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## 3,370,634 APPARATUS FOR BURNING EXHAUST COMBUSTION GASES

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### ABSTRACT OF THE DISCLOSURE

An apparatus integrated with a boiler to burn exhaust combustion gases which functions to draw off and mix combustion gases with air and to cause the heating of this mixture to flaming temperature, wherein the mixing is achieved in a body having a tortuous passageway to provide thorough mixing, the body is mounted above the boiler flame to facilitate heating of the mixture, and the discharge of the mixture is at the upper surface of the flame of the boiler which provides assurance that there will be complete combustion of the mixture.

This invention concerns a process and apparatus for intimately mixing, in the top surface of the flames of a furnace, preheated supplementary air with the combustion gases in order to obtain complete combustion of said gases and, consequently, economy in fuel and avoiding any soot at the outlet of the flue.

Devices are known in which air in the pure state, or mixed with the exhaust combustion gases, is fed to the furnace so as to engage the flames of the furnace itself perpendicularly.

All these devices have the following disadvantages:

(1) The path of the air, or mixture of air and smoke, in the furnace is not sufficiently long to ensure intense preheating of the air or mixture.

(2) The stream of flames is engaged only marginally by the air or mixture since the air or mixture only engages the margin of the flame stream.

(3) The turbulence of the impact zone is low.

(4) For such reasons the mixing of air with combustion gases does not take place at the temperature and with the uniformity of mixing necessary for completely burning up the soot and carbon monoxide carried by the combustion gases.

The invention proposes to locate in the top surface of the flames a preheating device formed by a body, the length and width of which is slightly less than the length and width of the opening or aperture of the flow of the combustion gases in said top limits. Formed in this body is a spiral having several turns for the flow of the air or mixture, the last turn communicating with a ring which encloses the preheater in a plane lying in the direction of the flow of the flames and which is provided, at least on one face, with a ring of bores directed perpendicularly to the direction of the flow of the flames.

The large dimensions of the preheater relative to the aperture of the flow from the furnace result in two advantages. In particular, the path of the air or mixture is greatly lengthened without excessively increasing the flow resistance, so that the air or mixture is readily preheated to the temperature of the flames. Secondly the throttle caused by the presence of the preheater in the cross-section of the flow of the flames, at the place where the latter impact normally with jets issuing from the crown or crowns of bores of the ring of the preheater, makes the gaseous flow extremely turbulent and the intimate mixture of the gas with the air or mixture is appreciably improved relatively to that obtainable in known devices. Due to the com-

bination of the above two advantages, substantially complete combustion of the soot and carbon monoxide is obtained.

According to a development of the invention, smoke and air, taken up respectively from the chimney and the atmosphere in separately controlled quantities, travel together a relatively long path in the same tube, thus mixing together intimately before reaching the intake of a fan from which air or mixture is fed, which then, through successive branches of the feed pipe, is divided in a first flow which enters the preheater, a second flow which flows out just below the latter, and a third flow which issued over the grid of the furnace. In such manner, the supply of mixture or air exceeding the requirements of the preheater is fed to be consumed under the latter or on the grid of the furnace. Since the second and third branch are fitted with control valves, it is possible to distribute the three supplies of air or mixture according to the operating conditions of the boiler.

The accompanying drawings illustrate an embodiment of the invention in the particular case of a boiler, a lower furnace below it burning naphtha and a coiled pipe above it for a water circulation. In the drawings:

FIG. 1 is a longitudinal section through a boiler provided with the device according to the invention, and

FIG. 2 is a longitudinal section through a preheater according to the invention.

Provided in a flue 1 is a controllable valve 2. Through a pipe 4 a fan 5 takes up smoke from the flue 1 in front of the valve 2, and atmospheric air through a valve 3 which is controllable externally and communicates with the pipe 4 through a nozzle having a knee bend, the opening of which is turned in in the direction of flow of smoke so that the meeting of the latter with the air takes place under the best conditions. The bend in the pipe 4 which takes up smoke from the flue 1 is provided with a valve 4a so that:

(a) It can take up fresh air with the valve 4a closed and the valve 3 suitably controlled;

(b) With the valve 4a open and the valves 2, 3 suitably controlled relatively to each other it takes up the amount and degree of mixture required by the existing conditions of operation of the boiler, as required by the variation of the head of the boiler. On the account of the long path common to the air and the smoke to reach the fan 5, the two gases issue from the latter well mixed together.

The feed pipe of the fan 5 has 3 branches: The first, indicated by 7, through which the air or mixture passes to the preheater 6; the second indicated by 8 and provided with a control valve 8a, through which branch an initial supply of air or mixture exceeding the requirements of the preheater 6 is consumed immediately below the latter; the third indicated by 9 is provided with a control valve 9a, through which branch a second excess supply of air or mixture is consumed in the flame of the naphtha burner, in the embodiment indicated by 10 and immediately above the grid of the furnace. By 12 a known valve for controlling the general draught is indicated.

Through the branch 7, the air of mixture flows into the body 6 of the preheater. Such body has an elongated form with an almost square cross section and has external fins. Its normal projection in plan in the direction of the outlet for the flames is of such dimensions as to block a large portion of the outlet itself. The preheater is closed at the ends by the removable covers 6a, 6b and is provided with an inner pipe coil 6c which is connected at the inlet to the branch 7 and communicates with a ring 6d which encloses the centre area of the body 6 externally in a plane transversely thereto. On at least one of the two opposed faces of the ring 6d a ring of small bores is formed along the longitudinal axis of the preheater, thus perpendicular to the flow of the flames.

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The air or mixture entering the body 6 through the conduit 7 passes through the entire coil 6c, at the end of which the air or mixture, heated to the temperature of the flames, passes into the ring 6d from the bores of which the air or mixture issues in a form of a ring of jets 11 which meet the flow of flames at an angle of 90° in the top surface thereof, which zone is made turbulent by the constriction of the outflow of the current, caused by the presence of the body 6. The intimate mixing at the same temperature and under a turbulent condition of the jets of air or mixture with the flames on a ring located within the outflow path thereof, causes substantially completely combustion of the soot and carbon monoxide present in the flames themselves.

When the load of the boiler is changing, during which periods there are present in the outlet of the flue comparatively large quantities of soot and carbon monoxide, the above described apparatus feeds the preheater 6 with a mixture of air and smoke in order to subject the smoke to additional combustion. When, however, the boiler is working at a constant rate it is sufficient to supply the preheaters with pure or almost pure air to burn up the soot and carbon monoxide present in the flames of the furnace.

For the above purposes the controllable damper 2, the air intake valve 3 and the smoke intake valve 4a, the fan 5 and the valve 8a, 9a are according to the type of installation preadjusted once and for all in reciprocal concordance according to any one of known systems of apparatus for returning a mixture of air and smoke to the furnace. The burner 10 and the valve 12 are controlled, however, by the user with one of the known methods.

We claim:

1. The combination with a boiler having an internal combustion zone communicating with a combustion gas outlet of an apparatus for burning exhaust combustion gases comprising an externally finned body operatively mounted in said internal combustion zone so as to partially block said combustion gas outlet, said body having a tortuous internal passageway formed therein, an inlet conduit and an outlet conduit each having a knee bend therein

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respectively connected to said body to serve as an inlet and as an outlet for said tortuous internal passageway, a supply pipe communicating with the atmosphere connected to said inlet conduit, and a tubular ring connected to said outlet conduit, said tubular ring having an operative position encircling the medial portion of said body and further having circumferentially spaced bores so arranged therein that flow through said bores is generally parallel to the longitudinal axis of the body.

2. The combination as claimed in claim 1 wherein said boiler includes a combustion gas flue and a burner located beneath said externally finned body and said apparatus for burning exhaust combustion gases includes an end conduit section on said supply pipe in communication with said combustion gas flue, a controllable first valve on said end conduit section effective to regulate the flow of combustion gases from said combustion gas flue into said supply pipe, a controllable second valve in said supply pipe effective to regulate the flow of atmospheric air into said supply pipe, a fan having an inlet connected to said supply pipe and an outlet having a first branch connected to said inlet conduit of said externally finned body effective to cause the flow of a mixture of said combustion gas and air to said externally finned body, and second and third branches of said fan outlet each with a valve therein effective to accommodate any excessive amount of said mixture of combustion gas and air and connected to respectively discharge any said excessive mixture between said burner and said externally finned body and beneath said burner.

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