BRITISH STANDARD

BS 3142-3: 1970
Incorporating Amendment No. 1

Specification for

Manufactured solid smokeless fuels for household use —

Part 3: Specially reactive fuels for all types of domestic open fire

Co-operating organizations

The Solid Fuel Industry and the Gas Industry Standards Committees, under whose supervision this British Standard was prepared, consist of representatives from the following Government departments and scientific and industrial organizations:

Association of Consulting Engineers
BCURA Industrial Laboratories
British Cast Iron Research Association
British Coke Research Association*
British Electrical and Allied Manufacturers' Association
British Ironfounders' Association*
British Mechanical Engineering Confederation
British Steel Industry
Chamber of Coal Traders
Chemical Industries Association
Coal Utilisation Council*
Coke Oven Managers' Association*
Council of Ironfoundry Associations
Domestic Solid Fuel Appliances Approval Council
Electricity Council, the Central Electricity Generating Board and the Area Boards in England and Wales
Gas Council*
Heating and Ventilating Contractors' Association
Imperial Chemical Industries Ltd.
Institute of British Foundrymen
Institute of Fuel
Institution of Gas Engineers
Institution of Heating and Ventilating Engineers
Institution of Mechanical Engineers
Liquefied Petroleum Gas Industry Technical Committee
Low Temperature Coal Distillers' Association of Great Britain Ltd.*
Ministry of Housing and Local Government
Ministry of Public Building and Works
Ministry of Technology
National Coal Board*
Society of British Gas Industries
Water-tube Boilermakers' Association
Women's Advisory Council on Solid Fuel*

The scientific and industrial organizations marked with an asterisk in the above list, together with the following, were directly represented on the committee entrusted with the preparation of this British Standard:

Association of Municipal Corporations
Consumer Council
Consumers' Association
County Councils Association
Independent Coke Producers Association
Institute of Weights and Measures Administration
National Federation of Coke Distributors' Associations
Solid Smokeless Fuels Federation
Women's Advisory Committee of BSI

This British Standard, having been approved by the Solid Fuel Industry and the Gas Industry Standards Committees, was published under the authority of the Executive Board on 18 November 1970

The following BSI references relate to the work on this standard:
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Contents

Foreword

This standard makes reference to the following British Standards and Code of Practice:

BS 410, *Specification for test sieves.*

BS 792, *Specification for mild steel dustbins.*

BS 1016, *Methods for the analysis and testing of coal and coke.*

BS 1016-1, *Total moisture of coal.*

BS 1016-2, *Total moisture of coke.*

BS 1016-3, *Proximate analysis of coal.*

BS 1016-4, *Moisture, volatile matter and ash in the analysis sample of coke.*

BS 1016-5, *Gross calorific value of coal and coke.*

BS 1016-13, *Tests special to coke.*

BS 1016-18, *Size analysis of coal.*

BS 1017, *Methods for sampling coal and coke.*

BS 1017-1, *Sampling of coal.*

BS 1017-2, *Sampling of coke.*

BS 1251, *Specification for open-fireplace components.*

This Part of BS 3142 has been prepared under the direction of the Solid Mineral Fuels Standards Policy Committee. A minor amendment, published in 1990, deleted references to asbestos-containing material for reasons of safety.

The specification provides for one size range of specially reactive fuels, made by the partial carbonization of coal, and intended for use with all types of domestic open fire. An alternative fire performance test is included.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 18 and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

Introduction deleted

1 Scope

This British Standard specifies the requirements of quality control at producers' works for specially reactive open fire fuels for use on all types of domestic open fires.

2 Sampling and preparation of samples

Regular sampling of fuels produced to this standard shall be carried out at producers' works. The samples shall be collected in the manner described in Appendix A and shall be prepared for testing in the manner described in Appendix B.

3 Calorific value

When tested in the manner described in Appendix C the mean calorific value, as despatched from producers' works, shall be not less than 25 600 kJ/kg (11 000 Btu/lb).

4 Undersize

When tested in the manner described in Appendix D the mean proportion of fuel passing a 19 mm (¾ in) mesh BS test sieve[1)] shall not exceed 7 %.

5 Fire performance tests

When tested in the stool bottomgrate in the manner described in Appendix E, fuels shall conform to the following requirements.

Ignition time. The mean time for the radiation output to reach 630 W/m^2 (200 Btu/ft^2 h) using 4 220 kJ (4 000 Btu) of gas for ignition shall not exceed 35 min.

Three peak radiation test. The mean peak value for the third peak shall not be less than 945 W/m^2 (300 Btu/ft^2 h).

In Appendix F, provision is made for the use of an inset grate for fire performance testing, where it can be demonstrated that the fuel would meet the fire performance requirements of the specification if tested by the method of Appendix E. The alternative fire performance requirements are also given in Appendix F.

6 Assessment of results

The method of assessing the results is given in Appendix G.

[1)] BS 410, "*Test sieves*"

Appendix A Sampling procedure

A.1 Introduction

This appendix outlines the methods to be followed and the precautions to be observed in taking samples.

A.2 Frequency of sampling

Sampling shall normally be carried out on every day on which fuel is despatched from the producer's works. Samples shall be taken at such times in the course of each week that the whole loading period is covered.

A.3 Methods of sampling

Individual works differ in their procedure of fuel handling. Some works despatch fuel in weighed bags, some in bulk and others by both methods. Two methods of sampling are specified, one for sampling where fuel is filled into bags, the other where the fuel is loaded in bulk. The two procedures are described in **A.5** and **A.6** respectively.

It is important to ensure that the samples taken reflect the quality and consistency of the fuel despatched. This requires special attention where the fuel is despatched either from more than one point[2)] or both in bags and in bulk.

For some plants this can be achieved by using only one method to sample the fuel despatched. Two such examples are as follows.

Example 1. If both the bag and the bulk loading points are fitted with similar de-breezing or guard screens it is probable that the fuel from each point will have the same size distribution. If this is found to be so, all samples can be taken from the bag loading points by the method described in **A.5**, provided that all such points are covered in the sampling scheme.

Example 2. If the fuel for despatch alternates between two bulk loading points and it is not practicable to obtain samples from one of these points, all the samples may be taken from the other loading point, provided that there are no differences in operating procedure which could introduce a significant bias.

For plants where a significant difference is found between samples of the fuel loaded from different despatch points it will be necessary to include all such points in the sampling scheme, samples being taken from each by the methods described in **A.5** and **A.6** with a frequency roughly proportional to the quantity of fuel loaded from that point.

A.4 Stock and "imported" fuel

Any fuel taken from stock or imported from other works, which forms a part of the fuel bagged or loaded in bulk for despatch, shall be taken into account in the scheme of sampling. Where such fuel is returned to the screening plant and mixed with current production for despatch, no special arrangements are required.

Where fuel is loaded direct from stock heaps, an appropriate number of the samples shall be taken from this fuel. As a rough guide the frequency of sampling from stock heaps should depend on the proportions loaded from stock and direct from current production.

A.5 Bag sampling

When sampling 50 kg (1 cwt) bags of fuel, two bags shall be taken together each day that fuel is despatched from those filled for despatch. One of those bags shall be used as the sample for the determination of calorific value, the other for the fire performance and undersize tests. If smaller bags are being filled, sufficient bags shall be taken to provide the two 50 kg (1 cwt) samples.

After the samples have been taken, the fuel shall not be left in the bags, as this may lead to changes in size or moisture content or both. Unless, therefore, the samples are to be prepared immediately for testing by the methods described in Appendix B, they shall be transferred at once to closeable containers[3)] of metal or other suitable material, which shall immediately be closed.

A.6 Sampling during bulk loading

Two samples shall be taken each day that fuel is despatched. One of these samples shall be used for the determination of calorific value, the other for the fire performance and undersize tests. The weight of each sample shall be approximately 50 kg (1 cwt) and in no circumstances greater than 100 kg (2 cwt).

[2)] "Point of despatch" refers to the point in the works at which either bags, wagons or lorries are loaded immediately prior to despatch.

[3)] Sanitary dustbins with tight-fitting lids in accordance with BS 792, "*Mild steel dustbins*", are suitable for this purpose.

Sampling shall be carried out either at the loading point or at some position between the last screen (final de-breezing screen, if fitted) and the loading point. Each sample should be taken either as one or as a series of increments [each of which shall not be less than 4.5 kg (10 lb)] with the loading boom or conveyor temporarily stopped, the whole cross section of the fuel being taken. Alternatively, the increments may be collected at a point where the fuel is falling freely and taken so that the whole cross section of the stream is sampled at once. When the fuel is bulk loaded into wagons and it is not practicable to obtain a sample prior to loading, a wagon may be unloaded and a representative sample taken in increments from the fuel discharged from that wagon.

Unless the samples are to be prepared immediately for testing, they shall be transferred at once to closeable containers[4] of metal or other suitable material which shall immediately be closed.

Appendix B Preparation of samples for testing

B.1 Introduction

The two samples of fuel, taken as described in Appendix A each day that the fuel is despatched from the works, shall be used for the following determinations as required:

Sample A: calorific value;

Sample B: size,

fire performance.

B.2 Calorific value

The whole of Sample A shall be used for the preparation of a sub-sample for the determination of the calorific value as despatched from the producer's works.

According to whether the fuel is considered for analytical purposes to be of a "coke type" or a "coal type", one of the following procedures shall be used. (For the purposes of this specification a "coke type" fuel is defined as "the solid product of carbonization, generally at a temperature in excess of 900 °C, of a charge consisting predominantly of bituminous coal", see BS 1016-5[5], **2.1** 5); a "coal type" fuel covers all specially reactive solid fuels produced by other manufacturing processes.)

1) "*Coke type*'. A 1 kg (2 lb)[6] total moisture sample shall be taken and prepared as described in BS 1017-2[7], Section 7. After drying, a 60 g sub-sample of "through 212 μm" fuel shall be prepared as described in BS 1017-2[7], Section 8, for the determination of calorific value as described in Appendix C.

2) "*Coal type*". A 1 kg (2 lb)[6] total moisture sample shall be taken and prepared as described in BS 1017-1[8], Section 6. A 250 g sub-sample of "through 212 μm" fuel shall also be taken and prepared as described in BS 1017-1[8], Section 5, for the determination of calorific value as described in Appendix C.

B.3 Undersize

The whole of Sample B shall be spread in a single layer on a hard clean surface and a sub-sample removed by filling a 0.056 m^3 (2 ft^3) bulk density box, taking increments each of about 0.7 kg (1½ lb) evenly distributed over the sample. The remainder of the sample shall be used for the determination of undersize as described in Appendix D.

B.4 Fire performance

The sub-sample obtained from the 0.056 m^3 (2 ft^3) box (see **B.3**) shall be used for the determination of the bulk density of the fuel, using the procedure described in BS 1016-13[9] (the determination shall be carried out with the fuel at approximately the same moisture content as for the fire performance test). The sub-sample shall then be spread into a single layer on a hard, clean surface and a weight equivalent to 0.0095 m^3 (0.335 ft^3) shall be collected by taking increments each of about 0.7 kg (1½ lb) and evenly distributed over the sub-sample. This fuel shall be used for the ignition test as described in Appendix E. The further quantity of fuel required, when necessary, for the three peak radiation test shall be collected at the same time by similar increments.

If the procedure of Appendix F is to be used, the weight collected shall be increased to the equivalent of 0.115 m^3 (0.40 ft^3).

These samples may be dried, if desired, before carrying out the ignition and radiation tests.

[4] Sanitary dustbins with tight-fitting lids in accordance with BS 792, "*Mild steel dustbins*", are suitable for this purpose.

[5] BS 1016, "*Methods for the analysis and testing of coal and coke*", Part 5, "*Gross calorific value of coal and coke*".

[6] For fuels of low bulk density, it is permissible to reduce the mass of sample to not less than 750 g.

[7] BS 1017, "*The sampling of coal and coke*", Part 2, "*Sampling of coke*".

[8] BS 1017, "*The sampling of coal and coke*", Part 1, "*Sampling of coal*".

[9] BS 1016, "*Methods for the analysis and testing of coal and coke*", Part 13, "*Tests special to coke*".

Appendix C Determination of calorific value as despatched

The sample for the determination of calorific value, obtained and prepared as described in Appendix A and **B.2**, shall be tested in the manner specified in BS 1016-5[10]. The moisture content of the sample shall be determined, at the same time, by the method described in BS 1016-3 or BS 1016-4,[11] as appropriate.

The calorific value shall be calculated to the "as despatched" basis using the total moisture content of the sample, determined by the method described in BS 1016-1 or BS 1016-2[12], as appropriate, on the sample prepared for this purpose as described in **B.2**.

Alternatively, for works control purposes, provided a consistent relationship can be established, the "as despatched" calorific value may be calculated from the previously established dry, ash free calorific value, using the "as despatched" total moisture content (determined as described in BS 1016-1 or BS 1016-2[12], as appropriate) and ash content (determined as described in BS 1016-3 or BS 1016-4[11], as appropriate) of the sample. The validity of the relationship shall be checked at appropriate intervals.

Appendix D Determination of undersize

The sample for the determination of undersize, obtained and prepared as described in Appendix A and **B.3**, shall be tested in the manner specified in BS 1016-18[13]. The amount of fuel passing a 19 mm (¾ in) mesh BS sieve shall be determined and the result recorded as percentage of undersize.

Appendix E Fire performance tests

E.1 Introduction

The sample taken each day that fuel is despatched shall be subjected to an ignition test.

Samples taken every third day that the fuel is despatched shall also be subjected to a three peak radiation test, of which the ignition test forms the initial part.

E.2 Principle

E.2.1 *Ignition test.* A standard volume of 0.0095 m^3 (0.335 ft^3) of the prepared sample of fuel shall be charged into a standard design of open fire and setting. Using the ignition burner, the fuel shall be ignited with 4 220 kJ (4 000 Btu) of gas, supplied at a uniform rate of 7.3 ± 0.3 kW (0.25 ± 0.01 therm/h). The time taken for the intensity of radiation from the fire to reach 630 W/m^2 (200 Btu/ft^2 h), measured by a Moll thermopile in a standard position, shall be recorded.

E.2.2 *Three peak radiation test.* The fire, ignited by the method described in **E.2.1**, shall be allowed to continue burning and to pass the peak value of radiant intensity. Refuelling to the standard volume shall be performed when the radiant intensity drops to a level of 630 W/m^2 (200 Btu/ft^2 h). After a further peak value of radiant intensity has been passed, refuelling shall be performed again according to the standard procedure and the fire allowed to reach a third peak value of radiant intensity. The height of the third peak of radiant intensity shall be recorded.

The fire shall not be de-ashed at any stage of the test and the fuel bed shall be disturbed as little as possible at each refuelling. The test requirements have been specified so as to take into account the effect of ash accumulation over a prolonged burning period.

E.3 Equipment

E.3.1 *Setting.* The setting shall consist of a box of 0.9 mm (0.036 in) mild steel into which is fitted a refractory fireback, preferably of the six-piece type generally in accordance with BS 1251[14], without the use of jointing material. The height of the knee of the fireback above the hearth shall be 520 ± 10 mm (20–21 in). The fireback shall be insulated by pouring exfoliated vermiculite into the space between it and the casing ensuring that, without exerting any pressure, no voids exist; the commercial 10 mm (⅜ in) size is suitable after removal of material passing a 3 mm (⅛ in) mesh sieve. The setting shall include a tiled hearth and surround 50 mm (2 in) thick, rigidly fixed to the frame, and shall be connected by means of a gather of 0.9 mm (0.036 in) mild steel to a cylindrical flue of internal diameter 150 mm (6 in) and length 1.4–1.8 m (4 ft 6 in to 6 ft).

Details of the setting are given in Figure 1 and Figure 2.

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[10] BS 1016, "*Methods for the analysis and testing of coal and coke*", Part 5, "*Gross calorific value of coal and coke*."
[11] BS 1016, "*Methods for the analysis and testing of coal and coke*", Part 3, "*Proximate analysis of coal*", Part 4, "*Moisture, volatile matter and ash in the analysis sample of coke*".
[12] BS 1016, "*Methods for the analysis and testing of coal and coke*", Part 1, "*Total moisture of coal*", Part 2, "*Total moisture of coke*".
[13] BS 1016 "*Methods for analysis and testing of coal and coke*", Part 18, "*Size analysis of coke*".
[14] BS 1251, "*Open fireplace components*".

The setting may be mounted either on the floor or on a platform. In either case the ashpit floor shall be brought level with the top surface of the hearth by means of a slab of fireclay or refractory concrete.

The setting shall be sheltered from draughts and the Moll thermopile shall not be exposed to sunlight or other radiation that would interfere with the tests. Two or more settings may be installed side by side or back to back provided that they are not touching and that the provisions of **E.5.1**, third paragraph, are satisfied.

E.3.2 *Open fire and gas burner.* The Newtone stool bottomgrate and fret open "fire" shall be used, having a cast iron bottomgrate with air spaces of 9.5 ± 0.8 mm ($^3/_8 \pm {}^1/_{32}$ in) between the bars. The front slide shall be removed but the ring shall be replaced.

The design of the appliance is illustrated in Figure 3.

The ignition burner to be used is illustrated in Figure 4.

The bottomgrate shall be set back as far as possible in the setting and, during ignition, the burner shall be correctly located to ensure that the flames pass through the slots of the bottomgrate.

E.3.3 *Extraction system.* Products of combustion shall be removed by a suitable extraction system coupled to ducting and terminating in a hood placed above the flue pipe. The gases may be removed either by the natural draught or by an extraction fan, provided that the whole system has no effect on the normal draught in the flue.

E.3.4 *Gas supply to the ignition burner.* The gas used for ignition shall be town gas or coke oven gas having a calorific value of 18.8 ± 2.0 MJ/m^3 (450–560 Btu/ft^3). The gas supply to the ignition burner shall include a suitable pressure governor, a calibrated test gas meter reading to 0.005 m^3 (0.1 ft^3), a control valve and a stopcock. A suitable flowmeter should also be included for checking the gas rate to the ignition burner.

The gas shall be supplied at a rate corresponding to 7.3 ± 0.3 kW (0.25 ± 0.01 therm/h).

E.3.5 *Moll thermopile.* The radiation emitted by the fire shall be measured with a Moll thermopile[15)] with a 25° half-angle of acceptance, the receiver to be zincblacked or treated with equivalent material (carbon black is not suitable).

No special precautions are necessary when a thermopile is used to measure the relatively low radiant intensities of the ignition test. When used for the three peak radiation test, the non-compensated type of thermopile shall be fitted with a water-cooled back, as illustrated in Figure 5. A continuous flow of water, of approximately 25 ml/min, is passed through the back from a supply at ambient temperature.

The thermopile shall be securely mounted on a support and shall be positioned in relation to the setting and the open fire as shown in Figure 6.

The thermopile shall be calibrated in W/m^2 (Btu/ft^2 h) with reference to a source at a temperature in the range 900–1 100 °C. The calibration factor shall be checked at least once every 12 months and preferably at more frequent intervals. Initial and check calibrations shall be made either by the National Physical Laboratory or, using suitable equipment and a procedure such as that described in Appendix H, in other laboratories.

The thermopile should preferably be used in conjunction with a potentiometer, but may be used in association with a millivoltmeter provided that the thermopile, millivoltmeter and leads are all calibrated together. Calibration factors obtained in this way do not apply to the thermopile when used with a potentiometer.

E.3.6 *Potentiometer or millivoltmeter.* The Moll thermopile may be used with either a recording potentiometer or a millivoltmeter, In either case the instrument shall be capable of being read accurately to 0.1 mV and should have a response time of not more than 30 s for full-scale deflection. If a millivoltmeter is used the limitations set out in the last paragraph of **E.3.5** shall apply.

E.3.7 *Timer.* An instrument provided with minute and second hands, for measuring the time during which gas is supplied, is required.

E.4 Sample

The test shall be carried out on the sub-sample of the fuel taken and prepared as described in Appendix B.

E.5 Procedure

E.5.1 *Ignition test.* The gas regulator valve shall be set so that gas is supplied at a rate corresponding to 7.3 ± 0.3 kW (0.25 ± 0.01 therm/h) and the stopcock shall then be closed. This operation shall be performed in such a manner that no heat is supplied to the setting.

[15)] Suitable instruments may be obtained from Land Pyrometers Ltd. or Cambridge Instrument Co. Ltd.

The setting and the grate shall be clean and free from ash and the fire shall be set back as far as possible into the fireback. The front fret shall be left off throughout the ignition test.

The Moll thermopile shall be placed in its specified position in front of the fire. The level of radiant intensity from the setting shall be observed. A test shall not be started if the radiant intensity exceeds 16 W/m^2 (5 Btu/ft^2 h).

The fire shall be charged with 0.0095 m^3 (0.335 ft^3) of the fuel by means of a small hand shovel, so that the fuel bed is in a plane sloping upwards from the front of the fire. It is advisable to mark the level of the rear edge of the fuel bed on the fireback to facilitate refuelling to the correct level. The fuel shall be at room temperature when charging takes place.

The gas shall be ignited at the pre-set rate corresponding to 7.3 ± 0.3 kW (0.25 ± 0.01 therm/h) and the timer started simultaneously. The gas flow rate shall be checked frequently, e.g. by means of the flowmeter, and quickly adjusted whenever necessary.

When a volume of gas equivalent to 4 220 kJ (4 000 Btu) has been delivered the gas shall be turned off. The fire shall be allowed to burn undisturbed until the radiant intensity as measured by the Moll thermopile reaches 630 W/m^2 (200 Btu/ft^2 h). The time taken to reach this intensity from the moment the gas was ignited shall be recorded.

When the ignition test only is being carried out, the fuel may be raked out at this stage and the open fire removed, to accelerate the cooling of the setting.

E.5.2 *Three peak radiation test.* The three peak radiation test shall be carried out on every third sample. When sampling is carried out on six days a week the three peak radiation test shall be carried out on the samples taken on, for example, Monday and Thursday of the first week, Tuesday and Friday of the second week, Wednesday and Saturday of the third week, Monday and Thursday of the fourth week, and so on.

The procedure shall be as follows.

When the radiant intensity reaches 630 W/m^2 (200 Btu/ft^2 h) in the ignition test, the front fret shall be placed in position and the fire allowed to burn undisturbed until its radiant intensity has passed its peak and dropped to 630 W/m^2 (200 Btu/ft^2 h). The fire shall then be refuelled to its original volume[16)] with the minimum disturbance to the fuel bed, using a small hand shovel.

The fire shall be allowed to pass its second peak value of radiant intensity and, when the radiant intensity has dropped to 630 W/m^2 (200 Btu/ft^2 h), the fire shall again be refuelled in the same manner as before. The fire shall be allowed to reach and pass the third peak of radiant intensity.

The height of the third peak of radiant intensity shall be recorded.

Appendix F Alternative method of fire performance testing

F.1 Introduction

The sample taken each day that fuel is despatched shall be subjected to an ignition test.

Samples taken every third day that fuel is despatched shall also be subjected to a three peak radiation test, of which the ignition test forms the initial part.

F.2 Principle

F.2.1 *Ignition test.* A standard volume of 0.0115 m^3 (0.40 ft^3) of the prepared sample of fuel shall be charged into a standard design of open fire and setting. Using the ignition burner, the fuel shall be ignited with 4 220 kJ (4 000 Btu) of gas, supplied at a uniform rate of 7.3 ± 0.3 kW (0.25 ± 0.01 therm/h). The time taken for the intensity of radiation from the fire to reach 630 W/m^2 (200 Btu/ft^2 h), measured by a Moll thermopile in a standard position, shall be recorded.

F.2.2 *Three peak radiation test.* The fire, ignited by the method described in **F.2.1**, shall be allowed to continue burning and to pass the peak value of radiant intensity. Refuelling to the standard volume shall be performed when the radiant intensity drops to a level of 1 100 W/m^2 (350 Btu/ft^2 h). After a further peak value of radiant intensity has been passed, refuelling shall be performed again according to the standard procedure and the fire allowed to reach a third peak value of radiant intensity. The height of the third peak of radiant intensity shall be recorded.

The fire shall not be de-ashed at any stage of the test and the fuel bed shall be disturbed as little as possible at each refuelling. The test requirements have been specified so as to take into account the effect of ash accumulation over a prolonged burning period.

[16)] To obtain the correct level the use of a jig as shown in Figure 7 is recommended.

F.3 Equipment

F.3.1 *Setting.* As in **E.3.1**.

F.3.2 *Open fire and gas burner.* The London/Fulham Mark II 400 mm (16 in) inset "fire" shall be used without deepening bar or plate and fitted with a cast iron bottomgrate having air spaces 15.9 ± 0.8 mm ($^5/_8 \pm {}^1/_{32}$ in) between the bars. It shall be fitted with an integral gas ignition burner and supplied with an ashpan.

The general design of the appliance is illustrated in Figure 8.

The fire shall be set back as far as possible in the setting. It is not necessary to screw the firefront to the hearth or to seal the fire to the setting.

F.3.3 *Extraction system.* As in **E.3.3**.

F.3.4 *Gas supply to the ignition burner.* As in **E.3.4**.

F.3.5 *Moll thermopile.* As in **E.3.5**, except that the position of the thermopile is raised as shown in Figure 6.

F.3.6 *Potentiometer or millivoltmeter.* As in **E.3.6**.

F.3.7 *Timer.* As in **E.3.7**.

F.4 Sample

The test shall be carried out on the sub-sample of the fuel taken and prepared as described in Appendix B.

F.5 Procedure

F.5.1 *Ignition test.* The gas regulator valve shall be set so that gas is supplied at a rate corresponding to 7.3 ± 0.3 kW (0.25 ± 0.01 therm/h) and the stopcock shall then be closed. This operation shall be performed in such a manner that no heat is supplied to the setting.

The setting and the grate shall be clean and free from ash and the fire shall be set back as far as possible into the fireback. The ashpit cover shall be left off throughout the ignition test.

The Moll thermopile shall be placed in its specified position in front of the fire. The level of radiant intensity from the setting shall be observed. A test shall not be started if the radiant intensity exceeds 16 W/m^2 (5 Btu/ft^2 h).

The fire shall be charged with 0.0115 m^3 (0.40 ft^3) of the fuel by means of a small hand shovel, so that the fuel bed is in a plane sloping upwards from the front brick of the fire. It is advisable to mark the level of the rear edge of the fuel bed on the fireback to facilitate refuelling to the correct level. The fuel shall be at room temperature when charging takes place.

The gas shall be ignited at the pre-set rate corresponding to 7.3 ± 0.3 kW (0.25 ± 0.01 therm/h) and the timer started simultaneously. The gas flow rate shall be checked frequently, e.g. by means of the flowmeter, and quickly adjusted whenever necessary.

When a volume of gas equivalent to 4 220 kJ (4 000 Btu) has been delivered the gas shall be turned off. The fire shall be allowed to burn undisturbed until the radiant intensity as measured by the Moll thermopile reaches 630 W/m^2 (200 Btu/ft^2 h). The time taken to reach this intensity from the moment the gas was ignited shall be recorded.

When the ignition test only is being carried out, the fuel may be raked out at this stage and the open fire removed, to accelerate the cooling of the setting.

F.5.2 *Three peak radiation test.* The three peak radiation test shall be carried out on every third sample. When sampling is carried out on six days a week, the three peak radiation test shall be carried out on the samples taken on, for example, Monday and Thursday of the first week, Tuesday and Friday of the second week, Wednesday and Saturday of the third week, Monday and Thursday of the fourth week, and so on.

The procedure shall be as follows.

When the radiant intensity reaches 630 W/m^2 (200 Btu/ft^2 h) in the ignition test, the ashpit cover shall be placed in position with the primary air control fully open and the fire allowed to burn undisturbed until its radiant intensity has passed its peak and dropped to 1 100 W/m^2 (350 Btu/ft^2 h). The fire shall then be refuelled to its original volume with the minimum disturbance to the fuel bed, using a small hand shovel.

The fire shall be allowed to pass its second peak value of radiant intensity and, when the radiant intensity has dropped to 1 100 W/m^2 (350 Btu/ft^2 h), the fire shall again be refuelled in the same manner as before. The fire shall be allowed to reach and pass the third peak of radiant intensity.

The height of the third peak of radiant intensity shall be recorded.

F.6 Fire performance requirements

When tested in the manner described in this appendix, the fuels shall conform to the following requirements.

Ignition time. The mean time for the radiation output to reach 630 W/m^2 (200 Btu/ft^2 h) using 4 220 kJ (4 000 Btu) of gas shall not exceed 32 min.

Three peak radiation test. The mean peak value for the third peak shall not be less than 1 420 W/m^2 (450 Btu/ft^2 h).

Appendix G Assessment of results

G.1 Introduction

This appendix describes the method of examining the results of tests which have been carried out at the producer's works to establish whether the fuel complies with the requirements of this standard.

The results to be examined fall into two groups.

1) Calorific value, undersize and ignition tests carried out on samples taken each day that the fuel is despatched from the producer's works.

2) Three peak radiation tests carried out on samples taken every third day that fuel is despatched from the producer's works.

The requirements of this specification have been stated in terms of mean values calculated over an assessment period of eight complete weeks, or alternatively the period covered by forty consecutive days on which fuel is despatched. Alternative methods of assessment of equivalent standard have been specified to meet the requirements of works despatching fuel on a varying number of days each week, and also because certain works may prefer to assess results on a weekly basis, whilst others may prefer to assess results on a fixed number of consecutive samples irrespective of the period over which they are taken (see Table 1).

G.2 Tests on all samples

The requirements of this specification in respect of calorific value, undersize and ignition time are given in Clauses **3**, **4** and **5**.

G.2.1 *Assessment on forty consecutive samples*. The results for each of the variables shall be averaged and recorded when forty determinations have been made. When a further five determinations have been made the mean shall be recalculated and recorded using the forty most recent results. The mean values so calculated shall at all times conform to the requirements of Clauses **3**, **4** and **5**.

G.2.2 *Assessment on eight-weekly basis*. The results for each of the variables shall be averaged and recorded at the end of eight weeks. At the end of each week the mean shall be recalculated using the test results obtained during the eight most recent weeks. The mean values so calculated shall at all times conform to the requirements of Clauses **3**, **4** and **5**.

G.3 Tests on every third sample

The requirements under this specification in respect of the three peak radiation tests are given in Clause **5**. The results shall be recorded and averaged over the assessment period. When a further two determinations have been made, the mean shall be recalculated, the mean always corresponding with the most recent assessment period. The mean value so calculated shall at all times conform to the requirements of Clause **5**.

Table 1 — Alternative methods of assessing results

Number of samples normally taken each week (i.e number of days fuel is normally despatched from works each week)		Less than 5	5 or over	
Assessment period		40 consecutive samples	40 consecutive samples	8 weeks[a]
Calorific value **Undersize** **Ignition test**	**Number of consecutive samples tested**	all	all	all
	Period after which mean is recalculated	5 consecutive tests	5 consecutive tests	1 week
Three peak radiation test	**Number of samples tested**	every third	every third	every third
	Period after which mean is recalculated	2 consecutive tests	2 consecutive tests	2 consecutive tests

[a] Using this method of reporting there will be fewer than 5, 6, or 7 samples as the case may be, taken in weeks containing public holidays, unavoidable breakdowns, etc. Thus, when operating the eight-weekly system for fuel despatched on 5 days a week, the assessment will, for example, be made on 38 results for a period containing Christmas Day and Boxing Day.

Appendix H Method of checking the moll thermopile calibration

H.1 Introduction

The purpose of this appendix is to state the main physical conditions to be observed when checking the calibration of a Moll thermopile, in order that laboratories which are suitably equipped and staffed may undertake the operation.

The full calibration of a thermopile requires elaborate equipment and entails measurement of its sensitivity over a range of radiant intensities and for various source temperatures. This operation is normally effected by comparison with a Moll thermopile which has been standardized by the National Physical Laboratory. The conditions under which the Moll thermopile is used in the fire performance tests specified in this standard are not so stringent as to warrant a full calibration, and comparison with a secondary standard made at a convenient intensity and with reference to a source at one particular temperature is sufficient.

H.2 Principle

The two thermopiles are exposed in turn to a constant radiant source and their peak outputs measured. The calibration factor of the thermopile being checked is $S_o\ V/V_o$, where S_o is the calibration factor of the secondary standard thermopile for conversion of millivolts to W/m^2, and V and V_o are peak outputs in millivolts from the thermopile being checked and from the secondary standard, respectively. The incident radiation is restricted by an aperture in a screen between the source and the thermopile, so that the temperature-sensitive element of the thermopile receives radiation from the whole of the aperture and some of the surrounding screen. Between observations the aperture and its immediate surround is covered by a shutter, so that the thermopile is exposed to a surface which is at ambient temperature.

H.3 Detailed requirements

H.3.1 *Source.* This shall be at a temperature in the range 900–1 100 °C. Any convenient source, such as an electrically-heated element, a gas fire or a muffle furnace may be used, provided that the supply of energy to the source is stabilized so that the output of radiation remains constant to within ± 1 % over the period required for making the comparison.

H.3.2 *Radiation screen.* This shall consist of three aluminium sheets, about 13 mm (½ in) apart, two of which are polished on both sides and the third painted black on the side facing the thermopile, the other side being polished. The screen has a central aperture of suitable dimensions.

H.3.3 *Shutter.* This shall also consist of three spaced aluminium sheets, treated as in **H.3.2** and sufficiently large to ensure that no radiation reaches the thermopile when the shutter is across the aperture. The shutter should be situated on the thermopile side of the triple screen to prevent it becoming unduly heated.

H.3.4 *Secondary standard thermopile.* This should have been calibrated and its factor determined by the National Physical Laboratory.

H.3.5 *Thermopile mounting.* Equipment shall be provided by which the thermopiles being, compared may be quickly exposed, in turn and accurately at the same position, to the radiant source. Two convenient devices for this purpose are as follows:

1) a transverse slide with two thermopile mountings, so that when one thermopile is facing the aperture the other is exposed only to the surface of the screen;

2) a rotating turret head in which a number of thermopiles may be accommodated.

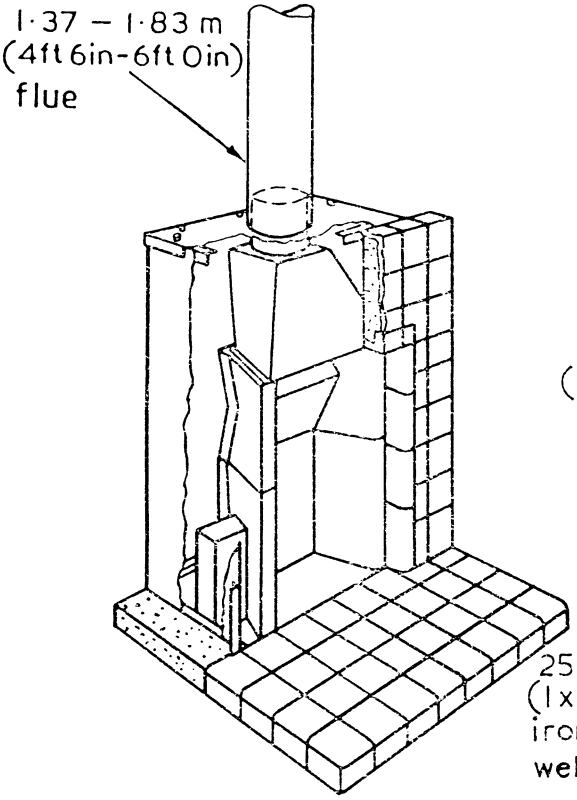
H.3.6 *Potentiometer.* A potentiometer reading to 0.01 mV or better shall be used to measure the output of the secondary standard thermopile, and also to measure the output of the thermopile being calibrated if it is subsequently to be used under open-circuit conditions. If, however, the thermopile is to be used with some form of millivoltmeter, then it shall be calibrated in association with that instrument and the connecting leads belonging to it. The connecting leads between the thermopile and measuring instrument shall always be of copper.

H.3.7 *General.* The equipment shall be arranged so that there is no possibility of stray radiation reaching the thermopile. Precautions shall be taken against draughts which would affect the constancy of output of the thermopile and might also affect the constancy of the source itself. For these purposes it is convenient to enclose the thermopile within a metal box, of which the triple screen forms one side. The rest of the box may be made of a single thickness of aluminium, blackened on the inside and polished on the outside.

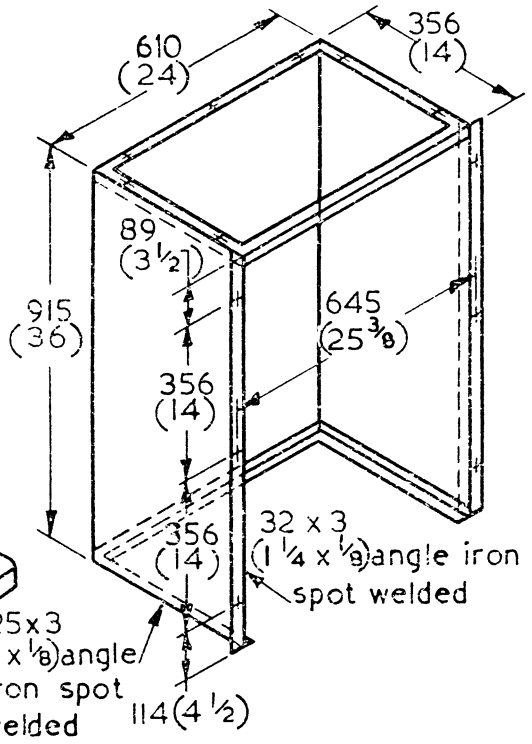
Before commencing a comparison, time shall be allowed for the whole system to approach thermal equilibrium as nearly as is practicable. For example, if the thermopile becomes warm through contact with the hand while being mounted and connected, it shall be allowed to cool to the ambient temperature before use.

The comparison of the thermopiles shall be made by exposing them alternately to the source and repeating the alternation until the readings obtained do not vary by more than ± 1 %, confirming that the radiant source is constant and that disturbing conditions are absent.

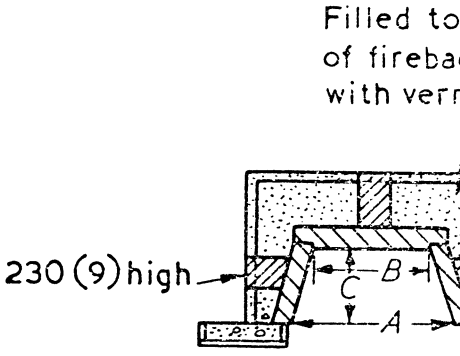
Appendix J *deleted*



a. Assembly

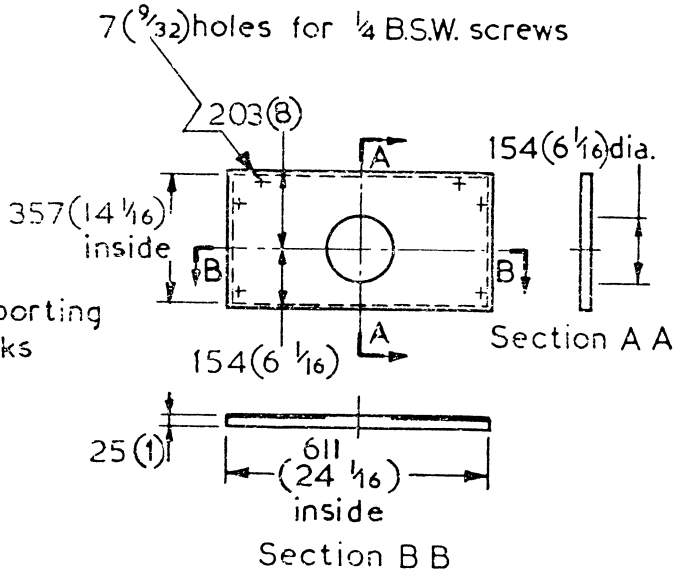


c. Metal box (back and sides in one piece)



A	381–394 (15–15½)
B	254–267 (10–10½)
C	171–184 (6¾–7¼)

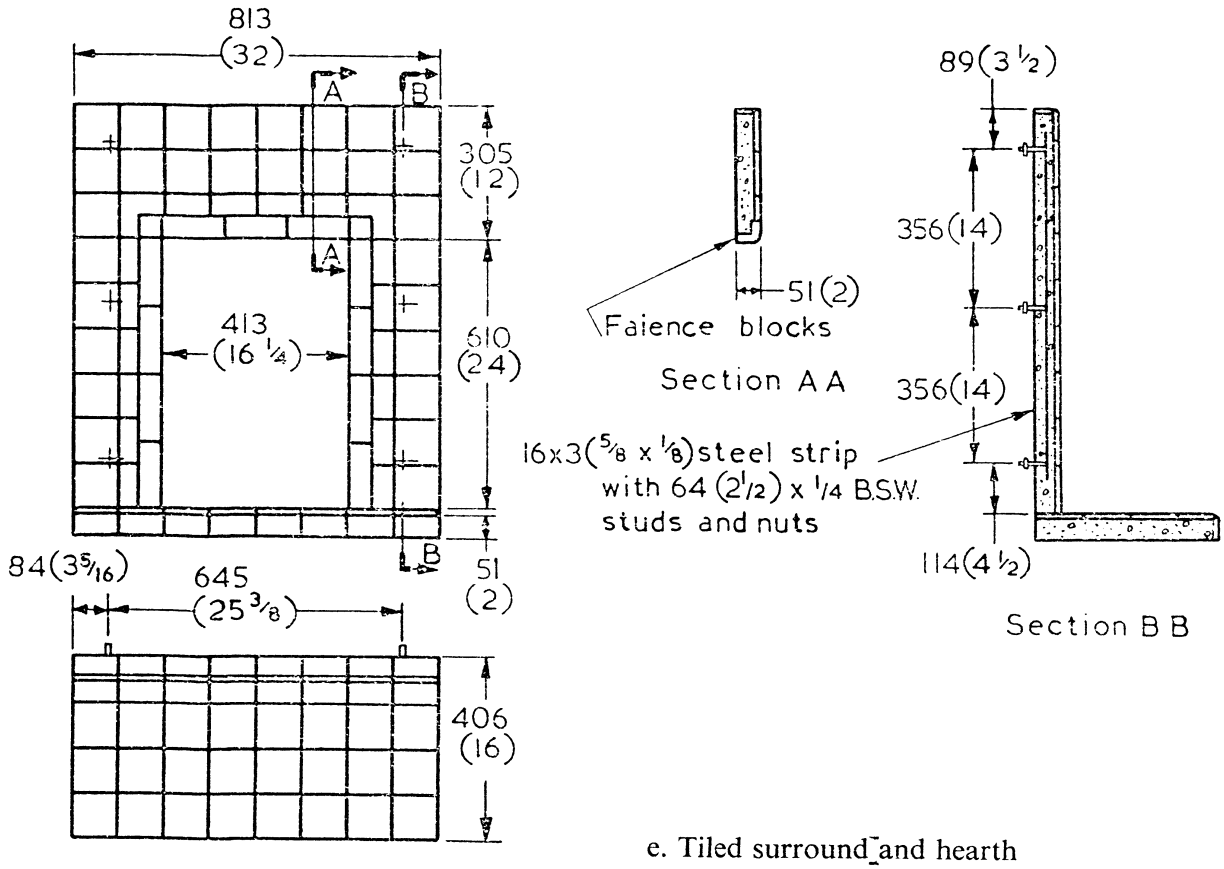
b. Method of supporting fireback



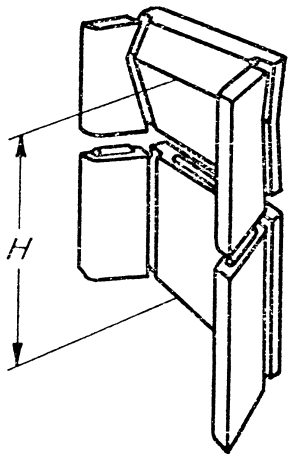
d. Top of box

Dimensions are in millimetres (inches)

Figure 1 — Details of test setting for fire performance tests

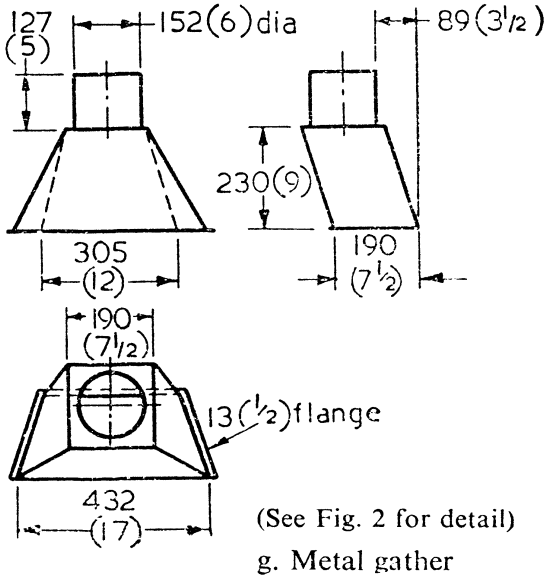


e. Tiled surround and hearth



$H = 520 \pm 10$ (20–21 in), otherwise as BS 1251

f. 400 mm (16 in) six piece fireback

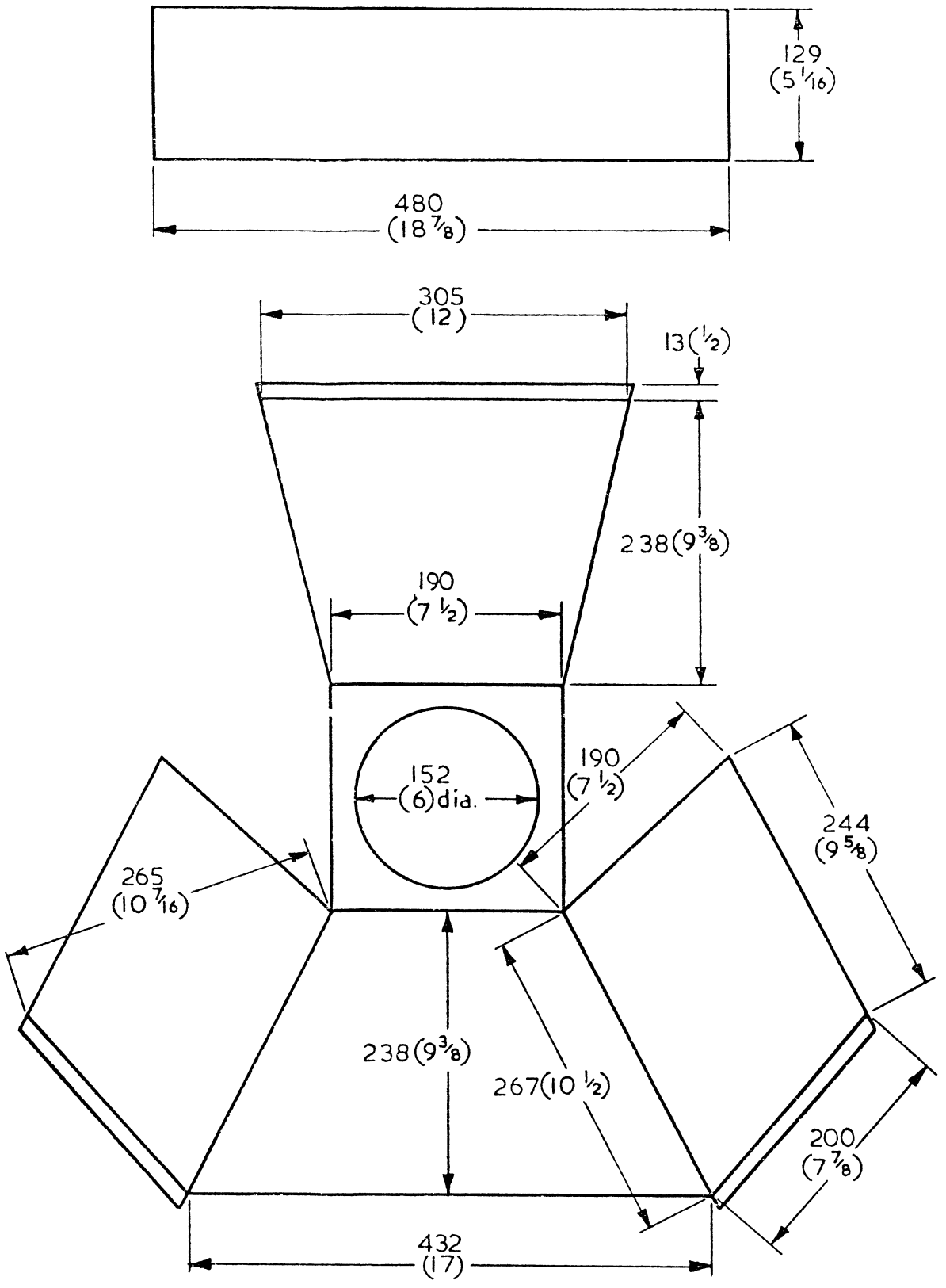


(See Fig. 2 for detail)

g. Metal gather

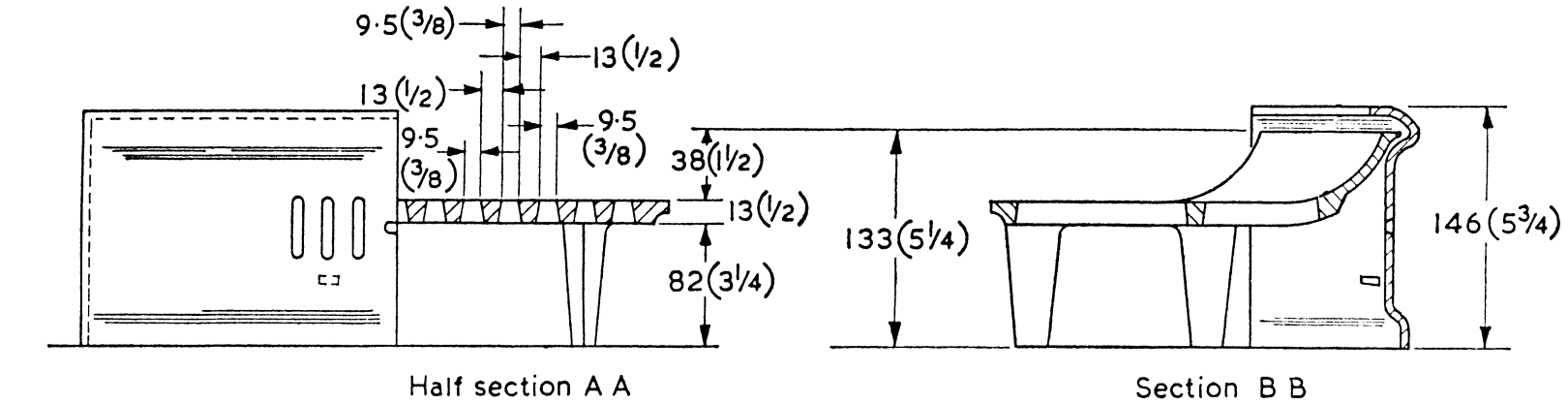
Dimensions are in millimetres (inches)

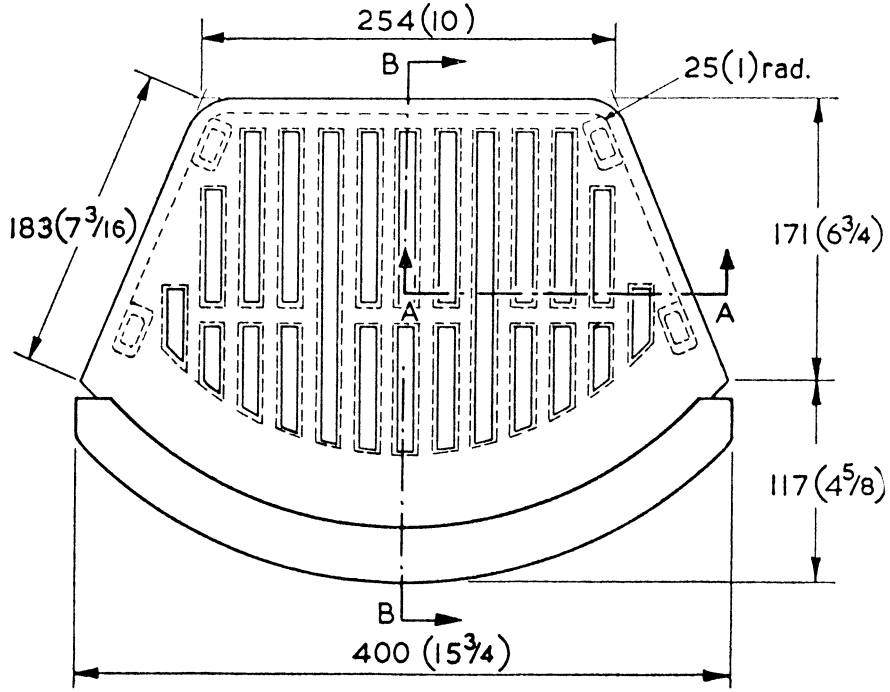
Figure 1 — Details of test setting for fire performance tests *(continued)*



Dimensions are in millimetres (inches)

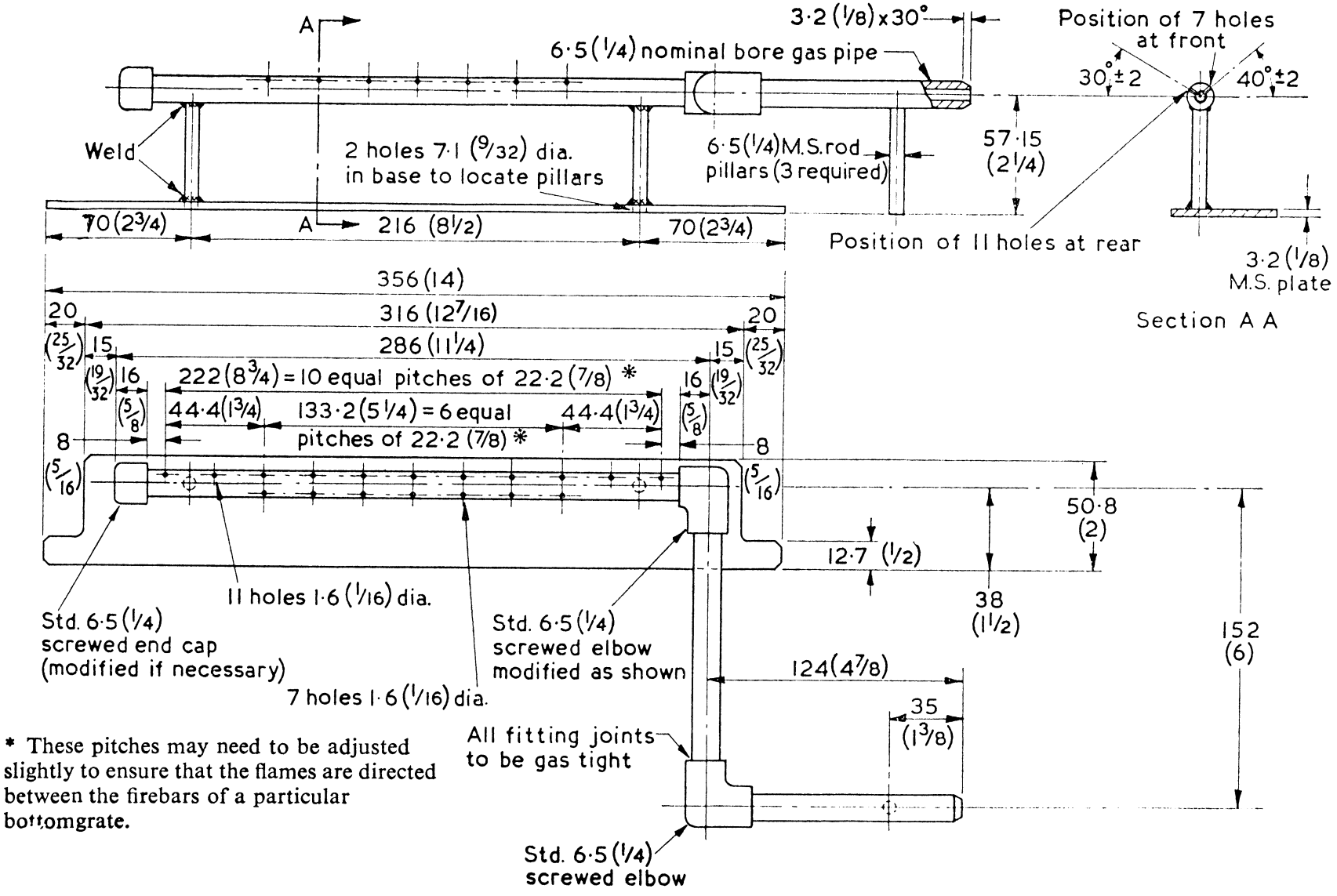
Figure 2 — Development of metal gather





Dimensions are in millimetres (inches)

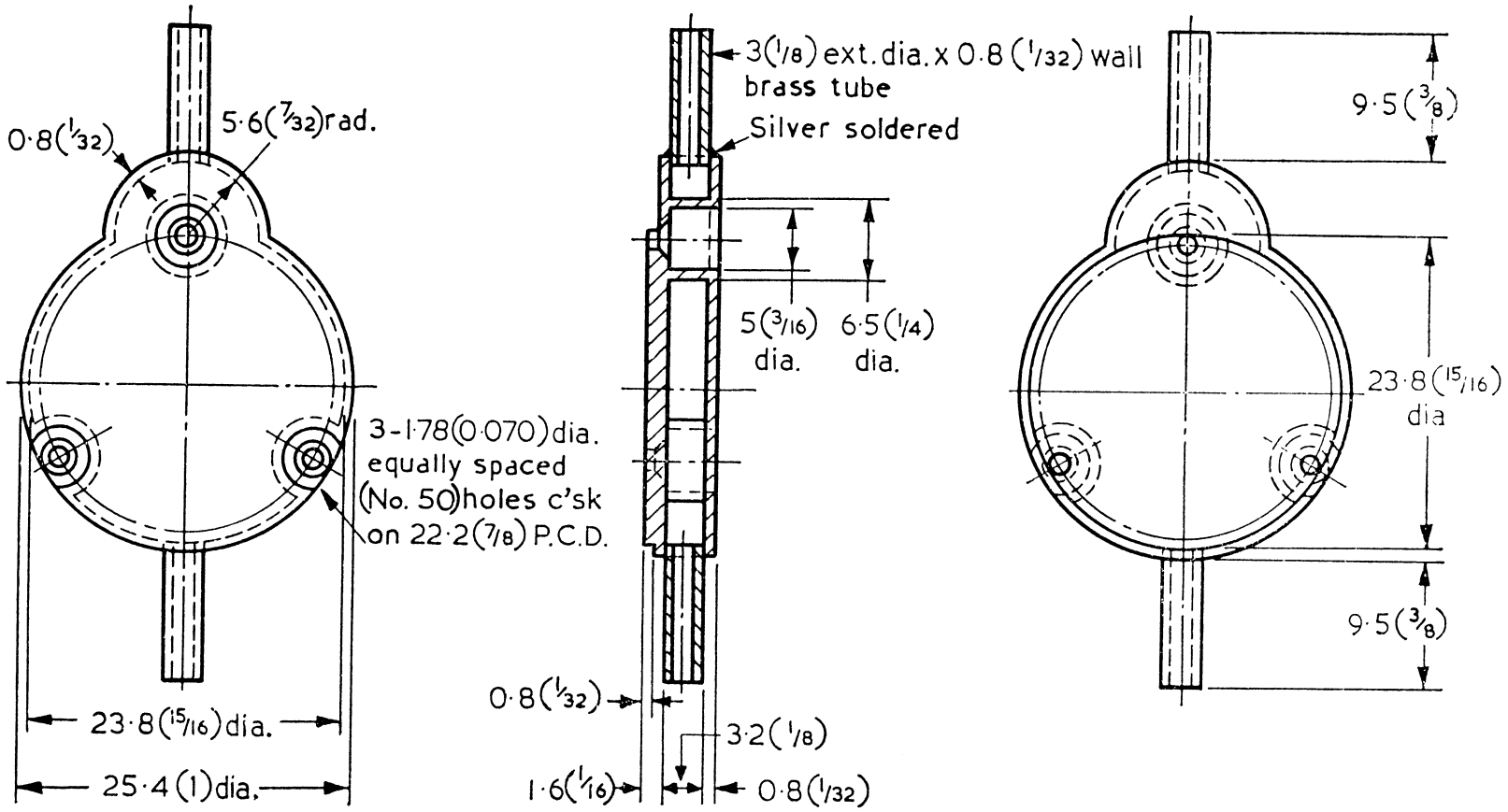
Figure 3 — Newtone grate and fret



* These pitches may need to be adjusted slightly to ensure that the flames are directed between the firebars of a particular bottomgrate.

Dimensions are in millimetres (inches)

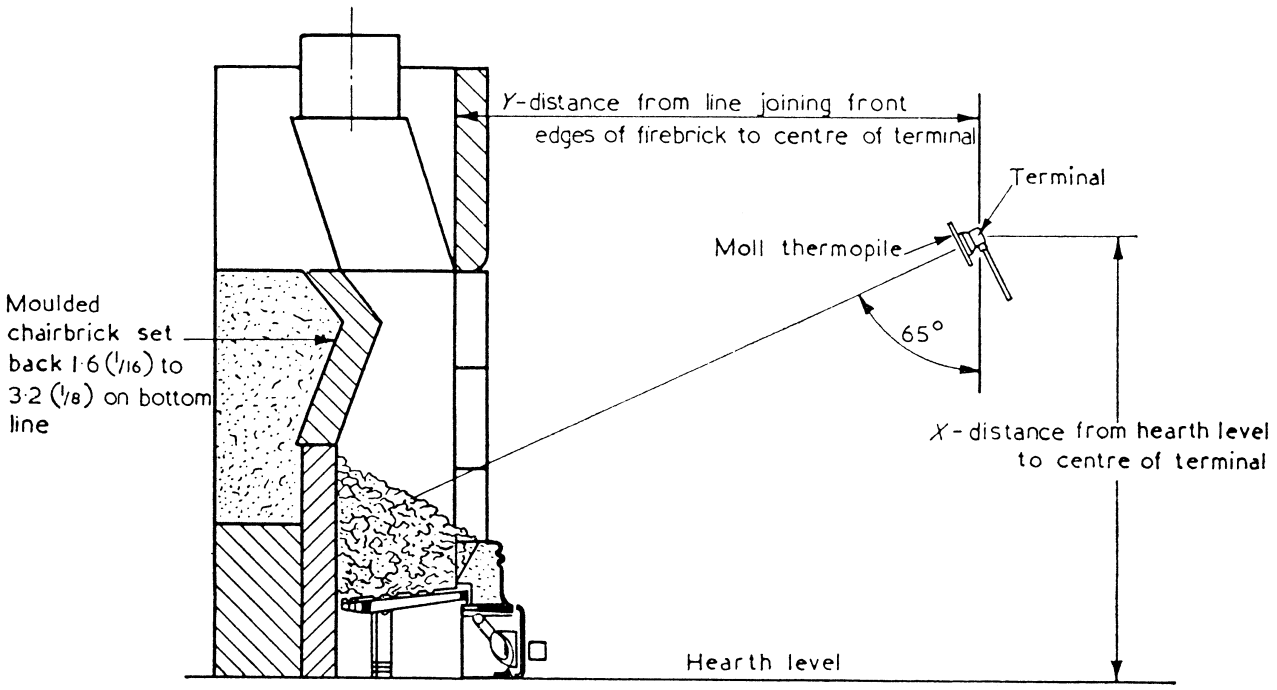
Figure 4 — Ignition burner



Material—brass

Dimensions are in millimetres (inches)

Figure 5 — Water-cooled back for non-compensated Moll thermopile



Dimensions are in millimetres (inches)

Grate	Thermopile			
	Land Pyrometers Ltd.		Cambridge Instrument Co. Ltd.	
	X	*Y*	*X*	*Y*
	mm (in)	mm (in)	mm (in)	mm (in)
Newtone	633 (25)	811 (32)	622 (24½)	787.5 (31)
London/Fulham Mark II	684 (27)	811 (32)	673 (26½)	787.5 (31)

Figure 6 — Thermopile position for performance tests

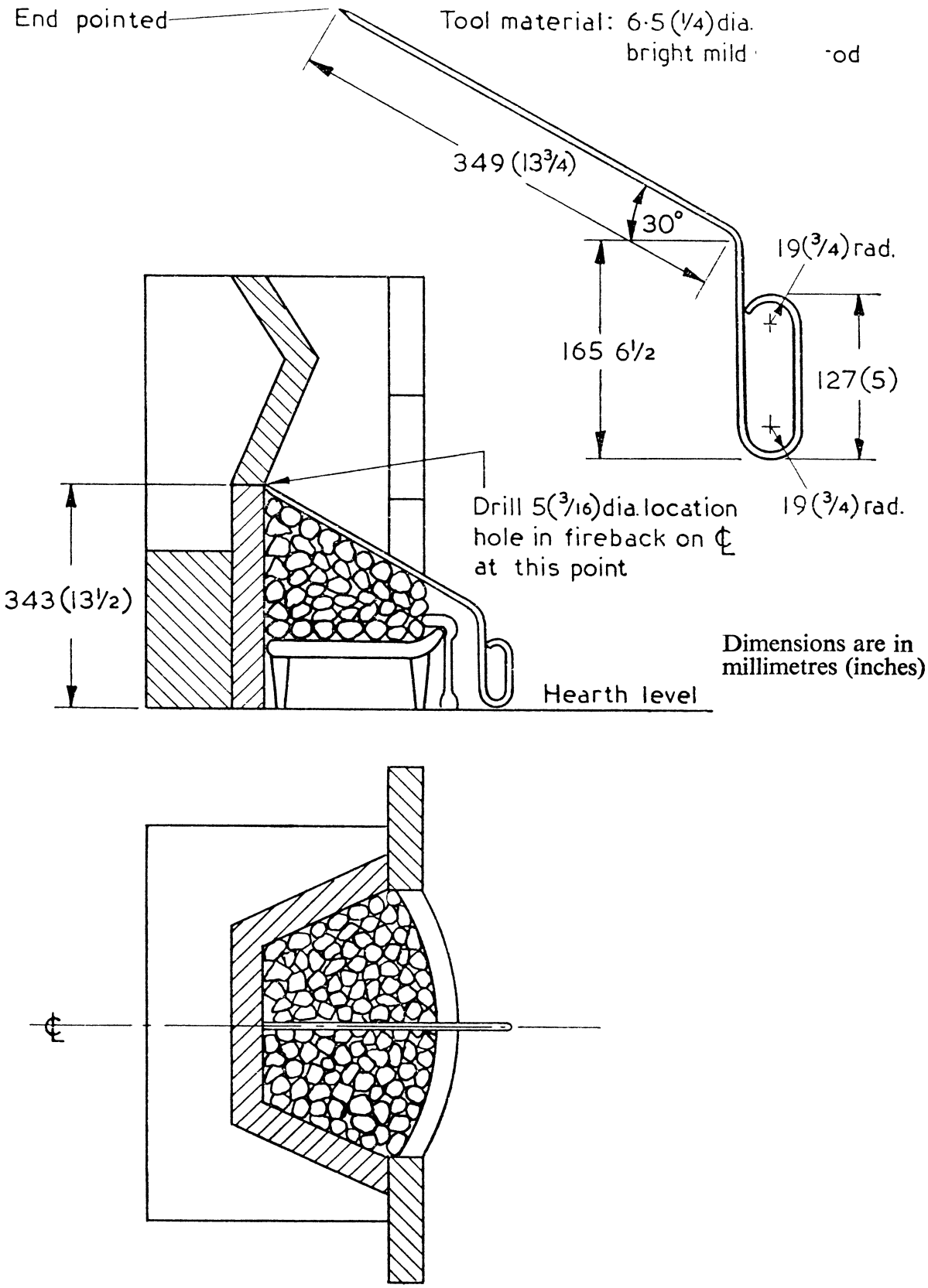
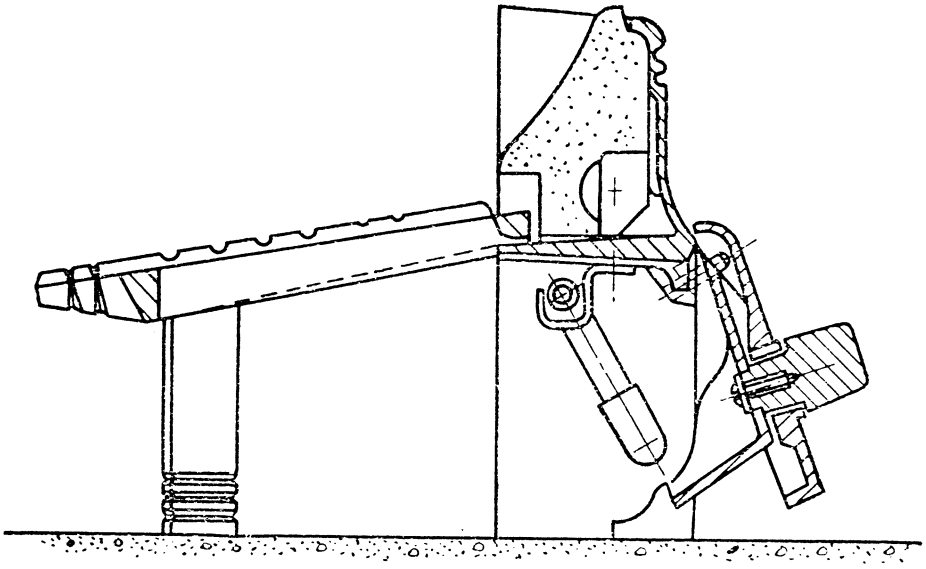
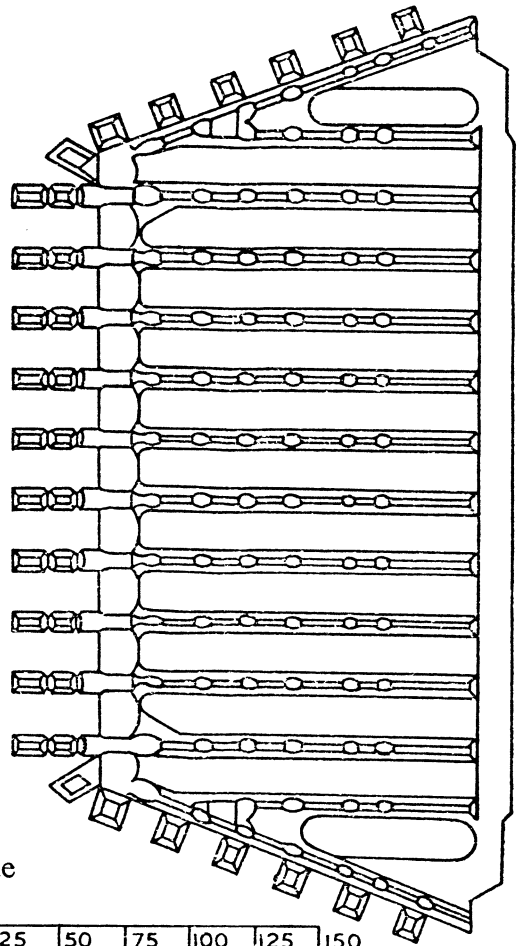


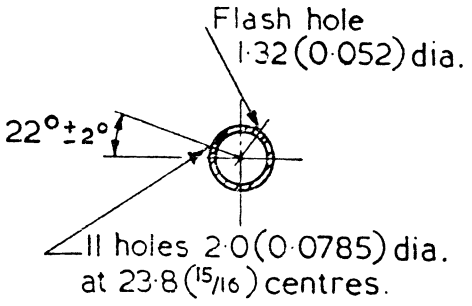
Figure 7 — Refuelling jig



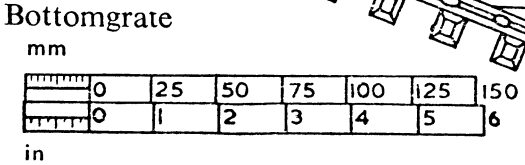
Assembly



Space between grate bars
15·9 ± 0·8 (5/8 ± 1/32)



Section through burner



Dimensions are in millimetres (inches)

Figure 8 — The London/Fulham Mark II inset open fire

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