

[54] STEEL-TOWER CHIMNEY

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FOREIGN PATENTS OR APPLICATIONS

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[30] Foreign Application Priority Data

Dec. 21, 1971 Japan..... 46-2669

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[51] Int. Cl. E04h 12/28

[58] Field of Search 48/58, 60; 110/184; 52/648, 649

[57] ABSTRACT

A steel-tower chimney comprising a steel tower for support, and a single stack located inside the tower and communicated to smoke sources, said stack being composed of a lower portion held upright on a foundation and an upper portion connected to the upper end of the lower portion with an expansion joint and formed of walls which are secured to the framework of the supporting steel tower.

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3 Claims, 14 Drawing Figures

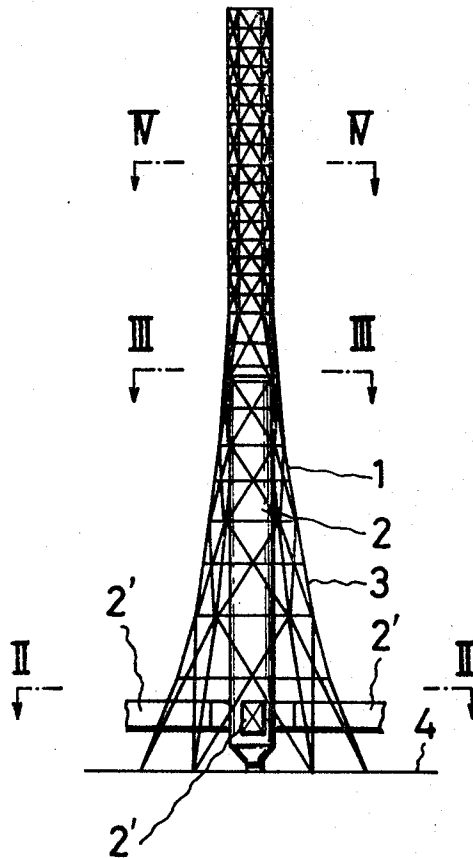


FIG. 1

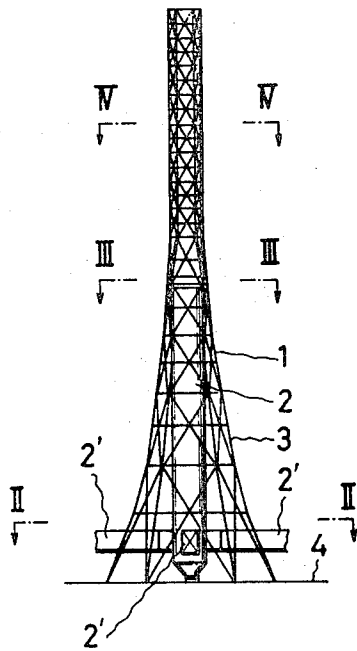


FIG. 5

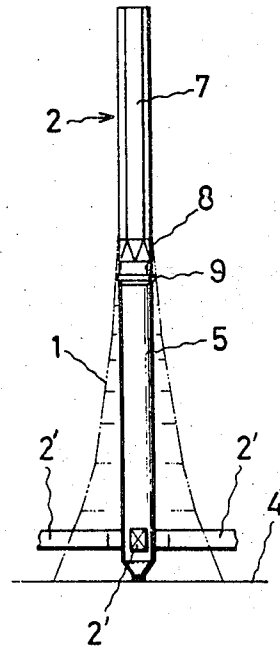


FIG. 2

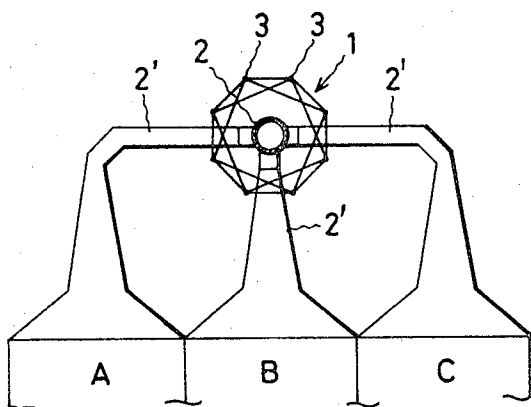


FIG. 3

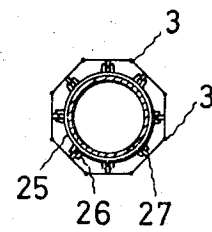


FIG. 4

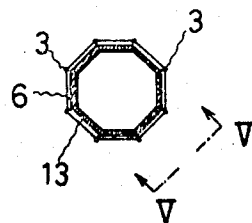


FIG. 6

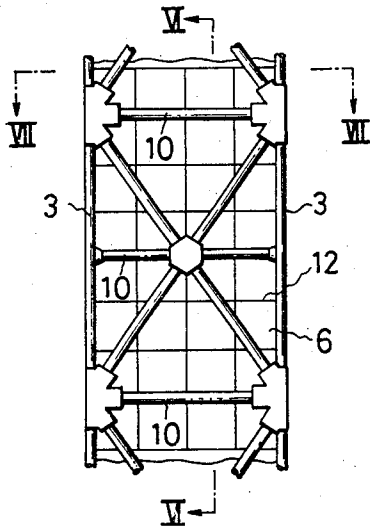


FIG. 7

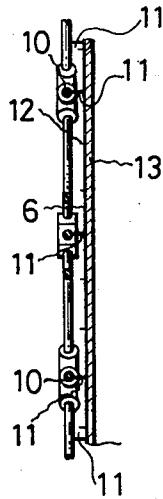


FIG. 8

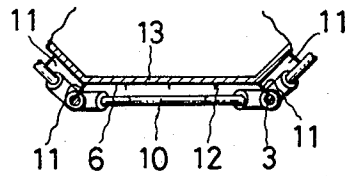


FIG. 10

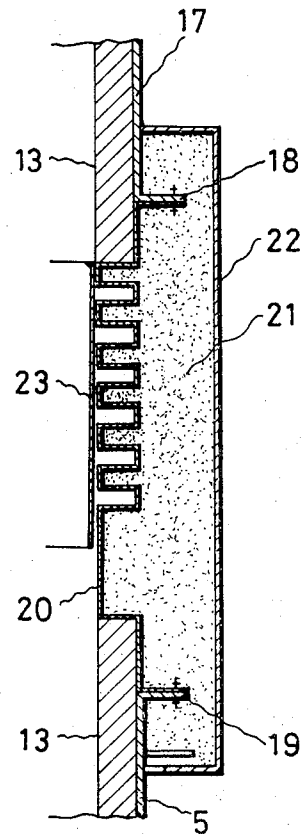


FIG. 9

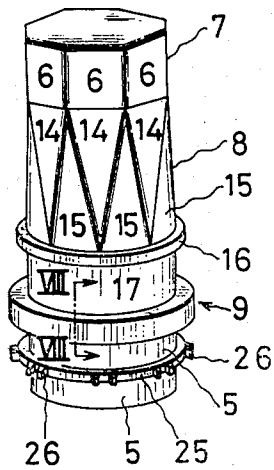


FIG. 11

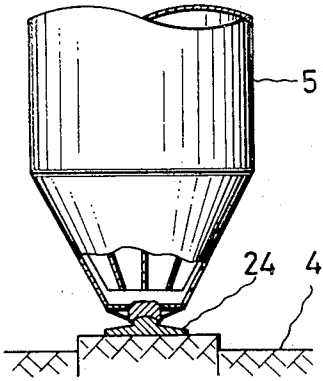


FIG. 13

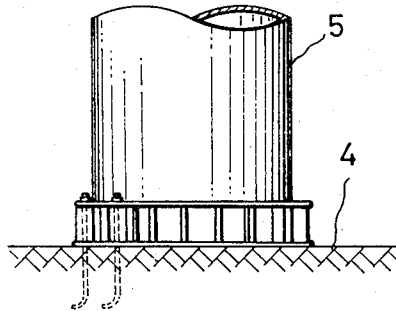


FIG. 12

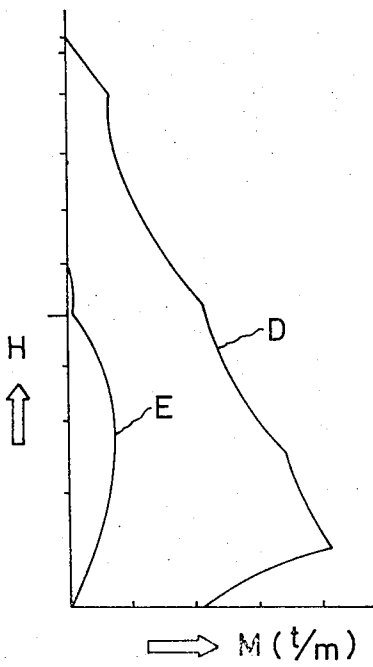
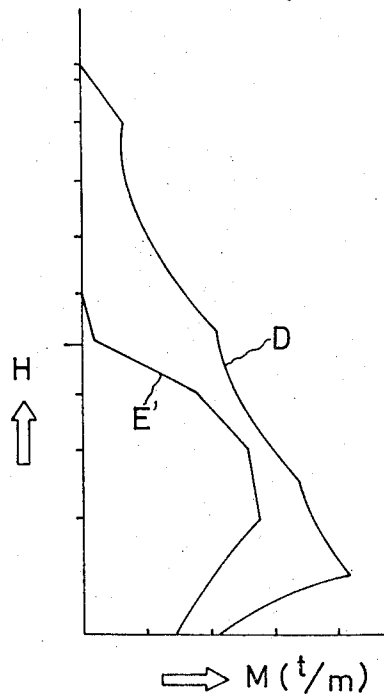


FIG. 14



STEEL-TOWER CHIMNEY

This invention relates to improvements of a steel-tower chimney.

Chimneys of the type which collect smoke and gases from a plurality of smoke sources into a single stack and then allow them to be discharged together to the outer air have been known as concentrating chimneys. A chimney of this type requires a stack of an extremely large diameter when it handles large volumes of exhaust gases, for example from a plurality of large-scale boilers of a thermal power station or the like.

By way of example, if exhaust gases from three 1,000-MW power plants under ordinary gas-discharging conditions have to be concentrated and released to the atmosphere, the stack must measure as much as some dozen meters across.

The large diameter of the stack necessarily involves high rigidity of the stack and increased bending moment therein. Conversely, the rate of strength of the stack against buckling (stress intensity) tends to drop with the increase of the diameter. This means that steel stacks must be made of very thick plates and accordingly the total weight of the steel to be used must be so heavy that the machining, fabrication, assembling, and erection at site are made difficult.

Chimneys of steel tower type comprising a stack fixed upright to a foundation and a steel tower surrounding and supporting the stack are also known in the art. In a chimney of this type, the stack has the strength to stand its own weight and is partly responsible for the resistance to its own bending. The steel tower surrounding the stack has the strength to stand its own weight and its own bending, and also the strength with which to restrict the bending of the stack being supported thereby. The expression "the stack has the strength to stand its own weight" as used herein means the strength with which a horizontal section at a given height of the stack can safely support the weight of the stack portion thereabove up to the top of the stack. The longer the distance between the upper end of the stack and the horizontal section, the heavier the weight that the latter must support and hence the greater the strength that the latter must possess. Also, the horizontal section's strength against the weight of the stack portion thereabove is directly proportional to the cross-sectional area of the stack members used. For added strength, therefore, a stack having the same outside diameter throughout must be made of the members or plates thick enough to provide the additional cross-sectional area as desired.

The bending moment that horizontal external forces, such as of vibrations due to winds or an earthquake, give to a stack is most intense near the lower end of the stack as indicated by curves D in FIGS. 12 and 14. The intensity of this bending moment increases in direct proportion to the height of the stack which is fixed at the bottom. As is the case with the strength against the stack's own weight, the strength to counteract this bending moment is calculated in terms of the cross-sectional area of the members necessary at a given height of the stack, and the total plate thickness is accordingly increased. In other words, the total plate thickness across a given portion of the stack may be regarded as the sum of the plate thickness for supporting the stack's own weight and that for standing the bending. For the reasons above explained, very thick plates

have had to be used in building conventional chimneys of steel tower type.

The present invention has for its object to overcome the foregoing difficulties and provide an improved steel-tower chimney particularly useful as a smoke eliminator with a remarkably large diameter and great height.

The present invention will be more fully described hereunder with reference to the accompanying drawings showing an embodiment thereof. In the drawings:

FIG. 1 is a general front view of an embodiment of the invention;

FIGS. 2 to 4 are horizontal sectional views taken at different heights, respectively, along the lines II—II, III—III, and IV—IV of FIG. 1;

FIG. 5 is a front view of the stack structure stripped of the steel tower shown in FIG. 1;

FIG. 6 is a fragmentary side view, on an enlarged scale, as seen in the direction V—V of FIG. 4;

FIG. 7 is a vertical sectional view as seen in the direction VI—VI of FIG. 6;

FIG. 8 is a horizontal sectional view taken along the line VII—VII of FIG. 6;

FIG. 9 is an enlarged perspective view of a connecting part between the upper and lower halves of the stack;

FIG. 10 is a fragmentary vertical sectional view, on an enlarged scale, as seen from the direction VIII—VIII of FIG. 9;

FIG. 11 is a front view, partly broken away, of the lower end part of the stack;

FIG. 12 is a graph comparing the moments of the chimney shown in FIGS. 1 through 11 and of a conventional chimney;

FIG. 13 is a front view of another form of the lower stack part; and

FIG. 14 is a graph comparing the moment of the chimney of the invention combined with the construction shown in FIG. 13 and the moment of a conventional chimney.

Referring first to FIG. 1, there are shown a steel tower 1 for support, a single concentrating stack 2 disposed in the center of the steel tower, and flues 2' communicating three smoke sources A, B and C to the stack 2. The steel tower 1, as better shown in FIGS. 2 to 4, is a regular octagon having eight vertical support members 3 extended along the total height of the tower. As can be seen from FIG. 5, the stack 2 consists of a lower half 5 having a cylindrical cross section which is set upright on a foundation 4 and held within the steel tower 1, and an upper half 7 having an octagonal cross section surrounded by eight vertical side walls 6 secured to the upper framework of the tower 1 in conformity with the octagonal cross-sectional contour of the tower as shown in FIG. 4. The lower end of the octagonal upper half 7 is provided with a deformed portion 8, through which and also through an expansion joint 9 the lower end is connected to the upper end of the cylindrical lower half 5. The side walls 6, as shown in FIGS. 6 to 8, are fabricated integrally with the octagonal steel tower 1 by welding horizontal and vertical flanges 11 on the outer sides of the walls to the inner sides of the vertical support members 3 provided on the outer surface of the steel tower 1 and to the inner sides of horizontal support members 10 interposed between the vertical members 3. Eight such walls

are joined side by side to form the upper half 7 of the stack octagonal in cross section.

In addition, the walls 6 have stiffeners 12 on the outer sides and a lining layer 13 inside. As illustrated in FIG. 9, the deformed portion 8 at the lower end of the stack's upper half 7 consists of a plurality of inverted-triangular plates 14 extending downward from the walls 6 and arranged alternately with a corresponding number of triangular plates 15 to converge in a circle equal in diameter to the cylinder constituting the lower half of the stack. The deformed portion thus rounded and reinforced with a ring 16 extends farther downward in the form of a short cylinder, with its lower extremity connected to the upper end of the stack's lower half 5 via the expansion joint 9.

As shown in FIG. 10, the expansion joint 9 comprises a bellows ring 20 of stainless steel connected between a flange 18 on the lower extremity of the upper half's lower portion 17 and a flange 19 on the upper extremity of the lower half 5, a soft heat insulation 21, such as glass wool, covering the outer surface of the bellows ring, a cover ring 22 for the insulation fixedly welded at the upper end to the outer surface of the upper half's lower portion 17, and an inner ring 23 welded at the upper end to the inner upper part of the bellows to cover the grooves of the bellows and prevent water deposition on the groove walls. In FIG. 10 inner lining layers for the upper and lower halves of the stack are indicated at 13.

The lower half 5 of the stack, as shown in FIG. 11, is pivotally supported upright by a spherical support 24 on a foundation 4. Where necessary, the support 24 which is spherically convex upward may be concave instead. Near the upper end of the stack's lower half 5 is mounted a ring 25, as shown in FIG. 9, which is formed with vertical grooves 26. The grooves 26 receive vertically slidably support members 27 provided on the framework of the steel tower, as shown in FIG. 3, so that the stack 5 can be supported by the steel tower regardless of the former's expansive or contractive movement.

With the construction above described, the stack according to this invention is so designed that the weight of the lower half 5 of the stack is supported by the foundation 4, whereas the weight of the upper half 7 is supported through the framework of the steel tower 1. The lengthwise expansion of the stack's lower half 5 is permitted by the vertical sliding of the engaging parts 26, 27 relative to the steel tower 1 and also by the deflective deformation of the expansion joint 9. On the other hand, the expansion of the upper half 7 is offset by the cross-sectional stress of the walls 6 secured to the framework of the steel tower at each specified height.

It should be appreciated that the steel tower 1 of the stack above described may take any desired shape and that the walls 6 to be secured to the framework of the upper part of the tower may consist of a suitable number of flat plates or, if desired, curved plates, so that the upper half 7 of the stack may have a cross section of a given polygonal contour or nearly circular or truly circular contour.

The construction above described is such that the walls 6 constituting the upper half 7 of the stack are generally secured to the framework of the steel tower at a number of points so that the walls are provided integrally with the tower. Consequently, both the weight

of the steel tower and the strength the tower must have increase, while the walls 6 need not be responsible for the strength with which to support their own weight and bending. Hence the walls may be made of fairly thinner plates than heretofore.

Assuming now that the overall height of the stack is 300 meters, a conventional stack will stand 300 meters high by itself, requiring a sufficient strength near its lower end to withstand its own weight, or the weight of the 300-meter structure and any bending force against the same. In the construction of the present invention, the upper half of the stack in the proportion shown in FIG. 5 is secured to the steel tower serving as surrounding walls, so that the self-standing height (that of the lower half) of the stack on the foundation is 150 meters, or about half the overall height. Stated differently, the stack portion near the lower end is required only to have both a sufficient strength to support about half the weight that an ordinary stack bears and a strength to withstand bending and, therefore, the lower half of the stack may be built of thinner plates than heretofore.

Also, according to the invention, the upper half of the stack may use thinner plates, too, because, as already described, the upper half is secured to, and supported by, the framework of the steel tower and, as compared with the conventional structure, it is not responsible for its own weight and resistance to bending. Consequently, the increments of the weight of the steel tower and the burden of strength the tower must bear can be relatively small, and the overall weight of steel in the upper half of the stack can be reduced to an advantage.

On the other hand, the lower half 5 of the stack is required to support the weight of the stack reduced in proportion to its length, with a strength only about half that of the conventional structure built in one piece throughout.

Further, with the aid of the support means shown in FIG. 11, the intensity of the bending moment that is produced in the lower half 5 of the stack is remarkably reduced as graphically indicated in FIG. 12. In the graph, the stack height H is plotted as ordinate and the bending moment M' as abscissa. The curve D represents the tendency of bending moment in a conventional stack of an overall-height solid type and the curve E represents that in the lower half 5 of a stack according to this invention. As can be seen from the graph, the lower half 5 of the stack according to this invention is considerably relieved from the burden of strength against its own weight and bending and permits a reduction in the weight of steel required for its construction.

These advantages are more and more pronounced with the increase in the height of the chimney. Also, the advantages are more tangible when the invention is embodied in stacks having larger diameters with greater rigidity and bending moment and less buckling stress intensity. As a consequence, the present invention advantageously provides either a steel-tower chimney having a one-piece stack or a superhigh, large-diameter concentrating chimney with a more stabilized and economical structure.

FIG. 13 shows a modification in which the lower end portion of the stack's lower half 5 above described is fixed to the foundation 4 and, so far as the lower half 5 is concerned, the stack is supported at several points by the steel tower 1 in the same way as with the conven-

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tional chimneys of tower type. Here again the strength that the lower half 5 must possess to carry its own weight may be approximately half the strength required for supporting the entire stack.

Referring to FIG. 14, wherein the stack height H is plotted as ordinate and the bending moment M as abscissa, the intensity E' of the bending moment in the stack 5 indicates a tendency of less strength requirement similar to that of the curve E in FIG. 12, as compared with the tendency D with the stack of conventional overall-height solid type.

As has been described above, this invention provides a large, superhigh steel-tower chimney with a stabilized and economical structure wherein a single stack to be disposed within the steel tower is composed of a lower half held upright on a foundation and an upper half formed of walls secured to the framework of the tower, said upper and lower halves of the stack being united together with an expansion joint.

We claim:

1. A steel-tower chimney comprising a steel tower for support having an equilaterally polygonal cross section,

and a single stack located inside the tower and communicated to smoke sources, said stack being composed of a lower half having a cylindrical cross section which is supported at its lower end on a foundation and held upright in the steel tower, an upper half with a polygonal cross section which is composed of a plurality of plates vertically extended, connected side by side, and secured together to the inner surface of the upper framework of the supporting steel tower, in agreement with the equilaterally polygonal cross-sectional contour of the tower, and means for uniting said two halves, said uniting means including an expansible, flexible joint.

2. A steel-tower chimney as defined in claim 1, wherein said uniting means further includes a portion deformed in the cross-sectional contour and adapted to connect the lower end of the upper half and the upper end of the lower half together.

3. A steel-tower chimney as defined in claim 2, wherein the lower half of the stack is pivotally supported at its lower end on the foundation.

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