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WASTE HEAT BOILER

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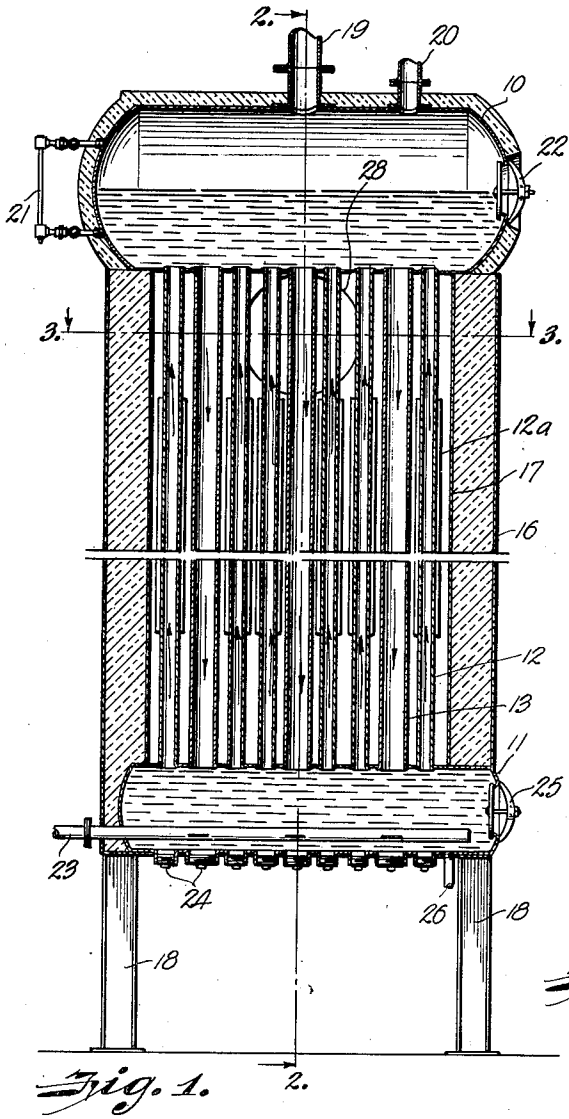

Fig. 1.

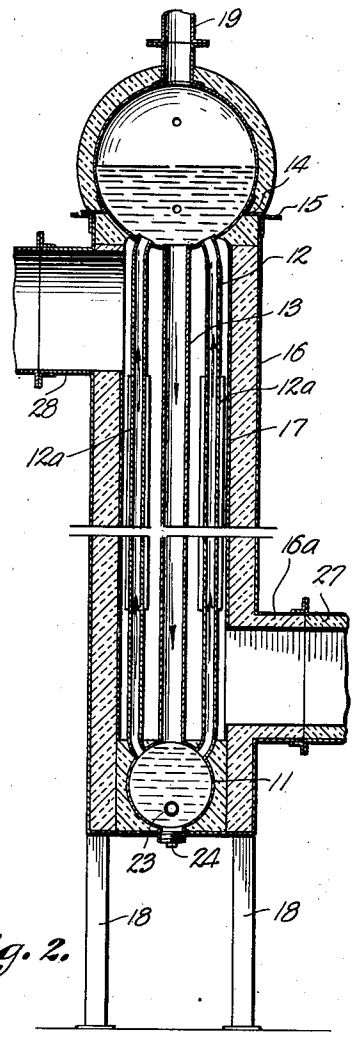

Fig. 2.

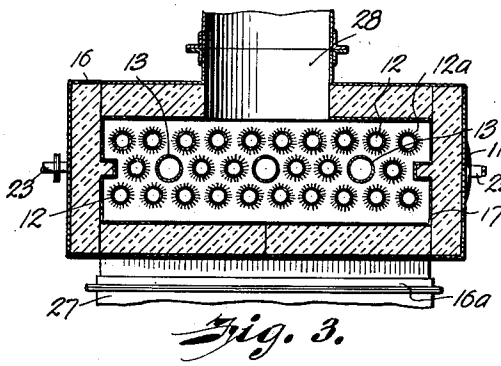

Fig. 3.

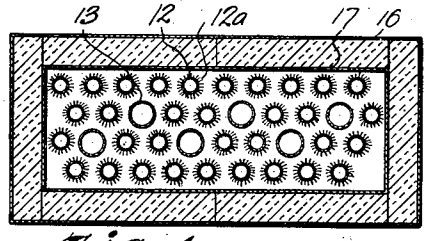

Fig. 4.

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WASTE HEAT BOILER

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7 Claims. (Cl. 122—7)

This invention relates to improvements in waste heat boilers and refers more particularly to a boiler having an upper steam liberating drum and a lower mud drum connected by vertical tubular heating elements surrounded by an insulated enclosure or casing with an inlet for the flue gases near the bottom of the casing and an outlet near the top.

The novelty lies primarily in the design which includes a flue-like passageway in which the vertical heating tubes are positioned to afford a minimum resistance to the passage of the gases. In addition, an efficient fluid circulation through the boiler is assured by bare tube downcomer pipes of greater diameter than the risers which transfer the fluid being heated from the mud drum to the steam liberator drum. Besides the difference in diameter between the risers and downcomer tubes the central portion of the riser tubes are equipped with longitudinal fins or extended surface to increase the heat exchange capacity of the risers and thereby accelerate circulation. Furthermore, the extended surface is limited to the central zone of the riser tubes in order that only bare tubes are exposed to the entering flue gases in the inlet and in the zone adjacent the outlet port, thus assuring more even distribution of the gases over the tubes, less resistance to flow of the gases, and increased efficiency in the over all heat exchange between the flue gases and fluid being heated.

The construction is adaptable for use in the generation of steam where waste heat is available from flue gas from any source, particularly is it applicable to existing petroleum refining furnaces, open hearth furnaces in steel mills, flue gases discharged from rotary furnaces in the manufacture of cement, annealing furnaces, power plants, Diesel engine exhausts, the compressor exhausts, or any type of furnace or oven where the waste flue gas temperature is sufficiently high to make heat recovery economical. Obviously, an advantageous feature in any waste heat boiler is the existence of a low pressure drop on the flue gas side to avoid the use of motors and fans. This is accomplished in the present design by the shape of the furnace casing, the vertical positioning of the tubes, the use of longitudinal fins and causing even and uniform distribution and flow of the flue gases over the tubes by exposing bare tubes adjacent the inlet and outlet ports.

A further requirement in a waste heat boiler is that adequate downpipe capacity be provided to obtain proper circulation of the fluid being heated.

The circulation in a waste heat boiler is usually considerably less rapid than that in a direct fire boiler because flame temperatures of the heating gases in the direct fire type approximate 3000° F., producing rapid heat exchange and evaporation and, consequently, a high rate of circulation. In a waste heat boiler where flue gas temperatures approximate 1200° F. or below, the evaporation of water, if the boiler is used for steam generation, is less rapid than in the direct fire type, hence, circulation is less and downpipe capacity must be provided to obtain proper heat exchange and steaming characteristics.

In the proposed design the flue gas passage through the casing or housing surrounding the boiler, the flue gas passage is in an upper direction, the passageway acting as a stack or flue without baffles or obstruction to change the direction of the flue gas and increase the frictional resistance to the flow of gases.

In the accompanying drawing which forms a part of the instant specification and is to be read in conjunction therewith and in which like reference numerals are used to indicate like parts in the various views,

Fig. 1 is a side sectional view of the furnace,

Fig. 2 is a view taken along the line 2—2 in Fig. 1 in the direction of the arrows,

Fig. 3 is a sectional view taken along the line 3—3 in Fig. 1 in the direction of the arrows,

Fig. 4 is a sectional view similar to that shown in Fig. 2 showing a boiler design with an increased number of tubular elements and indicating the relative positioning of the tubular risers and downcomer elements.

Referring to the drawing and particularly to Figs. 1 and 2, the waste heat boiler shown consists of an upper steam liberating drum 10, a lower mud drum 11, connected by a plurality of tubular heating surface elements, those constituting the risers for transferring fluid from the mud drum to the steam liberating drum number 12, and tubes of larger diameter serving as downcomers or downpipes designated as 13. The weight of the boiler is preferably supported from above by means of hangers or brackets 14 which fit beneath the curvature of the upper liberating drum. These hangers are carried by angles 15 which are attached to the outer shell 16 of the casing or furnace portion of the boiler. Between the outer shell 16 and an inner liner 17 are layers of refractory and insulating material. Insulation also surrounds the upper steam liberating

drum and the lower mud drum to prevent heat loss. The boiler is supported by standards 18 and is braced laterally to any convenient structure such as a stack, furnace, power plant or mill to which it may be connected.

The steam liberating drum 10 is equipped with a steam outlet 19, a safety valve connection 20, a liquid level gauge 21 and a manway 22. The mud drum 11 has a fluid inlet pipe 23 extending substantially its length and perforated to assure even distribution of the fluid introduced to the drum. In the bottom drum are a plurality of clean-out plugs 24 positioned in alignment with the tubes 12 and 13. The mud drum is also equipped with a manway 25 and a blowdown line 26. The riser tubes 12 have short bare sections at the top and bottom adjacent the flue gas inlet 27 and the flue gas outlet 28 to obtain better flue gas distribution at these locations and more even distribution of the flue gas during its passage over the tubes. The central portion of the risers 12 or the portions intermediate the inlet port 27 and outlet port 28 have extended surfaces in the form of longitudinal fins 12*a*. This extended surface increases the heat exchange of the tubes throughout this section, thereby increasing evaporation of the fluid and accelerating flow of fluid relative to the flow in the downpipes 13. In other words, these fin tube sections of the tubes 12 pick up a major portion of the heat, due not only to the extended surface, but also their location in the casing surrounding the downpipes.

It will also be noted that the downpipes are larger in diameter than the risers (approximately equal to the size of the diameter of the fins on the risers) and are bare throughout their length. This construction is provided to obtain a proper circulation through the boiler since more heat must be picked up in the risers than is picked up in the downpipes to obtain circulation. It is obvious that the downpipes should have a minimum surface and the risers a maximum surface exposed to the heating gases.

In the modified form of construction shown in Fig. 4, the only difference in the design is the increased number of risers and downpipes and their relative positioning in the furnace casing. It will be noted that the outer steel jacket 16 may be provided with a removable panel as shown at 16*a* in Fig. 3. This is to permit access to the tubes for cleaning and replacement. The insulation and refractories are likewise made in removable sections behind the panel. This construction is contemplated not only in the design shown in Figs. 1, 2, and 3, but also the modified construction shown in Fig. 4.

With the arrangement of downpipes and risers as previously described, any number of downpipes can be installed to maintain the optimum ratio of downpipe surface area relative to heating surface area on the risers. In the design shown in Figs. 1 to 3, inclusive, 3½ inch O. D. tubes are used as risers with forty-eight (48) 1 inch fins located as shown at their central section giving approximately 9½ square feet of surface per foot of tube, whereas the downpipes are 5 inch I. P. S. tubes (5.563 O. D.) providing 1.45 square feet of surface per lineal foot of tube. The heat pickup on the downpipe is approximately 17 per cent of the heat pickup on the risers which is indicative of rapid circulation.

From the standpoint of manufacture it is proposed that the boilers will be provided in standard sizes having top and bottom drums of the same diameter and the length of the down pipes and risers the same for all sizes. To increase the capacity of the boilers it will be necessary only to increase the length of the vapor and mud drums and the number of tubes and downpipes used for the different capacities.

From the foregoing it will be seen that the invention is well adapted to attain all of the ends and objects hereinbefore set forth together with other advantages which are obvious and which are inherent to the structure.

As many possible embodiments may be made of the invention without departing from the scope thereof, it is to be understood that all matter herein set forth or shown in the accompanying drawing is to be interpreted as illustrative and not in a limiting sense.

Having thus described our invention, we claim:

1. In a waste heat boiler having an upper steam liberating drum and a lower mud drum connected by heating surface elements enclosed within a casing through which flue gas passes from a lower inlet to an upper outlet in said casing, the improvement which comprises providing extended surface on certain of said heating surface elements and plain surfaces on the remaining heating surface elements, the former elements upon which the extended surface is imposed functioning as risers for the fluid being heated, the latter elements having plain surfaces and relatively less heat exchange surface functioning as downcomers to transfer fluid from the steam drum to the mud drum.

2. In a waste heat boiler having an upper steam liberating drum and a lower mud drum connected by tubular heating surface elements, said elements enclosed within a casing through which flue gases pass from a lower inlet to an upper outlet, the improvement which comprises providing extended surface on the tubular elements constituting the risers through which the fluid being heated passes from the mud drum to the steam liberating drum, the remaining tubes being bare tubes and constituting the downcomers for transferring fluid from the steam drum to the mud drum.

3. In a waste heat boiler having an upper steam liberating drum and a lower mud drum connected by tubular heating surface elements, said elements enclosed within a casing through which flue gas passes from a lower inlet to an upper outlet, the improvement which comprises providing extended surface on the riser tubes in a zone centrally of their length between the inlet and outlet ports of the casing, with bare tubes acting as downcomers for transferring fluid from the steam liberating drum to the mud drum.

4. In a waste heat boiler having an upper steam liberating drum and a lower mud drum connected by tubular heating surface elements, said elements enclosed within a casing through which flue gas passes from a lower inlet to an upper outlet, the improvement which comprises providing extended surface on the riser tubes in a zone centrally of their length between the inlet and outlet ports of the casing with bare tubes acting as downcomers for transferring fluid from the steam liberating drum to the mud drum, said latter tubular downcomers surrounded by the riser tubes.

5. In a waste heat boiler having an upper steam liberating drum and a lower mud drum connected by tubular heating surface elements, said elements enclosed within a casing through which flue gas passes from an inlet to an outlet, the improvement which comprises providing ex-

tended surface on certain of said tubular elements which are to act as risers to transfer the fluid being heated from the mud drum to the steam drum, the remaining tubular elements which are to act as downcomers being plain surface tubes, and limiting the extended surface on the risers to a zone centrally thereof to expose plain surface sections of the riser and downcomer tubular elements to the flue gases adjacent the zones where the flue gas is admitted and discharged whereby increased efficiency in distribution of the gas over the tubes is effected.

6. In a waste heat boiler having an upper steam liberating drum and a lower mud drum connected by tubular heating surface elements, said elements enclosed within a casing through which flow gases passing from a lower inlet to an upper outlet, the improvement which comprises utilizing bare tubes as downcomers for transferring fluid from the steam liberating drum to the mud drum and tubes of relatively smaller diameter than the downcomers having extended surfaces as risers for transferring the fluid being heated from the mud drum to the steam liberating drum.

7. In a waste heat boiler having an upper steam liberating drum and a lower mud drum connected by tubular heating surface elements, said elements enclosed within a casing through which flow gases passing from an inlet to an outlet, the improvement which comprises utilizing bare tubes as downcomers for transferring fluid from the steam liberating drum to the mud drum and tubes of relatively smaller diameter than the downcomers having extended surfaces as risers for transferring the fluid being heated from the mud drum to the steam liberating drum, said extended surface on the tubular risers limited to the sections of the tubes intermediate the inlet and outlet ports in the casing whereby only plain surface sections of the riser and downcomer tubes are exposed in the vicinity of said ports and a more unobstructed flow of gas obtained.

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