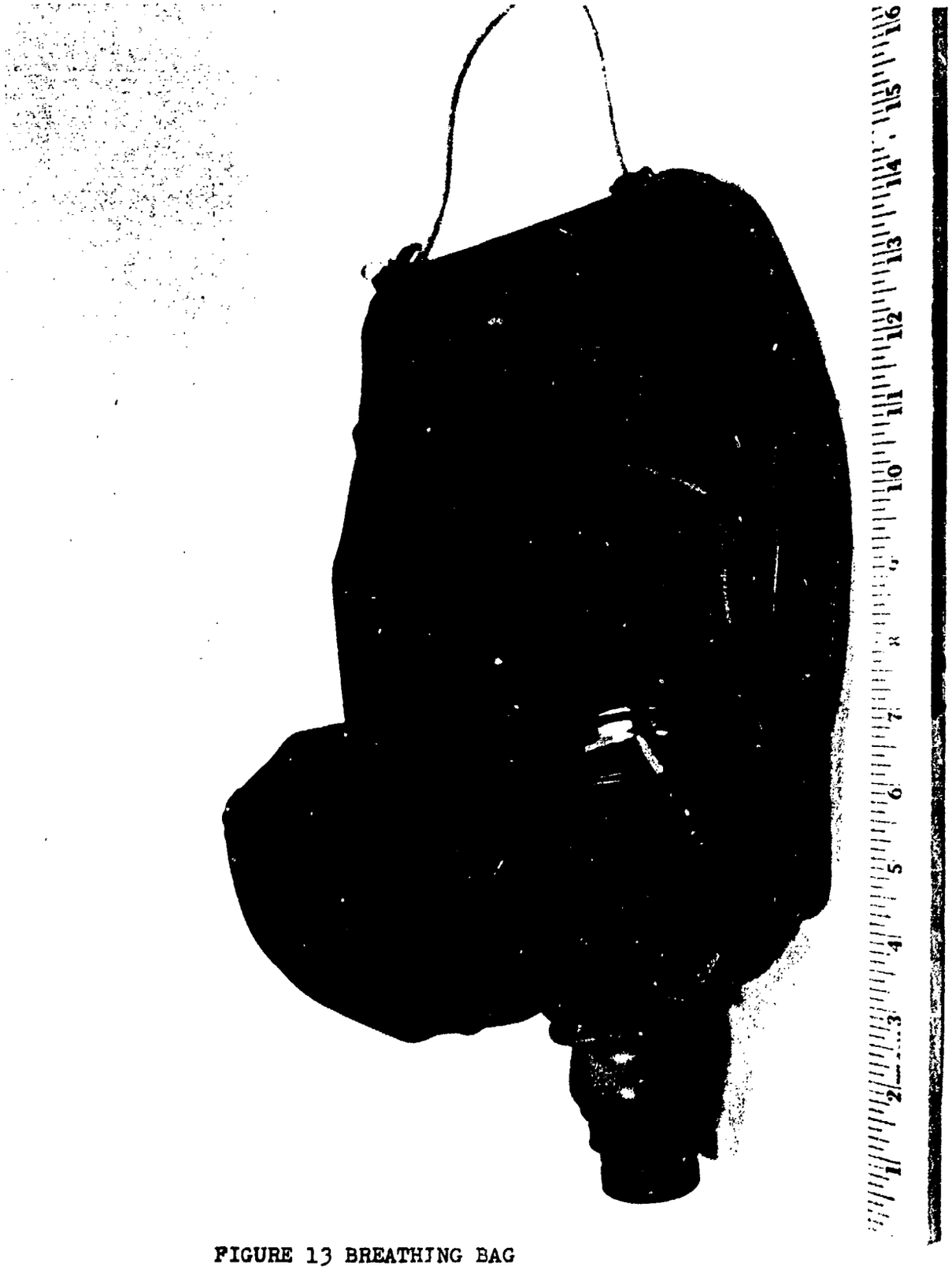


FIGURE 13 BREATHING BAG

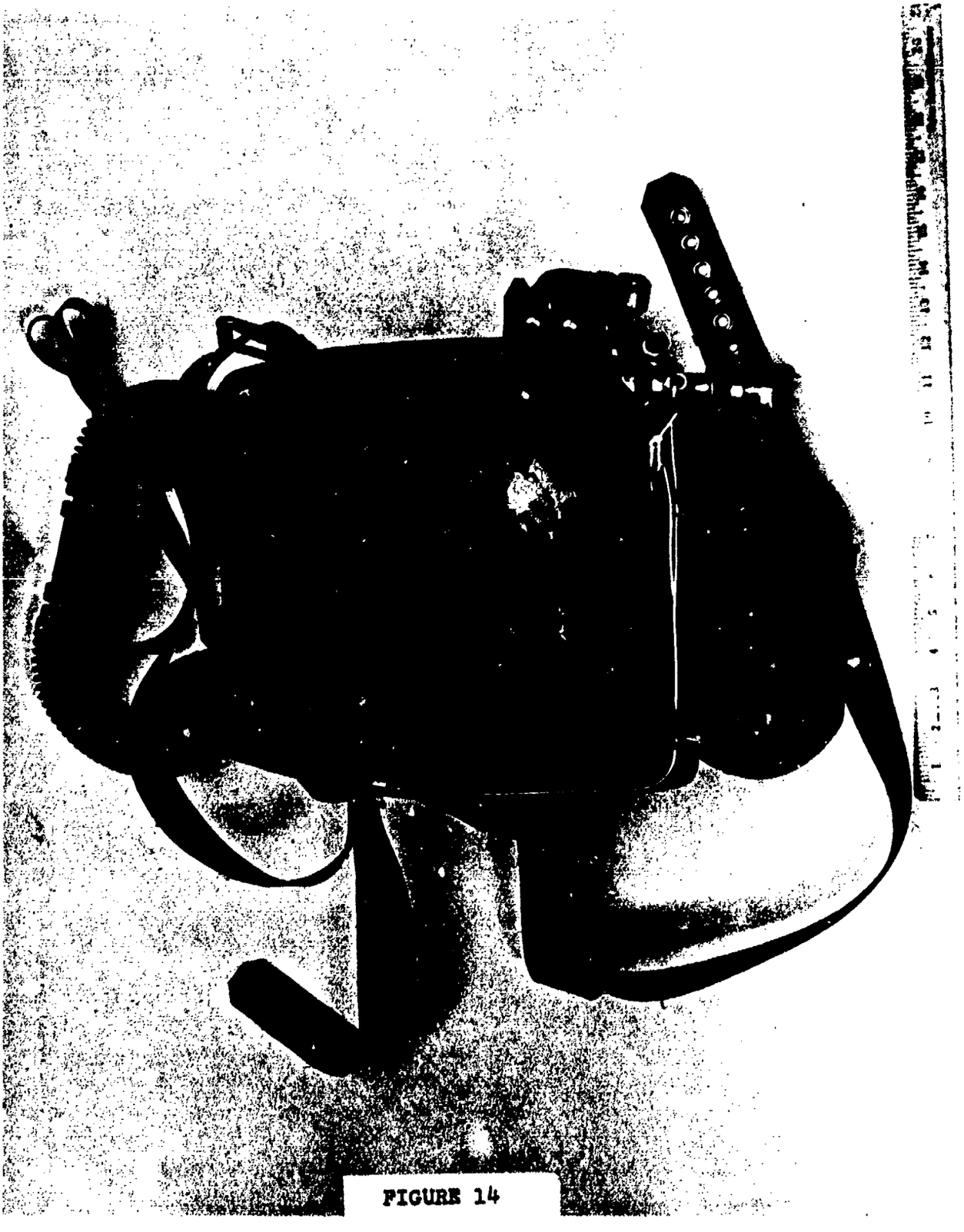


FIGURE 14