F.R. Note No. 215

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH AND FIRE OFFICES' COMMITTEE
JOINT FIRE RESEARCH ORGANIZATION

SPECIFICATION FOR ROOF TEST

Foreword

A roof is required to protect a building against external damage including the hazards presented by fire in a neighbouring building; it is not required to confine a fire inside a building and is not therefore expected to withstand the same fire conditions described in B.S. 476 as for walls, columns, etc., nevertheless it should resist the penetration of fire from a neighbouring building and should not allow flame to spread over its surface. The two tests described here have been designed to measure these qualities. In the penetrations test, specimens are exposed to radiation of an intensity approximately equivalent to that which might be expected on a roof at a point 25 ft. above ground level from a fire in a building 45 ft. away, and with a facade of 50 ft. x 50 ft., and 50 percent window openings; and since a roof may be exposed to wind at the same time as fire, provision is made to simulate the air movement of a wind at (15 miles/h approx.) In the spread of flame test the intensity of radiation varies in different parts of the specimen. Roofs are graded according to the duration of their resistance to penetration of flame coupled with the resistance they offer to superficial spread of flame. Some roofing materials melt when involved in fire, and allow burning drops to fall; behaviour in this respect to be observed and to be recorded during tests.

Scope

The specification describes test procedure for ascertaining

(a) the resistance of a roof to penetration by fire when exposed to radiation from fire in a neighbouring building; and

(b) the resistance to superficial spread of flame by roofs surfaced with combustible materials.

General: Construction of specimen

The tests shall be applied to a completely representative section of a roof 3 ft. square. The thickness shall include the whole surface treatment and the full depth of the rafters or purlins but shall not exceed 9 in., and shall include any underdrawing. If the distance between the roof members is 18 in. or more then the specimen shall be so constructed that one member is located on the underside across the centre of the specimen.

Where necessary sufficient rigidity may be obtained by providing an incombustible frame at the boundaries of the specimen (see Fig. 1). Any gaps between the specimens and the frame shall be plugged with cement mortar to provide an air seal. The specimen and its frame shall also form an air seal with the test apparatus,

Specimens shall be conditioned to a moisture content with an equilibrium of 70 ± 5 F and 55-65 per cent relative humidity.

Heat Penetration test

Number of specimens

Three specimens shall be tested.

Method of test

The roof specimen shall be supported at 45 degrees and shall be brought into position in not longer than 5 seconds from a position at room temperature to a position where its upper surface is exposed to radiated heat. The intensity of the radiation incident on the specimen shall be 0·35 ± 0·02 cal/cm^{-2}/sec^{-1}. Immediately the roof is exposed to the radiated heat the pressure on the underside shall be reduced by 1.5 mm of water below that on the upper side. This difference of pressure shall be maintained throughout the test. At five minutes from the start of the test a luminous gas flame 9 in. long from a $\frac{3}{8}$ in. diameter orifice shall be applied for 1 minute crossing and recrossing the roof at a rate of about 3 in. per sec. So that the whole of the surface excluding the boundaries is tested.

Observations during test

The time at which any glowing or flaming appears on the underside of the roof shall be recorded.

Computation of results

The average time for fire to penetrate the three specimens shall be used in determining the classification.

Surface spread of flame

Number of specimens

Three specimens shall be tested.

Method of test

The roof specimen shall be supported at 45 degrees and shall be brought into position in not longer than 5 seconds from a position at room temperature to a position where its upper surface is exposed to radiated heat. The radiated heat shall be such that the intensity in the plane of the roof down the centre line of the roof would give the values shown in Table 1. These intensities are equivalent to the radiation received, on a roof at a point 25 ft. above ground level from a 1000°C fire in a building having a 50 ft. square facade with 50 percent window openings at various distances as shown in Table 4. Immediately the roof specimen is exposed to radiated heat a luminous gas flame shall be applied to the hotter end for one minute. The flame shall be 9 in. long and shall issue from a $\frac{3}{8}$ in. diameter orifice.

Table 1

The intensities received of radiation equivalent distances from burning facade

Distance from hotter end in in.	Radiation intensity cal/cm^{-2}/sec^{-1}	Distance from 50 x 50 foot facade feet
3	0·32	48
9	0·38	42
15	0·28	51
21	0·16	76
27	0·12	90
33	0·1	96
36	0·08	106

Observations during test

The maximum distance of spread of flame down the roof shall be observed. Measurements shall be continued until flames have died out or for 10 minutes, whichever is the longest.

Computation of results

The average distance of spread of flame on the three specimens shall be used for determining the classification.

Classification

The roof specimens tested shall be classified according to time of penetration and the distance of spread of flame along the surface, as follows :

Class 1

Those roofs which resist penetration for more than 1 hour.

Class 2

Those roofs which resist penetration for more than $\frac{1}{2}$ hour.

Class 3

Those roofs which resist penetration for less than $\frac{1}{2}$ hour.

Class A

Those roofs on which there is no spread of flame.

Class B

Those roofs on which there is not more than 21 in. spread of flame.

Class C

Those roofs on which there is more than 21 in. spread of flame.

APPENDIX 1

Suggested apparatus for roof test

An apparatus for carrying out roof tests in accordance with this Specification has been constructed and used as described below.

The apparatus is shown in Figure 2. A 3 ft. square radiant panel is supported at an angle of 45° in a vertical frame and consists of four 1 ft. square surface combustion panels with their centres arranged at the corners of a square of 19 in. side.

Between the vertical legs of the frame a 2 ft. wide track supports the trolley which conveys the roof specimen to the radiation panel. The trolley carries a frame, supporting the specimen, at 45°. In the test the roof is then parallel with the radiant panel and the position of the trolley is such that the distance of the roof from the surface combustion heaters is twenty inches. A cover with a mica window is fixed to the lower side of the frame and suction is applied by connecting a $\frac{1}{6}$ H.P. motor and fan to the cover. To provide an air seal so that air is drawn through the upper surface of the roof, the specimen is framed on the edge of the lower surface with asbestos wood board and a flat bearing surface obtained. Around the sides of the specimen frame on the trolley asbestos millboard is laid to help provide an air seal when the specimen is placed in position. Any small holes around the edges of specimen and its frame are plugged with cement mortar.

The suction under the roof is measured by a gauge of the type shown in Figure 3. The slope of the side tube should be 1 in 10 and the movement of the liquid for 1·5 mm water pressure should be 1·5 cm.

The radiation intensity incident on the specimen is monitored by 4 copper asbestos disc thermocouples* placed symmetrically at a distance of 6 in. in front of the surface combustion panels in the corner of a square of 2 ft. side. When the radiation intensity is at the correct value for the penetration tests the output from each disc is ~~11·7~~ 25·5 MV.

For the spread of flame test only the two upper surface combustion heaters are used. When the heaters are correctly adjusted the two copper asbestos disc thermocouples opposite the heaters should give an E.M.F. of ~~11·7~~ 25·5 MV.

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*B.S. 476 Part I (1953).

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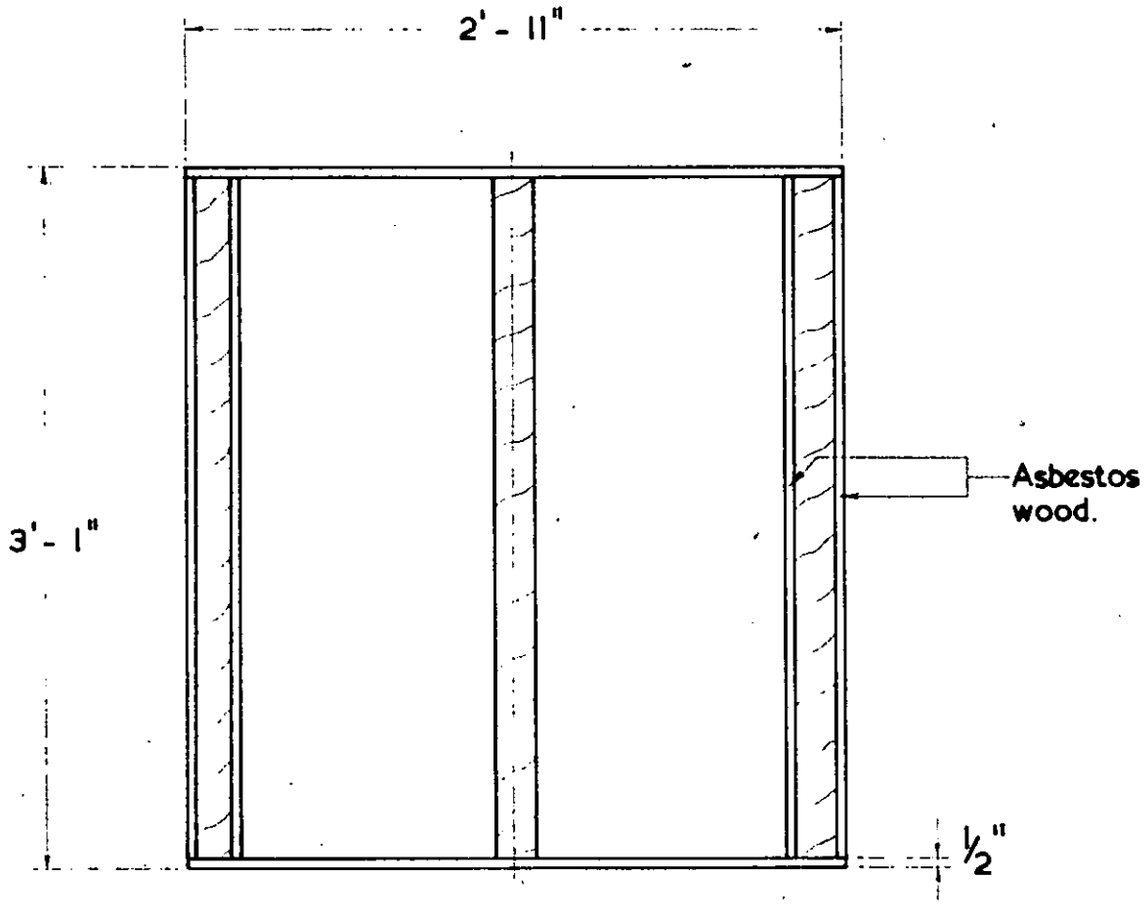

FIG. 1. UNDERSIDE OF SPECIMEN WITH FRAMING.

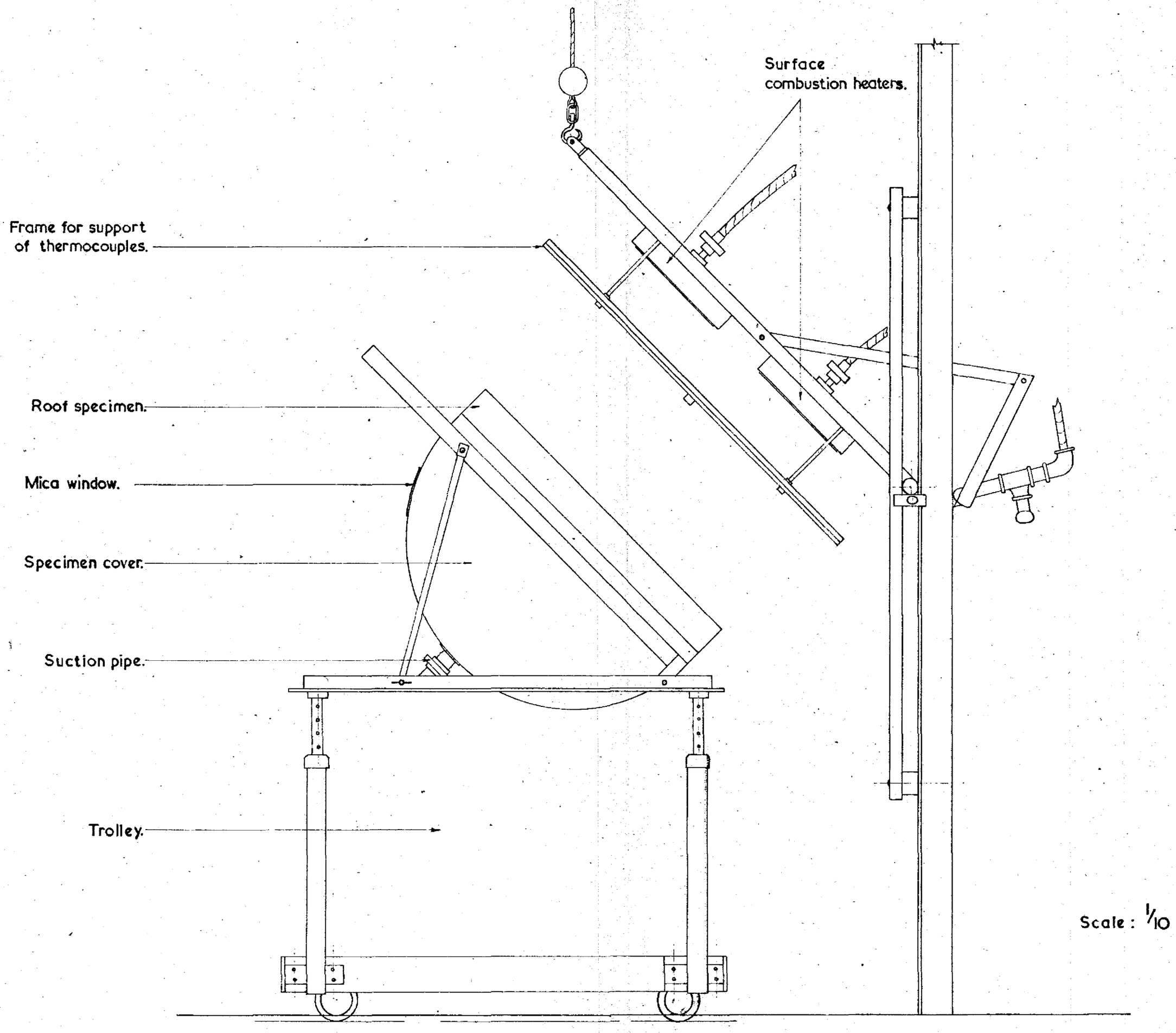

FIG. 2. ROOF TEST APPARATUS.

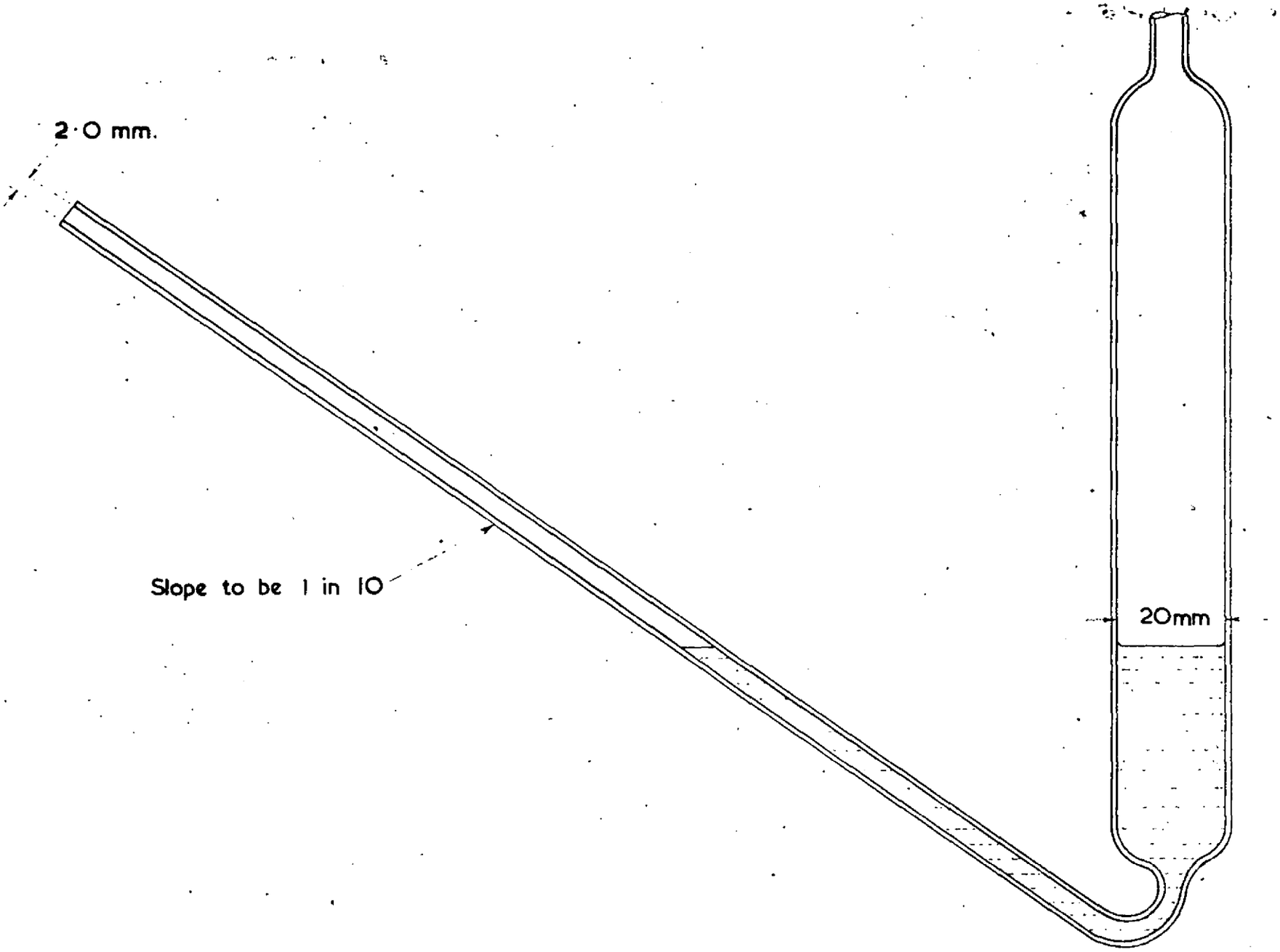

FIG. 3.