Oct. 6, 1953 D. M. SCHOENFELD 2,654,352

STEAM GENERATOR SUPPORT AND CASING STRUCTURE OF BOX COLUMN CONSTRUCTION

Filed Feb. 28, 1952 9 Sheets-Sheet 1

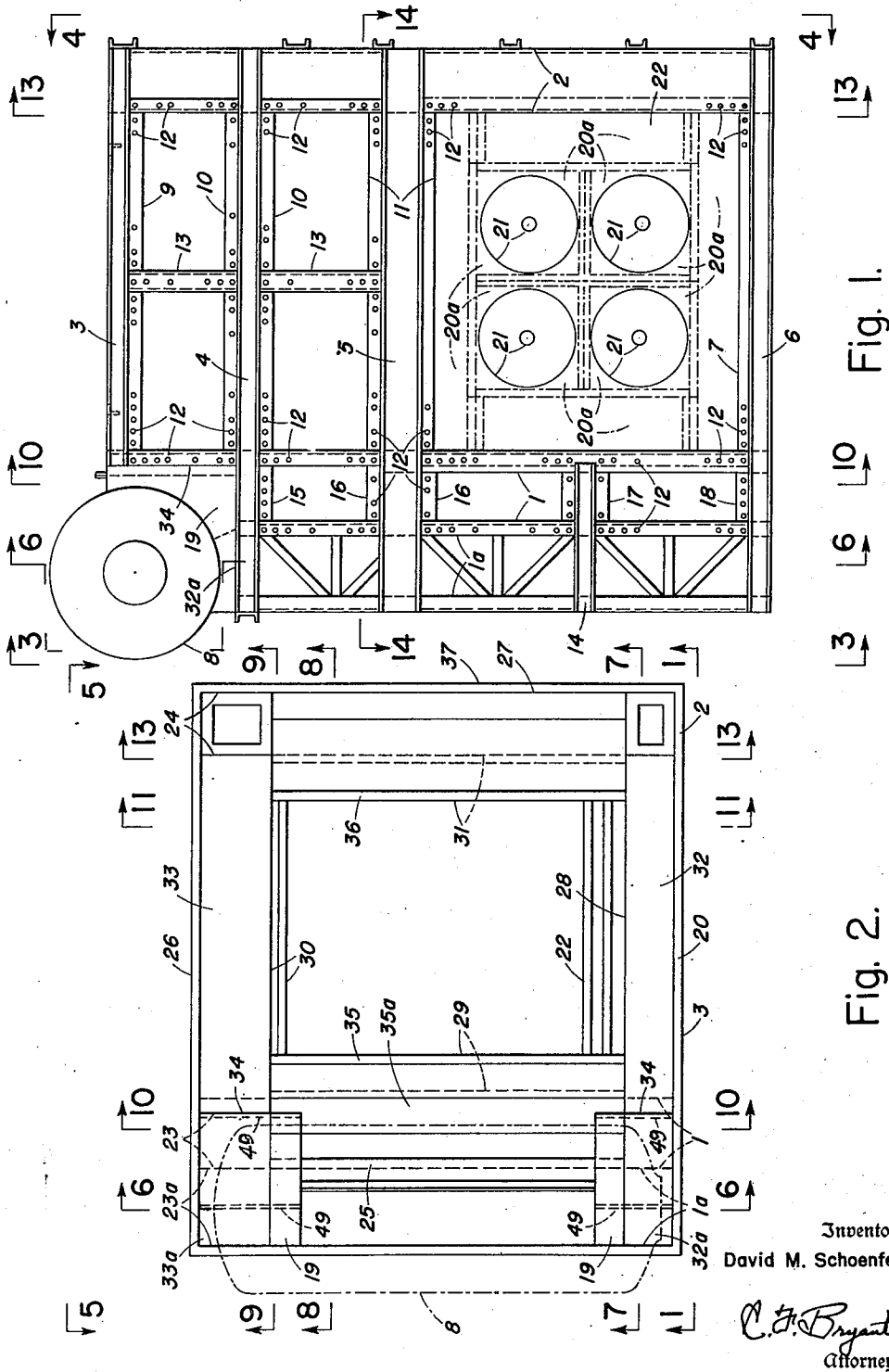


Fig. 1.

Fig. 2.

Inventor
David M. Schoenfeld

C. A. Bryant
Attorney

Oct. 6, 1953 D. M. SCHOENFELD 2,654,352

STEAM GENERATOR SUPPORT AND CASING STRUCTURE OF BOX COLUMN CONSTRUCTION

Filed Feb. 28, 1952 9 Sheets-Sheet 2

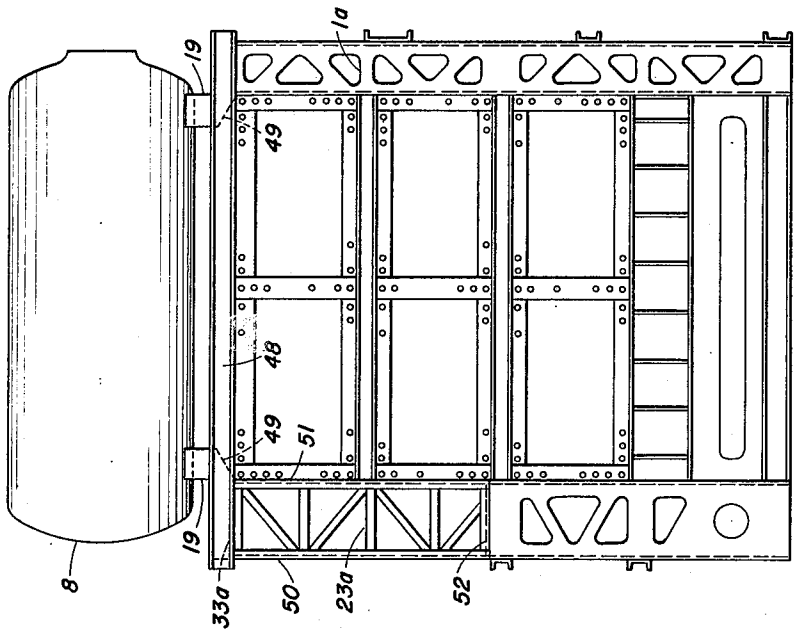


Fig. 3.

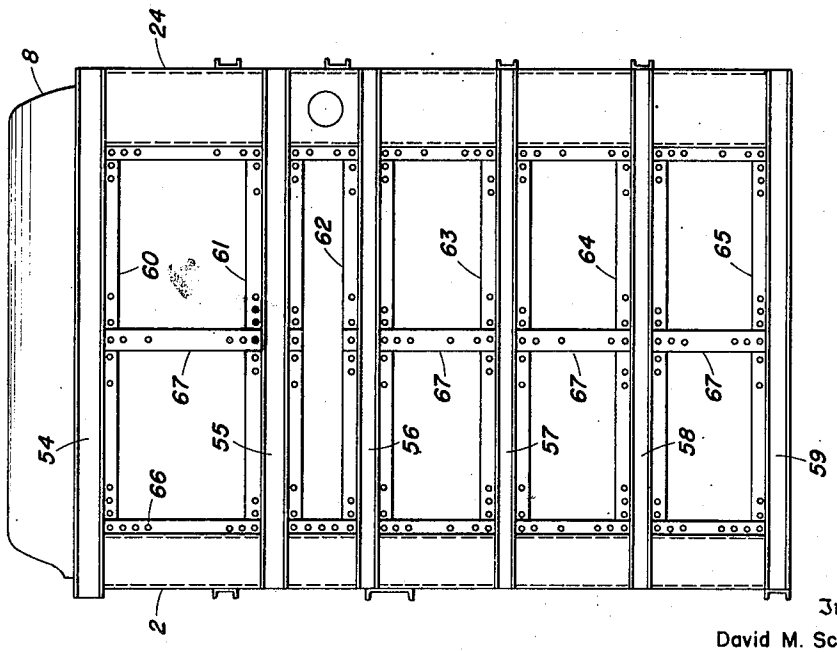


Fig. 4.

Inventor
David M. Schoenfeld

By

Attorney

Oct. 6, 1953 D. M. SCHOENFELD 2,654,352

STEAM GENERATOR SUPPORT AND CASING STRUCTURE OF BOX COLUMN CONSTRUCTION

Filed Feb. 28, 1952 9 Sheets-Sheet 3

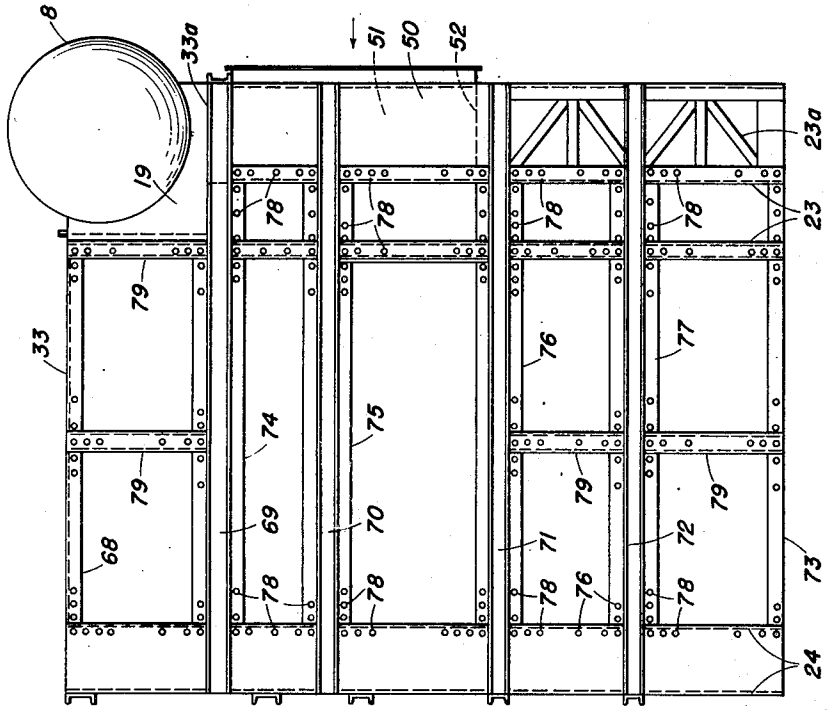


Fig. 5.

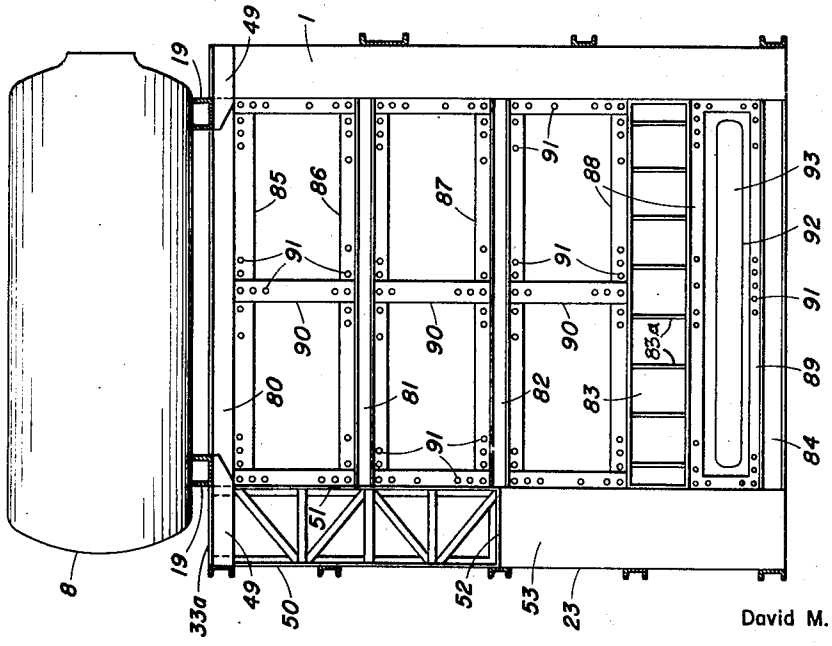


Fig. 6.

Inventor
David M. Schoenfeld

By

R. J. Bryant
Attorney

Oct. 6, 1953 D. M. SCHOENFELD 2,654,352

STEAM GENERATOR SUPPORT AND CASING STRUCTURE OF BOX COLUMN CONSTRUCTION

Filed Feb. 28, 1952 9 Sheets-Sheet 4

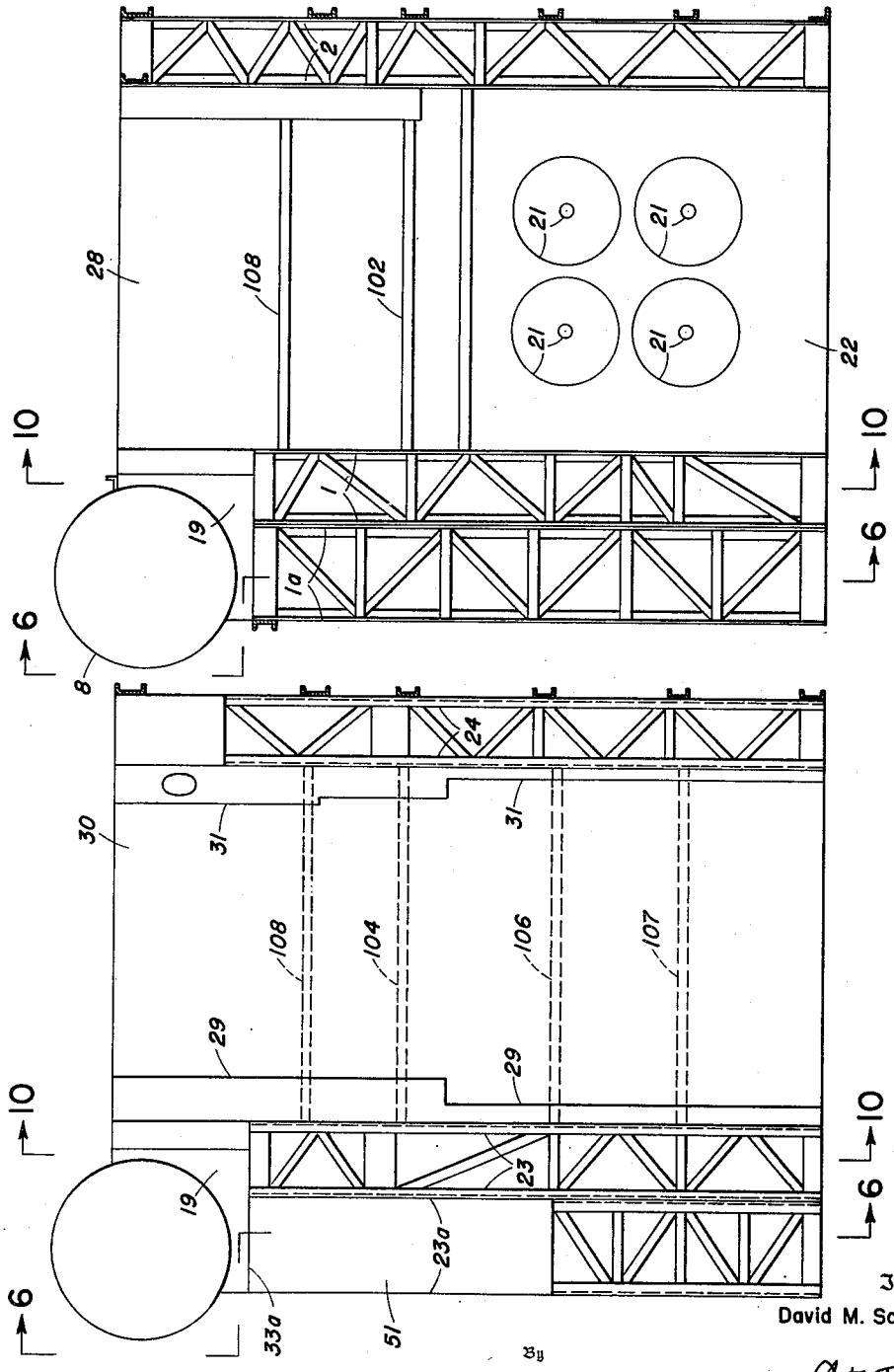


Fig. 7.

Fig. 9.

Inventor
David M. Schoenfeld

By

Attorney

Oct. 6, 1953 D. M. SCHOENFELD 2,654,352

STEAM GENERATOR SUPPORT AND CASING STRUCTURE OF BOX COLUMN CONSTRUCTION

Filed Feb. 28, 1952 9 Sheets-Sheet 5

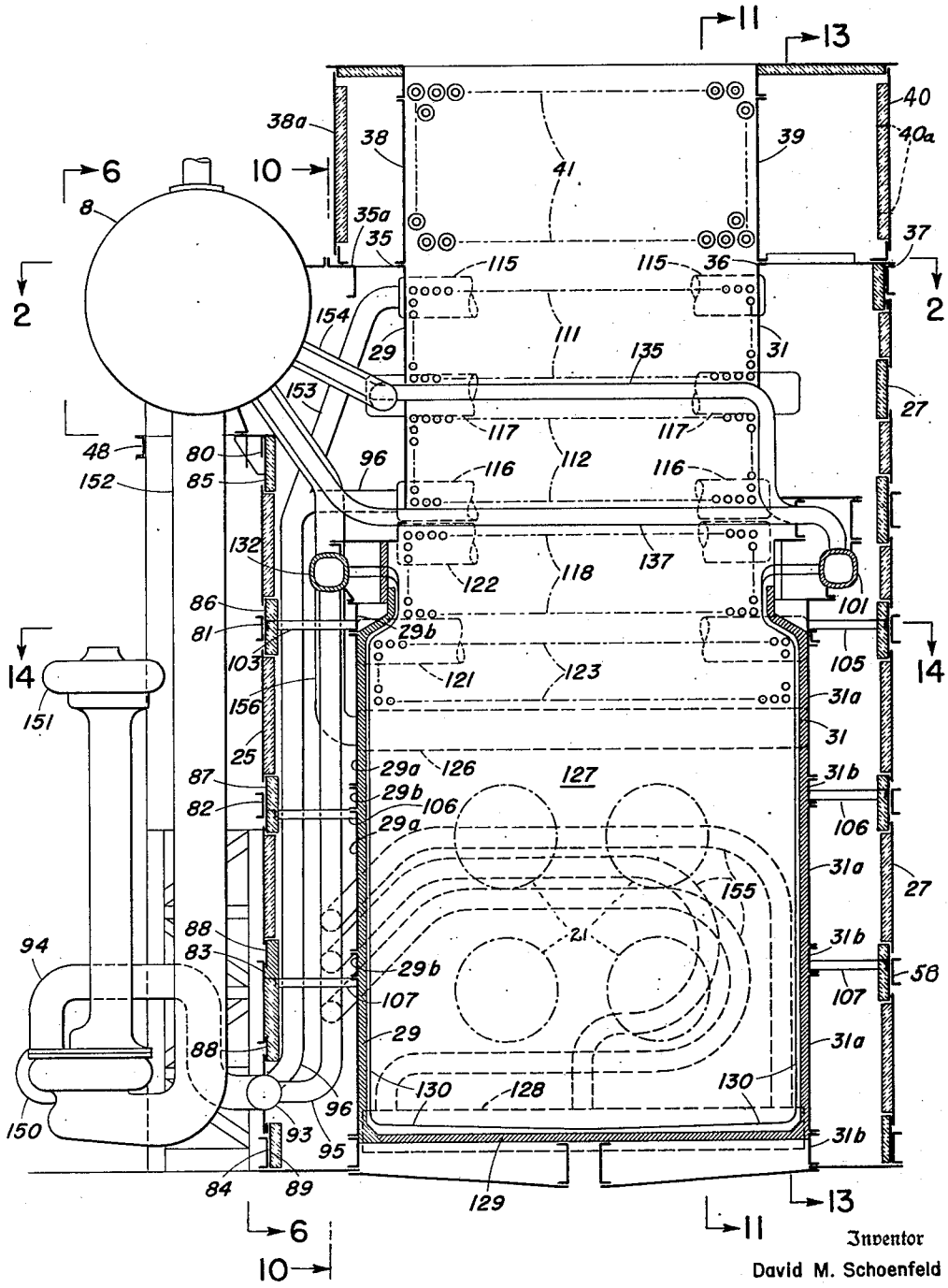


Fig. 8.

Inventor
David M. Schoenfeld

Attorney

Oct. 6, 1953 D. M. SCHOENFELD 2,654,352

STEAM GENERATOR SUPPORT AND CASING STRUCTURE
OF BOX COLUMN CONSTRUCTION

Filed Feb. 28, 1952 9 Sheets-Sheet 6

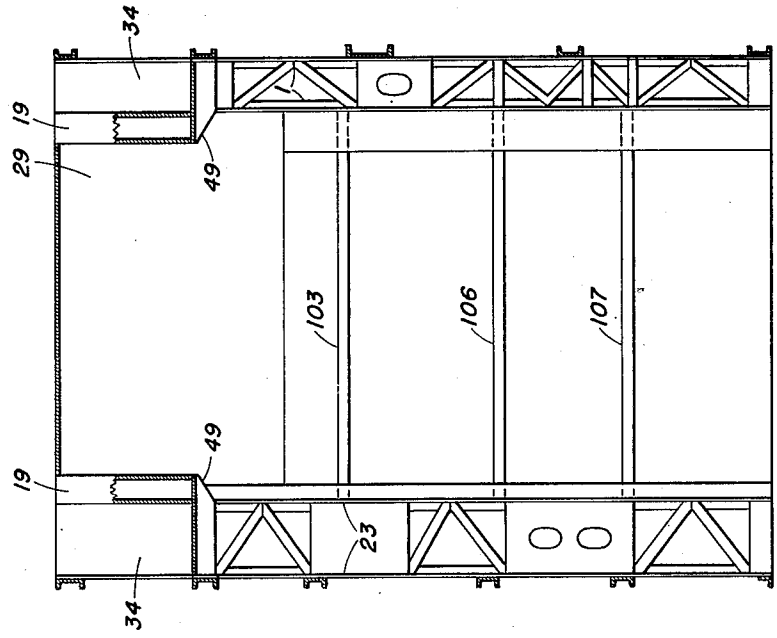


Fig. 10.

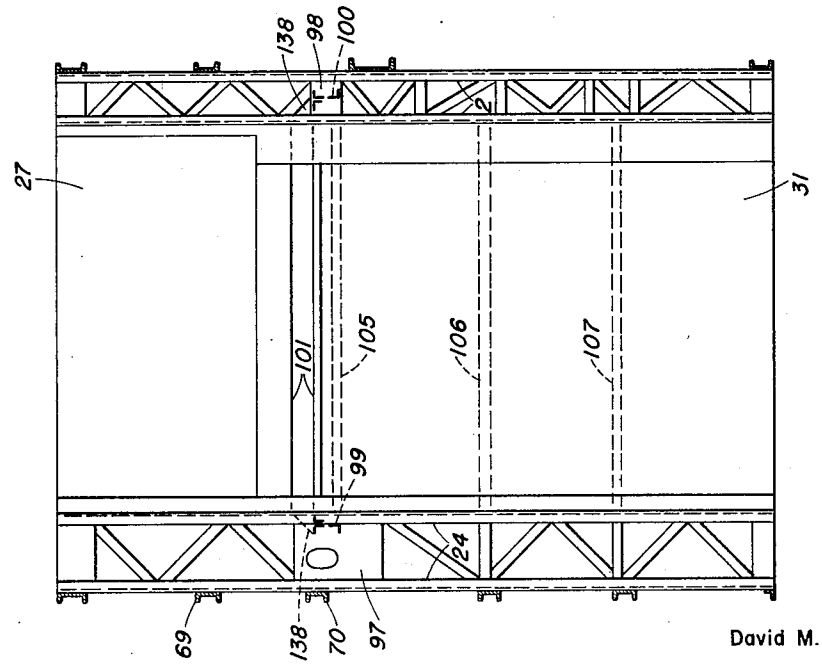


Fig. 13.

Inventor
David M. Schoenfeld

By

Attorney

Oct. 6, 1953 D. M. SCHOENFELD 2,654,352

STEAM GENERATOR SUPPORT AND CASING STRUCTURE OF BOX COLUMN CONSTRUCTION

Filed Feb. 28, 1952 9 Sheets-Sheet 7

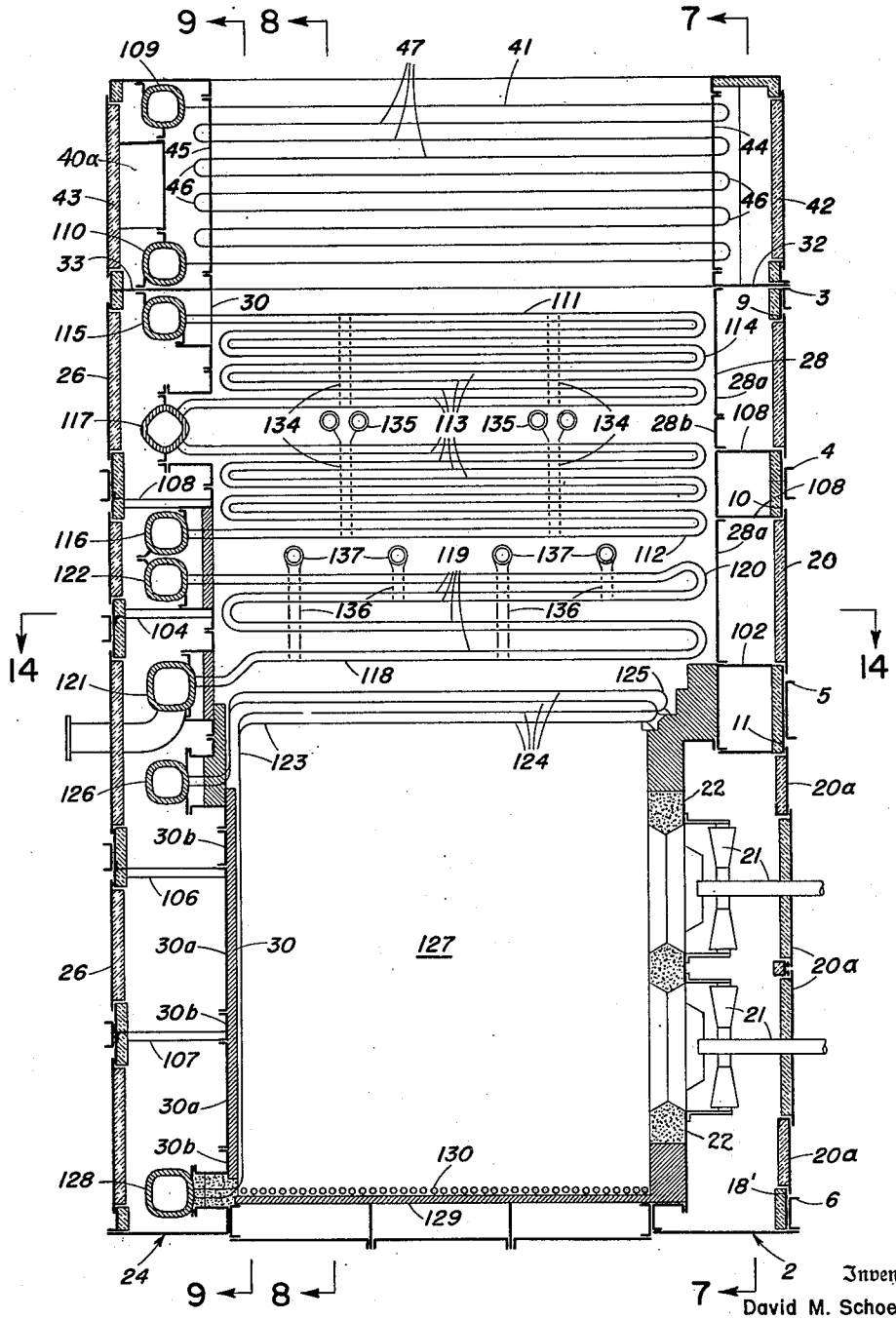


Fig. 11.

Inventor
David M. Schoenfeld

Attorney

Oct. 6, 1953 D. M. SCHOENFELD 2,654,352

STEAM GENERATOR SUPPORT AND CASING STRUCTURE OF BOX COLUMN CONSTRUCTION

Filed Feb. 28, 1952 9 Sheets-Sheet 8

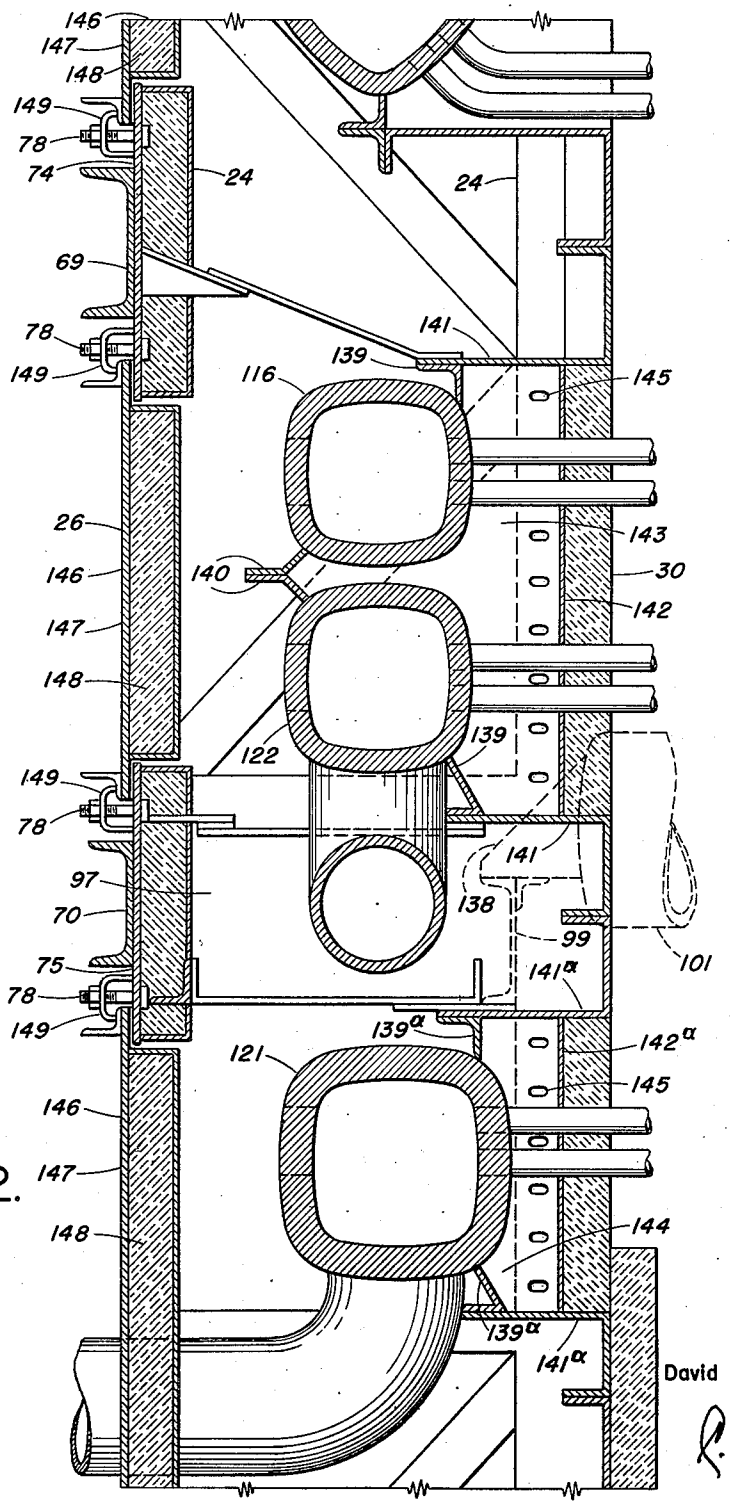


Fig. 12.

Inventor
David M. Schoenfeld

R. J. Bryant
Attorney

Oct. 6, 1953 D. M. SCHOENFELD 2,654,352

STEAM GENERATOR SUPPORT AND CASING STRUCTURE OF BOX COLUMN CONSTRUCTION

Filed Feb. 28, 1952 9 Sheets-Sheet 9

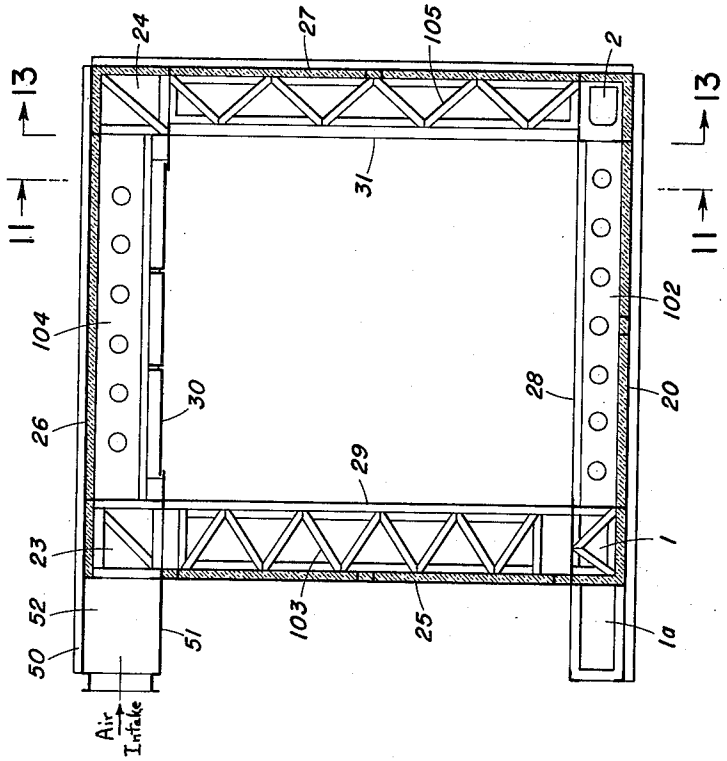


Fig. 14.

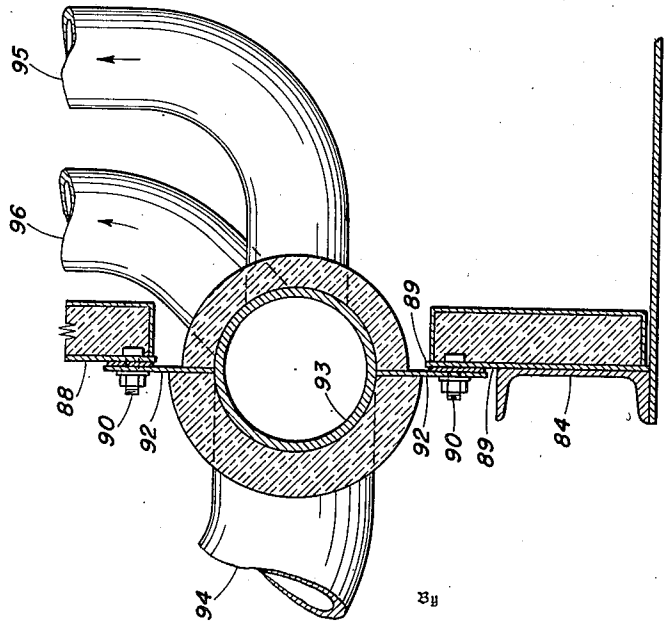


Fig. 15.

Inventor
David M. Schoenfeld

By
R. J. Bryant
Attorney

Patented Oct. 6, 1953

2,654,352

UNITED STATES PATENT OFFICE

2,654,352

STEAM GENERATOR SUPPORT AND CASING STRUCTURE OF BOX COLUMN CONSTRUCTION

David M. Schoenfeld, Scarsdale, N. Y., assignor to Combustion Engineering, Inc., New York, N. Y., a corporation of Delaware

Application February 28, 1952, Serial No. 274,001

1 Claim. (Cl. 122—494)

1

This invention relates to steam generators of the boiler furnace type and it has special reference to supporting means for steam generators that are intended for marine service and that have spaced-apart inner and outer casings which form air chambers or air passages surrounding the generator heat absorbing elements and through which passages the air for combustion flows and is heated, by keeping the inner casing cool, before entering the boiler furnace with the fuel; the air passages also serving to prevent gases from the boiler and furnace from reaching the space outside thereof in the ship.

Recent requirements for a certain type of marine steam generator fitted in a ship call for the generator supports to resist vertical and/or horizontal shock forces equivalent to at least about six times the weight of the generator. Furthermore, the requirements call for the total weight of the generator and casing to be a practical minimum; also for the casing to withstand a comparatively high air pressure within its inner portion as well as between its inner and outer portions.

Broadly stated, the object of this invention is to provide a novel design of support and casing for a marine steam generator which will meet the requirements mentioned above.

A more specific object is to provide a boiler supporting and casing structure which is exceptionally strong and which has a minimum weight.

Additional objects and advantages will become apparent as the disclosure and description hereof proceeds.

To achieve the foregoing, the supporting structure and casing have been designed to act as an integral unit in the form of two concentric box columns. Each of the corner columns, itself a smaller box column, unites adjacent sides of the inner and outer casings. Horizontal girders and trusses close the top of the casing structure (exclusive of the flue gas outlet opening) and the foundation structure closes the bottom. The inner and outer casings are fitted into the resulting frame structure. Horizontal trusses at suitable levels distribute the shock loads between the inner and outer casings. The column verticals withstand the bending action due to the athwartship and fore and aft shock loads, as well as the vertical shock loads. The casing panels transmit the athwartship and fore and aft shock loads by shear to the boiler base, and also provide the strength required to withstand the shutoff pressure of the blower which furnishes the air for combustion of the fuel fired in the furnace of the

2

boiler. This construction provides a path for the shock loading on each item in the boiler from its position in the boiler to the four column footings, where the shock loads are applied to the boiler from the ship framing structure.

The invention itself will best be understood from the following description of an illustrative embodiment thereof when taken in conjunction with the accompanying drawings, wherein:

Figure 1 is a front vertical elevation, taken on line 1—1 of Fig. 2, of a frame structure for a steam generator embodying one form of the invention; the casing panels being removed to more clearly show the structure.

Figure 2 is a plan view of Fig. 1 (also taken on line 2—2 of Fig. 8) showing the structure of the steam generator casing with the drum removed.

Figures 3, 4 and 5 are respectively the left, right and rear side vertical elevations of the structure of the steam generator, taken respectively on lines 3—3 and 4—4 of Fig. 1 and on line 5—5 of Fig. 2.

Figure 6 is a vertical cross section, taken on line 6—6 of Figs. 1, 7, 8 and 9 showing the structure of the left side columns supporting the steam and water separating drum of the steam generator; this being the same as the outside structure of the left corner columns of the inner and outer casing walls.

Figure 7 is a vertical cross section, taken on line 7—7 of Fig. 2, showing the front side structure of the front inner casing and rear side of the front drum columns.

Figure 8 is a vertical cross sectional elevation, taken on line 8—8 of Fig. 2, showing the heating elements including those of the economizer, of the steam generator and of the superheater within the casing and the side walls and floor of furnace, and the water circulation pump and its pipe connections to the steam generator for maintaining a controlled circulation of the boiler water.

Figure 9 is a vertical cross section, taken on line 9—9 of Fig. 2, showing the inner side structure of the rear inner casing and drum columns.

Figure 10 is a vertical cross section, taken on line 10—10 of Figs. 1, 2, 7, 8 and 9, showing the inside structure of the left side casing columns adjacent the drum supporting columns; these columns forming the corners of the inner and outer casing walls.

Figure 11 is a vertical cross section, taken on line 11—11 of Figs. 2 and 8, showing the heating elements including those of the economizer, of the steam generator and rear wall of furnace and

of the superheater within the casing and their respective headers and showing the means for supporting and sealing said headers into box structures which in turn are supported by the casing structures.

Figure 12 is a fragmentary portion of Fig. 11 to an enlarged scale showing typical structural details for supporting said headers and typical structural details for mounting the casing panels on the casing structure.

Figure 13 is a vertical cross section, taken on line 13—13 of Figs. 1, 2 and 8, showing the inner structure of the right side casing columns which form the corners of the inner and outer casing walls.

Figure 14 is a horizontal cross section, taken on line 14—14 of Figs. 1, 8 and 11, showing typical horizontal beams within the casing for stiffening the inner and outer casing walls and rigidly tying together the corner columns.

Figure 15 is a vertical cross section of a fragment of Fig. 8 (at the bottom of left casing wall 25) to an enlarged scale showing the mounting for the main supply header which distributes boiler water from the circulation pump to the steam generator elements.

In general the supporting structure and casing for the steam generator elements are designed to act as a unit. The casing is in the form of two concentric boxes providing air chambers therebetween, at the vertical corners of which boxes are vertically extending box columns. The sides of these columns which lie between the inner and outer casing walls are preferably of lattice construction except where occasional plates are required for accommodating fastenings to other members of the structure. Their outersides are imperforate plates wherever the column forms a part of the air tight casing. Corner columns and casings are unified through the employment of horizontally extending girders.

Figure 1 shows the front outer casing supporting structure with the casing panels (which provide access to the air chambers) removed. This front outer support structure comprises the left and right vertical corner columns respectively shown at 1 and 2, together with horizontally extending and vertically spaced apart stiffeners 3, 4, 5 and 6, here shown as structural steel channels, which are rigidly fastened to the outer faces of columns 1 and 2 by known means. The stiffeners 4, 5 and 6 extend to the left beyond column 1 and over the width of column 1*a* which mainly supports about half of the load of the steam and water drum 8. Said stiffeners are rigidly fastened to column 1*a*. Columns 1 and 1*a* therefore are in effect a single column.

Said stiffeners 3, 4 and 5 have plates 9, 10 and 11 respectively fastened on their inner sides which plates extend beyond the top and bottom of stiffeners 4 and 5 and the bottom of stiffener 3 to form ledges as shown, against which ledges the removable casing panels are fastened as by studs and nuts 12. Typical panels will be described at a later point herein. A vertical member 13 extends between stiffeners 3 and 4, and 4 and 5, is fastened to each; and divides the two openings between stiffeners and columns 1 and 2 into four openings as shown. The panel-holding bolts 12 are placed around each of these openings and are fastened to the columns 1 and 2 as well as to the plates 9, 10 and 11.

Column 2 has an imperforate plate on its front side extending for the full width and height to serve as part of the air tight casing later to be described. The front face of column 1*a* is of lattice construction for lightness as shown by Figs. 1 and 7, and may be made up of angle irons or may be made of a perforate plate shown in Fig. 3. A further stiffener 14 extends horizontally across columns 1 and 1*a* (see Fig. 1) and is fastened to each. Plates 15, 16, 17 and 18 (again see Fig. 1) are fastened to the rear sides of stiffeners 4, 5, 14 and 6 respectively where they cross column 1, and extend beyond the top and/or bottom of said stiffeners as shown, to form ledges against which the removable casing panels providing access to the air chamber are fastened as by bolts 12; typical panels being described below. Drum 8 is mounted in saddle 19 (see Figs. 1, 2, 3, 5, 6, 7, 9) which is fastened thereto and to the top of columns 1 and 1*a*.

Between columns 1 and 2 and stiffeners 5 and 6 are mounted removable panel structures 20*a*, their location being shown in dashed and dotted lines in Fig. 1 and shown in cross section in Fig. 11. The outer panels 20*a* adjacent the burners 21 provide access to these burners. Said burners 21 (see Figs. 1, 7, 8) are mounted on the inside casing 22 (see also Fig. 11) and having suitable openings to establish communication between the space defined by the inner and outer casings and the interior of the inner casing for the passage of heated combustion supporting air from said space into the interior of the inner casing; and the central fuel pipes of these burners 21 extend through said adjacent casing panels 20*a*. The outer panels 20*a*, surrounding the space occupied by the burners, are mounted as by bolts 12, onto the lower ledge 11 of stiffener 5 (see Fig. 1), the upper ledge 7 of stiffener 6 (see also Fig. 1) and the front faces of columns 1 and 2.

Figure 2 is a plan view of the Fig. 1 boiler with the drum 8 shown in dashed and dotted lines (in order to achieve greater clarity in representing the boiler parts beneath the drum). From Fig. 2 it will be seen that the four columns 1, 2, 23 and 24 constitute the four corners for the outer and inner casing walls of the steam generator. The reference numbers for the outer casing walls are 20 for the front wall, 25 for the left side wall, 26 for the rear wall, and 27 for the right side wall. The equivalent or corresponding inside walls are 28, 29, 30 and 31 (see again Fig. 2); said inner walls 29 and 31 being offset vertically as shown in Fig. 8.

The air spaces between left walls 25 and 29 and between right walls 27 and 31 are open at the top (Fig. 8); while the air spaces between front walls 20 and 28 and between rear walls 26 and 30 are closed at the top by plates 32, 33 respectively (see Fig. 11). Moreover, the tops of columns 2 and 24 (shown at right of Figs. 1–2) are open at the top, while the tops of columns 1, 1*a*, 23 and 23*a* (shown at left of Figs. 1–2) are closed by the plates 32*a*, 33*a* respectively (again see Figs. 1–2). It also will be noted that the saddles 19, 19 (see Figs. 1, 3, etc.) supporting the drum 8, fasten to and are supported by bracket members 49 (Figs. 10, 3 and 2) extending from the tops of columns 1*a* and 23*a* and further fasten to vertical members 34 extending upwardly on the right side of columns 1 and 23 (Figs. 1, 2 and 10).

From Figs. 2 and 8 it will be seen that flanges 35, 36 and 37 are provided at the top edges of

walls 29, 31 and 27 respectively, and that onto these walls the respective casing walls 38, 39 and 40 of an economizer 41 are fastened and supported (Fig. 8). The left economizer wall 38*a* rests upon and fastens to seal plate 35*a* (Figs. 2 and 8). The top flange of outside front wall stiffener 3 (Fig. 8) and the top of outside rear wall 26, fasten to and support the respective casing wall panels 42, 43 of economizer 41 (Fig. 11) and inside walls 28 and 30 fasten to and support the economizer casing walls 44, 45, respectively. The economizer is principally supported by the casing walls 44, 45 through which the return bends 46 of the economizer's tubular elements 47 project (see Fig. 11).

Figure 3 shows the left side of columns 1*a* and 23*a* to be of lattice construction for lightness. They are tied together at the top by channel 48. Bracket members 49, behind channel 48, support the saddles 19 and their superimposed drum 8 (see also Fig. 10). Imperforate plates 50, 51, 33*a* and 52 extend from the left side to the right side of column 23*a* (at right angles to the plane of the paper in Figs. 3 and 6) to form an air intake conduit leading into the air spaces of the casing; said air intake conduit being shown in Fig. 14 (at upper left portion thereof). Said plates connect to the walls 25, 26 (Fig. 14) and to the plate 53 on the left face of column 23 (Fig. 6). The former structure for supporting the removable casing panels will be described in the reference to Fig. 6.

Figure 4 shows the supporting structure of the right side outer casing wall of the steam generator. Columns 2 and 24 have imperforate plates on their outer sides which serve as part of the outer air tight casing wall 27 (Figs. 2 and 8). As in Fig. 1, the casing panels which provide access to the air chamber between the inner and outer walls are removed (to clarify representation) and the casing supporting structure comprises horizontally extending and vertically spaced apart stiffeners 54, 55, 56, 57, 58 and 59, here shown as structural steel channels, which are rigidly fastened to the outer faces of columns 2 and 24. The stiffeners have plates 60, 61, 62, 63, 64, 65 respectively fastened on their inner sides which plates extend beyond the top and/or bottom of the stiffeners to form ledges as shown, against which the removable casing panels of the outside right wall 27 (Fig. 8) are fastened as by bolts 66.

Vertical members 67 extend between the stiffeners where shown and are fastened thereto and divide each of all but one of the openings between the stiffeners and columns 2 and 24 into two openings as shown. The panel-holding bolts 68 are placed around each of these openings and are fastened to the columns 2 and 24 as well as to said plates and vertical member 67.

Figure 5 shows the supporting structure of the rear outer casing of the steam generator. Column 24 has an imperforate plate on its outer side which serves as part of the outer air tight casing wall 26 (Fig. 11). Column 23*a* is of lattice construction for lightness on its lower portion and has an imperforate plate 69 on the upper portion forming a side of the air intake conduit (see Fig. 14) leading into the air spaces of the casing. As in Figs. 1 and 4, the casing panels which provide access to the air chamber space are removed and the casing supporting structure comprises horizontally extending and vertically spaced apart stiffeners 68, 69, 70, 71, 72, 73 here shown as structural steel angle irons (68, 73) and channels (69, 70, 71, 72).

The channels are rigidly fastened to the outer faces of the columns 24, 23 and 23*a* and the angle irons are fastened to columns 24 and 23 with their outer faces flush. The columns 23, 23*a* thus are in effect a single column. The stiffeners 69, 70, 71, 72 have plates 74, 75, 76, 77 fastened on their inner sides, which plates extend beyond the top and bottom of the stiffeners to form ledges as shown; and against these ledges the removable casing panels of the outside rear wall 26 (Fig. 11) are fastened as by bolts 78. Said plates 74, 75, 76, 77 extend across the width of column 23 as shown. Vertical members 79 extend between the stiffeners where shown and are fastened thereto and divide the openings between the stiffeners and columns 24 and 23 into a multiplicity of openings as shown. Four access openings are provided in column 23 as shown. Bolts 78 extend around each of these openings and are fastened to the columns 23 and 24 as well as to said plates and vertical members 79.

Figure 6 shows the left faces of columns 1 and 23, or the right faces of columns 1*a* and 23*a*, these being common to both columns, and supporting structure of the left side outer casing of the steam generator.

In this view the portions of the adjoining columns 1*a* and 23*a* other than the intermediate common face shown between columns 1*a* and 1, and between 23*a* and 23, have been omitted from the drawing. Such omitted portions are the structural members of the front and rear faces of columns 1*a* and 23*a*, which members are at right angles to and frame into said common faces of columns 1 and 1*a* shown.

From Fig. 6 it will be seen that column 1 has an imperforate plate on its outer side which serves as part of the outer air tight casing wall 25 (Figs. 2 and 3). Column 23 has an imperforate plate 53 on the lower portion of its outer side which serves as part of the air tight casing wall 25. It is of lattice construction for lightness on the upper portion which lies within the air intake conduit (see Fig. 14) bounded by the imperforate plates 50, 51, 33*a*, 52 previously referred to in the description of Fig. 3. As in Figs. 1, 4 and 5, the casing panels which provide access to the air chamber are removed from Fig. 6 (to clarify representation), except for the lowermost one which Fig. 6 does show.

The casing supporting structure represented in Fig. 6 comprises horizontally extending and vertically spaced apart stiffeners 80, 81, 82, 83, 84; shown as structural steel members, which are rigidly fastened to the sides of columns 1 and 23. Stiffening member 83 comprises a plate provided with bracers 83*a*. The aforesaid stiffeners have plates 85, 86, 87, 88, 89 (see also Fig. 8) respectively fastened to their inner sides which plates extend beyond the top and/or bottom of the stiffeners to form ledges as shown, against which the removable casing panels of the outside left wall 25 (Fig. 8) are fastened. Vertical members 90 extend between the stiffeners where shown and are fastened thereto and divide each of the upper three openings between stiffeners and columns 1 and 23 into two openings as shown. Bolts 91 for holding the casing panels in place are provided around each of these openings and are fastened to the columns 1 and 23 as well as to said panel and vertical members 90.

The lowermost casing panel shown at 92 in

Fig. 6 (see also Figs. 8 and 15) serves as a support for the header 93 from which boiler water is delivered to the various steam generating elements; the novel organization of these parts 92 and 93 being disclosed and claimed by co-pending application Serial No. 273,984 filed February 28, 1952 in the name of Edward W. Ludt for "Header Integral With and Sealed Into Boiler Casing."

As shown in Figs. 6 and 15 hereof, the header 93 is welded into the panel plate 92 thereby serving as a stiffening member for said plate and providing a communication between the outside water delivery pipe 94 to said header and the discharge pipes 95, 96 located within the air space of the casing. Stuffing boxes as otherwise required are thereby avoided.

In Figs. 7, 9, 10 and 13 omission has been made (as in Fig. 6 and also for purpose of clarifying representation) of the portions of the adjoining columns such as the structural members of the faces which are at right angles to and frame into the backs of the columns represented by those drawing views.

Figure 7 shows the front elevation of inside lower casing wall 22 which supports the burners 21 and shows the upper casing wall 28 thereabove (see also Fig. 11). It further shows the inner sides of box columns 1, 1a and 2 to be of lattice construction for lightness.

Figure 9 shows the inside elevation of the inside casing wall 30 and the front sides of the box columns 23, 23a and 24 to be of lattice construction for lightness. The upper portion of column 23a has an imperforate plate 51 which forms one side of the air intake conduit shown in Figs. 3, 5 and 6.

Figure 10 shows the inside elevation of the inside casing wall 29 (Figs. 2 and 8) and the right sides of the box columns 1 and 23. The column sides are of lattice construction for lightness except where plates are required for accommodating fastenings such as the structural members supporting the various headers of the steam generating tubes to be described below.

Figure 13 shows the inside elevation of the lower portion of the inside casing 31 (see Figs. 2 and 8) and the upper portion of the outside casing 27. It shows the left sides of the box columns 2 and 24 to be of lattice construction for lightness except where plates 97 and 98 on columns 24 and 2 respectively are placed to support structural members 99 and 100 supporting a steam generator header 101 to be described later.

Figure 14 shows a typical horizontal group of beams 102, 103, 104, 105 located within the air spaces of the casing for stiffening the casing walls and rigidly tying together the corner columns 1, 2, 24 and 23 to which they are fastened. The beams may be made with web plates of perforated steel sheets as shown in beams 102, 104 or the beams may be made latticed beams for lightness, as shown in beams 103, 105. There are a multiplicity of similar horizontal groups of stiffening beams located within the air spaces of the casing at other vertical locations than the one group shown at section 14 in Figs. 8 and 11, that is made up of beams 102, 103, 104 and 105. Such groups of beams may occur at other levels such as 106, 107, 108 shown in Figs. 8 and 11 and in Figs. 7, 9, 10 and 13; and a typical fastening of said beams to the casings is shown in Fig. 8 where beam 107 is fastened to the inner stiffener 31b and to the outer casing stiffener 58.

Figures 8 and 11 show in general the locations of the economizer, steam generator and superheater elements within the casing. The products of combustion produced by the burning of fuel entering via burners 21 rise from the furnace 127 to pass upwardly across said elements to generate and heat steam.

The economizer 41 (Fig. 11) comprises a bank of horizontally disposed parallel spaced apart tubes 47 interconnected by return bends 46 as shown for serial flow of feed water therethrough from the inlet header 109 to the outlet header 110. The headers 109, 110 lie between the rear side economizer casing walls 43, 45; and outlet header 110 is connected by a pipe (not shown) to the steam and water drum 8. Preferably an air intake 40a (Figs. 8 and 11) is provided in the casing wall 40 of the economizer; said air intake 40a being in supplement to the earlier mentioned first air intake for the boiler furnace, which first intake is shown at 52 in Fig. 14.

The secondary evaporator shown by Figs. 8 and 11 is made in two superimposed sections 111 and 112. Each section comprises a bank of horizontally disposed parallel spaced apart tubes 113 interconnected by return bends 114 for serial flow of boiler water from inlet headers 115, 116, to outlet header 117. The headers 115, 116, 117 lie between the rear side generator casing walls 26, 30.

The superheater shown by Figs. 8 and 11 at 118 comprises a bank of horizontally disposed parallel spaced apart tubes 119 interconnected by return bends 120 for serial flow of steam therethrough from the inlet header 121 to the outlet header 122.

The primary evaporator shown at 123 comprises a bank of horizontally disposed parallel spaced apart tubes 124 interconnected by return bends 125. One end of each of said tubes 124 connects into the outlet header 126, as shown and the other end bends downwardly to continue along the side of the rear inside wall 30 facing the furnace 127, thence to pass through wall 30 to enter the inlet header 128 adjacent the bottom 129 of the furnace.

In Figure 8 are shown the evaporator tubes 130 lining the left, bottom and right walls respectively 29, 129 and 31 of the furnace 127. These tubes are parallel spaced tubes connected at one end to the inlet header 132 within the air space between the left side walls 25, 29 of the casing and connected at the other end to the outlet header 101 within the air space between the right side walls 31, 27.

The economizer tubes 47 (Fig. 11) pass through the rear and front side casing walls 45, 44 respectively, and are supported thereby. The secondary evaporator tubes 113 are supported by members 134 passing vertically between tubes through the bank, which members are in turn supported by the relief or riser tubes 135 (see also Fig. 8). The superheater tubes 119 are supported by members 136 passing vertically between tubes through the bank, which members are in turn supported by the relief or riser tubes 137. The primary evaporator tubes 124 are supported at one end by outlet header 126 and at the other end by pads under the return bends 125 which in turn rest upon upper ledges of the inner front wall 22 as shown.

The wall tubes 139 (Fig. 8) are supported from the headers 132, 101 and by the furnace bottom 129. The riser tubes 135, 137 (Fig. 8) through which the steam and water mixture from the outlet header 101 passes to the drum 8, are supported by said header at the right end and by

said drum at the left end. The loads of the evaporator banks of tubes 111, 112 plus the superheater bank of tubes 118 are transmitted by the relief or riser tubes 135, 137 to the drum 8 and the header 101 of the wall tubes 130.

The principal supports of the header 101 as mentioned above are structural members 98, 99 (Figs. 13 and 12) which are framed into the columns 2 and 24. Brackets 138 are fastened as by welding, onto the ends of header 101 and rest upon the members 98, 99. The remaining headers 132 (Fig. 8) and 115, 116, 117, 121, 122 and 126 (Fig. 11) are supported in similar manner to that typically shown in Fig. 12 for headers 116, 121, 122. Each header in Fig. 12, has angle members 139 fastened longitudinally thereto adjacent its inner side from end to end as by welding. Each header 116 and 122 has angle members 140 fastened thereto adjacent its outer side, the two angles 140 being fastened together to form a gas tight seal therebetween. The angles 139 each fasten to a plate 141 extending outwardly from the inside casing wall 30 toward the headers.

The inside wall plates 142 are fastened to plates 141 as by welding to form a gas tight seal therewith. Both plates 141 and 142 and the angles 139, 140 extend for the full width of the wall 30 to the adjacent columns 23 and 24 to which they are fastened. End plates 143 adjacent the columns 23, 24, close each end of the gas tight chamber formed by the headers 116, 122, the associated angles 139, 140 and plates 141, 142 to which they are fastened, as by welding. Similar end plates 144 close the chamber formed by header 121, the associated angles 139*a* and plates 141*a*, 142*a*. The end plates 143, 144 are each provided with holes 145 through which bolts pass to fasten them to the vertical members of columns 24 as shown. The fastenings of the end plates 143, 144 adjacent column 23 to said column 23 are similar to those shown and described with relation to column 24.

From the above description it will be seen that all of the elements of the steam generating unit comprising the economizer, the evaporator sections including those on the furnace walls, the superheater, all of the associated headers and the steam and water separating drum are all ultimately supported by the corner columns represented at 1—1*a*, 2, 24 and 23—23*a* in Fig. 2 and other views.

The attachment of the removable casing panels to the outside walls is typically shown in Fig. 12. Typical panels 146 of rear outside wall 26 comprise plates 147 backed by insulation 148. Each plate 147 is strengthened by "hat" or bracer sections in the form of members (not shown) attached to the outer surface of the plate (in the way that members 83*a* of Fig. 6 are attached to plate 83), along which surface they extend vertically in spaced relationship. The plates 147 extend over the ledges formed by plates 74, 75 which extend beyond the stiffeners 69, 70 respectively (see also Fig. 5). Studs 78 are fastened to said ledges and pass through holes in the yokes 149. By means of nuts on said studs 78 bearing against battens 149 as shown, which in turn bear against plates 147 (while heeling against plates 74, 75), the plates 147 are snugly held against the ledge plates 74, 75. Gaskets (not shown) are provided between plates 147 and 74, 75 to make gas tight joints. A similar construction is used to fasten all of the removable casing panels of all the outside casing walls to the outer wall casing frame structures. The weight of all of said casing panels is thereby carried through said frame structure to the corner columns.

The inside casing walls 28, 29, 30, 31 are divided into flanged panels 28*a*, 29*a*, 30*a*, 31*a*, as typically shown in Figs. 8 and 11. These may be removable and are generally supported by horizontal structural members such as channels 28*b*, 29*b*, 30*b*, 31*b* which in turn extend to and are fastened to and are supported by the corner columns 1, 2, 23, 24.

Controlled circulation (sometimes referred to as "forced" circulation) of boiler water through the steam generating elements is accomplished by a pump shown at 150 in Fig. 8 and driven by a motor or turbine 151. A pipe 152 is connected to the drum 8 and to the pump inlet for supplying of boiler water, and a pipe 94 connects the pump discharge to the distribution header 93 to the inlet header 132 of wall tubes 130 and delivers water thereto. The relief or riser connections 135, 137 between outlet header 101 of wall tubes 130 to the drum 8 have already been described at an earlier point herein. A water supply pipe 96 connects the distribution header 93 (Fig. 8) to the inlet header 116 of the evaporator section 112 and a pipe 153 interconnects the pipe 96 and the inlet header 115 of the evaporator section 111.

The secondary evaporator sections 112, 111 discharge steam and water via the extension 154 of outlet header 117 directly into drum 8. Pipes 155 adjacent the left side and rear furnace walls (Fig. 8) connect into pipes 95 and into the inlet header 128 of the primary evaporator 123 for water supply thereto. A pipe 156 connects the outlet header 126 of the primary evaporator 123 to the drum 8 for steam and water discharge therethrough. The usual steam supply connection from the drum 8 to the superheater inlet header 121 (Figs. 8 and 11) is external of the casing and not shown, but the weight of this connection is supported by the drum and header which in turn carry said weight to the drum and casing columns.

From the foregoing it has been seen that the complete steam generator casing provides a novel supporting structure for all the elements of the steam generating unit. The illustrative casing and support structure here disclosed is capable of resisting vertical and horizontal shock forces equivalent to at least about six times the weight of the generator; the casing and generator unit are of minimum weight in construction; and the casing comprises two spaced apart inner and outer casing walls (the inner casing itself being gas tight) forming a fluid tight compartment therebetween on the sides of the unit, vertical box columns of lattice construction at the corners of said compartment, and horizontally extending, vertically spaced stiffening beams and girders between columns and casing and fastened thereto.

While one preferred embodiment of invention has been here shown and described, it will be understood that such disclosure is illustrative rather than restrictive and that changes in construction, combination, and arrangement of parts may be made without departing from the spirit and scope of the invention as claimed.

What I claim is:

A boiler for marine use comprising an upright structural steel frame having four upright latticed columns of rectangular transverse section

forming the corners of the frame; horizontally disposed latticed beams interconnecting adjacent columns at vertically spaced intervals, the inner and outer extremities of the beams corresponding with those of the columns; metallic panels disposed adjacent the inner extremities of the beams and columns and secured to said beams and columns so as to form a fluid tight inner casing for the boiler; means forming a bottom for the interior of the inner casing; steam generating tubes lining the inner surface of said bottom and the lower portion of the inner casing; metallic panels disposed adjacent the outer extremities of the beams and columns and held in fluid tight engagement therewith by removable clamps secured to said beams and engageable with said panels; a steam and water drum supported by two of said columns and secured to said outer panels in a fluid tight manner so that a portion of the drum wall forms a portion of the outer casing with the remainder of said outer casing being made up of said outer panels; means sealing the top and bottom of the space embraced by said inner and outer casings; one of said columns having an opening for the entrance of air; fuel burning means adjacent the lower portion of the frame for introducing fuel into the interior of the inner casing; said burning means having openings for the passage of air from the space between the casings into the interior of the inner casing; economizer, steam generating and superheating serpentine tube sections vertically spaced in the upper portion of the inner casings; headers for each of said tube sections and for the steam generating tubes in the lower portion of the casing, said headers being positioned within the space between the inner and outer casing and adjacent the place where the tubes of the associated tube section passes through the inner wall to connect to said headers; angled members extending throughout the length of said headers and welded thereto and to an adjacent part of said columns thereby supporting said headers from said latter columns; means sealing said headers to the inner casing so as to form a closed chamber encompassing the ends of the tubes connected to the respective headers; the return bends of the economizer tubes projecting through the inner casing wall, with the chamber that includes the headers for the economizer encompassing the bends at one end and a special fluid tight chamber formed to encompass the opposite bends at the other economizer end; a single distributing header at least a portion of the surface of which extends into the space between the casings; means pumping water from the steam and water drum into said distributing header; tubes extending entirely within said space and connecting said distributing header with the inlet headers of the steam generating tubes; and fluid conveying tubes extending entirely within said space and interconnecting the outlet headers of the economizer and the steam generating tubes and the inlet header of superheater tubes with the steam and water drum.

DAVID M. SCHOENFELD.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
1,733,169	Purdy	Oct. 29, 1929
1,818,418	Millard	Aug. 11, 1931
1,894,692	Kerr et al.	Jan. 17, 1933
1,958,124	Bemis	May 8, 1934
1,988,388	Mioton	Jan. 15, 1935
2,011,423	Sheldon	Aug. 13, 1935
2,105,500	Parsons	Jan. 18, 1938
2,134,000	Mayo	Oct. 25, 1938
2,175,983	Walsh	Oct. 10, 1939
2,209,580	Sargent	July 30, 1940
2,355,800	Hensel	Aug. 15, 1944
2,499,478	Feser	Mar. 7, 1950
2,529,648	Borton	Nov. 14, 1950