United States Patent

Lawrence, deceased

[15] **3,669,042**

[45] **June 13, 1972**

[54] **SECTIONALIZED STACK WITH CIRCUMFERENTIAL AND RADIAL EXPANSION MEANS**

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[22] Filed: **April 10, 1970**

[21] Appl. No.: **27,355**

[52] **U.S. Cl.** **110/184,** 98/48, 98/60

[51] **Int. Cl.** **F23j 11/00**

[58] **Field of Search** 110/184; 98/46, 60; 126/307

[56] **References Cited**

UNITED STATES PATENTS

3,363,591 1/1968 Lawrence 110/184

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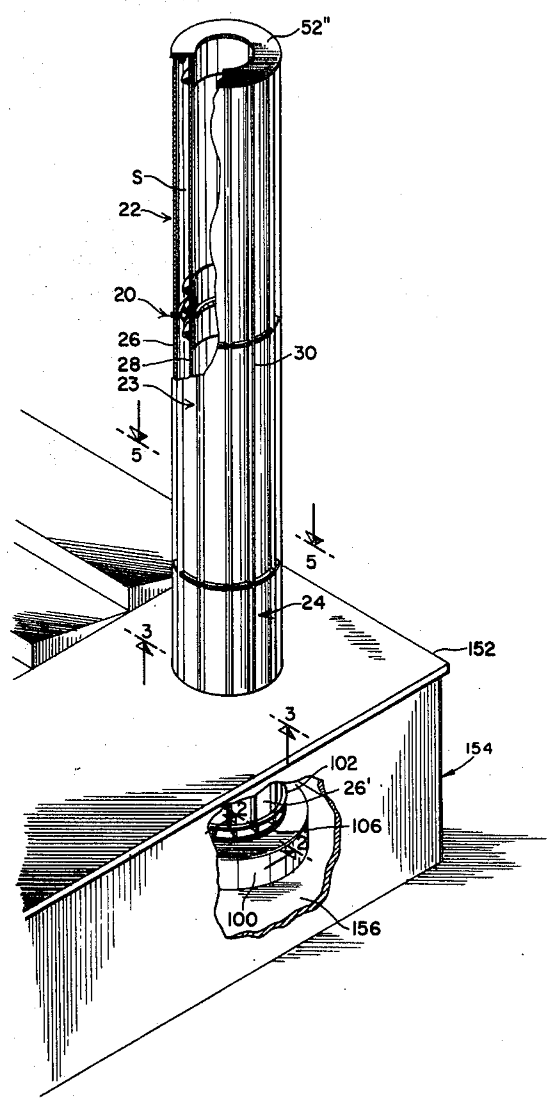
Attorney—Kelman and Berman (agents)

[57] **ABSTRACT**

A smokestack has axially aligned tubular sections. Each section has concentric inner and outer walls. Accordion-like circumferential flanges on the inner wall of each section permit relative axial expansion and contraction of the walls. Other accordion-like circumferential flanges between the inner and outer walls permit relative radial and circumferential expansion and contraction of the walls. Dynamic vibration absorbers are provided at the base of the smokestack. The sections are reinforced by flexible internal braces located in the air space between the inner and outer walls, and secured to the circumferential flanges.

8 Claims, 14 Drawing Figures



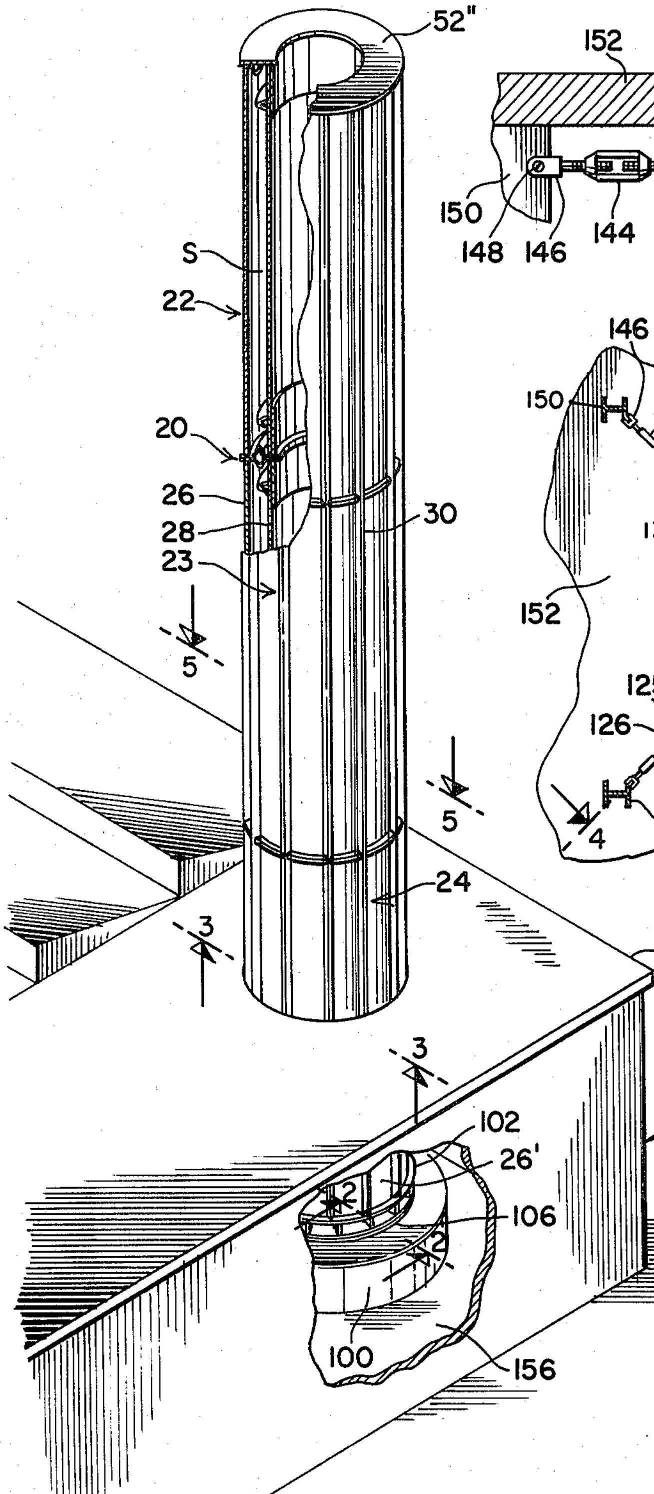


FIG. 1.

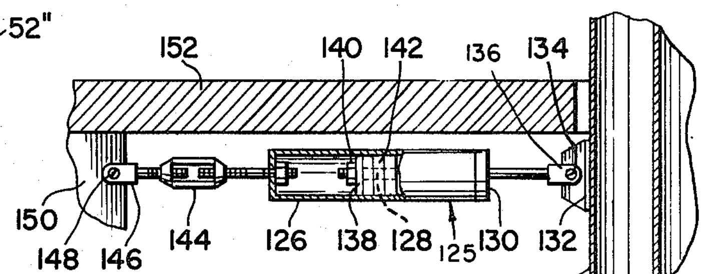


FIG. 4.

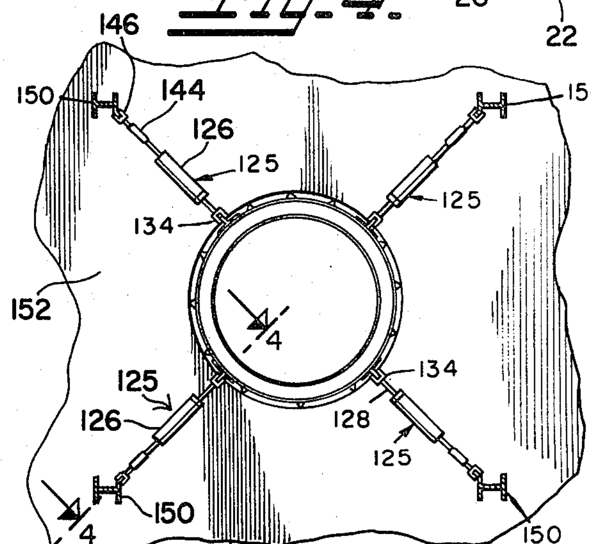


FIG. 3.

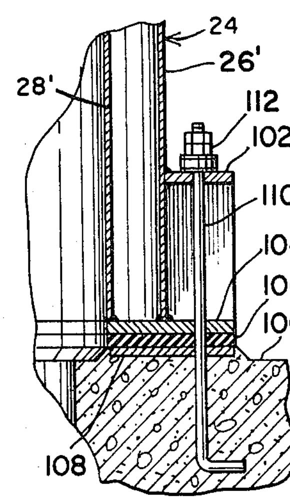


FIG. 2.

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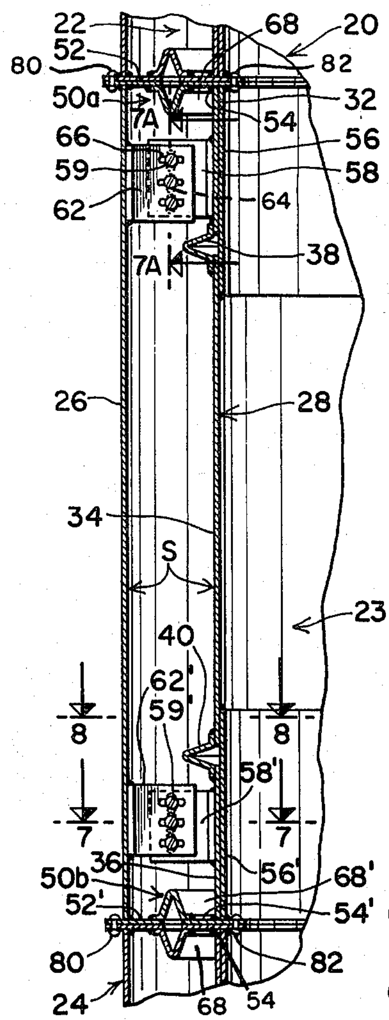

Fig. 6.

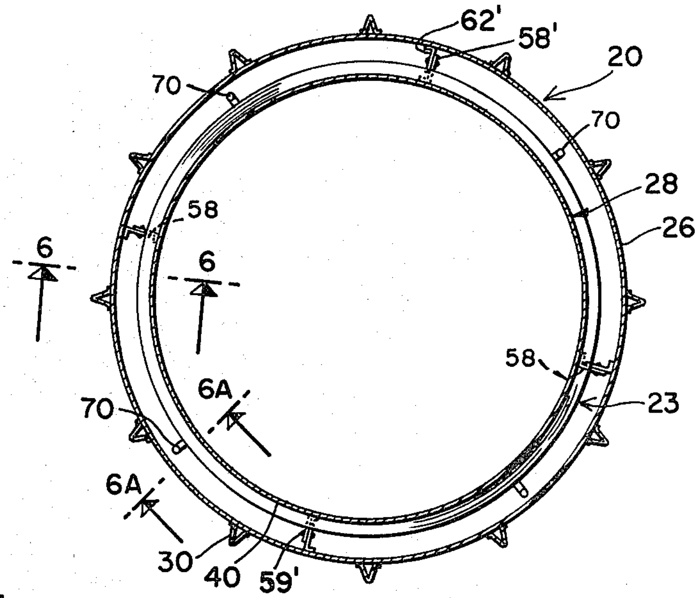

Fig. 5.

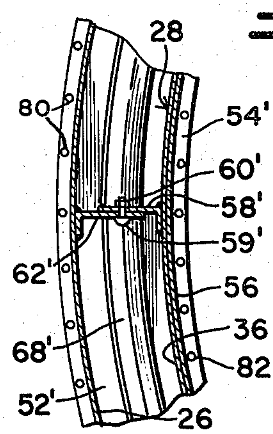

Fig. 7.

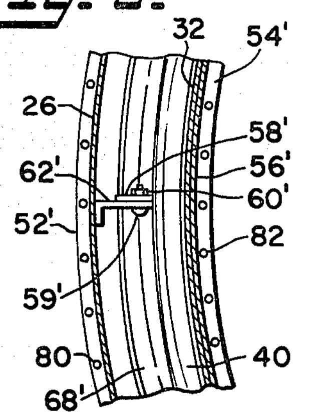

Fig. 8.

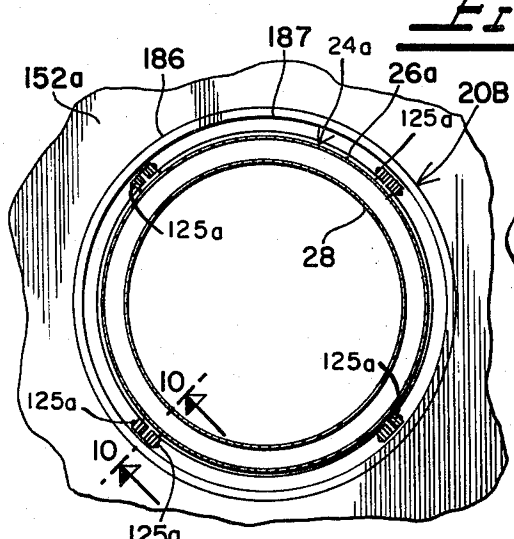

Fig. 9.

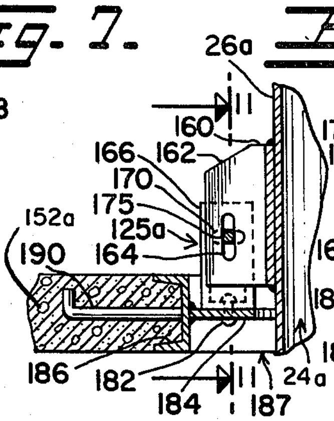

Fig. 10.

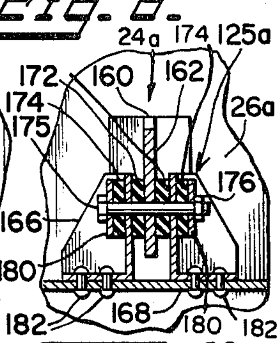

Fig. 11.

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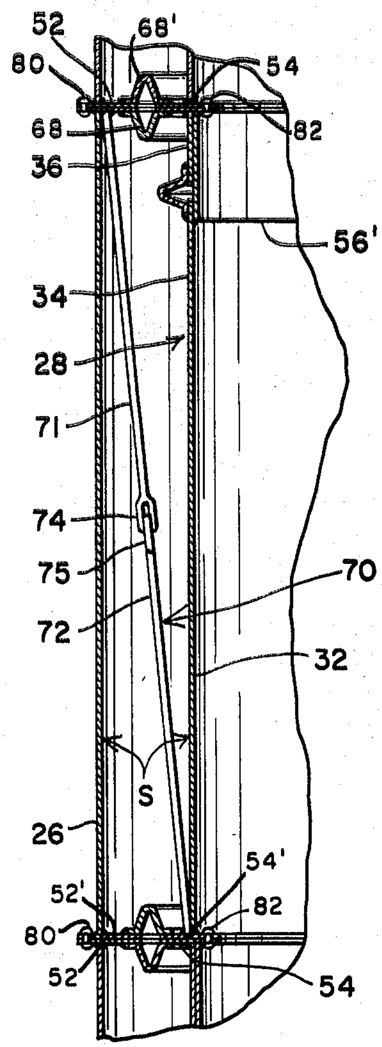

Fig. 6A.

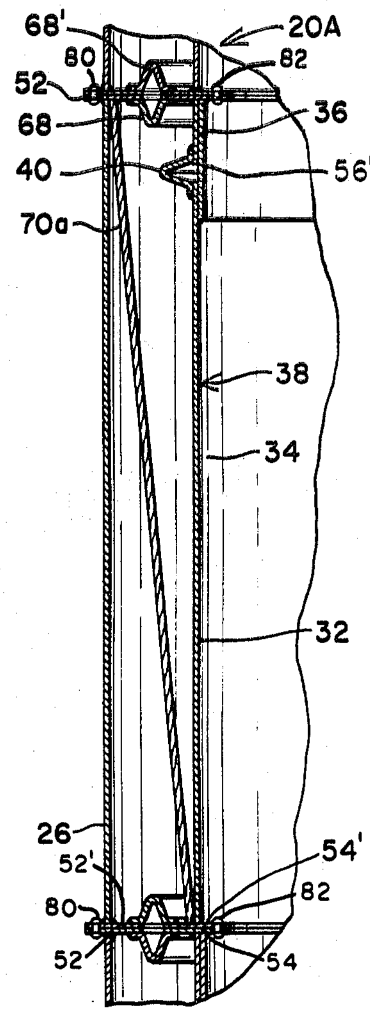

Fig. 6B.

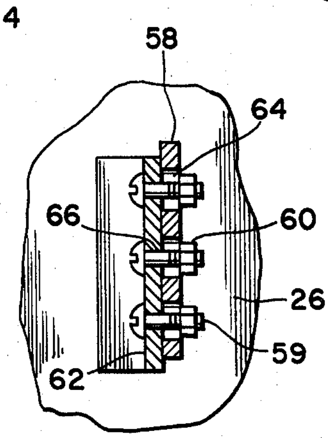

Fig. 7A.

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SECTIONALIZED STACK WITH CIRCUMFERENTIAL AND RADIAL EXPANSION MEANS

This invention relates to the art of smokestack construction, and more particularly concerns a stack having tubular sections with double walls provided with means to permit relative radial and circumferential expansion between the walls.

The invention involves improvements over those described in my prior U.S. Pat. Nos. 3,302,599, 3,363,591, 3,368,506 and 3,487,795. In those prior patents I described steel smokestacks having double wall construction with a sealed dead air spaced between the double walls to eliminate condensation and destructive corrosion of the steel walls. I further described means to permit relative longitudinal expansion and contraction of the inner and outer walls.

In the present invention, the smokestacks are further improved by means enabling relative circumferential and radial expansion of the double walls of the stack sections. Further, there are provided vibration dampening supports at the base of the stack. Other improvements involve flexible internal brace rods or cables between the walls of the double sections.

Other and further features, objects and advantages of the invention are explained in detail in the following description taken together with the drawings, wherein:

FIG. 1 is a perspective view of a multiple section stack embodying the invention, shown mounted on a massive base parts being broken away to show internal construction.

FIG. 2 is an enlarged fragmentary sectional view taken on line 2—2 of FIG. 1.

FIG. 3 is an enlarged horizontal sectional view looking upward and taken on line 3—3 of FIG. 1.

FIG. 4 is a further enlarged fragmentary sectional view taken on line 4—4 of FIG. 3.

FIG. 5 is an enlarged horizontal sectional view taken on line 5—5 of FIG. 1.

FIG. 6 and FIG. 6A are further enlarged fragmentary vertical sectional views taken on lines 6—6 and 6A—6A of FIG. 5.

FIG. 6B is a sectional view similar to FIG. 6 showing another internal brace construction.

FIG. 7 and FIG. 8 are fragmentary horizontal sectional views taken on lines 7—7 and 8—8 respectively of FIG. 6.

FIG. 7A is a fragmentary further enlarged sectional view taken on line 7A—7A of FIG. 6.

FIG. 9 is a horizontal sectional view similar to FIG. 3 of another stack.

FIG. 10 is an enlarged fragmentary vertical sectional view taken on line 10—10 of FIG. 9.

FIG. 11 is another fragmentary vertical sectional view taken on line 11—11 of FIG. 10.

Referring first to FIG. 1, there is shown a stack **20** comprising a plurality of axially aligned joined sections **22, 23, 24.** Only three sections are shown but it will be understood that stack may have one, two three or more sections. Center section **23** is typical of the others and will be described in detail first with particular reference to FIGS. 5–8. Section **23** has concentric outer and inner cylindrical steel walls **26, 28.** Welded to the outer side of outer wall **26** and extending longitudinally from end to end are flanges or strakes **30.** These ribs are spaced circumferentially apart all around wall **26.** These flanges increase the rigidity of the outer wall and also improve the appearance of the stack since they simulate architectural flutes of a column. A principal purpose of these strakes is to create a spoiler action against the forces of dynamic vibration. The flanges or strakes **30** have the same coefficient of thermal expansion as wall **26** and expand and contract with this wall both longitudinally and circumferentially.

The inner wall **28** is formed of three tubular parts **32, 34** and **36.** These parts are axially aligned. Upper part **32** is joined to intermediate part **34** by a flexible, circumferential accordion-like folded flange ring **38.** Part **34** is joined to lower part **36** by a similar flexible, circumferential accordion-like flange **40.** By this arrangement the parts of the inner wall can expand and contract relative to each other axially, and the inner and outer walls can also expand and contract relative to each other axially. The inner and outer walls are joined by flange assemblies **50*a*** and **50*b*** at upper and lower ends respectively. Each flange assembly **50*a*** comprises an outer flat annular flange **52** welded to the upper end of wall **26.** An inner flat annular flange **54** is welded to the upper end of wall part **32** and to the upper end of inner tubular reinforcing and sealing flange ring **56.** Flange **56** nests snugly inside part **32** and extends downwardly just beyond flange **38** and the upper most end of part **34.** Four flat flanges **58** extend radially outward from part **32** and are engaged by bolts **59** and nuts **60** with four radial flanges **62** extending inwardly from wall **26.** Flanges **58** are provided with vertical elongated holes or slots **64** which intersect horizontal elongated holes or slots **66** in flanges **62.** The flanges **58** are laterally abutted to flanges **62** respectively and the bolts extend through the intersecting holes; see FIG. 7A.

The outer annular flange **52** and inner coplanar annular flange **54** are connected by a flexible, circumferential folded accordion-like flange ring **68.**

The lower flange assembly **50*b*** is similar to the upper assembly **50*a*.** An outer flat annular flange **52′** is welded to the bottom end of wall **26.** A coplanar inner annular flange **54′** is welded to the lower end of wall part **36** and to the lower end of an inner tubular reinforcing and sealing flange **56′.** Flexible accordion-like circumferential flange ring **68′** connects flanges **52′** and **54′.** Flange ring **56′** nests snugly inside part **36** and extends upwardly just beyond accordion-like flange **40** and the lowermost end of part **34.** Four flat flanges **58′** extend radially outward from part **36** and are engaged by bolts **59′** and nuts **60′** with four radial flanges **62′** extending inwardly from wall **26.** Flanges **58′** and **62′** have crossed vertical and horizontal slots receiving bolts **59′.**

A plurality of flexible brace rods **70** is provided inside hermetically closed space S between the walls **26, 28.** These rods have two parts **71, 72** respectively welded to upper flanges **52** and lower flanges **54′** and cross space S diagonally as best shown in FIG. 6A. The two parts of the rod are joined by mutually links **74, 75** to permit relative circumferential and axial movement between walls **26, 28.**

Flanges **52** and **52′** have the same coefficient of thermal expansion as outer wall wall **26** and may be made of the same kind of steel. Inner flanges **54, 54′** have the same coefficient of thermal expansion as wall parts **32** and **36** and may be made of the same kind of steel. Walls **26** and **28** will in general be made of different kinds of steel. The inner wall **28** will be best adapted to withstand continuous temperatures as highly as 2,000° F. and will be high resistant to corrosion by acid products of combustion. The outer wall **26** will be adapted to withstand external atmospheric conditions and weather changes.

Flanges **52** and **52′** extend radially outward of wall **26.** The lower flange **52′** of an upper section of the stack **20** can be abutted to the upper flange **52′** of a lower section and secured by bolts or rivets **80**; see FIGS. 7 and 8. A suitable moisture proof sealing compound can be applied to the joints of flanges **50, 52** to seal them hermetically. Flanges **54** and **54′** extend radially inward of tubular flanges **38, 40.** The flat annular flange **54′** at the lower end of each upper section of the stack will be abutted to the flange **54** at the upper end of the next lower section. Bolts or rivets **82** will be used to secure these flanges together.

By the arrangement so far described, the several sections of the stack can expand axially, radially and circumferentially with respect to each other. They are also adapted to sway laterally and twist torsionally when subjected to very severe wind and weather conditions.

FIGS. 1 through 4 further illustrate a dynamic vibration dampening mounting assembly for the stack associated with the lowermost stack section **24.** The stack rests on a flat concrete base block **100.** A flat annular flange **102** is welded to the outer side of outer wall **26′** near its bottom end. Another flange **104** is welded to this outer wall **26′** and inner wall **28′** at their bottom ends and made parallel to flange **102.**

A flat, resilient energy absorption pad **106** which will absorb the energy generated by the forces of dynamic vibration is disposed under flange **104**. A flat, rigid annular leveling plate or ring **108** is disposed under pad **106**. Bolts **110** extend through the flanges **102** and **104**, pad **106** and ring **108** and are anchored in concrete base block **100**. Nuts **112** are engaged on the upper ends of bolts **110**.

Vibration dampeners **125** are further provided at the lower end of the stack. Each vibration dampener comprises a cylindrical housing **126**. A piston rod **128** extends through closed end wall **130** and is anchored to outer wall **26'** of stack section **24** by a bracket **132**, pivotal hinge **134** and bolt **136**, see FIGS. **3** and **4**. The rod **128** terminates just beyond a plate piston **138** in housing **126** and is engaged by a nut **140**. Energy vibration absorbtion pads **142** on rod **128** serves as a vibration absorbing means. The other end of housing **126** is secured by a turnbuckle **144** to a hinge **146** pivotally secured by a bolt **148** to anchoring beam **150** extending between the roof **152** of base enclosure **154** and the bottom floor **156** of the enclosure and located close to the underside of the roof. Four such vibration dampeners are circumferentially spaced around the stack.

The uppermost section **22** of the stack **20** as shown in FIG. **1**, is basically the same as the lower stack sections **23** and **24**, except that the upper stack section **22** terminates in an imperforate top flange **52''** closing space S, since no other sections are to be bolted to this top section.

FIG. **6B** shows part of a stack **20A** which is generally similar to stack **20** as shown in FIG. **6A**, and corresponding parts are identically numbered. A flexible cable **70*a*** replaces each brace rod **70** for internally bracing the sections of the stack. Opposite ends of the cables are secured between upper flanges **52** and lower flanges **54'**.

FIGS. **9**, **10** and **11** show another mounting assembly which can be used in place of the arrangement shown in FIG. **3**. Here the stack **20B** is provided with vibration dampening assemblies **125*a*** spaced circumferentially apart around the stack. T-plates **160** are secured to the outer side of outer wall **26*a*** of lowermost stack section **24*a***. The radially extending flange **162** of each T-plate has an elongated vertical slot or hole **164**. This flange is disposed between vertical flanges **166** forming parts of a bracket **168**. Each flange **166** has a horizontal elongated slot or hole **170**. Resilient heat resistant, vibration absorbing pads **172** are disposed between flange **162** and flanges **166**. Further pads **174** are disposed on outer sides of flanges **166**. Bolts **175** extend through holes in the flanges and pads and are secured by nut **176** between end washers **180** abutting outer pads **174**. Brackets **168** are secured by rivets **182** to support plates **184** welded to a metal ring **186** lining hole **187** in the roof **152*a*** of the base enclosure of the stack. Anchor bolts **190** extend radially outwardly from ring **186** into the roof to reinforce the mounting structure.

By the arrangement of FIGS. **1–11**, the stack has a floating support which permits lateral swaying and twisting movements of the stack. Vibration is absorbed effectively by the resilient joint structure.

In all forms of the invention described, the stack is adapted for limited lateral, radial, circumferential, axial and torsional movements under all kinds of adverse and/or changing weather and temperature conditions. The stacks can be erected on or adjacent to buildings and connected by conventional breeching to boilers, exhaust systems and the like.

What is claimed is:

1. A smokestack for the conveyance of hot gases comprising:

a. a plurality of elongated tubular sections having respective longitudinal axes and being connected in axial alignment,
   1. each section including inner and outer axial walls defining a dead air space therebetween,
   2. said inner wall including a circumferential accordion-like fold to compensate for differences in axial thermal expansion of said walls,
   3. each section further including a radial flange at each axial end thereof, said radial flange connecting said inner and outer walls and axially bounding said dead air space,
   4. each of said radial flanges including a circumferential, accordion-like fold to compensate for differences in radial and circumferential expansion of said walls; and

b. fastening means fastening said radial flanges of axially juxtaposed sections to each other.

2. A smokestack as defined in claim **1**, further comprising further flat flanges extending radially inwardly of the outer wall and outwardly of the inner wall, said further flanges being laterally juxtaposed, and slip joint means connecting said further flanges to permit relative axial, radial and circumferential expansion and contraction of the inner and outer walls.

3. A smokestack as defined in claim **1**, further comprising radially projecting, circumferentially spaced ribs on the outer wall of each section axially extending from end to end thereof.

4. A smokestack for the conveyance of hot gases comprising:

a. a plurality of elongated tubular sections having respective longitudinal axes and being connected in axial alignment,
   1. each section including inner and outer axial walls defining a dead air space therebetween,
   2. said inner wall including a circumferential accordion-like fold to compensate for differences in axial thermal expansion of said walls,
   3. each section further including a radial flange at each axial end thereof, said radial flange connecting said inner and outer walls and axially bounding said dead air space,
   4. an elongated brace member secured in said dead air space to said outer wall adjacent one of said radial flanges and to said inner wall adjacent the other radial flange; and

b. fastening means fastening said sections to each other in said axial alignment.

5. A smokestack for the conveyance of hot gases comprising:

a. a support;

b. a plurality of elongated tubular sections having respective vertically extending longitudinal axes and being connected in axial alignment above said support,
   1. each section including inner and outer axial walls defining a dead air space therebetween,
   2. said inner wall including a circumferential accordion-like fold to compensate for differences in axial thermal expansion of said walls,
   3. each section further including a radial flange at each axial end thereof, said radial flange connecting said inner and outer walls and axially bounding said dead air space; and

c. a vibration absorbing pad interposed between the lowermost of said sections and said support.

6. A smokestack for the conveyance of hot gases comprising:

a. a stationary support;

b. a plurality of elongated tubular sections having respective vertically extending longitudinal axes and being connected in axial alignment horizontally adjacent said support,
   1. each section including inner and outer axial walls defining a dead air space therebetween,
   2. said inner wall including a circumferential accordion-like fold to compensate for differences in axial thermal expansion of said walls,
   3. each section further including a radial flange at each axial end thereof, said radial flange connecting said inner and outer walls and axially bounding said dead air space; and

c. resilient vibration absorbing means connecting one of said sections to said support.

7. A smokestack as defined in claim **6**, further comprising other stationary support means underneath said aligned sections, and a vibration absorbing pad disposed between the lowermost section and said support means.

8. A smokestack as defined in claim 6, wherein said vibration absorbing means include a plurality of vibration absorbing elements angularly offset about said longitudinal axes, each element including a casing, a piston and a vibration absorbing pad in said casing, and connecting means connecting said piston and said casing to said one section and said support respectively for moving said piston against the restraint of said pad in said casing when said one section moves relative to said support.

* * * * *