Technical Notes 19E - Brick Masonry Fireplaces, Part 2 - Fountain and Contemporary Style Heaters [1983](Reissued Feb. 1988)

Abstract: Brick masonry heaters may be used instead of conventional fireplaces to provide efficient supplemental heating for residential buildings. The design, detailing and construction of brick masonry fireplaces with baffle systems through which combustion gases are circulated are discussed. Information regarding building code compliance, operation and accessories is presented, along with the basic heating principles.

Key Words: **brick**, **buildings (codes)**, **design**, **energy**, fireplaces, **heating**, **masonry**, mortar.

INTRODUCTION

The basic concepts of a fireplace designed with a baffle system replacing the conventional smoke chamber are discussed in *Technical Notes* 19D. Such fireplaces are often referred to as *Russian-style* fireplaces. These fireplaces, or brick masonry heaters, although capable of providing efficient heat, tend to eliminate the esthetic value of the fireplace because the firebox is typically deep within a small opening. An alternate approach to the fireplace designed to include a baffle system through which combustion gases are circulated is the *Finnish or fountain-style heater.* This *Technical Notes* provides the information necessary to properly design and construct a fountain-style brick masonry heater or to modify conventional fireplace designs to incorporate baffle systems to allow the circulation of combustion gases.

The basic principles by which high efficiencies are obtained for heating the building interior and for the combustion of wood are the same as for the Russian-style brick masonry heater. Hot combustion gases circulating through the massive brick masonry heater, combined with properly controlled air intake for combustion, result in high efficiencies. The hot combustion gases are circulated through baffle chambers within the heater. The massive brick masonry is warmed and retains the heat. This warmed brick masonry radiates the heat long after the fire is extinguished. The basic concepts of design, construction and operation are simple, but there are several concerns which must be addressed to insure safety and durability.

GENERAL

Operation

The operation of both the fountain-style brick masonry heater and the contemporary-style heaters is quite similar. Both systems have unique operational advantages which are directly related to their design and the way in which combustion gases are circulated through the massive brick masonry assembly.

Typically, the combustion chamber or firebox is loaded with 10 lb (4.5 kg) to 20 lb (9.1 kg) of wood, after a fire with kindling is ignited. Once good combustion starts, the firebox doors or glass screens are closed and the air intakes adjusted to the proper setting so that good combustion continues. Unlike the Russian-style brick masonry heater, because of the design of the firebox, glass screens may be used on the fountain-style heater and the modified conventional fireplace. The glass screens or firebox doors used should be equipped with operable air inlets so that the air intake to the combustion chamber can be controlled. The metal firebox doors or glass screens selected for the firebox opening should be capable of withstanding the high temperatures in the combustion chamber. Temperatures of combusting wood will usually range from 1000°F (540°C) to 1500°F (820°C), and the temperature of the combustion gases near the fire usually ranges from about 800°F (430°C) to 1200°F (650°C). (See Reference 10). Thus, all components of the firebox should be capable of withstanding these temperatures.

The 10 lb (4.5 kg) to 20 lb (9.1 kg) of wood loaded in the firebox will burn for about 30 min when properly seasoned wood is used with adequate draft and combustion air. For maximum heating, the firebox should be reloaded with about 10 lb (4.5 kg) to 20 lb (9.1 kg) of wood every 30 min for a 2-hr period. This procedure usually results in enough heat being supplied by the brick masonry heater to keep a 2400 ft ^{3} (68 m^3) room warm for a period of 8 to 12 hr during the coldest months in severe climates, such as in Scandinavia. Under these severe climate conditions, the heater is usually operated for a 2-hr period twice a day, once in the morning and once in the evening. During the more moderate seasons, or in the more moderate climates, operating the heater once in the evening may be adequate to supplement the mechanical heating system to maintain comfortable interior temperatures throughout the night. Other variations in operation, such as the number of loadings and the amount of wood used for each firing may also result in increased comfort. The operator should experiment with several operations to determine how to achieve the best performance for the various seasons.

This method of operation may be used with any properly designed and constructed brick masonry heater. Because of the variations in the design of the fountain style heater and the modified conventional fireplace, the actual method of operation should be modified for the specific design. The contemporary-style brick masonry heater is usually operated the same as a conventional fireplace.

Fountain-Style Heater. The fountain-style heater is shown in Figures 1 through 3. It consists of a relatively conventional fireplace firebox. The smoke chamber is rectangular and the baffle chambers for circulating the combustion are located on the sides of the smoke and combustion chambers. The baffle chambers meet under the combustion chamber where combustion gases are vented to the chimney.

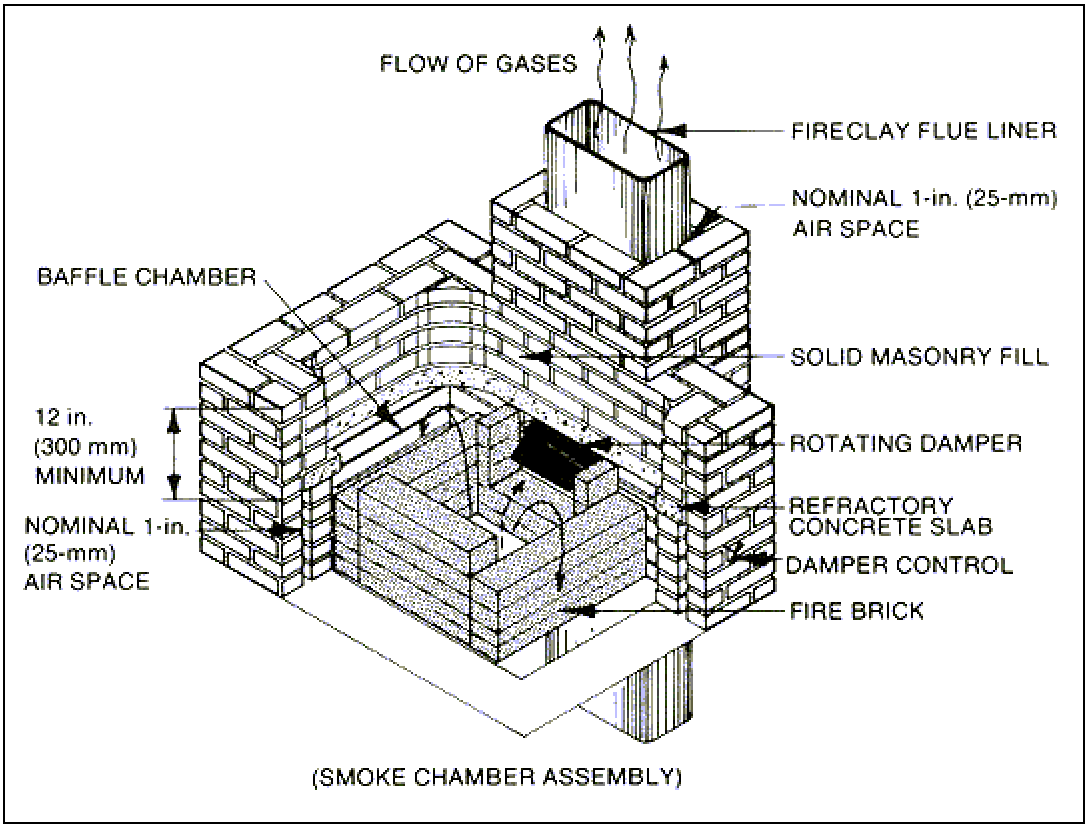


FIG. 1a

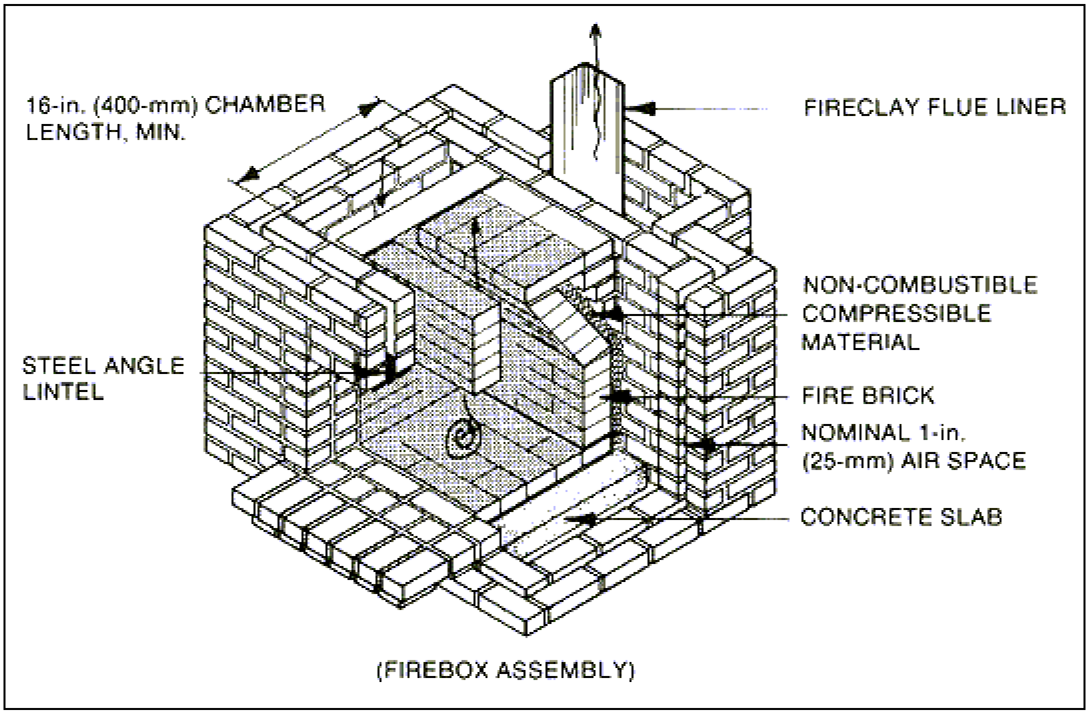
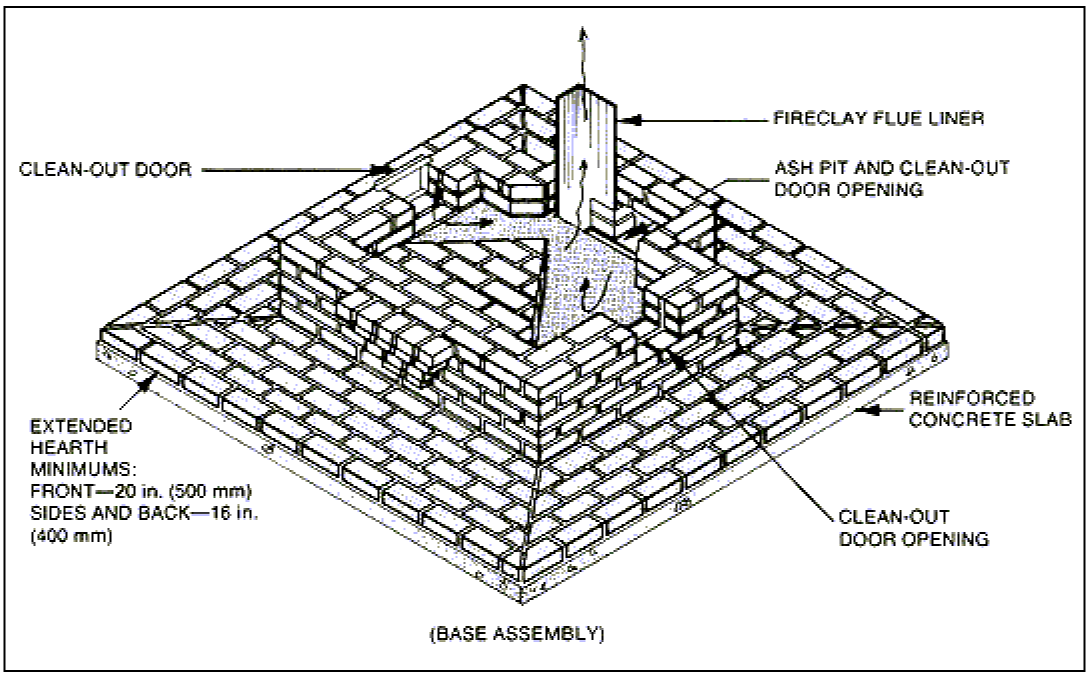


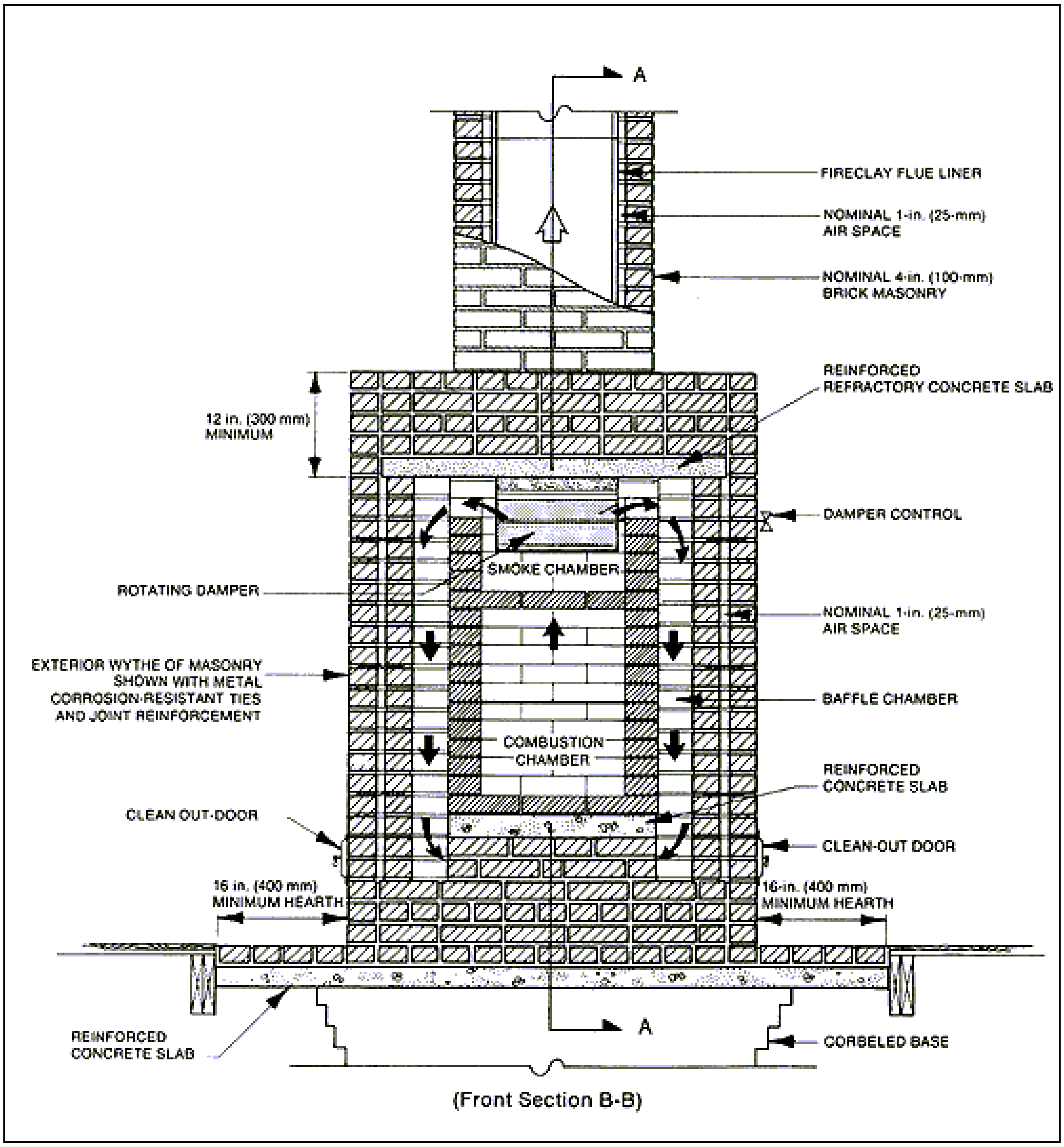
FIG. 1b



Fountain-Style Brick Masonry Heater, Isometric

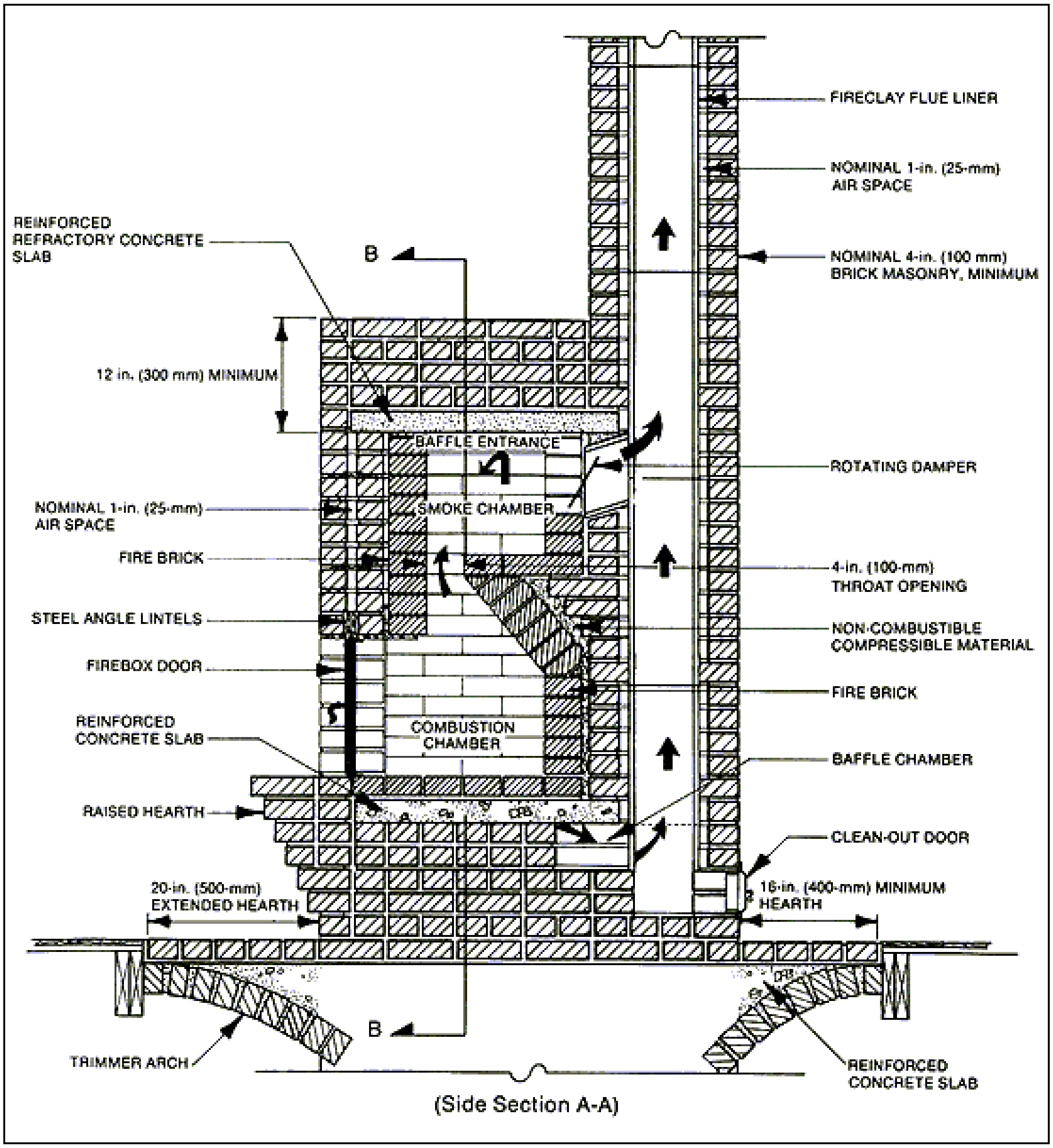
FIG. 1c

The heating output of the fountain-style heater may be increased by using a specially designed air supply system from the firebox doors to the smoke chamber. Providing the smoke chamber with this additional air ignites the combustion gases in the smoke chamber. The combustion gases burn at temperatures of about 1800°F (1100°C) to 2100°F (1150°C). This method of operation, because of the higher temperatures of the circulating combustion gases, greatly increases the heating capability of the heater. This second combustion within the heater also results in a very clean and complete combustion of the wood and its by-products. This nearly complete combustion maximizes the efficiency of the wood fuel and considerably reduces any creosote buildup within the brick masonry heater and chimney.



Fountain-Style Brick Masonry Heater

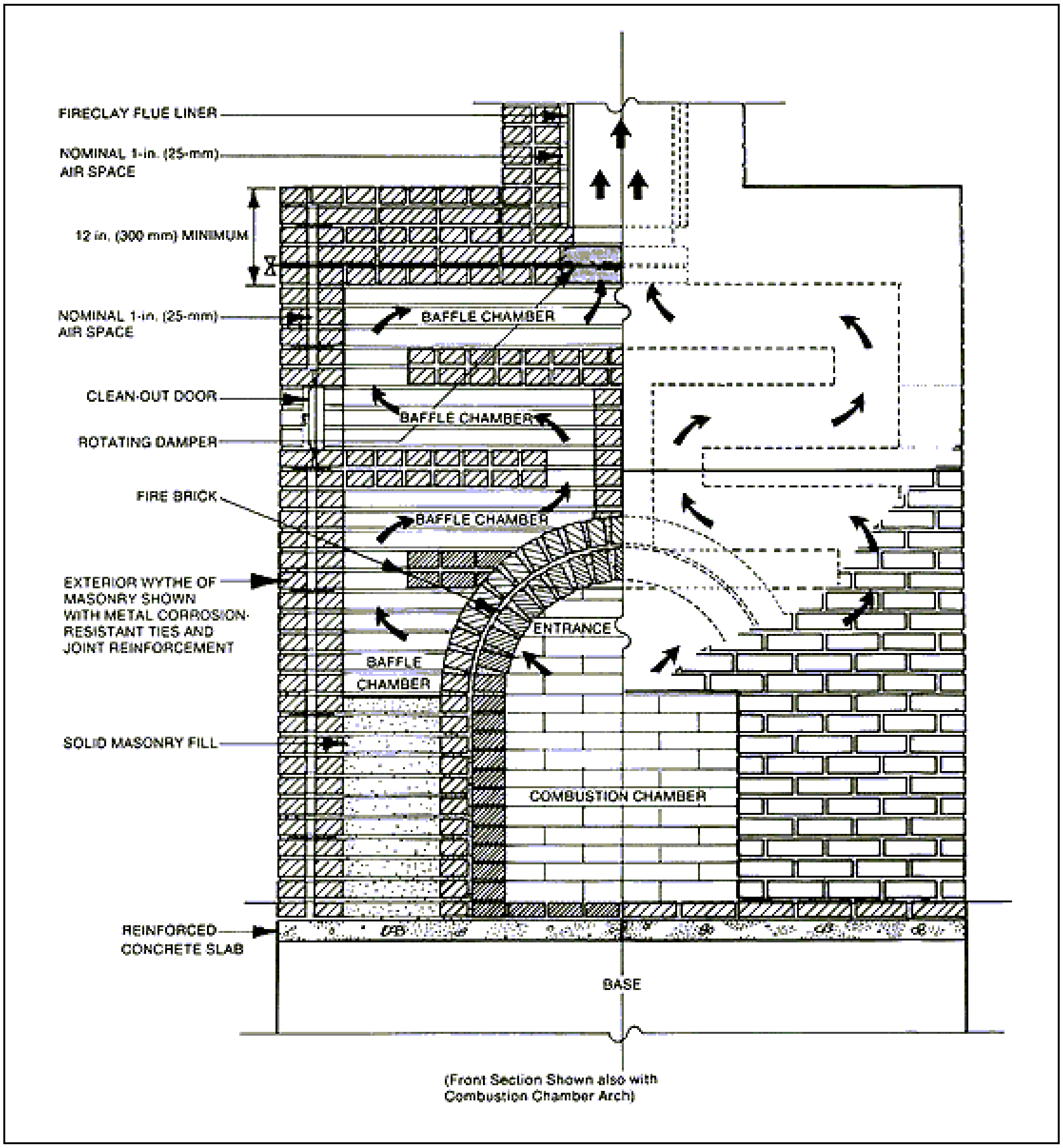
FIG. 2



Fountain Style Brick Masonry Heater

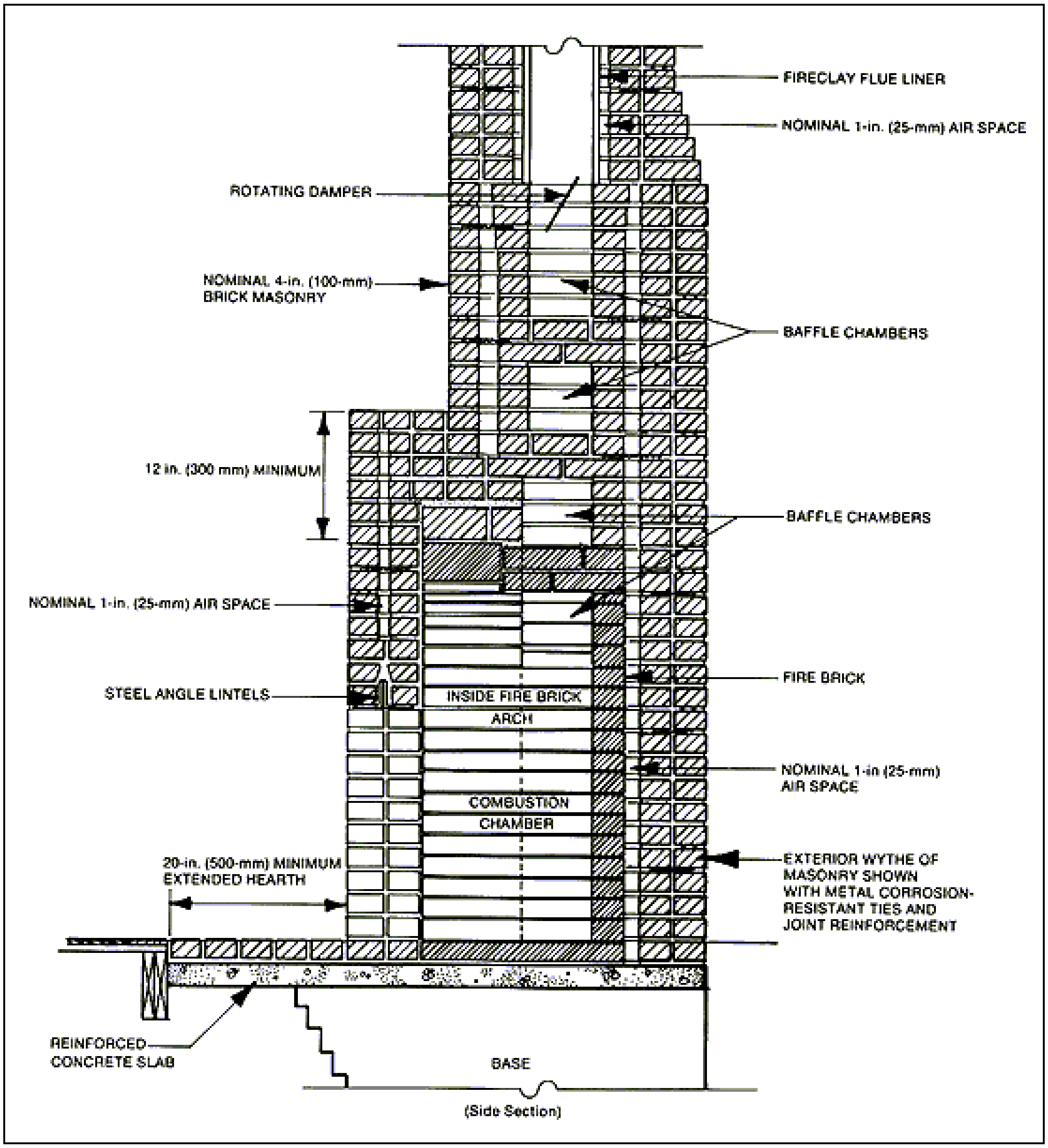
FIG. 3

Contemporary-Style Heater. The contemporary-style heater, shown in Figs. 4 through 7, although much more efficient than a conventional fireplace, will not achieve the high efficiency normally obtained in the fountain-style heater. The fountain-style heater achieves efficiencies of about 80 to 95 percent and the contemporary-style heater provides a heating efficiency of about 70 to 80 percents. (See Reference 8). The contemporary-style heater is designed with a rectangular firebox with the throat located at the rear of the firebox. Combustion gases are circulated through baffle chambers within the smoke chamber and exhausted to a conventional fireplace chimney located on top of the smoke chamber. Although this type of heater does not provide as much heat, it is usually preferred because it provides the esthetic appearance similar to a conventional fireplace.



Modified Conventional Fireplace

FIG. 4



Modified Conventional Fireplace

FIG. 5

Building Code Compliance

There are no major model building code requirements which specifically address brick masonry heaters or their baffle chambers. For the most part, the building code requirements for fireplaces and chimneys are applicable to the brick masonry heater except for those requirements which address the firebox and smoke chamber dimensions. All building code requirements for chimneys and clearances for combustibles are applicable. Because the temperatures normally achieved in the brick masonry heater are much higher than those obtained in conventional fireplaces, additional consideration should be given to safety and durability.

The exterior walls of the brick masonry heater should consist of at least two wythes of brick masonry when constructed of solid units. The two wythes should be separated by a nominal 1-in. (25 mm) air space. This separation prevents any cracks from penetrating the interior wythe through the exterior wythe of the heater. Filling this 1-in. (25 mm) air space with a compressible, non-combustible material will insure that a separation is provided. The two wythes should be tied to each other with corrosion-resistant metal ties, placed 16 in. (400 mm) o.c. vertically and a maximum of 24 in. (600 mm) o.c., horizontally. The exterior wythe should contain horizontal joint reinforcement every 16 in. (400 mm) vertically to add to the integrity of the heater. The ties and joint reinforcement should *not* occur in the same course. These provisions should prevent problems due to thermal expansion and differential movement without affecting the overall thermal performance of the brick masonry heater.

When reinforced brick masonry construction is required, the enclosing walls or shell of the heater may be constructed of fully grouted hollow wall construction or fully grouted hollow brick units. If the fully grouted hollow wall construction is to be used, the minimum 2 in. (50 mm) grout core must be fully grouted and contain sufficient horizontal and vertical reinforcement to resist structural and thermal stresses. The two wythes must also be adequately tied together with corrosion-resistant metal ties. If grouted hollow brick masonry is used, the cores must be fully grouted and sufficiently reinforced to resist structural and thermal stresses. Horizontal joint reinforcement should have proper mortar coverage in the bed joints and the units should not be less than 8 in. (200 mm) in thickness. For additional information on reinforced brick masonry construction and hollow brick, see *Technical Notes* 17 and 41.

In addition to the thermal movements, the exterior surface temperatures of the brick masonry heater also need to be considered. These surface temperatures normally range between 100^{o}F (38^{o}C) and 130^{o}F (54^{o}C). Temperatures as high as 190^{o}F (88^{o}C) have been reported on certain styles of brick masonry heaters and are typical when fountain-style heaters are operated with gas combustion occurring in the smoke chamber.

A minimum 16-in. (400 mm) clearance is recommended between the sides and the back of the brick masonry heater and combustibles. At the floor line, this may be achieved by providing a 16-in. (400 mm) extended hearth. In the front of the heater, a minimum 20-in. (500 mm) extended hearth should be used. This is easily achieved when the heater is properly positioned in the room for maximum heating. This position is in the center of the room so that all four brick walls of the heater are providing radiant heat to the room.

The brick masonry heater should always be positioned entirely inside the building. It should never be incorporated into an exterior wall, because much of the radiant heat would be lost to the exterior. In addition to this heat loss, the location on the exterior wall will usually result in at least one cold surface on which a considerable amount of creosote may form. A creosote fire may well result in sufficient damage to the heater so that it is no longer safe to operate.

FOUNTAIN-STYLE HEATER

General

A typical design of a fountain-style heater is shown in Figs. 1 and 2. There are many variations to the design and construction of the fountain-style heater. The fountain-style heater, often referred to as a *Finnish stove* or *vertical contra-flow masonry stove,* is believed by most experts to be the most efficient brick masonry heater. For proper combustion, the air intake to the combustion chamber should be approximately 0.80 cfm/lb (0.00083 m^3/sec/kg) of wood being burned in the combustion chamber. This requirement is for the typical size fountain-style heater, which is usually loaded with 10 lb (4.5 kg) to 20 lb (9.1 kg) every 30 min for a 2-hr period.

Base Assembly

In the fountain-style heater, the baffle system provides for the circulation of combustion gases under the hearth of the firebox where they are vented to the chimney. Thus, when designing and constructing this style heater, the baffle system and chimney support must be incorporated into the base assembly.

Foundation. The foundation system must be adequate to support the mass of the brick masonry heater and the masonry chimney. When designing the foundation, care should be taken to account for soil types and foundation conditions. Undisturbed or well-compacted soil will generally be sufficient. However, some types of soils or foundation conditions may require special analysis. This could result in the need for special soil treatments or a unique foundation design.

Building codes generally require that the footing be at least 12 in. (300 mm) thick, and in plan view extend a minimum of 6 in. (150 mm) beyond each face of the masonry heater and chimney assembly. The footing should be positioned so that its base is below the frost line to reduce the possibility of "heaving."

Hearth Support. The brick masonry used to form the hearth support is constructed directly on the foundation system. Even with a thickened slab in a newly constructed slab-on-grade structure, masonry is usually used to construct the base assembly to the height of the hearth support because to properly construct a fountain-style heater, a raised hearth is usually required. The hearth support may be solid masonry carried up from the footing to support the entire hearth area. To conserve materials, the base assembly is usually constructed of masonry which has the same dimensions in plan as the masonry heater and chimney assembly itself. The base assembly is corbeled to form the support for the extended hearth.

A soot pocket should be formed at the base of the chimney assembly, approximately 20 in. (500 mm) to 24 in. (600 mm) below the firebox hearth. These dimensions will provide a soot pocket that is, approximately 8 in. (200 mm) in height, which will accommodate a standard size clean-out door. The baffle chamber is started at the top of the soot pocket. The baffle chamber should be at least 5 in. (125 mm) (about two courses of standard size brick) high. The last course of brick forming the soot pocket should be corbeled to provide the support for the chimney liner. The first chimney liner should be cut so that the entire front of the liner, for the height of the base baffle chamber, is removed. This opening is used to exhaust the combustion gases to the chimney. The baffle system needs to be designed so that the vertical baffle chamber, at least 3 in. (75 mm) wide and 16 in. (400 mm) long, may be continued up along the sides of the firebox. The remaining portion of the baffle chamber should be constructed so that the combustion gases will be directed to the rear of the base assembly and vented to the chimney. At the base of the baffle chamber, clean-out doors should be installed so that soot and ash deposits may be removed. The shell of the fountain-style heater is also started at the base of the baffle system. This shell should be constructed of two wythes of brick masonry separated by a nominal 1-in. (25 mm) air space and tied with metal ties. The exterior wythe should contain horizontal joint reinforcement. Because these vertical baffle chambers must extend up along the sides of the firebox, the size of the base is directly dependent upon the firebox dimensions.

Extended Hearth. As the base assembly is constructed, the support for the extended hearth is usually formed so that the top of the extended hearth may be constructed at or slightly below the clean-outs. The extended hearth is usually formed by placing a reinforced concrete slab on top of the corbeled base assembly, as shown in Fig. 1. Non-combustible, or removable, forming should be placed so that it spans from the corbeled masonry to the floor joists forming the opening for the heater. Double joists should be used around the entire perimeter of the opening with a nailer attached to the joists to support the edge of the forming material. This type of construction is discussed in more detail in *Technical Notes* 19A Revised. To decrease the number of concrete slabs occurring within the heater assembly, the extended hearths may be formed by using trimmer arches, as shown in Fig. 3.

The extended hearth should be at least 20 in. (500 mm) in front of the firebox opening and 16 in. (400 mm) around the remaining perimeter of the heater. The extended hearth may be eliminated on the back of the heater if it is positioned against a non-combustible wall with a minimum fire rating of 1 hr. Once the reinforced slab is installed, the extended hearth may be finished with brick pavers and at least one course of brick masonry should be placed to form the base of the fountain-style heater baffle chamber. If removable forming is used, the concrete slab used to support the extended hearth must be designed as a cantilever

Ash Pit. The masonry heater, because of its efficient combustion of wood, does not require an ash pit. If an ash pit is desired, it should be positioned so that the ash drop occurs in the center of the firebox width, toward the front of the firebox. This location results in the ash pit being formed by brick masonry used to construct the portion of the baffle system in the base assembly. The ash drop should extend through the firebox hearth and hearth support. If an exterior combustion air system is desired, the optional ash pit should be eliminated and replaced with the vertical air passageway which forms the exterior combustion air inlet to the firebox.

Firebox Assembly

The firebox assembly is constructed on a reinforced concrete slab, which spans from the front to the rear of the heater. The reinforced concrete slab should be at least 2 1/2 in. (63 mm) thick and must be thick enough to satisfy the structural and reinforcement coverage requirements. The slab should bear at least 2 in. (50 mm) on the interior wythe of the shell of the brick masonry heater. The width of the slab must be limited to the outside dimensions of the firebox width so that the baffle chamber may be continuous to the base assembly.

The typical dimensions of the firebox opening are: 12 in. (300 mm) to 18 in. (450 mm) wide, by 24 in. (600 mm) in height. The firebox is usually 18 in. (450 mm) to 24 in. (600 mm) deep, and about as wide as the firebox opening. The shape of the firebox is similar to that of a conventional fireplace without flared sides. The back wall of the firebox is sloped forward to form the throat. This slope usually begins at about 12 in. (300 mm) from the firebox hearth and should form a 4-in. (100 mm) throat that is as wide as the combustion chamber.

The combustion chamber should be constructed of refractory brick units to obtain a thickness of at least 2 1/2 in. (63 mm). A sliding damper may be installed at the throat. The throat damper is usually installed so that it may be operated from the face of the fireplace. If a throat damper is used, sufficient provisions are necessary to allow for the thermal expansion so that the damper does not bind or crack the surrounding brick masonry. Whenever possible, a throat damper should *not* be used.

If air is to be provided to the smoke chamber, provisions must be made in the face of the heater to form an air passageway. The air inlet is usually through specially fabricated firebox doors and placed so that the air enters the smoke chamber at the throat where the velocity of the combustion gases is the greatest. A specially designed firebox door is usually required to provide combustion air to the smoke chamber.

Smoke Chamber Assembly

The smoke chamber assembly should be constructed of refractory brick units. The base of the smoke chamber should be constructed of fire brick. The front and rear walls of the smoke chamber should be 12 in. (300 mm) to 16 in. (400 mm) high. The side walls should be 8 in. (200 mm) to 12 in. (300 mm) high to provide an opening for the combustion gases to enter the vertical baffle chambers. The top of the smoke chamber should be constructed of a 2 1/2 in. (63 mm) to 4 in. (100 mm) thick reinforced refractory-concrete slab. The slab thickness must be adequate for structural and reinforcement coverage requirements. The rear of the slab should bear at least 2 in. (50 mm) on the wythe of brick immediately behind the fire brick wall of the smoke chamber. The front and sides should bear at least 2 in. (50 mm) on the interior wythe of the shell of the heater. The distance from the bottom of this slab to the bottom of the baffle chamber should not exceed 5 ft (1.5 m), thus controlling the distance combustion gases are circulated and the height of the heater.

The smoke chamber is often constructed with an opening directly into the chimney. This opening is installed to provide a by-pass for when little or no heating is required. It should be equipped with a rotating damper. This by-pass is shown in Figs. 1 through 3.

Crown

The crown of the fountain-style heater should be at least 12 in. (300 mm) thick, including the refractory slab forming the top of the smoke chamber. The crown should terminate at least 12 in. (300 mm) below the ceiling of the room. This may require that the baffle chambers be extended below the floor line of the room.

Chimney

The chimney for the fountain-style heater is similar to those used for residential appliances. The chimney should be constructed of fireclay flue liners and 8 in. (200 mm) of brick masonry surrounding the liner in such a way as to maintain a nominal 1 in. (25 mm) space between the flue liner and the brick chimney walls. Additional information on chimney design and construction is provided in *Technical Notes* 19B Revised.

The chimney height required for draft is usually higher than that necessary for a conventional fireplace, but following building code requirements for fire safety will usually result in a sufficiently high chimney. The major model building codes require that chimneys must terminate at least 3 ft (1 m) above the roof at the highest point of exit and at least 2 ft (600 mm) above any portion of the building or adjacent structures within 10 ft (3 m) of the chimney. If draft is determined to be inadequate by a smoke test, the chimney height should be increased to provide adequate draft.

CONTEMPORARY-STYLE HEATERS

General

The brick masonry heater formed by modifying a conventional fireplace, as shown in Figs. 4 through 7, is one of the easiest brick masonry heaters to construct and also retains most of the esthetic value of a conventional fireplace. This style of heater has the baffle system, through which combustion gases are circulated, incorporated solely in the smoke chamber assembly. Variations in the smoke chamber and the firebox are the only major differences from a conventional fireplace. The front and side sections of the contemporary-style heater are shown in Figs. 4 and 5, respectively. The heater under construction is shown in Fig. 6, and Fig. 7 shows a completed contemporary-style heater.

Base Assembly

The requirements for the base assembly are essentially the same as for the other brick masonry heaters and conventional fireplaces. The foundation system requirements discussed for fountain-style heaters are also applicable to the modified conventional fireplace.

The hearth support is similar to that of a conventional fireplace, as discussed in *Technical Notes* 19 Revised and 19A Revised. The hearth support is usually constructed of a reinforced concrete slab, as previously discussed. For this style heater, it is necessary to have only a 20-in. (500 mm) extended hearth at the front face of the heater. The thickness of the side and rear walls at the floor line usually provides adequate fire protection. However, because the higher portions of this heater are much hotter, a minimum 12-in. (300 mm) clearance should be maintained between the back and sides of the heater and any combustible materials.

If an ash pit is desired, it may be constructed the same as for a conventional fireplace. External combustion and draft air systems used with conventional fireplaces may also be incorporated into this style heater. Additional information is provided in *Technical Notes* 19 Revised and 19A Revised.

Firebox Assembly

The firebox is constructed as a rectangular box that is usually about 20 in. (500 mm) deep and 30 in. (750 mm) wide. The opening of the firebox is usually about 27 in. (675 mm) high. Immediately behind the top of the firebox opening, which is constructed of face or building brick on a steel lintel, is the top of the firebox. The top of the firebox is formed as a brick masonry arch, extending from the inside face of the heater and terminating about 6 in. (150 mm) to 8 in. (200 mm) from the rear wall of the firebox. At the crown of the arch, above the opening, the first horizontal baffle is constructed. This baffle extends about 8 in. (200 mm) to 12 in. (300 mm) on either side of the firebox, and is constructed of refractory units.

Smoke Chamber Assembly

The conventional smoke chamber is replaced by a baffle system as shown in Figs. 4 and 5. The baffle system begins at the top of the rear of the firebox. The baffle chambers should be about 7 1/2 in. (188 mm) by 7 1/2 in. (188 mm) square. Immediately above the first horizontal baffle are three horizontal baffle chambers, each separated by 5 in. (125 mm) of face or building brick. The baffle system is separated vertically into right and left chambers by 4 in. (100 mm) to 8 in. (200 mm) of brickwork. The second horizontal baffle above the firebox should be equipped with a clean-out so that any soot or ash deposits may be removed.

Contemporary-Style Brick Masonry Heater Under Construction

FIG. 6

Crown

The crown of this modified conventional fireplace should be at least 12 in. (300 mm) thick, and terminate at least 12 in. (300 mm) from the ceiling of the room. A rotating damper should be installed at the center of the heater width.

Chimney

The chimney should be constructed as a lined chimney with 8 in. (200 mm) of brick masonry surrounding the flue liner in such a way that a nominal 1-in. (25 mm) air space is maintained between the flue liner and the brick. The flue liner support should be formed by the last course of brick masonry in the crown. The termination requirements as previously discussed apply and additional information regarding chimney design is provided in *Technical Notes* 19B Revised.

Contemporary-Style Brick Masonry Heater

FIG. 7

SELECTION OF MATERIALS

General

The accessories used in Europe are not usually available in the United States. The design and construction of the brick masonry heater using products available in North America are slightly different from the construction of the heater in Europe. There are methods to modify the design and construction so that products readily available in the United States may be used with the brick masonry heater. The option also exists to import the accessories or to fabricate accessories similar to those used in Europe. However, these options are usually uneconomical. Additional information regarding accessories may be obtained from the cited references.

Brick

Most building codes require that solid masonry units be used for fireplace construction. Solid brick should be nominal 3 in. (75 mm) or 4 in. (100 mm) thick, conforming to ASTM C 216 or C 62, for facing brick or building brick, respectively. If a single wythe of reinforced, grouted hollow brick is used, the hollow brick should be at least 8 in. (200 mm) wide and should conform to ASTM C 652. Grade SW brick should be used because of its greater durability.

Refractory brick, conforming to ASTM C 64, medium duty, should be used for the firebox. The lining for the first baffle chamber of the contemporary-style heater and the smoke chamber of the fountain-style heater should also be constructed of refractory units because these areas are exposed to the greatest amounts of heat. The refractory units are more resistant to heat and thermal shock.

Salvaged or used brick should *not* be used, because they usually will not bond well with the mortar and lack the durability necessary for satisfactory performance. The use of salvaged brick is discussed in *Technical Notes* 15.

Flue Liners

Flue liners should conform to ASTM C 315. They should be thoroughly inspected just prior to installation for cracks or other damage that might contribute to smoke and flue gas leakage.

Mortar and Grout

It is most convenient and economical to use only one type of mortar for the entire brick masonry heater and chimney assembly. This becomes difficult when constructing a brick masonry heater because of the specific requirements of each component. The portions of the heater consisting of building, face or hollow brick should be constructed using a Type N, portland cement-lime mortar, conforming to the proportion specifications of ASTM C 270 or BIA M1-72. The same mortar should be used for the chimney brickwork except when wind loads exceed 25 psf (1.2 kPa). Where high wind loads exist, a Type S, portland cement-lime mortar, conforming to the proportion specifications of ASTM C 270 or BIA M1-72, should be used. It may be desirable to use high temperature-resistant mortars, such as calcium aluminate mortars, for the interior wythes and baffles of the brick masonry heater. Such mortars will increase the durability of the heater.

The firebox and all other components constructed of refractory units should be placed using a fireclay mortar conforming to ASTM C 105, medium duty. Other refractory mortars have also been used successfully, and thus any high temperature-resistant mortars that have performed well may be used. It is not within the purview of the Brick Institute of America to recommend proprietary products. The selection of the proper mortars should be determined by an experienced fireplace expert for the specific design being considered.

Grout is required for reinforced hollow walls and reinforced hollow brick construction. Such assemblies must be fully grouted. The grout should conform to ASTM C 476.

Steel Lintels and Dampers

Steel lintels should be used only above the firebox opening because of the high temperatures occurring within the heater. The thermal expansion characteristics of the different materials could cause cracking of the brick masonry heater. Lintels of corrosion-resistant steel, conforming to ASTM A 36, should be used to span over the firebox door openings. Non-combustible, compressible material should be placed at the ends of all lintels to provide for differential thermal movements.

Ties and Reinforcement

Corrugated Metal Ties. Corrugated metal ties may be used to anchor the baffles to the interior wythe of the heater walls and to tie the two wythes of the exterior walls of the heater. Ties should be corrosion-resistant, approximately 22 ga, 7/8 in. (22.2 mm) wide, and 6 in. (150 mm) long. Stiffer ties should not be used, as they may transfer stresses due to thermal expansion of the interior wythe to the exterior wythe of the brick masonry heater.

Prefabricated Joint Reinforcement. Prefabricated joint reinforcement should be used only in the exterior wythe of the heater walls. T he joint reinforcement should be fabricated from wire which complies with ASTM A 82 or ASTM A 185, and must be corrosion-resistant.

Reinforcement. Reinforcement should conform to any of the following applicable standards:

> Standard Specifications for Deformed Billet-Steel Bars for Concrete Reinforcement-ASTM A 615
>
> Standard Specifications for Rail-Steel Deformed Bars for Concrete Reinforcement-ASTM A 616
>
> Standard Specifications for Axle-Steel Deformed Bars for Concrete Reinforcement-ASTM A 617

Corrosion Resistance. Corrosion resistance is usually provided by a copper or zinc coating, or by using stainless steel. To ensure adequate resistance to corrosion, coatings or materials should conform to any of the following applicable standards:

> Zinc-Coating of Flat Metal-ASTM A 153, Class B-1, B-2, or B-3
>
> Zinc-Coating of Wire-ASTM A 641, Class 3

Copper Coated Wire-ASTM B 227, Grade 30 HS

Stainless Steel-ASTM A 167, Type 304

Firebox Doors

The doors for the firebox opening may be fabricated locally, ordered from Europe, or may be conventional, metal Dutch oven doors, which are the most economical. The brick masonry heater is not designed for airtight combustion and thus the doors need to be equipped with operable vents to control air intake into the firebox. The size of the firebox opening is determined by the size of the firebox door used. Other alternatives which exist for the firebox design and firebox doors are discussed in other *Technical Notes* in this Series. Glass screens may be used, but they must be capable of withstanding the high temperatures and severe exposure occurring within the firebox.

Clean-Out Doors

Conventional clean-out doors may be used, but to ensure tightness, refractory units should be placed within the door opening with a compressible material or set in a sand-lime mortar. The refractory units increase the resistance to combustion gas leaks, provide protection to the metal door from high temperatures, and may easily be removed and replaced when cleaning. This is shown in *Technical Note* 19D. Clean-out doors for the ash drop may be conventional clean-out doors, installed in the conventional manner.

SUMMARY

The information and suggestions contained in this *Technical Notes* are an accumulation of the available information within the Brick Industry Association on brick masonry heaters. The information is based on empirical data from actual performance of such heaters here in North America and in Europe. The information provided in this *Technical Note* and *Technical Note* 19D does not address all of the possible variations, or alterations, which may be incorporated into a brick masonry heater by design or construction requirements. The information and recommendations provided in this *Technical Note* discuss the basic principles and guidelines by which fireplace experts using good technical judgment may design and construct a functional brick masonry heater.

Final decisions on the design and use of materials, as discussed in this *Technical Notes,* are *not* within the purview of the Brick Industry Association and must rest with the project designer, owner, or both.

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