Sept. 7, 1965

D. SMITH

3,204,613

SUPPORTING MEANS

Filed April 8, 1963

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Fig. 1.

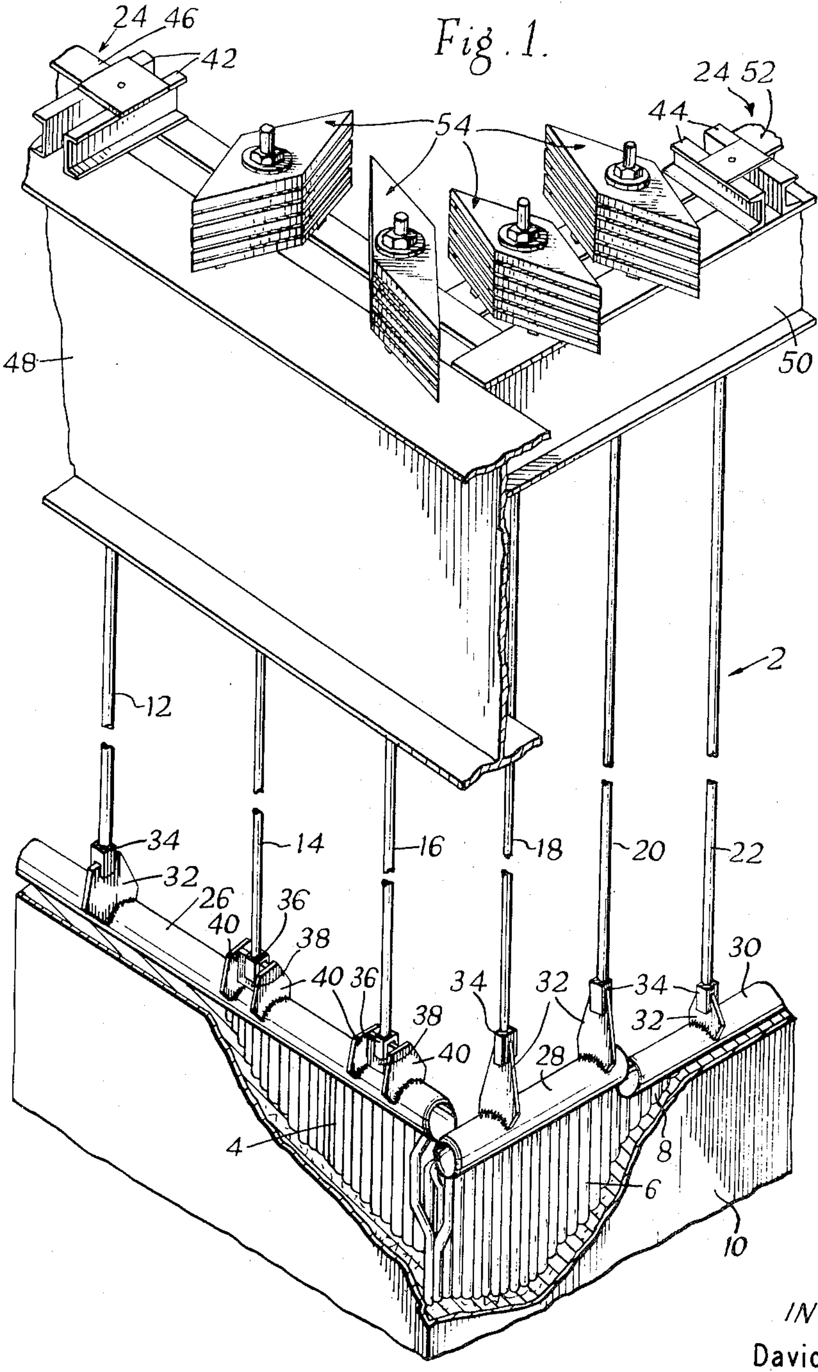

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Fig. 3.

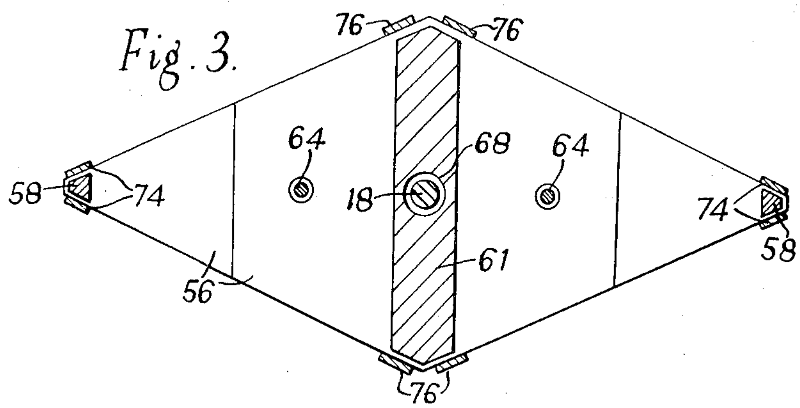

Fig. 2.

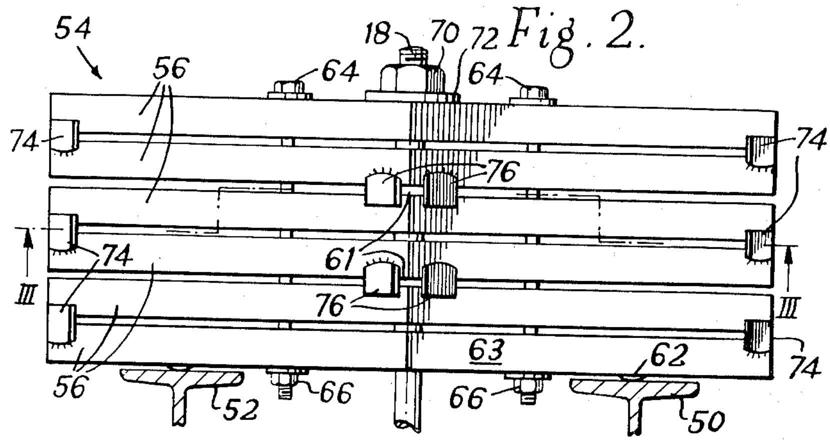

Fig. 4.

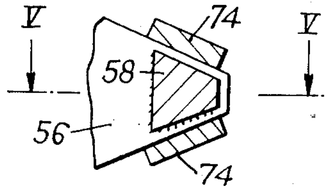

Fig. 5.

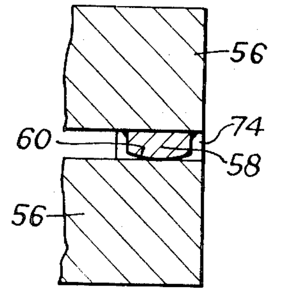

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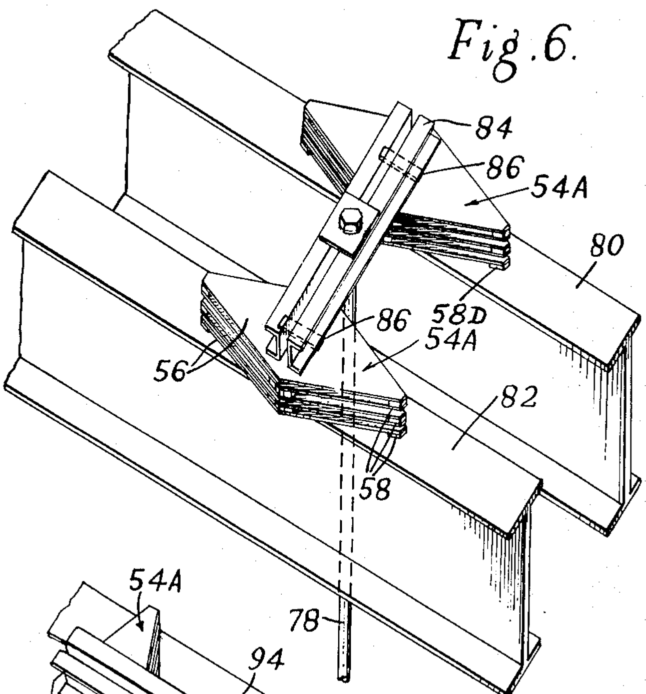
Fig. 6.



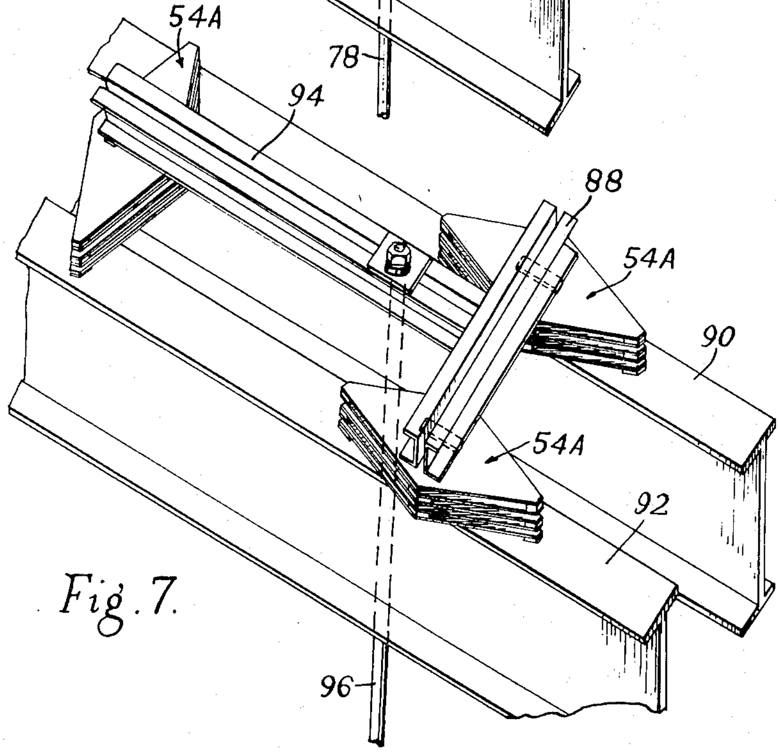


Fig. 7.

Fig. 8.

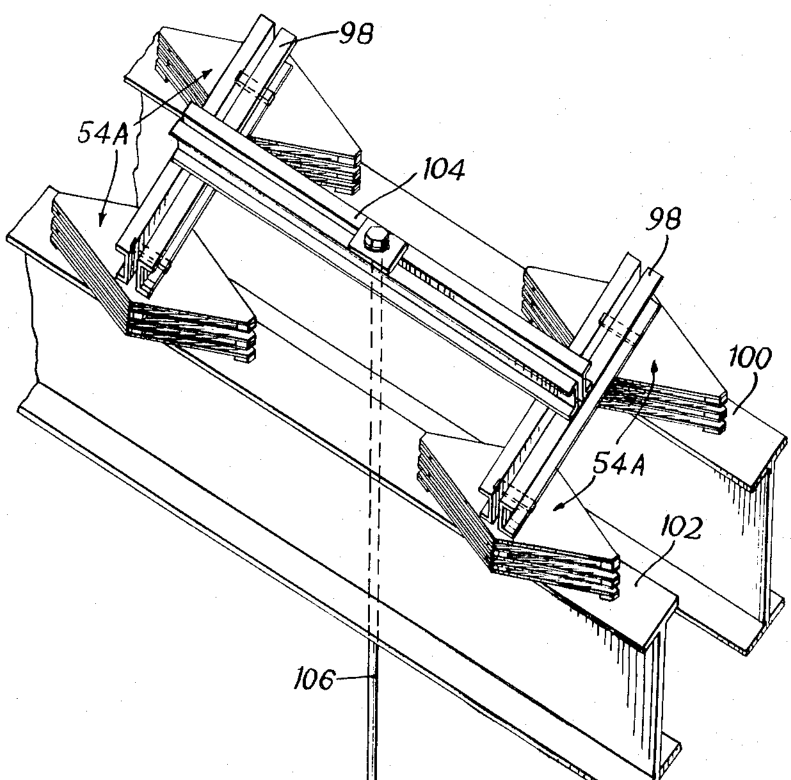


Fig. 9.

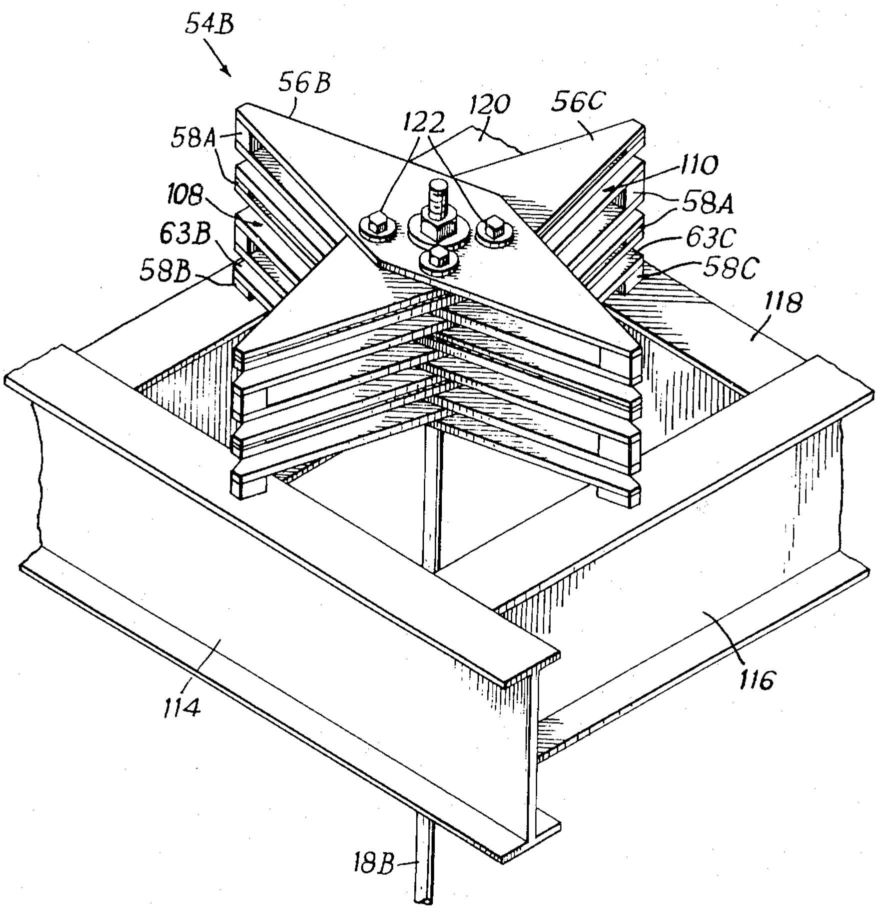

54B
56B
120
56C
122
58A
110
108
58A
63B
63C
58B
58C
118
116
114
18B

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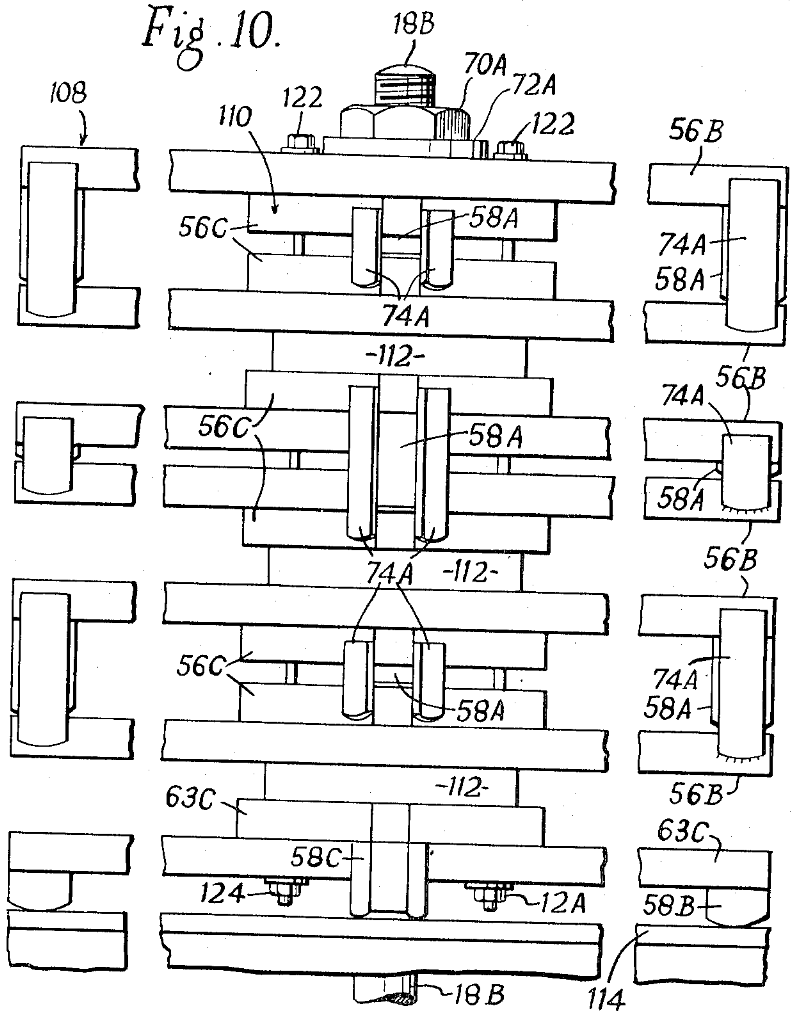
Fig. 10.



3,204,613
SUPPORTING MEANS

David Smith, London, England, assignor to Babcock & Wilcox Limited, London, England, a British company
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Claims priority, application Great Britain, Apr. 9, 1962, 13,554/62
13 Claims. (Cl. 122—510)

This invention relates to units suitable for giving resilient support to heavy loads, such as furnace chamber walls.

In the furnace of a high capacity steam generating and superheating unit a gas-tight wall may be provided by welding heat exchange tubes in the wall to one another or to intermediate filler strips. In an upright wall formed in this manner the wall has in its own plane great rigidity. As a result, the difficulty occurs that in the event of deflection of a support beam, under the weight of the wall, uneven loading of the slings and eventual sling failure is liable to occur. Moreover, uneven loading may be brought about by thermal expansion of the wall leading to lateral deflection of the lower extremities of slings in the neighbourhood of the ends of the top of the wall. Such uneven loading may be increased by slings at a centre part of the wall reaching higher temperatures and expanding more than the slings in the neighbourhood of the ends of the top of the wall.

By the invention there is provided means whereby the danger of sling failure due to over-stressing is lessened or avoided. To this end use is made of resilient support units. Such units are required to support heavy loads and conveniently have a low deflection to load ratio. By the invention there is also provided a form of unit which is particularly suitable for supporting a heavy load affording a low deflection to load ratio, and which is of simple and economical construction, allows great flexibility in design, is easy to install and is capable of operating for long periods without attention.

The present invention includes a furnace chamber having an upright, top-supported wall including heat exchange tubes united by welding to one another or to intermediate filler strips to form a gas-tight wall and distributed along the top of and supporting the wall a series of slings of which slings or groups of slings adjacent the supports of a beam from which slings hang are connected to the beam through resilient means adapted through strain thereof to limit the stresses in the associated slings.

The invention also includes a unit for the resilient support of a load having a pair or pairs of resilient plates spaced apart at opposite end locations and adapted to give support to a load at locations intermediate their ends.

The invention will now be described, by way of example, with reference to the accompanying partly diagrammatic drawings, in which:

FIGURE 1 is an isometric elevation of a part of a furnace chamber, a roof portion of which is omitted for the sake of clarity, with part of the insulation broken away;

FIGURE 2 is an elevation, to an enlarged scale, of a portion of FIGURE 1 showing a support unit in greater detail;

FIGURE 3 is a cross-sectional plan view taken on the line III—III of FIGURE 2;

FIGURE 4 is a portion of FIGURE 3 to an enlarged scale;

FIGURE 5 is a cross-section elevation of a part of the support unit corresponding to the section line V—V of FIGURE 4;

FIGURE 6 is an isometric elevation of an arrangement embodying two support units;

FIGURE 7 is an isometric elevation of an arrangement embodying three support units;

FIGURE 8 is an isometric elevation of an arrangement embodying four support units;

FIGURE 9 is an isometric elevation of an alternative, compound arrangement of a support unit; and

FIGURE 10 is a fragmentary elevation, to an enlarged scale, of FIGURE 9.

As shown in FIGURE 1, a furnace chamber **2** includes membrane tube wall panels **4**, **6**, **8** provided externally of the chamber with a layer of insulation **10** and supported on slings **12**, **14**, **16**, **18**, **20**, **22** mounted on beams **24** provided with support columns (not shown) adjacent the corner intersections thereof. The sling **12** is connected to a header **26** of the panel **4**, the slings **18**, **20** are connected to a header **28** of the panel **6** and the sling **22** is connected to a header **30** of the panel **8** by means of plates **32** each having an arcuate side welded to the respective header and a connector block **34** pinned or welded to the plate **32** and provided with a threaded bore co-acting with a threaded portion at the lower end of the respective sling. The slings **14**, **16** are connected to the header **26** by means of connector blocks **36** pinned or welded to bridge plates **38** each welded to a pair of plates **40** welded along arcuate sides thereof to the header **26**, a threaded bore in each connector block **36** co-acting with a threaded portion at the lower end of the respective sling.

The slings **12**, **22** are supported non-resiliently on pairs of transom girders **42**, **44** respectively spanning pairs of girders **46**, **48** and **50**, **52** of the beams **24**. The slings **14**, **16**, **18**, **20** adjacent the corner intersection of the beams **24** are resiliently supported on units **54** respectively spanning the pairs of girders **46**, **48** and **50**, **52** in order to achieve a substantially uniform loading in each of the slings despite deflection of the beams **24** under load and differential thermal expansions in the tube wall panels **4**, **6**, **8**.

As shown in FIGURES 2 to 5, each unit **54** includes a stack of lozenge-shaped plates **56** adjacent plates of which are spaced apart in pairs by spacers **58** positioned at diametrically opposed end portions along the major axis of each pair and welded to the underside of the upper plate of the pair. The lower face **60** of each spacer **58** is of part cylindrical form and rests tangentially on the upper surface of the lower plate of the pair. Adjacent pairs of plates **56** are spaced apart by pads **61** extending diametrically across the surfaces of the plates, in the direction of the minor axes, and welded at intervals to the underside of the lower plate of each pair of plates **56** except the lowermost pair.

Pads **62** extend across the lowermost plate **63** parallel to the minor axis thereof and are welded at intervals to the undersurface of the lowermost **63**. The lower face of each pad **62** is of part cylindrical form and rests tangentially on the upper surface of a subjacent girder, such as **50** or **52**.

Pre-tensioning bolts **64** (omitted from FIGURE 1 for the sake of clarity) extend through the plates **56** and are secured in position by nuts **66** which are positioned on the bolts while the unit **54** is compressed by a predetermined loading, thereby obtaining an even ditribution of stress between the bolts **64** upon relaxing the predetermined loading and holding the unit in a partially compressed state. Thus the deflection upon applying the actual loading to the unit **54** is reduced in comparison with the deflection of a unit **54** not initially in a partially compressed state.

The respective sling **18** extends through central apertures **68** in the plates **56** and the pads **61** and is provided with a sling nut **70** seated on a washer **72** resting on the uppermost plate. Alternatively, if desired, a rocker may be fitted under the sling unit 70 to permit slight movement of the sling 18 from the vertical position.

Pairs of locating lugs 74 (also omitted from FIGURE 1 for the sake of clarity) are welded to the lower plate of each pair of plates 56 adjacent the spacers 58 and extend upwardly over the edges of and serve to locate the upper plate of the pair of plates relative to the lower plate of the pair. Additionally, the lower plate of each pair of plates is located relative to the upper plate of the subjacent pair of plates by means of pairs of locating lugs 76 (also omitted from FIGURE 1) welded to each lower plate, except the lowermost plate 63, adjacent the pad 61.

In operation, when a unit 54 is placed under compression the adjacent plates 56 flex along their major axes in opposite directions and the total vertical movement is the sum of the movements of the different plates. Since the plates 56 are spaced apart, shear forces between the plates are avoided together with the necessity for lubrication.

By utilising lozenge-shaped plates 56, the cross sectional area of plates between opposite ends thereof varies in a manner adapted to afford substantially constant stresses in the plates due to bending under load.

In an alternative arrangement (not shown), cover means extending across the openings to the spaces between adjacent plates 56 are provided in order to prevent the ingress of dirt or foreign bodies and may also serve as plate positioning means.

It will be appreciated that the units 54 allow great flexibilty in use since a set of units of the nature described in connection with FIGURES 2 to 5 may readily be arranged to exert a supporting force through load distributing means.

Thus, as shown in FIGURE 6, a sling 78 passing downwardly through the space between two girders 80, 82 of a beam is supported from a transom 84, the ends of which rest on pads 86 on respective units 54A resting the one on the one girder and the other on the other girder.

The units 54A are of similar construction to the units 54 described in connection with FIGURES 2 to 5 but consist of five plates 56, the lowermost plate 63 being omitted, so that the lowermost spacers 58D of the two units rest tangentially on the upper surfaces of the respective girders 80, 82.

Alternatively, as in the arrangement shown in FIGURE 7, a transom 88 rests on two units 54A positioned on respective girders 90, 92 of a beam with their major axes parallel to the axes of the girders. A third unit 54A is spaced from the transom 88 and its major axis extends in a plane normal to the longitudinal axes of the girders 90, 92, while a horizontal, auxiliary beam 94 is connected at one end to the transom 88 and rests at the other end on the top of the third unit, sling 96 hanging from the auxiliary beam 94 and extending downwardly between the girders 90, 92. Suitably, the three units 54A are similar to one another, the sling being so located in relation to the auxiliary beam 94 that the three units are equally loaded. Naturally, however, units of different design may be used, but in such case the load distributing means is arranged to ensure appropriate loading of each unit.

In the further alternative arrangement shown in FIGURE 8, in which four units 54A are used, two transoms 98 are provided, each supported on a pair of units 54A resting on two girders 100, 102 of a beam with the major axes of the units 54A parallel to the longitudinal axes of the girders 100, 102 and an auxiliary beam 104 rests at its ends on the transoms 98, a sling 106 being supported by the auxiliary beam and extending downwardly between the girders.

In the alternative, compound arrangement of a unit 54B shown in FIGURES 9 and 10, plates 56B, 56C are arranged in two interleaved stacks 108, 110 in which the plates 56B of the first stack 108 are positioned perpendicular to the additional plates 56C of the second stack 110.

The plates 56B are arranged in pairs in the first stack 108 and the additional plates 56C are arranged in pairs in the second stack 110, the plates of each pair being spaced apart by spacers 58A. The spacers 58A of each pair of plates are welded to the upper plate of the pair and have lower faces of part cylindrical form resting tangentially on the upper surface of the lower plate of the pair. The pairs of plates 56B of the first stack 108 are alternately widely and narrowly spaced apart, each pair of widely spaced plates accommodating between them additional pairs of plates 56C of the stack 110 and the pair of narrowly spaced plates being accommodated between the plates 56C of an additional pair of plates of the stack 110. The groups of four plates, each consisting of a pair of plates accommodating another pair of plates between them, are spaced apart by spacers 112.

Locating lugs 74A (also omitted from FIGURE 9) are respectively welded in pairs to the lower plate of each pair of plates adjacent the spacers 58A and serve to position the respective upper plate of the pair.

The lowermost group of plates consists of two plates 63B, 63C only, which are similar in nature to the upper plates of the pairs of plates forming the superjacent groups of four plates. Spacers 58B, 58C are respectively welded to each of the plates and have a lower face of part cylindrical form resting tangentially upon girders 114, 116, 118, 120 of a supporting framework.

Four tensioning bolts 122 extend through the plates 56B, 56C and spacers 112 and are provided with nuts 124 positioned on the bolts 122 whilst the unit 54B is compressed by a predetermined loading in order to reduce the deflection of the unit upon application of an actual loading.

A sling 18B extends through central apertures in the plates 56B, 56C and spacers 112 and is mounted on the uppermost plate by means of a sling nut 70A and washer 72A.

It will be appreciated that the units described above are not only simple and cheap to make but are also easily installed on site.

I claim:

1. A support system comprising a beam system and a spring unit, said spring unit comprising a vertically disposed stack of lozenge-shaped resilient plates, said stack including at least one pair of spaced co-acting plates arranged to deflect along substantially their entire major dimension in opposite directions from each other upon the application of a load, spacer members disposed between said pair of co-acting plates along their major axes at opposite end portions thereof, the uppermost plate of said pair being the uppermost plate of said stack, and a lowermost plate adapted to engage said beam system, means forming an aligned centrally disposed opening in each of the plates of said stack, a sling member passing through the openings in said plates and including means for engaging said uppermost plate, and means for applying said load downwardly and substantially axially to said sling member.

2. A support system as claimed in claim 1 wherein said resilient plates are of substantially equal size and shape, and wherein the peripheral edges of all the plates in said stack are substantially aligned.

3. A support system as claimed in claim 1 wherein all of said resilient plates are spaced apart and are arranged to deflect in the opposite direction from each adjacent plate upon the application of said load.

4. A support system as claimed in claim 1 wherein said stack includes a multiplicity of pairs of co-acting plates, and wherein spacer pads are provided between adjacent pairs of co-acting plates along the minor axes thereof.

5. A support system as claimed in claim 1 wherein said resilient plates are of substantially equal shape and have a major axis, and wherein some of said plates in said stack are aligned so that their major axes are angularly disposed from the major axes of some other of said plates.

6. A support system as claimed in claim 1 wherein said stack includes at least two pairs of spaced co-acting plates, and wherein one of said pairs of co-acting plates is disposed between the other of said pairs of co-acting plates.

7. A support system comprising a beam system and a spring unit, said spring unit comprising a vertically disposed stack of lozenge-shaped resilient plates, said stack including multiple pairs of spaced co-acting plates, the plates of each pair having spacer members disposed therebetween at opposite end portions along the major axes thereof and being arranged to deflect in opposite directions from each other upon the application of a load to said unit, the lowermost plate of said stack being engaged with said beam system, means forming aligned centrally disposed openings in all of the plates of said stack, a sling member passing through the aligned openings in said plates and being engaged with the uppermost plate of said stack, means for applying said load downwardly and substantially axially to said sling member, and means for holding said unit in a pre-compressed condition for reducing the deflection-load ratio of said unit prior to the application of said load.

8. A top support system for an upright furnace wall comprising a support beam system including a laterally extending girder disposed above the upper end of said wall and supported at its ends, laterally spaced downwardly extending rigid sling members interconnecting said girder and said wall and being in load-bearing relationship therebetween, means for equalizing the stresses in said sling members to compensate for downward deflection of said girder comprising resilient spring support units connected to those of said sling members adjacent the lateral ends of said wall, and substantially rigid connections between said girder and those of said sling members intermediate the resiliently supported sling members.

9. A top support system for an upright furnace wall comprising a support beam system including a laterally extending girder disposed above the upper end of said wall and supported at its ends, downwardly extending sling members interconnecting said girder and said wall and being in load-bearing relationship therebetween, and means for equalizing the stresses in said sling members to compensate for downward deflection of said girder comprising resilient support units connected to those of said sling members adjacent the lateral ends of said wall, each of said resilient support units comprising a stack of resilient plates engaged with said girder, said stack including at least one pair of spaced co-acting plates arranged to deflect in opposite directions from each other upon the application of load thereto, and spacer members disposed between said pair of co-acting plates at opposite end portions thereof.

10. A top support system for an upright furnace wall comprising a support beam system including a laterally extending girder disposed above the upper end of said wall and supported at its ends, downwardly extending sling members interconnecting said girder and said wall and being in load-bearing relationship therebetween, and means for equalizing the stresses in said sling members to compensate for downward deflection of said girder comprising resilient support units connected to those of said sling members adjacent the lateral ends of said wall, each of said resilient support units comprising a stack of resilient lozenge-shaped plates engaged with said girder, said stack including a multiplicity of spaced pairs of aligned co-acting plates arranged to deflect in opposite directions from each other upon the application of load thereto, and spacer members disposed between said co-

acting plates at opposite end portions along the major axes thereof.

11. A top support system for an upright furnace wall comprising a beam system including a laterally extending girder disposed above the upper end of said wall and supported at its ends, downwardly extending sling members interconnecting said girder and said wall and being in load-bearing relationship therebetween, and means for equalizing the stresses in said sling members to compensate for downward deflection of said girder comprising resilient support units connected to those of said sling members adjacent the lateral ends of said wall, each of said resilient support units comprising a vertically disposed stack of lozenge-shaped resilient plates, said stack including multiple pairs of spaced co-acting plates, the plates of each pair having spacer members disposed therebetween and being arranged to deflect in opposite directions from each other, the lowermost plate of said stack being engaged with said girder, and means forming aligned centrally disposed openings in all of the plates of said stack, one of said sling members being received in said openings and attached to the uppermost plate of said stack to apply the load downwardly thereon.

12. A top support system for an upright furnace wall having a plurality of contiguous interconnected upright heat exchange tubes, said support system comprising a laterally extended girder disposed above the upper end of said wall and supported at its ends, downwardly extending sling members interconnecting said girder and said wall and being in load-bearing relationship therebetween, and means for equalizing the stresses in said sling members to compensate for downward deflection of said girder and lateral thermal expansion of said wall comprising resilient support units having a low deflection/load ratio and being connected to those of said sling members adjacent the lateral ends of said wall, and means rigidly connecting those of said sling members adjacent the laterally intermediate portion of said wall to said girder and said wall, each of said resilient support units comprising a vertically disposed stack of lozenge-shaped resilient plates, said stack including multiple pairs of spaced co-acting plates, the plates of each pair having spacer members disposed therebetween at opposite end portions along the major axes thereof and being arranged to deflect in opposite directions from each other upon the application of load to said unit, the lowermost plate of said stack being engaged with said girder, means forming aligned centrally disposed openings in all of the plates of said stack, one of said sling members passing through the aligned openings in said plates and being engaged with the uppermost plate of said stack, and means for holding said unit in a pre-compressed condition for reducing the deflection-load ratio of said unit prior to the application of said load.

13. A support system as claimed in claim 1 wherein means are provided for holding said spring unit in a pre-compressed condition for reducing the deflection/load ratio of said spring unit prior to the application of said load.

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