Sept. 18, 1934. A. C. WEIGEL ET AL 1,973,968

WASTE HEAT BOILER

Filed Jan. 23, 1933 3 Sheets-Sheet 1

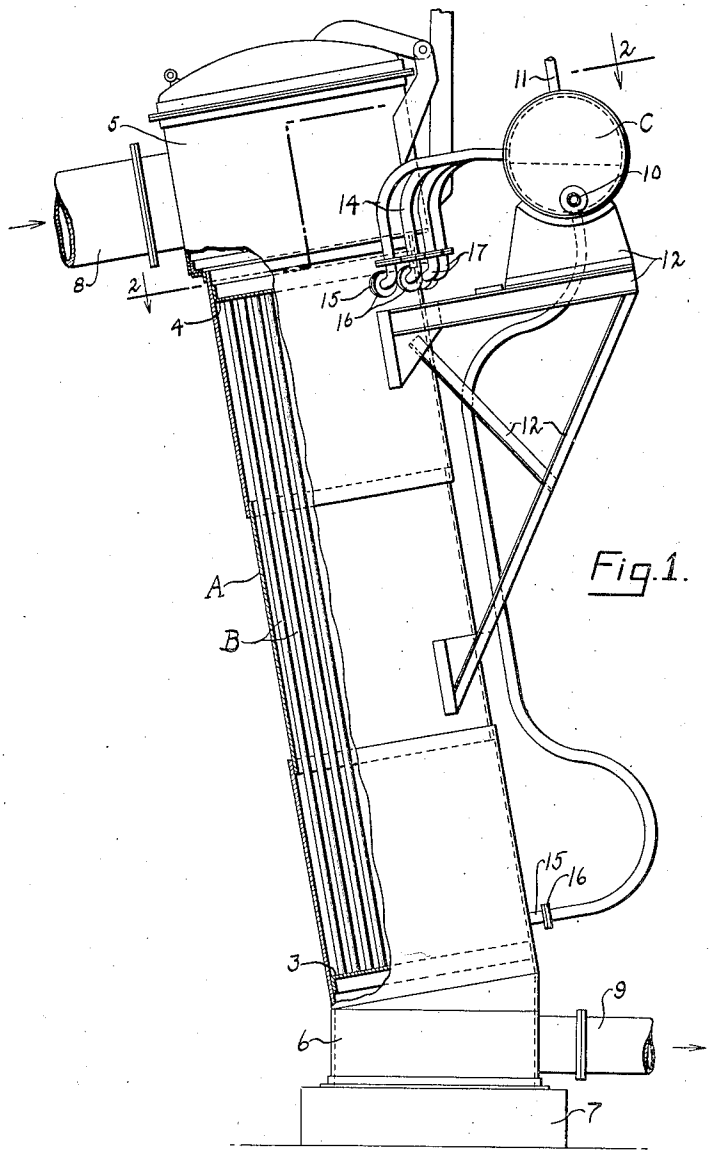
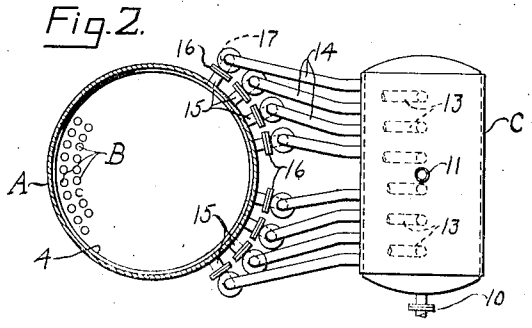


Fig. 1.

Fig. 2.



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Sept. 18, 1934. A. C. WEIGEL ET AL 1,973,968

WASTE HEAT BOILER

Filed Jan. 23, 1933 3 Sheets-Sheet 2

Fig. 3.

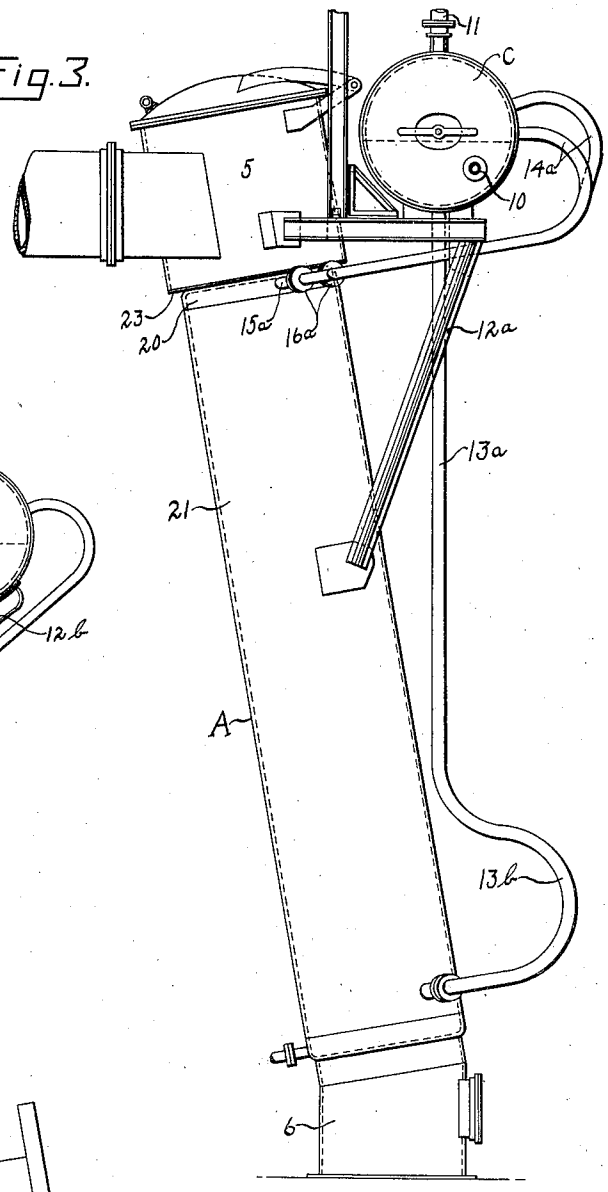
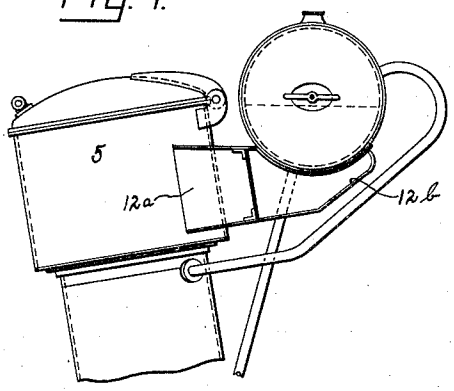


Fig. 9.



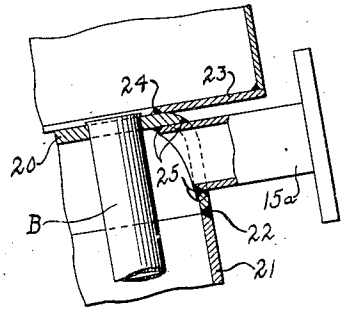


Fig. 4.

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WASTE HEAT BOILER

Filed Jan. 23, 193[illegible] 3 Sheets-Sheet 3

Fig. 5.

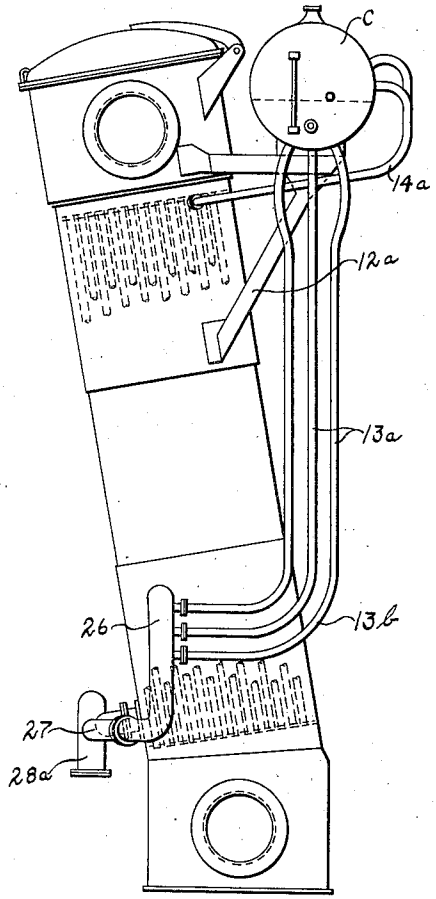


Fig. 6.

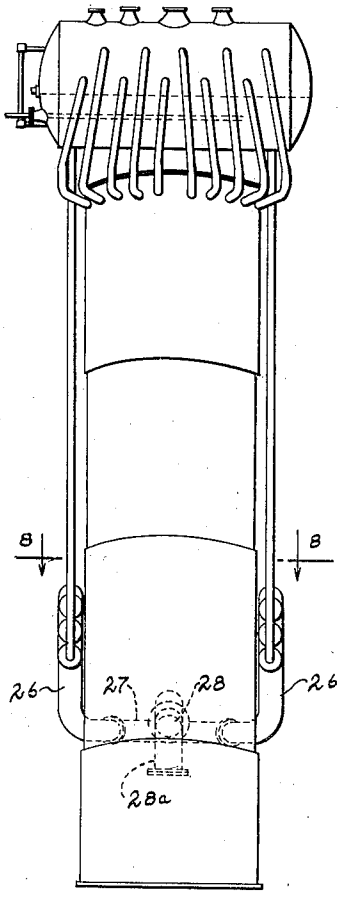
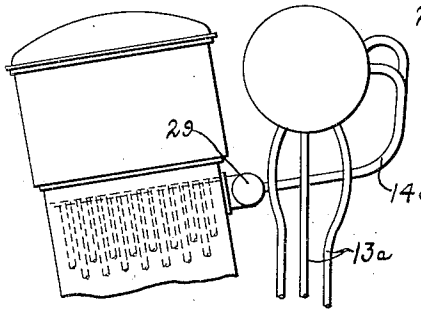


Fig. 7.



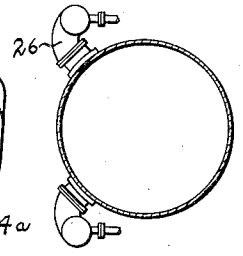


Fig. 8.

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UNITED STATES PATENT OFFICE

1,973,968

WASTE HEAT BOILER

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Application January 23, 1933, Serial No. 652,986

17 Claims. (Cl. 122—7)

This invention relates to improvements in waste heat boilers and in particular to upright waste heat boilers having a main boiler drum or shell associated with an upper steam and water drum.

The primary object of our invention is the provision of a boiler of the above type in which expansion and contraction difficulties heretofore experienced are overcome.

How the foregoing, together with such other objects and advantages as may hereinafter appear or are incident to our invention are realized, is illustrated in preferred form in the accompanying drawings, wherein—

Figure 1 is an elevational view of a boiler constructed in accordance with our invention, with a portion of the boiler shell broken away to show the interior construction.

Figure 2 is a plan section taken substantially on the line 2—2 of Figure 1.

Figure 3 is an elevational view of a modified form of the invention.

Figure 4 is an enlarged fragmentary sectional view of the upper right-hand portion of Figure 3.

Figure 5 is an elevational view of another modification of our invention.

Figure 6 is a side view of Figure 5.

Figure 7 is a fragmentary elevation showing a modified form of steam circulator connections to the boiler shell.

Figure 8 is a fragmentary sectional view of a modified form of connection between the downcomer tubes and the main drum; and

Figure 9 is a fragmentary view showing a modified form of the support of steam drum.

The boiler comprises in general an upright, vertically inclined main boiler shell or drum A, a plurality of flue tubes B located therein and connected at their lower ends into a lower tube sheet 3 and at their upper ends into an upper tube sheet 4, an upper gas chamber 5, a lower gas chamber 6, and supporting or foundation structure 7 on which the boiler is mounted.

Hot gases, for example, from a gas plant, are led to the upper gas chamber 5 by means of a conduit 8 and pass downwardly through the flue tubes B and into the lower gas chamber 6, from which they exit by means of a conduit 9 leading to a flue.

An upper steam and water drum C is located to one side of the main boiler drum A preferably on the high side of and at a level above the upper tube sheet 4 and is provided with a feed water inlet 10 and a steam outlet 11. The steam and water drum is supported from the main drum or shell A by means of suitable bracket structure 12 which is secured to the main drum well above the bottom thereof, or to the shell of the gas chamber 5.

A plurality of downcomer tubes 13, in this instance six, are provided to supply water to the main drum A from the steam and water drum C, the tubes 13 being connected at their upper ends into the water space of the steam and water drum and at their lower ends into the shell A at a point adjacent to and above the lower tube sheet 3. In the modification shown in Figures 5 and 6, the downcomer tubes 13 lead into headers 26 disposed at each side of the main drum. The headers 26 are connected by pipes 27 to a main or connection 28, communicating with the main drum above the lower tube sheet 3. Main 28 is preferably provided with a mud pocket 28*a*. Figure 8 shows a modification in which the headers 26 are each directly connected to the main drum.

Referring again to Figure 1, a plurality of upcomer tubes 14, are connected at their lower ends into the main drum A at a point adjacent to and below the high side of the upper tube sheet 4 and at their upper ends into the steam and water drum C. While we have illustrated the upcomer tubes 14 as being connected into the drum C above the water line so as to deliver into the steam space of the drum, it is to be understood that we also contemplate connecting them into the drum below the water line.

The connections between the upcomer and downcomer tubes and the main drum A are made by means of flanged connections such as flanged nipples 15 opening into the interior of the drum or shell A, to which the upcomer and downcomer tubes are detachably secured by means of suitable flanges 16 carried by the tubes. In the form illustrated in Figures 1 and 2, flanged elbows 17 are provided between the tube flanges 16 of the upcomer tubes and the upper flanged nipples 15 of the drum A.

Referring to the modification illustrated in Figures 3, 4, 5, 6 and 9, it will be seen that the drum C is located materially closer to the drum than in the form illustrated in Figure 1 and that in consequence thereof the overhang of the bracket structure 12*a* is considerably reduced. In this modification, the upcomer tubes 14*a* are connected directly to the upper nipples 15*a* by means of flanges 16*a* without the use of elbows such as shown in Figure 1. These upcomer tubes lead to the out ide or right-hand side of the drum and are connected into the steam space of the drum, it being noted that the points of con-

nection of alternate tubes into the drum are staggered.

In the modification shown in Figure 7 upcomer tubes 14*a* enter, at their lower ends into header 29 which connects them to the shell of the boiler. The downcomer tubes 13*a* lead straight down from the drum C and are connected to the lower nipples by means of the lower flanges as shown in Figure 3, or connected to the lower headers as shown in Figures 5, 6 and 8, the tubes being curved at their lower portions as indicated at 13*b*, (Figure 5) for expansion purposes.

Referring now to Figure 4, it will be seen that the tube sheet portion 20 is welded to the main portion 21 of the main drum, as indicated at 22, and that the casing 23 which forms the gas chamber is welded to the tube sheet portion 20 as indicated at 24. The nipples 15*a* are welded to the tube sheet portion 20 as indicated at 25. It will thus be seen that we have provided a very compact and rugged welded construction in which the nipples may be conveniently welded to the tube sheet portions or heads 20 and the heads may be welded to the main portion 21 of the drum. Furthermore, it is to be noted that by this welded construction we are enabled to weld the nipples to the tube sheet portions at the very top of the curvature so as to leave no space for steam pockets such as result when employing tube sheets of the form illustrated in Figure 1. By eliminating such steam pockets, burning-out difficulties are overcome. The ends of the nipples are configured to correspond to the curvature of the tube sheet portion to facilitate welding.

The foregoing constructions secure desired flexibility permitting of expansion and contraction, without running into practical difficulties, as will be seen from the following.

The relatively large number of small diametered bent upcomer and downcomer tubes secure the desired flexibility of connection as between the main drum and the steam and water drum. The provision of the flanged nipple connections for the tubes not only makes it possible to secure tight connections but also makes assemblage easy. If the ends of the downcomer and upcomer tubes were directly secured to tube holes in the main drum by the usual expanding of such ends, it will be seen that great difficulty would be encountered in expanding the ends and in obtaining tight joints because the interior of the drum must be largely occupied by the nest of upright tubes, if efficiency is to be obtained and the use of a main drum of relatively large diameter is to be avoided. By the arrangement shown and described it is possible to use a tube nest which practically occupies the entire cross-sectional area of the drum.

Similarly, it will be seen that in the matter of replacement of any of the downcomer or upcomer tubes or of any of the nipples, this can be done very readily by the arrangement shown, whereas if the customary arrangement were employed this would be a matter of great difficulty unless a very large main drum were employed.

The steam drum is supported from the main drum intermediate the ends thereof, or from the upper gas chamber, the downcomer tubes are in general disposed substantially parallel to the drum and bends in the downcomer tubes provide sufficient flexibility to take care of expansion without placing undue strains on the tube joints.

Owing to the fact that the main drum is supported at the bottom, with freedom to expand upwardly, and to the fact that the steam and water drum is supported from the main drum or from the upper gas chamber at a point well above the bottom of the main drum, it will be seen that the upcomer tubes are subject only to that expansion which occurs in the region of support of the steam and water drum, and they have ample flexibility to take care of this and furthermore, since the arrangement is one which necessitates only a small amount of flexure for these tubes, the joints will remain tight. It will be seen that if the steam and water drum were also supported from the bottom, as, for example, at the same level as the support for the main drum, then the upcomer tubes would be subject to the full expansion of the main drum from the bottom to the point of connection of the upcomer tubes thereto. Thus, in the present arrangement, only the downcomer tubes are subjected to such expansion and this is readily taken care of by the bend therein.

The arrangement of the support for the steam and water drum is also one which takes care of expansion and contraction. It will be apparent that since the points of connection of the support to the main drum are separated longitudinally of the drum, the support is subject to the expansion of that portion of the drum intermediate such points. The support is composed in part of structural members arranged in substantial V form, thus affording the desired flexibility as the legs can readily spread somewhat. Thus the heavy steam and water drum, although laterally disposed with reference to the main drum, can be effectively supported by relatively light structure, the bottom members of the support constituting thrust members and the upper members of the support being lateral tying members, subject to no substantial stress. The inclination of the axis of the main drum is of assistance in this regard as it reduces the effect of the overhang, the support being subjected largely to compression rather than bending thrusts.

In Figure 9, the bracket 12*b* has an extended base for attachment to the shell of chamber 5.

We claim:—

1. In a waste heat boiler, the combination of a main upright boiler drum, an upper steam and water drum, a plurality of relatively small diametered downcomer tubes connected at their upper ends into the steam and water drum and at their lower ends into the lower portion of the main drum; a plurality of relatively small diametered upcomer tubes connected at their lower ends into the upper portion of the main drum and at their upper ends into the steam and water drum, and a support for said steam and water drum including structural members disposed substantially in the form of a V with the apex at the steam and water drum and the extremities of the legs at the main drum, and means for securing the legs to the main drum at points well above the bottom of said main drum.

2. In a waste heat boiler, the combination of a main upright boiler drum, an upper steam and water drum, a plurality of relatively small diametered downcomer tubes connected at their upper ends into the steam and water drum and at their lower ends into the lower portion of the main drum; a plurality of relatively small diametered upcomer tubes connected at their lower ends into the upper portion of the main drum, and at their

upper ends into the steam and water drum, and a support for said steam and water drum including structural members disposed substantially in the form of a V with the apex at the steam and water drum and the extremities of the legs at the main drum, and means for securing the legs to the main drum at points well above the bottom of said main drum, one leg being secured to the main drum above and the other leg below the point of connection of the upcomer tubes into the main drum.

3. In a waste heat boiler, the combination of a main upright boiler drum, an upper steam and water drum, a plurality of relatively small diametered downcomer tubes connected at their upper ends into the steam and water drum and at their lower ends into the lower portion of the main drum; a plurality of relatively small diametered upcomer tubes connected at their lower ends into the upper portion of the main drum and at their upper ends into the steam and water drum, and a support for said steam and water drum including a structural member disposed to constitute a thrust member and a structural member disposed to constitute a lateral tying member, and means for securing said members to the main drum above the bottom thereof.

4. In a waste heat boiler, the combination of a main upright boiler drum, an upper steam and water drum, a plurality of relatively small diametered downcomer tubes connected at their upper ends into the steam and water drum and at their lower ends into the lower portion of the main drum; a plurality of relatively small diametered upcomer tubes connected at their lower ends into the upper portion of the main drum and at their upper ends into the steam and water drum, and a support for said steam and water drum including structural members secured to the main drum at points separated longitudinally of said main drum and well above the bottom thereof, and means for so securing said structural members.

5. In a waste heat boiler, the combination of a main upright boiler drum, an upper steam and water drum, a plurality of relatively small diametered downcomer tubes connected at their upper ends into the steam and water drum and at their lower ends into the lower portion of the main drum; a plurality of relatively small diametered upcomer tubes connected at their lower ends into the upper portion of the main drum and at their upper ends into the steam and water drum, and a support for said steam and water drum including a horizontally disposed structural member, and a structural member disposed at an acute angle thereto, and means for securing said members together and to the main drum.

6. In a waste heat boiler, the combination of an upright vertically inclined main boiler drum, an upper steam and water drum, a plurality of bent downcomer and upcomer tubes connecting the steam and water drum and the main drum, and a bracket for supporting said steam and water drum at the side of the main drum away from which the drum leans, said bracket including a substantially horizontal structural member, and a substantially upright thrust member arranged in the form of a V, and means for securing said members to said main drum above the bottom thereof.

7. In a waste heat boiler, the combination of a main upright boiler drum supported at the bottom and free to expand upwardly, an upper steam and water drum, upcomer means connected to deliver from the upper portion of the main drum to the steam and water drum, a plurality of relatively small diametered bent downcomer tubes connected to lead water from the steam and water drum to the lower portion of the main drum, and a support for the steam and water drum secured to the main drum at a location such that the downcomer tubes are enabled to freely expand in a direction from the steam and water drum and opposite to that of the main drum and in approximately the same amount thereby reducing the resulting expansion strains within the downcomer tubes to a minimum.

8. In a waste heat boiler, the combination of a main upright boiler drum supported at the bottom and free to expand upwardly, an upper steam and water drum, a plurality of relatively small diametered bent upcomer tubes connected to deliver from the upper portion of the main drum to the steam and water drum, a plurality of relatively small diametered bent downcomer tubes connected to lead water from the steam and water drum to the lower portion of the main drum, and a support for the steam and water drum secured to the main drum at a location such that the downcomer tubes are enabled to freely expand in a direction from the steam and water drum and opposite to that of the main drum and in approximately the same amount thereby reducing the resulting expansion strains within the downcomer tubes to a minimum.

9. In a waste heat boiler, the combination of a main upright boiler drum supported at the bottom and free to expand upwardly, an upper steam and water drum, upcomer means connected to deliver from the upper portion of the main drum to the steam and water drum, a plurality of relatively small diametered bent downcomer tubes connected to lead water from the steam and water drum to the lower portion of the main drum, and a support for the steam and water drum secured to the main drum well above the bottom thereof so that the downcomer tubes are enabled to freely expand in a direction from the steam and water drum and opposite to that of the main drum and in approximately the same amount thereby reducing the resulting expansion strains within the downcomer tubes to a minimum.

10. In a waste heat boiler, the combination of a main upright boiler drum supported at the bottom and free to expand upwardly, an upper steam and water drum, upcomer means connected to deliver from the upper portion of the main drum to the steam and water drum, a plurality of relatively small diametered bent downcomer tubes connected to lead water from the steam and water drum to the lower portion of the main drum, and bracket means for supporting said steam and water drum secured to the main drum at its upper portion whereby the downcomer tubes are enabled to freely expand in a direction from the steam and water drum and opposite to that of the main drum and in approximately the same amount thereby reducing the resulting expansion strains within the downcomer tubes to a minimum.

11. In a waste heat boiler, the combination of a main upright boiler drum supported at the bottom and free to expand upwardly, an upper steam and water drum, upcomer means connected to deliver from the upper portion of the main drum to the steam and water drum, a plurality of rela-

tively small diametered bent downcomer tubes connected to lead water from the steam and water drum to the lower portion of the main drum, a support for the steam and water drum secured to the main drum well above the bottom thereof and means for admitting feed water to said steam and water drum, said bent downcomer tubes by virtue of so securing the steam and water drum being subjected to minimum expansion strains including those caused by feed water entering the downcomer tubes.

12. In a waste heat boiler, the combination of a main upright boiler drum supported at the bottom and free to expand upwardly, an upper steam and water drum, a plurality of relatively small diametered bent downcomer tubes connected to lead water from the steam and water drum to the lower portion of the main drum, a support for the steam and water drum secured to the main drum at its upper portion so that the downcomer tubes are enabled to freely expand in a direction from the steam and water drum and opposite to that of the main drum and in approximately the same amount thereby reducing the resulting expansion strains within the downcomer tubes to a minimum, said support being adapted to position the steam and water drum closely adjacent the upper portion of the main drum, and upcomer means leading from the main drum to the steam and water drum and connected to the latter at the side thereof remote from the main drum.

13. In a waste heat boiler, the combination of a main upright boiler drum supported at the bottom and free to expand upwardly, an upper steam and water drum, a plurality of relatively small diametered bent downcomer tubes connected to lead water from the steam and water drum to the lower portion of the main drum, a support for the steam and water drum secured to the main drum at its upper portion so that the downcomer tubes are enabled to freely expand in a direction from the steam and water drum and opposite to that of the main drum and in approximately the same amount thereby reducing the resulting expansion strains within the downcomer tubes to a minimum, said support being adapted to position the steam and water drum closely adjacent the upper portion of the main drum, and upcomer means leading from the main drum to the steam and water drum and connected to the latter at the side thereof remote from the main drum, said upcomer means comprising a plurality of relatively small diametered short bent tubes.

14. In a waste heat boiler, the combination of a main upright boiler drum supported at the bottom and free to expand upwardly, an upper steam and water drum, upcomer means connected to deliver from the upper portion of the main drum to the steam and water drum, downcomer means including a plurality of downcomer tubes connected at their upper ends with the water space of the upper steam and water drum, a lower header into which the lower ends of said downcomer tubes are connected, and means for connecting said header into the lower portion of the main drum, and a support for the steam and water drum secured to the main drum at a location such that the downcomer means expands freely in a direction from the steam and water drum and opposite to that of the main drum and in approximately the same amount thereby reducing the resulting expansion strains within the downcomer tubes to a minimum.

15. In a waste heat boiler, the combination of a main upright boiler drum supported at the bottom and free to expand upwardly, an upper steam and water drum, upcomer means connected to deliver from the upper portion of the main drum to the steam and water drum, downcomer means including a plurality of downcomer tubes generally disposed at each of two opposite sides of the main drum, said tubes being connected at their upper ends into the water space of the upper steam and water drum, lower headers at said opposite sides of the main drum into which the lower ends of said downcomer tubes are connected and means for connecting said header into the lower portion of the main drum, and a support for the steam and water drum secured to the main drum at a location such that the downcomer means expands freely in a direction from the steam and water drum and opposite to that of the main drum and in approximately the same amount thereby reducing the resulting expansion strains within the downcomer tubes to a minimum.

16. In a waste heat boiler, the combination of a main upright boiled drum, a steam and water drum having one side disposed close to the side of said main drum, a plurality of relatively small diameter upcomer tubes connected to deliver from the upper portion of said main drum to said steam and water drum, said upcomer tubes leading into the side of the steam and water drum remote from said main drum, and downcomer means for leading water from the steam and water drum to the lower portion of said main drum.

17. In a waste heat boiler, the combination of a main upright boiler drum, a steam and water drum having one side disposed close to the side of said main drum, a plurality of relatively small diameter upcomer tubes connected to deliver from the upper portion of said main drum to said steam and water drum, said upcomer tubes leading into the side of the steam and water drum remote from said main drum, downcomer means for leading water from the steam and water drum to the lower portion of said main drum, and a support for the steam and water drum secured to said main drum so that expansion strains to which said downcomer means are subjected are reduced to a minimum.

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