Technical Notes on Brick Construction

Brick Industry Association 11490 Commerce Park Drive, Reston, Virginia 20191

19C REVISED

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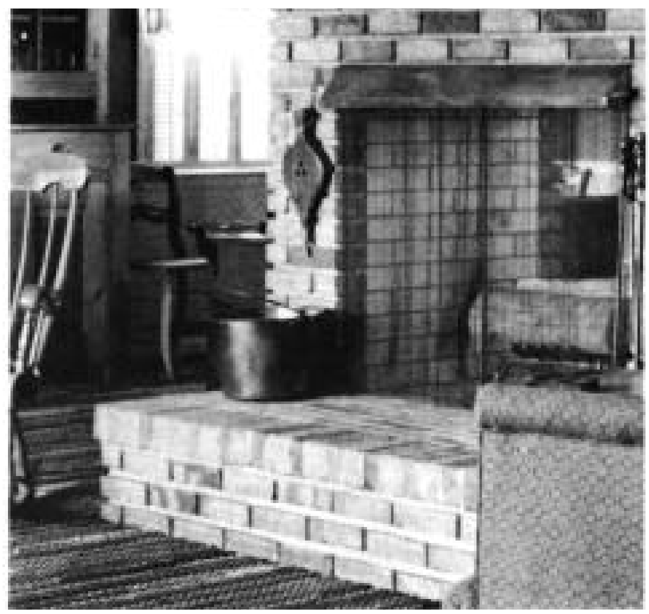
# CONTEMPORARY BRICK MASONRY FIREPLACES

**ABSTRACT:** Considerations and recommendations necessary for the successful design of fireplaces are addressed. Design and construction recommendations are included for Rumford fireplaces, air-circulating fireplaces and multi-face fireplaces. Concepts for increased energy efficiency are also provided.

**KEY WORDS:** brick, dampers, design, energy efficiency, fireplace, heating, masonry.

**Contemporary Brick Masonry Fireplace**
**FIG. 1**



**Contemporary Brick Masonry Fireplace**
**FIG.2**

## INTRODUCTION

There are many types of fireplaces available for residential applications. Conventional single-face fireplaces are discussed in *Technical Notes* 19 Revised and 19A Revised. These *Technical Notes* also provide information about the many energy-efficient features which may be applied to single-face fireplaces. This *Technical Notes* discusses fireplaces other than the conventional single-face fireplace. See Figures 1 and 2. Information is provided to design Rumford fireplaces, air-circulating fireplaces and multi-face fireplaces. Rumford air-circulating fireplaces are usually selected to provide a more energy-efficient fireplace. Multi-face fireplaces usually have lower energy efficiencies. They may be incorporated into a residential building for aesthetics and, as is true with all fire places, to add mass to the inside of the building for thermal storage. Other *Technical Notes* in this series provide information on masonry heaters, often referred to as Finnish or Russian Stoves, and residential chimneys.

## INCREASED ENERGY EFFICIENCY

### General

Increasing the energy efficiency of fireplaces has been a goal since fireplaces were first used for heating buildings. There are two types of energy efficiency which are of importance: 1) combustion of the wood, and 2) heating of the building or room.

Any wood-burning appliance that does not have controlled intake of air for draft or combustion does not usually result in efficient combustion of the wood. Early fireplaces, although not designed or constructed much differently than fireplaces built today, had a higher efficiency in heating a building because they were the sole source of heat. The number of fireplaces per building and the comfort levels achieved greatly affect this efficiency. Today's fireplaces are typically used to provide supplemental heat to reduce the heating load on the mechanical heating system. Efficiency today is lower because fireplaces are used while interior temperatures are already comfortable. The major portion of heat obtained from a brick masonry fireplace is radiant heat from the fire and the re-radiated heat from the massive brick masonry. The masonry mass gradually warms from the fire and continues to provide heat to the building long after the fire is extinguished. Most of the recently constructed fireplaces are located on exterior walls. Unfortunately, this results in a substantial portion of the heat absorbed by the masonry mass being lost to the exterior. Thus, fireplaces, especially when being considered to provide supplemental heating, should *not* be located on exterior walls because this significantly reduces the heating efficiency. The fireplace should be centrally located on the interior of the building to maximize the performance of the fireplace as a source for supplemental heating. This central location also increases the safety of the fireplace because all chimney surfaces maintain higher temperatures which help to eliminate the problem of creosote build-up and possible chimney fires.

The concepts for increasing energy efficiency in fireplaces, discussed here and in *Technical Notes* 19 Revised, are not new concepts. As early as the Fifth Century, metal doors were installed over fireplace openings to reduce air infiltration when the fireplace was not being used. Today, glass screens are used for this purpose. The metal doors provided both radiation to the room and a method to control the amount of combustion air to the fire. Openings in the firebox to introduce outside air for combustion and draft were commonly used in the 1700's. Air-circulating fireplaces were introduced in the 1600's, and in the 1700's the Rumford fireplace, a fireplace with obliquely flared sides which increase the amount of heat radiated to the room, was in common use.

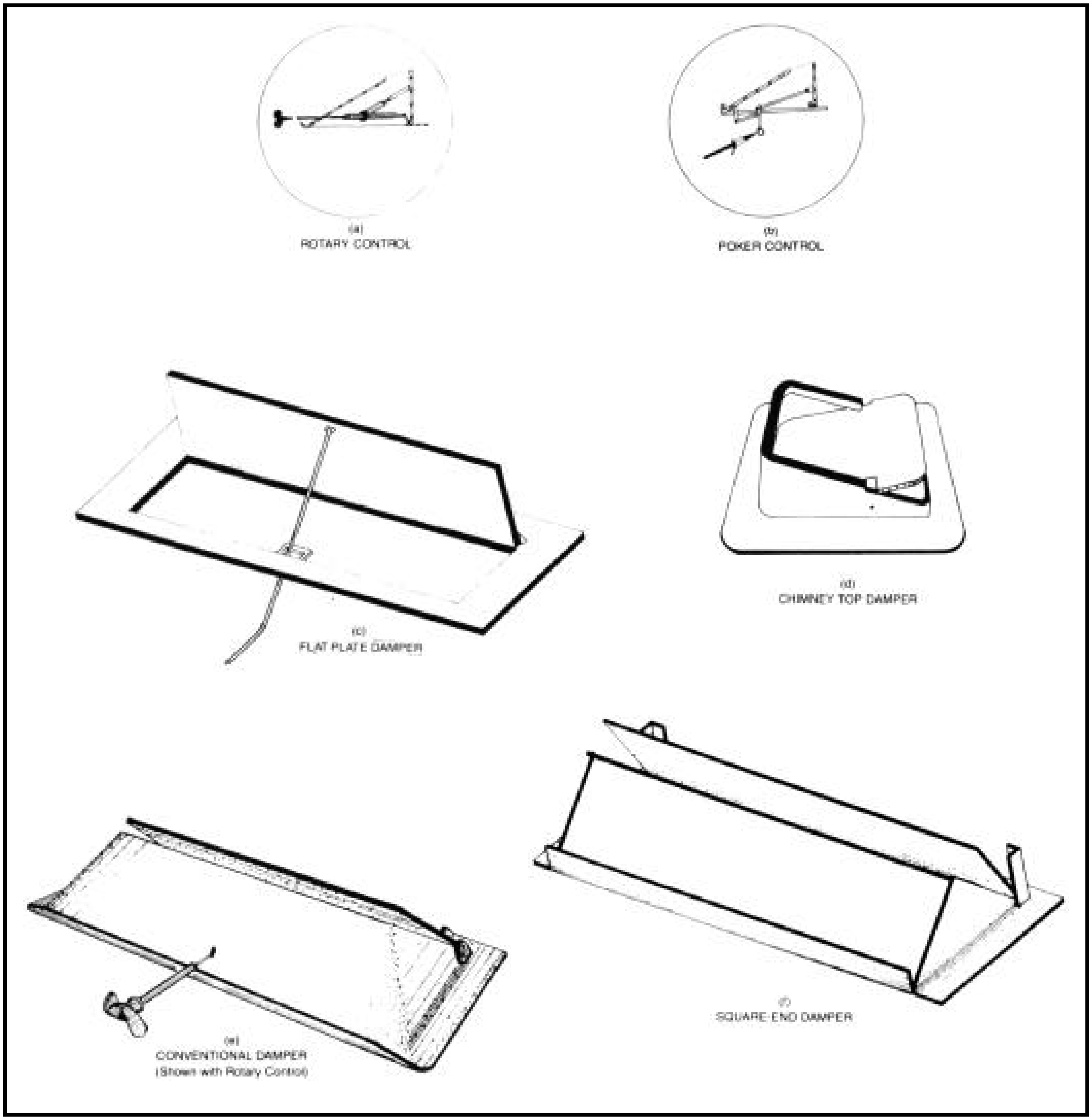
Adding energy-efficient features to a conventional fireplace should be carefully considered before attempting special fireplace designs. Conventional fireplaces with energy-efficient features are usually the most economical, easiest to construct and have the best track record for operational performance, i.e., proper draft and reduced smoking. In addition, operation has a significant effect on fireplace energy efficiency. Regardless of all the energy-efficient features incorporated into a fireplace, efficiency can only be achieved with proper operation. One operational feature, which is all too frequently overlooked, is the damper. The fireplace damper is usually designed so that its opening may be adjusted. The damper should be completely open when starting the fire, but during operation, the damper opening should be reduced to maximize the heat provided to the room while open sufficiently to discharge all of the smoke. The operation of the damper is usually easiest and safest when a rotary-controlled damper is used. Such dampers are controlled from the face of the fireplace and the operator does not have to reach into the firebox to adjust the damper as is necessary with most poker or chain-controlled dampers. Typical rotary and poker controls are shown in Fig. 3. The installation and proper operation of a rotary controlled damper could greatly increase the energy efficiency of any new or existing fireplaces.

**Rumford Fireplaces**

Most of the heat obtained from a brick masonry fireplace is radiant heat. Conventional fireplaces are typically deep, with only slightly flared sides. In this type of fireplace, most of the heat absorbed by the brick is radiated back to the fire or other portions of the firebox. This results in a hotter-burning fire, but does not allow much of the radiant heat to enter and warm the room. By decreasing the depth and flaring the sides of the firebox, a greater amount of radiant heat may be directed into the room. This configuration results in what is commonly referred to as a "Rumford fireplace".

Typical dimensions for Rumford fireplaces are provided in Fig. 4 and Table 1. However, these dimensions are not precise dimensions, but are dimensions based upon successful performance of constructed Rumford fireplaces. Rumford fireplaces have a reputation for allowing a small amount of smoke to enter the room while the fireplace is cold because of the narrow depth of the firebox. In addition to the concern of smoking, several of the fireplace dimensions in Fig. 4 may be in violation of local building codes, i.e., the narrow, 16 in. (400 mm) firebox hearth.

The Rumford fireplace usually requires either a flat plate throat damper or a chimney top damper, as shown in Fig. 3. The flat plate throat damper may not be commercially available, and a special damper may have to be manufactured to meet the dimensions of the fireplace design selected. The flat plate damper is simply two pieces of 1/4 in. (6 mm) plate steel, fastened together with hinges, and provided with a stop so that when in the open position the damper is opened slightly more than 90 deg. This type of damper requires a poker control, which should have at least one catch so that the damper cannot be blown shut by downdrafts. The flat plate damper is preferred for the Rumford-style fireplace, but fabrication costs may make its selection uneconomical. Chimney top dampers may be used in lieu of flat plate dampers. However, the chimney top damper should be spring-loaded so that it will be in the open position if the controlling mechanism ever fails. The Rumford fireplace design is such that cold air flows down the chimney through the rear half of the flue. As this air flows downward, it is warmed and reverses its flow upward from the throat through the front half of the flue. If chimney top dampers are used, they must be properly selected so that they do not impair this air flow in the chimney, because it provides suction to increase the drafting of smoke and gases from the firebox. In addition to the flat plate and chimney top dampers, conventional dampers have been successfully used in Rumford fireplaces with only slight modifications in the design of the firebox and smoke chamber.

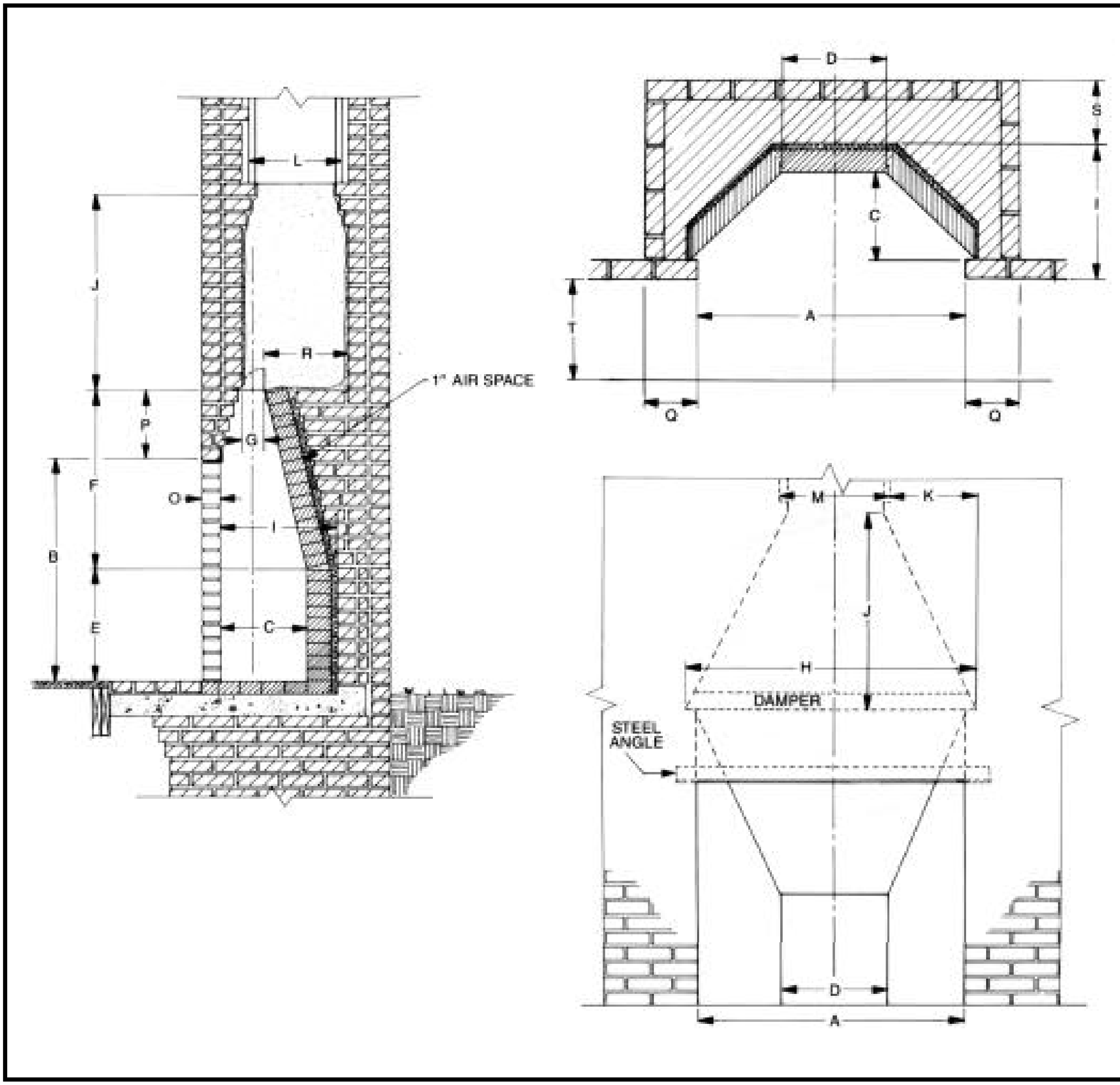



**Typical Fireplace Dampers and Damper Controls**
**FIG. 3**

Another difference between a traditional Rumford fireplace and a conventional fireplace is the chimney. The original Rumford fireplaces had brick-lined chimneys. Thus, the dimensions for the Rumford fireplace provided in Table 1 have been slightly modified to accommodate modular clay flue liners. The result is a wider smoke shelf which may decrease the drafting capability of the assembly.

The effect of the performance of the Rumford fireplace by using dampers other than the flat plate damper, or using clay flue liners and a wider smoke shelf is not well documented. These modifications should be carefully considered and further modifications may be recommended by an experienced fireplace contractor.

Rumford fireplaces greatly increase the amount of radiant heat obtained from the fireplace. The energy efficiency of the Rumford fireplace may be increased through the use of other energy-efficient features, such as supplying outside air and using glass screens which should be closed when the fireplace is not in operation.




**Rumford Fireplace with Clay Flue Liner**
**FIG. 4**

### Air-Circulating Fireplaces

In addition to increasing the amount of radiant heat from a fireplace by altering its shape, increased energy efficiency can also be achieved by using an air-circulating fireplace. An illustration of an air-circulating fireplace is shown in *Technical Notes* 19 Revised. Air-circulating fireplaces may either provide natural air circulation or forced air circulation. The forced air circulation is typically accomplished by the use of low horsepower fans to reverse the natural air flow. With either system, interior air is drawn through baffles immediately behind the firebox where the air is heated and exhausted to warm the living areas of the building.

With conventional fireplaces and Rumford fireplaces, the principal means of supplying heat is by radiation. In addition to radiation, there is a thermal convective loop which occurs between the fireplace and cooler interior surfaces of the building. This phenomena may cause some discomfort to the occupants of the building because it results in a flow of cool air close to the floor. Depending on natural air circulation, cool air entering the baffles from near the floor and warm air being exhausted at the ceiling may aggravate this situation. For this reason, it is preferable to reverse the natural air flow with low horsepower fans. The result is to intake air near the ceiling and force the heated air to be exhausted to the room near the floor.

**TABLE 1**
**Rumford Fireplace Dimensions [a,b]**

| Finished Fireplace Opening | | | | | | Rough Brick Work | | | | | Flue | Angle | Throat and Smoke Shelf | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **A** | **B** | **C** | **D** | **E** | **F[c]** | **G** | **H** | **I[c]** | **J** | **K** | **L x M** | **N** | **O** | **P** | **R** |
| 36 | 32 | 16 | 16 | 16 | 28 | 4 | 44 | 19 1/2 | 27 | 14 | **12 x 16** | A-48 | 4 | 12 | 10 |
| 40 | 32 | 16 | 16 | 16 | 28 | 4 | 48 | 19 1/2 | 29 | 16 | **16 x 16** | A-48 | 4 | 12 | 14 |
| 40 | 37 | 16 | 16 | 16 | 33 | 4 | 48 | 19 1/2 | 29 | 16 | **16 x 16** | A-48 | 4 | 12 | 14 |
| 40 | 40 | 20 | 20 | 20 | 32 | 4 | 48 | 23 1/2 | 29 | 16 | **16 x 16** | A-48 | 4 | 12 | 14 |
| 48 | 37 | 16 | 16 | 16 | 33 | 4 | 56 | 19 1/2 | 36 | 18 | **16 x 20** | B-60 | 4 | 12 | 14 |
| 48 | 40 | 20 | 20 | 20 | 32 | 4 | 56 | 23 1/2 | 36 | 18 | **16 x 20** | B-60 | 4 | 12 | 14 |
| 48 | 48 | 20 | 20 | 20 | 40 | 4 | 56 | 23 1/2 | 36 | 18 | **20 x 20** | B-60 | 4 | 12 | 16 |
| 54 | 40 | 20 | 20 | 20 | 32 | 4 | 66 | 23 1/2 | 45 | 23 | **20 x 20** | B-72 | 4 | 12 | 16 |
| 54 | 48 | 20 | 20 | 20 | 40 | 4 | 66 | 23 1/2 | 45 | 23 | **20 x 20** | B-72 | 4 | 12 | 16 |
| 54 | 54 | 20 | 20 | 20 | 46 | 4 | 66 | 23 1/2 | 42 | 21 | **20 x 24** | B-72 | 4 | 12 | 16 |
| 60 | 48 | 20 | 20 | 20 | 40 | 4 | 72 | 23 1/2 | 45 | 24 | **20 x 24** | B-72 | 4 | 12 | 16 |

[a] These are approximate dimensions based on historical data of Rumford fireplace construction. As is true with all fireplaces, successful performance is experimental.
[b] These dimensions have been developed from the following formulas. These formulas may also be used for opening dimensions other than those listed. Minimum dimensions are taken from the CABO One and Two-Family Dwelling Code, 1986 Edition.

**NOTES TO TABLE 1**

A = Fireplace opening width, in.
B = Fireplace opening height, in. where: $2/3\,A < B \leq A$
C = D = E where: $1/3\,B \leq C \leq 1/2\,B$
F = B - E + P where P =12 in. minimum
G = 4 in.
H = A + 8 in. for A ≤ 48 in.; A + 12 in. for A > 48 in.
I = C + 3 1/2 in. minimum when fire brick are laid as shiners or C + 5 1/2 in. when fire brick or common brick are laid as stretchers.
J = K/u, where: $0.50 \leq u \leq 0.58$
K = 1/2 (H-M)
L X M > 0.16 (AX B)

N = A = 3 X 3 X 3/16 in. angle (number denotes length, in.)
B = 3 1/2 X 3 X 1/4 in. angle
O = Nominal brick thickness
P = 12 in. minimum
Q = 8 in. minimum when A X B< 864 $in.^2$; 12 in. minimum when A X B ≥ 864 $in.^2$
R = Smoke shelf width (flue opening, in.)
S = 8 in. minimum when fire brick lining is used; 10 in. minimum when common brick lining is used.
T = 16 in. minimum when A X B < 864 $in.^2$; 20 in. minimum when A X B ≥ 864 $in.^2$

[c] Minimum dimensions

This provides a means for making the occupants of the room more comfortable. In addition to the comfort benefit, the forced air circulation provides safety. The baffles in which the air is warmed are usually located immediately behind the firebox. By the use of fans to provide forced air circulation, the air in the baffles is pressurized and if there are any leaks or cracks in the firebox, toxic gases remain in the firebox until they are discharged up the chimney. The combustion gases in the firebox would not be drawn through the circulating system and exhausted into the room as might occur with a natural air-circulating fireplace system.

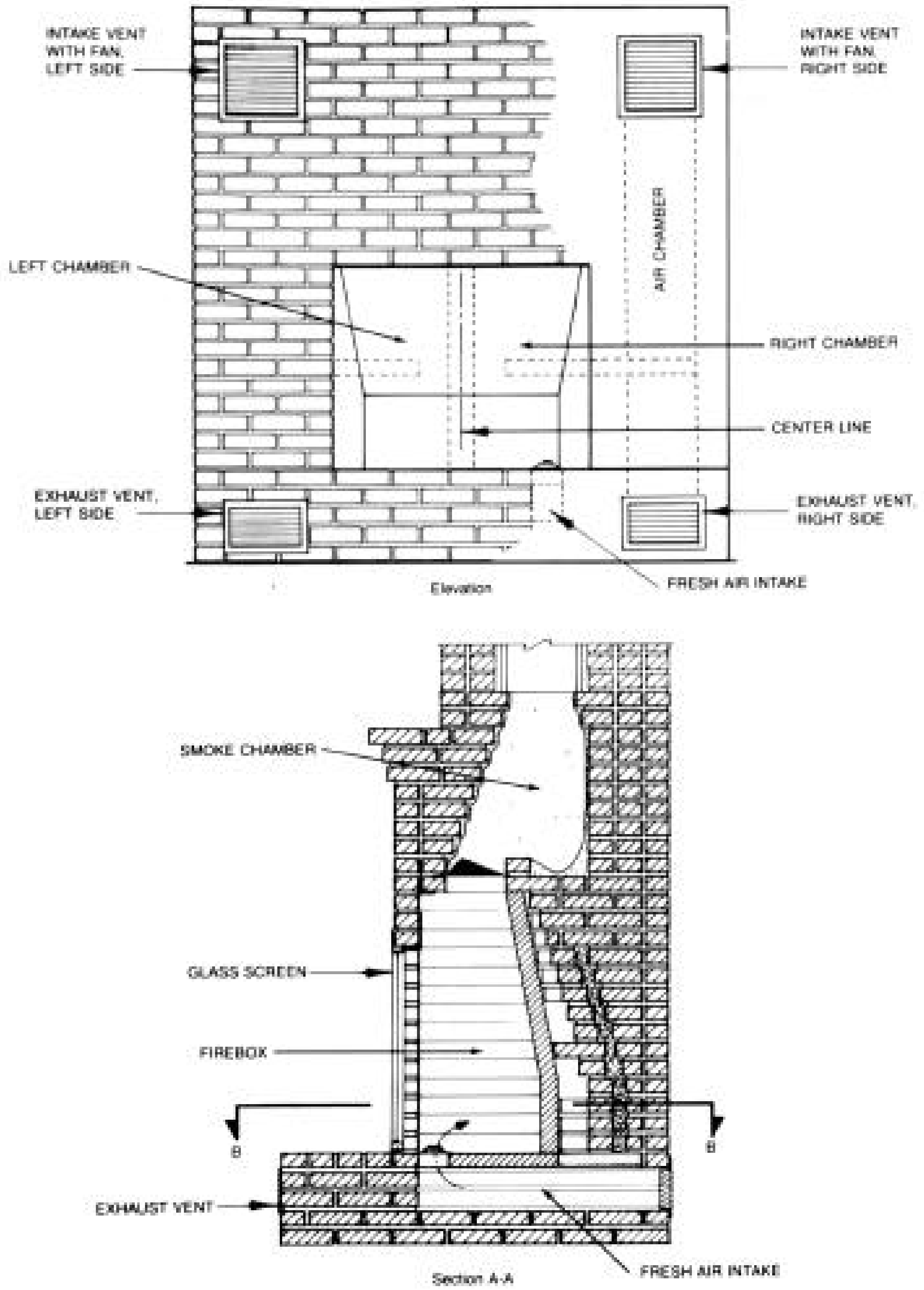
The energy efficiency of an air-circulating fireplace may be increased by installing and properly operating an external combustion and draft air system, by the use of glass screens, or by combining both. One such forced air-circulating fireplace is the Brick-O-Lator (The Brick-O-LatorÆ, a registered trademark, by the Brick Association of North Carolina, P.O. Box 13290, Greensboro, NC 27415-3290, General Information Plans and Details; Brick-O-Lator, Brick Institute of America, Region 9, 5885 Glenridge Dr., Atlanta, GA 30328, General and Construction Information), as shown in Fig. 5.

Maximized radiant heating is provided by the Rumford fireplace, maximized convective heating is provided by the air-circulating fireplace. Masonry heaters, which are discussed elsewhere in this *Technical Notes* series, combine these two basic concepts. The masonry heater has baffles through which flue gases are circulated, warming a large portion of the fireplace, which in turn radiates heat to the surroundings and building occupants.

## MULTI-FACE FIREPLACES

### General

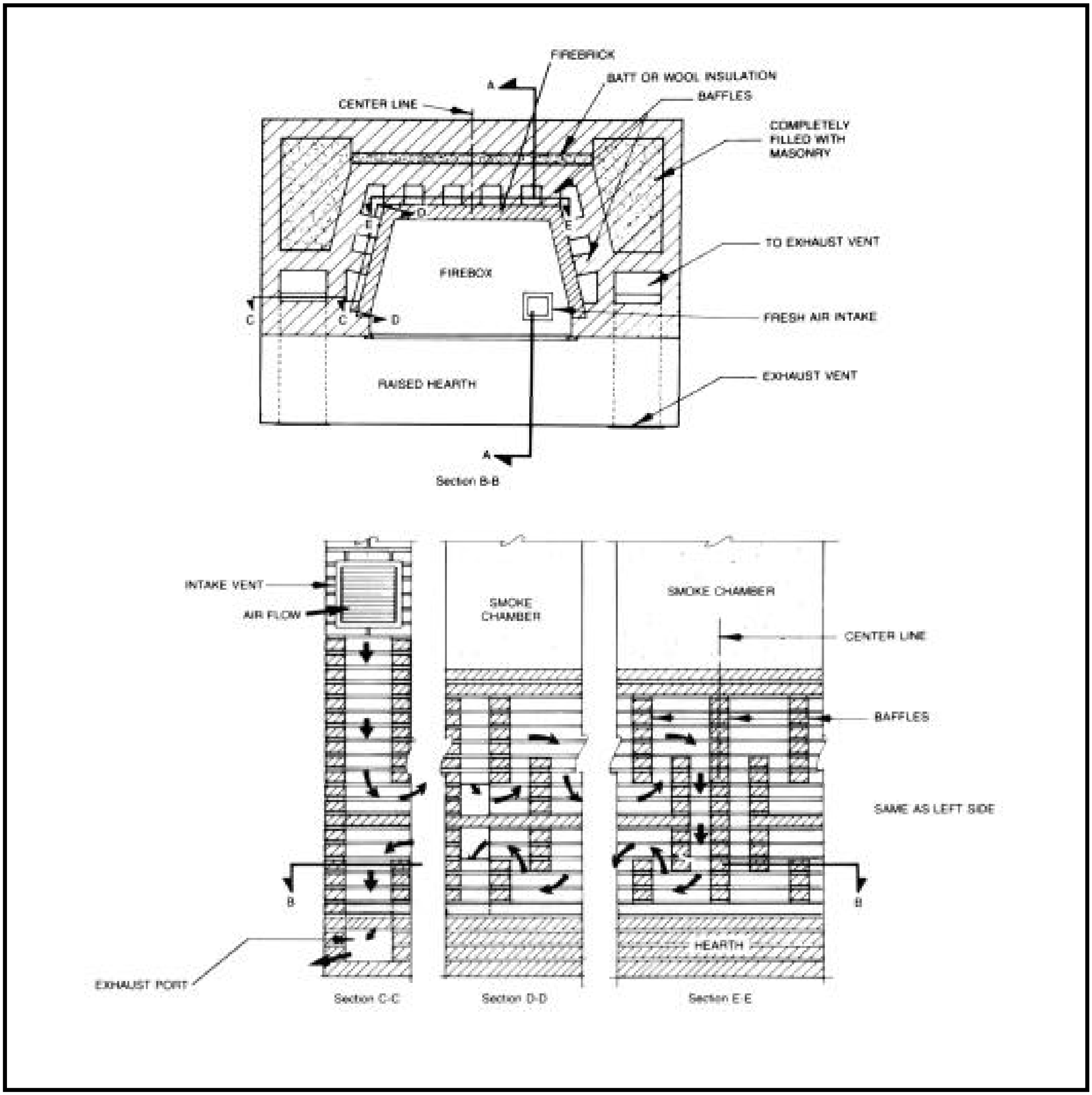
Multi-face fireplaces are usually not as energy efficient as single-face fireplaces, simply because there is less mass surrounding the fire to hold and radiate heat to the room. However, such fireplaces are usually located on the interior of buildings, and a large portion of the stored heat is not lost to the exterior. As is true with all fireplaces, their efficiency can be increased with the proper installation and operation of glass screens and external combustion and draft air. Because of the diversity of the systems, the installation and operation of these energy-efficient features should be in accordance with the recommendations of the manufacturers of the glass screens and external air supply systems.




**Air-Circulating Fireplace (Brick-O-Lator)**
**FIG. 5**

## Projected Corner Fireplaces

The projected corner fireplace, shown in Fig. 6, is similar to a conventional, single-face fireplace with one side removed. Steel angles, supported on a noncombustible post, support the masonry above the opening. The only significant difference between this fireplace design and the conventional single-face fireplace is the shape of the damper. Instead of using a damper with tapered ends, a square-end damper, as shown in Fig. 3, should be used for the projected corner fireplace. The open side of this fireplace should have a short wall to help stop the escape of combustion gases when cross-drafts occur. This protection may be increased by corbeling the top of the short wall. The flanges of the damper should be fully supported on masonry as protection against intense heat. But, as is true with all metal dampers and lintels in any fireplaces, they should not be solidly embedded in the masonry. Otherwise, there will not be any freedom for thermal expansion. Dimensions for typical projected corner fireplaces are provided in Fig. 6.

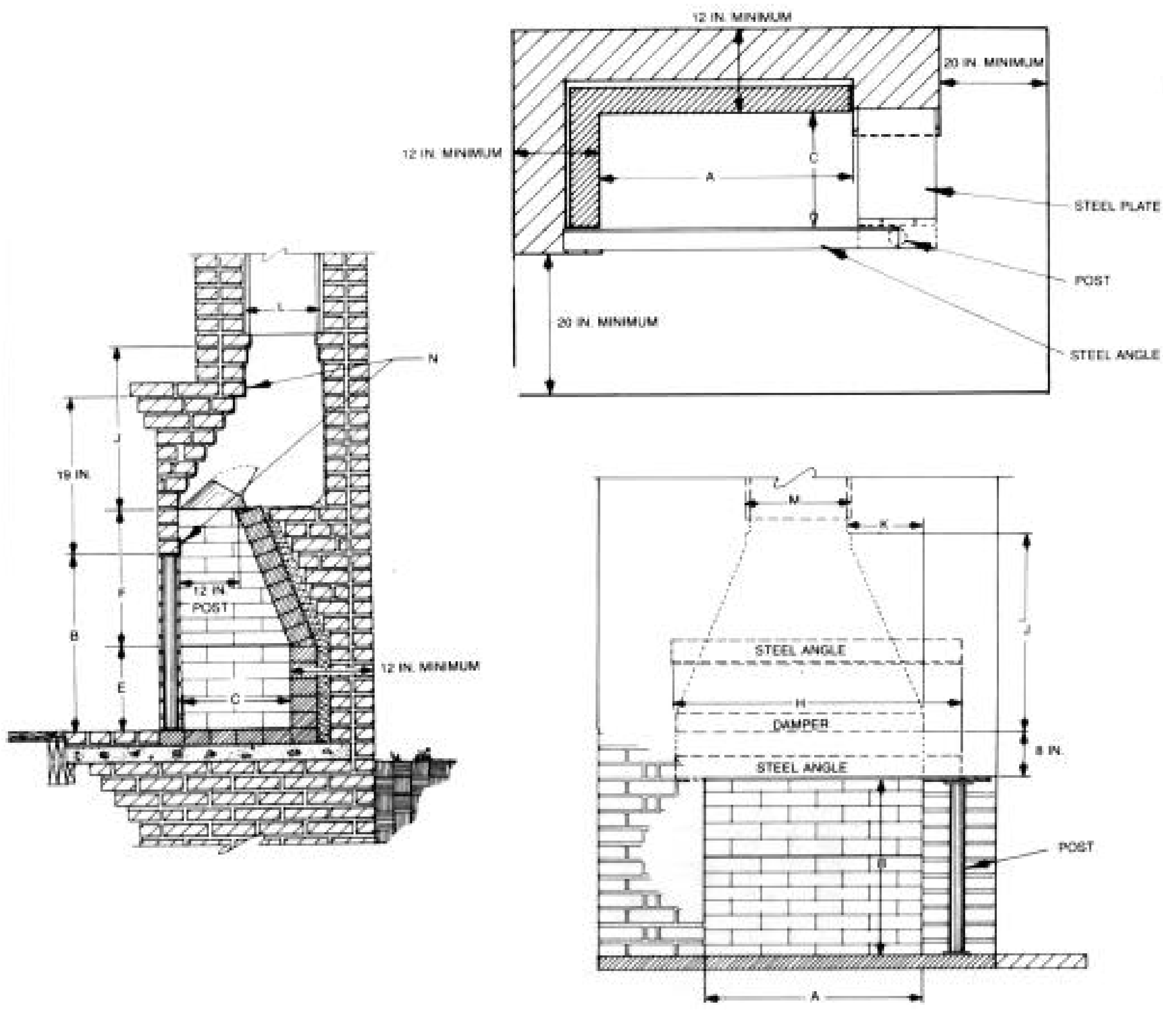



**Air-Circulating Fireplace (Brick-O-Lator)**
**FIG. 5 (continued)**

## Three-Face Fireplaces

**Wide Face.** The three-face fireplace with a wide front face is very similar to the projected corner fireplace, and also uses a square-end damper. The three-face fireplace is shown in Fig. 7, along with a table of typical dimensions. The width of the opening on the front face of this fireplace may range from 28 to 60 in. (700 to 1,500 mm). The sides of the fireplace are partially enclosed by short walls which help to eliminate smoking when there are cross-drafts.

**Narrow Face.** The three-face fireplace with a narrow front face is almost identical to the three-face fireplace with a wide front face. An illustration and table of dimensions for this type of fireplace are provided in Fig. 8. The width of the opening on the front face of this fireplace is maintained at 27 in. (675 mm). There is one major dissimilarity between the wide and narrow three-face fireplaces. The narrow, three-face fireplace requires two square-end dampers because of its narrowness and the distance it projects into the room. Welded angles or a




**Projected Corner Fireplace Dimensions, Inches** [a]

| A | B | C | E | F | H | J | K | L | M | N[b,c] | O[d] | P |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 28 | 26 1/2 | 16 | 14 | 20 | 36 | 29 1/2 | 12 | 12 | 12 | A-36 | 11x16 | 16 |
| 32 | 26 1/2 | 16 | 14 | 20 | 40 | 32 | 12 | 12 | 16 | A-42 | 11x16 | 16 |
| 36 | 26 1/2 | 16 | 14 | 20 | 44 | 35 | 14 | 12 | 16 | A-48 | 11x16 | 16 |
| 40 | 30 | 16 | 14 | 20 | 48 | 35 | 16 | 16 | 16 | B-54 | 11x16 | 16 |
| 48 | 30 | 20 | 14 | 24 | 56 | 43 | 20 | 16 | 16 | B-60 | 11x16 | 20 |
| 54 | 30 | 20 | 14 | 23 | 62 | 45 | 23 | 16 | 16 | B-72 | 11X16 | 20 |
| 60 | 30 | 20 | 14 | 23 | 68 | 51 | 24 | 16 | 20 | B-78 | 11X16 | 20 |

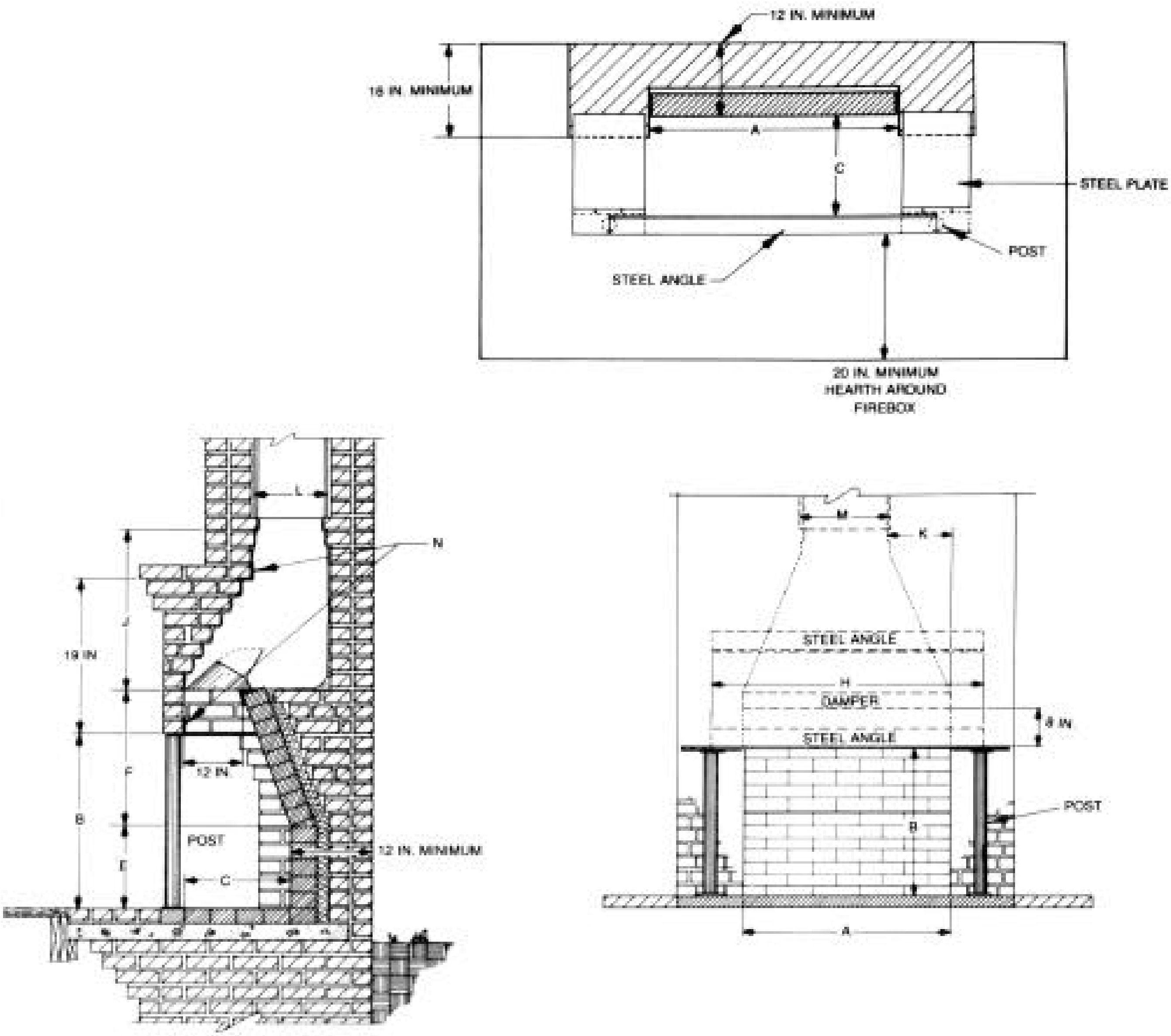
[a] SI Conversion: mm = in. X 25.4 [b] Two required [c] Angle sizes A = 3x3x3/16 in. B = 3 1/2x3x1/4 in. [d] Plate lintel

**Projected Corner Fireplace**
**FIG. 6**

steel tee are needed to support the dampers at the centerline of the fireplace. To allow for expansion, the dampers should not be solidly embedded in mortar nor mechanically fastened to the supporting centerline tee or welded angles.

## Double-Face Fireplaces

The multi-face fireplaces discussed so far can be used at projecting corners of a room to bring the fireplace closer to the center of the room, or to provide a partial

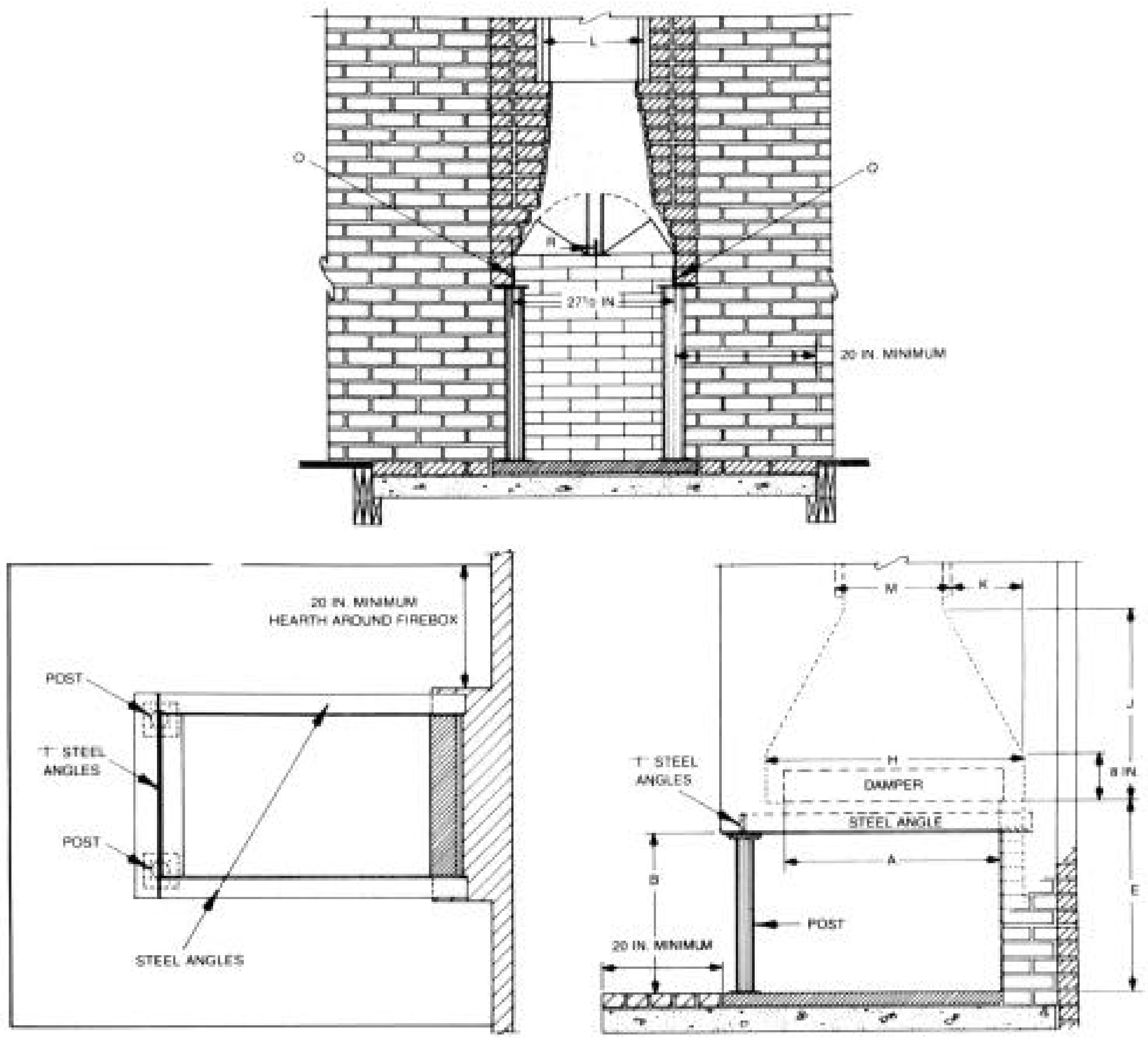



**Three-Opening Fireplace, Wide Face, Dimensions, Inches [a]**

| A | B | C | E | F | H | J | K | L | M | N[b,c] | O[b,d] | P |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 28 | 26 1/2 | 20 | 14 | 18 | 36 | 27 | 12 | 12 | 16 | A-42 | 11x16 | 20 |
| 32 | 26 1/2 | 20 | 14 | 18 | 40 | 32 | 12 | 16 | 16 | A-48 | 11x16 | 20 |
| 36 | 26 1/2 | 20 | 14 | 18 | 44 | 32 | 14 | 16 | 16 | A-48 | 11x16 | 20 |
| 40 | 30 | 20 | 14 | 21 | 48 | 35 | 16 | 16 | 16 | B-54 | 11x16 | 20 |
| 48 | 30 | 20 | 14 | 21 | 56 | 40 | 18 | 16 | 20 | B-60 | 11x16 | 20 |
| 54 | 30 | 20 | 14 | 23 | 62 | 45 | 21 | 16 | 20 | B-72 | 11X16 | 20 |
| 60 | 30 | 20 | 14 | 23 | 68 | 51 | 24 | 16 | 20 | B-78 | 11X16 | 20 |

[a] SI Conversion: mm = in. X 25.4 [b] Two required [c] Steel Angle sizes A = 3x3x3/16 in. B = 3 1/2x3x1/4 in. [d] Plate lintels

**Three-Front Fireplace, Wide Front Face**
**FIG. 7**



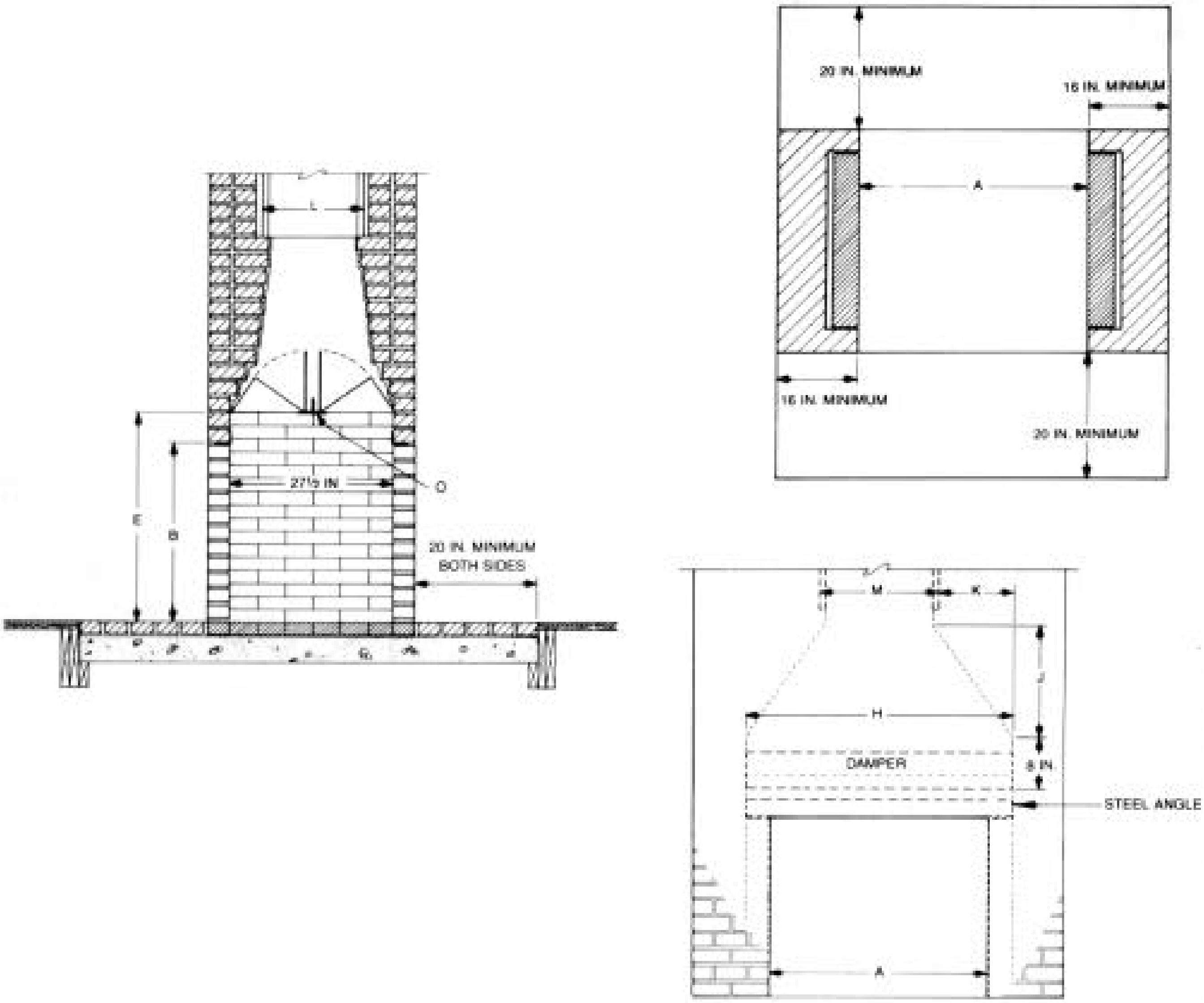

**Three-Opening Fireplace, Narrow Face, Dimensions, Inches [a]**

| A | B | E | H | J | K | L | M | N[b,c] | O[b,d] | R[b,d] |
|---|---|---|---|---|---|---|---|---|---|---|
| 28 | 27 1/2 | 32 | 36 | 24 | 8 | 16 | 20 | A-34 | A-36 | A-35 |
| 32 | 27 1/2 | 32 | 40 | 27 | 10 | 20 | 20 | A-34 | A-40 | A-39 |
| 36 | 27 1/2 | 32 | 44 | 32 | 12 | 20 | 20 | A-34 | A-44 | A-43 |
| 40 | 27 1/2 | 32 | 48 | 35 | 14 | 20 | 20 | A-34 | A-48 | B-47 |
| 48 | 27 1/2 | 32 | 56 | 35 | 16 | 20 | 24 | A-34 | B-56 | B-55 |

[a] SI Conversion: mm = in. X 25.4  [b]Angle sizes A = 3x3x3/16 in. B = 3 1/2x3x1/4 in.  [c]Two angles welded together or steel tee  [d] Two required

**Three-Face Fireplace, Narrow Face**
**FIG. 8**

divider in a room. The double-face fireplace can be used as a room divider, or may even separate two rooms. The double-face fireplace is very similar to the narrow, three-face fireplace. It requires two square-end dampers and fireplace centerline steel tee, or welded steel angles, to support the dampers. The steel tee, or welded angles, should be supported on masonry at both ends, but must be free to move. The dampers are supported on the steel tee or welded angles and the masonry, and must be permitted to move independently of all their supporting members. The double-opening fireplace is shown with a table of dimensions in Fig. 9.




**Double Opening, Dimensions, Inches** [a]

| A | B | E | H | J | K | L | M | N[b,c] | O[b,d] |
|---|---|---|---|---|---|---|---|---|---|
| 28 | 24 | 30 | 36 | 19 | 10 | 12 | 16 | A-36 | A-35 |
| 32 | 30 | 35 | 40 | 21 | 12 | 16 | 16 | A-40 | A-39 |
| 36 | 30 | 35 | 44 | 21 | 12 | 16 | 20 | A-42 | A-43 |
| 40 | 30 | 35 | 48 | 27 | 14 | 16 | 20 | A-48 | A-47 |
| 48 | 30 | 37 | 56 | 32 | 16 | 20 | 20 | A-54 | B-55 |

[a] SI Conversion: mm = in. X 25.4 [b]Steel angle size A = 3x3x3/16 in. B = 3 1/2x3x1/4 in.
[c]Two required [d] Two angles welded together or steel tee

**Two-Face Fireplace**
**FIG. 9**

## SUMMARY

The basic concepts of detailing and construction provided in *Technical Notes* 19 Revised and 19A Revised are applicable to all of the fireplaces discussed in this *Technical Notes*. The information and suggestions contained in this *Technical Notes* are based on empirical data from actual performance of fireplaces and the experience of the technical staff of the Brick Institute of America. The information and recommendations contained herein should produce a functional and energy-efficient fireplace if followed with the use of good technical judgment. Final decisions on the design and use of the dimensions discussed are not within the purview of the Brick Institute of America, and must rest with the project designer, owner or both.

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