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POWER PLANT
ENGINEERING REPORT NO. 3
(Revised)

STANDARD FIRE TEST APPARATUS AND PROCEDURE

(FOR FLEXIBLE HOSE ASSEMBLIES)

FEDERAL AVIATION AGENCY
E. R. Quesada, Administrator

BUREAU OF FLIGHT STANDARDS

POWER PLANT

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STANDARD FIRE TEST APPARATUS AND PROCEDURE

(FOR FLEXIBLE HOSE ASSEMBLIES)

(Revised March 1961)

Prepared by

Andrew K. Ness

Andrew K. Ness

Kenneth S. Cullom

Kenneth S. Cullom

Approved by

For J. W. Baird

Stephen H. Rolle

Chief, Propulsion Branch

STANDARD FIRE TEST APPARATUS AND PROCEDURE

(For Flexible Hose Assemblies)

Standard Fire Test Apparatus and Procedure

This method of test is intended to determine the fire resistance of flexible hose assemblies under simulated conditions. The test is aimed at producing a typical aircraft powerplant fire, vibration of the type encountered during rough engine operation, and the various flight conditions of fluid flow, pressure, and temperature.

The fire test apparatus described in Appendix I of this report, or equivalent equipment, shall be used for determining fire resistance. The main components of this apparatus are:

a. Burner: Modified gun-type conversion oil burner, Lennox Model OB-32.
b. Vibrating mechanism.
c. Bench.
d. Hood.
e. Temperature measurement and recording.
f. Oil circulator and heater.

The flame produced by the burner shall be calibrated by means of the standardization device and method described in Appendix II, and shall have a minimum B.t.u. value of 4500 B.t.u. per hour.

The length of hose assembly to be tested shall be not less than 24 inches. The hose shall be mounted horizontally on the test bench (see figure 1) and shall include one full 90° bend. The hose assembly shall be located inside of the hood except when limited by physical characteristics such as recommended minimum bend radius. The nearest surface of the hose is to be located 4 inches beyond the burner barrel extension. SAE 20 oil at a temperature of not less than 200° F. shall be circulated through the hose assembly and system to remove all air from the piping system and to establish the required operating temperature. The oil flow rate and pressure parameters specified in the applicable Technical Standard Order (TSO) shall be established and maintained during the test. The vibrating mechanism shall then be started and the assembly checked to make certain that no resonant whipping occurs. The fan which affects the air movement over the assembly shall be started. The actual fire test is then begun by igniting the burner and starting the chronometer simultaneously. A satisfactory and convenient means of accomplishing this is by use of the control panel shown in figure 2.

A hose assembly is considered acceptable if it complies with the test conditions and parameters for the time period specified in the TSO without any evidence of leakage. Leakage shall be detected by visual observation from a distance of not more than five feet, at a position where the specimen, flame, and drip pan are visible.

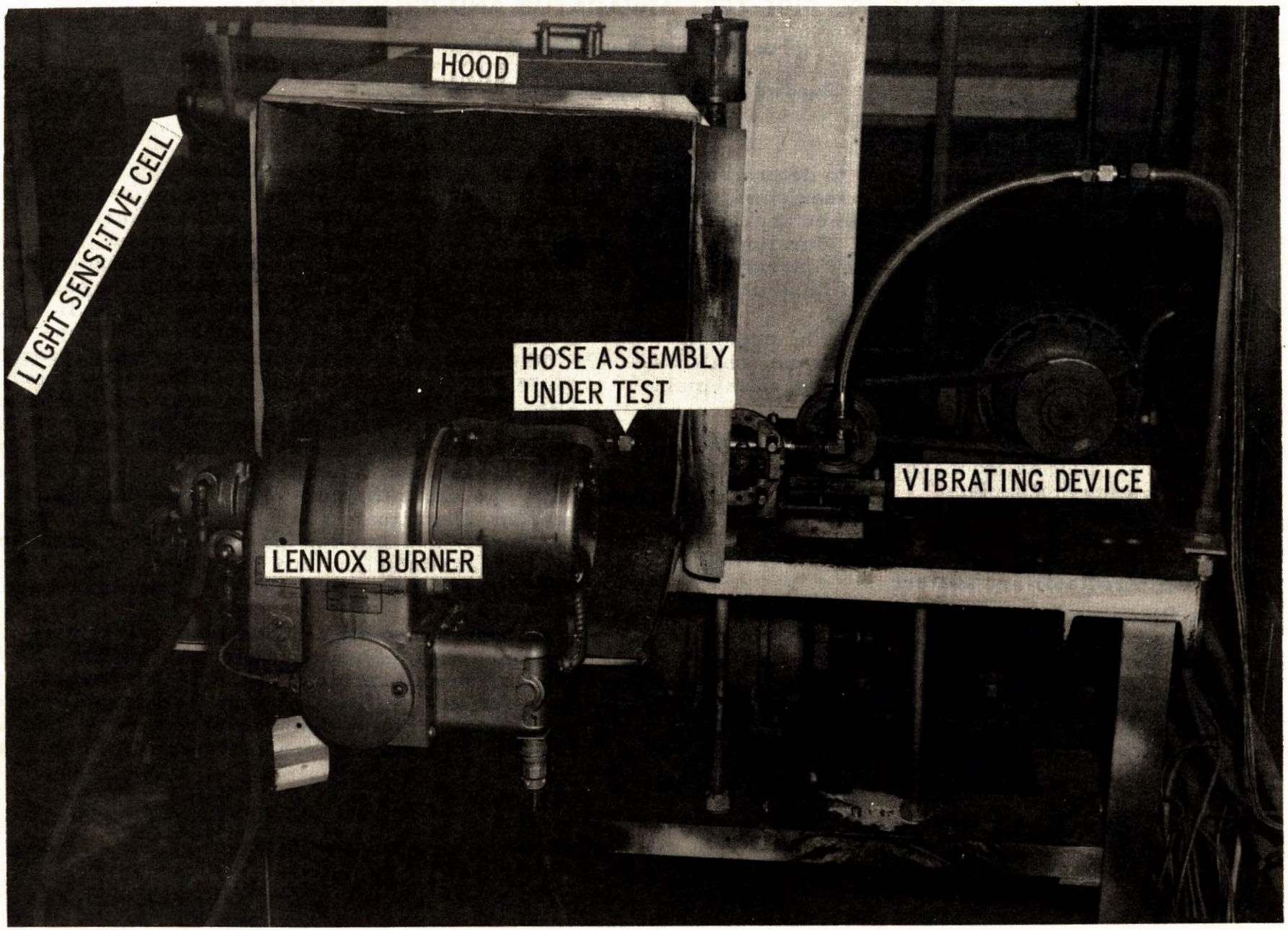


FIGURE I. HOSE ASSEMBLY TEST BENCH

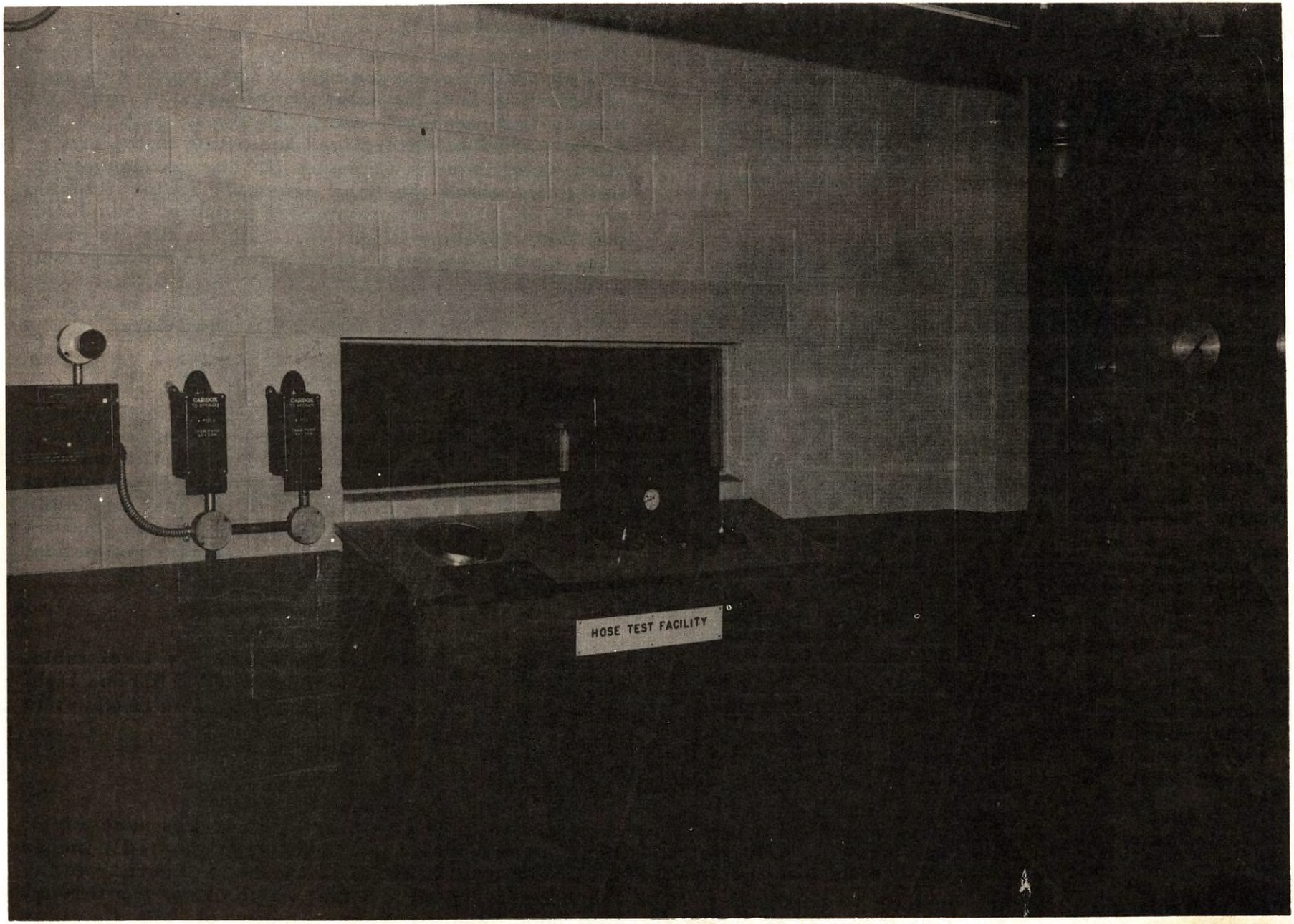


FIGURE 2. HOSE TEST CONTROL PANEL

APPENDIX I – Description of Test Apparatus

Test Burner

The burner used to produce the flame shall be a modified gun-type conversion oil burner, Model OB-32 Lennox-Conversion oil burner, as shown in figures 3 and 4. The following modifications shall be made:

1. The auxiliary air deflector (DV-486A) (see figure 4) shall be removed from the draft tube assembly.
2. The burner nozzle furnished with the Lennox burner shall be replaced with an 80^{o} spray angle nozzle, capable of delivering 2 gallons of kerosene per hour. The exact delivery rate of 2 gallons per hour shall be obtained by adjustment of the pressure on the return relief valve (see figure 4).
3. Two 3/4-inch-wide deflector strips (see figure 5) are to be fastened to the end of the draft tube, one on each side, so that the ends of the strips are $1\frac{1}{2}$ inches apart and $1\frac{1}{2}$ inches beyond the oil nozzle.
4. A 12-inch burner extension shall be added to the end of the draft tube (see figure 6). This extension has an opening 6 inches high and 11 inches wide. A layout of the pattern for this extension is shown in figure 7. The extension shall be installed on the draft tube so that the wide end is 10 inches beyond the end of the draft tube.
5. A fitting for a manometer connection shall be installed in the burner housing $\frac{1}{2}$ inch from the draft tube bolt flange (see figure 3).

The air consumed by the burner is controlled by adjusting the damper plate (see figure 4) so that the pressure at the manometer connection is approximately 0.15 inch of water, with the burner operating in still air.

With the fuel delivery rate of 2 gallons of kerosene established and the inlet air adjusted to approximately 0.15 inch of water, the B.t.u. output of the flame should be determined according to the procedure described in Appendix II. The portion of the flame in which the hose assembly is to be tested should deliver a minimum heat output of 4500 B.t.u. per hour. Because slight variations in the air pressure as determined by the manometer readings will produce a marked variation in the flame B.t.u. output, it may be necessary to vary the air pressure slightly to obtain the required rate of heat transfer.

Vibrating Mechanism

The vibrating mechanism is shown in Figure 1. One end of the hose assembly shall be subjected to a total lateral or longitudinal displacement of not less than 1/8 inch (1/16 inch on each side of normal) at 2000 c.p.m. The vibrated end of the hose assembly shall be subjected to the flame. The vibrating fixture shall be as light as possible to avoid excessive heat transfer or loss through the fixture.

Bench

The bench consists essentially of a steel table, 60 inches wide, 28-inches deep, and 32 inches high. Mounted on this bench is the vibrating mechanism and a hood.

Hood

The hood (see figure 1) is 25 inches wide and 25 inches high. The vibrated fitting is located 7 inches back of the open front of the hood. The rear end of the hood is ducted to a fan, which draws air through the hood opening at a velocity of 400 f.p.m. as measured by an Alnor velometer located at the hose assembly specimen. This air movement aids in keeping the flame horizontal and in exhausting fumes.

Temperature Measurement and Recording

The temperature sensing system including the thermocouples and indicator shall have an allowable overall error of ± 1 (one) percent at 2000° F. The flame temperature shall be measured four inches from the end of the burner barrel extension. A sufficient number of the thermocouples shall be used to assure that the specified temperature exists at least along the entire end fitting and the hose for a distance of not less than five inches.

Oil Circulator and Heater

The oil circulating and heating equipment consists of an electrically driven oil pump and an oil tank with a thermostatically controlled immersion heater. The plumbing of the oil system also includes pressure relief valves, flow indicators, pressure gages, and control and selector valves.

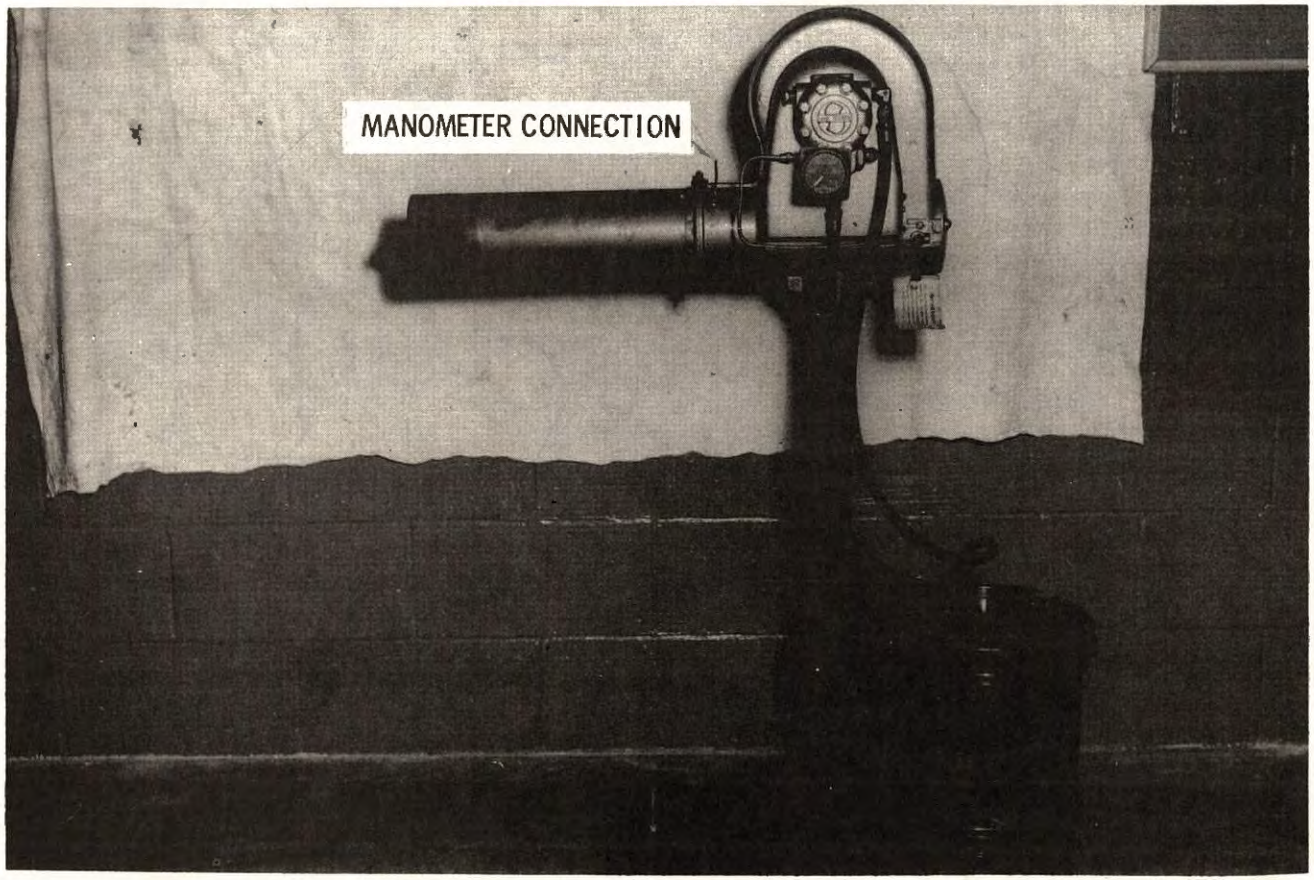


FIGURE 3. LENNOX OIL BURNER

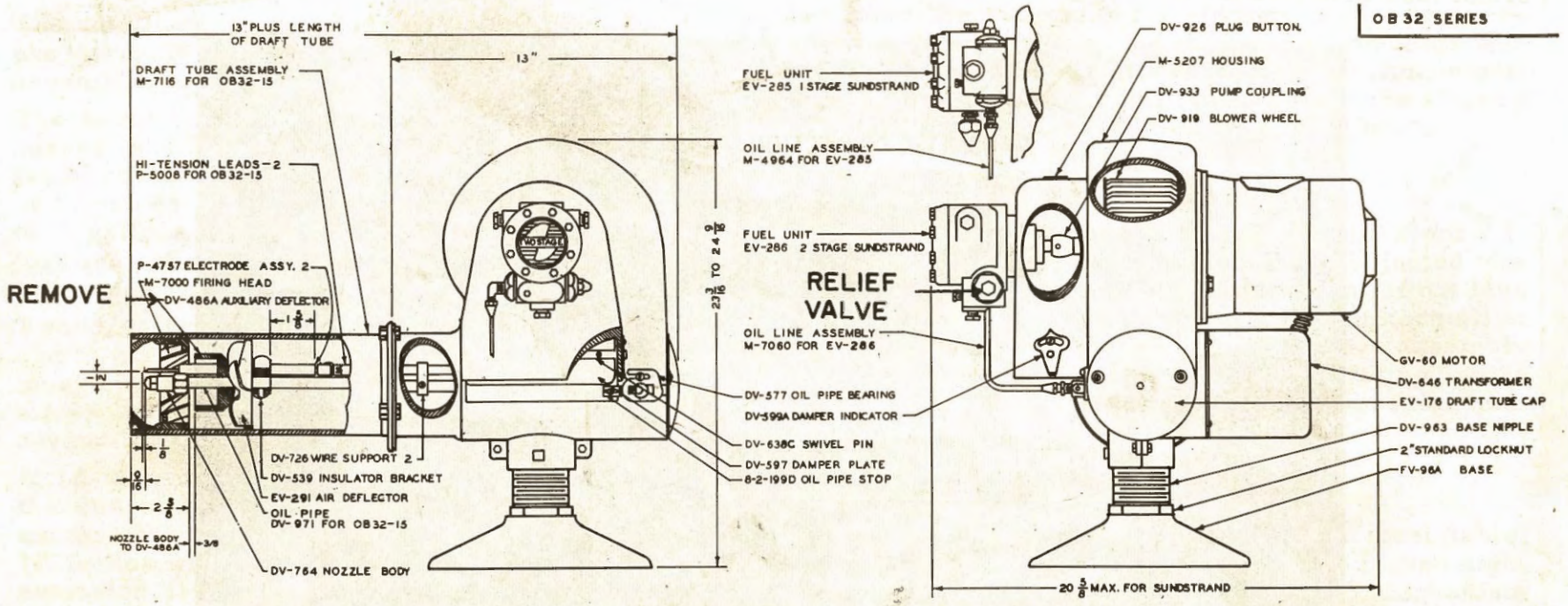


FIGURE 4. LENNOX OB-32 OIL BURNER

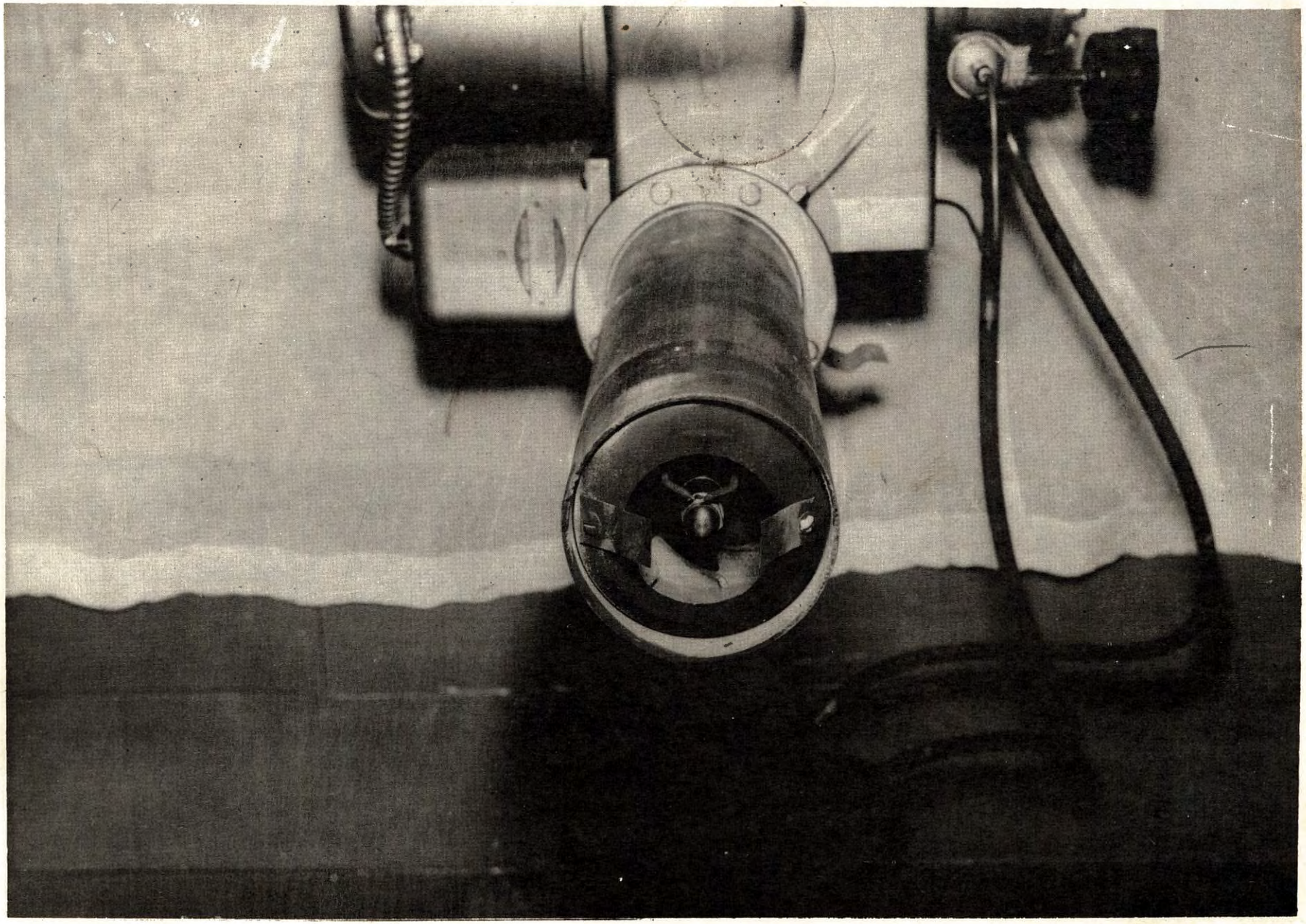


FIGURE 5. DEFLECTOR STRIPS

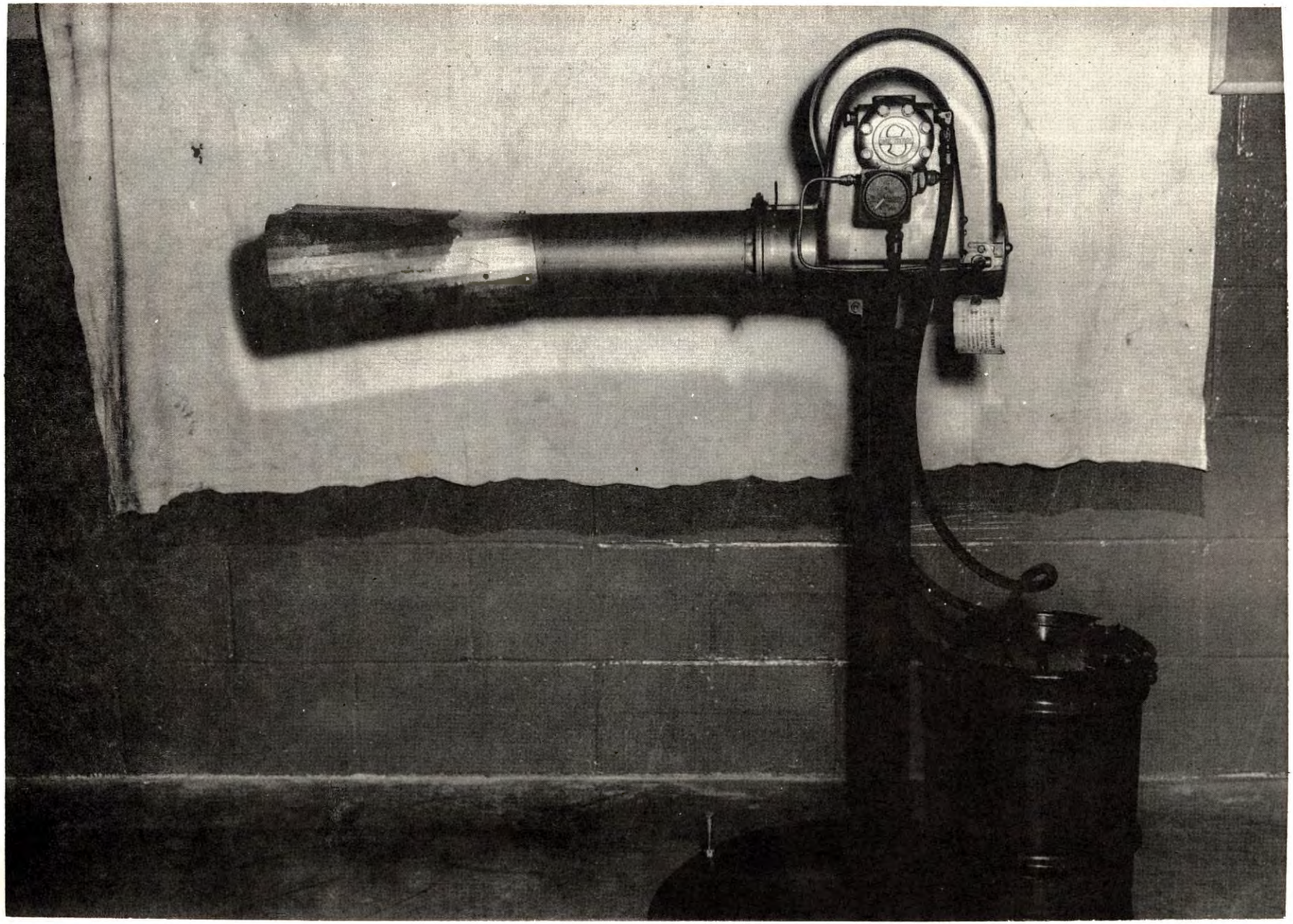


FIGURE 6. BURNER WITH EXTENSION

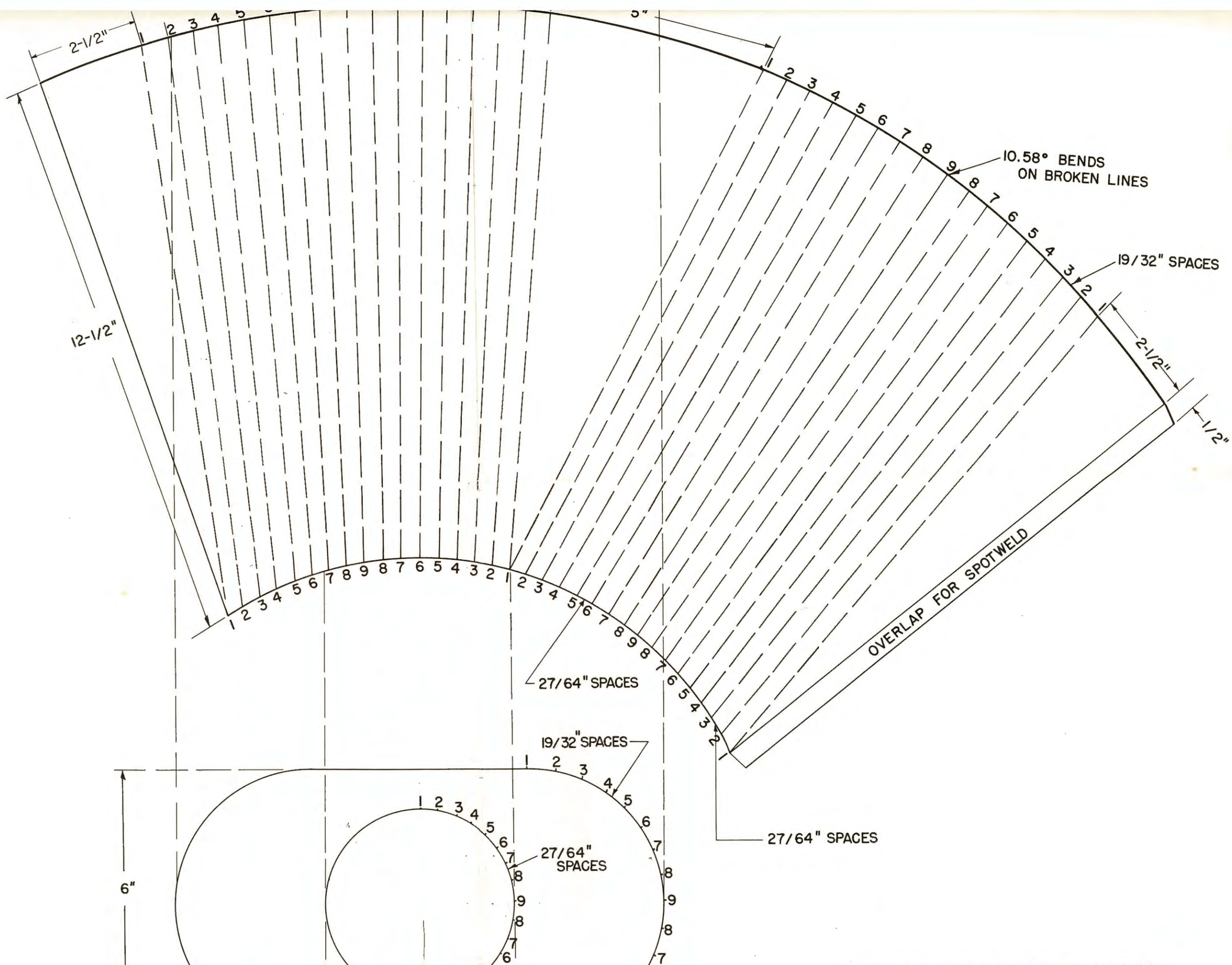


FIGURE 7 – DRAFT TUBE EXTENSION FOR

APPENDIX II – Test Burner Standardization Apparatus

In order to standardize the B.t.u. output of the flame utilized in testing, B.t.u. measuring equipment shall be used. The heat transfer surface, which is similar in shape to a hose, may be inserted in the flame from the test burner and a B.t.u. measurement obtained for the portion of the flame to which a hose test specimen is subjected during a test. Such measurement will enable adjustment of the burner until a standard minimum B.t.u. value of 4500 B.t.u. per hour, as measured by the standardization device, is obtained.

Fabrication of Apparatus

The illustration of the apparatus shows the layout of the complete assembly. A 5-foot constant head of water above the heat transfer tube and a 2-foot drop to the end of the tailpipe are specified so as to obtain consistent flow conditions. A standard 1/4-inch metering valve is attached just before the tail pipe for adjustment of the waterflow rate. A gallon-measuring container or a container and a weighing scale are also required.

The drawings, Nos. TD-271-1A-B, TD-271-1-A, TD-271-1-B, TD-271-2-B, TD-271-3-B, and TD-271-4-B, specify materials and dimensions for fabrication of the center portion of the device. The materials needed are readily available and inexpensive. Certain of the parts require machining. The mercury thermometers should be inserted into the wells, with the bulb within 1/16 inch of bottoming in the asbestos base tubing. The woven copper fabric should be inserted carefully so that it causes the flowing water to be mixed without restricting the flow below the maximum flow rate of the 1/4-inch metering valve. The woven copper fabric is manufactured by Metal Textile Corporation, Roselle, N. J. The Chore Girl pot cleaners are currently being manufactured from this type material. The Cenco thermometers can be purchased from Central Scientific Company, 1700 Irving Park Road, Chicago 13, Ill.

Procedure

The following preparations are necessary prior to making a measurement:

(1) Water should be supplied at a temperature not lower than 50° F. and not higher than 70° F.

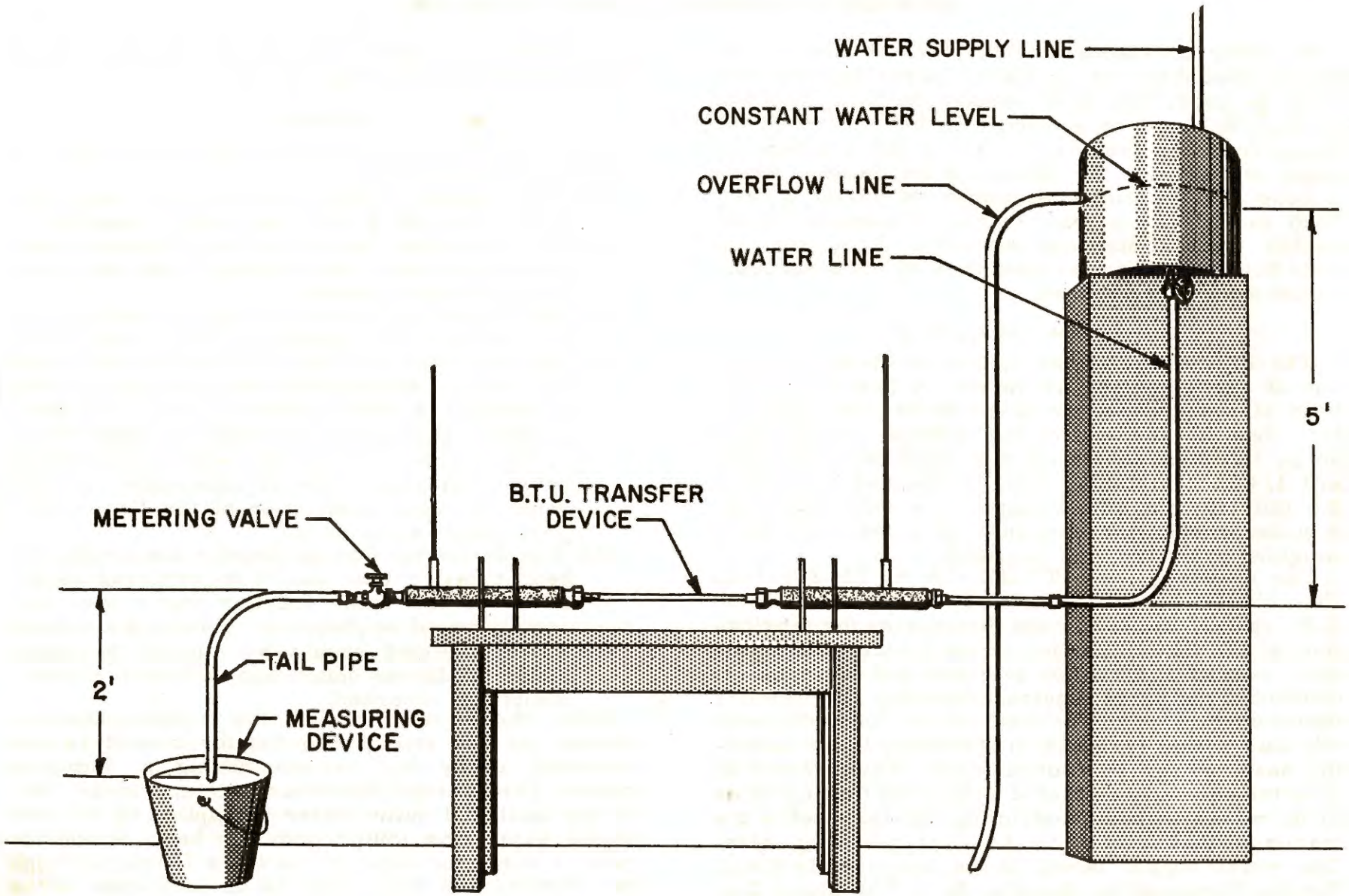
(2) The waterflow rate should be adjusted to 500 pounds per hour, which is approximately equal to 1 gallon per minute.

(3) The external surface of the copper tubing should be cleaned with fine steel wool before each test.

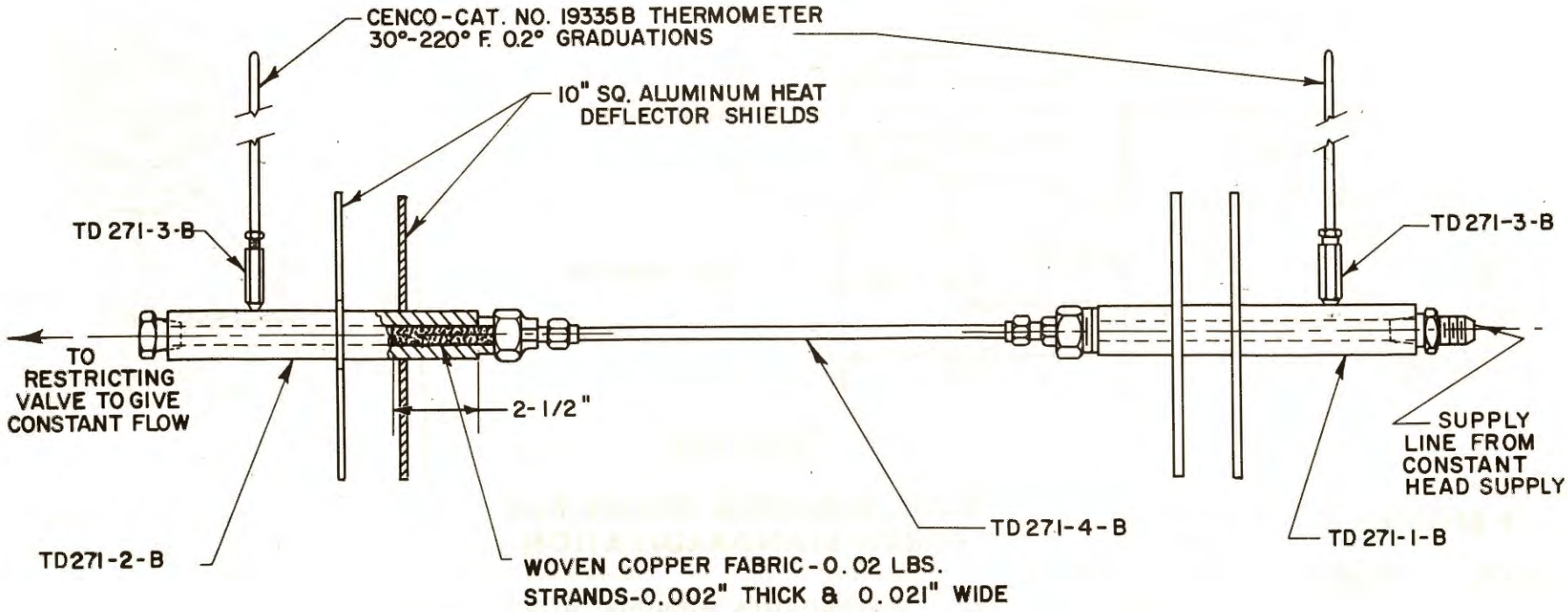
(4) The hood ventilating fan shall be turned on and the fire test burner should be carefully adjusted to produce a 2000° ± 100° F. flame. The temperature shall be determined at a point which is four inches beyond the end of the burner barrel extension. The thermocouple shall be removed upon completion of the flame temperature determination.

(5) With the water flowing through the device, the heat transfer tube should be centered in the flame in the same location that a hose assembly would be placed for testing. A 3-minute warmup period should be allowed to obtain stable conditions before temperature measurements are recorded.

After the warmup period, the temperatures indicated by the inlet and outlet thermometers are recorded every 1/2 minute during a 3-minute period. The average difference in temperature (°F.) of the inlet and outlet water multiplied by the rate of the water flow (500 pounds per hour) equals the rate of B.t.u. increase of the water flowing through the device, and this value is an indication of the severity of the portion of the flame in which hose assemblies are tested.



BURNER STANDARDIZATION APPARATUS

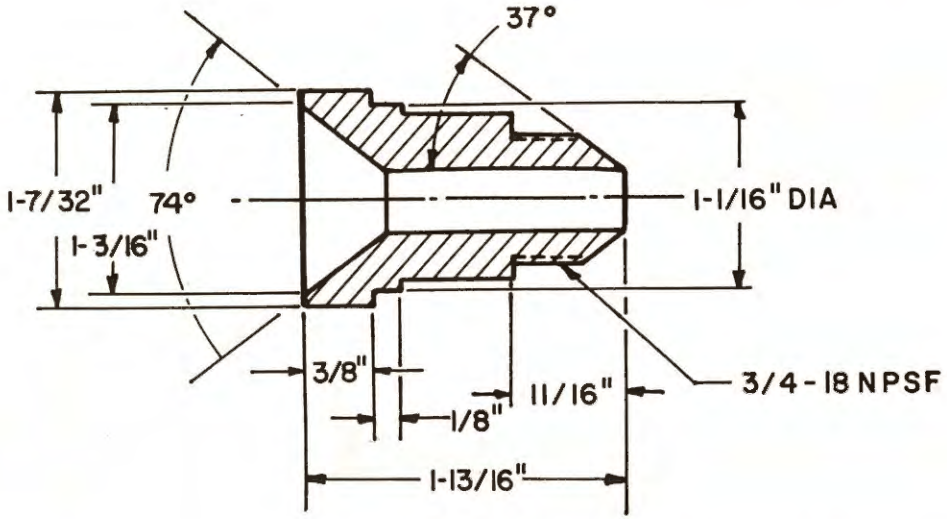


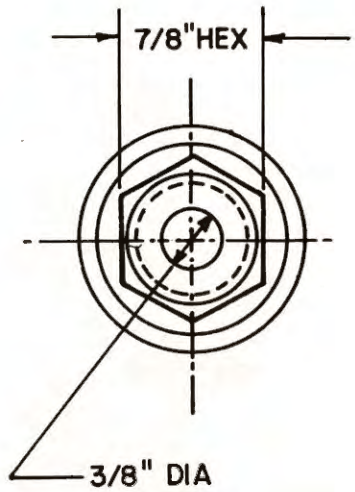
ASSEMBLY

B.T.U. TRANSFER DEVICE FOR TORCH STANDARDIZATION

Civil Aeronautics Administration
Technical Development and Evaluation Center
Indianapolis, Ind.

Drawing No. TD271—1A—B





REDUCER

B.T.U. TRANSFER DEVICE FOR TORCH STANDARDIZATION

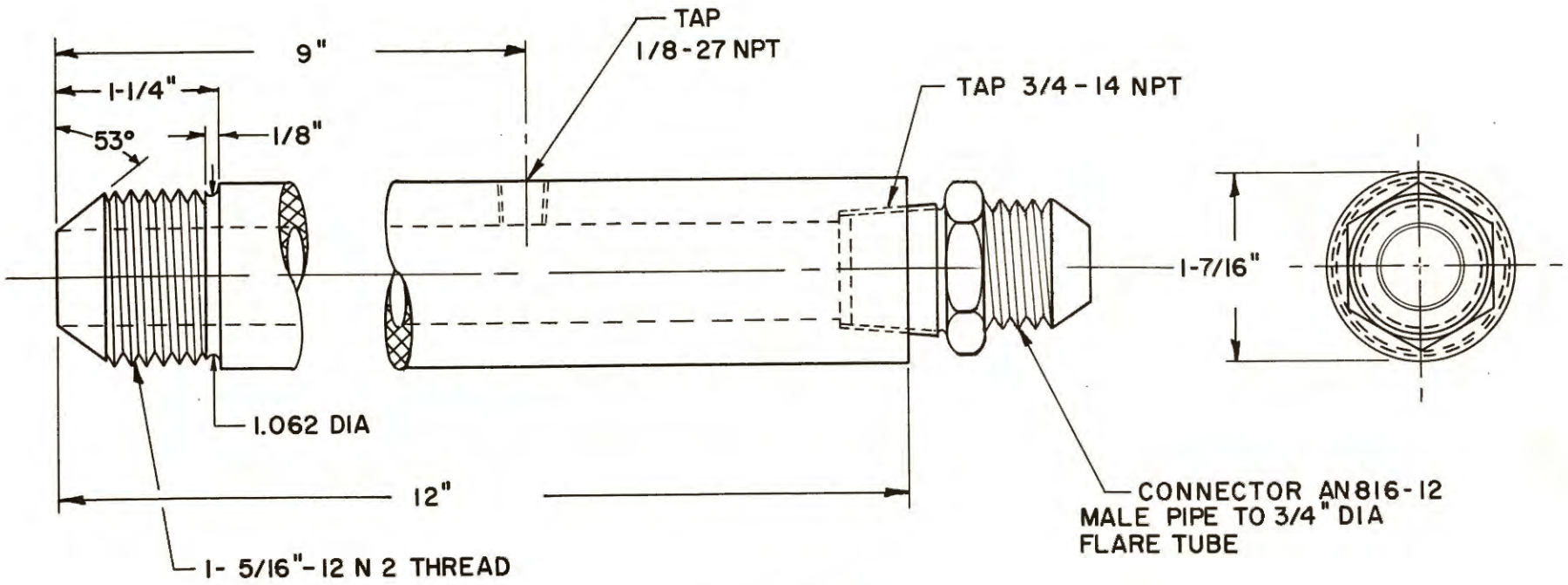
2 REQUIRED

MATL. — BRASS

Civil Aeronautics Administration
Technical Development and Evaluation Center
Indianapolis, Ind.

Drawing No. TD271—1—A

MATL. — DILECTO ASBESTOS BASE TUBING, AA-79
Made by Continental-Diamond Fibre Corp., Newark, Del.
1 7/16" O.D. x 13/16" I.D. x 12"



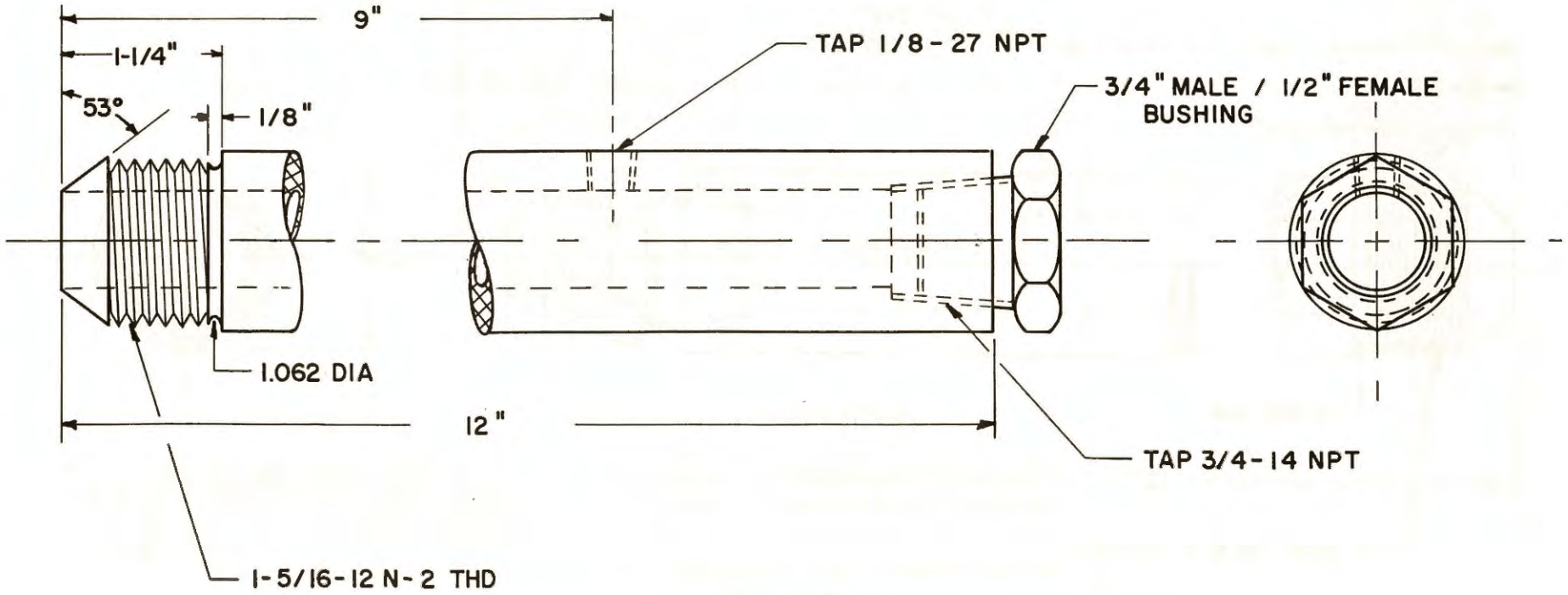
INLET TUBE

B.T.U. TRANSFER DEVICE FOR TORCH STANDARDIZATION

Civil Aeronautics Administration
Technical Development and Evaluation Center
Indianapolis, Ind.

Drawing No. TD271—1—B

MATL. — DILECTO ASBESTOS BASE TUBING, AA—79
Made by Continental-Diamond Fiber Corp., Newark, Del.
1 7/16" O.D. x 13/16" I.D. x 12"



OUTLET TUBE

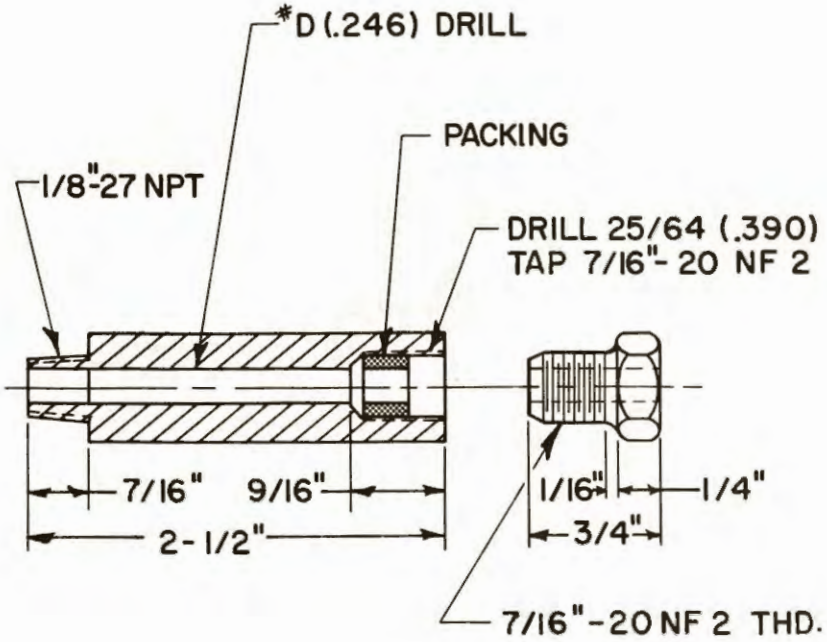
B.T.U. TRANSFER DEVICE FOR TORCH STANDARDIZATION

Civil Aeronautics Administration
Technical Development and Evaluation Center
Indianapolis, Ind.

Drawing No. TD271—2—B

2 REQUIRED

MATL. — BRASS, 9/16" HEX. x 3 3/4"

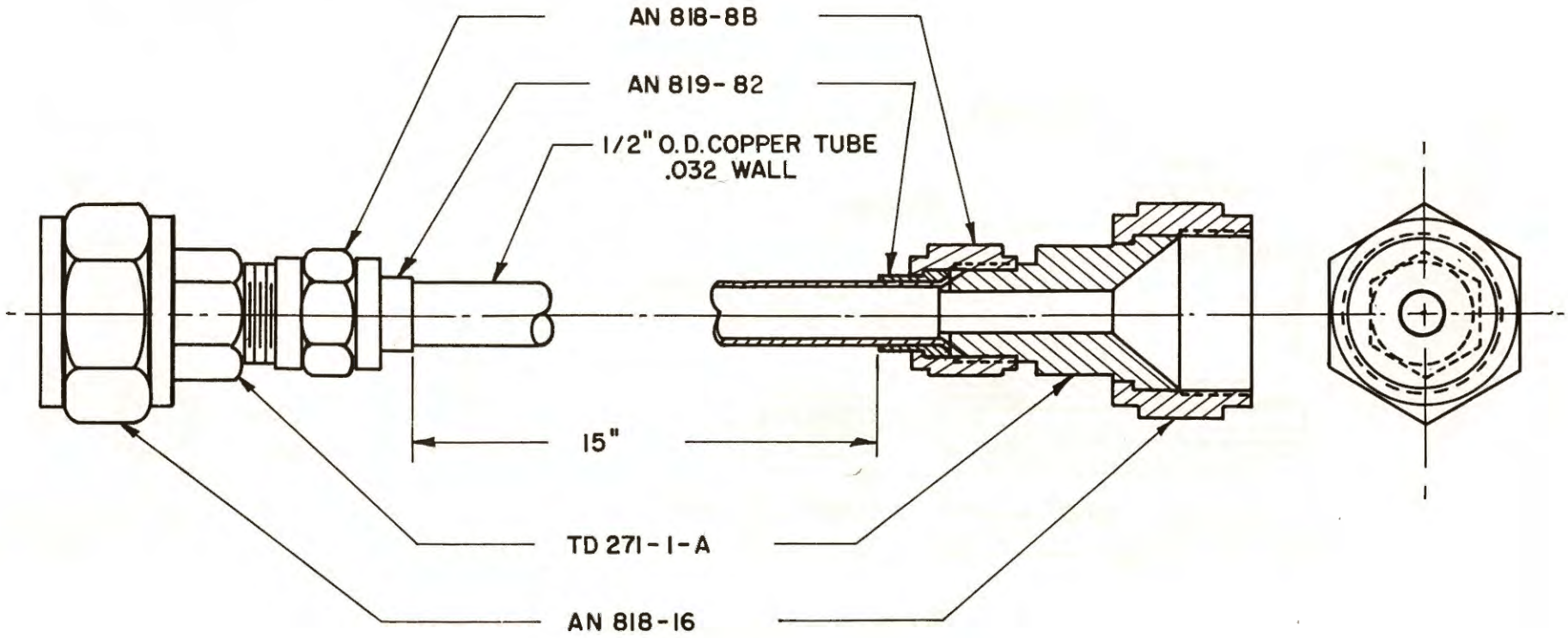


THERMOMETER MOUNTING

B.T.U. TRANSFER DEVICE FOR TORCH STANDARDIZATION

Civil Aeronautics Administration
Technical Development and Evaluation Center
Indianapolis, Ind.

Drawing No. TD271—3—B



TEST SPECIMEN

B.T.U. TRANSFER DEVICE FOR TORCH STANDARDIZATION

Civil Aeronautics Administration
Technical Development and Evaluation Center
Indianapolis, Ind.

Drawing No. TD271—4—B

GPO 907413