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Laboratory methods of test for

Determination of smoke generation characteristics of cellular plastics and cellular rubber materials

Part 1. Method for testing a 25 mm cube test specimen of low density material (up to 130 kg/m³) to continuous flaming conditions

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Foreword

This British Standard has been prepared under the authority of the Plastics and Rubber Industries Standards Committees in view of the increasing use of cellular materials.

The method described in this British Standard assesses the propensity of small test specimens of cellular plastics and cellular rubber materials to produce smoke and to obscure light transmission; it does not measure toxicity or the effect of smoke as an irritant to the eye. In the test, a small piece of material is enveloped in flame under test conditions that have been chosen to be most sensitive to differences between test specimens of low density materials, such as cellular plastics and cellular rubber, which are to be examined for the purposes of comparison and of monitoring consistency of production. The apparatus of the test has been used also for higher density materials but the conditions specified in this standard are likely to be inappropriate for test specimens of these materials because, for example, the ratio of available air to fuel may alter the character of the burning. It should be noted that a Draft for Development, DD 36 'Fire tests on building materials and structures. Measurement of the optical density of smoke produced by small specimens of materials' covering the measurement of smoke evolved by test specimens of sheet materials of a homogeneous or composite nature used as linings in buildings, has also been published. This Draft for Development incorporates the test procedure and apparatus of BS 476 'Fire tests on building materials and structures' : Part 6 'Fire propagation tests for materials', and can provide a measure both of the contribution of a material to the development of fire (in which it is not necessarily the first material ignited) and of the smoke generated by its own burning under similar conditions. It tests a flat sample, which may be a composite heterogeneous material, heated from one side as would be appropriate to a lining material. Two test environments are specified, one where the material can flame and one where it is prevented from doing so. *It is more relevant to a fire situation than to a particular type of material.*

It is intended to produce other parts of this British Standard covering other aspects of smoke generation.

British Standard Laboratory methods of test for

Determination of smoke generation characteristics of cellular plastics and cellular rubber materials

Part 1. Method for testing a 25 mm cube test specimen of low density material (up to 130 kg/m³) to continuous flaming conditions

1. Scope

This Part of this British Standard describes a small scale laboratory procedure for measuring the relative amounts of smoke produced by the burning or decomposition of cellular plastics and cellular rubber materials of density up to 130 kg/m³. Correlation with other fire conditions is not implied. The test is intended for use in product development and monitoring consistency of production, but is not intended as a measure of potential smoke production in fire situations. The measurements are made in terms of the loss of light transmission through a collected volume of smoke produced under standardized conditions. The apparatus is constructed so that the flame and smoke can be observed during the test.

NOTE. The titles of the British Standards referred to in this standard are listed on the inside back cover.

2. Apparatus

The apparatus shall be essentially as shown in Fig. 1. It shall be used inside an adequately vented fume cupboard and shall consist of the following items.

2.1 Test chamber

2.1.1 *Chamber.* The test chamber shall consist of a box, constructed from aluminium of thickness 1.65 ± 0.05 mm, mounted on a suitable base as shown in Fig. 2.

The internal dimensions of the box shall be as follows:

length: 300 ± 3 mm
width: 300 ± 3 mm
height: 790 ± 5 mm

The inside surfaces of the test chamber shall be painted matt black with a fire retardant paint conforming to at least Class 2 requirements of BS 476: Part 7.

2.1.2 *Door.* A door containing a heat resistant glass window shall be hinged to the open front of the chamber to leave a 25 mm gap at the base as shown in Fig. 1.

The door surround shall have a heat resisting rubber sealing strip to form a smoke tight seal when the door is closed.

2.1.3 *Ventilation openings.* The chamber shall have three horizontal openings of dimensions 230 mm x 25 mm on the three vertical walls at the base of the chamber as shown in Fig. 2.

2.1.4 *Smoke extraction unit.* A hole of appropriate size shall be cut at the top of the chamber to allow connection of a gas tight shutter and an extraction fan for removal of smoke after a test.

2.1.5 *Windows for optical path.* Two holes of diameter 70 mm shall be cut centrally in the two opposing side walls of the chamber so that their centres are 480 mm above the base. These holes shall be fitted with heat resisting glass windows fitted in gas tight seals as shown in Fig. 3.

2.2 Specimen support gauze. The support shall be a square of side 65 mm and shall consist of 6.4 mm mesh gauze constructed from 0.9 mm diameter stainless steel wire.

2.3 Gauze holder. The gauze shall rest in a stainless steel holder such that the gauze is located centrally with respect to the sides of the chamber and at a height of 220 ± 2 mm above the base of the chamber.

The holder shall be supported by a rod passing through the side of the chamber and attached to a handle such that by operation of the handle the specimen may be inverted and dropped into a water tray placed on the base of the chamber. The water tray shall be positioned in such a way that it does not obstruct any ventilation openings.

2.4 Drip collector. A second steel holder shall be located 75 mm below the gauze holder (see Fig. 1) in such a way that 64 mm squares of asbestos paper may be used to catch any drips or blazing particles falling from the specimen during a test.

2.5 Ignition system

2.5.1 *Burner.* An exploded view of the burner is shown in Fig. 4. Propane gas shall be supplied through an inner tube terminating in a jet of diameter 0.13 mm. Air shall be drawn from outside the chamber through a tube surrounding the gas tube by the Venturi effect of the propane being released through the jet. The air supply tube shall extend for at least 150 mm outside the chamber to prevent any recirculation of air via the ventilation opening.

NOTE. A suitable burner is available as a 'Bernz-O-matic, Pencil tip burner-TX-1' from A. J. Shaw Company, Osborne House, Alsager, Stoke-on-Trent, Staffs., ST7 2PJ. The burner should be modified to conform with the details of Fig. 4.

2.5.2 *Positioning of burner.* The burner shall be mounted on a swivel in one lower rear corner of the chamber in such a way that it can be quickly moved from its rest position (parallel to the side wall of the chamber) to its test position. The burner is in its test position when its axis is on a line starting 8 mm above the lower rear corner of the chamber and extending diagonally across the chamber at an angle of 45° to the base. The length of the burner is such that its top is 260 mm from the reference point (8 mm above the lower rear corner of the chamber). This position shall be such that the burner flame, when lit, is central on the specimen support gauze.

2.5.3 *Gas supply.* Propane gas of at least 93 % purity and complying with the requirements of BS 4250 shall be supplied via on/off and pressure regulating valves. A pressure gauge shall be fitted on the outlet side of the regulating valve.

2.6 Optical measuring system. A light source, photoelectric cell and potentiometric recorder shall be used to determine the proportion of a light beam which penetrates through the smoke generated by the test specimen. The distance between the inner surfaces of the two windows described in **2.1.5** shall be 300 ± 3 mm.

2.6.1 *Light source.* The light source shall be mounted in a light proof box fitted to one side of the chamber as shown in Fig. 1.

The box shall contain a small optical bench on which are mounted a spherical reflector, a 6 V, 18 W compact filament microscope lamp, and a 60 mm to 65 mm focal length lens. These items are positioned to produce a parallel light beam across the chamber as shown in Fig. 3. Steps shall be taken to ensure a constant voltage to the lamp by the use of, for example, an accumulator or a constant voltage transformer.

2.6.2 *Photocell unit.* The photocell unit shall be contained in a second light proof box mounted on the opposite wall of the chamber to the light source as shown in Fig. 1.

The field of view of the photocell shall be limited to an included angle of not more than 60°. This is facilitated by introducing a grid having openings at least twice as deep as they are wide and painted dull black to prevent any reflected stray light reaching the cell.

The photocell shall have a standard observer spectral response.

NOTE. A suitable photocell is available from Evans Electroselenium Ltd., Type Spec. 1, Part No. 001 55 004. This should be fitted with an EEL filter for correction of the response of the photocell to that similar to human vision.

2.6.3 *Recorder unit.* The output from the photocell shall be connected across a potentiometer. The output from the potentiometer shall be connected to a potentiometric recorder having a chart speed of at least 40 mm/min.

NOTE 1. A 10 turn, 500 Ω helical potentiometer has been found suitable.
NOTE 2. If desired, a multirange recorder may be used to obtain more accurate readings at high obscuration values.

3. Calibration procedure

Before commencing any series of tests a calibration graph of recorder reading against actual obscuration shall be obtained using at least five photographic neutral density filters giving obscurations at approximately equal intervals throughout the range. This shall be done as follows.

(1) Turn on the photometer light and allow it to stabilize for 15 min.
(2) Adjust the photocell output potentiometer until the recorder reading is equivalent to 0 % light obscuration.
(3) Carefully position a filter against the photocell window.
(4) Read the recorder deflection.
(5) Repeat (3) and (4) using at least four other filters.
(6) Plot a graph of recorder deflection against obscuration value.

4. Size and number of test specimens

4.1 Five specimens shall be cut from a representative sample of the material. Care shall be taken to remove all dust and particles from the surfaces.

4.2 Each test specimen shall be a cube of side 25 + 1 mm, – 0. These dimensions shall be determined according to BS 4370 : Part 1, Method 1A or BS 4443 : Part 1, Method 1A as appropriate. Where material is less than 25 mm in thickness pieces shall be plied together without bonding to obtain the necessary cube.

5. Conditioning of specimens

The material shall be tested not less than 72 h after manufacture. Prior to the test, the test specimens shall be stored for at least a further 16 h in the following standard atmosphere:

23 ± 2 °C, 50 ± 5 % r.h.

6. Test procedure

6.1 Turn on the photometer light and allow it to stabilize for 15 min.

6.2 Switch on the extraction fan and open the shutter.

6.3 Ensure that the burner is in its rest position. Turn on the propane, ignite the burner, and adjust the gas pressure to 2.75 ± 0.05 bar*.

NOTE. The standard burner under these conditions gives a flame of 125 ± 10 mm in length.

6.4 Adjust the photocell output potentiometer until the recorder reading is equivalent to 0 % light obscuration.

6.5 Place a test specimen centrally on the specimen support gauze. Where a skin or skins are present they shall be the lower surfaces of all plies.

NOTE. In certain cases, problems may occur due to movement of the test specimen during the test. Where this occurs the test piece should be fixed using, for example, a thin pin.

6.6 Switch off the extraction fan and close the shutter.

6.7 Close the chamber door, start the recorder chart motor and immediately bring the burner to its test position.

6.8 Record the behaviour of the specimen during the test including the time for specimen flame extinction or the time when the specimen is totally consumed and any burning characteristics of the material, e.g. melting, dripping, charring, etc.

6.9 After the test has run for 4 min, immediately open the shutter, switch on the extraction fan and return the burner to its rest position. Record the deflection due to soot deposits on the windows and switch off the recorder motor.

6.10 Clean any combustion deposits off the windows and the glass door of the chamber with detergent and water and ensure that readings of less than 2 % obscuration are obtained. Burn off any residue on the gauze or replace the gauze and asbestos square for the next test.

6.11 Read from the recorder chart the maximum deflection reached and the time to reach this value.

6.12 Repeat the procedures **6.4** to **6.11** for the remaining specimens.

6.13 At the beginning of each series of tests or at least once per day check the calibration of the photocell unit using a series of neutral density filters held against the photocell window. (See Clause **3.**)

6.14 Convert the recorder deflections to obscuration values using the calibration graph obtained.

7. Test report

The test report shall include the following.

(1) The statement, in prominent type:

'The following test results relate only to the behaviour of the test specimens under the particular conditions of test; they are not intended as a means of assessing the potential smoke production in fire situations.'

(2) Identification, density of material, number of plies and presence or absence of skins.

(3) Maximum obscuration for each specimen.

(4) Mean maximum obscuration for each set of specimens rounded up to the next 5 %.

(5) Time of reaching maximum obscuration for each specimen.

(6) Mean time of reaching maximum obscuration for each set of specimens expressed to the nearest 5 s.

(7) The obscuration due to soot deposit on the windows at the end of each test.

(8) Mean obscuration due to soot deposit on the windows for each set of specimens.

(9) Observation of the burning behaviour of each set of specimens, e.g. time of extinguishment, melting, dripping, charring.

*1 bar = 10^2 kPa.

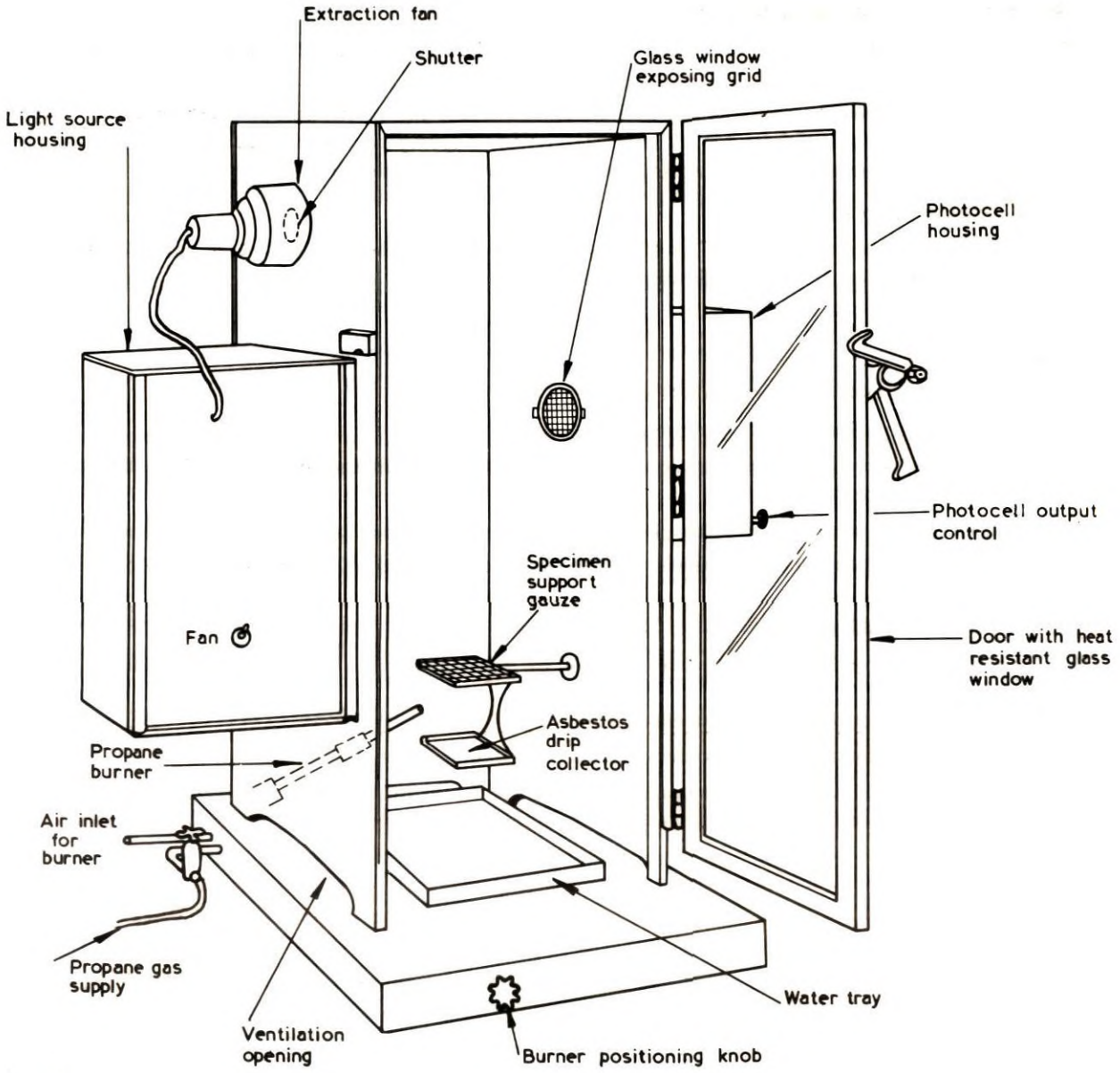
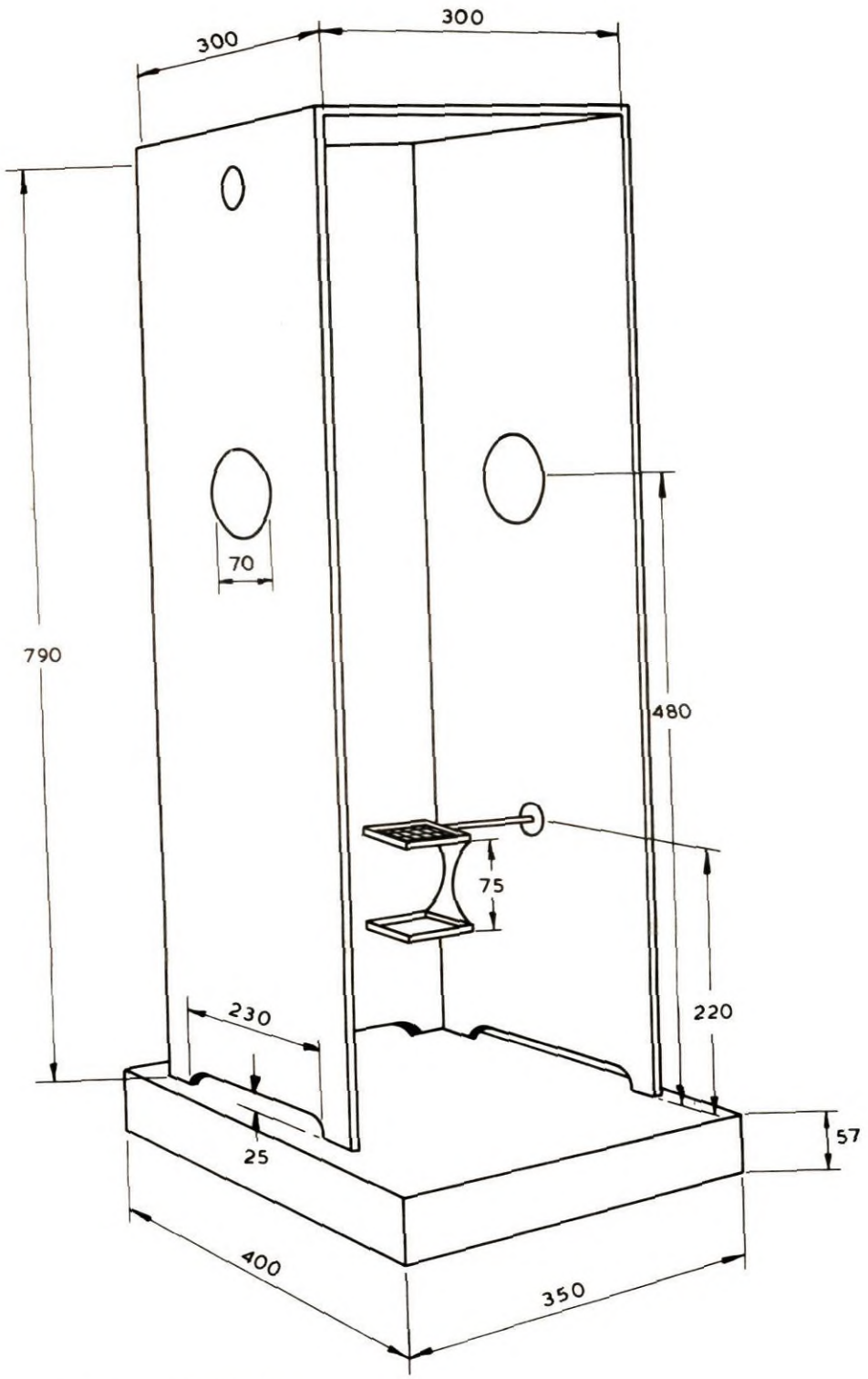


Fig. 1. Schematic diagram of test chamber



All dimensions in millimetres.

Fig. 2. Dimensional diagram of test chamber

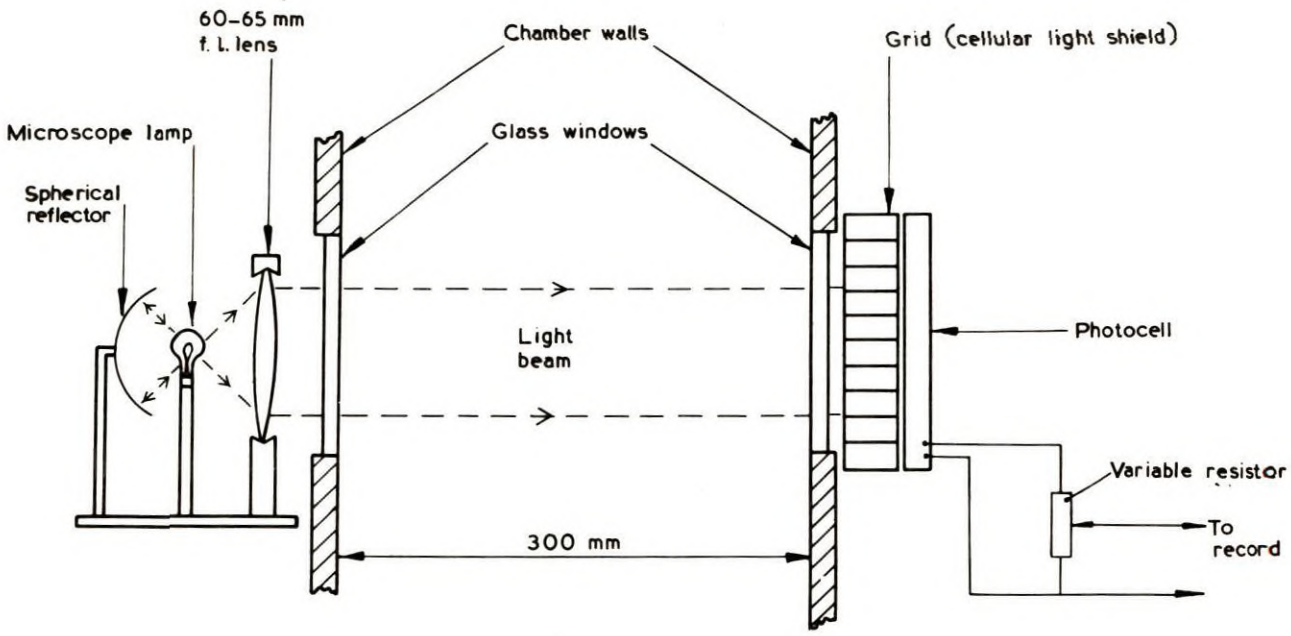


Fig. 3. Schematic illustration of optical system for test chamber

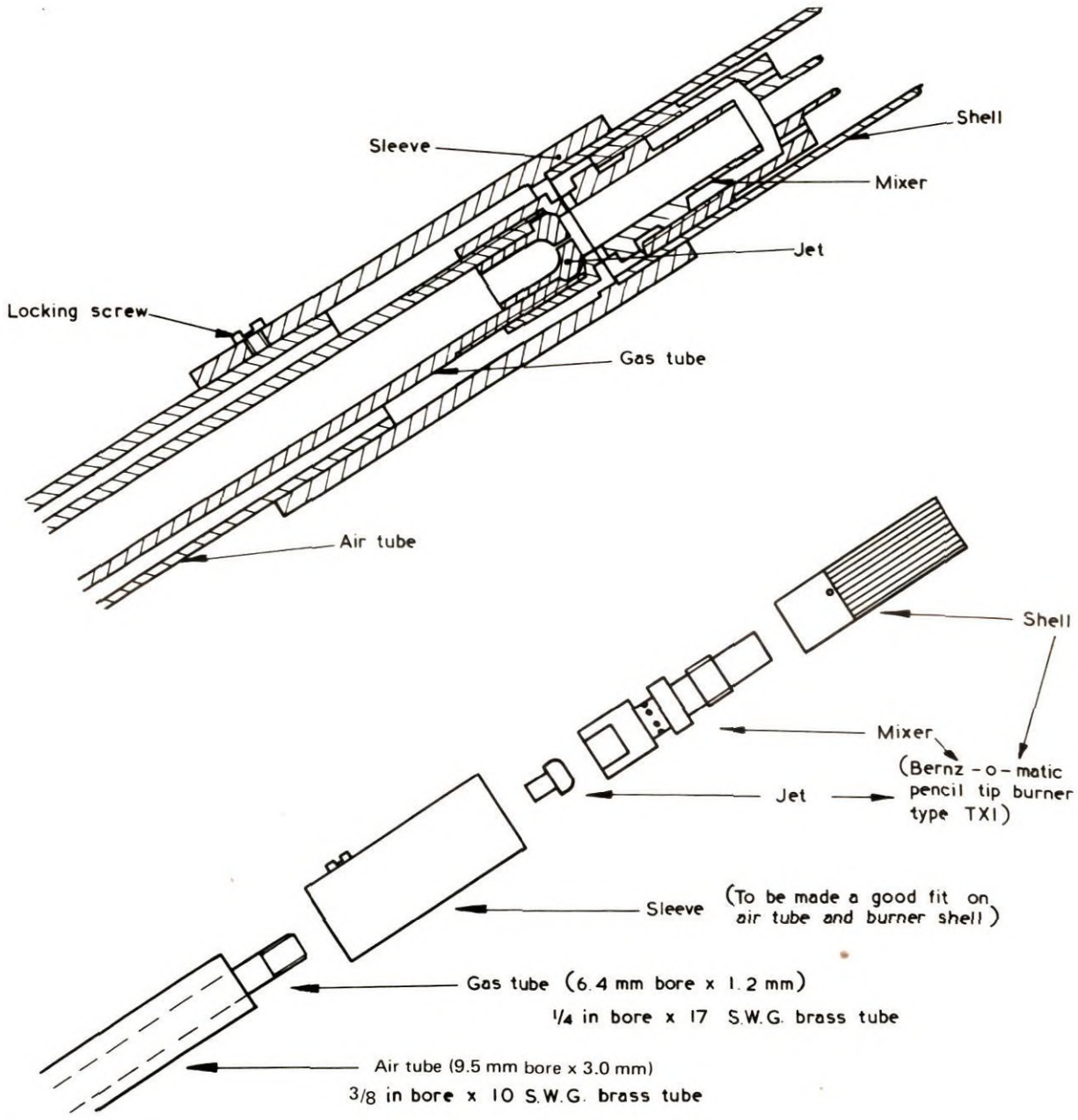


Fig. 4. Details of a suitable burner