United States Patent

Holland

[15] **3,706,290**

[45] **Dec. 19, 1972**

[54] SYSTEM FOR EXHAUSTING GASEOUS PRODUCTS OF COMBUSTION

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[22] Filed: **April 20, 1972**

[21] Appl. No.: **245,808**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 804,527, March 5, 1969, abandoned.

[52] **U.S. Cl.** **110/184,** 98/58

[51] **Int. Cl.** **F23j 13/00**

[58] **Field of Search** 110/184; 98/58, 59, 60

[56] **References Cited**

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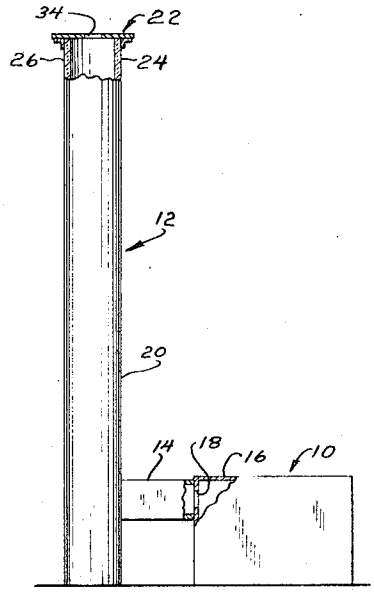
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Primary Examiner—Edward G. Favors
Attorney—Anthony S. Zummer

[57] **ABSTRACT**

The instant system improves the efficiency of a combustion exhaust system and thereby improves the efficiency of a fuel combustion unit such as a boiler. A specific application of the invention includes a flat plate having an outer periphery sufficiently great to cover the entire opening at the top of a smokestack, which plate contains a sharp-edged circular orifice having an area less than the area of the opening at the top of the smokestack. The size of the orifice is such that it is substantially equal to the effective size of an exhaust port of a boiler connected to the smokestack. The orifice in the plate has its center aligned with the center line of the smokestack to create a thermal chimney within the smokestack, so that gaseous products of combustion travel through the central portion of the thermal chimney to eliminate eddying of substantially all of the gaseous products of combustion within the smokestack.

7 Claims, 6 Drawing Figures



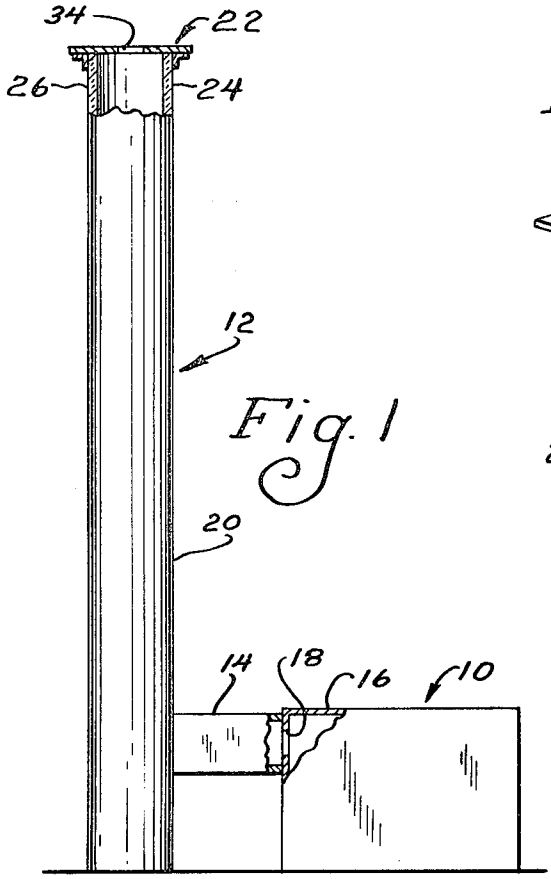


Fig. 1

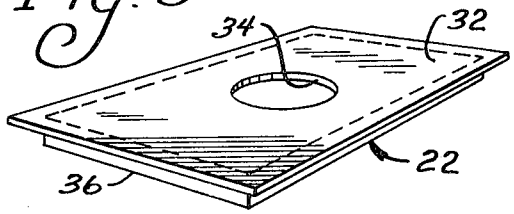


Fig. 3

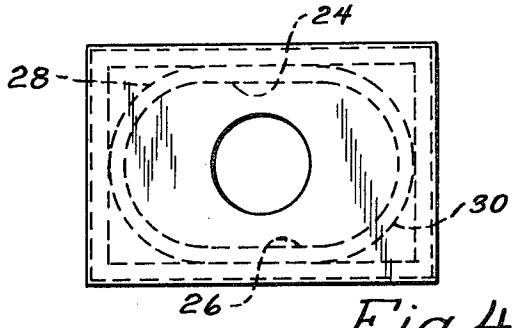


Fig. 4

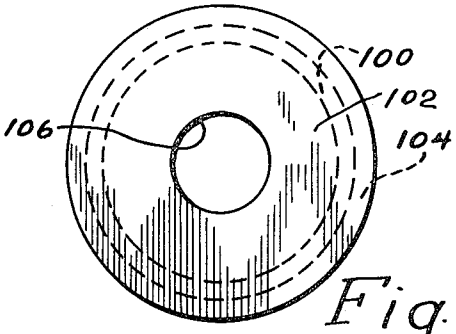


Fig. 5

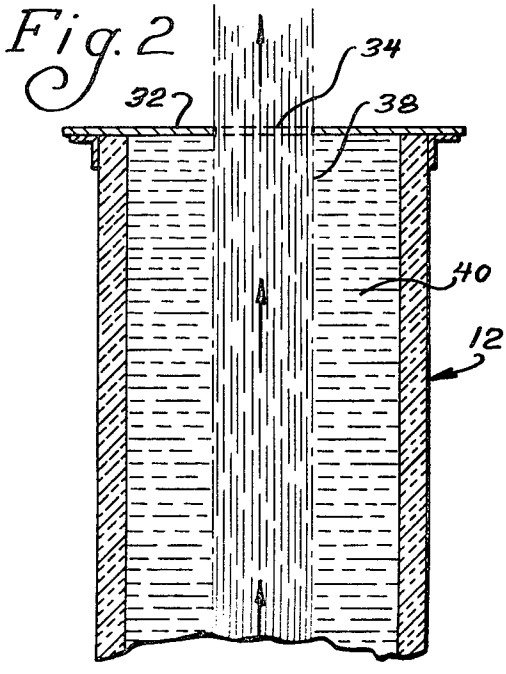


Fig. 2

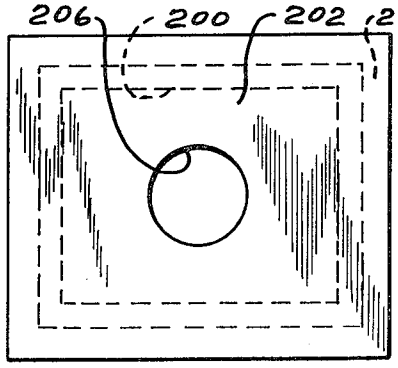


Fig. 6

SYSTEM FOR EXHAUSTING GASEOUS PRODUCTS OF COMBUSTION

CROSS-REFERENCE TO RELATED APPLICATION

This is a continuation-in-part of U.S. Pat. application Ser. No. 804,527, filed Mar. 5, 1969, now abandoned entitled APPARATUS AND METHOD FOR IMPROVING COMBUSTION EXHAUST OPERATION.

BACKGROUND OF THE INVENTION

The design of smokestacks for use with boilers is predicated on the amount of air which is required for complete combustion of the fuel used in a combustion chamber which is connected to the smokestack. The existing formulas for the design of a smokestack are empirical. In a smokestack, the exhaust gases entering the smokestack rise within the smokestack because of the difference between the specific weight of the heated exhaust gas and the ambient air. It is well known that as the exhaust gas rises, it cools. In most instances, smokestacks are designed with a greater capacity than that which is required for the existing combustion chamber to accommodate for the possible addition of combustion chambers or as a factor of safety.

The normal operation of the present-day smokestacks is often such that the flow of exhaust gases through the smokestack is slowed down because of eddying or turbulenee of the gases. In many instances, the gases are cooled sufficiently so that some of the water vapor carried in the exhaust gases condenses, and the condensation gathers on the interior of the smokestack. This condensation of water vapor is often one of the causes of deterioration of the interior of the smokestack, especially those stacks which are metal stacks. Furthermore, the condensation of the water vapor inhibits the flow of exhaust gases upward and out of the smokestack.

In certain instances, it may be noted that the exhaust gases carry incomplete products of combustion, thereby having a pungent odor at the top of the smokestack, and the flow rate of the exhaust gas is rather slow, as may be observed by watching the exhaust gas leave the smokestack.

SUMMARY OF THE INVENTION

The present invention is directed to an improved apparatus for operation of a combustion exhaust system. Recognizing that it is desirable to provide a means for eliminating the condensation of water vapor carried by the gaseous products of combustion, the present invention provides a thermal insulating chimney within a specific exhaust apparatus, such as, a smokestack, whereby the central core of the thermal chimney has a high rate of flow of gaseous products of combustion. The outer periphery of the thermal chimney has a layer of substantially static dead exhaust gases, which exhaust gases provide a thermal insulating chimney for the central core stream of hot exhaust gases. These exhaust gases forming the thermal chimney act as an excellent insulator between the smokestack and the stream of hot gases flowing through the central portion of the thermal chimney, so that the cold exterior of the smokestack has little effect upon the temperature of the central core flow stream of hot exhaust gases. Since the central core flow stream of hot exhaust gases has a high rate of flow through the central core of the thermal chimney, there is a minimum of an opportunity of the gases in the central core flow stream to be cooled within the smokestack. Thereby, the exhaust gases leaving the chimney carry away substantially all of the water vapors in vapor form, thus reducing the opportunity for damage to the interior of the smokestack by water vapor condensing on the interior walls of the smokestack.

The thermal chimney is formed within the smokestack by a flat plate mounted on top of the smokestack, which flat plate has a sharp-edged orifice. The orifice has a cross-sectional area substantially less than the cross-sectional area at the opening on top of the smokestack, and the orifice determines the size of the core or thermal chimney along which flow the exhaust gases. The size of the orifice is determined by the effective size of the exhaust port of a boiler shell from which the smokestack receives the exhaust gases.

The purpose of the exhaust control device or chimney cap is to control the supply of combustion air to the combustion chamber proportionate to the requirements of complete combustion.

The chimney cap is a flat plate, safely affixed to and covering the top of the chimney, with a centered, round, sharp edged orifice, sized large enough to accommodate the maximum flow of the exhaust from the boiler or boilers, thus creating a thermal reaction within the smokestack. This thermal reaction (hot goes to cold) develops a gas-insulated thermal chimney, sized by the cap orifice, and extends the length of the smokestack.

This thermal chimney is insulated by trapped, dead gases held in place by the solid portion of the cap between the wall of the chimney and the periphery of the thermal chimney core, that pulls the combustion gases up and out of the smokestack proportionate to the combustion rate. This buoyant thermal chimney action stabilizes the combustion chamber pressure negative to the burner pressure so as to allow a constant fuel-air flow proportionate to the firing rate.

It is therefore a principal object of the herein disclosed invention to provide an apparatus for use in connection with a combustion exhaust system which produces a thermal chimney of exhaust gases within the exit portion of the exhaust system to provide a buoyant high rate flow path within the central core of the thermal chimney.

It is another object of the present invention to provide an apparatus for use with a smokestack to produce an optimum high rate of flow of exhaust gases through the smokestack to further reduce the cooling of the exhaust gases.

Other objects and uses of the present invention will become readily apparent to those skilled in the art upon a perusal of the following specification in light of the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a side elevational view of a combustion chamber connected to a smokestack embodying the present invention, parts are broken away in this view in order to show better the construction thereof;

FIG. 2 is an enlarged cross-sectional view of a portion of the smokestack shown in FIG. 1, with a plate

mounted on the top of the smokestack and showing a central core or high rate of flow path through a thermal chimney within the smokestack shown in FIG. 1;

FIG. 3 is a perspective view of the plate shown in FIGS. 1 and 2;

FIG. 4 is a plan view of the smokestack and the plate shown in FIGS. 1 and 2;

FIG. 5 is a plan view of a plate mounted on the upper portion of a smokestack having a circular cross-section; and

FIG. 6 is a plan view of a plate mounted on the top of a rectangular smokestack.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawing, and especially to FIG. 1, a combustion chamber generally indicated by numeral **10** is shown connected to an exhaust apparatus **12** through a conventional flue **14**.

The combustion chamber **10** is a conventional boiler, including a boiler shell **16** having a circular exhaust port **18** communicating with the flue **14**.

The exhaust apparatus includes a vertical smokestack **20** having an exhaust control device **22** mounted on the top thereof. In this instance, the smokestack **20** has a pair of parallel sides **24** and **26** and a pair of ends **28** and **30**, each of which define a portion of a circle formed integral with the sides **24** and **26**.

The exhaust control device **22** is a rectangular plate **32**, with a sharp-edged circular orifice **34** positioned in its center. The orifice **34** is substantially the same size as the exhaust port **18**, for reasons which will become apparent hereinafter. An angle iron retainer **36** is mounted on the outer periphery of the rectangular plate **32**. The angle iron retainer engages the top of the smokestack **20**, so that the angle iron retainer acts as a lock means to secure the plate to the top of the smokestack.

A conventional fuel is fed to the combustion chamber **10** in a conventional manner, and air is provided to that chamber. After the fuel burns, the gaseous products of combustion are exhausted through the exhaust port **18**, through the flue **14**, and into the smokestack **20**. The gaseous products of combustion then rise up the smokestack and are vented to the atmosphere through the top of the smokestack. The exhaust control device **22** on the top of the smokestack causes the smokestack to be filled with exhaust gases. These exhaust gases form a hot, buoyant center stream along the center core of the smokestack, as indicated by numeral **38** in FIG. 2. Surrounding the center stream **38** is a cylindrical thermal chimney **40** of dead exhaust gases which insulate the center stream **38** from the cold outer walls of the smokestack, thereby preventing the center stream from being cooled by the outer walls of the smokestack. The center stream has a high rate of flow through the smokestack and out through orifice **34**, thereby further decreasing the possibility of heat loss from the exhaust gas to the smokestack wall. The center of the orifice **34** is aligned with the axial center of the smokestack, so that there is a substantially uniform thermal chimney of dead exhaust gases surrounding the center stream **38**, which passes out through the orifice **34**.

The subject invention stabilizes a constant pressure in the combustion chamber **10**, so that the fuel and air entering the combustion chamber mix in a proper proportion in a steady state flow to develop complete combustion. The exhaust control device mounted on the top of the smokestack, with its sharp-edged orifice **34**, controls the flow of exhaust gases. The size of the orifice **34** is determined by the effective exhaust size of the exhaust port **18**. It must be noted that, in the instant case, the exhaust port **18** is a round aperture. However, if a particular boiler shell is built with an aperture which is not round, the effective size of the exhaust port is determined in order to determine the size of the orifice **34**. The effective size of the exhaust port is the area through which the exhaust gases flow in a substantially steady state flow.

With the exhaust control device **22** in position, there is a uniform flow of hot exhaust gases which provides a positive buoyant pull. This positive buoyant pull pulls the hot exhaust gases, including water vapor, out of the chimney, so that the water vapor does not have an opportunity to condense. The use of the thermal chimney provides a continuous flow of the exhaust gases, eliminating pulsing of the exhaust gases and thereby eliminating pulsing of the boiler, which causes vibration of the boiler.

Heretofore, when boilers were in operation, there was a considerable amount of pulsing of the boiler because the exhaust gases did not leave at a steady flow rate, but rather pulsed. This was readily observed by observing the gases leaving the top of a smokestack. There was a definite relationship between the pulsing of the boiler and the pulsing of the exhaust from the smokestack. The pulsing of the boiler is attributable to the fact that, as the exhaust gases build up a back pressure, they inhibit the entrance of air into the combustion chamber. After sufficient time has passed and enough air has come into the combustion chamber, there is an ignition which causes the pressure to rise in the boiler; but there is not sufficient air to sustain the combustion. Thereby, the combustion rate decreases, thereby causing a decrease in pressure; and the build-up of back pressure in the exhaust system again reduces the amount of air available for combustion. When sufficient time has elapsed to introduce enough air, there is another increase in rate of combustion, thereby causing an intermittent rise and fall in the combustion chamber and a resulting vibration of the boiler and an intermittent or pulsing exhaust of exhaust from a smokestack.

The purpose of the device **22** is to maintain a constant combustion chamber pressure so that the fuel and air will proportionally mix to develop complete combustion. The orifice **34** forms a center core or thermal chimney between the boiler exhaust breeching and the plate **32**. The solid portion of the cap holds the trapped, dead gases between the thermal flue and the outer wall of the smokestack, creating an insulating gas blanket that protects and preserves the heat of the main flow of exhaust gas.

This flow of uniformly hot exhaust gases promotes a positive buoyant chimney pull that exhausts the combustion gases up and out of the chimney as fast as they leave the boiler and at a temperature very close to the boiler exhaust temperature, which is above the condensing temperature of water vapor gases. This

buoyant exhaust method through the thermal chimney stabilizes the combustion chamber pressure constantly negative to the burner pressure, so that the fuel and air will have space and time to complete their combustion reactions within the combustion chamber. When the proper ratio of fuel and air portions of complete combustion are supplied by the burner, the combustion chamber reactions are smooth and non-vibrant; and the exhaust leaving the chimney is cleaner, hotter, and non-pulsating.

The instant invention has been used in conjunction with a smokestack having a height of approximately 567 feet for a 41-story building. The specific smokestack had a pair of parallel sides, such as shown in FIG. 4. The maximum interior dimension of the smokestack was 64 inches; and the diameter of each of the circles was 39½ inches. The smokestack was connected to three boilers exhausting into a common breeching; and each of the boilers had an exhaust opening of 200 square inches. The total exhaust opening from the boilers was 600 square inches. An exhaust control apparatus, such as apparatus **22**, was mounted on top of the smokestack, with an orifice of **28** inches, thereby having an area of 616 square inches. The boilers did not pulse; and the exhaust gases from the orifice came out at a steady rate.

The size of the orifice was determined in the following manner. It was first noted that the temperature of the gases in the breeching was 300° F.; and exhausted out of the stack at 100° F. The boilers vibrated, and the exhaust gases pulsated out of the stack. A plate, such as plate **32**, was mounted on the stack top. The plate had a round sharp-edged orifice having a 38-inch diameter. The exhaust temperature was increased to 125° F., the breeching temperature was reduced to 275° F., and exhaust odor was noticeably reduced. The exhaust flow did not exert any noticeable pressure to lift off the plate from the stack. The orifice was successfully reduced in two-inch increments. The vibration of the boilers was observed; and a noticeable reduction in vibration was observed with each reduction. Also, the odor of the exhaust gases was also reduced. The orifice in the plate was reduced to a diameter of 28 inches. The temperature in the breeching was reduced to close to 200° F.; and that leaving the stack was observed to be 180° F. There was no pulsation of exhaust from the chimney. The noxious exhaust gases had decreased, and vibration of the boilers was eliminated. The size of the orifice was further reduced, and it was found that there was an increase in exhaust gas pungency, indicating that an optimum size had been reached. The fuel consumption of the boilers was observed for a period; and it was noted that the fuel consumption for the period, with the exhaust control device mounted on the smokestack, was reduced, as compared with a like period of the previous year.

Although a specific description has been made for a smokestack having a generally oval cross-section, it may be appreciated that the instant invention may be used in connection with a chimney having a circular cross-section, as shown in FIG. 5. In FIG. 5, a smokestack **100** having a circular cross-section is shown with a plate **102** mounted on its top, with a retainer **104** connected to the outer periphery of the smokestack to hold the plate in position. The plate has an orifice **106** in its center, which has its center aligned with the center line of the smokestack.

Referring to FIG. 6, a smokestack **200** having a rectangular cross-section is shown with a plate **202** mounted thereon, which plate **202** has a retainer **204** fixed to its outer periphery and in engagement with the smokestack **200** to hold the plate in position. A sharp-edged orifice **206** is positioned in the center of the plate and is aligned with the center line of the smokestack.

From the foregoing description, it may be readily appreciated that various modifications of the instant invention may be made without departing from the spirit and scope of the present invention. It is to be expressly understood that the present invention is limited only by the appended claims.

What is claimed is:

1. An exhaust system for removing gaseous products of combustion from a boiler having an exhaust port, comprising a smokestack having its lower portion connected to the exhaust port of the boiler, said smokestack having its top portion communicating with the atmosphere, and an exhaust control device mounted on top of the smokestack, said exhaust control device being a flat plate, said flat plate having an aperture, said aperture being a sharp-edged circular orifice having a cross-sectional area substantially equal to the effective cross-sectional area of the exhaust port.

2. An exhaust system for removing gaseous products of combustion from a boiler as defined in claim 1 wherein the smokestack is a substantially vertical chimney and the orifice has its center aligned with the longitudinal axis of the chimney.

3. An exhaust system for removing gaseous products of combustion from a boiler as defined in claim 1, including means connected to the flat plate to hold the flat plate on the top of the chimney.

4. An exhaust system for removing gaseous products of combustion from a boiler as defined in claim 1, including a thermal chimney within the smokestack formed by products of combustion to provide an insulating boundary layer within the smokestack.

5. An exhaust system for removing gaseous products of combustion from a boiler as defined in claim 1 wherein the smokestack is a substantially vertical chimney and the orifice has its center aligned with the longitudinal axis of the chimney, and including lock means connected to the flat plate to hold the flat plate on top of the chimney.

6. An exhaust system for removing gaseous products of combustion from a boiler as defined in claim 1 wherein the smokestack is a substantially vertical chimney and the orifice has its center aligned with the longitudinal axis of the chimney, and including a thermal chimney within the vertical chimney formed by products of combustion to provide an insulating boundary layer within the chimney, and lock means connected to the flat plate to hold the flat plate on the top of the chimney.

7. An exhaust system for removing gaseous products of combustion from a boiler as defined in claim 1 wherein the smokestack is a substantially vertical chimney and the orifice has its center aligned with the longitudinal axis of the chimney, and including a thermal chimney within said vertical chimney formed by an insulating boundary layer of products of combustion

within the vertical chimney, said thermal chimney being aligned with the orifice in the flat plate.

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