NIOSH/TC/R-009

SILICA DUST TEST

for

RESPIRATORY PROTECTIVE DEVICES

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Respirator Section Test Procedure

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The silica dust test evaluates the perfomrance of air-purifying respirators against dusts of materials having a TWA not less than 0.05 mg/m^3 or 2 mppcf. This test also evaluates the resistance performance of pesticide respirators and filters to be used against materials having a TWA less than .05 mg/m^3 or 2 mppcf.

The dust test procedure is designed to determine whether a respirator meets the test performance requirements set forth in Title 30 Part 11 of the Code of Federal Regulations, Subparts 11.140-4 and 11.162-7 for maximum allowable penetration and in Subparts 11.130-9, 11.140-12, 11.162-1, and 11.183-4 for maximum allowable breathing resistances.

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LIST OF ABBREVIATIONS AND SYMBOLS

cm -- Centimeter

gm -- Gram

l -- Liter

lpm -- Liters per Minute

m^3 -- Cubic Meter

mg -- Milligram

mg/m^3 -- Milligram per Cubic Meter

min. -- Minute

ml -- Milliliters

mm -- Millimeter

mppcf -- Million Particles per Cubic Foot

psig -- Pound per Square Inch Gauge

TWA -- Time-weighted Average Concentration

$\leq$ -- Less than or Equal to

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ABSTRACT

The silica dust test evaluates the performance of air-purifying respirators against dusts of materials having a TWA not less than 0.05 mg/m^3 or 2 mppcf. This test also evaluates the resistance performance of pesticide respirators and filters to be used against materials having a TWA less than .05 mg/m^3 or 2 mppcf.

The dust test procedure is designed to determine whether a respirator meets the test performance requirements set forth in Title 30 Part 11 of the Code of Federal Regulations, Subparts 11.140-4 and 11.162-7 for maximum allowable penetration and in Subparts 11.130-9, 11.140-12, 11.162-1, and 11.183-4 for maximum allowable breathing resistances.

INTRODUCTION

This procedure describes the equipment and testing used by the National Institute for Occupational Safety and Health, Division of Safety Research, Testing and Certification Branch, Respirator Section to evaluate

(1) The penetration and resistance performance of various respirators used for protection against silica dust or any dust of a material with a time-weighted average (TWA) not less than .05 mg/m^3 or 2 mppcf (30 CFR, Part 11, Subparts 11.140-4, 11.140-9 and 11.162-1).

(2) The resistance performance of a respiratory protective device used for protection against the dust of a material with a TWA less than 0.05 mg/m^3 or 2 mppcf (30 CFR, Part 11, Subpart 11.140-12).

(3) The resistance performance of a respiratory protective device used for protection against pesticides (30 CFR, Part 11, Subparts 11.183-1 and 11.183-4).

Minimum test requirements of air-purifying respirators challenged against silica dust are set forth in Part 11 of 30 CFR, Subparts 11.140-4, 11.140-9, 11.140-12, 11.162-1, 11.162-7, 11.183-1, and 11.183-4.

§ 11.140–4 Silica dust test; single-use or reuseable filters; minimum requirements.

(a) Three respirators with single-use filters will be tested for periods of 90 minutes each at a continuous airflow rate of 32 liters per minute for air-purifying respirators, and for periods of 4 hours each at a flowrate not less than 115 liters per minute to tight-fitting facepieces, and not less than 170 liters per minute to loose-fitting hoods and helmets for powered air-purifying respirators.

(b) The relative humidity in the test chamber will be 20–80 percent, and the room temperature approximately 25° C.

(c) The test suspension in the chamber will not be less than 50 nor more than 60 milligrams of flint (99+ percent free silica) per cubic meter of air.

(d) The flint in suspension will be ground to pass 99+ percent through a 270-mesh sieve.

(e) The particle-size distribution of the test suspension will have a geometric mean of 0.4 to 0.6 micrometer, and the standard geometric deviation will not exceed 2.

(f) The total amount of unretained test suspension in samples taken during testing shall not exceed 1.5 milligrams for an air-purifying respirator, 14.4 milligrams for a powered air-purifying respirator with tight-fitting facepiece, and 21.3 milligrams for a powered air-purifying respirator with loose-fitting hood or helmet.

(g) Three respirators with reusable filters will be tested and shall meet the requirements specified in paragraphs (a) through (f) of this section; each filter shall be tested three times: Once as received; once after cleaning; and once after recleaning. The applicant's instructions shall be followed for each cleaning.

§ 11.140–9 Airflow resistance tests; all dust, fume, and mist respirators; minimum requirements.

(a) Resistance to airflow will be measured in the facepiece, mouthpiece, hood, or helmet of a dust, fume, or mist respirator mounted on a test fixture with air flowing at a continuous rate of 85 liters per minute, both before and after each test conducted in accordance with §§ 11.140–4 through 11.140–7.

(b) The maximum allowable resistance requirements for dust, fume, and mist respirators are as follows:

MAXIMUM RESISTANCE
(mm. water-column height)

Type of respirator	Initial Inhalation	Final Inhalation	Exhalation
Single-use	12	15	15
Dust, fume, and mist, with single-use filter	30	50	20
Dust, fume, and mist, with reusable filter	20	40	20
Radon daughter	18	[1] 25	15
Asbestos dust and mist	18	25	15

[1] Measured after silica dust test described in § 11.140–4.

§ 11.140–12 Silica dust loading test; respirators designed as protection against dusts, fumes, and mists having an air contamination level less than 0.05 milligram per cubic meter and against radionuclides; minimum requirements.

Three respirators will be tested in accordance with the provisions of § 11.140–4 and shall meet the minimum requirements of §§ 11.140–4 and 11.140.9.

§ 11.162–1 Breathing resistance test; minimum requirements.

(a) Resistance to airflow will be measured in the facepiece, mouthpiece, hood, or helmet of a chemical cartridge respirator mounted on a test fixture with air flowing at a continuous rate of 85 liters per minute, both before and after each test conducted in accordance with §§ 11.162–5 through 11.162–8.

(b) The maximum allowable resistance requirements for chemical cartridge respirators are as follows:

MAXIMUM RESISTANCE
(mm. water-column height)

Type of chemical cartridge respirator	Inhalation		Exhalation
	Initial	Final [1]	
For gases, vapors, or gases and vapors	40	45	20
For gases, vapors, or gases and vapors, and dusts, fumes, and mists	50	70	20
For gases, vapors, or gases and vapors, and mists of paints, lacquers, and enamels	50	70	20

[1] Measured at end of service life specified in Table 11.

§ 11.162–7 Dust, fume, and mist tests; respirators with filters; minimum requirements; general.

(a) Three respirators with cartridges containing, or having attached to them, filters for protection against dusts, fumes, and mists, except the mists of paints, lacquers, and enamels, will be tested in accordance with the provisions of § 11.162–8.

(b) In addition to the test requirements set forth in paragraph (a) of this section, three such respirators will be tested, as appropriate, in accordance with the provisions of §§ 11.140–1 through 11.140–14, however, the maximum allowable resistance of complete dust, fume, and mist, and gas, vapor, or gas and vapor chemical cartridge respirators shall not exceed the maximum allowable limits set forth in § 11.162–1.

§ 11.183–1 Breathing resistance test; minimum requirements.

(a) Airflow resistance will be measured in the facepiece, mouthpiece, hood, or helmet of a pesticide respirator mounted on a test fixture with air flowing at a continuous rate of 85 liters per minute, both before and after each test conducted in accordance with §§ 11.183–4 and 11.183–7.

(b) The maximum allowable resistance requirements for pesticide respirators are as follows:

MAXIMUM RESISTANCE
(mm. water-column height)

Type of Pesticide respirator	Inhalation		Exhalation
	Initial	Final [1]	
Front- or back-mounted gas mask	70	85	20
Chin-style gas mask	65	80	20
Powered air-purifying	[2] 50	[2] 70	[2] 20
Chemical cartridge	50	70	20

[1] Measured at end of the service life specified in Table 12.

[2] Resistance of filter(s), cartridge(s), and breathing tube(s) only with blower not operating.

§ 11.183–4 Silica dust test; minimum requirements.

Three completely assembled pesticide respirators will be tested with a mechanical-testing apparatus as follows:

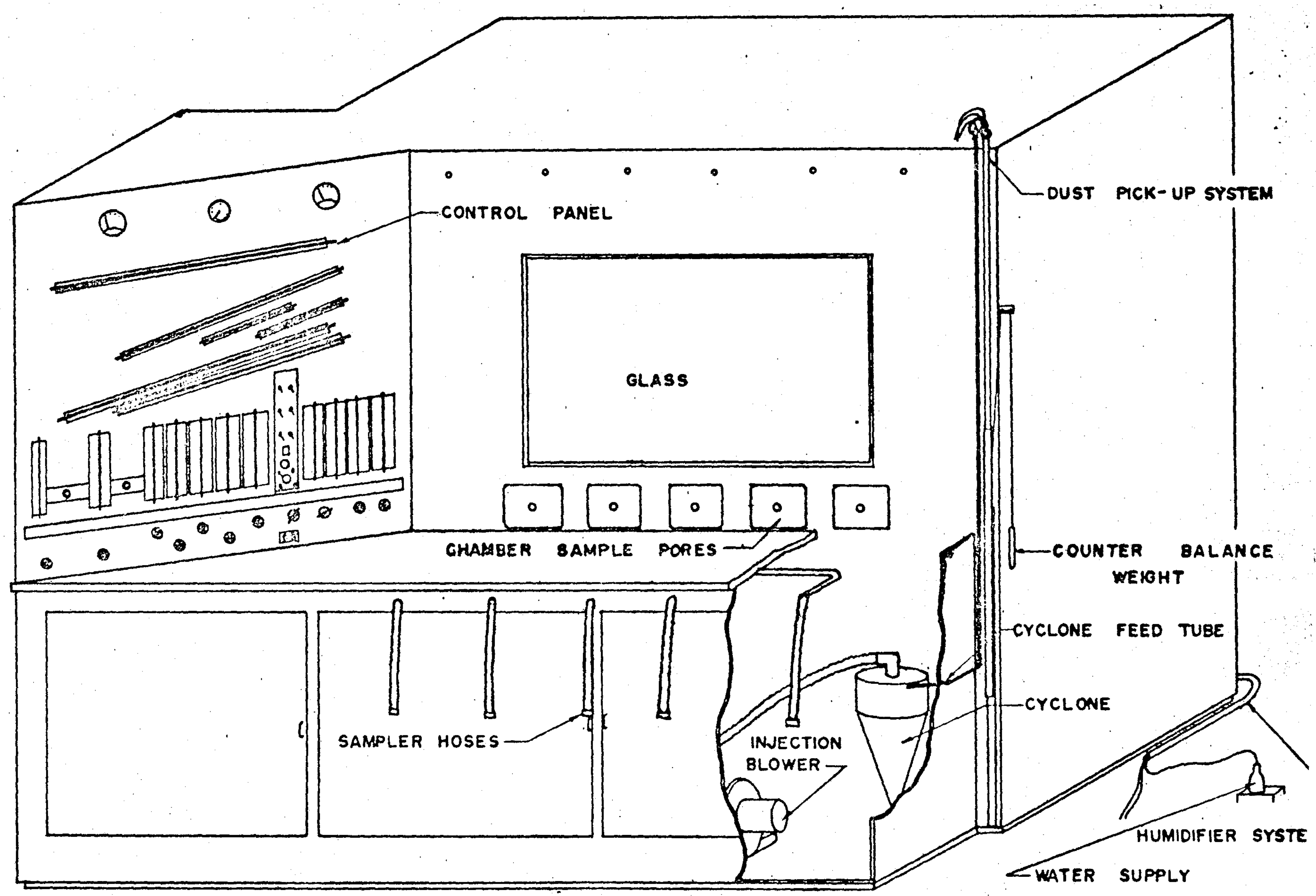
(a) Temperature in the test chamber will be approximately 25° C.

(b) Continuous airflow through the respirator will be 32 liters per minute for front-mounted, back-mounted, and chin-style gas mask pesticide respirators and chemical cartridge pesticide respirators, and not less than 115 (4 cubic feet) liters per minute to tight-fitting facepieces and 170 liters (6 cubic feet) per minute to loose-fitting hoods and helmets of powered air-purifying respirators.

(c) The test aerosol will contain 50–60 milligrams of 99+ percent free silica per cubic meter of air.

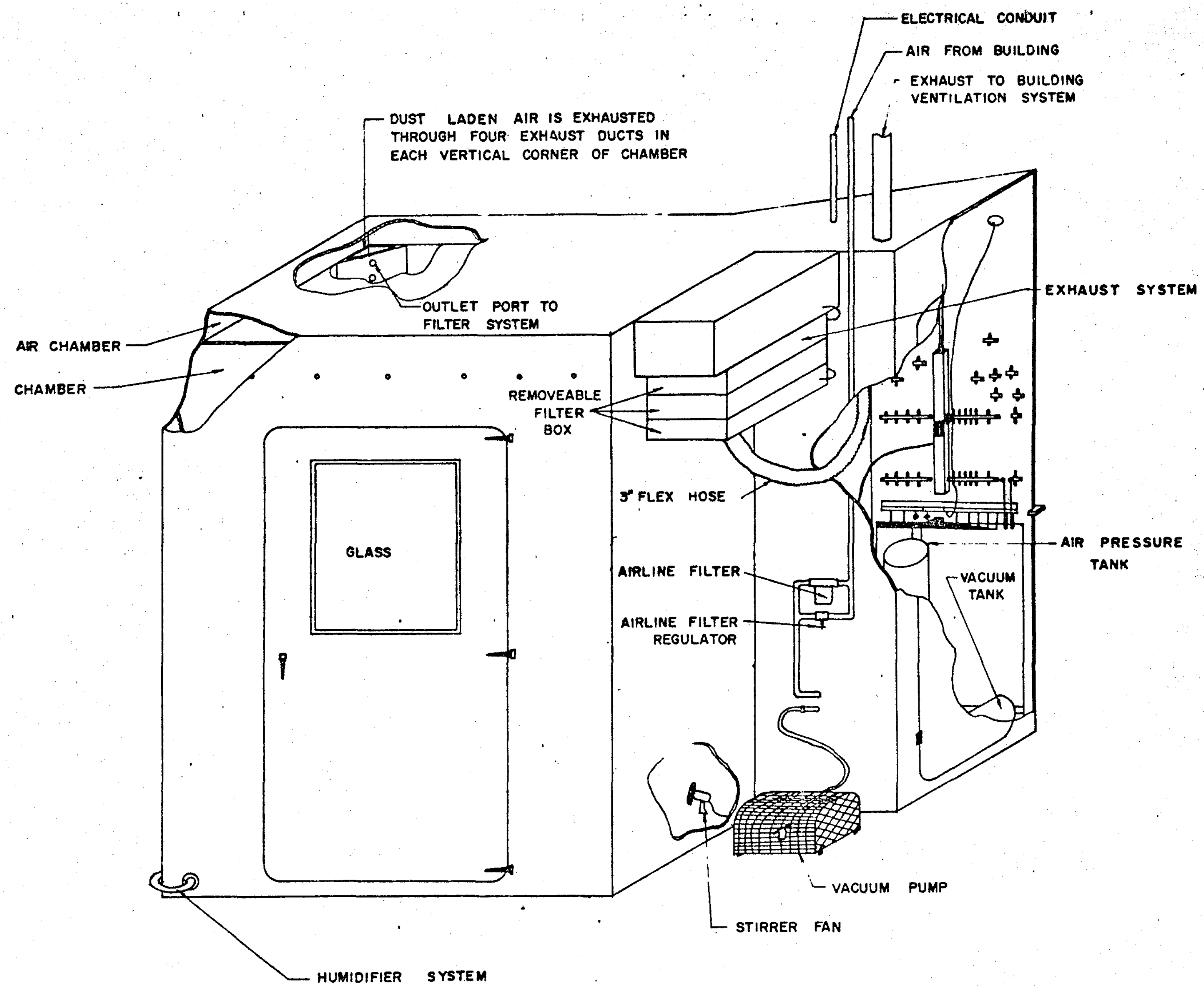
(d) The particle size distribution of the test suspension will have a geometric mean diameter of 0.4 to 0.6 micrometer, with a standard geometric deviation less than 2.

(e) Front-mounted, back-mounted, and chin-style gas mask pesticide respirators and chemical cartridge pesticide respirators will be tested for 90 minutes and powered air-purifying respirators will be tested for 4 hours.



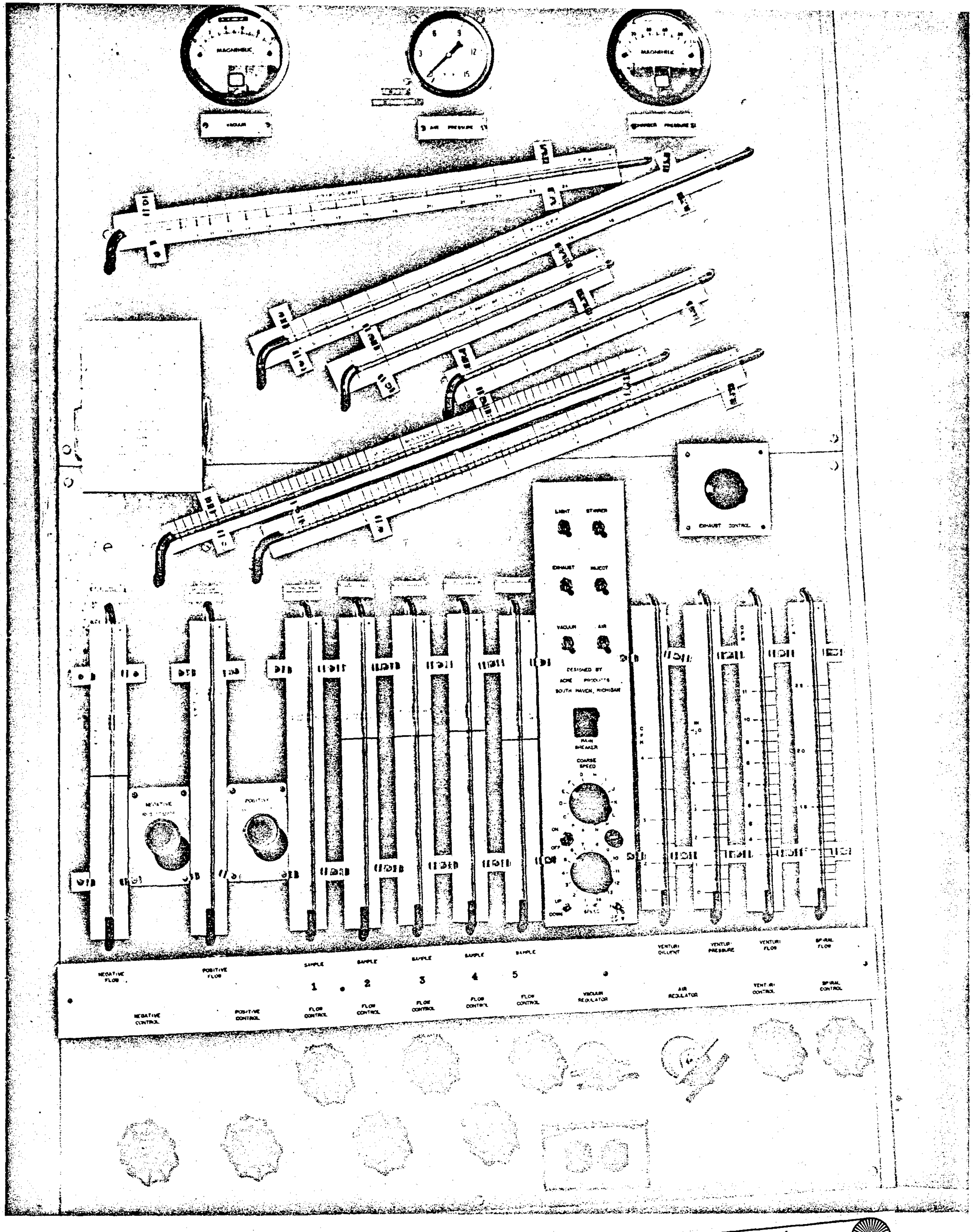
FRONT ISOMETRIC OF CHAMBER

Fig. 1

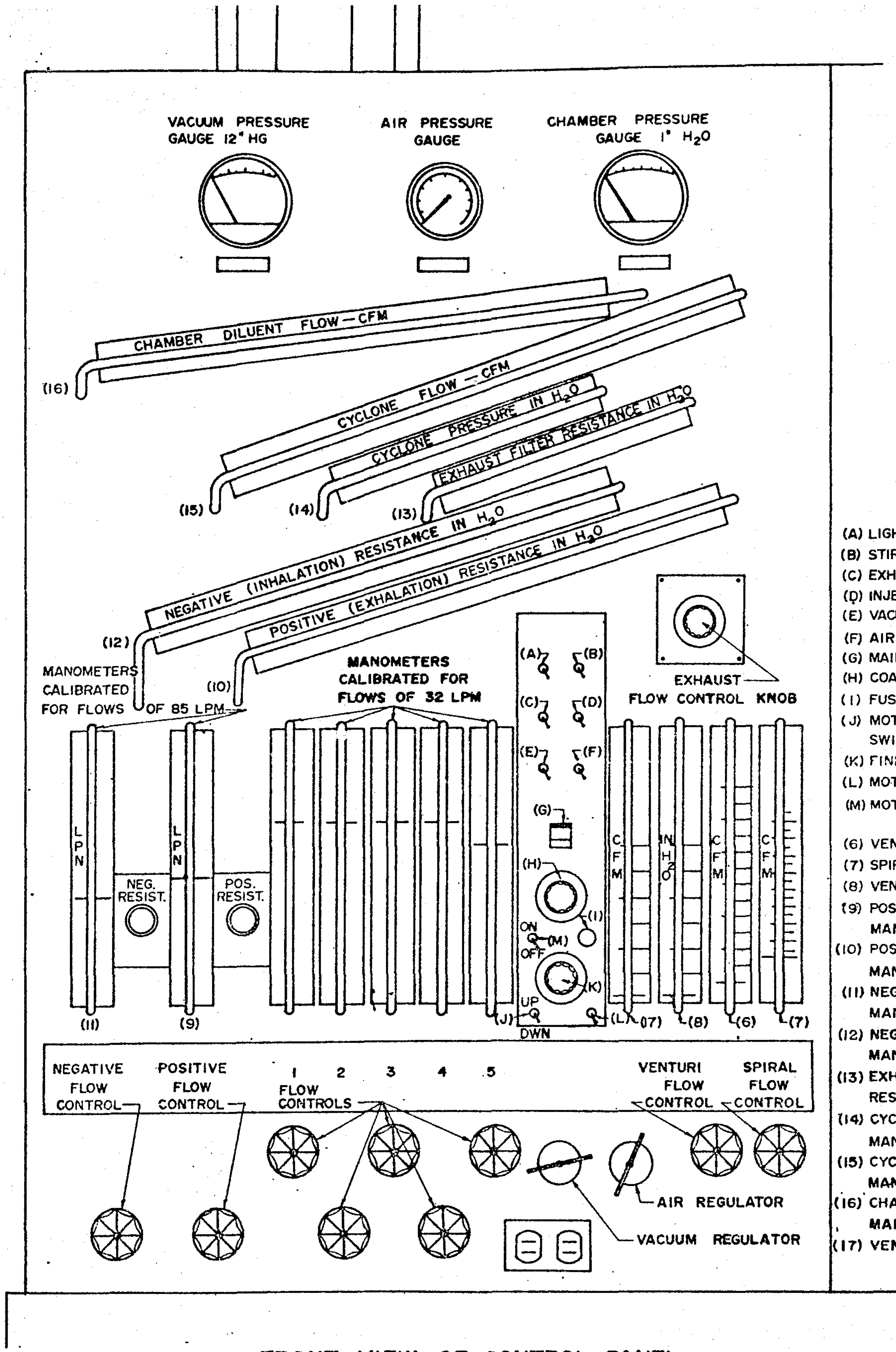


REAR ISOMETRIC OF CHAMBER

Fig. 2



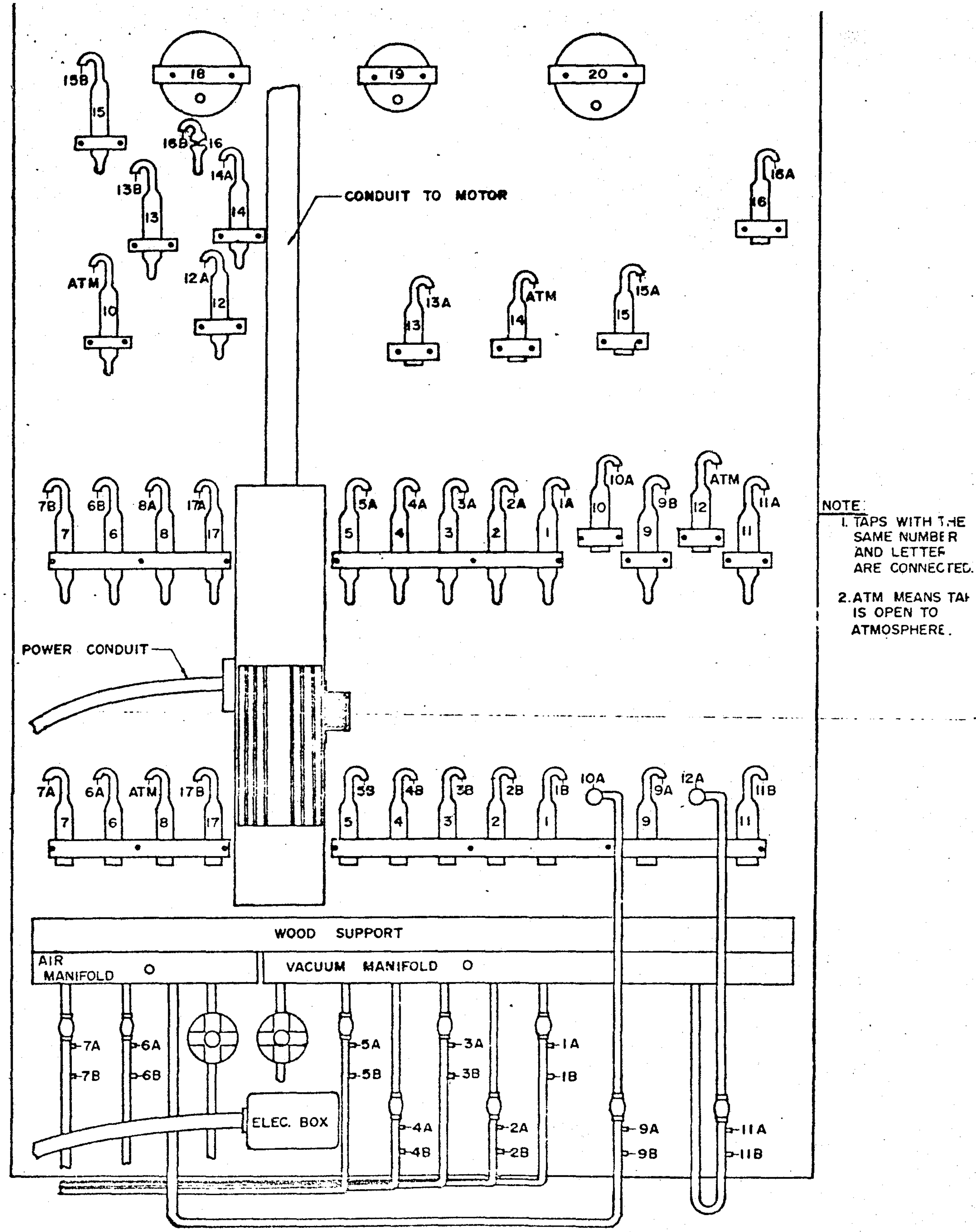
CONTROL PANEL Fig. 3



(A) LIGHT
(B) STIRRER. FAN
(C) EXHAUST BLOWER
(D) INJECTION BLOWER
(E) VACUUM PUMP
(F) AIR PUMP
(G) MAIN BREAKER
(H) COARSE SPEED
(I) FUSE
(J) MOTOR DIRECTIONAL SWITCH
(K) FINE SPEED
(L) MOTOR SPEED SWITCH
(M) MOTOR OFF-ON SWITCH

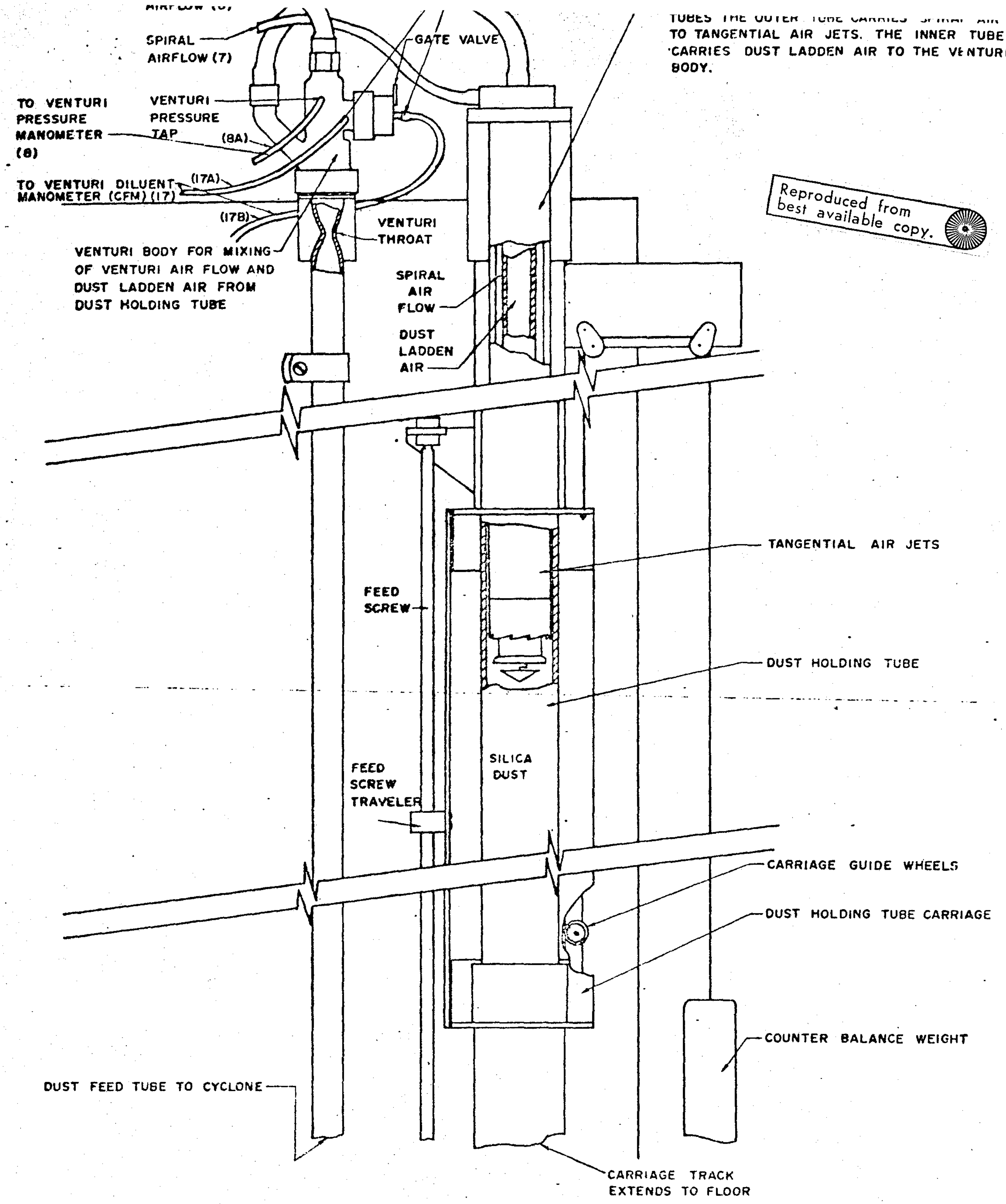
(6) VENTURI FLOW
(7) SPIRAL FLOW
(8) VENTURI PRESSURE
(9) POSITIVE 85 LPM MANOMETER
(10) POSITIVE RESISTANCE MANOMETER
(11) NEGATIVE 85 LPM MANOMETER
(12) NEGATIVE RESISTANCE MANOMETER
(13) EXHAUST FILTER RESISTANCE MANOMETER
(14) CYCLONE PRESSURE MANOMETER
(15) CYCLONE FLOW MANOMETER
(16) CHAMBER DILUENT MANOMETER
(17) VENTURI DILUENT

FRONT VIEW OF CONTROL PANEL



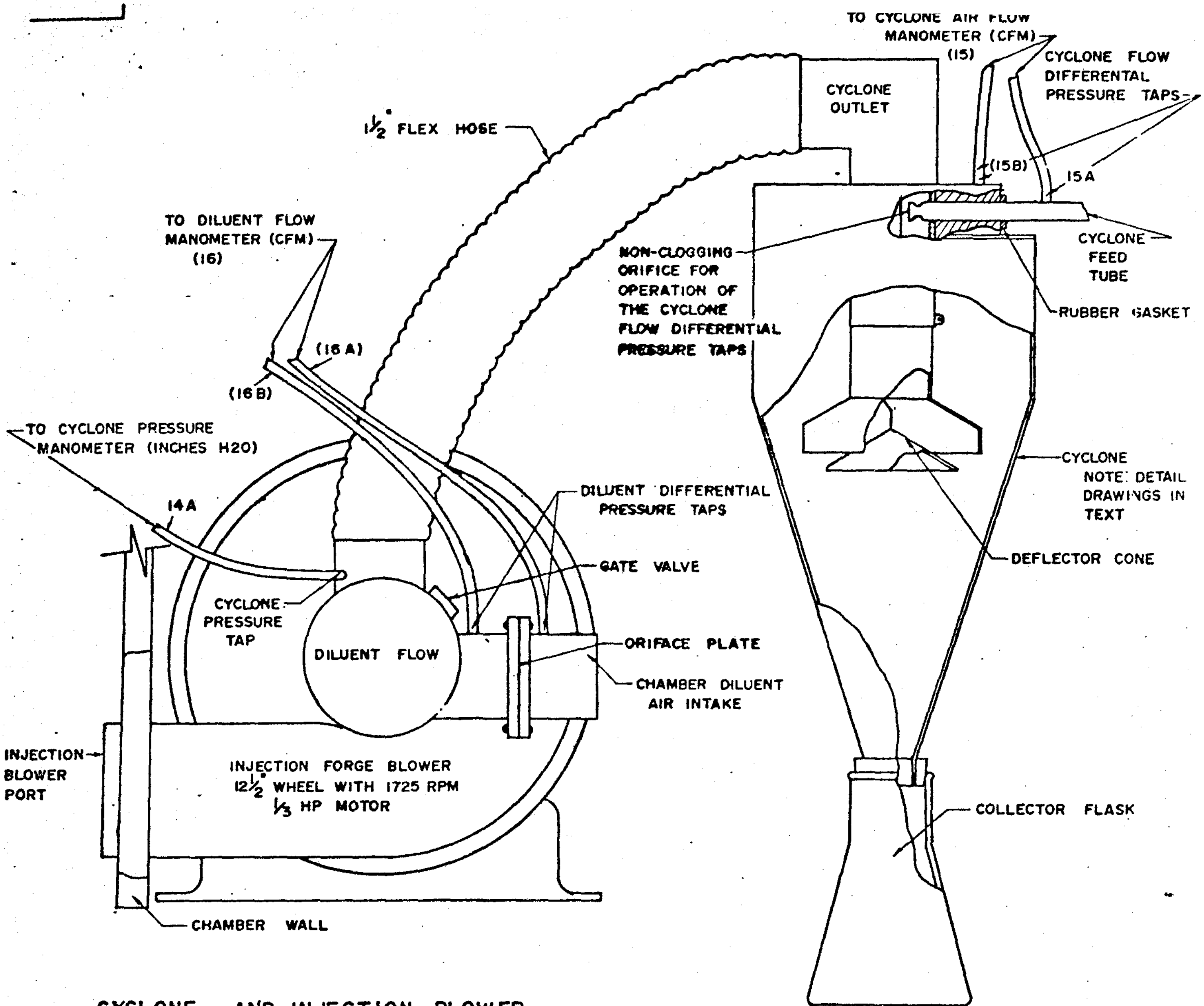
REAR VIEW OF CONTROL PANEL

Fig. 5



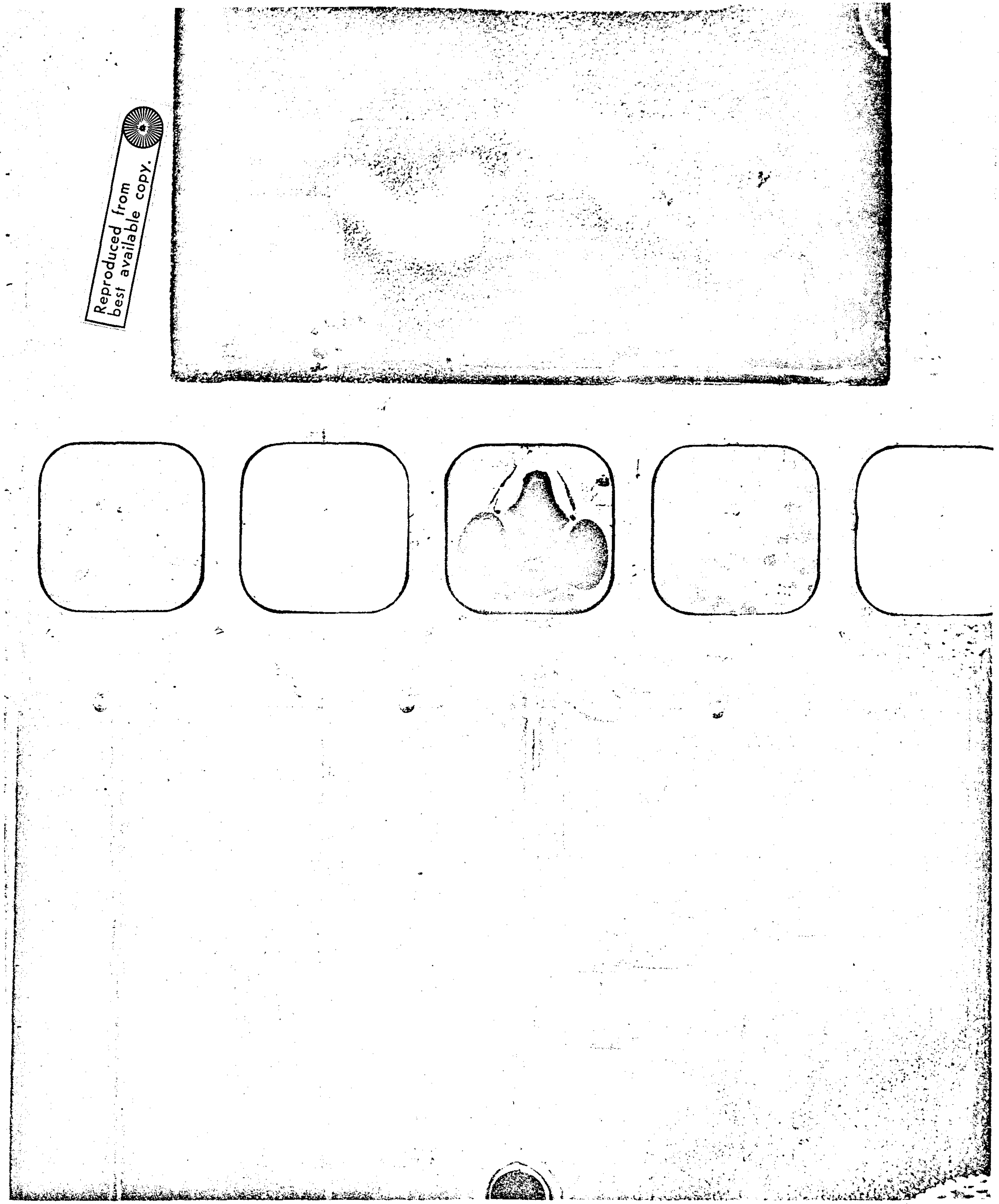
DUST FEED MECHANISM

Fig. 6

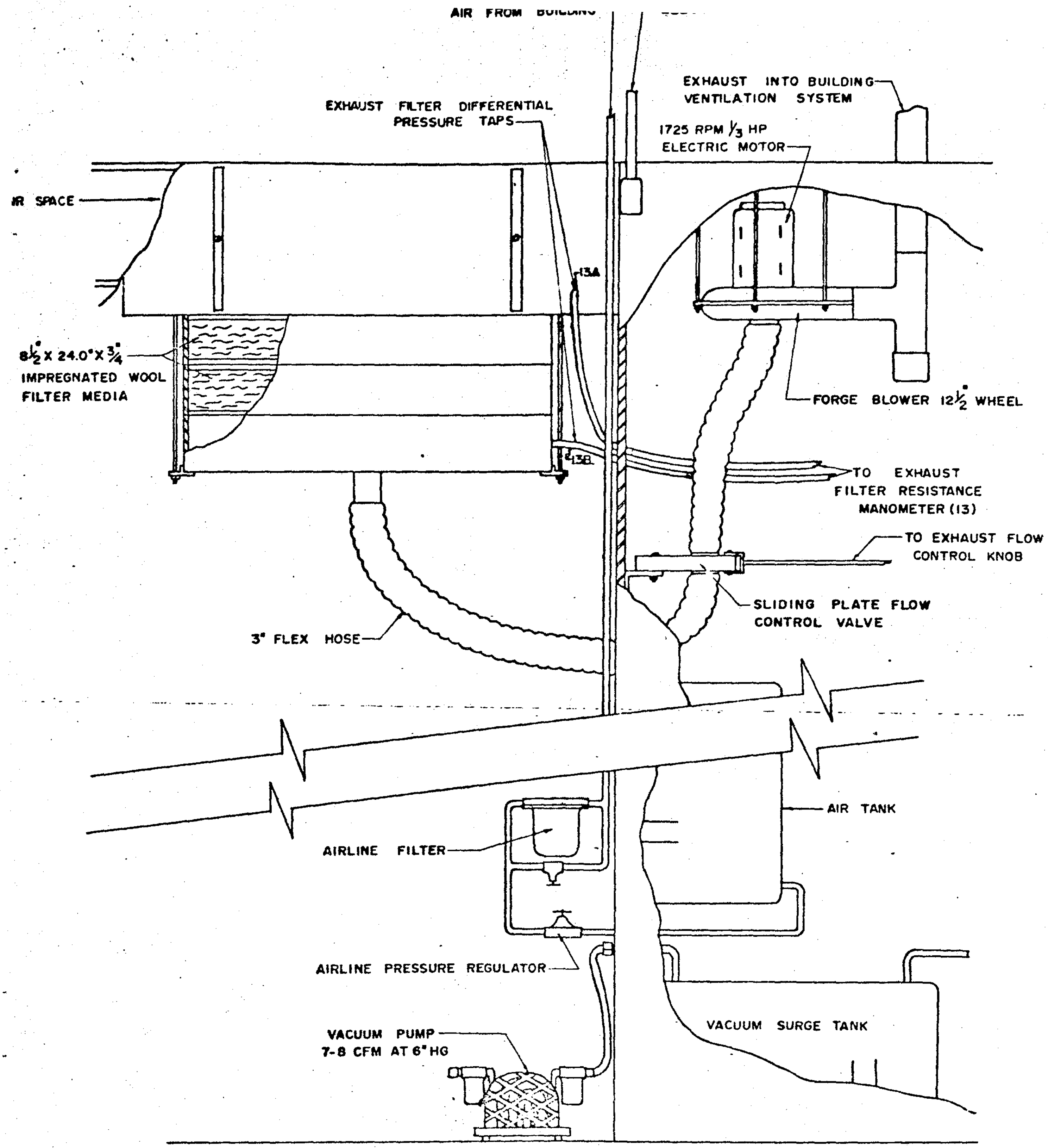


CYCLONE AND INJECTION BLOWER

Fig. 7

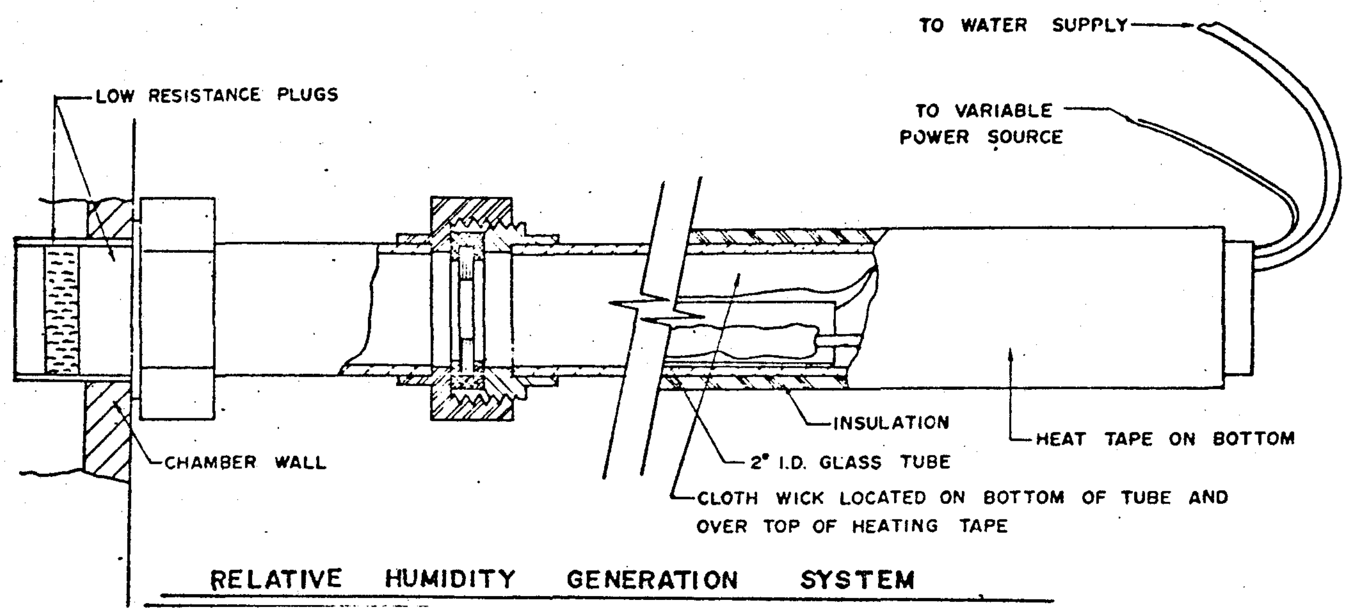


RESPIRATOR (without filters) IN TEST CHAMBER   Fig. 8



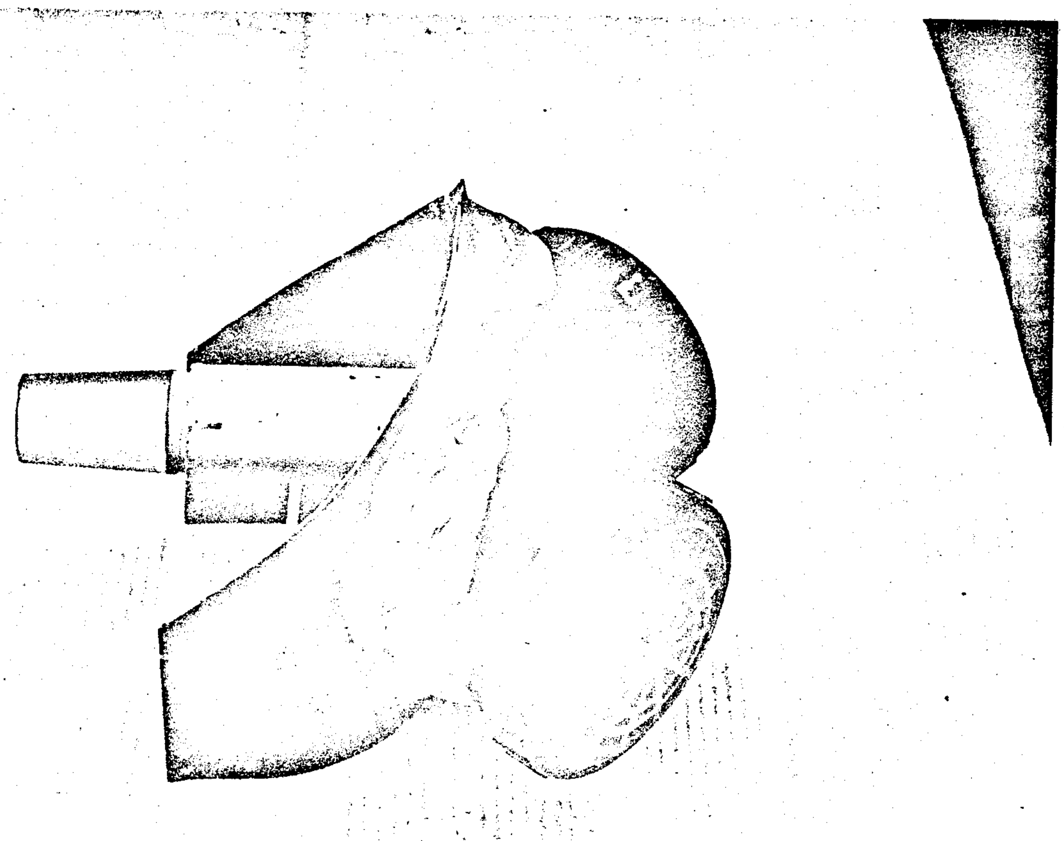
CHAMBER EXHAUST SYSTEM

Fig. 9



TO WATER SUPPLY
TO VARIABLE POWER SOURCE
LOW RESISTANCE PLUGS
CHAMBER WALL
INSULATION
HEAT TAPE ON BOTTOM
2" I.D. GLASS TUBE
CLOTH WICK LOCATED ON BOTTOM OF TUBE AND OVER TOP OF HEATING TAPE
RELATIVE HUMIDITY GENERATION SYSTEM

Fig. 10



Respirator Mounted on Test Jig Fig.11

EQUIPMENT REQUIRED

Silica Dust Chamber: Tests are conducted in a specially built laminated 1/2 inch marine grade plywood chamber equipped with a door in the rear and safety glass windows in both front and rear. The chamber floor is 5 feet by 5 feet, and the floor-to-ceiling distance is 7 feet (Figure 1 and 2). An explosion proof light fixture is installed inside the chamber, and a formica-topped work shelf 24 inches wide and 1-1/2 inches thick extends across the entire outside front of the chamber.

The control panel at the left side of the chamber front contains all electrical and air controls for the chamber operation. The following gauges and flow manometers are located on this panel (Figure 3): internal chamber pressure (neg. in. H_2O), sampling vacuum (in. Hg), air supply pressure (psi), spiral air flow (CFM), Venturi pressure (in. $H2O$), Venturi air flow (CFM), Venturi diluent (CFM), cyclone flow (CFM), injector diluent (CFM), cyclone pressure (in. H_2O), and five sampling flow meters (calibrated at 32 lpm) (Figures 4 and 5).

Dust is fed to the sizing equipment by means of a feed screw which lifts a glass dust holding tube at a constant rate (Figure 6). The feed screw is driven by an electronically controlled synchronous motor that allows rapid changes in feed rates for maintaining concentration. A step switch selects the feed rate; each step is synchronous and reproducible. Also a fast forward and fast reverse clutch is installed for quickly setting up the proper conditions in the dust feed tube (Figure 4, Items H, J, K, L, and M).

Dust pickup is accomplished by a jet flow pickup tube which dries and disperses dust evenly in the air stream, thereby eliminating clumps of particles due to packing. All components of the dust pickup apparatus (except the tangential jets) are constructed of pyrex glass so that operation can be monitored visually at all times (Figure 6).

Dust sizing is accomplished in a cyclone type separator equipped with an adjustable outlet and deflector cone. Properly sized particles are transported from the cyclone and injected into the chamber by a Buffalo Forge blower. The cyclone and injection blower are mounted conveniently below the right hand side of the work table (Figures 1 and 7). A totally enclosed motor and stirring fan are installed in the chamber to circulate the test atmosphere and help maintain uniform concentration at all sampling ports (Figure 2).

Five identical sampling ports, each of which accomodates a respirator, are provided in the front of the chamber below the window and above the work table. Adjacent to each sampling port is a suction line connection for drawing the test atmosphere through the respirator being evaluated at that port (Figure 1 and Figure 8). The inlet end of each sampling unit is fitted with a 29/42 female ground glass joint and contains an absolute filter holder three inches in diameter.

Each suction outlet connects to individual flow control facilities consisting of needle valve and calibrated orifice-manometer type flow meter. All manometers are oil filled and equipped with surge dampers and overflow reservoirs to prevent fluid loss in case of inadvertant overpressure in the system. Reservoirs automatically return fluid to manometer tube after overpressure has passed (Figures 4 and 5, Items 1, 2, 3, 4, and 5).

The source of negative pressure for the entire sampling system is a rotary carbon vane vacuum pump with a 12 gallon surge tank and vacuum regulator set to maintain a six-inch Hg vacuum. The rotary vacuum pump is powered by a 3/4 H.P. electric motor chosen for its dependability, minimum maintenance, and low noise level (Figure 9). The capacity of the pump exceeds the amount of vacuum required for testing. Air pressure for the chamber is supplied by house air and is regulatored to maintain 15 psi.

Test atmosphere is exhausted from the chamber at equal constant rates from the four vertical corner Ports (Figure 2) of the chamber through a high efficiency filter. A Buffalo Forge blower provides moving power for the exhaust system and discharges the filtered air back into the laboratory ventilation system. The entire chamber is maintained at a negative pressure during operation to prevent laboratory contamination (Figure 9).

A separate resistance measuring assembly is incorporated into the control panel for measuring positive and negative resistances at 85 lpm (Figure 3). Respirators are connected to this unit by means of 29/42 female ground glass joints. Respirator resistance is read on a slant tube manometer with a six-inch water column scale. A flow meter calibrated for 85 lpm and valves to adjust flow are incorporated into the resistance assembly (Figures 4 and 5, Item 9, 10, 11, and 12).

Chamber relative humidity is regulated between 40 and 60% relative humidity with a relative humidity generation system (Figure 10).

Analytical balance: Mettler BH-26 or equivalent. The balance is used to measure absolute filter weights and should have an accuracy of 10^{-4} gm.

Particle sizing system: A variety of equipment--including laser, optical, and electron microscope systems--is available for particulate size determination.

Absolute filter: Scott Aviation #68117-00 or MSA 1106B filters or equivalent.

Silica dust: Must conform to 30 CFR 11 minimum requirements.

SPECIAL PRECAUTIONS

(1) Care must be exercised so as not to bump the hoist carriage or the silica dust column once a test is in progress. The accumulation of dust in the spiral tube is easily dislodged and such a surge of dust increases the chamber concentration dramatically.

(2) The chamber pressure, cyclone pressure, Venturi flow, Venturi dilution, and spiral flow must be watched closely. These are the most critical chamber parameters. Cyclone flow is the most important factor in controlling particle size in the chamber. Since cyclone flow is a composite of Venturi flow, Venturi diluent, and spiral flow, it is important that these variables be held at their proper predetermined values.

CALIBRATION PROCEDURE

Part 11 of the Federal Register states that respiratory protective devices will be tested at a continuous airflow rate of 32 lpm and that the resistance of these devices will be checked at an airflow rate of 85 lpm. No error limit has been set for these flow rates; thus it is necessary to establish one.

The NIOSH Testing and ertification Branch, Respiratory Laboratory has established, by consideration of the realistic performance of differential pressure manometers, that estimates of air flow rates can be considered acceptable if within an error limit of 1% of the absolute 32 and 85 lpm flow rates. The acceptable estimates of the absolute flow rates are then 32 ± .3 lpm and 85 ± .8 lpm, respectively.

Calibration Procedure for the Silica Dust Chamber

The purpose of this procedure is to describe a calibration procedure, including minor repairs and adjustments, that can be performed in-house by a trainined technician.

Equipment Required:

Dry Gas Meter: American Meter model #115 and
American Meter model # 325, or equivalent.
Meter must be traceable to NBS.

Stopwatch: 1/10 second accuracy.

Tubing: Tygon or equivalent.

Calibration of the 32± .3 and 85 ± .8 lpm flows: The frequency of calibration is best established by experience; however, a calibration frequency of two months is recommended.

Connect dry gas meter via tubing to the sample port. Air flow through the meter should be as indicated by the flow manometer.

Set air flow manometer to the previous 32 or 85 lpm calibration mark.

If air flow does not fall within the limits of 32 ± .3 or 85 ± .8 lpm, readjust the air flow with the flow control valve until the desired flow is achieved.

A new calibration line should be made at the new manometer height position.

Particle Size Analysis

(1) Particle size should be checked every six months or if system parameters are readjusted. The particle-size distribution of the test suspension should have a geometric mean of 0.4 to 0.6 micrometers, and the standard geometric deviation should not exceed two.

(2) Equipment Required:

(a) Isokinetic sampler.

(b) Scanning electron microscope with an image analyzer.

(c) Other varied equipment is available for particle sizing and could also be used.

OPERATING PROCEDURE

I. Chamber Preparation: Before starting test, be sure that the door and all ports are closed.

II. Dust Tube Filling: To help maintain repeatability and uniformity in column packing, a known amount of dust (e.g. 200 gm) should be packed to a given column height (e.g. 11") each day. Using a funnel, pour about three or four inches of the preweighed dust into the tube and pack. Repeat filling and packing until all dust is added. Several techniques can be used to pack the tube after each three or four inch addition of silica dust. One technique is to attach a vacuum source to the top of the holding tube. (Note: A filter should be inserted into the vacuum line to prevent dust from entering the vacuum system.) By tapping the bottom of the dust holding tube on a rubber pad, the dust bed is packed and any trapped air is removed by the vacuum source.

The top surface of a properly packed column of dust should not bounce up and down more than 1/8 inch when the bottom of the holding tube is tapped on a rubber pad. Excessive bouncing of the top surface is indicative of trapped air.

III. Chamber Start-up:

(1) Place packed dust tube in the hoist carriage, taking care that the hoist carriage is firmly connected to the feed screw attachment.

(2) Turn on main breaker switch.

(3) (a) Turn stepping motor on-off switch to the on position and the up-down directional switch to the up (down if lowering the column) position.

(b) Set high-off-low speed switch, which provides manual control of stepping motor speed, in the high speed position. Tube will rise rapidly. Be sure the spiral tube enters the dust tube properly.

(c) When the top of the silica dust is approximately one inch from the bottom of the spiral tube, switch the motor speed control to off and then to low.

(d) Control low speed with the coarse and fine speed adjustments. Low speed control is important because it directly helps control the chamber concentration of silica dust.

(4) Turn on Venturi vibrator. This chamber modification was made to prevent excessive accumulations of silica dust within the Venturi body, which would break loose and suddenly alter the chamber concentration of silica dust.

(5) Relative Humidity System (Figure 9)

(a) Turn on water pump for the humidification system and adjust to deliver approximately 2.8 ml/min.

(b) When the wick is wet, activate heat tape powerstat and adjust to 85 volts (approx. 120° C).

(c) Inspect the wick visually and adjust flow during the day. The amount of water used by the system varies indirectly with room relative humidity.

(6) Turn on the house air supply and adjust to 14 psig with the in-line pressure regulator.

(7) Turn on the stirrer, exhaust, and inject switches.

(8) Chamber controls determined by operator should be set and held at their respective values, e.g.:

Air Pressure . . . . .14 psig

Chamber Pressure . . . . .0.56 $\pm$ 0.02 in H_2O*

Cyclone Flow . . . . .7.0 $\pm$ 5 CFM

Cyclone Pressure . . . . .2.1 to 2.2 in H_2O

Spiral Flow. . . . . .2.0 CFM

Venturi Flow . . . . .3.0 CFM

Venturi Diluent. . . . . .1.0 CFM

Venturi Pressure . . . . .1.0 to 1.2 in H_2O

Chamber Diluent. . . . . .0 CFM

* Make certain all ports are tightly closed.

(9) Check exhaust filter resistance. If the resistance

exceeds three inches of water, remove the upper filter holder and replace the filter. When reinstalling, interchange the top and bottom filtzr holders so that the newest filter is always on the bottom.

(10) Let the chamber run for a minimum of 30 minutes to reach equilibrium.

(11) Attach facepieces to the mask holders having male glass joints. Mounting is done with Rope Caulk[R]. (Figure 11).

(a) Test mounting seal to insure that no leaks are present. Place end of a clear piece of tubing over the male glass joint of the respirator holder and place the other end in a beaker containing at least three inches of water. Place rubber stoppers in the inhalation and exhalation valve openings. If the mounting has no leaks, the water in the tube will have very minimal movement when the tube is lifted to near the top of the water surface.

(b) Attach filters and/or cartridges on the facepiece.

(12) Measure and record the initial inhalation and exhalation resistances of the respirators.

(a) Negative Resistance--with ground glass joint open to atmosphere. Turn on vacuum pump and adjust negative flow control valve to register 85 lpm on flow meter.

Check zero on negative resistance slant tube manometer. If fluid level is not at zero, slide scale to read zero.

Insert test fixture into ground glass joint and re-adjust to 85 lpm if necessary. Read resistance (pressure drop) directly from slant tube manometer in inches of water.

(b) Positive Resistance--with ground glass joint open to atmosphere. Turn on air compressor and adjust positive flow control valve to register 85 lpm on flow meter.

Check zero on Positive resistance slant tube manometer and re-adjust if necessary.

Insert test fixture into ground glass joint and re-adjust to 85 lpm if necessary. Read resistance (pressure drop) directly from slant tube manometer in inches of water.

(13) Using a sling psychromoter, measure room and chamber relative humidity and record.

(a) A blank port with a "hole" serves as the chamber relative humidity sampling port. The arm holding the sling is placed in the chamber to measure chamber relative humidity.

(b) The relative humidity should be taken before the masks are placed in the chamber. This will insure ample room in which to swing the sling psychrometer.

(c) Be sure that the port is tightly closed and that no air leaks around the arm. If room air leaks around the port or arm, it will affect the chamber relative humidity reading. Leakage can be checked by observing the chamber pressure reading. If the reading returns to approximately 0.56, no leakage is present.

(14) Check chamber concentration.

(a) Weigh and record initial weight of absolute filter.

(b) Place absolute filter in filter holder.

(c) Remove blank port and install sampling port.

(d) Attach vacuum line to absolute filter holder.

(e) Turn on vacuum switch and timer. Adjust the flow rate to 32 lpm and the vacuum pressure to 6.2 in. Hg.

(f) After 10 minutes, stop vacuum and timer.

(g) Remove sampling port and replace blank port.

(h) Carefully remove and weigh filter. Record weight.

(i) Calculate chamber concentration (see analysis and recording of data, item #2).

If concentration is between 50 and 60 mg/m^3 , begin test. If the concentration is not within this range, run an additional concentration test for 10 minutes. If this test is within expected level, start respirator test. If this test is still outside the acceptable range, adjustments must be made to bring chamber concentration into proper level. To increase or decrease concentration, increase or decrease the speed of dust hoist drive motor by changing setting on dust hoist speed controls. Wait at least 15 minutes before the next chamber concentration check.

(15) Test respirators when concentration is within 50 - 60 mg/m^3 range, begin test using test parameters in 30 CFR, Part 11.

(a) Record absolute filter weights and place absolute filters in holders.

(b) Connect mounted masks to filter ports and install in chamber (Figure 8).

(c) Attach vacuum lines.

(d) Turn on vacuum and timer. Adjust flow rate to 32 lpm, vacuum pressure to 6.2 in. Hg. As concentration tests are started and stopped during the test, and as resistance builds up on the respirator filters, flow corrections will be necessary and should be made using the vacuum regulator control. This will simultaneously increase or decrease the flow in all operating flow meters.

(e) Adjust chamber pressure to 0.56 in. H_2O. As samples are withdrawn from chamber or concentration tests are started and stopped, a slight adjustment of the chamber pressure must be made with the exhaust flow control to balance the flow and maintain pressure in the chamber.

(f) Take four concentration samples at 0-10, 25-35, 55-65, and 80-90 minutes.

(g) At end of test, turn off vacuum and replace ports.

(h) Weigh and record absolute filter weights.

(16) Measure and record final inhalation and exhalation resistances. (See step 12).

(17) Lower dust column hoist carriage.

(18) Calculate chamber concentrations and respirator penetration.

(19) Chamber Shut Down:

(a) Turn dust hoist switch to down and set high/low speed switch in high position to lower dust tube. Remove from the hoist. Turn high/low switch to off position.

(b) Lightly tap dust pickup tube and Venturi housing to dislodge any accumulation of dust in these areas.

Also tap cyclone and injection blower to shake loose accumulated dust.

(c) Turn off house air or shut off spiral and Venturi air supply control valves.

(d) Turn off injection blower switch.

(e) Turn off stirrer fan within chamber.

(f) Open one sample port near center of chamber and allow exhaust blower to run until chamber is cleared (approximately 15 or 20 minutes).

(g) Shut off exhaust blower.

ANALYSIS AND RECORDING OF DATA

1. Resistance reported in the Federal Register, Part 11, are in mm H_2O (inches H_2O x 25.4 mm/inch = mm H_2O).

2. Concentration Calculation:

   Concentration = Filter weight gain divided by volume of air sampled.
   Note: Weight gain = final filter weight minus initial filter weight.
   Volume of air sampled = 32 l/min x 10 min = 320 l x 10^{-3}/l = .32 m^3
   (10^{-3} m^3/l is the factor for conversion of l to m^3).

3. Penetration Determination:

   Final filter weight minus initial filter weight = amount of penetration. If amount of penetration is less than or equal to that value specified in the Federal Register, Part 11.140-7, the respirator protective device passes the penetration criteria.

4. Resistance Determination:

   If the resistances, measured in mm of water for a respiratory protective device, do not exceed the limits specified for the device in the Federal Register, Parts 11.140-9 and 11.140-10, the device passes the resistance criteria.

5. Port Sampling error:

   Percent error was calculated by:

$$P.D. = \frac{\Delta \text{ observed value}}{\text{average of observations}} \times 100$$

or

$$P.E. = \frac{\text{high sample} - \text{low sample}}{\text{average of all samples}} \times 100$$

Where:

High sample = highest absolute filter weight gain between four ports when sampled simultaneously.

Low sample = lowest absolute filter weight gain between four ports when sampled simultantously.

Average of all samples= average absolute filter weight gain of four ports when sampled simultaneously.

MAINTENANCE

1. Lubrication--The vacuum pump has sealed bearings which are lubricated for life. However, the electric motors on the vacuum pump, injection blower, and exhaust blower should receive a few drops of a good quality light machine oil according to the recommendations. The dust hoist feed screw bearings at top and bottom of the feed screw should also be lubricated. No lubrication should be applied to the brass feed screw. The brass feed screw should be cleaned regularly to remove accumulated dust and dirt, but no lubrication should be applied. It is designed to operate "dry".

2. Flow Meters--All flow meters in the equipment are differential reading manometers which measure the pressure drop across stainless steel orifice plates (Figure 5 1A and B through 5A and B). An accumulation of dirt on this orifice plate can affect calibration. All orifice plates can easily be removed and cleaned in soapy water. Operating position and flow direction are marked on the plates and each is calibrated individually. If interchanged plates are on the chamber, the flow calibration will change. It is best to clean the plates one at a time to prevent confusion.

3. Cyclone and Venturi--The small barb type pressure taps on the cyclone and Venturi housings can occasionally become clogged with dust, which can result in improper readings or sluggish movement of the manometers. If improper action is observed, these samll barbs can be cleaned easily by removing the plastic hose and pushing a small wire through the fitting. Occasionally the cyclone should be removed from the cabinet and the top outlet assembly removed to allow visual inspection of the interior. The dust enters at the inlet and immediately strikes a stainless steel wear plate. Eventually this plate will wear thin at the point of impact and should be replaced. If it is not replaced, turbulence will be introduced and the cyclone side wall at the point of impact will be worn away. Several years of normal service should be expected before replacement of the wear plate is necessary.

4. Exhaust Filter Replacement--By loosening the two wing nuts clamping the exhaust filter boxes in place, the two filters can be removed. This should be done when the filter resistance manometer reads three inches of water (pressure drop). Discard the wool filter pad from the top filter box only. After cleaning loose dust from the filter holder, place a new filter pad in this box. Place the two filters back into position on the chamber with the new filter on the bottom and the old filter (formerly the bottom filter) on the top. The old final filter becomes th pre-filter and the new filter becomes the final filter.

5. Clean out injection blower port as necessary.

6. Check flow control valves for leakage.

Project # ____________ Date Initiated __/__/__ Test # ________

Company ____________ Test Unit ____________

Action Requested ____

____

Date Test Unit Received __/__/__ Date Tested __/__/__

Tested to meet requirements of Title 30 subpart ____________

Resistance: Inhalation (mm H_2O) Exhalation (mm H_2O)

	Inhalation Initial	Inhalation Final	Exhalation Initial	Exhalation Final
Mask A	( )______	( )______	( )______	( )______
Mask B	( )______	( )______	( )______	( )______
Mask C	( )______	( )______	( )______	( )______

Chamber Concentration:

Time (min)	Initial Wt.(mg)	Final Wt. (mg)	Gain (mg)	Conc. (mg/m)	Motor Speed
0					
30					
60					
90					

Average Concentration: ________ mg/m^3

Leakage:	Initial wt (mg)	Final wt (mg)	Gain (mg)
Mask A			
Mask B			
Mask C			

Relative Humidity:	Initial R.H. at Time	Final R.H. at Time
Room		
Chamber		

Operator: ____________________

Comments:

APPENDIX B--BIBLIOGRAPHY

Interior, United States Department of, Title 30 CFR, Part 11, 37 FR 6244.

APPENDIX C--GLOSSARY

Dust--A solid, mechanically-produced particle ranging in size from sub-microscopic to macroscopic.

Facepiece or mouthpiece--A respirator component designed to provide a gas-tight or dust-tight fit with the face. It may include headbands, valves, and connections for canisters, cartridges, filters, or respirable gas source.

Hood or helmet--A respirator component which covers the wearer's head and neck (or head, neck, and shoulders) and is supplied with incoming respirable air for the wearer to breathe. It may include a headharness and connection for a breathing tube.

NIOSH--National Institute for Occupational Safety and Health, Department of Health, Eduction, and Welfare.

Powered-air purifying respirator--A respiratory device equipped with a facepiece, hood or helmet, breathing tube, canister, cartridge, filter, canister with filter or cartridge with filter and a blower.

Respirator--Any device designed to provide the wearer with respiratory protection against inhalation of a hazardous atmosphere.

TCB--Testing and Certification Branch of the Division of Safety Research, Appalachian Laboratory for Occupational Safety and Health, National Institute for Occupational Safety and Health.