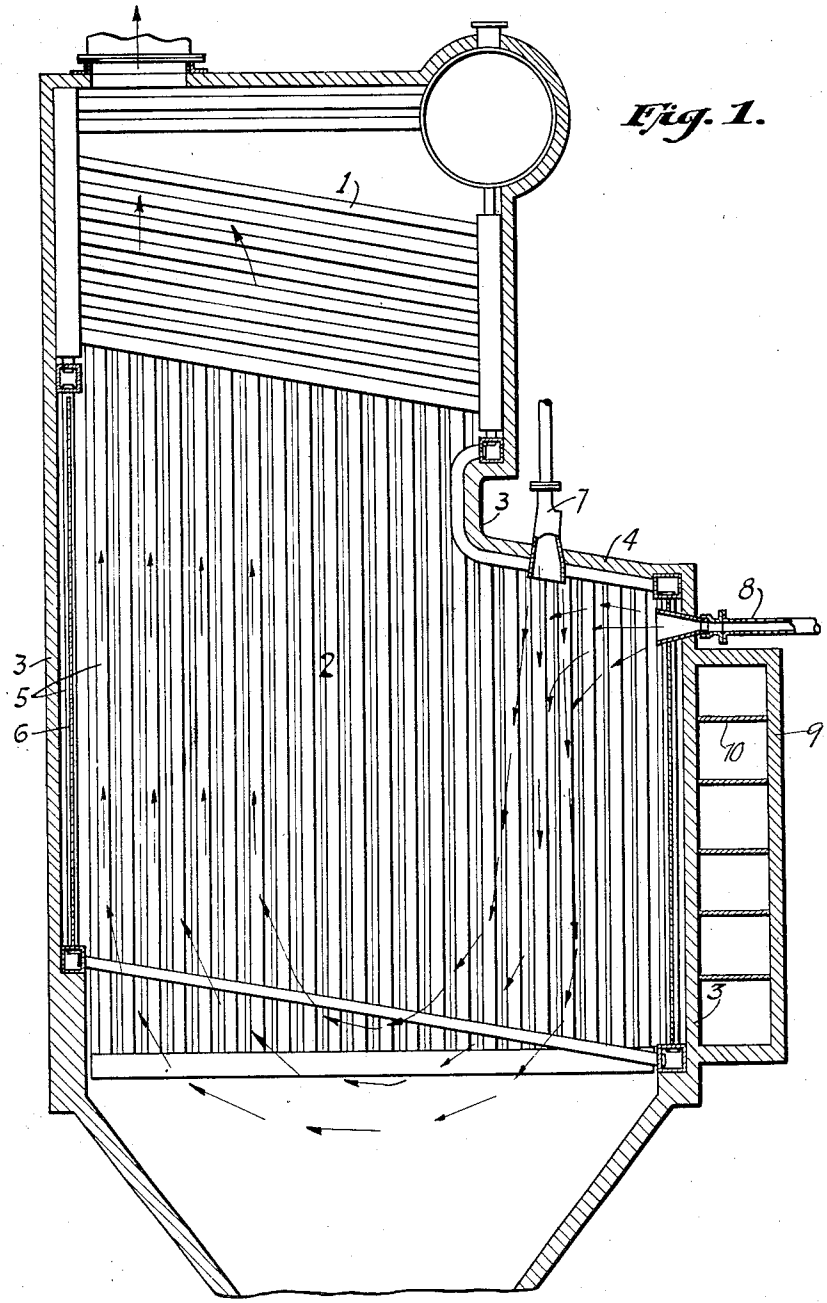
July 10, 1934. A. J. WHEELER, JR 1,966,054

METHOD OF COMBUSTION

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Fig. 1.



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METHOD OF COMBUSTION

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Fig. 3.

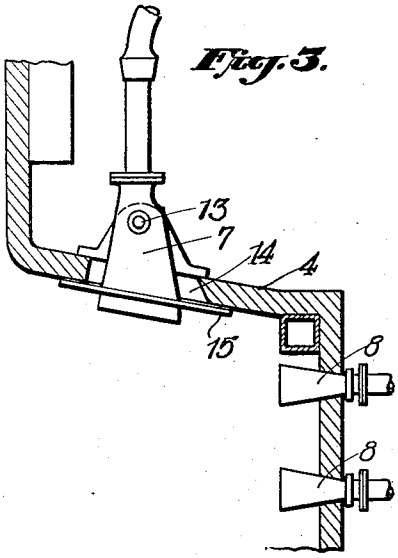


Fig. 2.

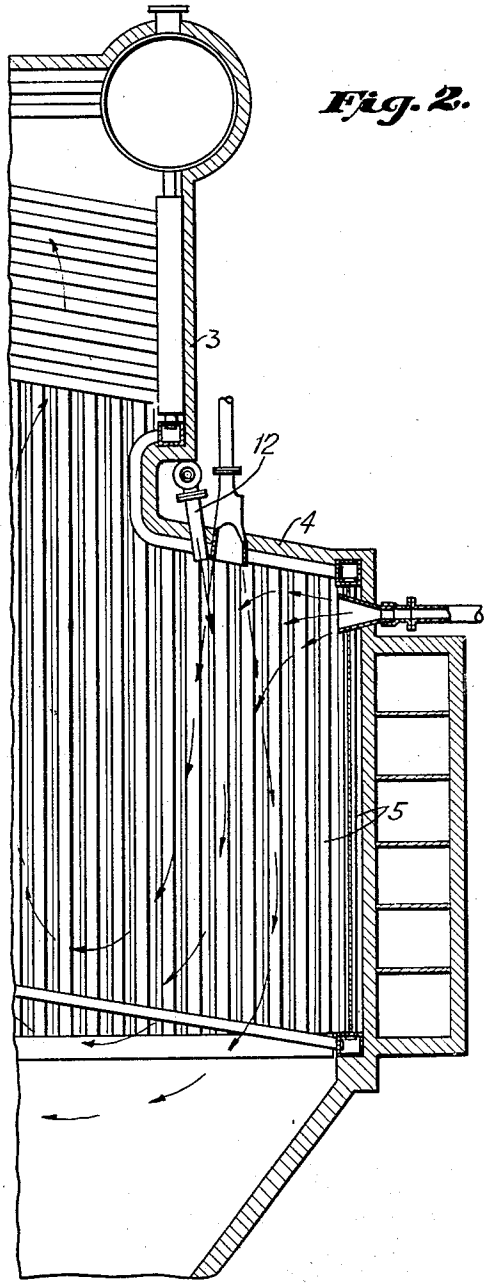
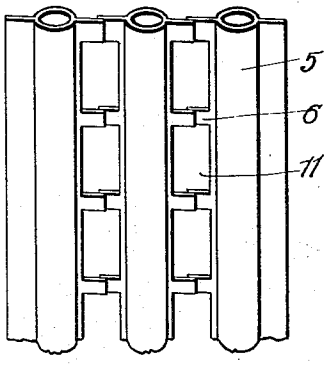


Fig. 4.



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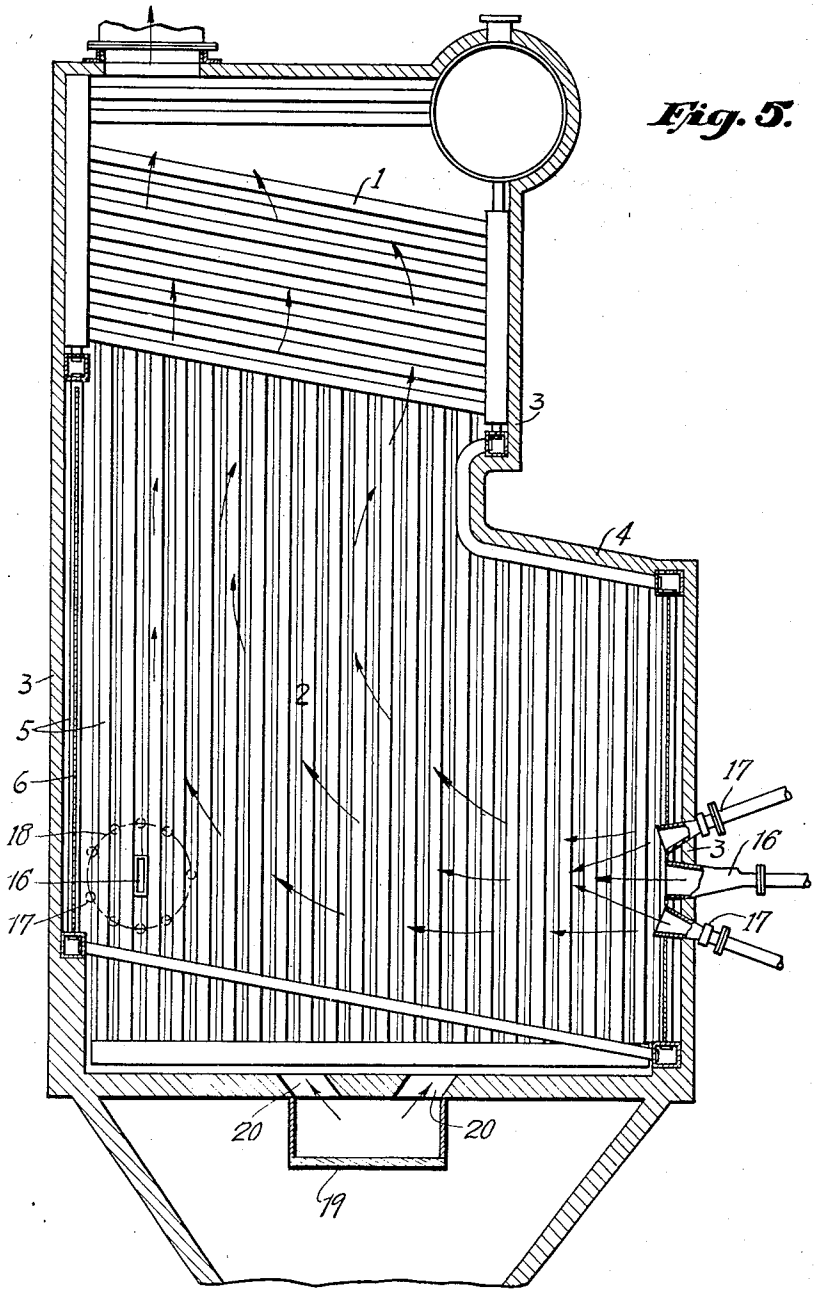
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METHOD OF COMBUSTION

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Fig. 5.



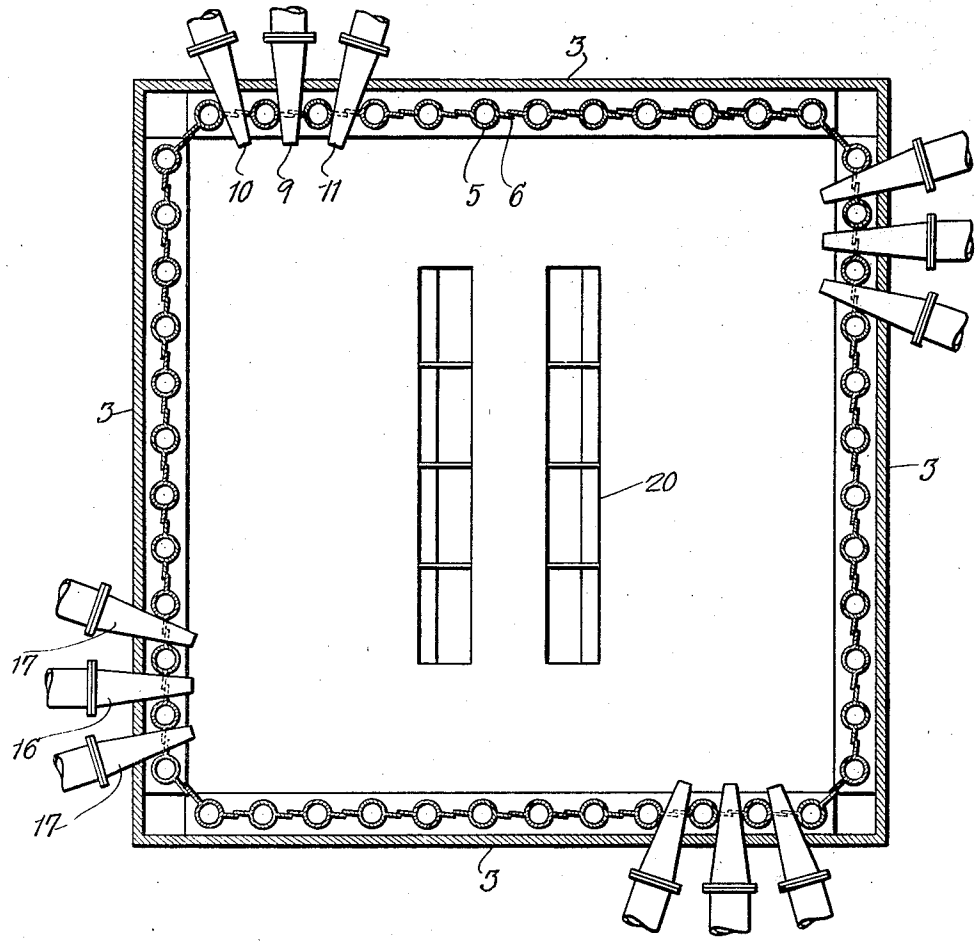
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METHOD OF COMBUSTION

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Fig. 6.



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UNITED STATES PATENT OFFICE

1,966,054

METHOD OF COMBUSTION

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Application November 21, 1928, Serial No. 320,841

3 Claims. (Cl. 122—235)

The purpose of the invention is to accelerate and aid the burning of fuels and to regulate such burning. The invention is especially useful in the furnaces of boilers designed to generate large quantities of steam rapidly and by means of jets or streams of coal dust, oil or gas.

The burning of such fuels is progressive, the more inflammable parts of these fuels burning first and providing heat which raises the temperature of the less inflammable parts up to a point where they will unite with oxygen and burn.

In some fuels these more inflammable parts appear as gases and tars and the rate at which these gases and tars are given off at a given temperature determines the rate at which this fuel can be burned. If, however, a method of burning these fuels is applied by which they are made to give off more gas or other inflammable material than would be given off under normal conditions if this method were not applied to these fuels, their rate of burning and completeness of burning is accelerated and aided.

As the rate of burning and the completeness of burning determines the amount of coal or other fuel that may be burned efficiently in a furnace or other device for burning fuel, it follows that the acceleration of this rate and the aid to completeness of burning of these fuels is a desirable feature.

If a stream of coal, oil or gas is admitted to a furnace and heat is applied to this stream by means of a flame whose temperature is higher at the point of its application than the temperature of the stream of fuel to which it is applied, this stream of fuel then takes on or absorbs some of the heat of the higher temperature flame and assumes a higher temperature itself. At this higher temperature it gives off a greater percentage of inflammable material than it would have given off if the heat of the flame had not been applied to it. This greater percentage of inflammable material burns, providing additional heat to burn the less inflammable parts of the fuel and raises the rate of completeness of burning of the fuel.

By regulating the amount of heat applied by this higher temperature flame a maximum rate of burning of the fuel may be obtained. Thus where with ordinary methods of combustion a certain fuel gives off a comparatively small amount of inflammable material, it can be made to give off a larger amount and thus can be made to burn with an ease and at a rate approaching those of a higher grade of fuel. (By which we mean a fuel which at a given temperature gives off a larger amount of inflammable material). That is to say, the higher grade of fuels give off at say 850 degrees F. a large amount of inflammable material which aids in the burning of the less inflammable material in the fuel; whereas a lower grade of fuel at the same temperature will give off considerably less inflammable material. If however the temperature of the lower grade fuel is raised enough, it will give off more inflammable material than it did at 850 degrees F. and its rate and ease of burning will approach those of the second fuel.

Anthracite or similar comparatively inactive coal can by the use of an auxiliary flame of bituminous coal, gas, oil or other comparatively active fuel be made to burn with increased ease and completeness in the furnace.

The accompanying drawings illustrate, largely diagrammatically, applications of the invention to boiler furnaces of the Murray type.

Fig. 1 represents a vertical section of a boiler furnace;

Fig. 2 is a partial section of a modification thereof;

Fig. 3 is a similar view of a further modification;

Fig. 4 is a partial inside elevation of a front wall;

Fig. 5 is a section similar to Fig. 1 of another modification;

Fig. 6 is a horizontal section of Fig. 5.

The boiler comprises one or more overhead banks of the usual inclined, approximately horizontal water tubes 1 through which the gases pass from the combustion chamber 2 of a furnace below, heating the water in these tubes largely by convection. The vertical walls 3 of the furnace and the approximately horizontal wall or arch 4 at the front are lined with water tubes forming in effect a water wall or lining. A cross section of such a water wall is illustrated in Fig. 4, composed of tubes 5 with flanges or other metal extensions 6.

This water wall is exposed to the direct radiant heat of the burning fuel and results in a very great increase in capacity over its rating based on the area of heating surface. The efficiency of such boilers is particularly dependent on the providing of a high temperature flame which is distributed throughout the combustion chamber and radiates heat directly to the water walls. The construction of the walls illustrated may be modified in various known or suitable ways.

According to Fig. 1 a burner or nozzle 7 projects a stream of fuel or fuel and air vertically downward through the arch. The flame is intended to go to the bottom of the combustion chamber along the front wall, across the bottom and thence upward along the back wall, as indicated by the arrows.

In such firing arrangements it often appears that the fuel advances a considerable distance beyond the burner before flaming to a substantial extent, so that the entering end of the stream is defective. To remedy this, I provide a second burner or nozzle 8 designed to project a supplementary flame into the main stream of fuel, the temperature of the supplementary flame being higher at its point of application than that of the main stream of fuel. The latter absorbs some of the heat of the higher temperature flame and gives off an increased percentage of inflammable material at the point where it would normally be defective.

In an actual installation there would be several burners 7 arranged along the front of the furnace, and a supplementary burner 8 for each of them. The main stream of fuel or flame may be projected in various ways and directions and at various points, depending on the design of the furnace. Several supplementary flames for each main stream may be used instead of one, if the fuel conditions warrant it, and such supplementary flames may be arranged in either a horizontal or a vertical plane. Or there may be a smaller number of supplementary burners for a large number of main burners.

On the front of the wall 3 there is a supplementary chamber 9 divided by horizontal partitions 10 into air lanes. These supply supplementary air for combustion at successive points in the length of the flame. Fig. 4 shows openings 11 between the tubes through which such air is admitted into the furnace.

The temperature of the auxiliary flame is regulated by admitting to the burner only enough air to burn the inflammable part of the fuel available. Thus the maximum temperature is developed, as no excess of air has to be heated. For example, the primary or main burners may be supplied with air to the extent of twenty-five per cent of the total air of combustion, and the auxiliary burners with from one to ten per cent of the total air, the exact percentage depending on the fuel used and the quantity of inflammable material available from such fuel at the temperature developed.

The quantity of heat supplied by the auxiliary burner can be regulated by the quantity of fuel and air furnished to it, or by the use of larger or smaller burners or a greater or smaller number of auxiliary burners for each primary burner.

The invention is shown with a primary burner of the ordinary sort designed to inject coal and air together. It may be applied, however, to various other known types of burner; as for example, the so-called mixing burners which introduce the air separately into the jet of powdered coal.

The supplementary burner 8 may be made movable vertically or horizontally toward and away from the main burner. Then by adjustment the hottest part of the flame from the supplementary burner may be applied to the main stream at a point where it is most effective in increasing the percentage of inflammable material given off in the main stream. The fuel for the main burner and for the supplementary burner can be taken from a common source or can be fed by separate feeders. The same is true for the air for both burners.

Fig. 2 illustrates an arrangement similar to that of Fig. 1, with an additional small nozzle 12 of air or fuel or both, arranged to strike the main stream at an angle so as to direct it toward the front wall of the furnace and retard its tendency to take a short cut across the back wall. Such a directing jet may be used to control the location of the main flame and to concentrate the latter wherever desired. Such a jet also produces a certain advantageous turbulence and a mixing effect.

Another method of directing the main flame is shown in Fig. 3. The burner 7 is pivoted at 13 to a support on top of the wall 4 and extends through a slot 14 in the wall. A flange 15 on the burner overlaps and substantially closes the ends of the slot. By observation the burner can be set at such an angle that the direction of the flame resulting from its own force combined with the lateral forces acting on it will be exactly that which is desired.

In this figure also I have illustrated the use of two (or there may be more) auxiliary burners 8 arranged to project their flames on the main stream at successive points.

In Figs. 5 and 6 there is illustrated a furnace with horizontal firing. The main stream of fuel comes from burners 16. Above and below this are supplementary burners 17 projecting their flames into the main stream so as to provide extra heat for prompt combustion.

The supplementary burners may be above and below or may be, as illustrated at the left of the figure, arranged around the main burner along the locations indicated by the dotted lines 18.

The several groups of burners 16 and 17 may be arranged in various locations along the side walls to direct the resulting flame squarely across the furnace or angularly or tangentially.

Fig. 6 illustrates the last-mentioned arrangement. The several groups of burners are arranged in succession at an angle to each other so as to effect a circulating motion of the stream of burning gases, to more thoroughly mix them and to hold the column of flame against channeling or too rapid vertical movement out of the combustion chamber.

It is advisable in this arrangement also to provide an air lane 19 at the bottom of the furnace with divergent openings 20 which deflect the air sidewise and distribute it into the approximately horizontal flame so as to effect complete combustion.

The invention has been tested in the practical working of large power-house boilers. It has resulted in a more rapid burning of fuel, in the production of less smoke and in the more complete burning of the fuel. A much more stable and reliable fire is maintained in the furnace, allowing the use of higher entering velocities of the main stream of fuel or fuel and air, without the flame blowing out, and giving a longer flame travel which in turn increases the efficiency of the furnace.

The carbon loss in the pit and flue ash of these boilers has been materially lessened, particularly where low volatile coals having a high fixed carbon content have been used.

The invention shows the above advantages in operating boilers even at comparatively low ratings. It is of peculiar importance in boiler furnaces made of or lined with water walls which

are heated by the heat of the furnace fuel. Such furnaces are designed for very large capacity and this result is best achieved by the use of the present invention which ensures an easy, rapid and complete combustion within the desired zones. The water walls are also important in connection with this method of firing because the ordinary refractory walls would burn out and require very much more frequent replacement.

The adjustability of the burner in Fig. 3 permits it to be set at such an angle that the flame resulting from the main and supplementary burners and from the force of the air which is admitted progressively and laterally along its travel will be predetermined and will be exactly that which is desired to secure the highest efficiency in heating the tubular walls and the overhead convection tubes. The velocity and temperature of the flame in comparison with the lateral streams of air coming through the openings 11 in Fig. 4 are such that the flame will be maintained steady, that is without blowing out or substantial pulsation, notwithstanding the lateral air currents which cut across it.

Various other modifications may be made without departing from the invention as defined in the following claims.

1. The method of burning fuel in a boiler furnace which consists in projecting a main stream of such fuel into the combustion chamber of the furnace, water cooling the walls of said combustion chamber, applying to said main stream a supplementary stream of fuel and regulating such streams of fuel so that the supplementary stream is converted into a flame whose temperature is higher at the point of application than that of the main stream, applying said flame to the main stream at a point near the origin of the latter and before said main stream has been converted into flame so as to hasten the ignition of the fuel therein and to maintain combustion at a high intensity as the stream passes along the face of the water cooled walls.

2. The method of burning pulverized anthracite or similar low volatile coal in a boiler furnace which consists in projecting a main stream of such coal into the combustion chamber of the furnace, water cooling the walls of said combustion chamber, applying to said main stream a supplementary stream of fuel and regulating such streams of fuel so that the supplementary stream is converted into a flame whose temperature is higher at the point of application than that of the main stream, applying said flame to the main stream at a point near the origin of the latter and before said main stream has been converted into flame so as to hasten the ignition of the coal therein and to maintain combustion at a high intensity as the stream passes along the face of the walls.

3. The method of burning fuel in a boiler furnace which consists in projecting a main stream of such fuel into the combustion chamber of the furnace, water cooling the walls of said combustion chamber, applying to said main stream a supplementary stream of fuel and regulating such streams of fuel so that the supplementary stream is converted into a flame whose temperature is higher at the point of application than that of the main stream, applying said flame to the main stream at a point near the origin of the latter and before said main stream has been converted into flame so as to hasten the ignition of the fuel therein and to maintain combustion at a high intensity as the stream passes along the face of the walls and admitting air through the water cooled wall progressively along the stream of burning fuel so as to substantially complete the combustion of the fuel within the combustion chamber.

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