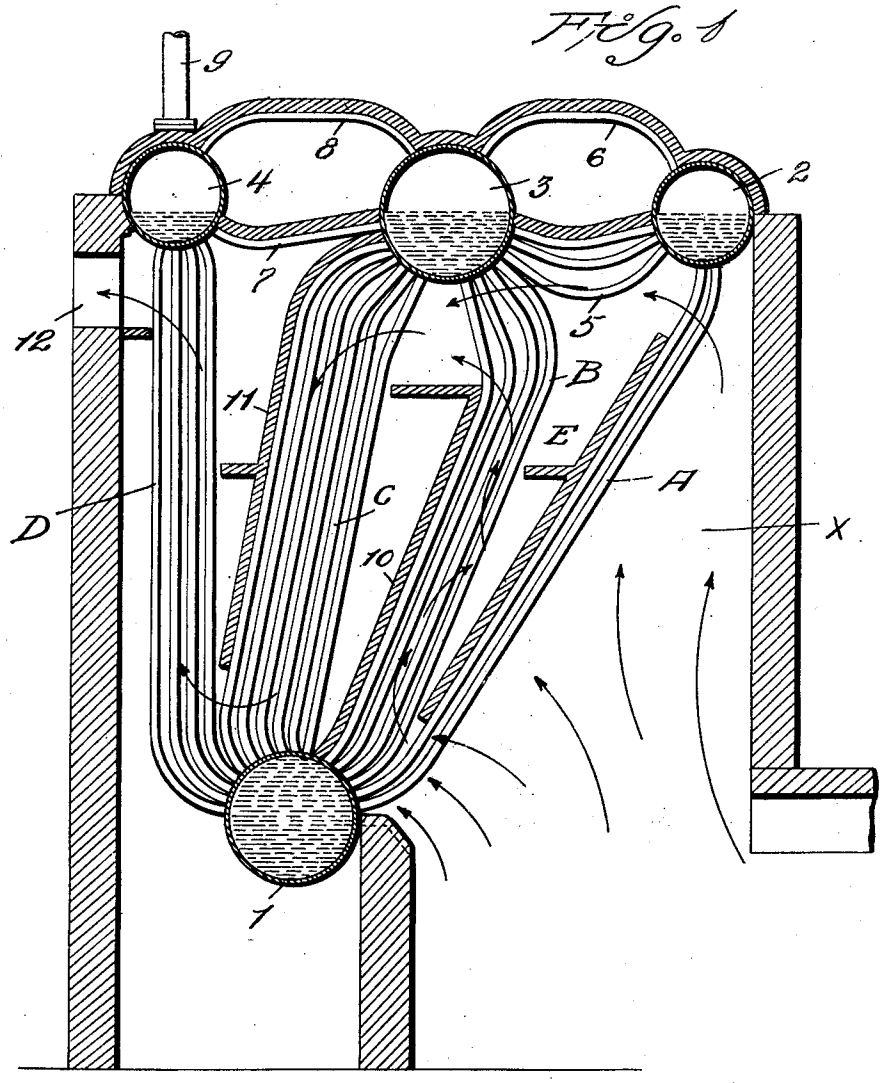
May 5, 1925. 1,536,776

A. COTTON

WATER TUBE BOILER

Filed April 12, 1920 3 Sheets-Sheet 1

Fig. 1



INVENTOR
ALFRED COTTON,
by Bakewell Church ATTORNEYS.

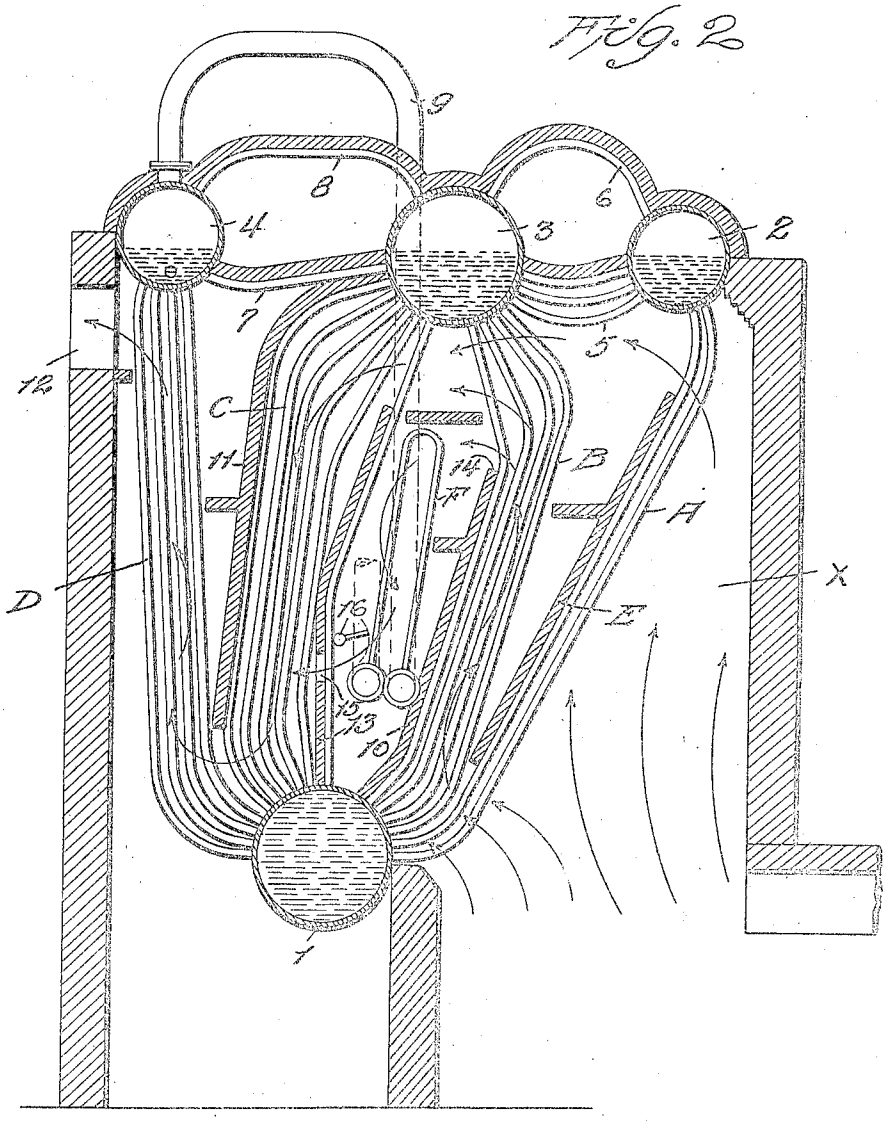
May 5, 1925. 1,536,776

A. COTTON

WATER TUBE BOILER

Filed April 12, 1920 3 Sheets-Sheet 2

Fig. 2



INVENTOR
ALFRED COTTON,
By Bakewell Clark Attorneys.

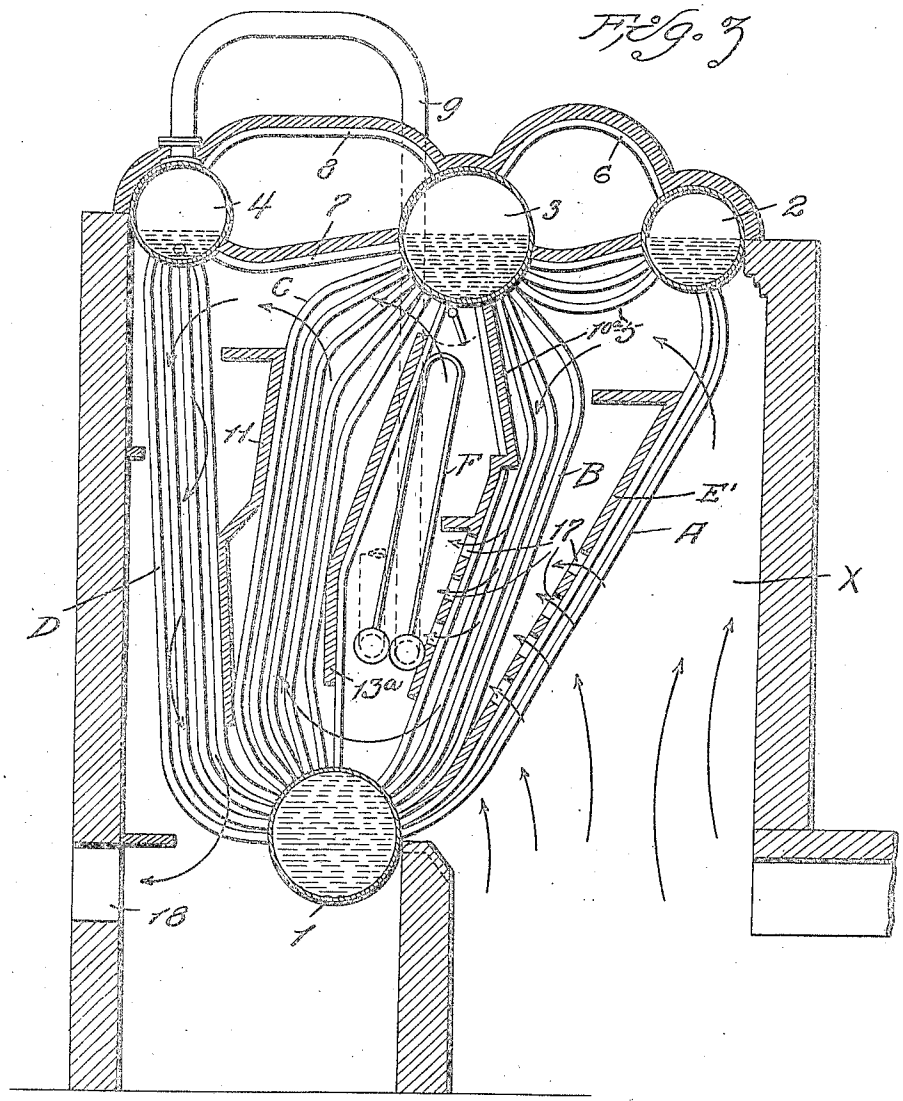
May 5, 1925. 1,536,776

A. COTTON

WATER TUBE BOILER

Filed April 12, 1920 3 Sheets-Sheet 3

Fig. 3



INVENTOR
ALFRED COTTON,
by Bakewell & Church ATTORNEYS

Patented May 5, 1925. 1,536,776

UNITED STATES PATENT OFFICE.

ALFRED COTTON, OF ST. LOUIS, MISSOURI, ASSIGNOR TO HEINE BOILER COMPANY, OF ST. LOUIS, MISSOURI, A CORPORATION OF MISSOURI.

WATER-TUBE BOILER.

Application filed April 12, 1920. Serial No. 373,249.

To all whom it may concern:

Be it known that I, ALFRED COTTON, a citizen of the United States, residing at St. Louis, Missouri, have invented a certain new and useful Improvement in Water-Tube Boilers, of which the following is a full, clear, and exact description, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to water tube boilers of the Stirling type.

The main object of my present invention is to provide a water tube boiler that has the desirable features and characteristics of the four bank boiler described in my pending application Serial No. 366,286, filed March 16, 1920, and which is so constructed that the hydrocarbon gases or long flame gases from the front of the fire will be divided or separated from the short flame gases from the back of the fire and directed upwardly through a large, effective combustion chamber, wherein combustion may be completed before said hydrocarbon gases become chilled by entering the compact tube banks of the boiler.

Another object is to provide a four bank boiler of the character above described which is equipped with a superheater.

Briefly described, my present invention consists of a water tube boiler composed of four banks of water tubes and cross drums arranged so that the water will circulate upwardly from the feed water chamber or mud drum through separate and distinct banks of tubes which communicate with separate and distinct elevated chambers or drums, and means for dividing or splitting up the gases distilled from the burning fuel and causing the long flame gases from the front of the fire to travel slowly upwards through the combustion chamber and the short flame gases from the back of the fire to come in contact with some of the tubes after a very short travel. If the boiler is equipped with a superheater it is preferable to arrange the superheater in the space between the second and third banks of tubes and heat the superheater by gases that have been partly cooled by contact with the tubes of the second bank of the boiler.

My improved boiler is distinguished from the usual Stirling boiler in two principal respects:

(1) Two separate and distinct banks of tubes are provided for conducting water upwardly from the mud drum into separate and distinct elevated drums or chambers, instead of conducting all of the water into a single steam-and-water drum, thus insuring the production of drier steam and overcoming numerous objectionable characteristics of the usual Stirling boiler, as described in my pending application previously referred to; and

(2) It is equipped with a shield or partition arranged in such a manner that the short flame gases from the back of the fire and the long flame gases from the front of the fire will divide and flow in different directions, the short flame gases preferably flowing upwardly longitudinally of the tubes of the second bank and the long flame gases or hydrocarbon gases flowing upwardly the full height of the combustion chamber before crossing over the tubes of the front bank.

By splitting up or dividing the gases in this manner I obtain the equivalent of a large effective combustion chamber wherein combustion may be completed before the gases become chilled by contact with the water tubes, thus increasing the efficiency of the boiler and minimizing smoke, and by conducting the upwardly circulating water into two separate and distinct chambers instead of causing all of the upwardly circulating water to flow through a single chamber, I overcome numerous objectionable features of the usual Stirling boiler such as the tendency of the level of the water in the front steam-and-water drum to rise abnormally and the tendency of the level of the water in the rear steam-and-water drum to drop abnormally.

Figure 1 of the drawings is a vertical sectional view of a boiler constructed in accordance with my present invention.

Figure 2 is a similar view, illustrating a superheater boiler constructed in accordance with my invention; and

Figure 3 is a vertical sectional view, illustrating another form of superheater boiler embodying my invention.

Referring to Figure 1 of the drawings which illustrates my invention in its simplest form, A designates a set of water tubes which may be called the radiant heat bank of the boiler. B designates another set of water tubes which may be called the con-

vected heat bank, C designates another set of water tubes which may be called the down-comer bank and D designates another set of water tubes which may be called the economizer bank. The radiant heat bank A and the convected heat bank B lead upwardly from the mud drum 1 to a front steam-and-water drum 2 and to a middle steam-and-water drum 3, respectively. The down-comer bank C leads downwardly from the middle drum 3 to the mud drum 1 and the economizer bank D through which the feed water is supplied to the mud drum leads downwardly to the mud drum from the rear steam-and-water drum 4.

The front bank or radiant heat bank A consists of only a few rows of tubes that are exposed to the radiant heat of the fire and of the combustion chamber x. Preferably this radiant heat bank is composed of two rows of tubes which are the only tubes discharging into the front steam-and-water drum 2. In all cases, however, the cross-sectional area of the tubes of the radiant heat bank will be less than the cross-sectional area of the tubes of the convected heat bank B. The front drum 2 is connected to the middle drum 3 by means of water circulators 5 and steam circulators 6, and said middle drum is connected with the rear drum 4 preferably by means of water circulators 7 and steam circulators 8, the outlet 9 for the steam produced in the boiler preferably leading from the upper side of the rear drum 4.

The means that governs the flow of the gases through the boiler can be constructed in various ways without departing from the spirit of my invention, so long as the boiler is equipped with four banks of water tubes combined with a mud drum or feed water chamber and with elevated drums or chambers in such a manner that the water which circulated upwardly from the mud drum will enter separate and distinct drums or chambers that communicate with the first and second tube banks of the boiler, and means for dividing or splitting up the gases distilled from the burning fuel and causing the long flame gases and the short flame gases to follow different paths. In the form of my invention illustrated in Figure 1 the means that is employed to divide or split up the gases is so constructed that the short flame gases from the back of the fire will enter the convected heat bank B and the long flame gases or hydrocarbon gases from the front of the fire will travel slowly upwards through the combustion chamber x. Said means consists of a shield or partition E arranged at the rear side of the radiant heat bank A, with its upper end spaced away from the front steam-and-water drum 2 and its lower end spaced away from the mud drum 1. A baffle 10 extends upwardly from the mud drum 1 at the rear side of the convected heat bank to a point in proximity to the middle drum 3 and a baffle 11 extends downwardly from the middle drum 3 at the rear side of the down-comer bank C and terminates at a point above the mud drum 1. While the shield E operates to change the flow or direction of travel of the gases distilled from the burning fuel, it does not perform the function of a baffle in the sense that the term baffle is used in this art.

When the boiler is in operation the short flame gases from the back of the fire flow under the lower edge of the shield E and then upwardly among the tubes of the convected heat bank B, and the long flame gases or hydrocarbon gases from the front of the fire travel upwardly the full height of the combustion chamber x and then transversely across the upper portions of the tubes of the radiant heat bank A and the convected heat bank B, as indicated by the arrows in Figure 1, all of the gases then flowing downwardly through the down-comer bank C and thence upwardly through the economizer bank D to the gas outlet 12 at the upper end of the boiler. As only approximately half of the gases travel upwardly through the combustion chamber, and as said upwardly flowing gases travel comparatively slowly, sufficient space, time and air are provided to insure practically complete combustion of the hydrocarbon gases. The partition E can be constructed easily and at a low cost on account of the fact that it does not have to be gas-tight or built so that the gases cannot leak through same. In the form of my invention illustrated in Figure 1 the shield E is shown as simply consisting of a partition member arranged at the rear side of the radiant heat bank A and supported by the rear tubes of said bank, but I wish it to be understood that it is immaterial, so far as my present invention is concerned, how the shield E is constructed or arranged, so long as it operates to divide or split up the gases in the manner above described.

In Figure 2 of the drawings I have illustrated a four bank boiler embodying my invention and provided with a superheater F. The superheater F can be arranged in various ways, but it is preferable to arrange the superheater in the space between the second and third banks of tubes of the boiler and form the walls of the superheater chamber in such a manner that a portion of the short flame gases that flow upwardly through the convected heat bank B will pass through the superheater chamber, as indicated by the arrows in Figure 2. As shown in Figure 2, the front side of the superheater chamber is formed by a baffle 10 that extends upwardly from the mud drum at the rear side of the convected heat

bank B, and the rear wall of the superheater chamber is formed by a baffle 13 that extends upwardly from the mud drum at the front side of the down-comer bank D and terminates at a point below the middle steam-and-water drum 3. The superheater chamber is provided at its upper end with an inlet opening 14 through which the gases enter said chamber and an outlet opening 15 is formed at the lower end of the superheater chamber in the rear wall 13 of same. A damper 16 is preferably employed for controlling the flow of the gases through the superheater chamber. When the boiler is in operation the short flame gases from the back of the fire will flow longitudinally of the tubes of the convected heat bank B and a portion of said gases will enter the superheater chamber through the inlet opening 14 at the upper end of said chamber. The long flame gases from the front of the fire travel upwardly through the combustion chamber x and then flow transversely across the upper end portions of the first and second tube banks into the down-comer bank C, finally escaping upwardly through the economizer bank D, as indicated by the arrows in Figure 2. It will thus be seen that the gases from the back of the fire which pass along the second tube bank B and which have had their temperature considerably reduced are those gases which enter the superheater chamber and come in contact with the superheater F, while the gases that have risen through the combustion chamber have so far encountered a small amount of heating surface and are consequently of much higher temperature, avoid entering the superheater chamber. This arrangement is of value in cases where only a moderate amount of superheat is required, as the lower temperature of the gases allows a longer life of the superheater elements. The flow of the gases through the superheater chamber can be easily controlled by means of the damper 16 which can be regulated either automatically or by hand.

Instead of equipping the boiler with a partition or shield whose upper and lower edges are spaced away from the front steam-and-water drum 2 and from the mud drum 1, respectively, as in the form of my invention illustrated in Figures 1 and 2, the boiler may be equipped with a perforated shield E′ that extends upwardly from the mud drum 1 to a point in proximity to the front steam-and-water drum 2, as shown in Figure 3. The first baffle 10^a of the boiler, which is arranged behind the shield E′, extends downwardly from the middle steam-and-water drum 3 to a point in proximity to the mud drum 1, said baffle 10^a being located at the rear side of the convected heat bank B. The shield E′ and the baffle 10^a are provided with openings 17, as shown in Figure 3, and the baffle 13^a that forms the rear side of the chamber in which the superheater F is arranged is so disposed with relation to the mud drum 1 and the middle steam-and-water drum 3 that passageways are provided at the upper and lower ends of said baffle 13^a through which the gases can flow. When the boiler is in operation the long flame gases from the front of the fire rise upwardly through the combustion chamber x and then flow rearwardly and downwardly among the tubes of the convected heat bank B. The short flame gases from the back of the fire escape from the combustion chamber through the orifices 17 in the shield E′ and mingle with the downwardly flowing gases in the convected heat bank B. Some of the gases flowing through the convected heat bank enter the superheater chamber through the openings 17 in the baffle 10^a, and the remainder escape upwardly among the tubes of the down-comer bank C, as indicated by the arrows in Figure 3, the final pass being downwardly through the economizer bank D to a gas outlet 18 at the lower end of the boiler. The gases that enter the superheater chamber escape at the upper end of said chamber through the passageway between the upper edge of the baffle 13^a and the middle steam-and-water drum 3.

Since the flow of steam and water into the front steam-and-water drum 2 is very much less in my boiler than in the usual Stirling boiler, the water in the front elevated drum of the boiler is much calmer and a much better separation of the steam and water is obtained. Furthermore, there is little liability of the water level in the front drum 2 rising abnormally, or the water becoming entrained with the steam and carried over with the steam into the steam space of the middle drum 3, thus insuring the production of drier steam, even when the boiler is driven at rates much higher than is considered reasonable practice with the usual Stirling boiler. Another desirable feature of such a boiler is that the water circulates more freely than in the usual Stirling boiler, owing to the fact that the upwardly flowing water in the convected heat bank B flows directly across the middle steam-and-water drum 3 without having to encounter the resistance to flow of any water circulators, thus insuring free flow of the water downwardly through the down-comer bank C. The water circulators 7 leading from the middle drum 3 to the rear drum 4 raise the temperature of the water sufficiently to prevent corrosion on the tubes of the economizer bank caused by condensation of water vapor in the gases flowing through the last pass of the boiler. The flow of the water through the circulators 7 also tends to prevent the level of the water in the rear drum 4 from dropping abnormally, but in view of

the fact that my boiler is so constructed that there is practically no restriction to the circulation of the water upwardly from the mud drum, lowering of the water level in the rear drum 4 is unobjectionable, even at high driving rates.

In addition to the desirable features above pointed out, my boiler insures practically perfect combustion of the fuel, due to the fact that the combustion chamber is of sufficient size to allow ample time to insure complete combustion of the hydrocarbon gases rising from the raw fuel at the front of the fire. In other words, in my improved boiler only approximately half of the gases, namely, the hydrocarbon gases which really need large combustion space, travel upwardly through the combustion chamber of the boiler. Consequently, twice the combustion volume for the same weight of gases burned is provided for the same space occupied.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent, is:

1. A water tube boiler, comprising at least two elevated transverse steam-and-water drums, a transverse mud drum, a radiant heat first bank of upflow tubes leading from the mud drum to the front steam-and-water drum, a convected heat second bank of upflow tubes leading from the mud drum to the second steam-and-water drum, water circulators connecting said elevated steam-and-water drums together, downcomer tubes leading from the second steam-and-water drum to the mud drum, and means for preventing the long flame gases from the front of the fire from coming in contact with the tubes of said convected heat bank before said gases have traveled upwardly through most of the combustion chamber and for causing the short flame gases from the bank of the fire to escape from the lower end of said combustion chamber and come in contact with some of the tubes of the boiler.

2. A water tube boiler, comprising at least two elevated transverse steam-and-water drums, a transverse mud drum, a radiant heat first bank of upflow tubes leading from the mud drum to the front steam-and-water drum, water circulators connecting said elevated steam-and-water drums together, a separate convected heat bank of upflow tubes leading from the mud drum to the second steam-and-water drum, downcomer tubes leading from the second steam-and-water drum for returning the water to the mud drum, and means for preventing the short flame gases liberated from the fuel at the rear of the fire from mingling with the hydrocarbon gases distilled from the green fuel at the front of the fire to such an extent that combustion of said hydrocarbon gases in the combustion chamber of the boiler is interfered with, said short flame gases escaping from the lower end of the combustion chamber and said hydrocarbon gases escaping through a separate outlet at the upper end of the combustion chamber.

3. A water tube boiler, comprising three steam-and-water drums arranged in an elevated position, a mud drum, a radiant heat tube bank connecting said mud drum with the front steam-and-water drum, a convected heat tube bank and a downcomer tube bank connecting the middle steam-and-water drum with the mud drum, an economizer tube bank connecting the rear steam-and-water drum with the mud drum, and means whereby the short flame gases rising from the rear of the fire will be caused to escape through an outlet at the lower end of the combustion chamber and enter the lower end of the convected heat bank and the long flame gases rising from the front of the fire will be caused to circulate upwardly through the combustion chamber and escape through a separate outlet at the upper end of said chamber.

4. A water tube boiler, comprising at least two elevated transverse steam-and-water drums, a transverse mud drum, a radiant heat first bank of upflow tubes leading from the mud drum to the front steam-and-water drum and arranged at the rear of the combustion chamber, water circulators connecting said elevated steam-and-water drums together, a convected heat second bank of upflow tubes leading from the mud drum to the second steam-and-water drum for causing the remainder of the water rising from the mud drum to pass directly into said second steam-and-water drum, downcomer tubes leading from the second steam-and-water drum directly into said mud drum, and a means between the first and second banks of tubes for separating the long flame gases rising from the front portion of the fire from the short flame gases rising from the back of the fire.

5. A water tube boiler, comprising at least two elevated transverse steam-and-water drums, a transverse mud drum, a radiant heat first bank of upflow tubes leading from the mud drum to the front steam-and-water drum and arranged at the rear of the combustion chamber, water circulators connecting said elevated steam-and-water drums together, a convected heat second bank of upflow tubes leading from the mud drum to the second steam-and-water drum for causing the remainder of the water rising from the mud drum to pass directly into said second steam-and-water drum, downcomer tubes leading from the second steam-and-water drum directly into said mud drum, and a partition arranged between the first and second banks of tubes in such a manner that the long flame gases rising from the front of the fire will travel upwardly through the

combustion chamber and then flow rearwardly over the upper edge of said partition and the short flame gases from the rear of the fire will flow rearwardly from the combustion chamber under the lower edge of said partition and then travel upwardly among the tubes of the second bank.

6. A water tube boiler, comprising at least two elevated transverse steam-and-water drums, water circulators connecting said drums together, a transverse mud drum, a radiant heat bank of upflow tubes leading upwardly from said mud drum to one of said elevated drums and constituting the sole source of water supply to said elevated drum, a separate and distinct convected heat bank of tubes spaced away from the radiant heat bank and connected to the other elevated drum for causing the remainder of the water rising from said mud drum to circulate upwadly to said elevated drum, downcomer tubes leading from one of said elevated drums directly to said mud drum, and a partition arranged between said radiant heat bank and said convected heat bank and so disposed with relation to the mud drum and the elevated drum to which the upper ends of the tubes of the radiant heat bank are connected that gas passageways are provided above and below said partition.

ALFRED COTTON.