Sept. 17, 1957 G. BROLA 2,806,516

COMBUSTION APPARATUS FOR USE WITH BOILERS

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Fig. 1

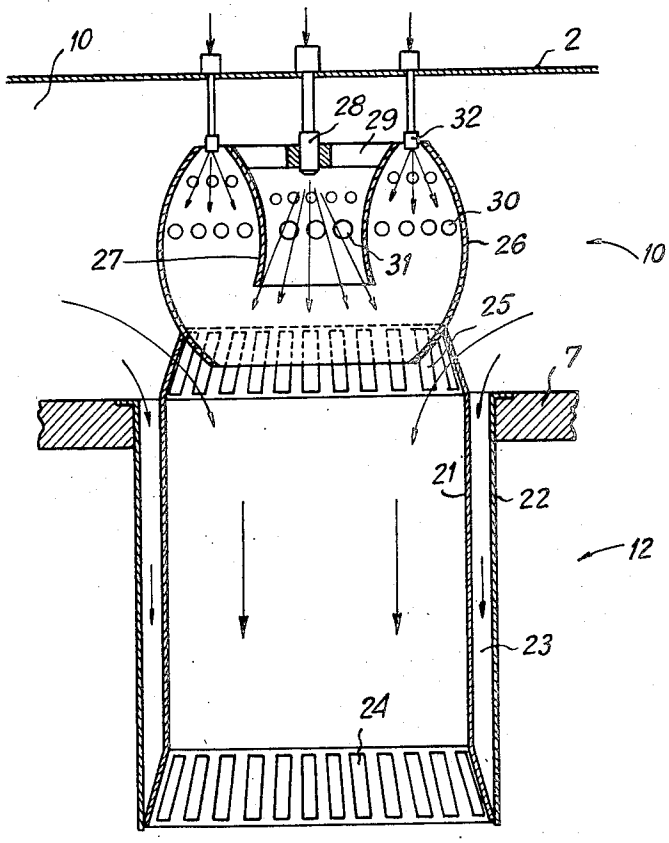

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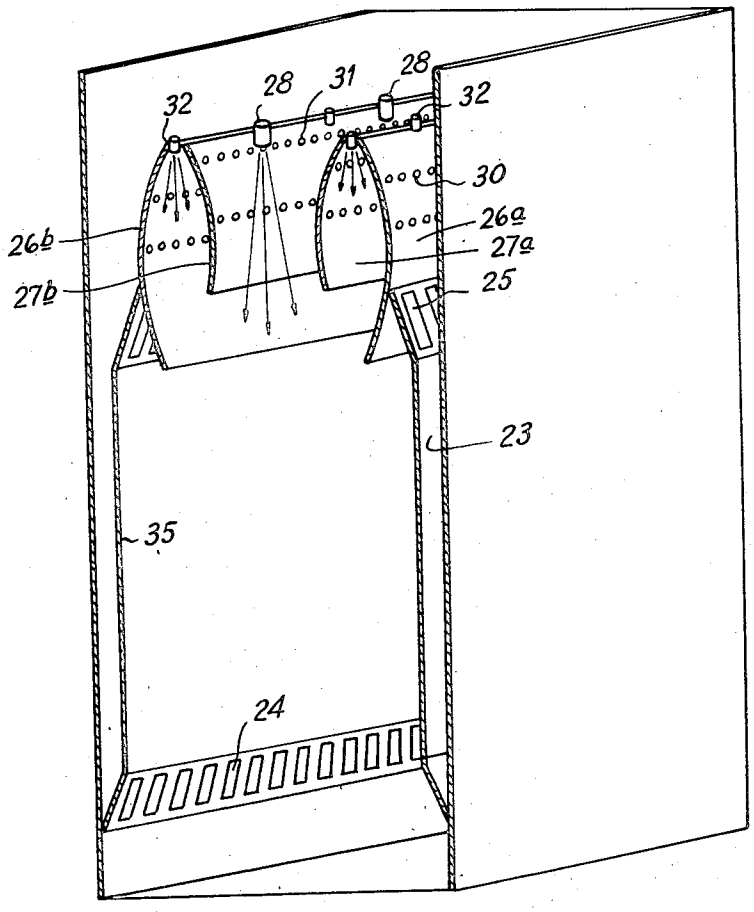
Fig. 2



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COMBUSTION APPARATUS FOR USE WITH BOILERS

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2 Claims. (Cl. 158—1)

This invention relates to combustion apparatus particularly adapted for use with boilers generating hot water or steam.

An object of the invention is to provide combustion apparatus cable of efficiently producing intensely heated products of combustion.

In accordance with an aspect of the invention, a combustion apparatus particularly adapted for use with a boiler generating hot water on steam comprises a main combustion chamber having inlet and outlet ends, an auxiliary combustion chamber opening into the main combustion chamber at the inlet end of the latter, a tuyere disposed substantially completely within the auxiliary combustion chamber to define an auxiliary combustion space between the tuyere and the auxiliary combustion chamber, the tuyere being convergent-divergent and having openings at the narrow portion thereof communication the interior of the tuyere with the auxiliary combustion space, the major supply of fuel and primary air being admitted to the interior of the tuyere, while an auxiliary supply of fuel and auxiliary air are admitted to the auxiliary combustion space to burn in the latter, thereby heating the tuyere to effect heating of the mixture of fuel and air admitted to the latter and permiting burning gases from the auxiliary combustion space to pass through the openings of the tuyere and ignite the fuel and air mixture in the latter.

Further, in accordance with the present invention, a combustion apparatus of the above described character may have its auxiliary combustion chamber tapering at the end thereof opening into the main combustion chamber to project the hot products of combustion from the auxiliary combustion space laterally inward for mixing with the primary fuel and air mixture issuing from the tuyere.

Other advantages and characteristic features of the invention will become apparent in the following detailed description of two embodiments thereof given merely as non-limitative examples with reference to the accompanying drawings, in which:

Fig. 1 is a sectional view of a combustion apparatus embodying the present invention; and

Fig. 2 represent in perspective another embodiment of combustion apparatus according to the invention, and which is shown partly in section.

Referring initially to Fig. 1 of the drawings, it will be seen that a combustion apparatus for a boiler, in accordance with the present invention, comprises a cylindrical tube of refractory steel sheet **21** which is surrounded by a spaced sheath **22**. The assembly of the tube **21** and sheath **22** is placed at the upper part of the central space **12** of a boiler (not shown) and is fixed to a head plate **7**. The passage **23** existing between the tube **21** and sheath **22** communicates with a space **10** above the plate **7** and also with the lower portion of the combustion chamber defined within the tube **21** through openings **24** for the admission of air. The upper portion of the combustion chamber communicates also with the space

10 by openings **25** in the tube **21** for the admission of air. These openings **24** and **25** are directed tangentially.

The cylindrical combustion chamber is surmonted by an auxiliary annular combustion chamber **26** inside which is placed a convergent-divergent tuyere **27** of nickel steel, with the chamber **26** having a concave internal surface.

At the center of the tuyere **27** is disposed the principal injector **28** which feeds the cylindrical chamber **21** with atomised fuel and round which is disposed a row of inclined blades **29** in order to impart a whirling motion to the air passing through the tuyere.

The annular auxiliary combustion space defined between the auxiliary combustion chamber **26** and the tuyere **27** is provided in its external wall and in its internal wall with orifices **30** and **31**, respectively, for the admission of air and a plurality of fuel injectors **32** extend into the auxiliary combustion space to supply auxiliary fuel to the latter. An ignition plug (not shown) may be provided within the auxiliary combustion space to ignite the auxiliary fuel and air admitted to the latter.

The air for supporting combustion of fuel within the above described apparatus is admitted through the space **10**.

A portion of this air then enters the annular chamber **26** through the openings **30** and **31** in which it ensures the combustion of the fuel injected at **32**. The combustion the auxiliary combustion space between chamber **26** and tuyere **27** is carried out at a slow speed so that the flame remains stationary in the auxiliary combustion space for all working conditions. This flame is used primarily as a pilot flame, but it also strongly heats the metallic wall of the central tuyere and, finally, it generates combustion gases at a very high temperature.

The air and the fuel which feed the cylindrical chamber within tube **21** pass through the tuyere **27** and, as the wall of the latter is raised to a high temperature, the intense radiation partially vaporises the atomised fuel and preheats the air. On issuing from the tuyere, the fuel and the air mix with the hot gases coming from the annular auxiliary combustion space. The fuel is completely vaporised and the vaporised mixture in contact with the hot gases is raised to a temperature which is higher than its ignition point. Owing to this, any delay in the burning of the vaporised mixture is decreased and its preheated state increases the speed of the kinetic reaction of combustion, so that the flame front becomes stationary at the entrance of the cylindrical chamber **21**.

Since the speed of reaction of combustion of a vaporised mixture is a function of the preheating temperature, the chamber according to the invention enables the speed of combustion to be increased at will only by increasing the output of fuel burned in the annular space between chamber **26** and tuyere **27**.

In this manner, the flame front can be stabilised in the main combustion chamber within the tube **21** for high gaseous conditions of flow and, consequently, the combustion intensity in the chamber can be increased.

The secondary air enters the main combustion chamber within tube **21** through the openings **24** and **25**. The air which passes through the openings **24** preliminarily circulates between the tube **21** and sheath **22** to cool the tube **21** around the main combustion chamber.

Besides, as the fuel atomised by the principal injector **28** passes through the tuyere **27**, the wall of which is raised to a high temperature, and as this wall is made of steel sheet loaded with nickel, the "incandescent wall effect" produces a catalytic action which enhances the reaction of combustion of the heavy fuels or of the pulverised coal. Further, burning gases from the auxiliary combustion space between the auxiliary chamber **26** and tuyere **27** can enter the latter, through the openings **31**

at the narrow portion of the convergent-divergent tuyere, thereby to ignite the fuel and air mixture in the latter.

By this arrangement of superposed chambers with combustion in stages, the intensity of the combustion can be increased and very heavy fuels can be easily burned. This type of combustion apparatus may be used in all the industries in which it is necessary to produce hot gases and to generate a large quantity of heat in a small space. It may be used advantageously for burning powdered coal or fuel waste, provided that the preheating flame of the annular chamber is fed with good quality fuel or with a gaseous fuel.

It is well understood that the invention is not limited to the embodiment which has been just described and that the latter can be modified without departing from the scope of the invention as defined in the claims. Particularly, the auxiliary and main combustion chambers may be flat. An example of such an arrangement is represented in Fig. 2, in which the principal or main combustion chamber **35** is of rectangular cross-section, while the auxiliary combustion chamber is defined by two plates **26***a* and **26***b* which are concave toward each other and represent diametrically opposed sections of a cylinder arranged with its axis perpendicular to the direction of flow of gases through the combustion apparatus. The tuyere of the apparatus of Fig. 2 is also defined by spaced apart curved plates **27***a* and **27***b* which are arranged between the plates **26***a* and **26***b* and have their convex sides facing each other so that the space between the plates **27***a* and **27***b* is convergent-divergent. Thus, in the embodiment of Fig. 2, the auxiliary combustion space defined between the auxiliary combustion chamber **26***a*—**26***b* and the tuyere **27***a*—**27***b* is divided into two parts at opposite sides of the latter and having rectangular cross-sections, for relation to the rectangular cross-sections of the main combustion chamber **35**. Otherwise, the embodiment of Fig. 2 is similar to the described embodiment of Fig. 1, and other parts of the embodiment of Fig. 2 are identified on the latter by the same reference numerals used in connection with the corresponding parts on Fig. 1.

What is claimed is:

1. A combustion apparatus particularly adapted for use with boilers generating hot water or steam; said apparatus comprising a main combustion chamber having inlet and outlet ends, an auxiliary combustion chamber opening into said main combustion chamber at said inlet

end of the latter, a tuyere disposed substantially completely within said auxiliary combustion chamber to define an auxiliary combustion space between said tuyere and said auxiliary combustion chamber, said tuyere being convergent-divergent and having openings at the narrow portion thereof to communicate the interior of said tuyere with said auxiliary combustion space, a main fuel injector in said tuyere for admitting the major supply of fuel to the latter, means admitting primary air to said tuyere for supporting the combustion of fuel issuing from said main injector, and means for admitting an auxiliary supply of fuel and auxiliary air to said auxiliary combustion chamber outside of said tuyere to burn in said auxiliary combustion space, thereby to heat said tuyere and effect heating of the fuel and air mixture admitted to the latter, while burning gases from said auxiliary combustion space can enter the interior of said tuyere through said openings at the narrow portion of the latter to ignite the fuel and air mixture in said tuyere.

2. A combustion apparatus as in claim 1; wherein said auxiliary combustion chamber tapers at the end thereof opening into said main combustion chamber to project the hot products of combustion from said auxiliary combustion space laterally inward for mixing with the primary fuel and air mixture issuing from said tuyere.

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