Fig. 4

Fig. 3

INVENTORS.
ROBERT RAYMOND PIERCE
DONALD JOSEPH KOSSLER

BY Emil W. Milan
ATTORNEY
This invention relates to the chimney constructing art. Particularly, it relates to an improved chimney structure, especially useful for the building of industrial and institutional chimneys where coal and oil are burned as fuels. More particularly, the invention relates to a corrosion-proof liner for the interior wall of the outer structure of the chimney, which usually is made of poured concrete but which may be steel, brick, stone or other similarly used material.

Chimneys for use in industrial and institutional applications are, as is well known, large to gigantic in size. For example, they may be from ten to over one hundred feet in external diameter and from 75 to 1,500 feet in height, or higher. The products of combustion which pass up the chimney in order to escape into the atmosphere consist of warm to hot, acid-laden gases containing dilute to concentrated acids, such as, hydrochloric, sulfuric and nitric acids, as well as acid salts. The chimney is further subject to pressure and temperature change conditions, as well as to mechanical forces existing from the structure itself, and to the effects of winds on the chimney.

A typical industrial or institutional chimney is constructed with an inner lining of brick which generally is of an acid-resistant type. Surrounding the exterior of the brick, there may be an air gap for insulation purposes, then a layer of protective coating, usually asphaltic in composition, which is applied to the inner surface of the principal outer structure. The inner structure of the wall may be reinforced with iron or steel reinforcing rods and may contain, as part of the design, corbel shelves, which serve to support some of the weight of the brick inner lining.

The brick structure inside the chimney is held together by acid- and sulfation-resisting mortar. However, despite the care with which the brick work is made, it is still hot, acid-laden, corrosive action, which may cause the mortar to crack, crumble, and otherwise deteriorate. The linings, being located inside the chimney, are subject to the same forces as the outer structure, but in reduced form. This is particularly so with respect to temperature change and mechanical forces, since the outer structure is in a sense an extension of the chimney. In addition, the outer structure is usually built of brick, and this may contribute further to the deterioration of the mortar in the brick structure.

In order to prevent the deterioration of the brick structure, and to provide a long-lived positive barrier to the passage of weak to very strong acids, at temperatures up to about 300°F. and under chimney flue gas pressures, from the outer wall of the brick to the inner wall of the outer structure. The new chimney liner of our invention comprises an impervious layer of acid-resistant fluorocarbon plastic membrane material, interposed between an outer and an inner layer of flexible corrosion-resistant mastic material, preferably of the trowelable type. The mastic material has been combined with the fluorocarbon plastic membrane, as described herein, that the objective of complete corrosion-proof impermeability has been attained.

The invention is illustrated by the accompanying drawings. In each figure, the same members correspond to the same members. In the drawing, Figure 1 is a diagrammatically drawn cross-section of the layers of materials comprising a fragment of a typical chimney structure in combination with the impervious chimney liner of the invention, embodying a spirally applied fluorocarbon plastic membrane.

Figure 2 is another diagrammatically drawn cross-section of an embodiment showing in further detail a fragment of a chimney structure in which there is present a corbel shelf protected with the impervious chimney liner.

Figure 3 is an expanded fragment of an exploded view of the impervious chimney liner.

Figure 4 is an embodiment of the invention in which the impervious chimney liner is constructed with the fluorocarbon plastic membrane applied in vertically lapped strips.

In constructing a chimney according to the embodiment shown in Figure 1, an outside concrete wall 1 is poured first and allowed to set. A layer of mastic material 2 is then trowelled on the inner wall of the concrete structure 1, completely covering the inner wall from the bottom to the top of the concrete structure with a layer of mastic about 1/16 inch to 1/4 inch in thickness, preferably, about 1/8 inch layer of mastic. A layer of acid-resistant, impervious fluorocarbon plastic membrane material 3, preferably polyvinylidene fluoride in the form of a sheet of convenient width and of continuous length at least sufficient to cover the inside circumference of the concrete wall 1 with an overlap, is firmly pressed and sealedly adhered against the freshly applied tacky mastic material 2, beginning at the lowest part of the chimney. The membrane material 3, preferably provided in the form of a continuous roll, is placed against the mastic material 2 and is unrolled against the wall spirally, much as a bandage is applied, allowing one to three inches of overlap on each turn around the inner circumference.

As the fluorocarbon plastic membrane material 3 is unfurling against the mastic 2, a second layer of mastic material 4 is unfurling by trowel or spraying, or other method, to cover and completely seal the membrane material 3. This second layer of mastic also serves to hold the membrane in place and thus helps to support it from vertical and lateral displacement. The membrane material 3 preferably is overlapped on itself on each turn with mastic 4 placed between the layers of membrane in the lap itself. Next, a layer of insulation material 5, for example, glass fiber insulation board, is applied directly against the layer of mastic 4. A layer of insulation material 5 should be of sufficient thickness to keep the temperature of the mastic 4 below its flow point, which when asphalactic cement, is about 230°F.-300°F.

Brick 7 is next installed in the chimney to form the inside of the chimney itself. An insulating air space 6 preferably is used to separate the brick from the other insulat-
ing material. The brick is cemented together with a sulfation- and acid-resistant mortar. In FIGURE 2 is shown a corbel shelf 9, which supports the membrane structure 2, 3, 4, the insulation 5, and the brick 7. In this embodiment, asbestos 10, or other acid resistant material, is packed as a dust barrier in the space between overhangs of the brick. As is shown in the drawings, the membrane structures 2, 3, 4 covers all portions of the inner wall of the concrete structure 1, including the corbel shelf.

FIGURE 3 further shows the membrane material 3 in relation to the first layer of mastic 2 and the second layer of mastic 4. From FIGURE 3, it is seen that the chimney liner consists essentially of a sheetlike layer of acid-resistant flexible fluorocarbon plastic membrane material 3 embedded in mastic material 2 and 4.

FIGURE 4 shows a chimney wherein the fluorocarbon plastic membrane material 3 has been applied in vertical strips. The overlap preferably is sealed with the same mastic material 2 as that used on the inner and outer surfaces of the membrane. However, the overlap 2, 4, is sealed with an adhesive, e.g., a solvent-type adhesive for the fluorocarbon material. Also, in FIGURE 4, the insulation used is an air space 6, insulating material, such as that used at 5 in FIGURES 1 and 3, being absent.

The completely coated fluorocarbon plastic membrane material 3 serves as a complete barrier to the passage of corrosive materials from the inside of the brick chimney structure, so that corrosion damage of the concrete wall 1 is prevented. In contrast to the asphalctic barriers used in the past, the barrier of this invention has been found to withstand prolonged exposure to sulfuric acid vapors in strengths from weak to 95%, hydrochloric acid in strengths up to 37%, and nitric acid in strengths to 5% under varying temperatures and stress conditions. These concentrations of these acids exceed the usually encountered strengths of these acids normally found in the flue gases in chimneys.

The fluorocarbon plastic membrane material used as the inner membrane of the barrier may be polyvinylidene fluoride, polytetrafluoroethylene, or other fluorocarbon- or chlorofluorocarbon-derived polymeric or copolymeric material having toughness, flexibility, chemical resistance, impermeability and thermal stability, and other substantially similar properties possessed by the two typical polyfluorocarbon polymer materials specifically named above. The membrane film, or sheet, 3 preferably has a thickness of from about 2 to about 30 mils, with a thickness of 4 mils to 10 mils being especially preferred for use in the invention. The fluorocarbon plastic material must be stable at high temperatures, preferably to at least 300° F. It must maintain an air-entrained chimney building material under year-round weather conditions in at least temperate climates, so that it can be readily applied to the mastic material. The surfaces of the membrane material 3 preferably are smooth, but can be corrugated, ribbed, embossed or roughened to provide a better non-slippery surface for contact with the mastic material 2 or 4.

The corrosion-proof membrane 3 of this invention provides strength to the chimney liner 2, 3, 4 during movement of the concrete 1 during contraction, expansion, and temperature and wind flexing of the chimney wall 1, without disrupting the impervious barrier properties of the structure.

While in the drawing the outer wall of the chimney has been shown as a concrete embodiment, it is to be understood that a steel wall, or brick outer wall could also be used and be similarly lined with the corrosion-proof fluorocarbon plastic membrane liner of this invention. Also, while the corrosion-proof membrane 3, FIGURES 1 and 2, is placed directly against the inner surface of the concrete structure 1, with insulating material 5 placed directly against the inner wall of the mastic 4, it is to be understood that in some chimney structure designs, it will be preferable to eliminate the insulating material 5, leaving a larger air space 6 between the brick 7 and the mastic outer surface 4, substantially as shown in FIGURE 4. This embodiment is advantageously used in low temperature stacks or chimneys of large diameter, where the expense of insulation can be eliminated. In such embodiments, an air space of 3 to 36 inches is advantageous. Also, while the insulation material 5 in the embodiment of FIGURE 1 and 2 preferably is a board form of fibrous glass material, it is also advantageous to use glass insulation blocks or bricks, or glass wool blocks or batts, or asbestos blocks, or batts, or asbestos cement, or other insulating material similarly used for insulation purposes.

The bottom foundation and the inside brickwork of the chimney and furnace foundations, in those areas where the temperatures do not rise above about 230° F., also can be protected with the corrosion-proof chimney liner of this invention in the manner described above.

The mastic material 2 and 4 preferably is an acid-resisting fibrous asphaltic cement material which can be sold applied with a trowel; or hot-mopped asphalt is applied by any other method known to the art. The asphaltic material preferably has a softening point of about 230° F. by the ring and ball test method and a flash point of about 316° C.

The term mastic as used herein is used broadly to describe any materials used as capping or adhesive cements, more particularly asphalt cements. See, for example, Kirk-Othmer "Encyclopedia of Chemical Technology," vol. 2, page 794 (2nd ed., 1963). However, the term mastic is intended also to include asphaltic cements modified with inorganic or organic synthetic polymers, e.g., silicone polymers, having a flow point of at least 230° F. It is also intended to include such polymers when they are completely substituted for the asphaltic cement. An important purpose of the mastic is to serve as a means to adhere the fluorocarbon plastic membrane 3 to the inner surface of the outer wall of the chimney 1 and further to seal the overlaps in the membrane 3. An added advantage of coating the inner surface of the membrane with the second layer of mastic 4 is that the mastic 4 serves then also to support the membrane 3 vertically as well as to hold it firmly against the first layer of mastic 2.

The type of brick 7 which is used as the inner lining of the chimney preferably is an acid-resisting brick of the type described under ASTM Standard C 279-54, Type H or L.

In FIGURE 1, the fluorocarbon plastic membrane material 3 is shown to be spirally applied with an overlap as it is adhered from the bottom of the chimney upwards against the first mastic layer 2. However, the membrane material can also be applied in the form of individual sections, i.e., rectangles or squares, which can be suitably overlapped in a shingle-like manner to permit condensation to drain downward in the chimney; the second layer of mastic 4 is then applied over the membrane 3. The area of overlap between the mastic material 2, 4 is sealed with mastic to further ensure a tightly sealed joint. In some cases, e.g., when the membrane is polyvinylidene fluoride, the overlaps can be heat-sealed to form a strong self-supported membrane. The polyvinylidene fluoride also can be applied by spraying the melted plastic onto the mastic 2.

When the fluorocarbon plastic membrane material 3 is applied in vertical strips as shown in FIGURE 4, the strips are preferably run continuously from the top to the bottom of the inner surface of the outer wall 1 and are overlapped much as one would apply wallpaper to a wall, thus forming a vapor and gas tight chimney liner in combination with the first and the second layers of mastic.

In most applications a single layer of membrane material is adequate to effectively seal and protect the outer wall 1 from attack by corrosive materials. However, in
5 some chimneys where especially corrosive flue gases will be encountered, it may be desirable to use more than one layer of membrane. In such application, the second layer of membrane preferably is applied on the inner surface of the second fresh, tacky layer of mastic, i.e., the surface closest to the brick, and a third layer of mastic is then applied.

Many different embodiments of this invention may be made without departing from the scope and spirit of it, and it is to be understood that our invention includes also such embodiments and is not limited by the above description.

We claim:

1. In a chimney having an outer wall with an inner and outer surface, an interior wall of brick having an inner and outer surface, the inner surface of said brick wall being designed to carry corrosive flue gases upwards to the atmosphere, the inner surface of said outer wall and the outer surface of said brick wall being separated an insulating distance from each other, the improvement which comprises a corrosion-proof, vapor-impervious chimney liner sealingly applied to the inner surface of said outer wall, said chimney liner essentially consisting of a first layer of mastic material sealingly adhered to said inner surface of said outer wall, at least one sheet-like layer of impervious fluorocarbon plastic membrane material adhered on one surface against the exposed surface of said first layer of mastic, a second layer of mastic sealingly adhered on the opposite surface of the membrane material, said mastic material substantially completely covering said membrane material.

2. The chimney according to claim 1 wherein a layer of insulating material is included in the space between the second layer of mastic and the outer surface of the brick wall.

3. The chimney according to claim 2 in which an air insulation space is present between the inner surface of the insulating material facing the outer surface of the brick wall and said outer surface of the brick wall.

4. The chimney according to claim 1 wherein the fluorocarbon plastic membrane material is a polyvinylidene fluoride polymer.

5. The chimney according to claim 1 wherein the fluorocarbon plastic membrane material is a polytetrafluoroethylene polymer.

6. The chimney according to claim 1 wherein the membrane material is in the form of a substantially continuous strip of film of about 2 to 30 mils in thickness applied to said first layer of mastic material spirally upwards with an overlap starting from the bottom and continuing to the top of the chimney.

7. The chimney according to claim 6 in which the membrane material is 4 to 10 mils in thickness.

8. Chimney liner consisting essentially of impervious fluorocarbon plastic membrane material in sheetform embedded in asphaltic mastic material.

9. The chimney liner according to claim 8 wherein the fluorocarbon plastic is polyvinylidene fluoride polymer.

10. The chimney liner according to claim 8 wherein the fluorocarbon plastic is polytetrafluoroethylene polymer.

11. The chimney liner according to claim 1 wherein the membrane material is in the form of overlapped vertical strips of film of about 2 to 30 mils in thickness extending from the top to the bottom of the inner surface of said outer wall.

12. The chimney liner according to claim 1 wherein the mastic material is an asphaltic cement having a flow point of at least 230° F.

13. The chimney liner according to claim 1 wherein the mastic material is a synthetic polymeric material having a flow point of at least 230° F.

References Cited

UNITED STATES PATENTS

774,545 11/1904 Wills ------------------ 52—411
1,478,875 12/1923 Ludwig ------------ 110—184 X
2,120,309 6/1938 Carson -------------- 110—184

FRANK L. ABBOTT, Primary Examiner.
JAMES L. RIDGILL, JR., Examiner.