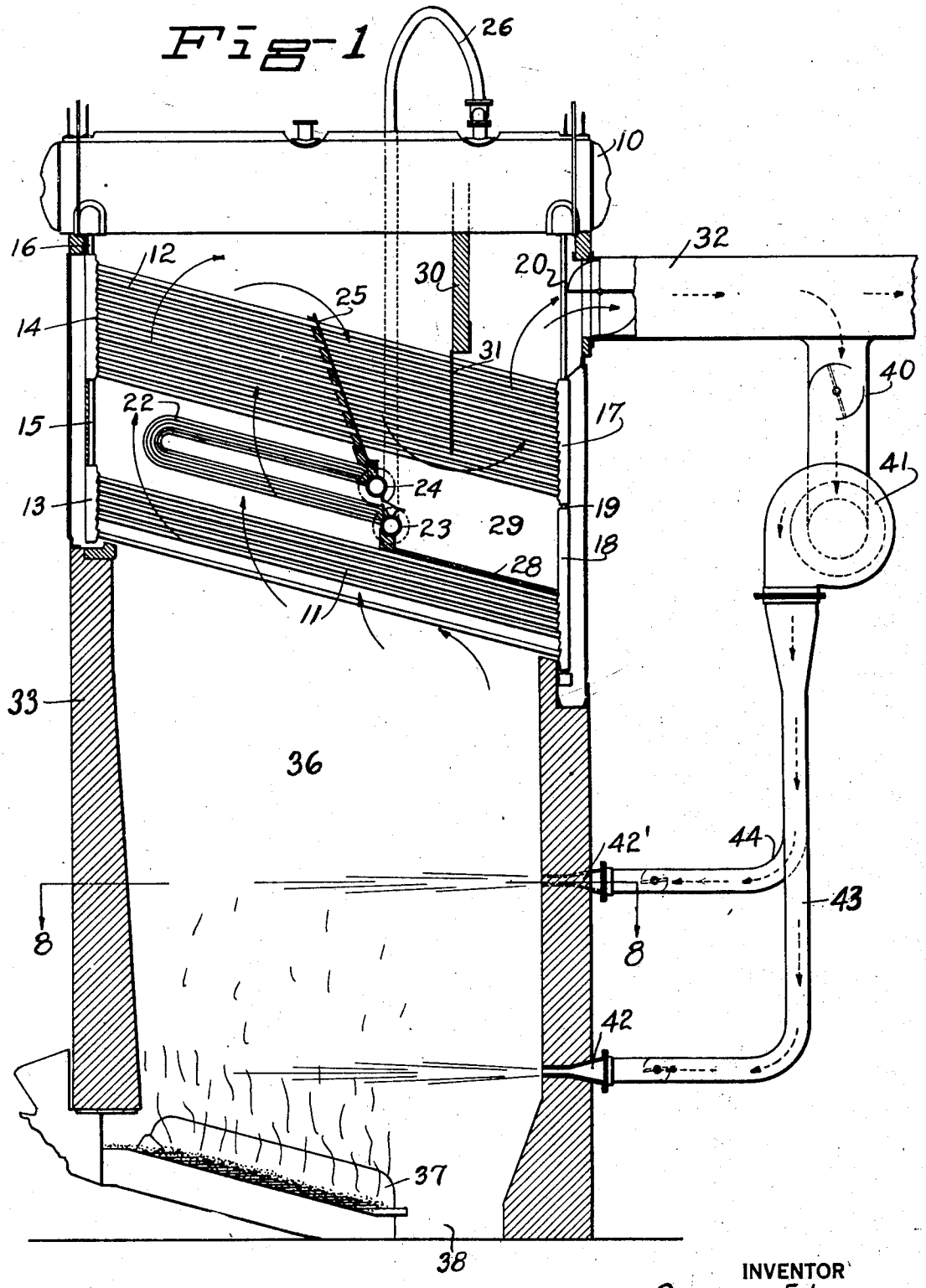
May 31, 1932. C. E. LUCKE 1,860,366

FURNACE AND METHOD OF OPERATING THE SAME

Filed March 11, 1927 4 Sheets-Sheet 1

Fig-1



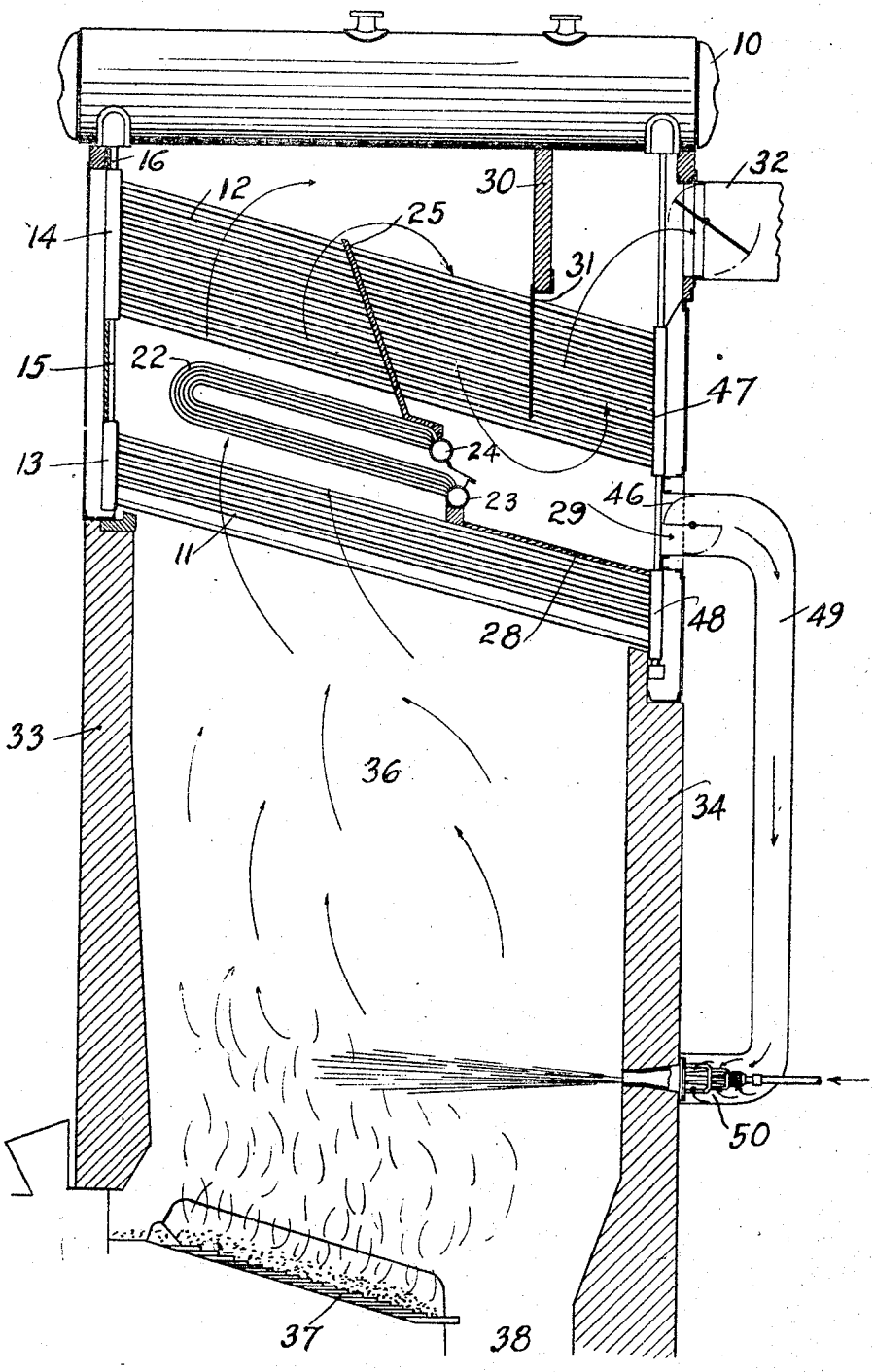
INVENTOR
CHARLES E. LUCKE.
BY
Gifford + Scull
ATTORNEYS

May 31, 1932. C. E. LUCKE 1,860,366

FURNACE AND METHOD OF OPERATING THE SAME

Filed March 11, 1927 4 Sheets-Sheet 2

Fig 2



INVENTOR
CHARLES E. LUCKE.
BY
Gifford + Scull
ATTORNEYS

May 31, 1932. C. E. LUCKE 1,860,366

FURNACE AND METHOD OF OPERATING THE SAME

Filed March 11, 1927 4 Sheets-Sheet 3

Fig- 3

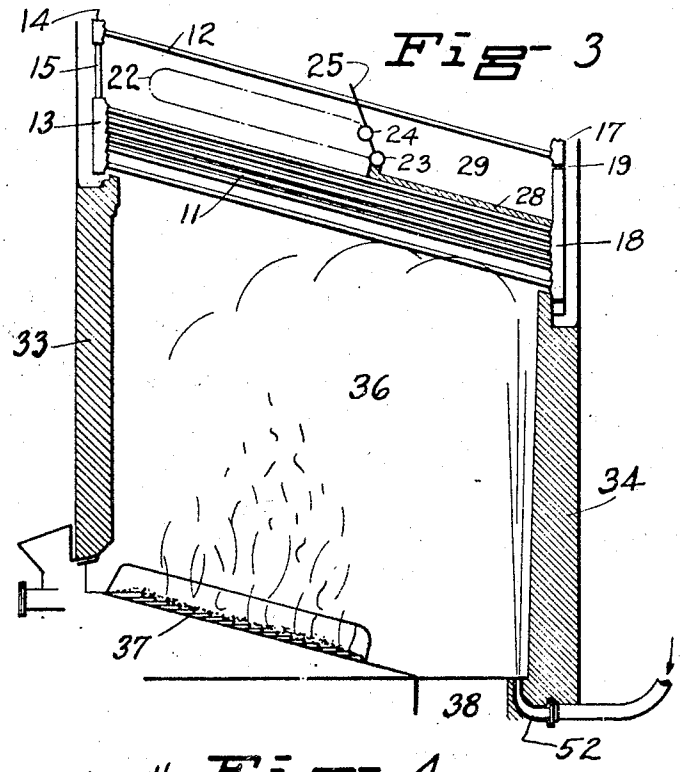


Fig- 4

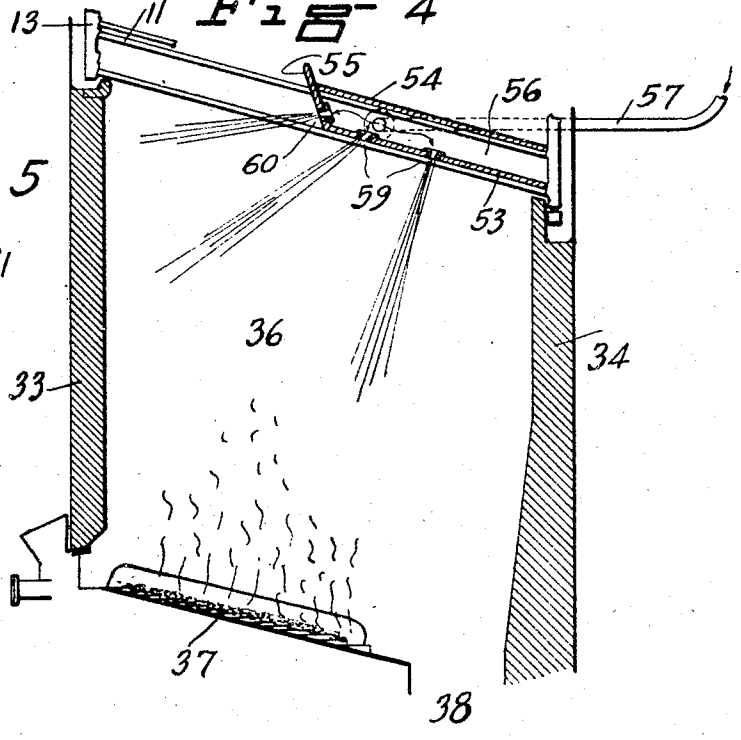
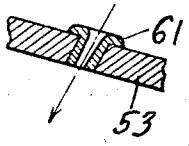


Fig 5



INVENTOR
CHARLES E. LUCKE.
BY
Gifford & Scull
ATTORNEYS

May 31, 1932. C. E. LUCKE 1,860,366

FURNACE AND METHOD OF OPERATING THE SAME

Filed March 11, 1927 4 Sheets-Sheet 4

Fig- 6

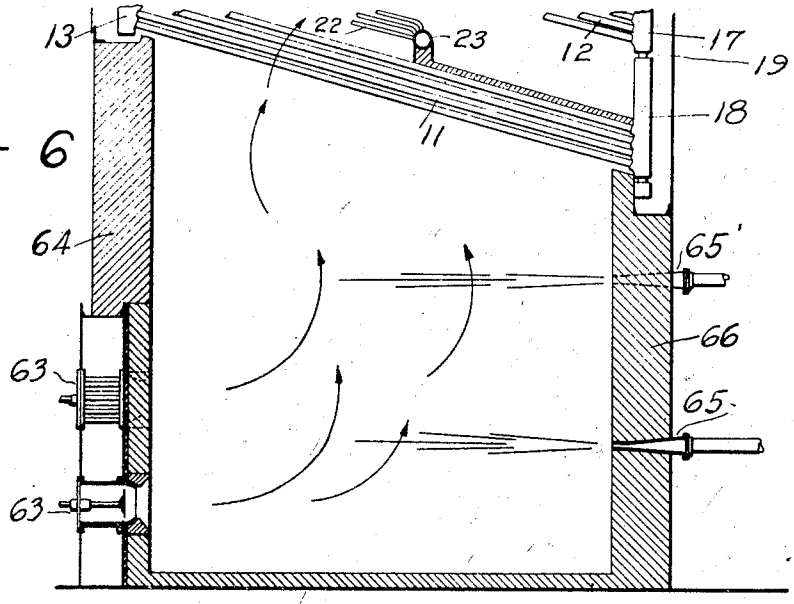


Fig- 7

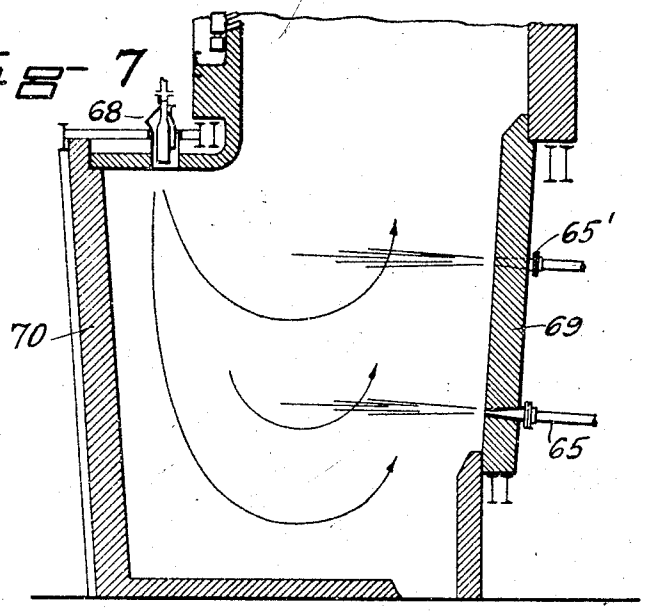
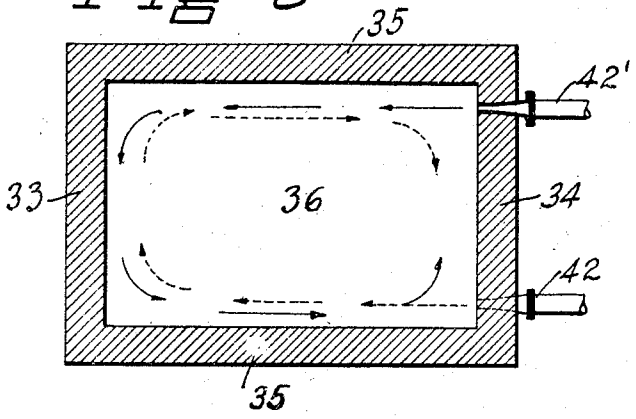


Fig- 8



INVENTOR
CHARLES E. LUCKE
BY
Gifford & Scull
ATTORNEYS

Patented May 31, 1932 1,860,366

UNITED STATES PATENT OFFICE

CHARLES E. LUCKE, OF NEW YORK, N. Y., ASSIGNOR, BY MESNE ASSIGNMENTS, TO FULLER LEHIGH COMPANY, A CORPORATION OF DELAWARE

FURNACE AND METHOD OF OPERATING THE SAME

Application filed March 11, 1927. Serial No. 174,501.

My present invention relates to furnaces and comprehends methods, applicable to various types of furnaces for burning various fuels, whereby combustion is improved by the use of jets of steam or air or waste flue gases entering the combustion chamber to mix the furnace gases for a more thorough or complete combustion of the fuel and for better utilization of air supplied for combustion. My invention will be best understood from the following description in connection with the accompanying drawings which show various practical applications of my invention.

A high rate of combustion in furnaces is a matter of importance to insure the highest possible temperature and a maximum heat output for a furnace of a given size. To this end, the excess air necessary to insure complete combustion must be as small as possible. With the means now in use it is difficult to avoid high excess air and yet have such intimacy of contact of fuel and air as will insure short flames and high combustion rates per cubic foot of furnace volume with reasonably complete combustion of fuel. Heretofore there has been also a lack of uniformity in combustion conditions in different parts of the furnace, especially with large furnaces, resulting in parallel, unmixed streams of fuel and of air.

One of the objects of my invention is to provide a method of operating furnaces whereby there is a maximum degree of combustion of fuel with a minimum of excess air. Another object of my invention is the protection of the walls of a furnace against the destructive action of slag and of high furnace temperatures. Still another object of my invention is the provision of means to utilize jets of air or steam or partially cooled furnace gases to mix the furnace gases and to protect the furnace lining. Further objects and advantages will appear later.

In the drawings, Fig. 1 is an elevational section through a water tube boiler and stoker fired furnace; Fig. 2 shows a modification of the arrangement of Fig. 1 permitting the use of hotter mixing gases; Figs. 3 and 4 show modifications of the method of employing my invention in the furnace of Fig. 1; Fig. 5 shows a detail from Fig. 4; Figs. 6 and 7 show a structure using this method in connection with furnaces burning finely divided fuel issuing from nozzles; and Fig. 8 is a plan in section showing the path of the gases from the mixing jets of Figs. 1, 6 and 7 and taken on the line 8—8 of Fig. 1.

Like reference characters indicate like parts in the several views.

I show in Fig. 1 a water tube boiler having a drum 10 and banks of horizontally inclined tubes 11 and 12 connected to uptake headers 13 and 14 and to downtake headers 17 and 18. The headers 13 and 14 are connected to one another and to the boiler drum by nipples 15 and 16. Downtake headers 17 and 18 are similarly connected to one another and the boiler drum 10 by nipples 19 and 20, respectively. A superheater has tubes 22 connecting the headers 23 and 24 and located between the banks of tubes 11 and 12. The headers 23 and 24 form part of an inclined baffle wall 25 which divides an upward pass of flue gases over the boiler tubes 11 and 12 from a downward pass over the tubes 12. The superheater is connected to the boiler drum by a pipe 26 and may be connected to the steam main by connections, not shown.

A baffle or partition 28 resting upon the upper tubes of the lower bank of boiler tubes 11 joins the lower extremity of the baffle 25 forming a chamber 29. The waste or cooled gas for the mixing jets may be taken from the chamber 29 and returned to the combustion chamber in the manner shown in Fig. 2. A baffle wall 30 extends downwardly from the boiler drum 10 to the boiler tubes 12. A baffle 31 hangs downwardly from the wall 30 and traverses the majority of the boiler tubes 12 to divide a downward pass of gases from the final upward pass of the same into the flue 32.

Front and rear walls 33 and 34 and side walls 35 enclose a furnace chamber 36. A stoker 37 of any type feeds solid fuel from the front of the furnace and discharges the solid products through an ash outlet 38. The entire structure is supported in any usual

way from a steel or other rigid framework.

The flue 32 of Fig. 1 is joined at any desired point by a pipe 40 to tap off and lead flue gases from the flue 32 to the center of a centrifugal fan 41. The fan 41 delivers the flue gas under pressure to nozzles 42 and 42′ through suitable connecting pipes 43 and 44, thus causing the jets from the nozzles to enter the furnace at high velocity, and one which will cause the jets to pass completely across the furnace chamber and be deflected from the opposite walls. The nozzles 42 and 42′ enter the furnace chamber through its rear wall 34 and discharge jets of gas near opposite side walls of the furnace chamber, at high velocity and at different elevations to cause the furnace gases to whirl oppositely at different levels. The jets carry the excess air normally present over the ash zone above the rear of the grate or stocker 37 and forward to the part where normally carbon monoxide is rising over the feed end of the stoker. This mixing action will destroy the tendency for the front and rear gases to rise without mixing and will therefore improve combustion conditions.

In Fig. 2 the hot mixing gases are drawn from the chamber 29 through and between nipples 46 extending between downtake headers 47 and 48. A pipe 49 returns these hot gases to the furnace through a steam draft nozzle 50. Any number of the draft nozzles 50 may be used and be located at convenient positions in the wall of the furnace chamber, to get any desired mixing effect.

In Figs. 3 and 4 mixing of the gases takes place as in Fig. 1, but with a slightly different disposition of the nozzles and entering jets. In Fig. 3 one or more nozzles 52 are arranged to direct an upward blast of flue gas approximately parallel with the rear wall 34 of the furnace. This blast of gas from the nozzle 52 is reflected or reverberated forwardly from a baffle 28 and carries the excess oxygen from the rear to the front of the furnace chamber, directing it across the stream of gases rising from the front or feed end of the stoker. This motion brings the oxygen and unburned gases into intimate contact with each other, increases the rate of combustion and permits of complete combustion within the furnace with less excess air. The whirling action in the furnaces of Figs. 3 and 4 may take place in approximately vertical planes.

In Fig. 4 a pair of parallel baffles 53 and 54 follow the line of spaced boiler tubes 11 and form with an upwardly extending baffle 55 a blast chamber 56 placed above and at the rear of the furnace chamber. This chamber 56 is connected with a blower by a pipe 57 delivering the gases into it, as a feeding chamber for mixing nozzles. Jets issuing from the orifices or nozzles 59 in the baffle 53 move the gases across the furnace and downwardly to establish turbulence and mix the furnace gases. Jets from nozzles 60 in the baffle 55 direct streams of hot gas forwardly in an approximately horizontal direction and for the same purpose. The nozzles 59 and 60 are furnished with tips 61 to give a good jet or blast. The tips 61 of the nozzles 59 and 60 also prevent erosion of the refractory material of the baffle and are of a material suitable for the particular conditions under which they operate.

In the case of furnaces heated by finely divided fuel issuing from nozzles, there is normally an excess of fuel along the center of the fuel stream and an excess of air forming an envelope surrounding the stream. It is necessary to mix the center and the envelope to get high rates of combustion and complete combustion with least excess air. This is accomplished by using gaseous jets entering the furnace at a velocity high enough to keep the furnace gases in a state of turbulence so that the stream will be whirled about and the center part be mixed with the surrounding layers, as the stream enters and crosses the turbulent zone. The velocity of the entering jets should be sufficient to insure the required turbulence and for this reason, it is preferable that the velocity should be sufficient to cause the jets to cross the furnace chamber and strike the opposite walls.

In Fig. 6 the fuel nozzles 63 for burning finely divided fuel are placed in the front wall 64 of the furnace and the nozzles 65 and 65′ introduce flue gas through the rear wall 66 of the furnace in a manner similar to that of Fig. 1. The staggered arrangement of the nozzles and the resulting method of mixing of the gases may be the same as in Fig. 1 and as shown in plan in Fig. 8, or they may be different in the object of maintaining a suitable turbulence in the furnace.

Fig. 7 shows a furnace for the burning of finely divided fuel. A nozzle 68 mounted above the furnace chamber directs a downwardly extending flame or fuel into the chamber. Nozzles 65 and 65′ piercing the rear wall 69 discharge streams of gas into the furnace and against the front wall 70. These streams of gas have sufficient velocity to mix the stream of burning fuel with the air surrounding it within the furnace by keeping the furnace in a turbulent state as the fuel stream crosses the turbulent zone.

It will be obvious that the application of my method is not limited to the exact structure shown and that other mixing fluids, such as air or steam, may be used, and other jet arrangements may be used to improve mixing conditions in the furnace chamber. By these means, the rate of combustion is raised with use of least excess air. The maximum heat generation is assured before the gases reach the boiler tubes and the maximum boiler capacity is made available without losses of

efficiency, such as results when gases burn between tubes.

The invention is particularly useful in connection with the type of apparatus in which the furnace is relatively large with respect to the area of the boiler pass through which gases from the furnace travel as they contact with the water tubes of the boiler. In that type, the gases in the furnace are very apt to form laminations which prevent thorough mixing of the gases, and consequently, complete combustion is prevented, even with a possible excess of air. My invention overcomes this difficulty by causing complete mixing of the gases in the furnace before they reach the pass through which they travel across the water tubes.

I claim:

1. In combination, a furnace having a burner therein, means for mechanically supplying fuel to said burner, a bank of boiler tubes disposed over the furnace, a roof baffle adjacent the bottom of said bank, a cross baffle extending upwardly from the room baffle to form a gas pass across the tubes, nozzles in said roof baffle, and means to discharge waste gases that have passed over said tubes through said nozzles, the space in the furnace beneath the tubes being relatively large with respect to the gas pass across the tubes.

2. In combination, a furnace having a burner therein, means for mechanically supplying fuel to said burner, a bank of boiler tubes disposed over the furnace, a roof baffle adjacent the bottom of said bank, a cross baffle extending upwardly from the roof baffle to form a gas pass across the tubes, nozzles in said roof baffle and in said cross baffle, and means to discharge waste gases that have passed over said tubes through said nozzles, the space in the furnace beneath the tubes being relatively large with respect to the gas pass across the tubes.

3. In combination, a furnace having a burner therein, means for mechanically supplying fuel to said burner, heat-absorbing surfaces over which pass the hot gases from said burner, means forming a restricted passage over said surfaces for said gases, said furnace having a space between the burner and the surfaces which is relatively large compared to said passage, a flue for conducting said gases away from said surfaces, and means for returning part of said gases to said space and for discharging them thereinto at a high velocity to thereby agitate the gases passing from the burner to the heat-absorbing surfaces.

CHARLES E. LUCKE.