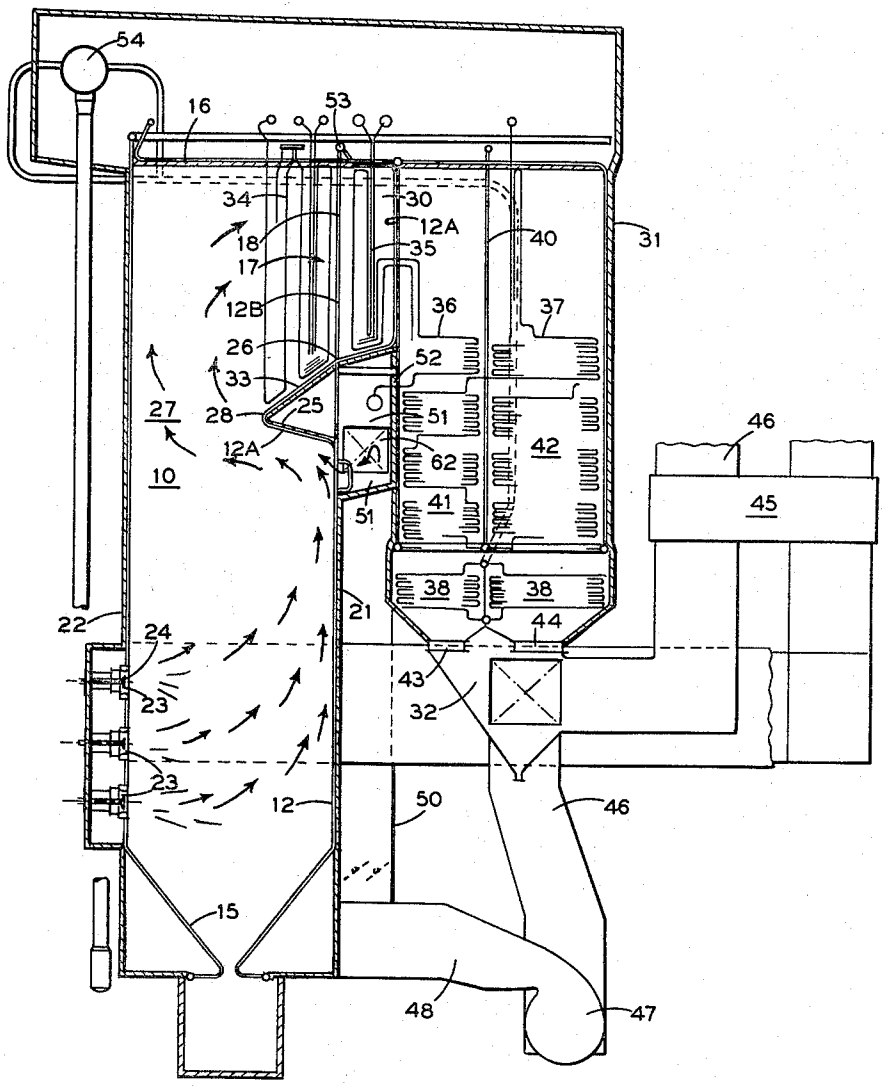
March 23, 1965 L. E. JOHNSON 3,174,464

VAPOR GENERATING APPARATUS

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FIG.1



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VAPOR GENERATING APPARATUS

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FIG.2

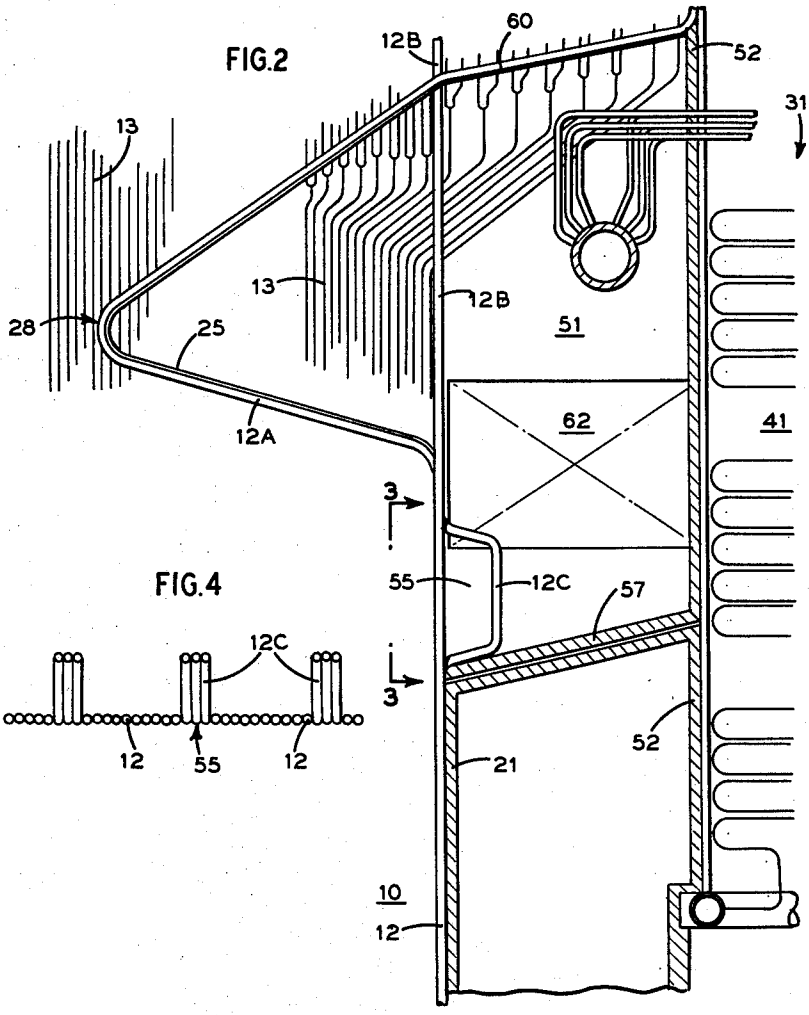


FIG.4

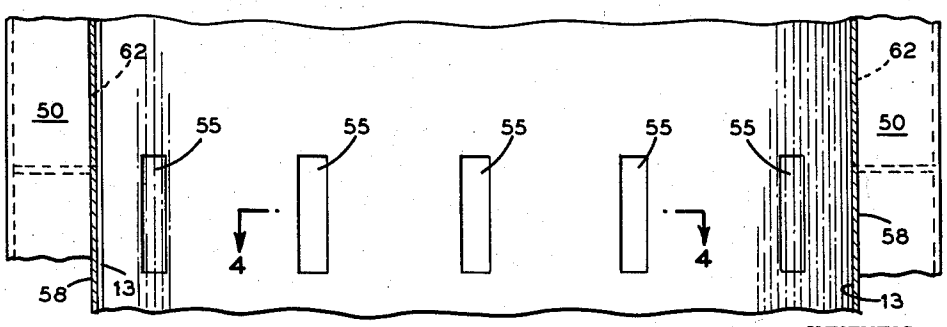


FIG.3

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3,174,464

VAPOR GENERATING APPARATUS

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4 Claims. (Cl. 122—235)

The present invention relates to the generation and heating of vapor, and more particularly to vapor generating and heating units wherein the heating gas temperature passing over fluid cooled heat exchange surfaces is reduced to acceptable values by the mixing of lower temperature recirculated gases therewith.

In the art of steam generation and heating the use of recirculated gases for superheat temperature control and to temper or cool the combustion gases passing through the furnace and entering the convection heating gas-pass is well known. The use of recirculated gases both for superheat temperature control and for gas tempering purposes has developed many forms and modes of application specific to different configurations of steam generating and heating units. When recirculated gases are used for tempering purposes it is necessary to insure adequate mixing of the hot newly formed combustion gases with the cooler recirculated gas so as to attain general temperature uniformity of the gas mixture leaving the furnace and entering the steam heating banks. With an approximation of gas temperature uniformity the quantity of recirculated gas flow can be controlled to maintain the mixture at a maximum temperature for effective steam heating while not exceeding safe metal temperatures in the heating banks of the heater. Ordinarily, mixing of tempering gas with newly generated combustion gas is attained by high velocity introduction of the former gas into the latter so as to obtain penetration.

In the present invention tempering gases are introduced into the upper portion of an upwardly elongated furnace directly beneath a nose or deflecting baffle projecting into the furnace from one of the furnace walls. Advantageously the fuel is introduced into the lower portion of the furnace through ports in a furnace wall opposite to the wall containing the nose or deflecting baffle. With this arrangement, the gaseous combustion products generated in the combustion of the fuel will tend to rise along the wall of the nose baffle and will flow along the lower surface of the baffle to accelerate in passing through the opening formed between the inner end of the nose baffle and the opposite wall containing the fuel admission ports. The tempering gas enters the furnace at an angle to the flow of the combustion gases, and with the combined flow occurring along the lower surface of the nose baffle and being accelerated to pass around the furnace end of the baffle, are thoroughly mixed so that the gas temperatures leaving the furnace are generally uniform. It has been found from model tests and actual experience that intimate gas mixing is attained in the arrangement of the invention, with a minimum of excess tempering gas pressure required for the introduction of the tempering gas into the furnace.

In many furnace constructions using a nose baffle for gas mixing and flow directing purposes the upwardly elongated furnace structure is transversely spaced from the associated vertically disposed convection gas-pass, and the furnace gas outlet is connected with the convection gas-pass inlet by a horizontally disposed gas-pass. The horizontal gas-pass is usually provided with conventional heat exchange surfaces, such as superheater and reheater tube banks. Advantageously, the space between the furnace rear wall and the adjacent walls of the convection gas-passes can be economically enclosed to provide a plenum chamber for the tempering gas thereafter passed through spaced ports into the furnace.

The various features of novelty which characterize my invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of the invention its operating advantages and specific objects attained by its use, reference should be had to the accompanying drawings and descriptive matter in which I have illustrated and described a preferred embodiment of the invention.

Of the drawings:

FIG. 1 is an elevation, partly in section, of a steam generating and heating unit incorporating the present invention;

FIG. 2 is an enlarged sectional elevation of a portion of the unit shown in FIG. 1;

FIG. 3 is a view of a portion of the structure as viewed from line 3—3 of FIG. 2; and

FIG. 4 is a section taken on line 4—4 of FIG. 3.

In the drawings, the invention is illustrated as embodied in a high pressure, high capacity boiler of known type. As shown, an upwardly elongated furnace **10** is provided with walls lined by fluid cooled tubes **11**, **12** and **13** where the tubes serve for the generation of steam. The furnace includes a hopper bottom **15** and a generally flat roof **16** with the gas outlet **17** from the furnace positioned within the upper portion **18** of the wall **21** containing the tubes **12**. The gas outlet wall **21** may be termed the rear wall of the furnace for convenience. The opposite or front wall **22** of the furnace containing the tubes **11** is provided in its lower portion with suitable openings **23** for the introduction of combustion constituents through, for example, oil burners **24**. As shown in FIG. 1 the burners **24** are of the conventional type for the introduction of fuel oil and combustion air, which is burned in the lower portion of the furnace.

As hereinafter described the rear wall **21** of the furnace **10** is provided with a nose baffle **25** which projects inwardly of the furnace immediately below the lower edge **26** of the gas outlet **17**. The nose baffle ordinarily extends into the furnace sufficiently to direct the gas flow from the lower portion of the furnace toward the gas outlet **17** through an opening **27** defined by the upright front wall **22** of the furnace and the tip **28** of the nose baffle **25**. The flow area of the opening **27** usually represents 50 to 70% of the total horizontal cross section area of the furnace **10**.

The gases passing through the gas outlet **17** moves through a horizontally disposed gas pass **30** opening into the upper portion of a downwardly extending convection gas-pass **31** having a gas outlet **32** at the bottom thereof.

The gas flow through a vapor generating and heating unit of the type disclosed is upwardly through the furnace **10** with the gases being deflected toward the front wall **22** by the nose baffle **25** with the gases thereafter turning to move in a horizontal direction into the upper portion of the downpass **31**. Customarily, superheating and steam reheating surfaces **34** and **35** respectively, are provided above the upper surface **33** of the nose baffle **25** and in the horizontal gas pass **30**. The gases in passing downwardly through the downpass flow over and around convection heating surfaces which will include other steam reheating surfaces **36** and superheating surfaces **37** as well as economizer surfaces **38**. In the embodiment shown in FIG. 1 the downpass is provided with a vertical row of tubes **40** to support the horizontally disposed banks of heat exchange surfaces **36**, **37** and **38** located in the downpass. The support tubes tend to divide the pass into two interconnected gas flow paths **41** and **42**. The quantity of gases flowing through the parallel flow paths **41** and **42** is regulated by suitable dampers **43** and **44** positioned below the economizer surfaces **38**.

With the combustion gases produced in the furnace cooled by heat exchange in the generation of steam and in steam superheating and reheating surfaces, the gases will thereafter be passed through an air heater **45** on their way through a stack **46** for discharge to the atmosphere.

As shown in FIG. 1, the cooled combustion gases passing from the economizer **38** toward the air heater **45** serve as a source of supply for recirculated gases discharged to the furnace for superheat temperature control purposes, and for tempering purposes. The recirculated gases are withdrawn from the gas flow path through a duct **46** by a recirculating gas fan **47** and discharged through a conduit **48** opening to the setting adjacent hopper bottom **15** of the furnace, and into a branch conduit **50** which discharges into a plenum chamber **51** hereinafter described.

As shown in FIGS. 2, 3 and 4 the rear wall **21** of the furnace **10** is defined by a row of tangent tubes **12**. It is, of course, understood that other than a tangent tube arrangement may be used to define the wall, such as for example a row of tubes joined by metallic webs. The nose baffle **25** shown in FIG. 2 is formed by bending a majority of the tubes such as **12A** of the rear wall **21** forwardly and upwardly to project into the furnace **10**. The tubes **12A** are then reversely bent to define the nose **28** of the baffle **25** with the tubes thereafter extended in an upwardly and outwardly direction beyond the plane of the rear wall **21** and are then bent upwardly along an extension of the plane of the adjacent wall **52** of the convection gas pass **31** (see FIG. 1) to discharge into a header **53** for discharge to a drum **54** of the boiler. Other tubes of the rear wall such as tubes **12B** extend upwardly across the base of the nose baffle **25**, in the plane of the rear wall, and across the gas outlet **17** from the furnace. These latter tubes are connected into the header **53** for the discharge of the steam and water mixture therefrom into the drum **54**. The tubes **12B** also serve as support tubes for the wall **21**.

As shown, some of the tubes **12C** of the rear wall **21** are bent outwardly from the plane of the rear wall and then reversely bent to project in a direction parallel to the plane of the wall **21**. Thereafter the tubes **12C** are bent toward the wall and into the plane of the wall. This construction is shown in FIGS. 2, 3 and 4, where three adjacent tubes **12C** of the rear wall are bent to form an opening or port **55** opening into the furnace **10**. In the embodiment shown, there are five ports **55** formed in the rear wall of the furnace, where each port is formed by displacing three adjoining tubes outwardly of the wall.

The dimensions and the number of the port openings **55** formed in the rear wall **21** are selected in consideration of the expected amount of and the desired velocity of the tempering gases to be introduced into the furnace for gas temperature control purposes.

Advantageously, in a boiler of the type disclosed the space between the rear wall **21** of the furnace **10** and the adjacent wall **52** of the convection gas pass **31** is enclosed by a refractory floor **57** positioned downwardly adjacent the lower edge of the gas inlet ports **55** and by side walls **58** enclosing the space between the bottom closure or floor **57**, the walls **21** and **52** and the rearward lower surface **60** of the horizontal gas pass. Such a closing structure defines a plenum chamber **51** which is supplied with tempering gases delivered thereto by a pair of conduits **50** opening into the plenum chamber **51** through side wall inlet openings **62** formed in the side walls for the discharge of the desired quantities of tempering gas through the ports **55** into the furnace **10**.

While the quantity of gases introduced into the furnace through the ports **55** for gas tempering purposes will vary with different installations, the usual range of tempering gas quantities will be from 20 to 30% of the quantity of newly generated gases passed upwardly through the furnace at normal maximum fuel combustion rates. The tempering gas quantity required for any particular installation is dependent upon a great number of factors, such as, the character of the fuel in use, the physical dimensions and configurations of the unit, the metallurgical character of heat exchange surfaces, and the like. When using the arrangement of the present invention, the ports are spaced across the rear wall of the furnace and are dimensioned to provide a gas velocity entering the furnace of the order of 5000 to 10,000 feet per minute at the desired quantity.

While in accordance with the provisions of the statutes I have illustrated and described herein the best form and mode of operation of the invention now known to me, those skilled in the art will understand that changes may be made in the form of the apparatus disclosed without departing from the spirit of the invention covered by my claims, and that certain features of my invention may sometimes be used to advantage without a corresponding use of other features.

What is claimed is:

1. In a boiler, the combination of upright walls defining an upwardly elongated substantially unobstructed furnace, means defining a heating gas outlet in the upper portion of one of the walls of said furnace, a nose baffle projecting into said furnace from the wall of said heating gas outlet and positioned downwardly adjacent the lower edge portion of said outlet, means for introducing combustion constituents through the lower portion of a furnace wall opposite said gas outlet wall and at a level beneath said nose baffle, the heating gases generated by the combustion of said combustion constituents moving upwardly in the lower portion of said furnace and being deflected toward the wall of said combustion constituent introduction by said nose baffle, and means for introducing tempering gas only through the wall of said gas outlet at a level immediately below said nose baffle to intersect said heating gases at an acute flow angle and to substantially uniformly mix therewith in discharging through said gas outlet.

2. In a boiler, the combination of upright walls defining an upwardly elongated substantially unobstructed furnace, means for introducing a fuel through one wall and into the lower portion of said furnace for the combustion thereof and the generation of high temperature heating gases thereby, means forming a heating gas outlet from the upper portion of said furnace opposite said one wall, means forming an upright gas-pass spaced from the wall of said furnace containing said gas outlet, a horizontally disposed gas-pass connecting said furnace outlet with the upper portion of said upright gas-pass for flow of heating gas from said furnace through said horizontally disposed gas-pass and downwardly in said upright gas-pass, means forming heat exchange surfaces in said gas-passes, a nose baffle extending into said furnace beneath said gas outlet to divert the heating gases toward said one wall of said furnace and to thereafter pass in a generally horizontal direction through said gas outlet, wall means positioned directly beneath the level of said nose baffle to define a plenum chamber outwardly of said furnace, and means for recirculating cooled combustion gases to the furnace including means for introducing said combustion gases from said plenum chamber through the outlet containing wall of the said furnace immediately below said nose baffle to mix with combustion gases in the combined movement thereof around said nose baffle and through said outlet.

3. In a boiler, the combination of upright walls defining the front, rear and sides of an upwardly elongated substantially unobstructed furnace, means for introducing a fuel through the front wall and into the lower portion of said furnace for the combustion thereof and the generation of high temperature heating gases thereby, means forming a heating gas outlet from the upper rear wall portion of said furnace, walls defining an upright gas-pass spaced from the rear wall of said furnace, a horizontally disposed gas-pass connecting said furnace outlet with the

upper portion of said upright gas-pass for flow of heating gas from said furnace through said horizontally disposed gas-pass and downwardly in said upright gas-pass, means forming heat exchange surfaces in said gas-passes to be traversed by the gases issuing from said outlet, a nose baffle extending from side wall to side wall and into said furnace from said rear wall beneath said gas outlet to divert the heating gases toward the front wall of said furnace to thereafter pass in a generally horizontal direction through said gas outlet, wall means including a bottom wall beneath the level of said nose baffle extending from the rear wall of said furnace to the adjacent wall of said spaced gas-pass to define a plenum chamber between said furnace and said upright gas-pass, and means for recirculating cooled combustion gases to the furnace including means for introducing said recirculated combustion gases from said plenum chamber through the rear wall of the said furnace immediately below said nose baffle to mix with combustion gases in the combined movement thereof around said nose baffle and through said outlet.

4. In a boiler, the combination of upright walls defining the front, rear and sides of an upwardly elongated substantially unobstructed furnace, means for introducing a fuel through the front wall and into the lower portion of said furnace for the combustion thereof and the generation of high temperature heating gases thereby, means forming a heating gas outlet from the upper rear wall portion of said furnace, walls defining an upright gas-pass spaced from the rear wall of said furnace, a horizontally disposed gas-pass connecting said furnace outlet with the upper portion of said upright gas-pass for flow of heating gas from said furnace through said horizontally disposed gas-pass and downwardly in said upright gas-pass, means forming heat exchange surfaces in said gas-passes to be traversed by the gases issuing from said outlet, a nose baffle extending from side wall to side wall and into said furnace from said rear wall beneath said gas outlet to divert the heating gases toward the front wall of said furnace and to thereafter pass in a generally horizontal direction through said gas outlet, wall means including a bottom wall beneath the level of said nose baffle extending from the rear wall of said furnace to the adjacent wall of said spaced gas-pass to define a plenum chamber between said furnace and said upright gas-pass, and means for recirculating cooled combustion gases to the furnace from the lower portion of said upright gas-pass including a horizontally spaced row of upwardly elongated inlet ports for introducing said recirculated combustion gases from said plenum chamber through the rear wall of the said furnace immediately below said nose baffle to mix with said heating gases in the combined movement thereof around said nose baffle and through said outlet.

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