

A RESPIRATOR TESTING AND TRAINING FACILITY

SUMMARY: A new facility has been constructed for training employees in the proper use of respiratory, protective equipment. The effectiveness of mouth-bit respirators has been markedly increased by the use of this facility. In this unit, the user is treated as a component of the protective system. Each employee is trained to use his respirator in a challenge atmosphere containing 500 ppm of Refrigerant 12. Nose-breathing or mouth-seal leakage is detected by a halide-detection meter analyzing the exhaled breath. Six hundred, sixty-six persons have been tested in two identical units. Of these, only two have been untrainable. Retention of the learned breathing skill appears to be excellent.

BACKGROUND: Chlorine is produced in several major production units in the Texas Division of Dow Chemical U.S.A. A mouth-bit respirator adopted to a large volume canister was the early method of providing personal protection in chlorine atmospheres. The presently used mouth-bit respirator (Plate 1) was developed as a joint effort between Dow and the manufacturer. It includes a large cartridge (Plate 2), a replaceable mouth-bit (Plate 3), inhalation valves (Plate 4), and an exhalation valve (Plate 5). The cartridge will withstand 5000 parts per million of chlorine in moist breathing air for fifteen minutes at the normal breathing rate. Use of the nose clip was discontinued several years ago because of poor acceptance by the employees. This unit affords the employee the highest level of protection in a mouthpiece respirator. Even so, some employees have continued to receive chlorine inhalations. In an emergency situation, the majority of employees would effectively utilize their respirators for a safe evacuation, while a few would require medical treatment. This became a growing concern of Dow management, and ways were investigated to improve the respirator training program. The first field testing facility was constructed in May 1975 to provide a technique to quantitatively measure the effectiveness of the training program and to provide both the trainer and the trainee a means to verify that the respirator was being used properly.

EQUIPMENT AND CONSTRUCTION: The facilities are housed in 16' x 8' portable buildings (Plate 6). One end of the interior is walled off to provide a chamber, 8' x 5'. A circulation fan for uniform mixing and an exhaust fan for clean-out are installed in the chamber. Two sinks, cabinets, and a desk and chair are the furnishings of the outer room. Breathing air and Refrigerant 12 are piped through the wall of the test chamber. The exhaled breath of the test subject is collected by attaching a silicone-rubber cup and polyethylene hose to the exhalation valve of his respirator (Plate 7). These gases and vapors are continuously analyzed by a halide-detection meter manufactured by the Gas Tech Corporation, Mountain View, California. The presence of halide compounds is indicated by a meter in the face of the instrument (Plate 8). Output of the meter is also recorded by a 0-10 millivolt strip-chart recorder. This recorder furnishes a 5" x 8" card with an individual record of each person's test results (Plate 9).

Since Refrigerant 12 quickly saturates activated charcoal, a dummy cartridge connected to a demand regulator is utilized. This supplies breathing air in place of purified air from the cartridge (Plate 10). For comfort, the breathing air is humidified prior to use (Plate 11).

Sample connections are provided to allow this meter to check both the halide concentration of the challenge gas in the chamber and the halide concentration in the exhaled breath.

PROCEDURE: A) Testing. The chamber is charged to a level of 500 parts per million of Refrigerant 12. This is one-half of the concentration allowed by the Threshold Limit Value. The respirator is prepared as shown in Plate 12. The subject is then seated in the chamber and the test ensues (Plate 13). When the breathing pattern at rest has been established, the subject is asked to make up some small pipe fittings in order to evaluate his use of the respirator while performing simple tasks. These two portions constitute the screening test. Maximum time in the test chamber is six minutes, and many tests are completed in three minutes. The greatest possible exposure to Refrigerant 12 is therefore:

$$\frac{(6)(500)}{(480)(1000)} \times 100 = 0.625\% \text{ of the TLV}$$

B) Training. The procedure for training is similar to the test procedure, except that the halide meter is placed so that the output dial is visible to the subject through a window. By watching the reading (and through exhortations from the trainer), a process of self-training results. Two to six training sessions are adequate to train even the worst subject. The duration of a training session is eight minutes, and only one session per employee is conducted each day. The maximum exposure is therefore:

$$\frac{(8)(500)}{(480)(1000)} \times 100 = 0.833\% \text{ of the TLV}$$

C) Discussion. A level of 10 ppm in the exhaled breath is easily determined by the halide meter. Zero concentration is not exact because of instability of the analyzer. It floats between 0 and 10 on the output dial; however, an experienced operator can easily detect 0 leakage by the pattern of breathing recorded on the strip-chart recorder. The test can determine 10/500 or 2% leakage, and much greater accuracy is the usual result. The halide meter requires purging after each use in order to clear the effects of moisture in the breath. In addition, it is somewhat susceptible to variations in line voltage. Once again, these conditions are quickly determined and adjusted by an experienced operator.

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In addition to the training that occurs in the chamber, very valuable one-on-one training can be carried out in the facility. The trainer emphasizes respirator care and maintenance and thoroughly discusses inspection procedures. An increased emphasis on respiratory protection is the end result.

RESULTS: A) Testing. Six hundred, sixty-six chlorine plant personnel have been tested for proper respirator use. These comprise four categories: supervisory, cell repair, maintenance workers, and operators. Overall, 71.6% of the tested group was proficient in the use of the mouth-bit respirator without additional training. Significantly, the operators were more capable than the other three groups. Operators who must use their respirators at times in small concentrations of gas were 84.6% proficient in respirator usage. The other three groups were roughly equal. Supervisors of twenty and thirty years experience often were among those requiring additional training. Some hourly employees, with many years of service, also failed the screening test.

The patterns of failure were many and diverse. Some had only slight leakage through the nose, while others breathed gross amounts from the chamber. Mouth leakage became easy to diagnose because of a particular, recurring pattern on the strip chart; however, the number of persons exhibiting this problem was not great.

B) Training. The true worth of the respirator facilities has been realized in their training function. Of the total population who received initial training, only two proved to be untrainable. Initially, the combined system of the employee and his respirator was 71.6% effective. With proper training, the effectiveness of the system has been increased to better than 99.5%. New employees are provided with genuine training that is accurately measured; proper documentation is furnished for personnel records.

Cases of gross inability to use a respirator can be corrected with a maximum of six training sessions of eight minutes duration. This number is infrequently required; the usual number is three sessions.

At the present time, it appears that proper respirator usage is a skill that is well retained after it is once acquired. The first group that received training has been retested after a six-month interval. 18 men have been retested; of these, 16 retained their breathing ability. This is a retention rate of 88.9%.

COMPLEMENTARY ACTIONS: A respirator training and testing program cannot stand alone. It is only one facet of the total respirator program. To this end, the chlorine department has taken several additional actions. Individually issued respirators are inspected by the employee on a

regular schedule. A log is maintained in each plant to record the results of these inspections. Respirator cleanliness is encouraged. Cartridges are changed on a fixed schedule, or they are changed at more frequent intervals after periods of heavy use. As required by OSHA, emergency equipment (such as SCBA's) is inspected and logged monthly.

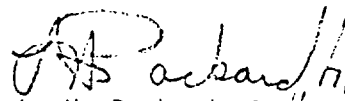
Over the past five years, cell area ventilation has been consistently improved. Individual exposures have been evaluated in the production areas, and these are all less than the time weighted average of 1 part per million. The requirement to wear SCBA's under conditions of greater exposure has been aggressively followed.

CONCLUSIONS: For the first time, an accurate index of mouth-bit respirator proficiency has been achieved. The facility shows an outstanding training capability, in that better than 99.5% of the personnel make an effective use of the respirator after testing and training. Respirator usage is a highly retained skill. Initial tests show 88.9% retention after a six-month interval.

The trained employees have a greater degree of confidence in their respirators and in their ability to use them properly. Respirator training is a portion of the safety program that is sincerely appreciated by a great majority of the employees. They fully realize that this is safety training that is carried out for their benefit.

Misinformation and improper training are both eliminated by these procedures. The largest single group of employees failing the initial test was made up of those persons who received faulty respirator training from well-meaning supervisors.

A very real benefit is that it is no longer necessary to breathe chlorine-contaminated air in order to gain experience in the use of a respirator.


L. H. Packard, Jr.

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PLATE NO. 1
A HIGH-CAPACITY MOUTH BIT RESPIRATOR

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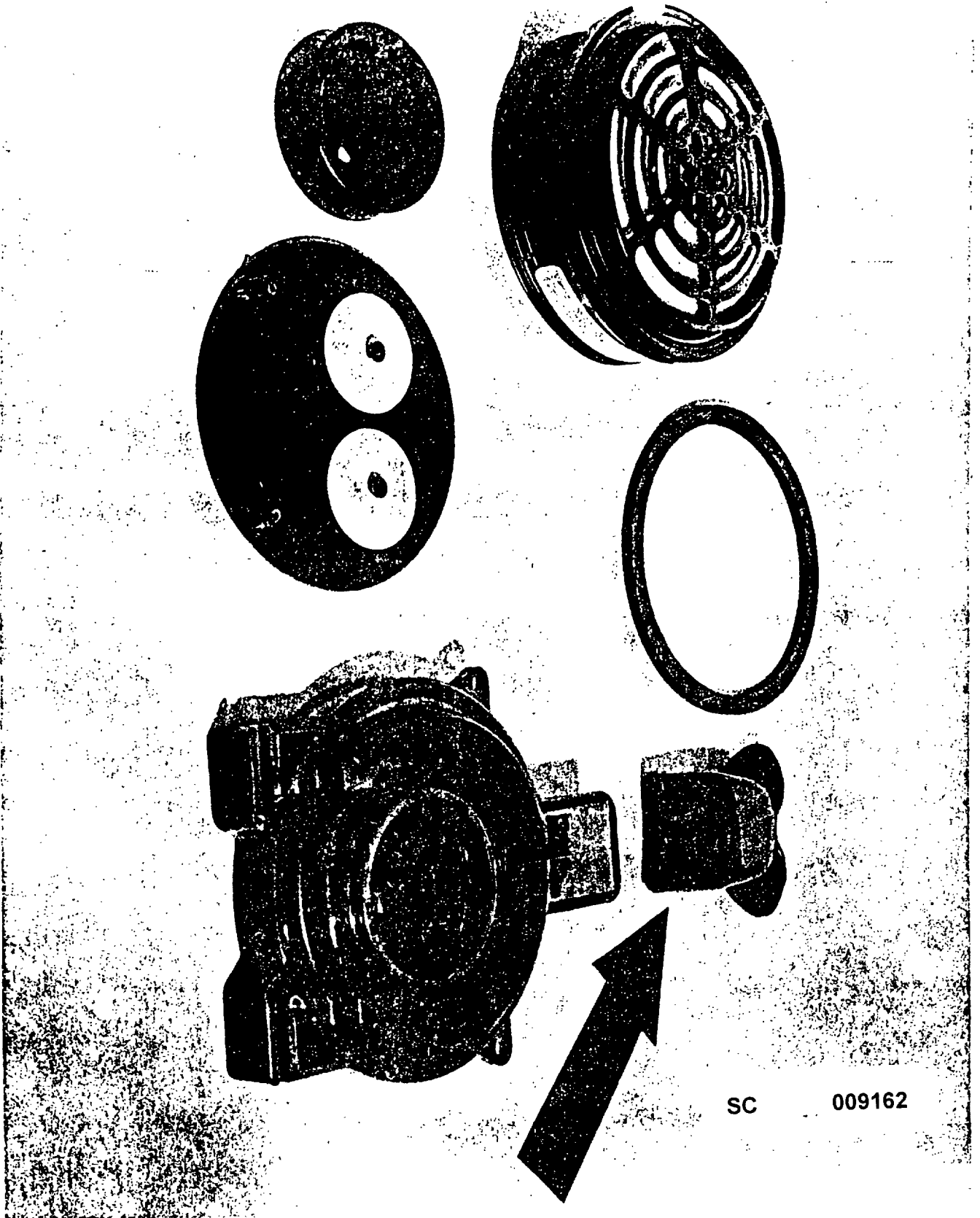


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PLATE NO. 2
RESPIRATOR CARTRIDGE

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PLATE NO. 3
REPLACABLE MOUTH BIT

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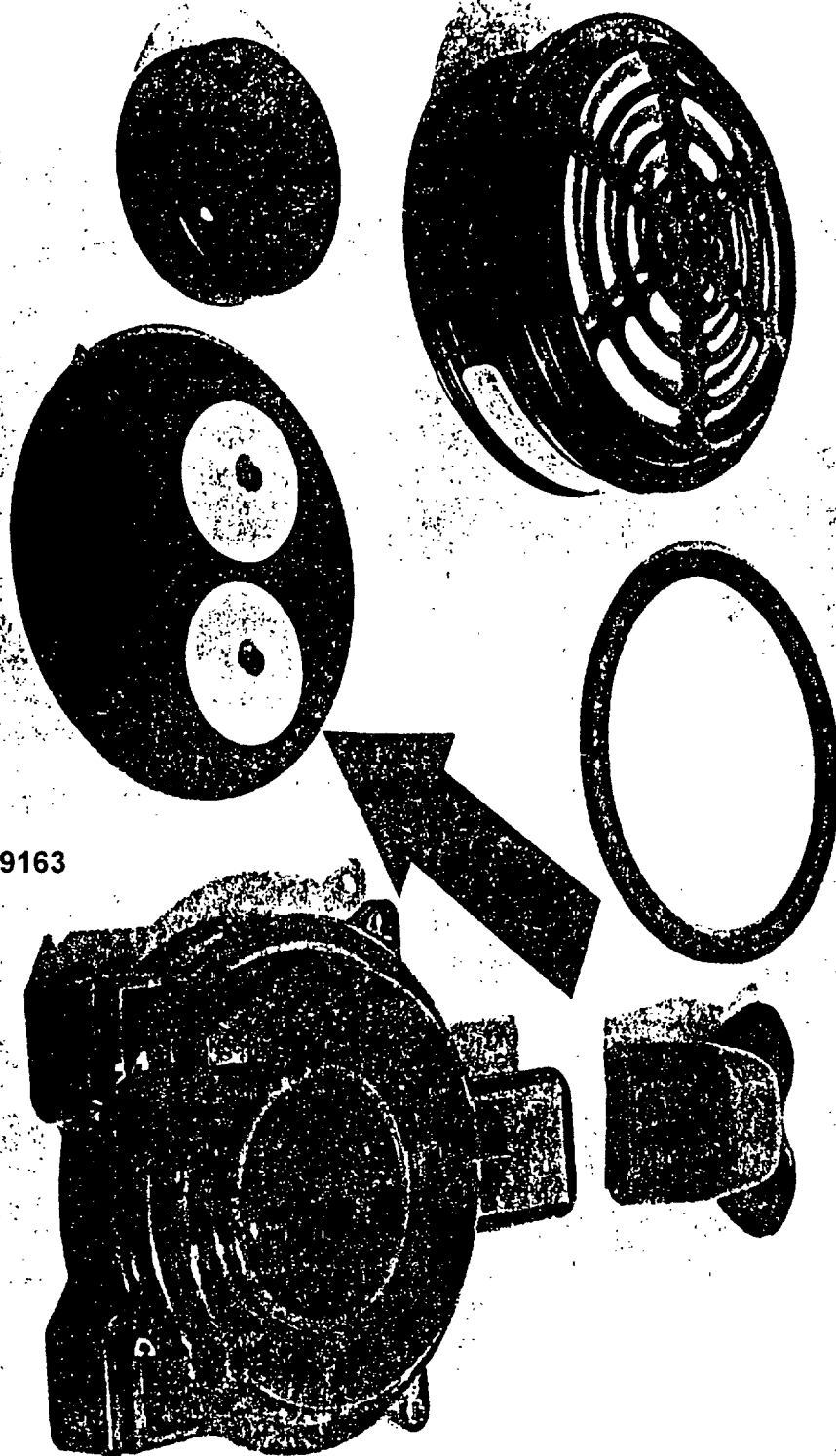
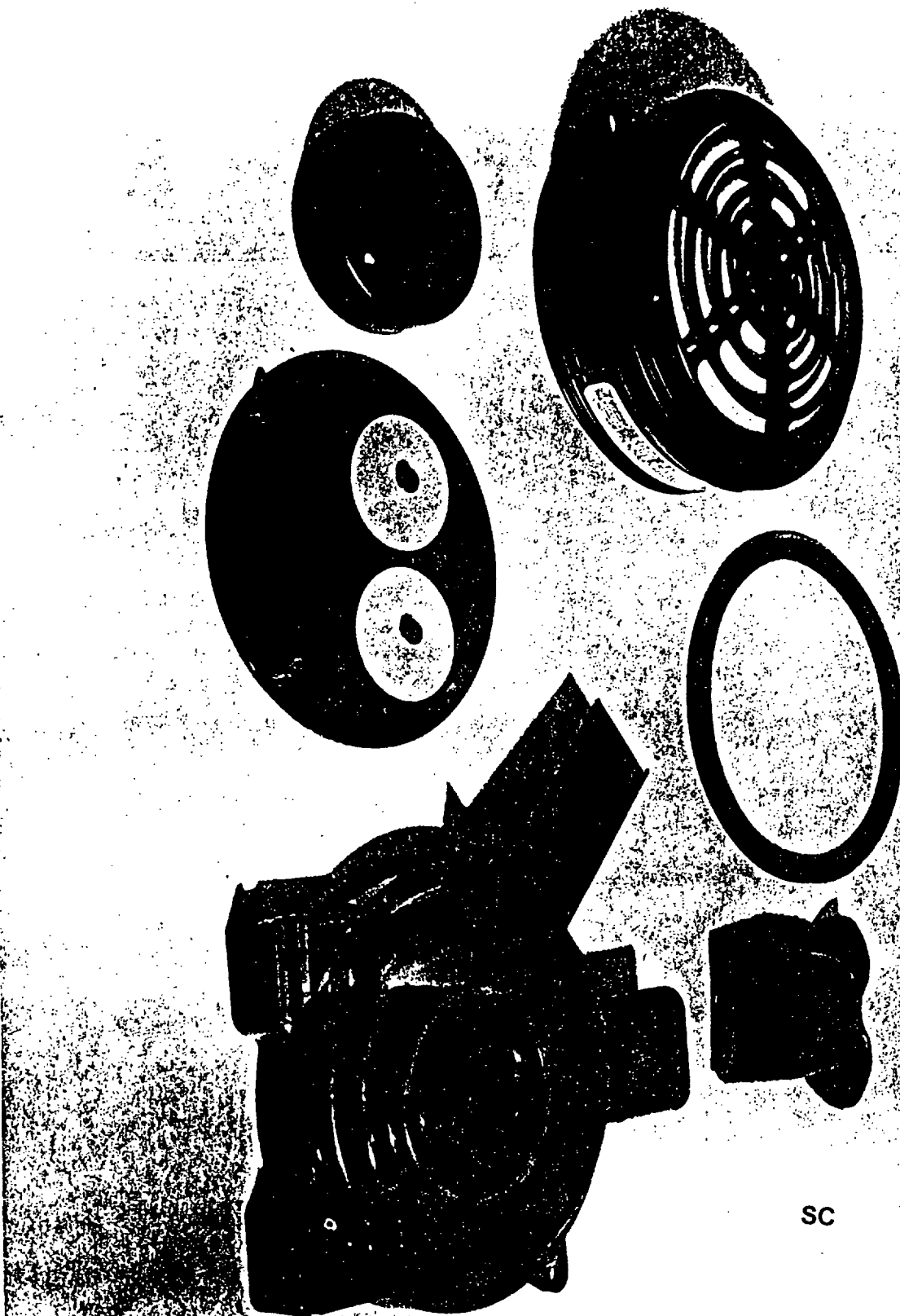


PLATE NO. 4
INHALATION VALVES

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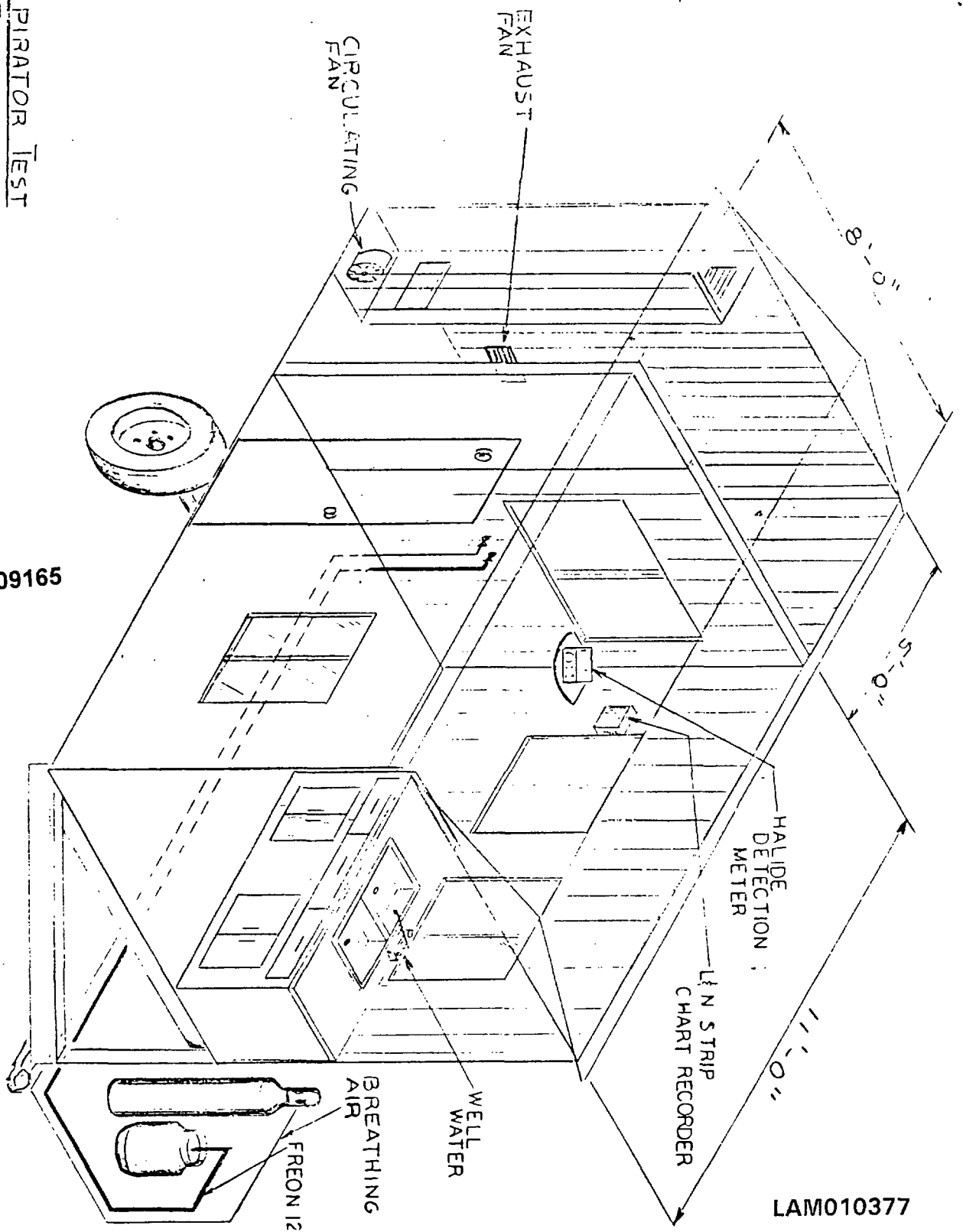
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PLATE NO. 5
EXHALATION VALVE

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RESPIRATOR TEST
FACILITY

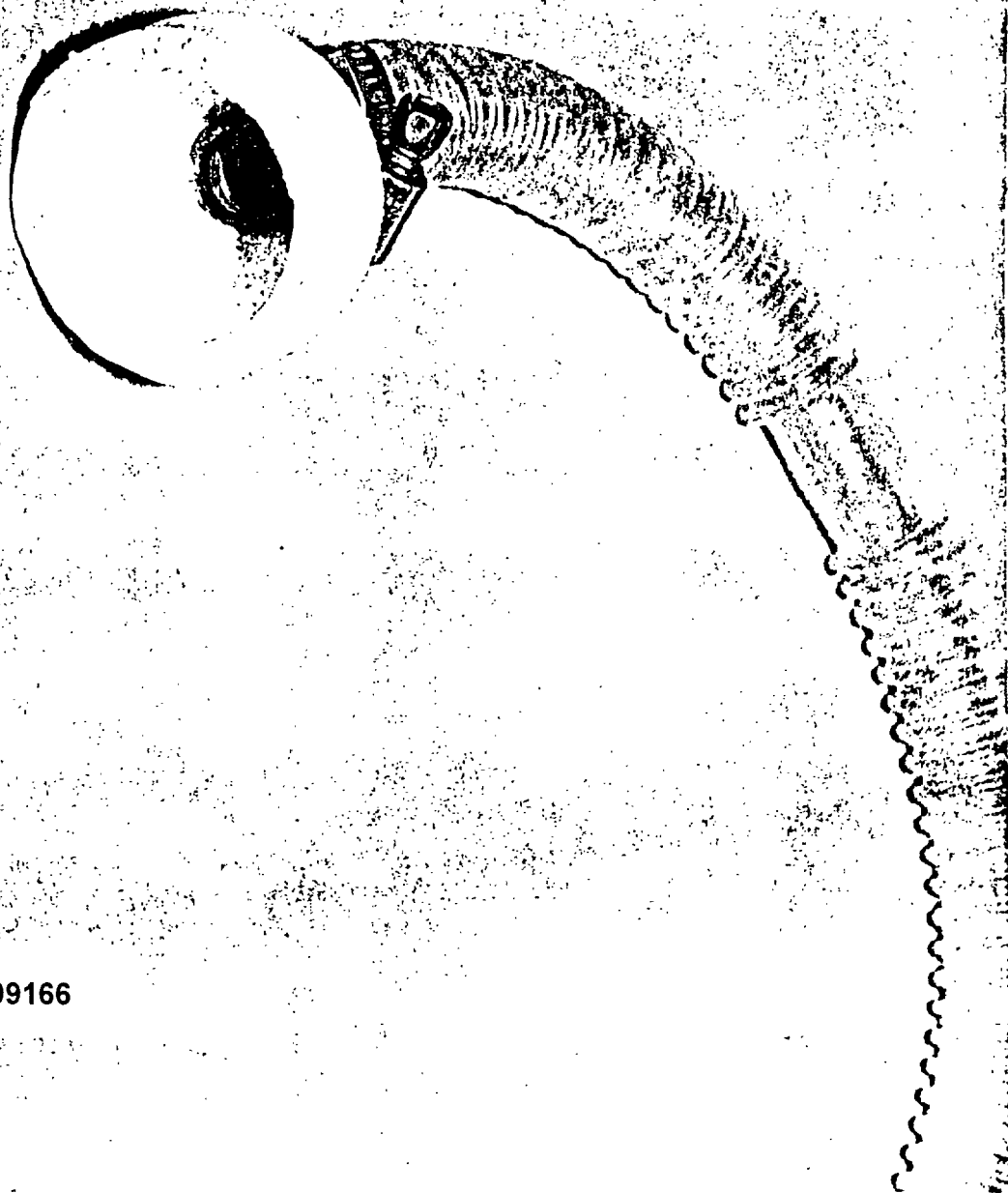
PLATE No.6



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PLATE NO. 7
SILICONE-RUBBER CUP AND PLASTIC NOSE

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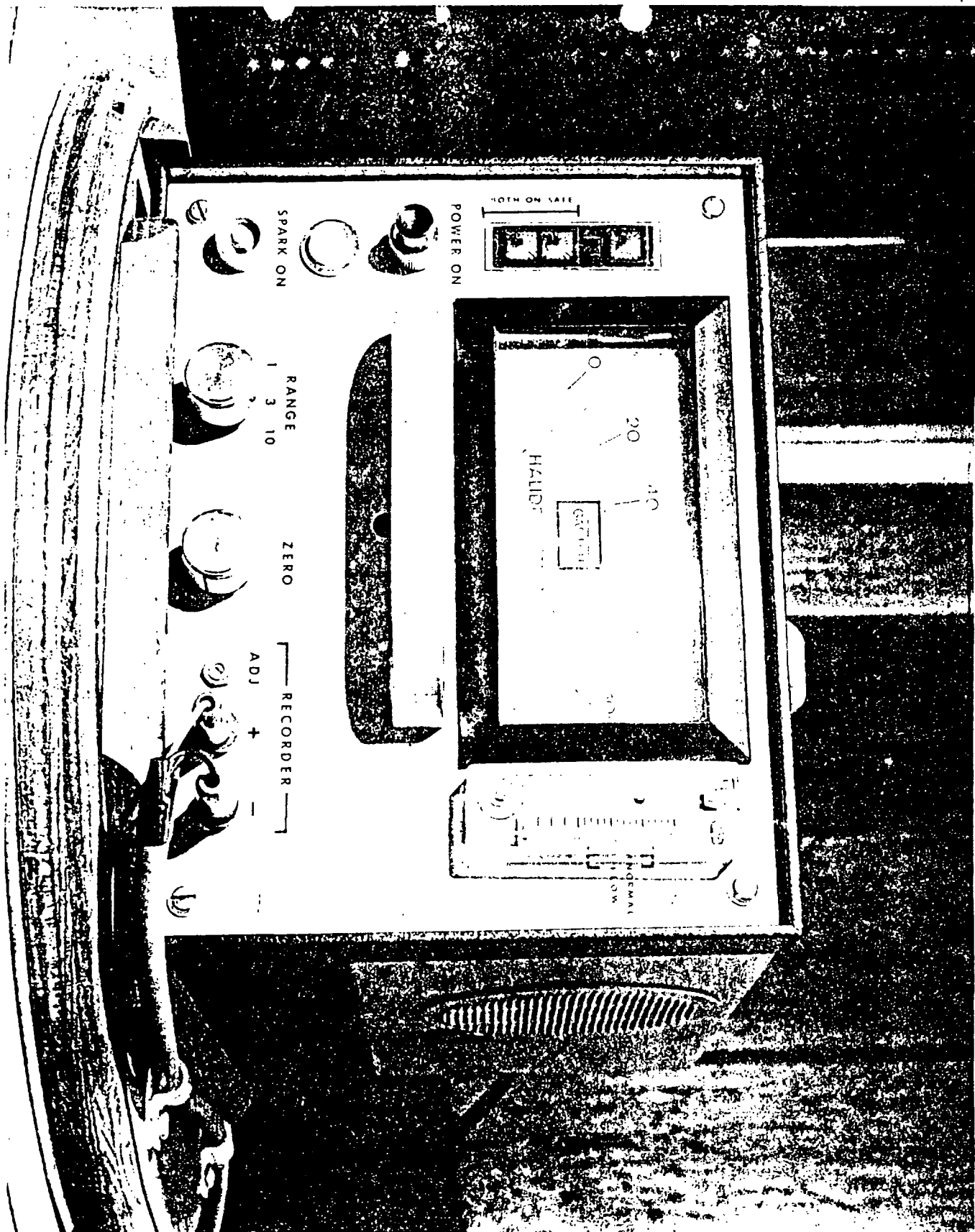


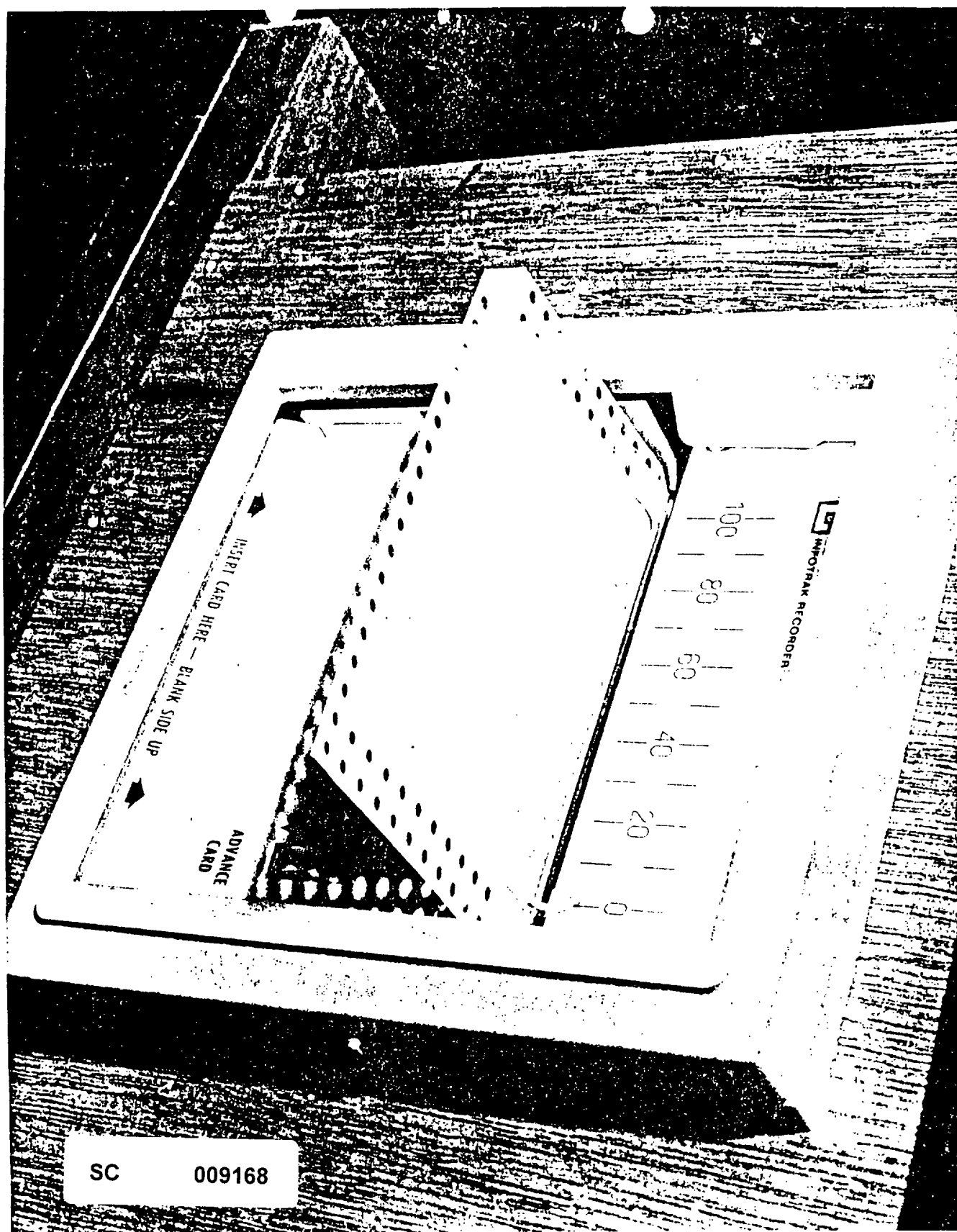
PLATE NO. 8

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THE GAS-TECH HALIDE DETECTION METER

LAM010379

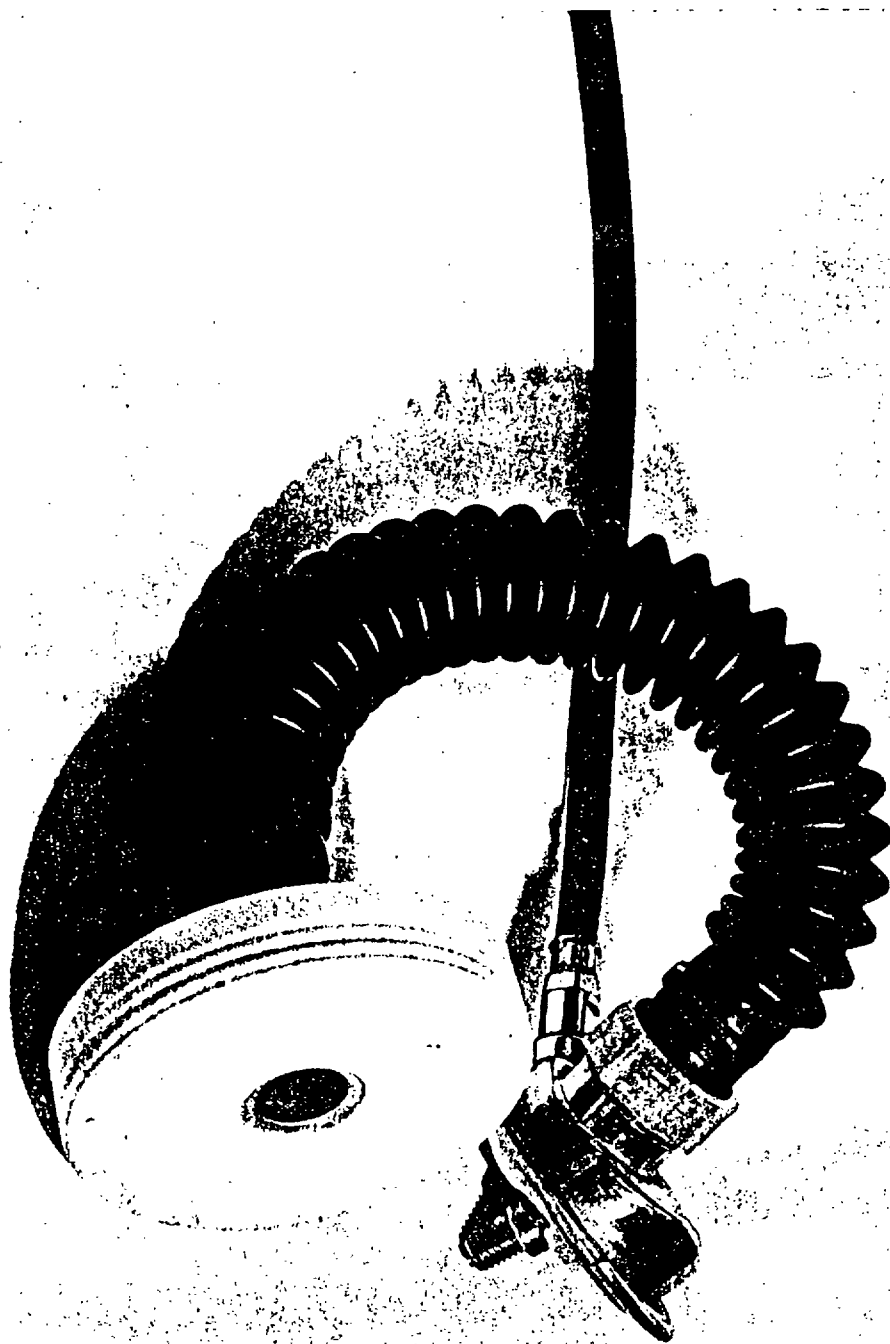


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PLATE NO. 9
STRIP CHART RECORDER

LAM010380



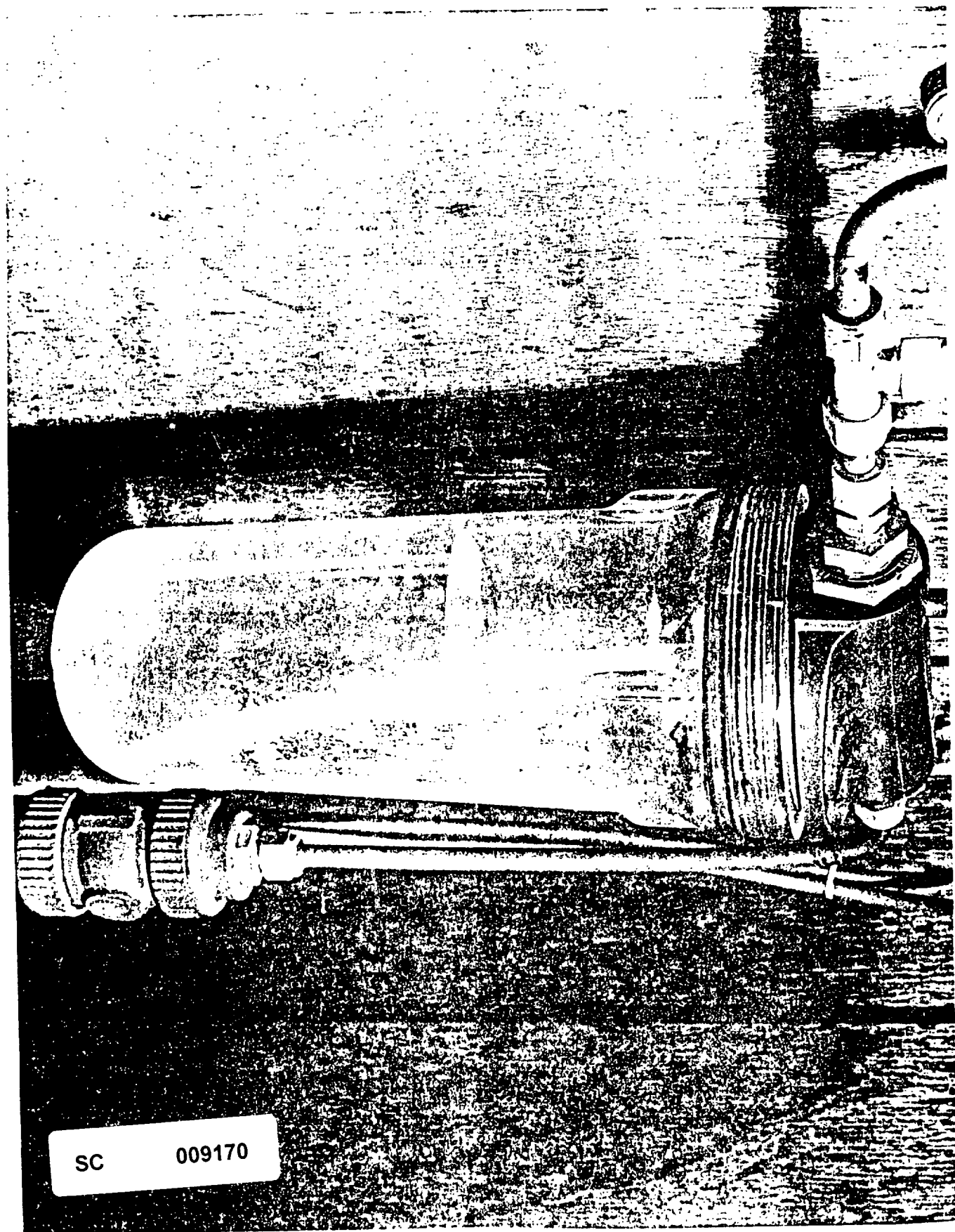
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PLATE NO. 10

DUMMY CARTRIDGE AND DEMAND REGULATOR

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PLATE NO. 11
HUMIDIFIER

LAM010382



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PLATE NO. 12

RESPIRATOR ASSEMBLED FOR TESTING

LAM010383



PLATE NO. 13
EMPLOYEE IN TEST PROCEDURE

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