



Technical Notes on Brick Construction

19c
REVISED

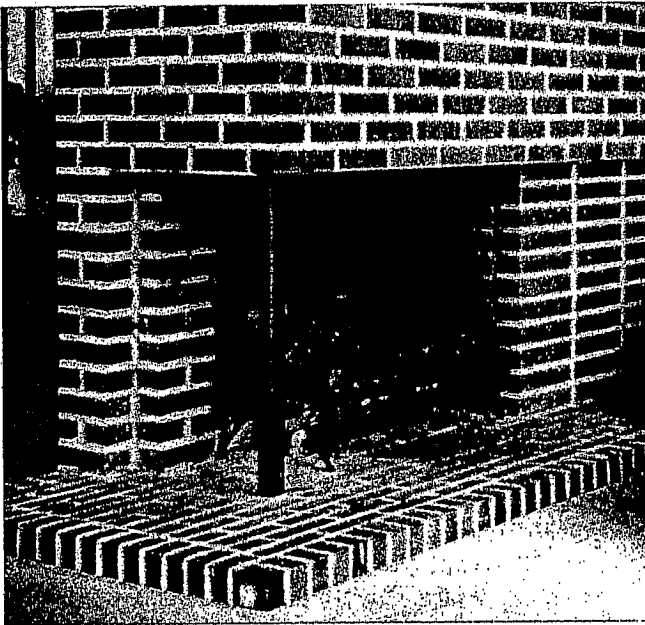
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CONTEMPORARY BRICK MASONRY FIREPLACES

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 fireplaces, 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 fire-

places, 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 of the mechanical heating system. Efficiency today is lower because fireplaces are used while interior temperatures are already comfortable. The major portion of the 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 the 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-Style Fireplaces

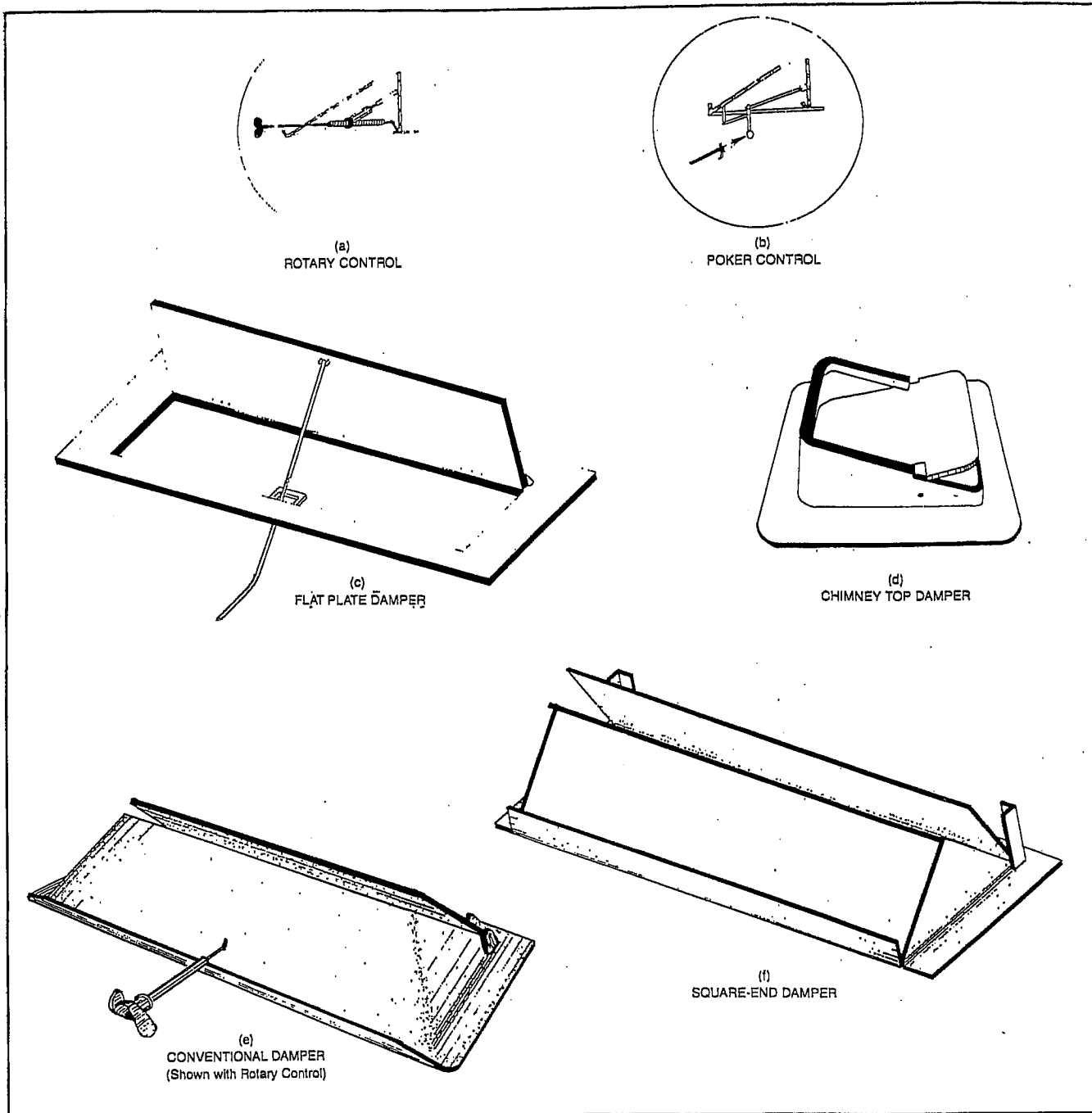
Most of the heat obtained from a brick masonry fireplace is radiant heat. Conventional fireplaces are typically deep, with only slightly flared sides. In this type of fireplace, most of the heat absorbed by the brick is radiated back to the fire or other portions of the firebox. This results in a hotter 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, in conjunction with a rounded throat and straight back, results in what is commonly referred to as a "Rumford fireplace." The curved configuration of the throat creates an airflow similar to that found in a venturi.

Typical dimensions for Rumford-style fireplaces are provided in Fig. 4 and Table 1. These dimensions are not precise, but are based upon successful performance of constructed Rumford fireplaces. Most model building codes require that the depth of the firebox be at least 16 to 20 in. (400 to 500 mm). However, some codes permit the depth of a Rumford fireplace to be as little as 12 in. (300mm), as long as the depth is at least one-third the width of the fireplace opening.

At present, several manufacturers offer prefabricated Rumford fireplace components. These designs incorporate extruded clay elements that form the chimney breast, smoke chamber and other elements of the fireplace. These prefabricated components speed the construction of the fireplace and provide greater quality control.

The Rumford fireplace usually requires either a flat plate throat damper or a chimney top damper, as shown in Fig. 3. 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, and is commercially available. 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. In addition to the flat plate and chimney top dampers, conventional dampers have been successfully used in Rumford-style fireplaces with only slight modifications in the design of the firebox and the smoke chamber.

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



Typical Fireplace Dampers and Damper Controls

FIG. 3

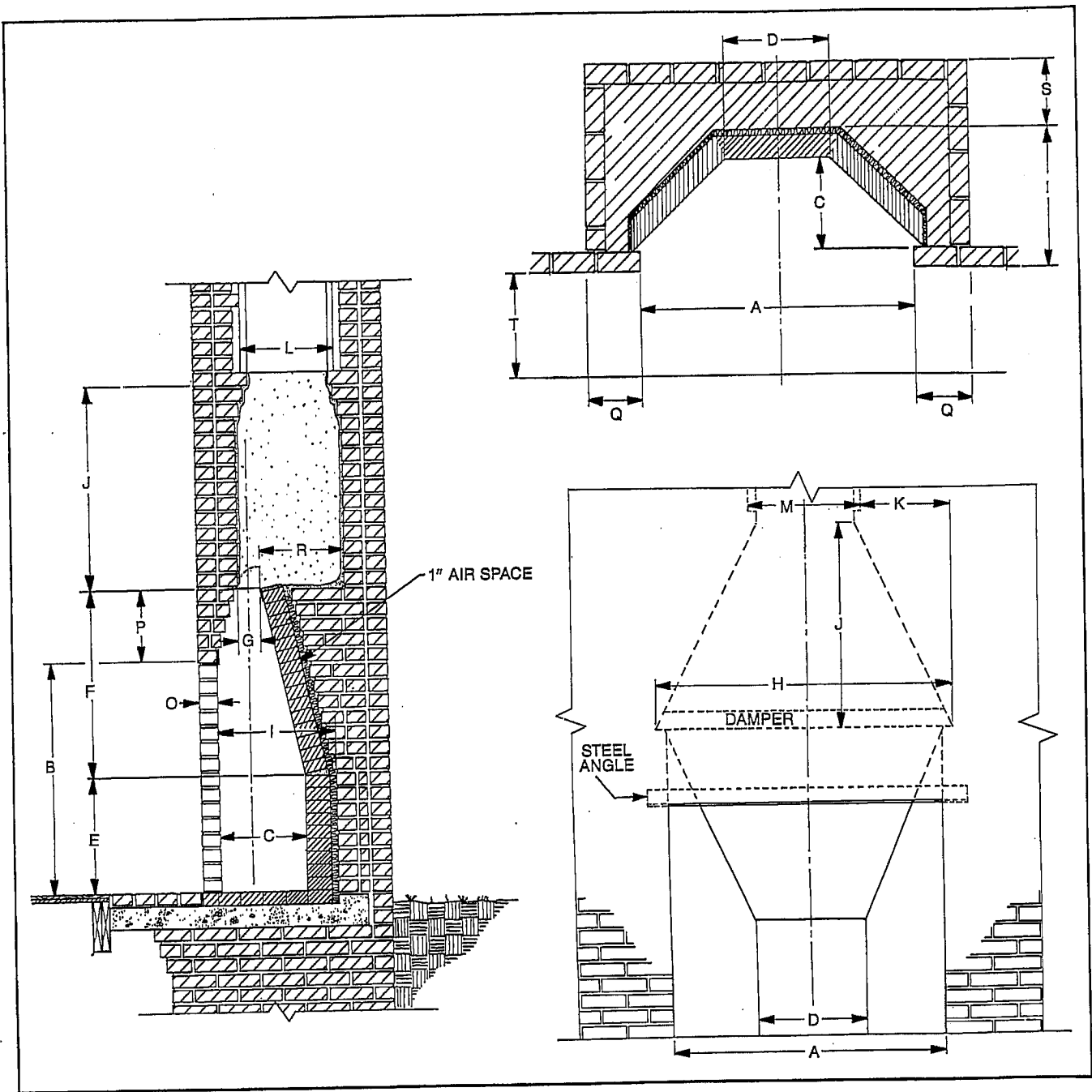
use of other energy-efficient features, such as supplying outside air and using glass screens which should be closed when the fireplace is not in operation.

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



Rumford Fireplace with Clay Flue Liner

FIG. 4

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 take intake air near the ceiling and force the heated air to be exhausted to the room near the floor. 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 in 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-Lator®, General Plans and Details and Construction

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	19½	27	14	12 x 16	A-48	4	12	10
40	32	16	16	16	28	4	48	19½	29	16	16 x 16	A-48	4	12	14
40	37	16	16	16	33	4	48	19½	29	16	16 x 16	A-48	4	12	14
40	40	20	20	20	32	4	48	23½	29	16	16 x 16	A-48	4	12	14
48	37	16	16	16	33	4	56	19½	36	18	16 x 20	B-60	4	12	14
48	40	20	20	20	32	4	56	23½	36	18	16 x 20	B-60	4	12	14
48	48	20	20	20	40	4	56	23½	36	18	20 x 20	B-60	4	12	16
54	40	20	20	20	32	4	66	23½	45	23	20 x 20	B-72	4	12	16
54	48	20	20	20	40	4	66	23½	45	23	20 x 20	B-72	4	12	16
54	54	20	20	20	46	4	66	23½	42	21	20 x 24	B-72	4	12	16
60	48	20	20	20	40	4	72	23½	45	24	20 x 24	B-72	4	12	16

^aThese are approximate dimensions based on historical data of Rumford fireplace construction. As is true with all fireplaces, successful performance is experimental.

^bThese 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 + 3½ in. minimum when fire brick are laid as shiners or C + 5½ 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 (A x B)

- N = A = 3 x 3 x 3/16 in. angle (number denotes length, in.)
B = 3½ x 3 x 1/4 in. angle
- O = Nominal brick thickness
- P = 12 in. minimum
- Q = 8 in. minimum when A x B < 864 in²; 12 in. minimum when A x B ≥ 864 in²
- 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 in²; 20 in. minimum when A x B ≥ 864 in²

^cMinimum dimensions

Information; the Brick Association of North Carolina, now Brick Association of the Carolinas, 8420 University Executive Park Drive, Suite 800, Charlotte, NC 28262; Southern Brick Institute, 1810 Overlake Drive, Suite A, Conyers, GA,) 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

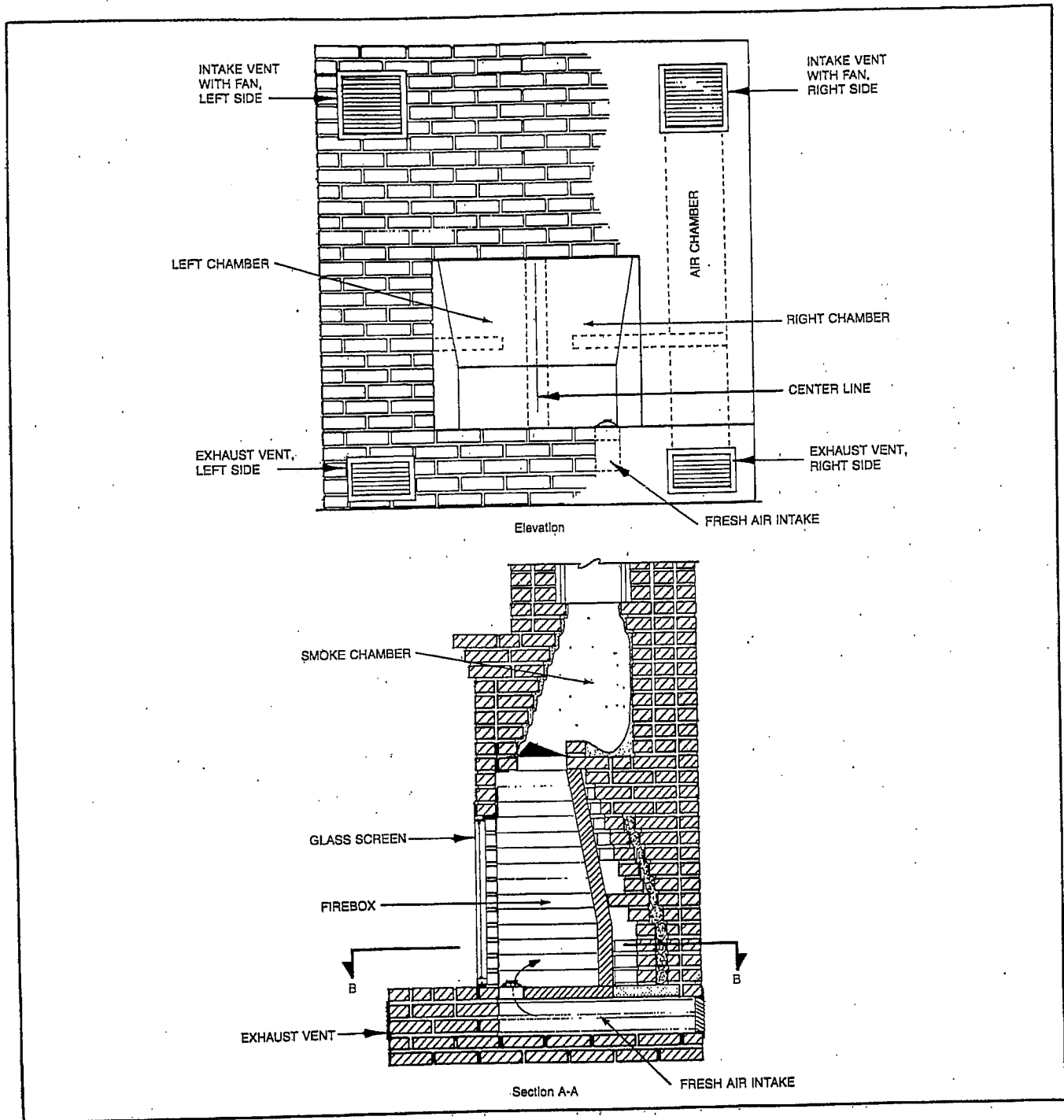
General

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 the building, 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.

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 protec-



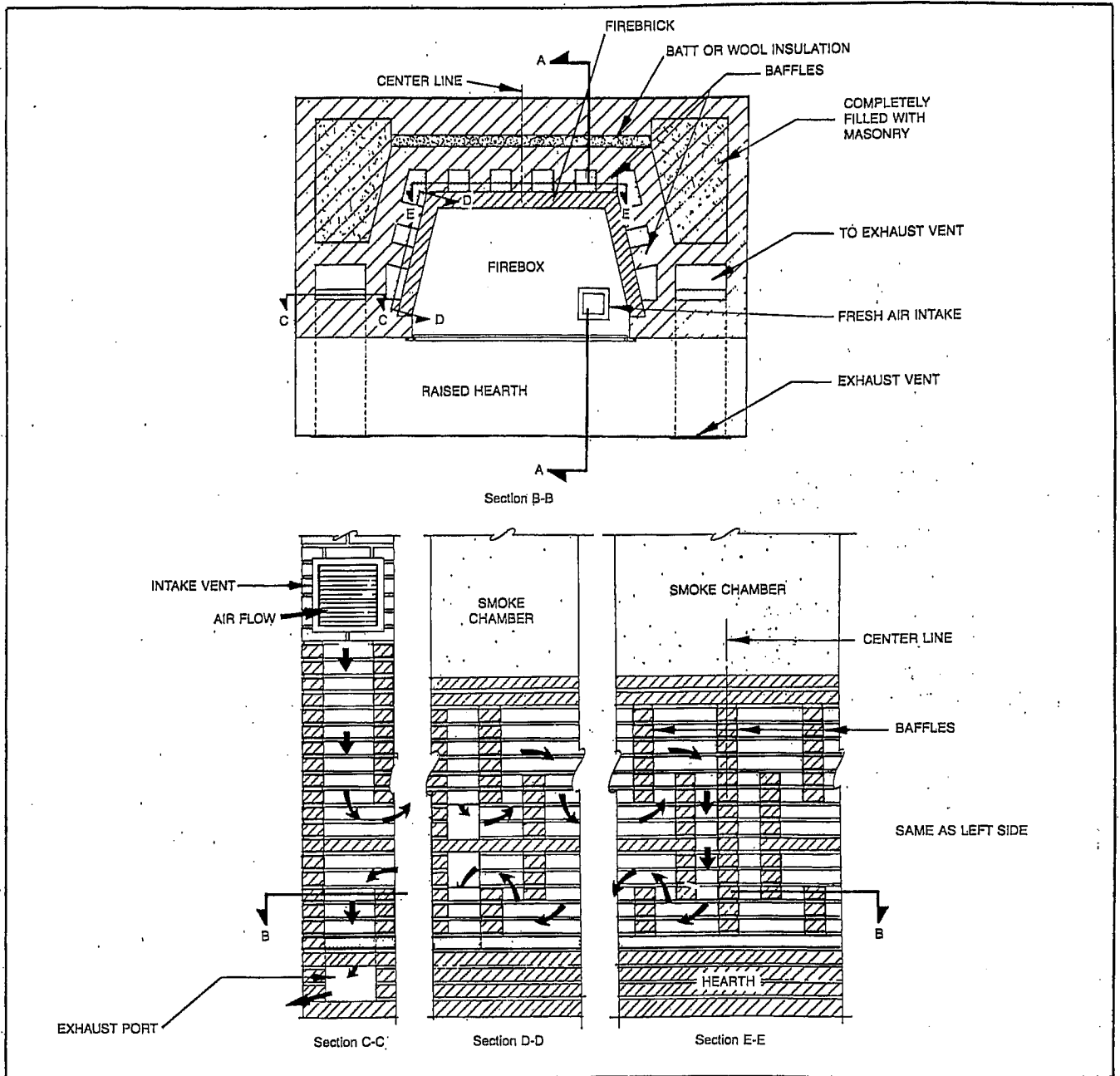
Air-Circulating Fireplace (Brick-O-Lator)

FIG. 5

tion 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 metals dampers and lintels in any fireplace, 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.

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



Air-Circulating Fireplace (Brick-O-Lator)

FIG. 5 (continued)

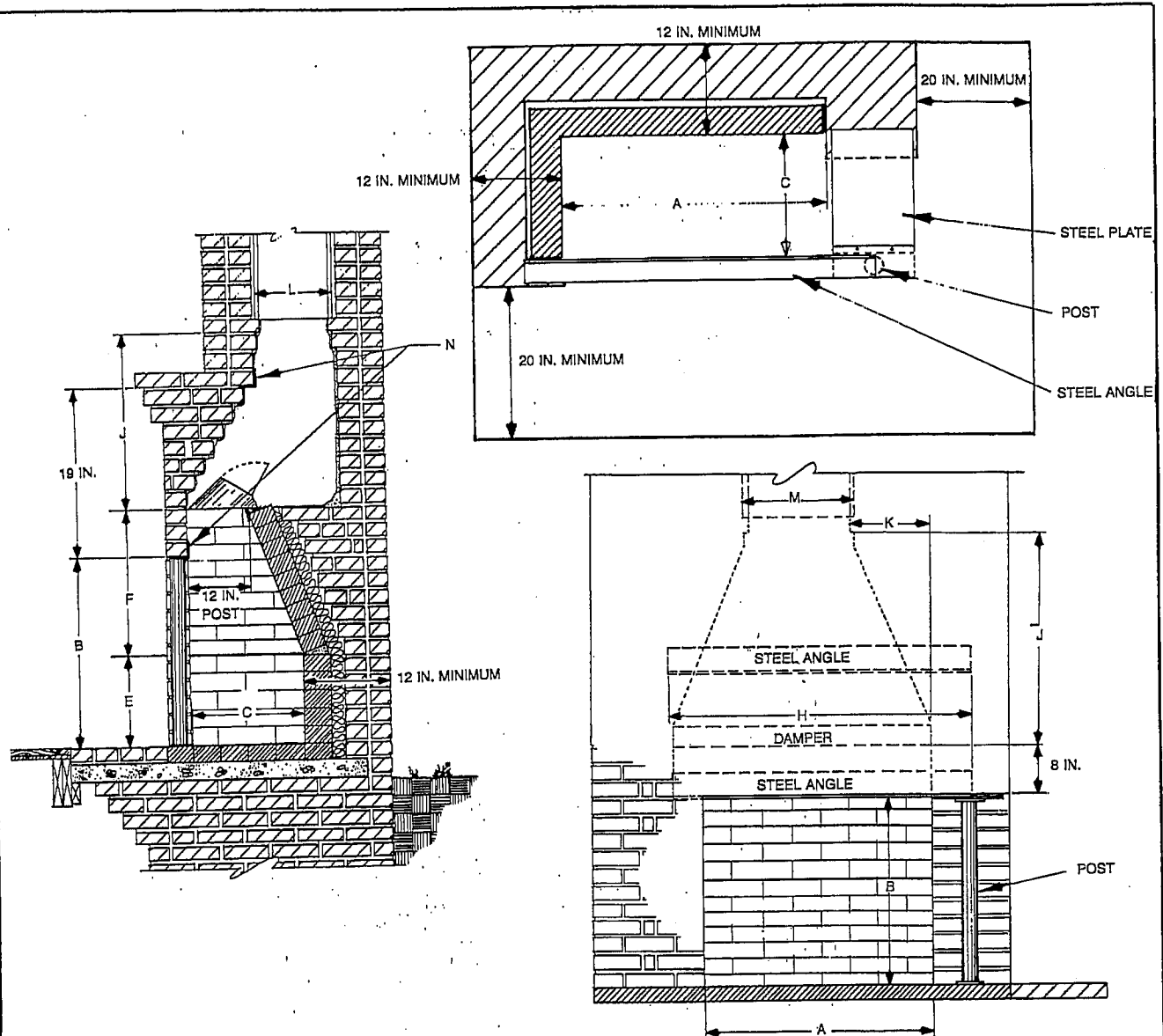
sides of the fireplace are partially enclosed by short walls which help to eliminate smoking when there are cross-drafts.

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. (675mm). There is one major dissimilarity between the wide and narrow three-face fire-

places. 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 steel tee are needed to support the dampers at the centerline of the fireplace. To allow for expansion, the damper 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 fireplaces



Projected Corner Fireplace Dimensions, Inches*

A	B	C	E	F	H	J	K	L	M	N ^{b,c}	O ^d	P
28	26½	16	14	20	36	29½	12	12	12	A-36	11 × 16	16
32	26½	16	14	20	40	32	12	12	16	A-42	11 × 16	16
36	26½	16	14	20	44	35	14	12	16	A-48	11 × 16	16
40	30	16	14	20	48	35	16	16	16	B-54	11 × 16	16
48	30	20	14	24	56	43	20	16	16	B-60	11 × 16	20
54	30	20	14	23	62	45	23	16	16	B-72	11 × 16	20
60	30	20	14	23	68	51	24	16	20	B-78	11 × 16	20

*SI conversion: mm = in. × 25.4

^bTwo required

^cAngle sizes A = 3 × 3 × ¼ in. B = 3½ × 3 × ¼ in.

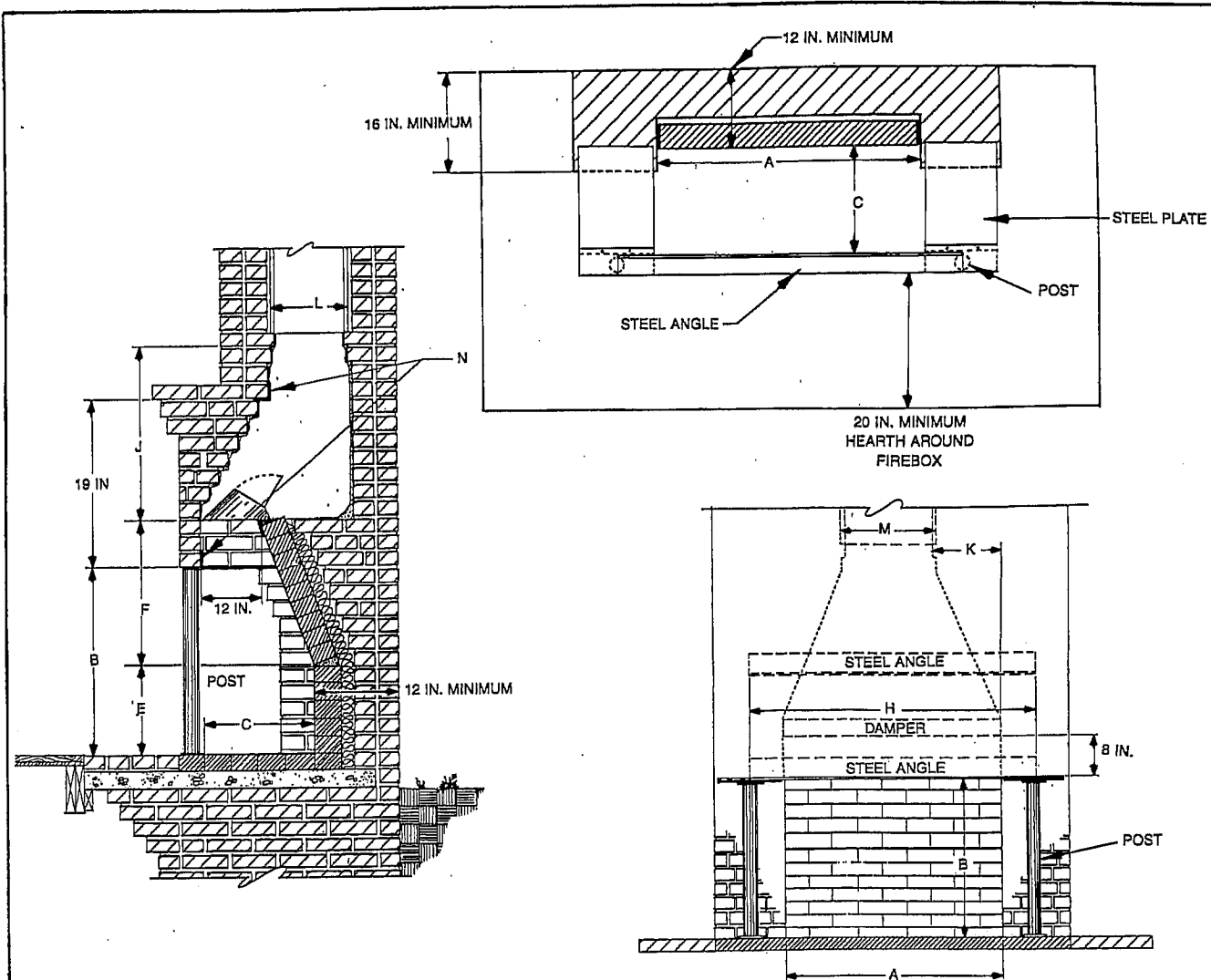
^dPlate lintel

Projected Corner Fireplace

FIG. 6

closer to the center of the room, or to provide a partial 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



Three-Opening Fireplace, Wide Face, Dimensions, Inches*

A	B	C	E	F	H	J	K	L	M	N ^{b,c}	O ^{b,d}	P
28	26½	20	14	18	36	27	12	12	16	A-42	11 × 16	20
32	26½	20	14	18	40	32	12	16	16	A-48	11 × 16	20
36	26½	20	14	18	44	32	14	16	16	A-48	11 × 16	20
40	30	20	14	21	48	35	16	16	16	B-54	11 × 16	20
48	30	20	14	21	56	40	18	16	20	B-60	11 × 16	20
54	30	20	14	23	62	45	21	16	20	B-72	11 × 16	20
60	30	20	14	23	68	51	24	16	20	B-78	11 × 16	20

*SI Conversion: mm = in. × 25.4

^bTwo required

^cSteel angle sizes A = 3 × 3 × ⅜ in. B = 3½ × 3 × ¼ in.

^dPlate lintels

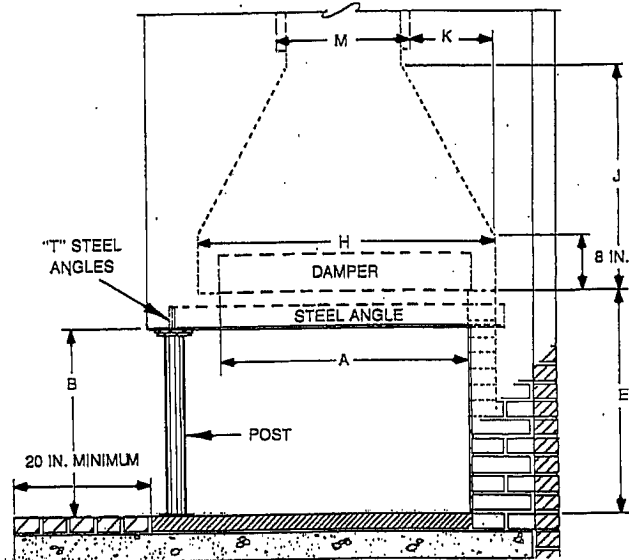
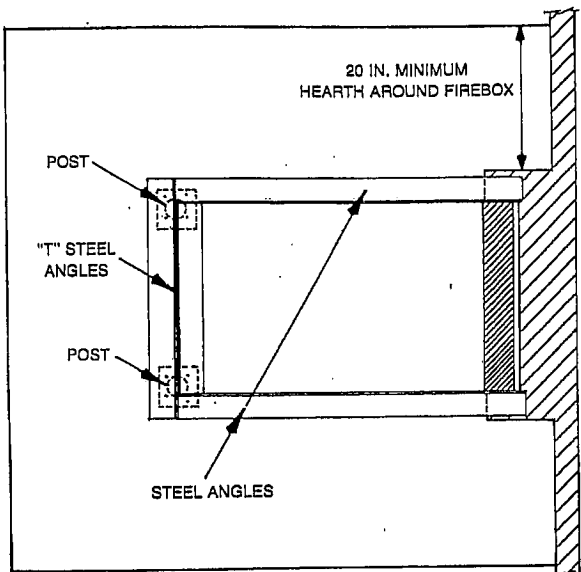
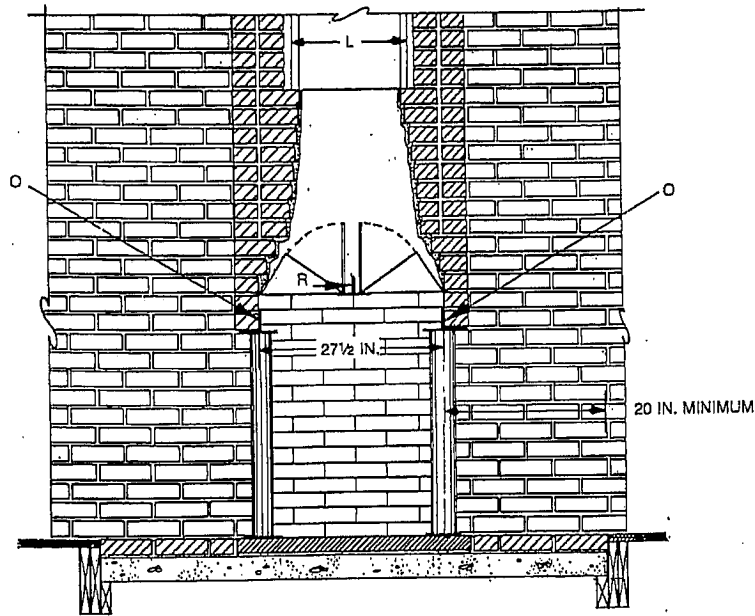
Three-Face Fireplace, Wide Front Face

FIG. 7

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 the available data and the experience of the engineering staff of the

Brick Industry Association. The information contained herein must be used in conjunction with good technical judgement and a basic understanding of the properties of brick masonry. Final decisions on the use of the information contained in this *Technical Notes* are not within the purview of the Brick Industry Association and must rest with the project architect, engineer and owner.



Three-Opening Fireplace, Narrow Face, Dimension, Inches^a

A	B	E	H	J	K	L	M	N ^{b,c}	O ^{b,d}	R ^{b,d}
28	27½	32	36	24	8	16	20	A-34	A-36	A-35
32	27½	32	40	27	10	20	20	A-34	A-40	A-39
36	27½	32	44	32	12	20	20	A-34	A-44	A-43
40	27½	32	48	35	14	20	20	A-34	A-48	A-47
48	27½	32	56	35	16	20	24	A-34	B-56	B-55

^aSI conversion: mm = in. × 25.4 ^bAngle sizes A = 3 × 3 × ¼ in. B = 3½ × 3 × ¼ in. ^cTwo angles welded together or steel tee ^dTwo required

Three-Face Fireplace, Narrow Face

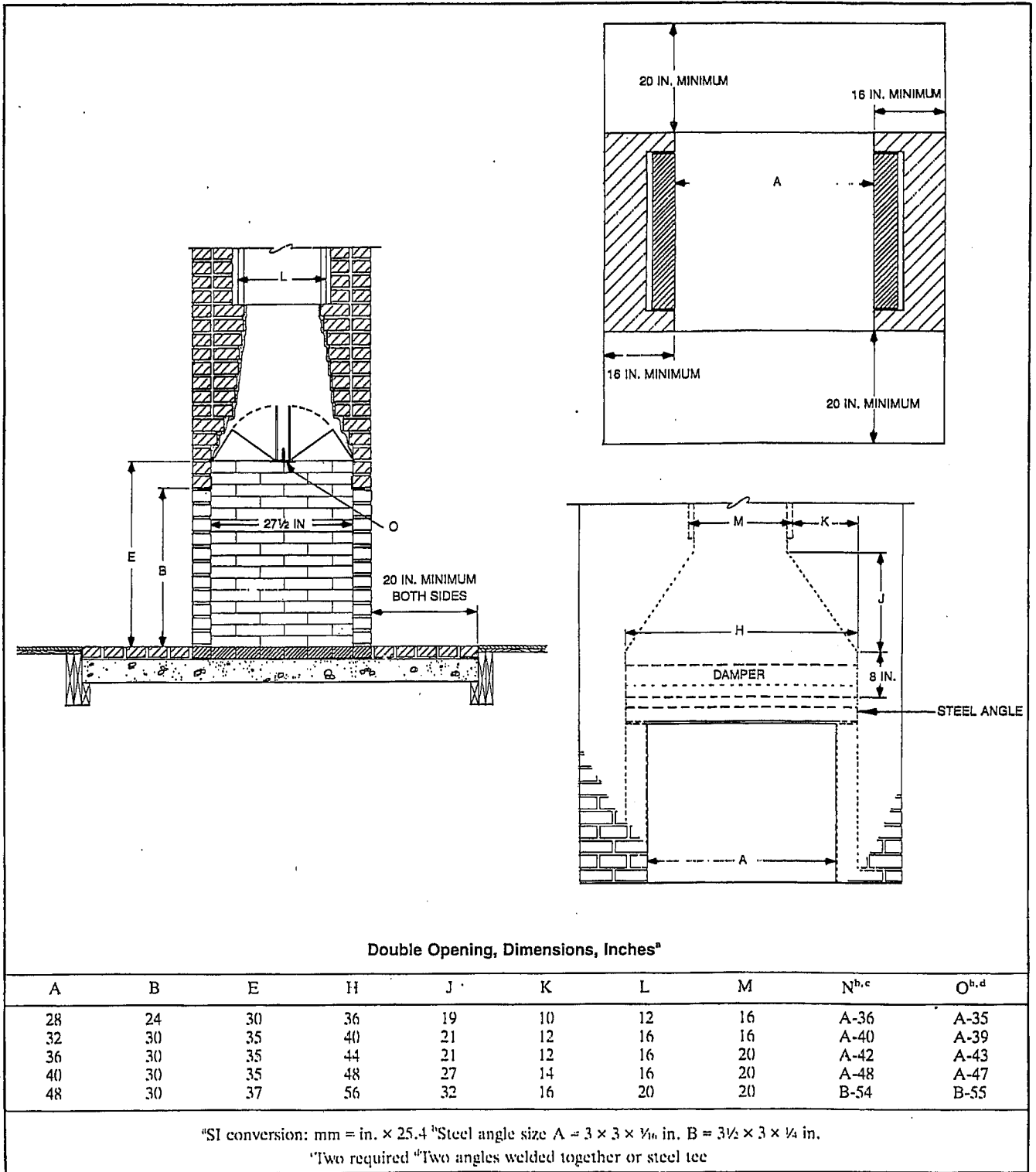
FIG. 8

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Two-Face Fireplace

FIG. 9