



Standard Guide for Construction of Solid Fuel Burning Masonry Heaters¹

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1. Scope

1.1 This guide covers the design and construction of solid fuel burning masonry heaters. It provides dimensions for site constructed masonry heater components and clearances that have been derived by experience and found to be consistent with the safe installation of those appliances.

1.2 Values given in SI units are to be regarded as standard. Inch/pound units may be rounded (see Practice E 380). All dimensions are nominal unless specifically stated otherwise. All clearances listed in this guide are actual dimensions.

1.3 This guide applies to the design and construction of masonry heaters built on-site with the components and materials specified herein. It does not apply to the construction/installation requirements for component systems that have been safety tested and listed. The requirements for listed masonry heater systems are specified in the manufacturer's installation instructions.

1.4 The design and construction of solid fuel burning masonry heaters shall comply with applicable building codes.

2. Referenced Documents

2.1 ASTM Standards:

C 11 Terminology Relating to Gypsum and Related Building Materials and Systems²

C 43 Terminology of Structural Clay Products³

C 71 Terminology Relating to Refractories⁴

C 270 Specification for Mortar for Unit Masonry^{2,3}

C 401 Classification of Alumina and Alumina-Silicate Castable Refractories⁴

E 136 Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C⁵

E 380 Practice for Use of the International System of Units (SI) (the Modernized Metric System)⁶

2.2 UL Standards:

UL 103 Chimneys, Factory Built Residential Type and

Building Heating Appliances⁷

3. Terminology

3.1 Terms used in this guide are as defined in Terminology C 11, Definitions C 43, Terminology C 71, and Classification C 401.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *approved*—acceptable to the authority having jurisdiction.

3.2.2 *authority having jurisdiction*—the organization, office, individual, or agent thereof, who is responsible for approving construction, materials, equipment, installation, procedure, etc. In most cases in which a building permit is required, the authority is typically the building official or his agent. Where a building permit is not required, the authority is typically the owner or his agent.

3.2.3 *bypass damper*—a valve or plate that provides a direct path to the chimney flue for the flue gases or portion thereof.

3.2.4 *capping slab*—a horizontal refractory barrier covering the top of the heater.

3.2.5 *cleanout opening*—an access opening in a flue passageway of the heater or chimney that is designed to allow access to the flue for purposes of inspecting for and removing ash, soot, and other extraneous matter that may become trapped.

3.2.6 *damper*—an adjustable valve or plate for controlling draft or the flow of gases, including air.

3.2.7 *firebox (firechamber)*—that portion of the masonry heater that is designed for containing and burning the fuel charge.

3.2.8 *gas slot*—a small fixed opening that provides a bypass for unburned flue gases, and is a critical safety feature in certain heater designs (namely those of the Grundofen type with vertical flue runs) (see Figs. 1 and 2).

3.2.9 *hearth extension*—the noncombustible surfacing applied to the floor area extending in front of and beyond each side of the fuel loading door of the heater; also applies to the floor beneath a heater or beneath an elevated overhanging heater hearth.

3.2.10 *heater base*—that portion of the support for the heater between the heater and the foundation that is below the firebox or the heat exchange areas.

⁷ Available from Underwriter's Laboratories, 333 Pfingsten Road, Northbrook, IL 60062.

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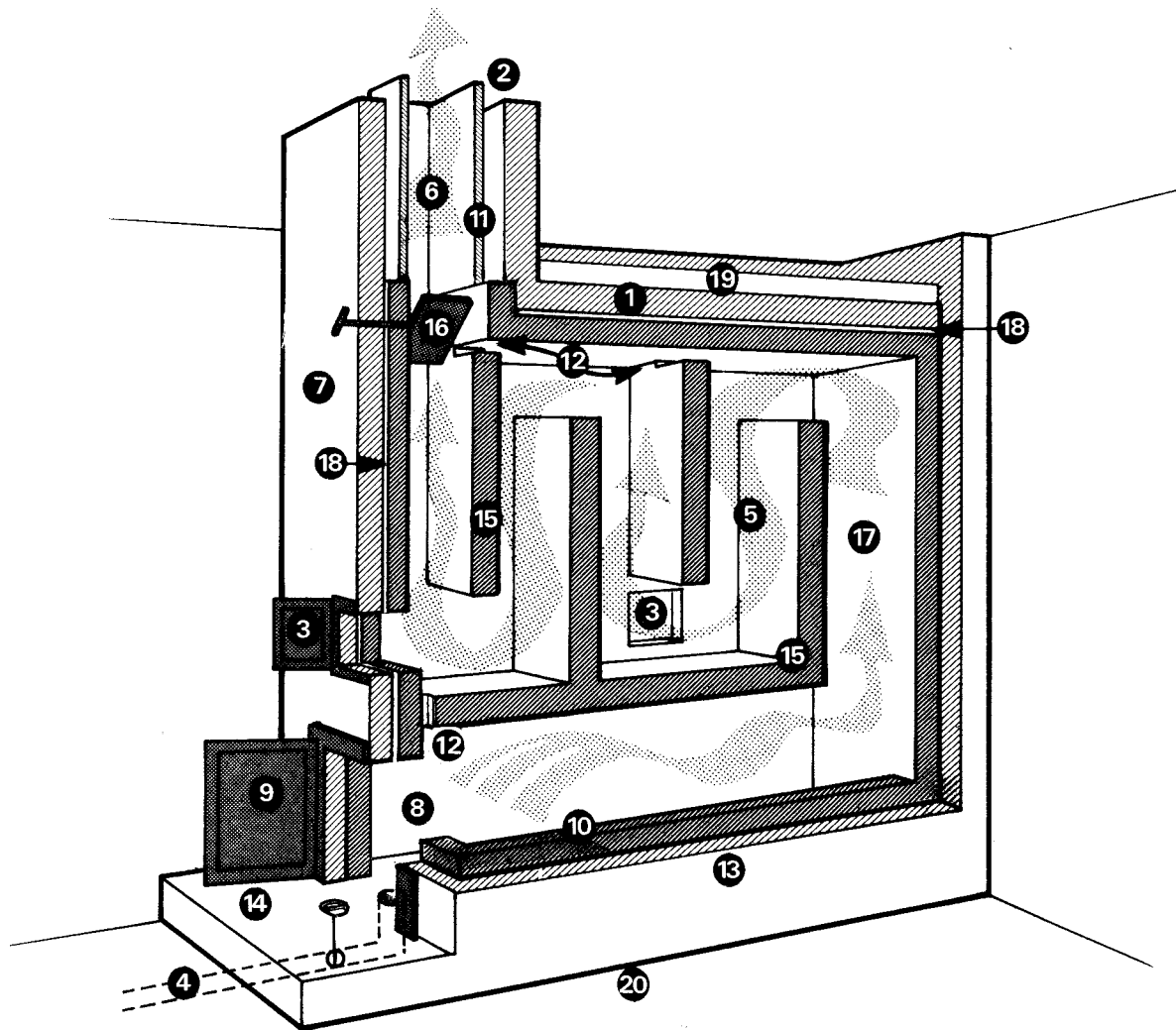
² *Annual Book of ASTM Standards*, Vol 04.01.

³ *Annual Book of ASTM Standards*, Vol 04.05.

⁴ *Annual Book of ASTM Standards*, Vol 15.01.

⁵ *Annual Book of ASTM Standards*, Vol 04.07.

⁶ *Annual Book of ASTM Standards*, Vol 14.02.



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|----------------------|------------------------|
| 1. Capping Slab | 11. Flue Liner |
| 2. Chimney | 12. Gas Slot |
| 3. Clean-Out | 13. Brick |
| 4. Combustion Air | 14. Hearth Extension |
| 5. Downdraft Channel | 15. Heat Exchange Area |
| 6. Exhaust Gas | 16. Shut-Off Damper |
| 7. Exterior Wall | 17. Updraft Channel |
| 8. Firebox | 18. Expansion Joint |
| 9. Firebox Door | 19. Insulation Joint |
| 10. Firebox Wall | 20. Heater Base |

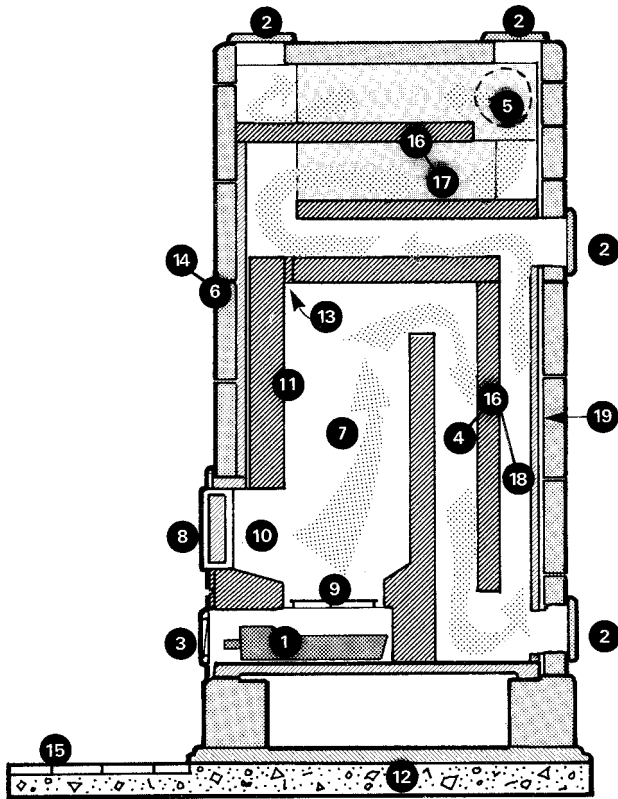
FIG. 1 Multi-Flue Heater (Russian)

3.2.11 *heat-exchange flue channel*—a chamber or passage-way between the firebox and the chimney flue in which heat resulting directly from combustion of fuel is transferred to the surrounding masonry.

3.2.12 *kachel*—a European term used to describe a masonry heater tile; a refractory ceramic tile intended for the outer wall of a masonry heater that is designed specifically to store and transfer heat.

3.2.13 *listed*—equipment or materials included in a list published by an organization concerned with product evaluation acceptable to the authority having jurisdiction to conduct periodic inspection of production of listed equipment or materials and whole listing states either that the equipment or materials meet appropriate standards or have been tested and found suitable for use in a specified manner.

3.2.14 *masonry heater*—a vented heating system of predominantly masonry construction having a mass of at least 800 kg (1760 lbs), excluding the chimney and heater base. In particular, a unit designed specifically to capture and store a substantial portion of the heat energy from a solid fuel fire in the mass of the appliance through internal heat exchange flue channels; enable a charge of solid fuel mixed with an adequate amount of air to burn rapidly and more completely at high temperatures in order to reduce emission of unburned hydrocarbons; and be constructed of sufficient mass and surface area such that under normal operating conditions, the external surface temperature of the heater (except in the region immediately surrounding the fuel loading door(s)), does not exceed 110°C (230°F).



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|---------------------------|------------------------|
| 1. Ashbox | 11. Firebox Wall |
| 2. Clean-Out | 12. Heater Base |
| 3. Combustion Air | 13. Gas Slot |
| 4. Downdraft Channel | 14. Kachel/Brick |
| 5. Exhaust Gas Outlet | 15. Hearth Extension |
| 6. Exterior Wall | 16. Heat Exchange Area |
| 7. Firebox | 17. Horizontal Channel |
| 8. Firebox Door | 18. Updraft Channel |
| 9. Firebox Floor or Grate | 19. Expansion Joint |
| 10. Firebox Opening | |

FIG. 2 German Tile/Brick Heater (Kachelofen/Grundofen)

4. Significance and Use

4.1 This guide can be used by code officials, architects, and other interested parties to evaluate the design and construction of masonry heaters. It is not restricted to a specific method of construction, nor does it provide all specific details of construction of a masonry heater. This guide does provide the principles to be followed for the safe construction of masonry heaters.

4.2 This guide is not intended as a complete set of directions for construction of masonry heaters.

4.3 Construction of these units is complex, and in order to ensure their safety and performance, construction shall be done by or under the supervision of a skilled and experienced masonry heater builder.⁸

5. Requirements

5.1 *Foundation*—Masonry heater foundations and foundation walls shall meet local building codes for standard masonry fireplaces and shall be designed with consideration given to the mass and size of the heater.

5.2 *Clearance from Combustibles*—Clearances shall be in conformance with this section, as illustrated in Fig. 3.

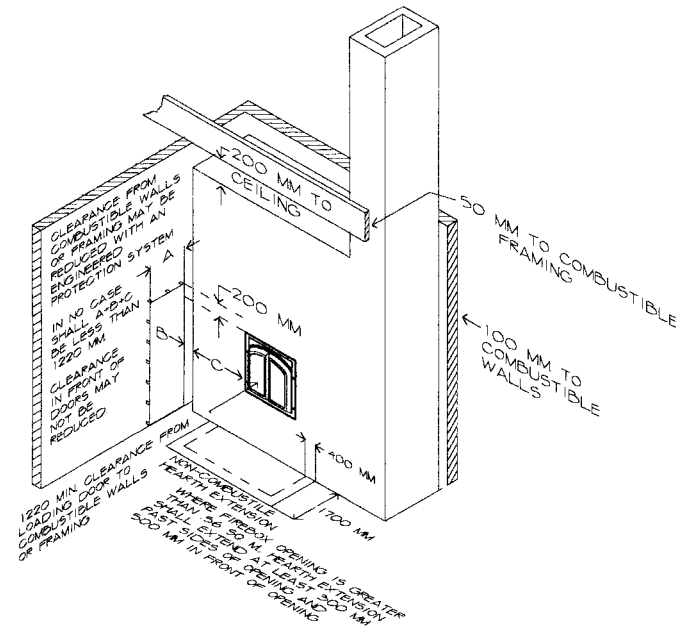


FIG. 3 Clearances to Combustibles

3.2.15 *mortar, masonry*—a mixture of cementitious materials (consisting of portland or blended cement and hydrated lime, masonry cement, masonry cement and portland cement, or masonry cement and blended cement), fine aggregate, and sufficient water to produce a workable consistency (see Specification C 270).

3.2.16 *mortar, fire clay*—mortar consisting of fine aggregate and fire clay as a binding agent.

3.2.17 *mortar, soapstone refractory*—a mixture of powdered soapstone and sodium silicate.

3.2.18 *noncombustible material*—a material that, in the form in which it is used and under the conditions anticipated, does not ignite, burn, support combustion, or release flammable vapors when subjected to fire or heat. Materials reported as passing the requirements of Test Method E 136 are, for the purpose of this guide, considered noncombustible.

3.2.19 *soapstone*—a variety of natural stone (hydrated silica of magnesium) that is suitable for high-temperature applications in masonry heaters.

3.2.20 *wing wall*—a noncombustible lateral projection from the exterior wall of a masonry heater for use in bridging the space between a heater and a combustible partition wall.

5.2.1 *Clearance from Foundation*—All combustible structural framing members shall have a clearance of not less than 50 mm (2 in.) from the masonry heater foundation.

5.2.2 *Clearance from Fuel-Loading Door*—Maintain a minimum clearance of 1200 mm (48 in.) from combustible materials to fuel-loading doors, unless an engineered protection system as specified in 5.2.2.1 is provided.

⁸ The Masonry Heater Association of North America, 11490 Commerce Park Drive, Reston, VA, is one organization that represents a body of knowledge on masonry heater construction and qualified builders.

5.2.2.1 Clearance from fuel-loading doors to combustible materials may be reduced if the combustible material is protected by an engineered protection system acceptable to the authority having jurisdiction. Engineered systems installed for the protection of combustible material shall limit the temperature of the combustible material to 50°C (90°F) above ambient temperature. Base the system design upon applicable heat transfer principles, taking into account the geometry of the system, the heat loss characteristics of the structure behind the combustible material, and possible abnormal operating conditions of the masonry heater.

5.2.3 *Clearance from Rear, Side, and Front Walls*—Clearance from a masonry heater to combustible structural framing and other combustible materials shall be not less than 100 mm (4 in.), unless an engineered protection system is provided.

5.2.3.1 Clearance from a masonry heater to combustible materials may be reduced by the use of materials or products listed for protection purposes. Materials and products listed for the purpose of reducing clearance to combustibles shall be installed in accordance with the conditions of the listing and the manufacturer's instructions and shall meet the criteria of Section 5.2.2.1.

5.2.4 *Clearance from the Ceiling*—The clearance from the masonry heater capping slab to the ceiling shall be a minimum of 200 mm (8 in.).

5.2.4.1 *Extensions of Exterior Wythes to Ceiling*—When exterior masonry wythes of the heater are carried to the ceiling, insulate and vent the top of the heater above the heat exchange channels to reduce possible static heat buildup.

5.2.5 *Wing Walls*—Wing walls may be added to a heater and used as room partitions. Wing walls located at the corners of a heater for the purpose of forming a room divider shall be a minimum of 100 mm (4 in.) in length and a maximum of 100 mm (4 in.) in thickness and be constructed with noncombustible materials. Wing walls located more than 200 mm (8 in.) from a corner of the heater shall be a minimum of 200 mm (8 in.) in length and a maximum of 100 mm (4 in.) in thickness and be constructed with noncombustible materials.

5.3 *Firebox Floor*—The firebox floor shall be a minimum thickness of 100 mm (4 in.) of noncombustible material and at least the top 50 mm (2 in.) shall be refractory material. The firebox floor or a portion thereof may also contain a cast iron grating.

5.4 *Hearth Extension:*

5.4.1 Masonry heaters shall have hearth extensions of brick, concrete, stone, tile, or other approved noncombustible material properly supported. Remove wooden forms used during the construction of hearth and hearth extension once construction is completed.

5.4.2 *Open Fireboxes:*

5.4.2.1 Where the firebox opening is less than 0.6 m² (6 ft²), the hearth extension shall extend at least 400 mm (16 in.) in front of the facing materials and at least 200 mm (8 in.) beyond each side of the heater opening.

5.4.2.2 Where the firebox opening is 0.6 m² (6 ft²) or larger, the hearth extension shall extend at least 500 mm (20 in.) in front of the facing materials and at least 300 mm (12 in.)

beyond each side of the heater opening.

5.4.3 *Closed Door Fireboxes*—With a unit designed to be fired with a closed door of glass or metal, the hearth extension shall be at least 500 mm (20 in.). When a raised hearth of at least 200 mm (8 in.) in height is used and the hearth is located at the base of the door, the hearth extension shall be at least 400 mm (16 in.).

5.4.4 Where a firebox opening overhangs a floor, the hearth extension shall also cover the area beneath the overhang and extend beyond the firebox opening as specified in 5.4.3.

5.5 *Cleanout Openings:*

5.5.1 Chimney flues shall have a cleanout access at their base.

5.5.2 *Heat Exchange Channels*—If the design limits natural access, install cleanout openings or a means for cleaning all chimney flues and heat exchange areas. If an ash dump or grate is provided in the firebox, provide a tight-fitting cover of noncombustible material, 3 mm (1/8 in.) minimum thickness, at the base of the ash pit. Cleanout doors for the foundation shall have a minimum size of 200 by 200 mm (8 by 8 in.). Situate the opening to facilitate inspection, cleaning, and maintenance of the heater.

5.6 *Outside Combustion Air*—When required by the local building code, provide a duct with a minimum cross-sectional area of 7700 mm² (12 in.²) or equivalent. The opening shall have a damper that can be fully closed when not in use. Materials and methods of construction shall comply with the requirements of the authority having jurisdiction.

5.6.1 In applications in which outside air is introduced directly into the firebox, the air duct must enter the building at a level below the firebox.

5.6.2 Design and position the air inlet to prevent live coals from entering the air duct. To prevent rodents from entering the air duct, cover the outside entry opening of the duct with a 6-mm (1/4-in.) corrosion resistant wire mesh.

5.6.3 *Ash Pit Located in Foundation*—When outside air is introduced into the firebox via the ash pit, introduce the air duct through the upper region of the ash pit wall.

5.6.4 When outside air is introduced into the firebox, construct the air duct from noncombustible materials.

5.7 *Heat exchange channels:*

5.7.1 Build heat exchange channels with firebrick, soapstone, or other refractory materials laid in refractory mortar, fire clay mortar, or soapstone refractory mortar. Lay the masonry units with full mortar joints.

5.7.2 *Capping Slab*—Place a capping slab of at least 57 mm (2 1/4 in.) in actual thickness above the uppermost heat exchange channels.

5.7.3 *Gas Slot*—When required, a gas slot shall have a cross-sectional area of at least 1/30 of the firebox floor area and a height of 30 mm (1 1/4 in.). Refer to Fig. 1 and Fig. 2 for typical locations.

5.8 *Shut-off Damper(s)*—One or more shut-off dampers may be installed near the juncture of the heater and chimney or in the chimney. Each damper shall have external controls and be constructed of cast iron or steel of at least 12 gage, 2.5 mm (0.10 in.) in thickness. To reduce the possibility of toxic gases

escaping into the room, the cross-sectional area of the damper's opening shall be not less than 5 % of the interior cross sectional area of the flue.

5.9 *Chimney*—Vent masonry heaters with a low-heat type masonry chimney approved by the authority having jurisdiction or with a factory-built residential type chimney that meets the “Type HT” requirements of UL 103.

5.9.1 The chimney shall not be supported by the interior walls of the masonry heater unless specifically designed to do so. The chimney can be built integrally with an exterior wythe of the heater, provided the exterior wythe is constructed of solid masonry and has a minimum thickness of 100 mm (4 in.).

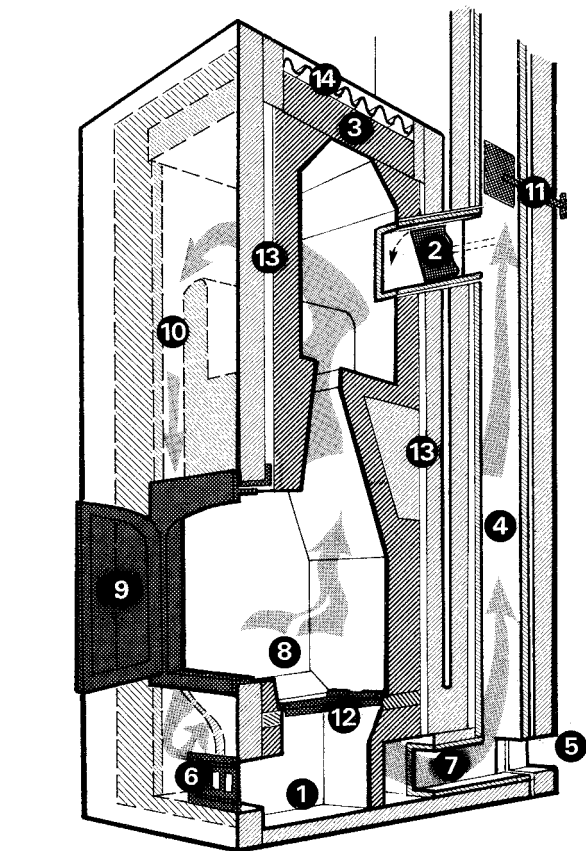
5.9.2 Flue sizes shall be in accordance with the design specification of the builder or the designer of the unit.

5.10 *Chimney Connector*—The chimney connector shall be accessible for inspection and cleaning. Chimney connectors

shall be airtight and fitted with airtight joints. Where differential movement can take place between a heater and chimney, make provision for this movement in such a way as to maintain the integrity of the connector joints. Materials and methods of construction shall comply with the requirements of the authority having jurisdiction.

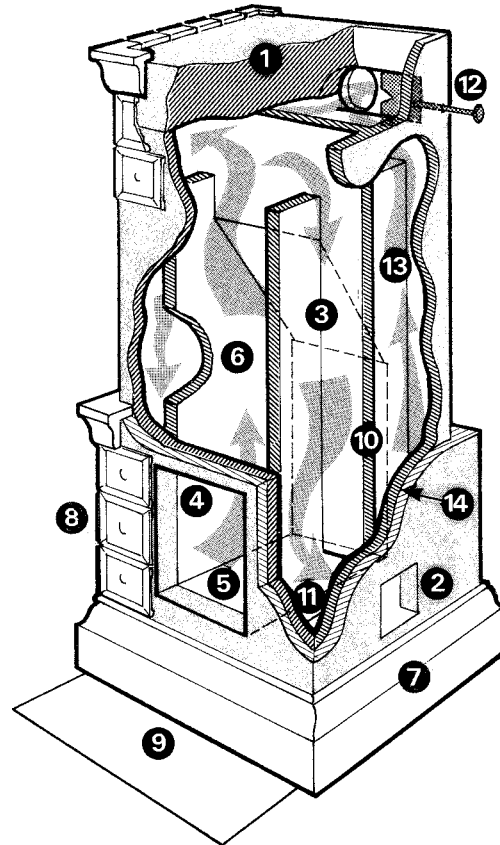
6. Typical Masonry Heater Types

6.1 There are several different masonry heater types. Fig. 1, Fig. 2, Fig. 4, and Fig. 5 show the names and schematic sections of typical masonry heater designs.



- 1. Ashbox
- 2. Bypass Damper
- 3. Capping Slab
- 4. Chimney
- 5. Clean-Out
- 6. Combustion Air
- 7. Exhaust Gas
- 8. Firebox
- 9. Firebox Door
- 10. Heat Exchange Area
- 11. Shut-Off Damper
- 12. Grate
- 13. Expansion Joint
- 14. Insulation

FIG. 4 Contraflow (Finnish Heater)



- 1. Capping Slab
- 2. Clean-Out
- 3. Downdraft Channel
- 4. Firebox
- 5. Firebox Floor or Grate
- 6. Firebox Wall
- 7. Heater Base
- 8. Kachel
- 9. Hearth Extension
- 10. Heat Exchange Area
- 11. Horizontal Channel
- 12. Shut-Off Damper
- 13. Updraft Channel
- 14. Expansion Joint

FIG. 5 Swedish Tile Heater (Kakelugn)

7. Keywords

7.1 brick; Contraflow; firebrick; fire clay mortar; Grund-ofen; Kachelofen; Kakelugn; masonry heater; mortar; refractory mortar; Russian; soapstone refractory mortar

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