

Glossary of

Terms associated with refractory materials —

Part 3: Applications in the
metallurgical industries

Confirmed
December 2011

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Refractory Products Standards Policy Committee (RPM/-) to Technical Committee RPM/7, upon which the following bodies were represented:

- British Cement Association
- British Ceramic Research Ltd.
- British Coal Corporation
- British Steel Industry
- Department of Trade and Industry (Minerals and Metals Division)
- Refractories Association of Great Britain
- Society of Glass Technology

This British Standard, having been prepared under the direction of the Refractory Products Standards Policy Committee, was published under the authority of the Board of BSI and comes into effect on 30 November 1990

© BSI 12-1999

First published May 1962
Second edition in Parts November 1990

The following BSI references relate to the work on this standard:
Committee reference RPM/7
Draft for comment 87/39012 DC

ISBN 0 580 18448 X

Amendments issued since publication

Amd. No.	Date of issue	Comments

Contents

	Page
Committees responsible	Inside front cover
Foreword	ii
Section 9. Metallurgical industries	
9.1 Iron making	1
9.2 Steelmaking	14
9.3 Steel casting	18
9.4 Secondary steelmaking	24
9.5 Heat treatment and reheating furnaces	26
9.6 Non-ferrous metals industry	28
Figure 1 — Tuyere stock assembly	6
Figure 2 — External combustion stove	8
Figure 3 — Internal combustion stove	9
Figure 4 — Types of external combustion stove	10
Figure 5 — Internal combustion stove; mushroom dome (self-supporting design)	10
Figure 6 — Torpedo ladle	13
Figure 7 — Open-hearth furnace	18
Figure 8 — Bottom teeming refractory shapes	22
Figure 9 — Typical tundish continuous casting	25
Figure 10 — Types of vacuum degassing vessel	26
Index	32
Publication referred to	Inside back cover

Foreword

This Part of BS 3446 has been prepared under the direction of the Refractory Products Standards Policy Committee. Together with Parts 1 and 2 it forms a revision of BS 3446:1962, which is withdrawn. Much of the work in preparing BS 3446 was conducted under a joint BSI/DTI¹⁾ Consultancy Scheme.

BS 3446 is published in three Parts:

- *Part 1: General and manufacturing (sections 1 to 6);*
- *Part 2: Applications in the coke, glass, cement and other non-metallurgical industries (sections 7 and 8);*
- *Part 3: Applications in the metallurgical industries (section 9).*

Terms are listed alphabetically within each section. Each term has an individual number consisting of five digits in two parts, the first of two digits, the second of three. The first two digits represent the number of the section and subsection. The third digit represents the number of the sub-subsection (in the case of subsections **9.4**, **9.5** and **9.6**, the third digit is 0 as these subsections have no divisions into sub-subsections). The last two digits represent the place that the term occupies within the sub-subsection.

Alternative terms are given below the preferred term. These terms are not individually numbered, but are included in the index with a reference to the preferred term. Terms of more than one word, e.g. “blast furnace”, are written in a direct style, not as “furnace, blast”.

Italicized words indicate terms that are defined elsewhere in this Part of BS 3446. The definitions presented in this Part of BS 3446 give the general meaning of terms, and should not be interpreted as being legally binding.

NOTE The title of the publication referred to in this Part of BS 3446 is listed on the inside back cover.

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 34, an inside back cover 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.

¹⁾ Department of Trade and Industry.

Section 9. Metallurgical applications

9.1 Iron making

91 100 Blast furnace

No.	Term	Definition
91 101	blast furnace	A tall conically-shaped furnace of sturdy construction using heavy duty steel shellplate. It is internally lined with high duty refractory products and incorporates differing water-cooling arrangements to preserve the refractory lining. Capacities range from 2 000 t to 10 000 t per day and furnaces are operated continuously over many years before repair. The raw materials of coke and ferrous materials are elevated and charged into the top of the furnace. Preheated air blast is blown in near its base, to generate the high temperature and reducing gases required for the complex smelting process to produce liquid iron. The process is continuous and the accumulation of liquid iron is tapped at intervals from the furnace hearth.
91 102	blow down	The action whereby the level of the burden materials in the furnace is lowered, e.g. into the <i>bosh</i> . The remaining burden materials are sealed over to allow internal repair work, after which the furnace is restarted.
91 103	blow-in lining blowing-in lining <i>non-preferred</i>	A sacrificial lining of refractory, installed normally from <i>bosh</i> to <i>hearth pad</i> , to protect the permanent lining on recommissioning a furnace after replacement of the refractory lining.
91 104	blown out	The condition when a furnace has been taken out of production on a permanent basis, or in preparation for a <i>reline</i> or major repair.
91 105	blowpipe	A short straight length of pipe, connecting the <i>goose neck</i> and the <i>tuyere</i> and using a spherical seating design on one or more joints. The pipe is usually of heat-resisting steel and refractory-lined.
91 106	bosh	The zone between <i>tuyere</i> level and <i>bosh parallel</i> , built with an inward <i>batter</i> . An area of intense process activity. The <i>bosh</i> is lined with high quality refractories and intensively cooled by either: a) internal copper plates; or b) external <i>stave coolers</i> or other <i>external cooling</i> .
91 107	bosh parallel belly <i>non-preferred</i>	A relatively short cylindrical section of the <i>stack</i> , situated immediately above the <i>bosh</i> level of the furnace. It is refractory-lined and cooled.
91 108	breeches piece	The refractory-lined section of the furnace top gas-collection system, where all four <i>gas uptakes</i> eventually merge into one common main to connect with the furnace <i>downcomer</i> .
91 109	bustle main	A large diameter steel tube, internally lined with refractories, encircling the furnace at upper <i>bosh</i> level. It has a series of equidistant blast exit ports on its underside coincident with furnace <i>tuyere</i> positions.
91 110	casing shell, jacket, <i>both non-preferred</i>	The metal casing of a <i>blast furnace</i> enclosing the refractory brickwork.
91 111	cast house	A building adjacent to, or surrounding, the bottom of the furnace above the <i>taphole(s)</i> , housing the <i>runner systems</i> transporting liquid iron to <i>transfer ladles</i> and diverting slag into <i>ladles</i> , pits or other disposal methods.

No.	Term	Definition
91 112	casting tapping <i>non-preferred</i>	A term describing the extraction of liquid iron and slag from the furnace hearth via a <i>taphole</i> .
91 113	clay gun taphole gun <i>non-preferred</i>	A heavy duty barrel and <i>nozzle</i> , with an internal clay extruding mechanism, pivoted from a pedestal adjacent to the furnace <i>taphole</i> and used to ram clay mixtures into the <i>taphole</i> .
91 114	downcomer	A large diameter refractory-lined main, collecting <i>blast furnace</i> gas from the top of the furnace and directing it down to the primary gas cleaning facility.
91 115	downleg tuyere stock <i>non-preferred</i>	A short straight length of refractory-lined main, located between the <i>bustle main</i> , swan neck and the goose neck . It incorporates an expansion allowance system.
91 116	dustcatcher	A large steel vessel which provides the primary stage of gas cleaning, allowing rapid gas expansion and deposition of dust particles.
91 117	external cooling	A term used for a cooling system applied externally to the refractory lining. It can be either spray-water cooling of the shellplate, <i>stave cooler</i> segments, or double shell cooling.
91 118	free standing furnace	A <i>blast furnace</i> in which all support of <i>top-gear</i> and mechanical loadings is transmitted to four or more columns of sturdy construction: the columns are built adjacent to, but independent of the <i>blast furnace</i> proper, i.e. not incorporating a <i>lintel</i> arrangement.
91 119	gas offtakes	Four refractory-lined large diameter angled mains, equally located around the furnace <i>top cone</i> , to collect gas products.
91 120	gas uptake	A vertical main, connecting <i>gas offtakes</i> to a common <i>breeches piece</i> and bleeder valve. The system is refractory-lined.
91 121	goose neck	A refractory-lined iron or steel casting, used for directional change of the blast at the base of the <i>tuyere stock</i> for entry into the <i>tuyere blowpipe</i> , using a spherical seating design.
91 122	grouting	The technique of injecting refractory material, by pumping from outside the furnace, in order to seal localized voids in the lining which have arisen during furnace operation, or to create a new lining.
91 123	hearth pad	A deep layer of refractory, forming the base of the furnace, to collect and contain the liquid products of slag and iron. It is often designed and constructed using large carbon blocks, but it sometimes incorporates ceramic (oxide) refractories. The <i>hearth pad</i> may be protected by <i>underhearth cooling</i> .
91 124	hearth sidewall hearth annulus <i>non-preferred</i>	An area which, with the <i>hearth pad</i> , forms a well to collect the liquid slag and iron produced in the furnace. It is encased in heavy duty steel shellplate and is usually lined with highly conductive carbon/graphite refractories. The area is heavily cooled externally by water spray systems or, alternatively, by large <i>stave cooler</i> segments.
91 125	hearth volume	The internal volume determined from the centre of the <i>tuyeres</i> to the centreline of the <i>taphole</i> .
91 126	internal cooling	A system of <i>plate coolers</i> installed horizontally within the thickness of the refractory lining.
91 127	lintel	A heavy duty ring girder supported by equidistant heavy steel columns (the columns are based on a foundation block). The <i>lintel</i> is used to support the furnace <i>stack</i> and all the top structure.

No.	Term	Definition
91 128	lintel furnace	A furnace where the <i>top gear</i> is supported on the <i>stack</i> shell which is in turn supported by a <i>lintel</i> arrangement and columns. (See <i>free standing furnace</i> .)
91 129	lower stack	Denotes the lower section of the furnace <i>stack</i> which is a zone of high dynamic process activity and which needs high duty refractory lining and intense cooling by internal copper <i>plate coolers</i> and/or external <i>stave coolers</i> .
91 130	main runner trough <i>non-preferred</i>	The first section of the <i>cast house runner system</i> leading from the <i>taphole</i> .
91 131	mid stack	Denotes the mid section of the furnace <i>stack</i> . This is lined with dense refractory brickwork incorporating an intensive internal cooling arrangement, generally using <i>plate coolers</i> or, alternatively, external <i>stave coolers</i> .
91 132	plate cooler	A fabricated steel or copper casting with internal labyrinth for water cooling of the refractory lining.
91 133	quench down flood down <i>non-preferred</i>	The treatment of a furnace taken out of service when full of burden material and requiring rapid water cooling from its top before emptying it prior to a <i>reline</i> .
91 134	reline	The procedure in which a furnace undergoes a complete renewal of its refractory lining at the conclusion of its campaign.
91 135	runner system	<i>Main runners</i> , along which molten iron or slag runs from the <i>blast furnace</i> .
91 136	salamander	Residual liquid iron-slag entrapped in the hearth well, below <i>taphole</i> level, after the final cast before a furnace <i>reline</i> . It is extracted by drilling through and/or oxygen lancing the refractory lining of the <i>hearth pad</i> or <i>hearth sidewalls</i> .
91 137	secondary runner rundown <i>non-preferred</i>	The section of the <i>runner system</i> immediately after the slag and iron have been separated at the <i>skimmer-dam</i> . This directs the hot metal into a transportation <i>ladle</i> , or into additional iron runners where more than one <i>ladle</i> is used. NOTE The term used (<i>secondary runner</i> or <i>rundown</i>) varies on different works.
91 138	shuttle	A similar function to a <i>tilting runner</i> , but moves horizontally.
91 139	skimmer-dam	A preformed refractory block, inserted inside the <i>main runner</i> , with limited clearance at the base. It allows rapid separation of liquid iron and slag.
91 140	slag notch	An annular insert of copper cooling members. A <i>slag notch</i> is used to drain off slag as required and is located at the top of the hearth level.
91 141	soaking bar	A steel rod used in conjunction with the <i>taphole drill</i> . This is inserted into a partially-drilled <i>taphole</i> to transfer heat and to dry out the clay mixture used in sealing the <i>taphole</i> .
91 142	spool tap, turret, <i>both non-preferred</i>	A short circular or oval-shaped steel stub piece, internally-lined with refractory materials and attached to the furnace shellplate at the aperture of the furnace <i>taphole</i> to form an extension of the <i>taphole</i> proper. It is designed to guide more easily the flow of iron or slag, during <i>casting</i> , directly into the <i>main runner</i> below. It is usually externally water-cooled. NOTE This is not to be confused with the <i>turret</i> of the <i>torpedo ladle</i> .

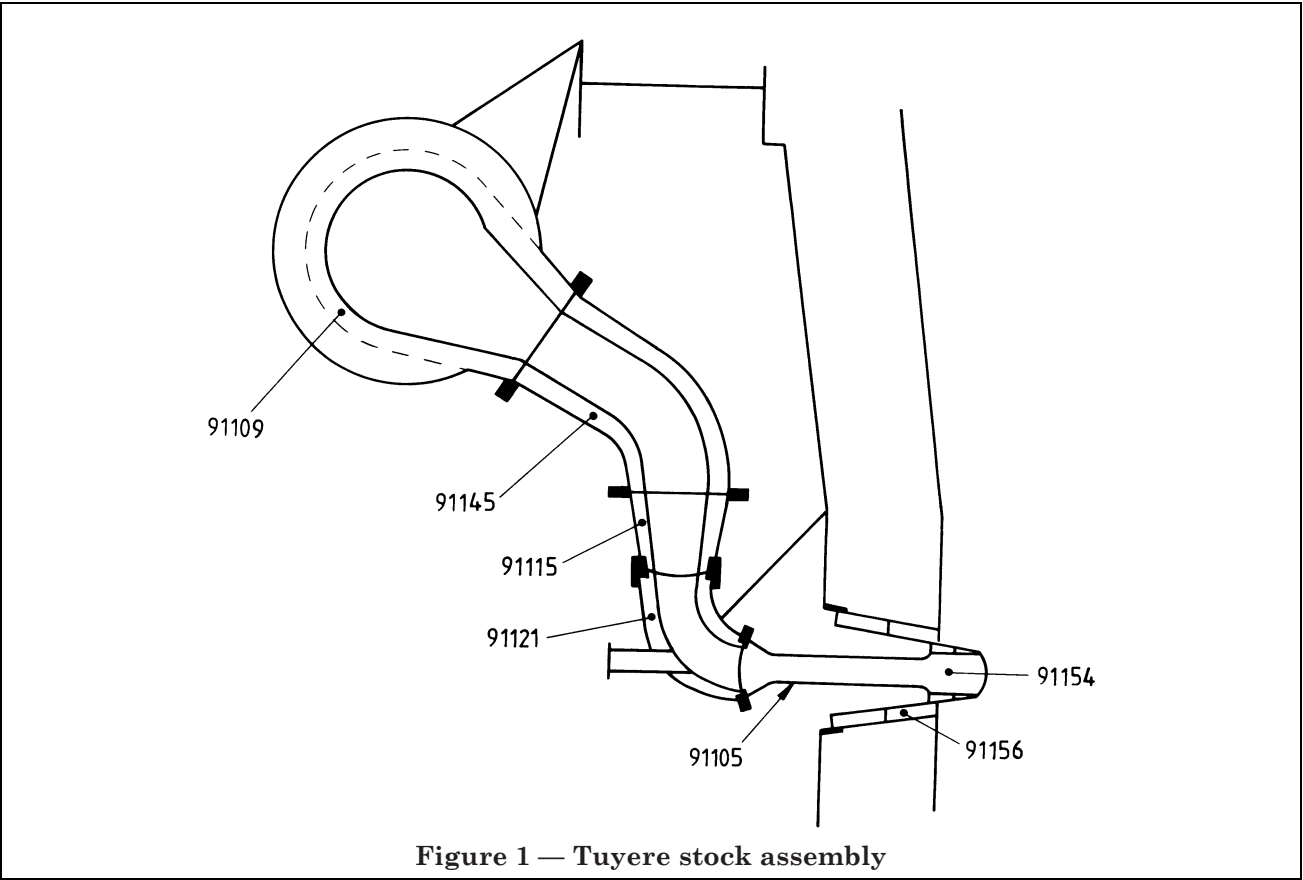
No.	Term	Definition
91 143	stack	The refractory-lined upper part of the furnace between <i>lintel</i> or bosh parallel and the throat . A <i>stack</i> is widely understood to comprise three sections, namely <i>upper stack</i> , <i>mild stack</i> and <i>lower stack</i> .
91 144	stave cooler	A thick cast steel segment with an internal water cooling labyrinth. It is used for the purposes of <i>external cooling</i> of the lining, and is installed in rings inside the furnace shellplate.
91 145	swan neck	A short length of refractory-lined angled main, fixed to the <i>bustle main</i> , and connecting it with the <i>downleg</i> .
91 146	taphole (1) iron notch <i>non-preferred</i>	A hole, inclined upwards from inside to outside of the furnace through the <i>hearth sidewall</i> , typically 1.5 m to 2.0 m above <i>hearth pad</i> level. Each furnace is equipped with one to four <i>tapholes</i> , depending on size. The hole is sealed with a <i>taphole clay</i> plug which is drilled for <i>casting</i> . The material surrounding the hole could be the same or different from that of the <i>hearth sidewall</i> .
91 147	taphole clay	A semi-plastic refractory mass used to seal the <i>taphole</i> on completion of <i>casting</i> . The <i>taphole clay</i> is administered by use of a <i>clay gun</i> .
91 148	taphole drill	A rotary drill which is pivoted from a pedestal adjacent to the <i>taphole</i> to enable the drilling of a 60 mm to 90 mm diameter hole into the <i>taphole</i> plug for <i>casting</i> purposes.
91 149	throat (1)	A relatively short cylindrical section below the <i>top cone</i> and <i>gas offtakes</i> ; it is refractory-lined with castable or brickwork and is often protected by metallic armour.
91 150	throat armour	Special steel segments built integral with, or suspended in front of, the refractory lining of the throat . The segments are designed to withstand the impact of raw materials entering the furnace via the bell or chute.
91 151	tilting runner tilting trough, tilter, <i>both non-preferred</i>	A short refractory-lined part of a <i>runner system</i> , capable of directing hot metal into alternative <i>ladles</i> by tilting from a central point.
91 152	top cone	A steel shell encasing the top of the furnace proper, including the four <i>gas offtakes</i> , and lined with gunned refractory material.
91 153	top gear	Equipment designed to allow the introduction of raw materials from a hopper into the top of the furnace using either a multiple chamber (bell) system or a rotating chute, to retain gas seal and pressure.
91 154	tuyere	A water-cooled high quality copper casting, shaped like the frustrum of a cone, providing entry of preheated air blast from the <i>blowpipe</i> to the furnace.
91 155	tuyere belt	A short vertical parallel section above the hearth. It includes a series of <i>tuyere port</i> holes for entry of preheated air blast. It is refractory-lined, and cooled with an appropriate cooling system.
91 156	tuyere port tuyere cooler <i>non-preferred</i>	A circular entry port in the shellplate and the refractory lining and containing a large copper cooler member of tapered design. The copper cooler is capable of locking the projecting <i>tuyere</i> in position.

No.	Term	Definition
91 157	tuyere stock assembly	The full arrangement of refractory-lined components between the furnace <i>bustle main</i> and the (<i>tuyere</i>) <i>blowpipe</i> , i.e. <i>swan neck</i> , <i>downleg</i> and <i>goose neck</i> . Arrangement of these components varies to suit individual furnace design and dimensions. (See Figure 1.)
91 158	underhearth cooling	A method of minimizing wear of the <i>hearth pad</i> by abstracting heat. This is achieved by passing a fluid (air, water or oil) through an arrangement of ducts or pipes beneath the <i>hearth pad</i> or, alternatively, by using a layer of highly conductive refractory, e.g. graphite.
91 159	upper stack	The top third of the furnace <i>stack</i> below the <i>throat</i> area. This is lined with a refractory which may incorporate a series of coolers set at regular intervals throughout its height and circumference.
91 160	working volume	The internal volume of a furnace measured from the centreline of the <i>tuyeres</i> to the height of the normal stockline, e.g. 1 m below the large bell in its fully open position.

91 200 Hot blast stoves and handling systems

(See Figure 2 to Figure 5.)

91 201	back draught chimney back draughting chimney <i>non-preferred</i>	A tall refractory-lined chimney stack, integral with the <i>hot blast main</i> , adjacent to the furnace and incorporating a water-cooled paddle valve for isolation purposes. It is used to pull and vent furnace gases from the <i>tuyeres</i> , after the furnace is shut down, and is a preferred alternative to <i>back draughting</i> through the <i>stove system</i> .
91 202	back draughting	A technique where a <i>stove system</i> or a <i>back draught chimney</i> is used to pull away gases from the furnace <i>tuyeres</i> , after the furnace is shut down. It is applied by operating the <i>stove chimney valves</i> in a special sequence.
91 203	boxed	The stove condition when all valves are closed and the stove is isolated from operation.
91 204	bridge wall (1) dividing wall, partition wall, <i>both non-preferred</i>	A wall in <i>internal combustion stoves</i> separating the <i>combustion chamber</i> and <i>chequerwork</i> sections.
91 205	ceramic burner	A purpose-made assembly of refractory brick shapes installed inside the base of the <i>combustion chamber</i> , constructed with a series of integral ports to ensure the mixing of combustion gas and air prior to ignition.
91 206	chequer brick	A refractory brick specially designed to maximize the surface area through an interlocking vertical flue arrangement when installed. The integral flue shape and dimensions can vary to meet specific stove design parameters.
91 207	chequerwork	A large mass of <i>chequer bricks</i> , specifically designed to offer a large surface area for heat transfer to the channelled gases.
91 208	chimney valves	Large valves (normally two) installed either side of the <i>cold blast main</i> valve, and used in the stove firing sequence to allow exit of waste gases to a common chimney main and <i>stack</i> .
91 209	cold blast main	A large diameter steel main, which may be insulated, which is used to supply cold air blast from a turbo-blower to each stove in a <i>stove system</i> , for regenerative heating purposes and for mixing to control the air temperature.



No.	Term	Definition
91 210	combustion chamber	The zone of a stove in which the combustion of the gas and air is carried out. The combustion chamber can be of circular or elliptical cross section, depending on the stove design, and may be an integral part of the stove or a separate unit.
91 211	dome plug	A small diameter refractory plug or insert placed in the dome section of the stove, to allow insertion of thermocouple(s) used to control the stove operation. On removal, it can also provide access to the top of the stove for inspection or maintenance purposes.
91 212	expansion system (1)	A special expansion bellows and retention system on the steel shellplate of the hot blast handling system.
91 213	expansion system (2)	The integral labyrinth type expansion allowances incorporated in the refractory lining of the hot blast handling system.
91 214	external combustion chamber stove	A stove in which the <i>combustion chamber</i> and <i>chequerwork</i> are constructed as separate sections, being connected by a common <i>stove dome</i> arrangement at the stove top.
91 215	grid columns and girders	A number of heavy duty cast iron or steel components, arranged under the <i>chequerwork</i> and used to support the total mass of <i>chequerwork</i> at a level above the main ports at the base of the stove to allow free passage of gases.
91 216	grids	Thick heavy duty castings, with a honeycomb pattern of apertures designed to coincide with the vertical flue arrangement of the <i>chequerwork</i> at the base of the stove.

No.	Term	Definition
91 217	hot blast branch	A short refractory-lined main connecting the <i>hot blast valve</i> to the <i>hot blast main</i> .
91 218	hot blast main	A straight large diameter steel main, lined with refractories, connecting with all stove <i>hot blast outlet branches</i> and leading to the <i>blast furnace bustle main</i> via the <i>mixing chamber</i> .
91 219	hot blast outlet branch stove branch <i>non-preferred</i>	A short refractory-lined main connecting the stove <i>hot blast outlet eye</i> to the <i>hot blast valve</i> .
91 220	hot blast outlet eye	A large diameter circular exit port in the <i>combustion chamber</i> . The port is located some distance above the stove burner position and at the level of the <i>hot blast main</i> . A refractory lining is installed to a bullseye design incorporating relieving arches in each independent course of the lining.
91 221	hot blast stove	A vertical cylindrical regenerator, of various designs, having a <i>combustion chamber</i> and <i>chequerwork</i> which alternately receives heat from combustion of <i>blast furnace gas</i> and delivers heat to the blast.
91 222	hot blast valve	A large diameter valve of an internal gate or paddle design with efficient water-cooling of both valve seating and paddle. The seatings are refractory-lined. The paddle faces are often refractory-coated.
91 223	interface	The level at which one quality of refractory material, e.g. silica, changes to another.
91 224	internal combustion chamber stove Cowper stove <i>non-preferred</i>	A stove in which the <i>combustion chamber</i> and <i>chequerwork</i> are built within the same cylindrical shellplate.
91 225	metallic burner	A high temperature steel diffuser incorporated in the stove burner valving assembly. The burner is situated at the base of the <i>combustion chamber</i> and is used to pre-mix combustion gas and air prior to firing. The burner location is external to the <i>combustion chamber</i> .
91 226	mixing chamber mixer pot <i>non-preferred</i>	A refractory-lined steel vessel, connecting both the <i>hot blast main</i> and the <i>cold blast main</i> ; the chamber is used for premixing air blast supplies before entry into the furnace <i>bustle main</i> .
91 227	mushroom dome	An <i>internal combustion chamber stove</i> where the refractory-lined <i>stove dome</i> is supported from a ring girder and is constructed on a catenary principle using insulation and high temperature refractories.
91 228	silica stove	A stove in which silica refractories are used in the <i>stove dome</i> roof and in the upper section of the <i>combustion chamber</i> and <i>chequerwork</i> for higher temperature operation. They are mainly <i>external combustion stoves</i> but some designs are <i>internal combustion stoves</i> .
91 229	stove dome dome <i>non-preferred</i>	The top part of an <i>internal combustion stove</i> , generally hemispherical and lined with insulation and dense brick courses. The stove dome is usually of arch design and is supported by the stove lining.

No.	Term	Definition
91 230	stove grouting	A low pressure pumping technique using semi-insulating grade materials, applied through the stove shellplate. It is used to rectify any localized loss of insulation lining or to rectify defects caused by tracking of gases causing overheating of the steel platework. NOTE Defects caused by tracking of gases causing overheating of the steel platework is a more common problem on older stoves and around entry points of the stove.
91 231	stove system	A configuration of three or four <i>hot blast stoves</i> used to preheat large volumes of air (under pressure) and operated in a sequential manner based on regenerative heating principles.
91 232	stove wall	The protective insulation and refractory lining installed within the vertical stove shellplate.

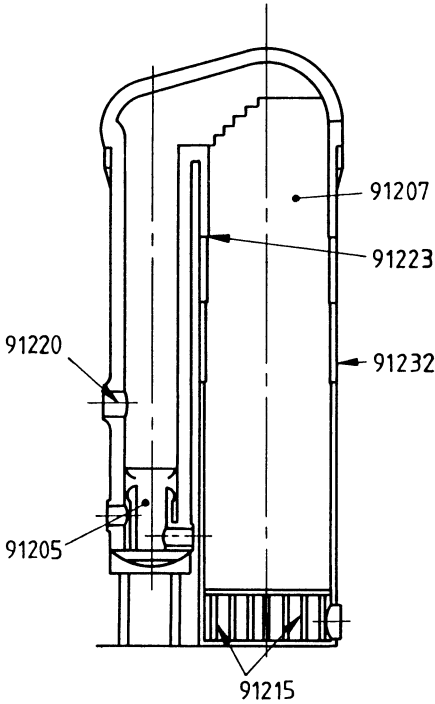


Figure 2 — External combustion stove