AIR CLEANER TEST CODE—SAE J726

SAE Recommended Practice

Report of the Tractor and Equipment Division approved January 1941 and last revised by the Engine Committee and Tractor Technical Committee March 1960.

CHART FOR DETERMINATION OF SPECIFIC TYPES OF AIR CLEANERS

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		Oil Wetted	Oil Bath	Dry Type	Multistage
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14.0	Determination of Backfire and Flame Resistance	14.2	14.1	14.2	As Applicable

1.0 Scope—This test code is for laboratory use in determining the operating characteristics of air cleaners. It refers specifically to laboratory testing of oil bath, oil wetted, dry and multistage air cleaners. Other types should follow this recommended practice wherever applicable. Multistage types should be evaluated as a complete assembly although, if desired, a component stage can be tested separately in accordance with its individual type.

This code contains alternate procedures and permits prescribing certain specific conditions of a test. Therefore reported results of tests are not complete unless accompanied by statements, where applicable, of the specific conditions such as: (1) rated air flow, (2) prescribed air flow, (3) steady or variable airflow, (4) fine or coarse dust, (5) amount of dust, and (6) maximum permissible restriction.

2.0 Material and Apparatus—Test oil for oil bath types shall be of two grades: (a) light, SAE 10; (b) heavy, SAE 30.

Test dust[1] shall be standardized and shall be of two grades (labeled "fine" and "coarse"). The following chemical analysis is typical:

TABLE 1—CHEMICAL ANALYSIS OF TEST DUST

Chemical	% by Weight
SiO_2	67 to 69
Fe_2O_3	3 to 5
Al_2O_3	15 to 17
CaO	2 to 4
MgO	0.5 to 1.5
Total Alkalis	3 to 5
Ignition Loss	2 to 3

The particle size distribution by weight as measured with a Roller analyzer shall be as follows:

TABLE 2—PARTICLE SIZE DISTRIBUTION BY WEIGHT, PER CENT

Size, Microns	Fine Grade	Coarse Grade
0-5	39 ± 2	12 ± 2
5-10	18 ± 3	12 ± 3
10-20	16 ± 3	14 ± 3
20-40	18 ± 3	23 ± 3
40-80	9 ± 3	30 ± 3
80-200	—	9 ± 3

[1] Obtainable from AC Division, General Motors Corporation, Flint, Michigan.

[2] Obtainable from Owens Corning Fiberglas Co., Santa Clara, California—their ½ in. PF105 or equivalent.

A suitable means (engine, blower, or the like) for inducing and controlling an adequate airflow under at least 8 in. Hg vacuum shall be provided.

The airflow meter shall be of an accepted design, such as a calibrated orifice. Corrections shall be made for variations in absolute pressure and temperature at the meter inlet, and the airflow shall be expressed in cubic feet per minute corrected to 29.92 in. Hg and 80 F or 29.70 in. Hg and 80 F, depending on the accepted practice. (Corrections to 29.70 in. Hg are generally used in the automotive field, while the 29.92 in. Hg corrections are generally used by ordnance and the heavy duty and tractor engine field.)

Piezometer tubes shall be made in accordance with Fig. 1. The inside diameter of the piezometer shall be the same as the inside diameter of the air cleaner outlet or of equivalent area for remotely mounted air cleaners. For air cleaners mounted directly to a carburetor, the piezometer should have approximately the same area as the carburetor air passage. It is recommended that the following standardized piezometer sizes be used where practical for cleaners mounted directly to a carburetor: piezometer inside diameter—2 in., 3 in., 4 in.

Ideal flow orifices for obtaining the tare restriction of the air cleaner flow stand should be made in accordance with Fig. 2A. The throat inside diameter should be the same as the piezometer inside diameter.

The absolute filter shall consist of one or more layers of fiberglass batting,[2] installed in suitable containers. The batting shall be ½ in. thick and shall consist of fibers 0.00003 to 0.00005 in. in diameter, bonded together with a thermosetting resin. The density shall be 0.6 lb per cu ft and the moisture adsorption shall be less than 1% by weight after exposure to 120 F. and 95% relative humidity for 96 hours. The nap side of the material should face upstream. An absolute filter of sufficient size shall be used so that there will not be excessive restriction to airflow before the test is completed. The size of the absolute filter shall also be sufficient to keep face velocity under 165 fpm. The absolute filter housing should be grounded during tests. Scales shall be of sufficient capacity and sensitivity to weigh the air cleaner and dust feeder to the nearest 0.1 g and the absolute filter media to the nearest 0.01 g. The absolute filter media should be weighed when the weight has stabilized and while in a ventilated oven at 220-225 F.

The dust feeding mechanism should feed the desired grade of dust at a steady rate to disperse a continuously uniform particle-size distribution in the air stream before reaching the air cleaner. The particle size shall not be changed by the dust feeding mechanism. Suggested setups are shown in Figs. 3 and 4A.

The variable airflow control mechanism shall operate to provide a variable airflow cycle similar to that suggested in Fig. 5.

When testing oil bath type air cleaners, a suitable observation means shall be provided to determine oil carry-over. Suggested designs are

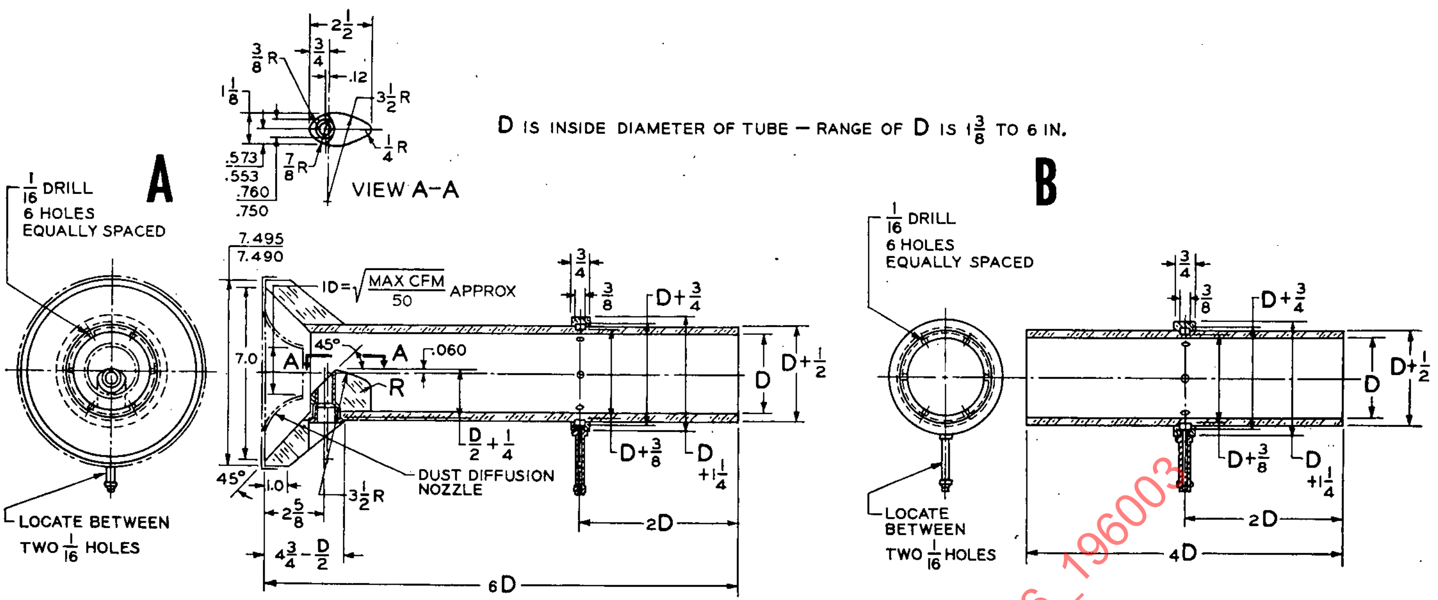

FIG. 1—(A) TRANSPARENT AIR CLEANER INLET FEEDER TUBE, AND (B) TRANSPARENT PIEZOMETER TUBE

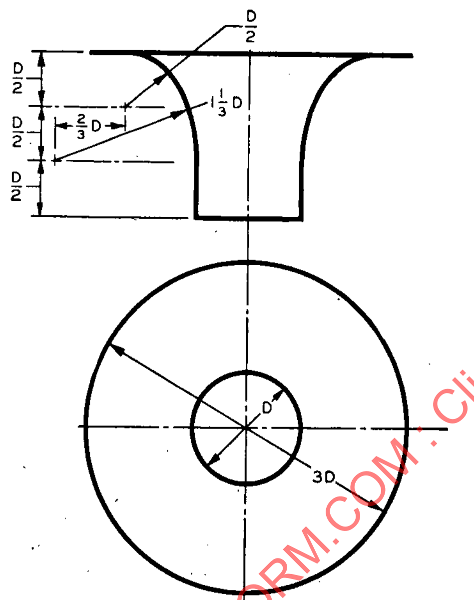

FIG. 2A—IDEAL FLOW ORIFICE

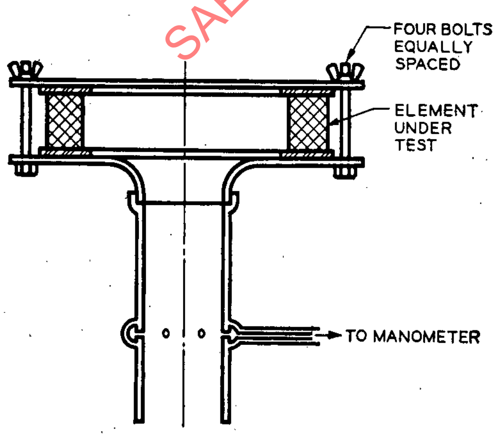

FIG. 2B—DRY CLEANER ELEMENT RESTRICTION TEST SETUP

shown in Figs. 1 and 6. Suggested shaking mechanisms are shown in Fig. 7. A suggested backfire test setup for oil bath air cleaners is shown in Fig. 12.

3.0 General Definitions and Test Conditions

Temperature of air and oil (if oil bath) shall be room temperature unless otherwise called for.

Rated Airflow of the air cleaner shall be expressed in cubic feet per minute as specified by the air cleaner manufacturer for the application.

Restriction shall be defined as "the static pressure drop across the air cleaner at the observed airflow, and shall be expressed in inches of water." Restriction of air cleaners incorporating some form of ideal air entrance shall be defined as "the net static pressure drop at the observed airflow expressed in inches of water." Net restriction is the difference between the observed restriction of the air cleaner mounted on the flow stand and the tare restriction of the flow stand obtained with an ideal flow orifice mounted in place of the air cleaner. An ideal flow orifice is shown in Fig. 2A.

A dry air cleaner element restriction test setup is shown in Fig. 2B.

Oil Carry-Over shall be defined as "the appearance of droplets of oil at the cleaner outlet."

Condition the oil bath air cleaner:

(a) Wash and dry the air cleaner thoroughly.
(b) Fill the oil cup to the indicated level with the specified oil.
(c) Flow air through the air cleaner at rated airflow for 15 minutes.
(d) Stop airflow and allow to drain 15 minutes.
(e) Readjust the oil in the cup to a specified level for the particular test, except type shown in Fig. 8B.

4.0 Determination of Restriction.

4.1 Air Cleaner Assembly

(a) Set up the air cleaner assembly as in Fig. 8.
(b) If oil bath, condition the air cleaner using heavy test oil.
(c) Measure and record restriction at the desired percentage of rated airflow.
(d) If net restriction is required, substitute an ideal flow orifice for the air cleaner and measure the restriction at the desired airflows to obtain the tare restriction of the flow stand.
(e) Determine net restriction by subtracting the tare restriction from the observed restriction obtained in operation (c).

4.2 Air Cleaner Element Restriction

Restriction of the conventional dry element in Fig. 2B can be measured by clamping the element between two flat plates, the lower of which has an approximation of an ideal air entrance and a fitting for attachment to the air cleaner flow stand. The element restriction, measured at specified airflows, is expressed in inches of water as "the difference between the restriction obtained with the element in place and the tare restriction of the test fixture with no element." If the element is low compared to its diameter, the tare restriction should be obtained with the top plate installed in the location occupied when the element is in place.

5.0 Determination of Oil Carry-Over Characteristics

5.1 Indicated Oil Level, Increasing Airflow

(a) Set up the air cleaner as in Fig. 8.
(b) Condition the air cleaner using light test oil. Readjust oil to the

indicated level, except type shown in Fig. 8B.

(c) Raise airflow to rated value (do not exceed), and maintain for 15 minutes. Record the following observations at 5-min intervals:

1. Airflow
2. Outlet air temperature
3. Restriction
4. Indications of oil carry-over

(d) Increase the airflow in increments of 5% of rated airflow at 5-min intervals, repeating the observations above. Continue this procedure until oil carry-over is observed.

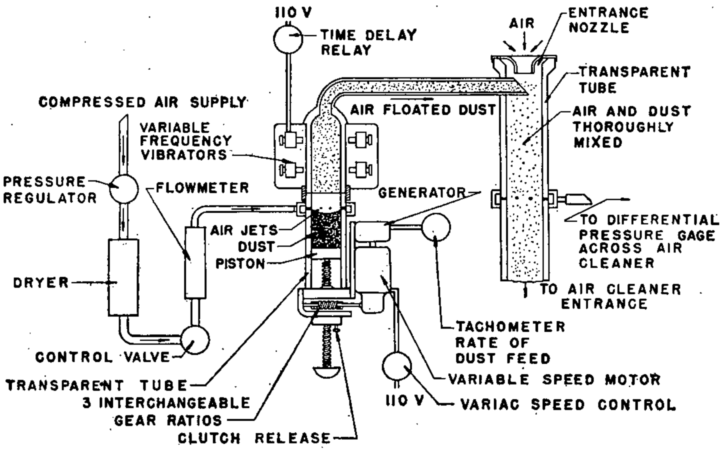

FIG. 3—MECHANICAL DUST FEEDER[3]

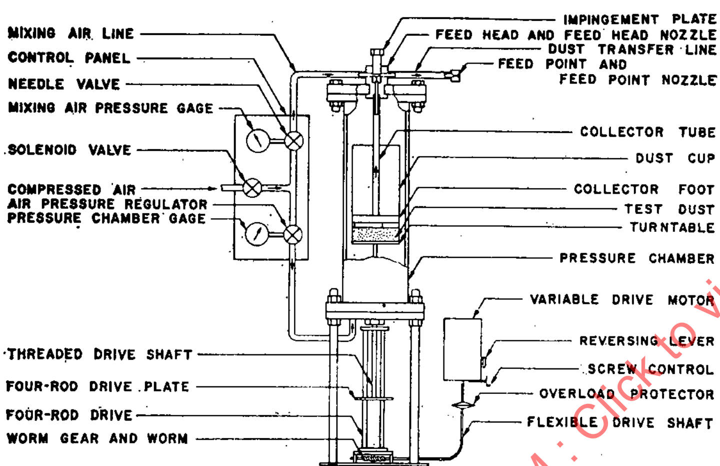

FIG. 4A—SONIC DUST FEEDER[4]

Dust Cup Dia, in.	Variable Drive Range, rpm	Feed Head Nozzle Dia, in.	Feed Point Nozzle Dia, in.
1	0–400	0.028	0.055
2	0–500	0.039	0.067
4	0–400	0.0465	0.081

FIG. 4B—NOZZLE SIZE SELECTION

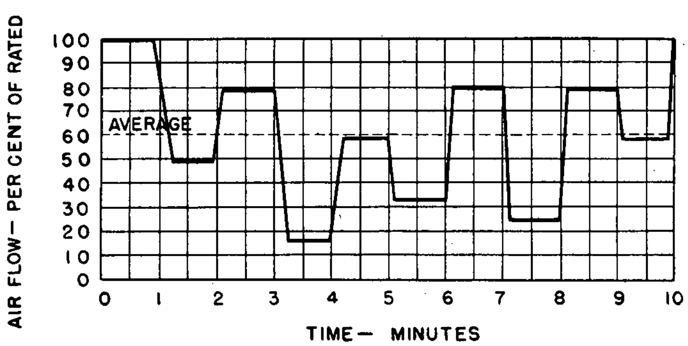

FIG. 5—VARIABLE FLOW CYCLE

5.2 Constant Airflow, Increasing Oil Level

(a) Set up the air cleaner as in Fig. 8.

(b) Condition the air cleaner using light test oil. Readjust oil to the indicated level, except type shown in Fig. 8B.

(c) Raise airflow to rated value (do not exceed), maintain for 15 minutes. Record the following observation at 5-min. intervals:

(1) Oil level
(2) Outlet air temperature
(3) Restriction
(4) Indications of oil carry-over

(d) Increase oil level in desired increments by volume or height, repeating the preceding observations. Continue this procedure until oil carry-over is observed.

5.3 Angle Operation

(a) Condition the air cleaner using light test oil. Readjust oil to the indicated level, except type shown in Fig. 8B.

(b) Set up the air cleaner as in Fig. 9 at desired angle.

(c) Raise airflow to rated value (do not exceed), and maintain for 15 minutes. Record the following observations at 5-minute intervals:

(1) Airflow or oil level
(2) Outlet air temperature
(3) Restriction
(4) Indications of oil carry-over

(d) Increase the airflow or oil level in increments as desired at 5-minute intervals, repeating the observations above. Continue this procedure until oil carry-over is observed.

5.4 Shaking Operation

Extreme variation in air cleaner application to vehicle, field conditions, and users' requirements preclude establishment of an all inclusive shake operation test procedure and apparatus design. It is the object of this procedure to point out test variables that must be controlled to obtain reproducible bench tests that will provide reasonable correlation to field tests.

Figs. 7A, 7B, and 7C suggest theory of shake mechanism only. Correlation and reproducibility are dependent upon selection of shake mechanism, control, and reporting of the following variables:

(a) Method of shake
(b) Direction of shake
(c) Displacement
(d) Frequency
(e) Severity—acceleration and/or deceleration
(f) Oil viscosity and ambient air temperature

The following procedure is recommended for general use:

(a) Set up the air cleaner as in Fig. 7 or in such a manner as to sim-

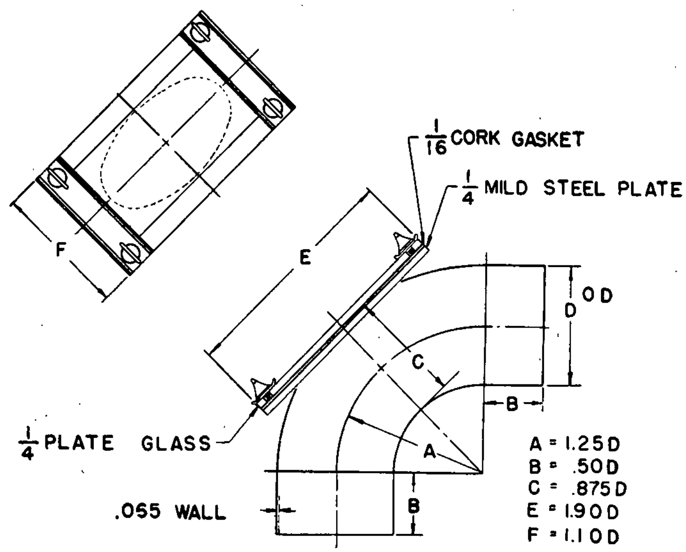

FIG. 6—OBSERVATION ELBOW

[3]Information obtainable from Power Plant Lab., Detroit Arsenal, Centerline, Mich.

[4]Information obtainable from Donaldson Co., Minneapolis, Minn.

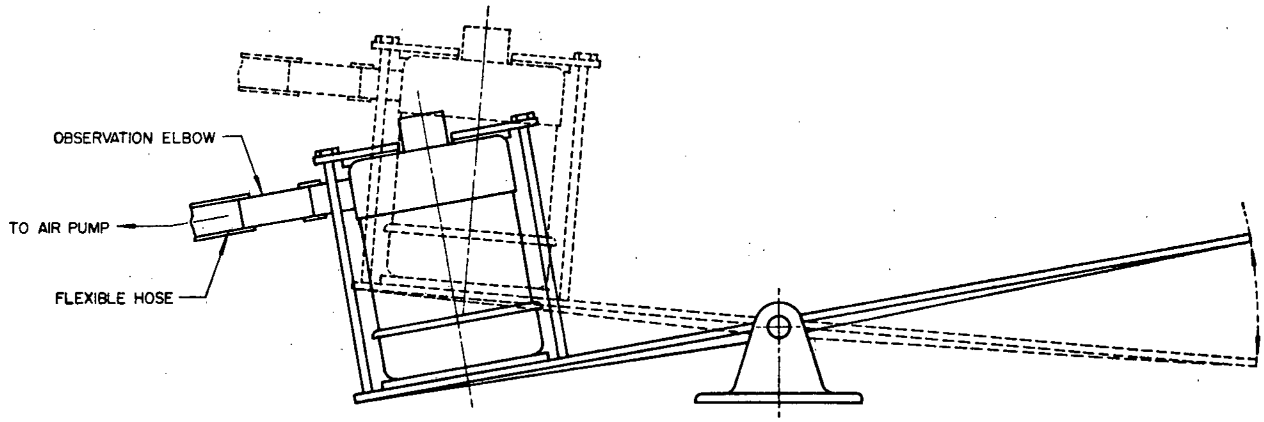

FIG. 7A—VERTICAL SHAKE AND ROLL

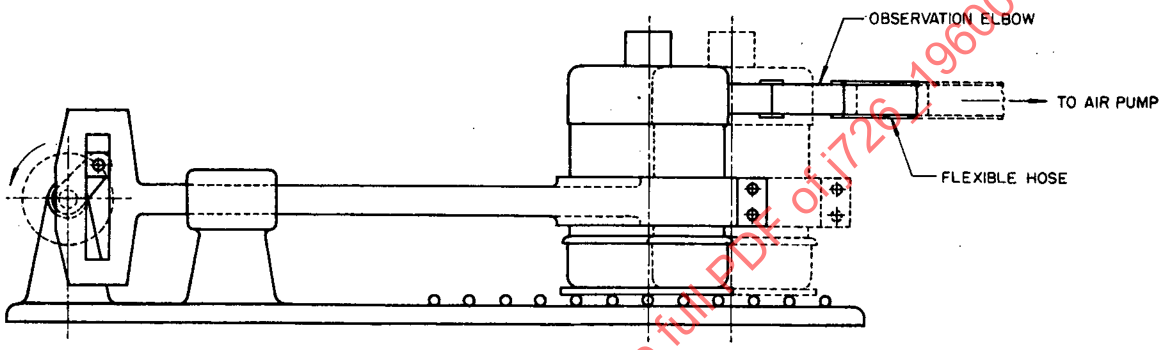

FIG. 7B—HORIZONTAL SHAKE

ulate field operation.

(b) Condition the air cleaner using light test oil. Readjust oil to indicated level, except type shown in Fig. 8B.

(c) Raise airflow to prescribed value (do not exceed), and maintain for 15 minutes.

(d) Perform shake operation at specified number and frequency. Stop shake without interrupting air flow.

(e) Observe for indications of oil carry-over.

(f) If no carry-over is observed, allow sufficient time for displaced oil to assume initial condition or recondition the air cleaner. Increase airflow or oil level in increments as specified and continue shake until oil carry-over is observed.

6.0 Determination of Oil Loss

NOTE: The air cleaner must be sufficiently dry prior to addition of oil to withstand rated airflow for 1 hr in its dry state without loss of weight.

(a) Determine weight of air cleaner in dry condition and set up as in Fig. 10.

(b) Condition the air cleaner using light test oil. Readjust oil to the indicated level, except type shown in Fig. 8B. Weigh the air cleaner to the nearest 0.1 g or as close as possible.

(c) Raise airflow to rated value (do not exceed), and adjust heater to obtain, within 5 minutes, a stabilized temperature of 100 ± 2 F at the air cleaner outlet.

(d) After 65 minutes of operation, including the time for adjustment of air temperature, stop airflow and reweigh air cleaner and record.

(e) Repeat steps (c) and (d) twice.

(f) Calculate percentage of oil loss from: $\dfrac{\text{Oil loss for } 3\frac{1}{4} \text{ hr}}{\text{Total weight of oil}} \times 100$

7.0 Determination of Initial Wetting of Element

7.1 Indicated Oil Level, Increasing Airflow

(a) Set up the air cleaner as in Fig. 8.

(b) Wash and dry the air cleaner thoroughly.

(c) Fill the oil cup to the indicated level with heavy test oil.

(d) Start airflow at 5% of rated value (do not exceed), and maintain for 5 minutes.

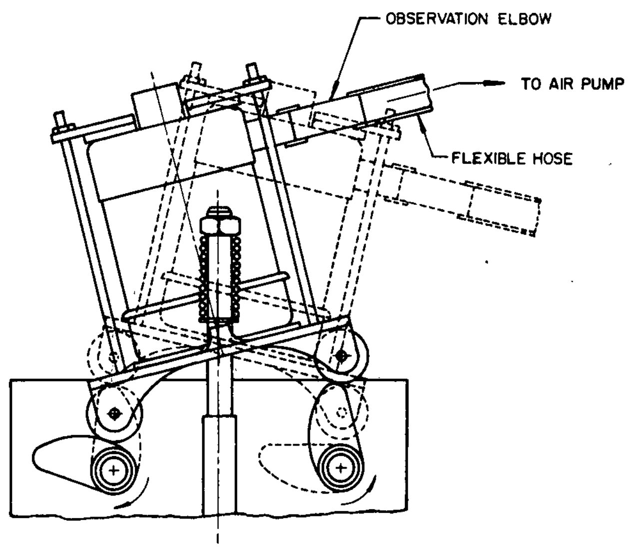

FIG. 7C—ROCKING SHAKE

(e) Stop airflow and remove the oil cup. Observe and record the degree of wetting on the lower element surface.

(f) Reassemble the air cleaner and raise airflow in increments of 5% of rated value until complete wetting on the lower element is observed.

7.2 Constant Airflow, Decreasing Oil Level

(a) Set up the air cleaner as in Fig. 8.

(b) Wash and dry the air cleaner thoroughly.

(c) Fill the oil cup to the indicated level with heavy test oil.

(d) Start airflow at 20% of rated value (do not exceed), and maintain for 5 minutes.

(e) Stop airflow and remove oil cup. Observe and record the degree of wetting on the lower element surface.

(f) Repeat steps (b), (d), and (e) with oil level lowered in desired increments until no wetting on the lower element surface is observed.

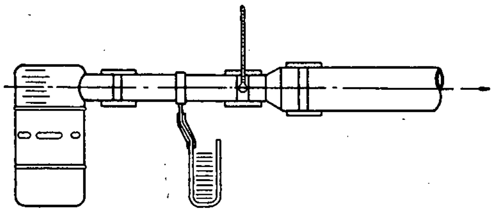

FIG. 8A—CIRCUMFERENTIAL OR LOUVERED INLET CLEANERS

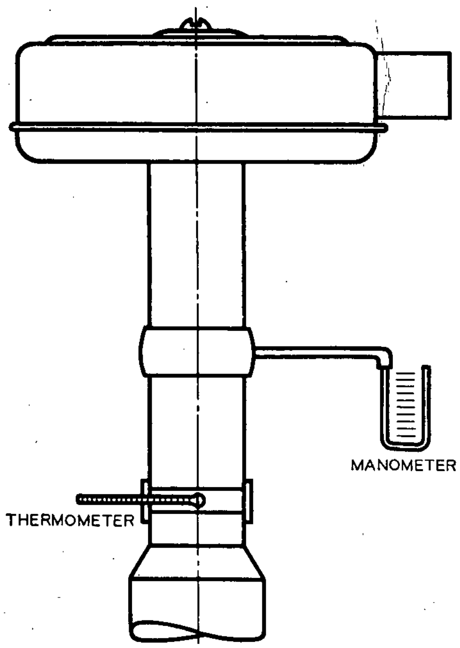

FIG. 8B—CARBURETOR MOUNTED TYPE CLEANER

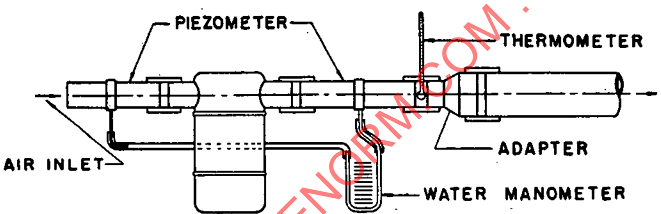

FIG. 8C—TUBULAR INLET CLEANERS

8.0 Determination of Efficiency

8.1 Steady Airflow—Steady airflow efficiency tests can be performed at rated airflow or any percentage thereof. The airflow shall be prescribed and the dust feed rate calculated from this airflow.

Test Procedure

(a) Set up the air cleaner or element as in Fig. 11.

(b) The dust feed rate should be calculated using the dust concentration of 0.025 g per cu ft of air (1.5 g per hr per cfm). Either fine or coarse test dust may be prescribed.

(c) Prepare the dust feeder with the prescribed amount of dust.

Initial Efficiency Test—Light Duty Air Cleaners—Use 20 g or the number of grams numerically equal to 10% of the rated airflow in cubic feet per minute, whichever is greater.

Spot Check on Heavy Duty Air Cleaners—Use 110 g or the quantity required for 30 minutes, whichever is greater. When testing very high efficiency cleaners, sufficient dust should be fed to obtain enough weight increase in the absolute filter to obtain an accurate determination.

Full-Life Efficiency Test—The quantity of dust, divided into amounts

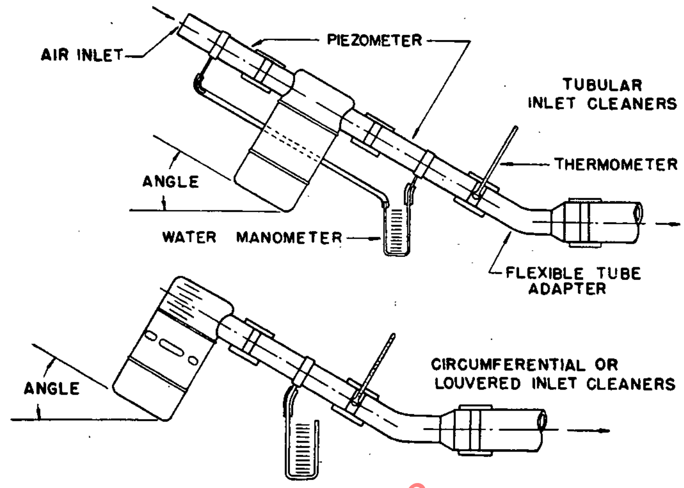

FIG. 9—TEST SETUP

satisfactory to feed, equal to that required to obtain maximum permissible restriction if average efficiency is desired.

(d) If testing an oil bath air cleaner, condition the air cleaner using heavy test oil. Readjust oil to the indicated level, except type shown in Fig. 8B.

(e) Determine and record the weights of the absolute filter elements and the air cleaner and dust feeder assemblies (along with their connecting passages).

(f) Start the test (within 10 minutes after end of conditioning, if testing an oil bath air cleaner) and operate at the prescribed airflow, making any necessary corrections for air density. Record the air cleaner restriction at suitable intervals. Maintain constant rate of dust feed until all dust in feeder is used.

(g) Carefully disconnect equipment and brush any dust in the air cleaner outlet connections onto the absolute filter elements. Determine and record the weights of the air cleaner and the dust feeder assemblies in the aforementioned manner. Dry and weigh the used absolute filter elements.

(h) Inspect the air cleaner filter element, baffles, gaskets and other parts and make any pertinent notes and sketches.

(i) Calculate the air cleaner efficiency by either of the following methods:

$$\text{Efficiency, \%} = \left(\frac{\text{increase in weight of air cleaner assembly}}{\text{increase in weight of air cleaner assembly} + \text{increase in weight of absolute filter elements}} \right) \times 100$$

$$\text{Efficiency, \%} = \left(1 - \frac{\text{increase in weight of absolute filter elements}}{\text{decrease in weight of dust feeder assembly}} \right) \times 100$$

If the dust unaccounted for exceeds 2% of the dust fed, the test should

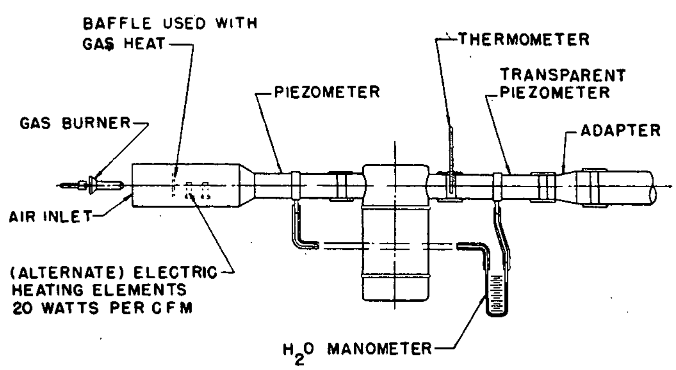

FIG. 10—OIL LOSS TEST SETUP