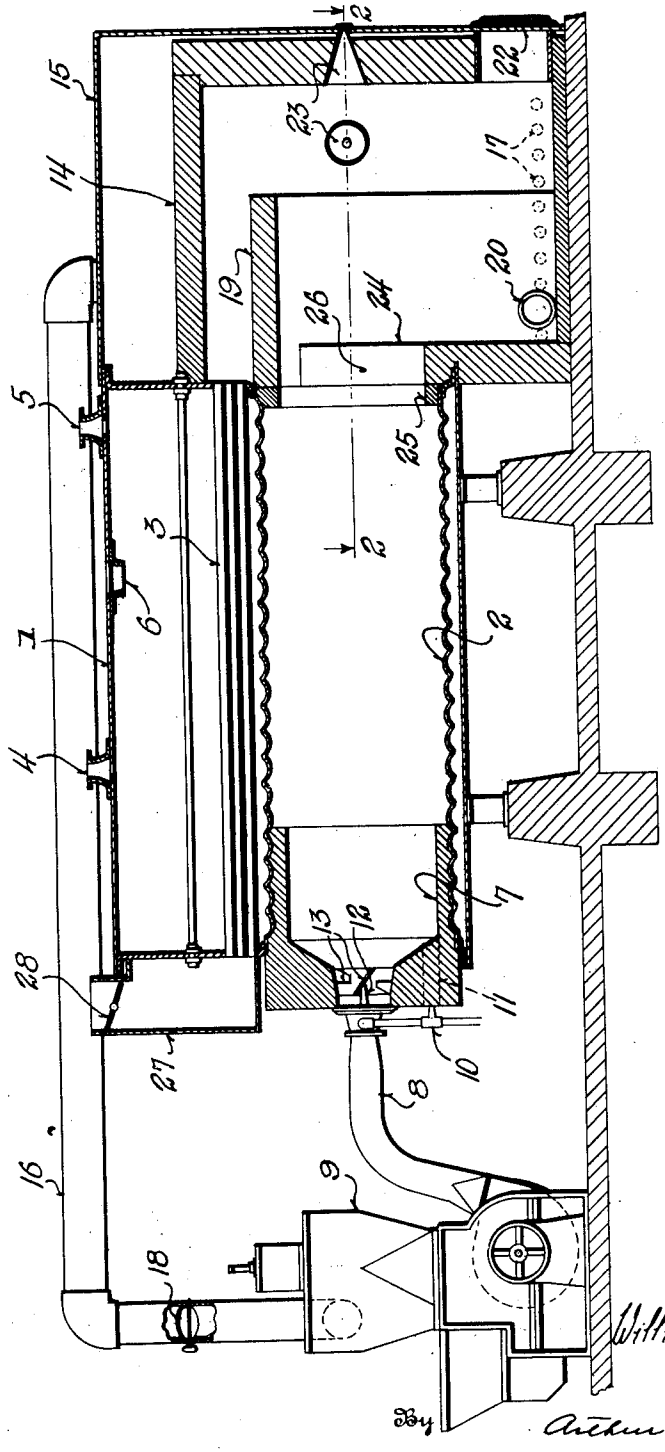
April 4, 1933. W. G. JOHNSON 1,903,313

SCOTCH MARINE BOILER CONSTRUCTION

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Fig. 1



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Fig. 2

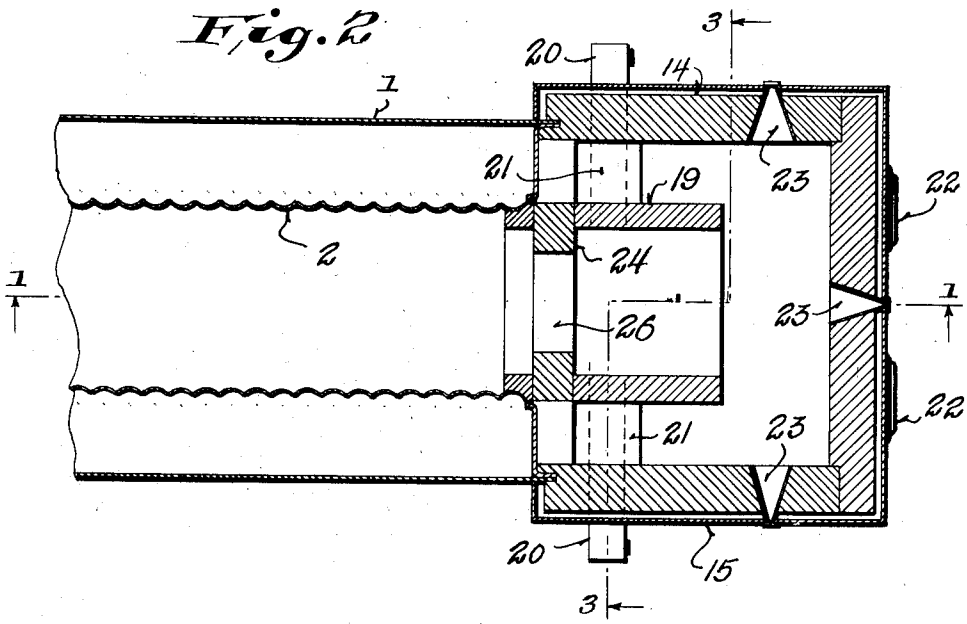
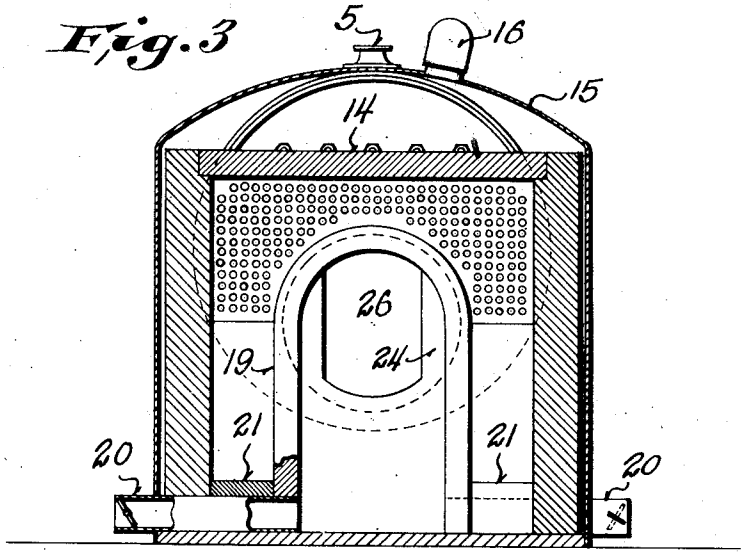


Fig. 3



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UNITED STATES PATENT OFFICE

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SCOTCH MARINE BOILER CONSTRUCTION

Application filed February 2, 1931. Serial No. 512,794.

This invention relates to a Scotch marine boiler and the setting therefor.

Scotch marine boilers, although possessing certain inherent desirable characteristics due to their simple design and due to their relative cheapness, as compared with other boiler installations, nevertheless have not been as efficient in operation as numerous other types, and additionally have the defect of lack of flexibility in carrying varying loads and their relatively efficiency being low for overloads.

When powdered fuel was employed, it was the usual practice to provide what are known as "Dutch ovens" in front of the boiler where ignition started. If the major part of the combustion took place in these combustion chambers, the output of the boiler was comparatively small or, in other words, the rating was necessarily low. When it was attempted to force the boiler and operate it under overload, its efficiency rapidly fell off and in addition, the rapid destruction of the Dutch ovens occurred, as intense heat was generated in these ovens and as there was no practical way of protecting them. If anything like a 100% overload was attempted, the cost of renewals for the Dutch ovens was prohibitive.

One of the reasons for the rapid falling off in efficiency was due to the fact that the combustion was not complete as a large portion of the combustion took place in the main furnace tube whose walls were maintained by the water in the boiler below the point where combustion could be maintained. If an excess of air was admitted with the fuel, the percent of carbon dioxide in the flue gases was greatly decreased, and the extra volume of air extracted heat which was lost with the discharged gases. On the other hand, if an excess of air was not admitted with the fuel, combustion was very incomplete and, therefore, under both conditions a rapid falling off in efficiency occurred.

At best, the Scotch marine boiler, as heretofore known, did not compare favorably in efficiency with the larger installations which employed the elaborate water wall combustion chamber, economizers, and large banks of boiler tubes joined by large headers.

Objects of this invention are to provide a Scotch marine boiler and setting therefor which, while retaining all of the advantages of the Scotch marine boiler due to its simple design, its suitability for small or medium sized installations, nevertheless has none of the defects heretofore encountered and as enumerated above, but has an efficiency, even under a very large overload equal to or comparable with that obtained from the largest, most elaborate, and latest design of boiler installations.

More specifically, further objects of this invention are to provide a Scotch marine boiler construction which has great flexibility and is adapted to operate with high efficiency throughout the range from underloads, normal loads, or large overloads; which does not require the use of preliminary combustion chambers such as the "Dutch ovens" mentioned above; in which there are no expensive renewals of the brickwork, or refractory material, even when the boiler has been operating for a long period under overload; and in which substantially complete combustion is secured under all conditions of operation.

In greater detail, objects of this invention are to provide a Scotch marine boiler construction which has means for securing secondary ignition after the gases have passed through the furnace tube or furnace tubes and before they pass through the flues, which provides for the substantially complete combustion of all of the combustible material remaining in the gases after passing through the furnace tube or furnace tubes and before the gases arrive at the flues, thereby securing, among other things, the two fold advantage of permitting the efficient operation of the boiler both at normal rating and at high rating or overload, and also greatly raising the temperature of the gases after passing through the furnace tube or furnace tubes and before such gases are passed through the flues.

Further objects are to provide a primary combustion chamber which is cooled by the furnace tube to thereby provide a water-cooled primary combustion chamber in the Scotch marine boiler, and in which this primary combustion chamber is formed of re-

fractory material which has good heating conducting characteristics.

Further objects are to provide a Scotch marine boiler in which a secondary combustion chamber is provided and is equipped with a secondary combustion arch, in which an ignition ring is provided, in which this ignition ring is constricted to cause the gases to pass over the heated surface to insure reignition, and in which means are provided for admitting air to the secondary combustion chamber to permit the recombustion of the gases, the secondary combustion chamber being so constructed that a long path of travel is provided for the gases to insure complete secondary combustion before the gases arrive at the flues.

Further objects are to provide a Scotch marine boiler in which the fuel is fed directly into the furnace tube or furnace tubes, in which heated air is supplied with the fuel to thus increase the efficiency, and in which this heated air is drawn around the secondary combustion chamber.

Further objects and advantages will appear as this description proceeds.

An embodiment of the invention is shown in the accompanying drawings, in which:—

Figure 1 is a longitudinal sectional view through a Scotch marine boiler constructed in accordance with this invention, such view showing a unit pulverizer with a portion of the air supply pipe broken away, such view corresponding to a section on the line 1—1 of Figure 2.

Figure 2 is a fragmentary sectional view on the line 2—2 of Figure 1.

Figure 3 is a sectional view on the line 3—3 of Figure 2.

Referring to the drawings, it will be seen that a Scotch marine boiler has been indicated by the reference character 1. This boiler is provided with a corrugated furnace tube 2 and with flue pipes 3. It is also provided with a steam outlet 4 and a safety valve outlet 5, and a manhole 6.

The boiler is provided with a primary combustion chamber 7 formed of a refractory material which nevertheless has good heat conducting characteristics. It has been found that carborundum forms an excellent material for the primary combustion chamber, although obviously the material could be varied without departing from the spirit of this invention. The main body portion of this chamber, it will be seen from Figure 1, is relatively thin and is water-cooled by means of the furnace tube 2. The burner is provided with a constricted inlet to which powdered fuel and heated air are fed by means of the pipe 8 from the unit pulverizer 9.

It is preferable to provide one or more steam jets 10 which are adapted to blow additional air through an opening or openings 11 formed in the head of the primary combustion chamber 7.

Further, it is preferable to provide a steam nozzle 12 located approximately centrally of the inlet portion of the primary combustion chamber. Further, it has been found desirable to produce a spinning or whirling motion of the flame so that the entire mass of burning gases swirls through the furnace tube 2. This is accomplished in any suitable manner, as by means of the twisted vanes 13 formed in the throat of the primary combustion chamber, as shown in Figure 1.

A secondary combustion chamber indicated generally by the reference character 14 is provided and is adapted to conduct the gases from the rear end of the furnace tube 2 to the flues 3. This secondary combustion chamber is formed of firebrick and is provided with a shield or housing 15 spaced therefrom and communicating with the unit pulverizer by means of a pipe 16. This housing is provided with inlet openings 17, see Figure 1, through which air may enter, the air being heated as it passes around the secondary combustion chamber 4 and the heated air passing through the pipe 16 to the unit pulverizer, a suitable control 18 being provided to control the supply of air.

The secondary combustion chamber is provided with a combustion arch 19, as shown in each of the three figures of the drawings. This arch extends rearwardly from the rear end of the furnace tube 2 into the secondary combustion chamber 14 and insures a thorough mixing of the gases with the secondary air supply hereinafter described, and also insures a long travel of the burning gases before they enter the flues 3 so that complete combustion is thus obtained.

The combustion arch 19 also constitutes an ignition arch as it becomes incandescent and insures reignition of the gases. The fresh air is supplied in any suitable manner, as by means of the pipes 20 extending inwardly from opposite sides of the secondary combustion chamber and entering within the combustion arch or ignition arch 19, as shown most clearly in Figure 3.

Preferably these air supply pipes 20 are protected by firebrick or other refractory protecting material, as indicated by the reference character 21 in Figure 3. The secondary combustion chamber 14 and the combustion arch or ignition arch 19 are formed of firebrick, and it is preferable to provide doors 22, see Figures 1 and 2, in the lower rear wall of the secondary combustion chamber. Further, peep holes or inspection openings 23 are provided at suitable points in the rear and sides of the secondary combustion chamber.

It is also preferable to provide an ignition wall or ignition ring over which the heated gases travel. This ignition wall is indicated by the reference character 24, and is prefer-

ably formed of firebrick. This wall extends upwardly within the arch 19 and it is preferable to form a ring 25 of firebrick just inside of the wall 24, as shown in Figures 1 and 2.

The ring 25 and wall 24 together constitute reignition means acting additionally to the arch 19. The wall 24 and the ring 25 also constrict the flow of gases from the furnace tube. For instance, the ring 25 provides a lesser area than that of the furnace tube, while the wall 24 is provided with a restricted opening 26 through which the heated gases must pass. This construction serves to pinch or contract the stream of heated gases and causes them to travel over the surface of these portions 24 and 25, and to thus reignite due to the additional supply of air furnished by the pipes 20.

While the invention has been described as designed for the use of pulverized fuel, nevertheless it is obvious that any other type of fuel may be used.

It is to be understood that one or more furnace tubes may be used and that any suitable means of feeding the fuel may be employed. Also, as stated above, it is obvious that any type of fuel could be employed as desired.

It is to be noted particularly that this invention provides a Scotch marine boiler which is adapted to carry overloads with high efficiency. Further, from actual tests conducted with a boiler constructed in accordance with this invention, it has been found that the efficiency of this boiler compares favorably and is equal to the efficiency obtained from very large installations employing the latest equipment, such as preheaters, economizers, large banked boiler tube structures, and the other accessories customarily employed for the very largest installations.

This invention, therefore, supplies a Scotch marine boiler which has an efficiency equal to that of the very large installations, such as those employed in large power houses and employing the latest design of apparatus. The Scotch marine boiler forming the subject matter of this invention may, however, be used as a single unit and may be in any size desired, so that even a small plant may have a boiler installation commensurate with the size of the plant, and having the high efficiency which heretofore has only been obtained in the very large installations of other types of boilers.

From tests conducted with a boiler constructed in accordance with this invention, it has been found that the temperature in the primary combustion chamber which is formed jointly by the chamber 7 and the furnace tube 2, is approximately between 3000° F. and 4000° F. The temperature of the gases as they emerge from the furnace tube is usually between 1500° F. and 2000° F. The temperature of the gases within the arch 19 of the secondary combustion chamber 14 varies from 2000° F. to 2700° F. The temperature of the completely burned gases when they pass to the flues 3 averages between 1800° F. and 2200° F.

The above figures are given merely as illustrative of one condition under which this boiler has operated. Obviously the temperatures may be varied without departing from the spirit of this invention. The actual B. t. u. efficiency obtained from a boiler constructed in accordance with this invention and under careful tests ranges from 80% to 85% even under high overload.

The temperature of the flue gases discharged into the stack 27 varies from approximately 450° F. for 100% rating to 625° F. for 200%, or 650° F. for 225% rating.

It is, of course, apparent that any suitable damper or other control 28 may be employed in the stack. The exact details of construction of the usual equipment supplied with this boiler has not been shown in detail in the drawings.

It has been found that the Scotch marine boiler as heretofore operated did not secure the maximum radiant heat for steam generation, whereas with this invention the radiant heat is freely absorbed in the furnace tube, as it directly impinges upon the inner surface of the furnace tube and a very large amount of the heat from the fuel is obtained in this manner.

With the old type of Scotch marine boiler the cooled gases discharged from the furnace tube were passed directly through the flues and very little additional heat was secured in this manner. However, with this invention the gases discharged from the furnace tube have their temperature raised a very large amount, and after complete secondary combustion, these highly heated gases are passed through the furnace tube, thus providing a source of additional heat without requiring the use of any more fuel.

Further, by constricting the flow of gases from the furnace tube adjacent the point where these gases mix with the secondary air supply, it is clear that reignition is insured and the additional air supply is maintained at just such a proportion as to insure complete and most efficient recombustion of these gases.

The construction of the secondary combustion chamber, as previously described, is such that a long travel for the gases is secured so that complete combustion takes place before the gases enter the flues. As a matter of fact, preferably at least 8 feet travel is provided for the gases from the time they leave the rear end of the furnace tube to the time they enter the flues.

In actual tests conducted with this boiler, it was found that the temperature of the gas

discharged from the furnace tube was raised from 500° F. to 700° F. before it was passed into the flues.

Further, from actual tests conducted with this boiler, it was found that a very high CO_2 reading was obtained for the gases passed to the stack.

It is also a well known fact that Scotch marine boilers usually do not have a very high efficiency, and when overloaded, their efficiency immediately drops off in a marked degree. However, in the practice of this invention it has been found that the efficiency was maintained even under a very high overload. In actual tests the rating reached from 200% to 225% and still the extremely high efficiency of this boiler was maintained.

It will be seen that a novel form of Scotch marine boiler has been provided which may be constructed in any size and which, even in small sizes, has an efficiency which is easily comparable to that obtained by the largest and latest installations employing other types of boilers equipped with the latest design of accessory apparatus.

It will be seen further that this invention provides a Scotch marine boiler in which the primary combustion chamber is water-cooled and carried within the furnace tube itself, and that a secondary combustion chamber has been provided for the reignition of the gases and the raising of the temperature of the gases to a high degree after they leave the furnace tube and before they enter the flue tube.

It has been found from actual practice that this invention is eminently practical, that renewal of the parts is so infrequent that it is negligible, and that the boiler may be operated continuously under overload and with a very high efficiency.

Although this invention has been described in considerable detail, it is to be understood that such description is intended as illustrative rather than limiting, as the invention may be variously embodied and is to be interpreted as claimed.

I claim:

1. A boiler having a furnace tube and flue tubes, means for supplying fuel and air to said furnace tube, a secondary combustion chamber communicating with said furnace tube and said flues, a combustion arch of refractory material beneath and over which the gases from said furnace tube pass, said combustion arch being located within said secondary combustion chamber, and means for admitting air to said secondary combustion chamber.

2. A boiler having a furnace tube and flue tubes, means for supplying fuel and air to said furnace tube, a secondary combustion chamber communicating with said furnace tube and said flues, a combustion arch of refractory material beneath and over which the gases from said furnace tube pass, said combustion arch being located within said secondary combustion chamber, and means for admitting air to said secondary combustion chamber, said air entering inside said arch.

3. A Scotch marine boiler having a furnace tube and flues, means for supplying fuel and air to said furnace tube adjacent the front end of said furnace tube, a secondary combustion chamber adjacent the rear of said boiler for conducting gases from said furnace tube to said flues, a combustion arch within said secondary combustion chamber, an ignition wall in front of said combustion arch having an opening for constricting the gas stream as it flows into said combustion arch, and means for admitting air within said combustion arch rearwardly of said ignition wall.

4. A Scotch marine boiler having a furnace tube and flues, means for supplying fuel and air to said furnace tube adjacent the front end of said furnace tube, a secondary combustion chamber adjacent the rear of said boiler for conducting gases from said furnace tube to said flues, a combustion arch within said secondary combustion chamber, an ignition wall in front of said combustion arch having an opening for constricting the gas stream as it flows into said combustion arch, and means for admitting air within said combustion arch rearwardly of said ignition wall, said combustion arch causing a long gas travel from the point where the gases leave said furnace tube to the point where the gases enter said flues, whereby substantially complete secondary combustion is secured before the gases enter said flues.

5. A boiler having a primary combustion chamber surrounded by a water wall which extends rearwardly and surrounds the flame and forms a radiant absorption chamber, and a secondary heat absorption surface; means for supplying fuel and air to said primary combustion chamber; a secondary combustion chamber for conducting gases from said primary combustion chamber to said secondary heat absorption surface; a combustion arch of refractory material located within said secondary combustion chamber through which said gases pass, said gases passing also over the outer side of said combustion arch; and means for admitting secondary air to said secondary combustion chamber within said combustion arch.

6. A boiler having a furnace tube and a secondary heat absorption surface, means for supplying fuel and air to said furnace tube, a secondary combustion chamber communicating with said furnace tube and conducting gases to said secondary heat absorption surface, a combustion arch of refractory material beneath and over which the gases from said furnace tube pass, said combustion arch

being located within said secondary combustion chamber, and means for admitting air to said secondary combustion chamber.

7. A boiler having a primary combustion chamber comprising a radiant heat absorption chamber, and a secondary heat absorption surface; means for supplying fuel and air to said primary combustion chamber; a secondary combustion chamber for conducting gases from said primary combustion chamber to said secondary heat absorption surface; a combustion arch of refractory material located within said secondary combustion chamber through which said gases pass, said gases passing also over the outer side of said combustion arch; and means for admitting secondary air to said secondary combustion chamber within said combustion arch.

In testimony whereof, the signature of the inventor is affixed hereto.

WILLIAM G. JOHNSON.