United States Patent

Miller

[15] **3,701,340**

[45] **Oct. 31, 1972**

[54] HEATING SYSTEM

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[21] Appl. No.: **44,334**

[52] **U.S. Cl.** .....**122/367 C,** 431/348

[51] **Int. Cl.** **F22b 21/00**

[58] **Field of Search** 122/235, 250, 367; 431/348

[56] **References Cited**

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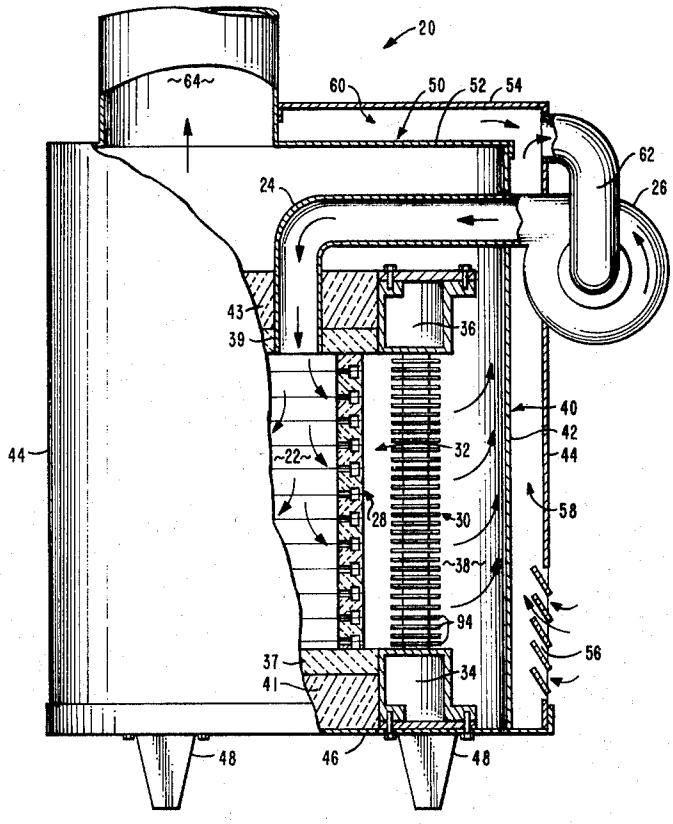
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Primary Examiner—Kenneth W. Sprague
Attorney—Donald E. Nist

[57] **ABSTRACT**

An improved compact heating system, particularly adapted for heating water and generating steam, includes a combustible gas supply zone, a combustion chamber therearound in the form of a hollow burner element having a plurality of radial channels in heat exchange relation with an array of heat exchange elements spaced peripheral therefrom, and gas ignition means. The channels are preferably of special configuration to improve heat transfer efficiency. The system is adapted to efficiently burn a high velocity stream of combustible gases and develop a wide range of B.T.U. outputs per hour, including multi-million B.T.U. output, while retaining advantages of larger types of heating systems. Improved baffles for heat exchanger elements are also provided.

10 Claims, 17 Drawing Figures



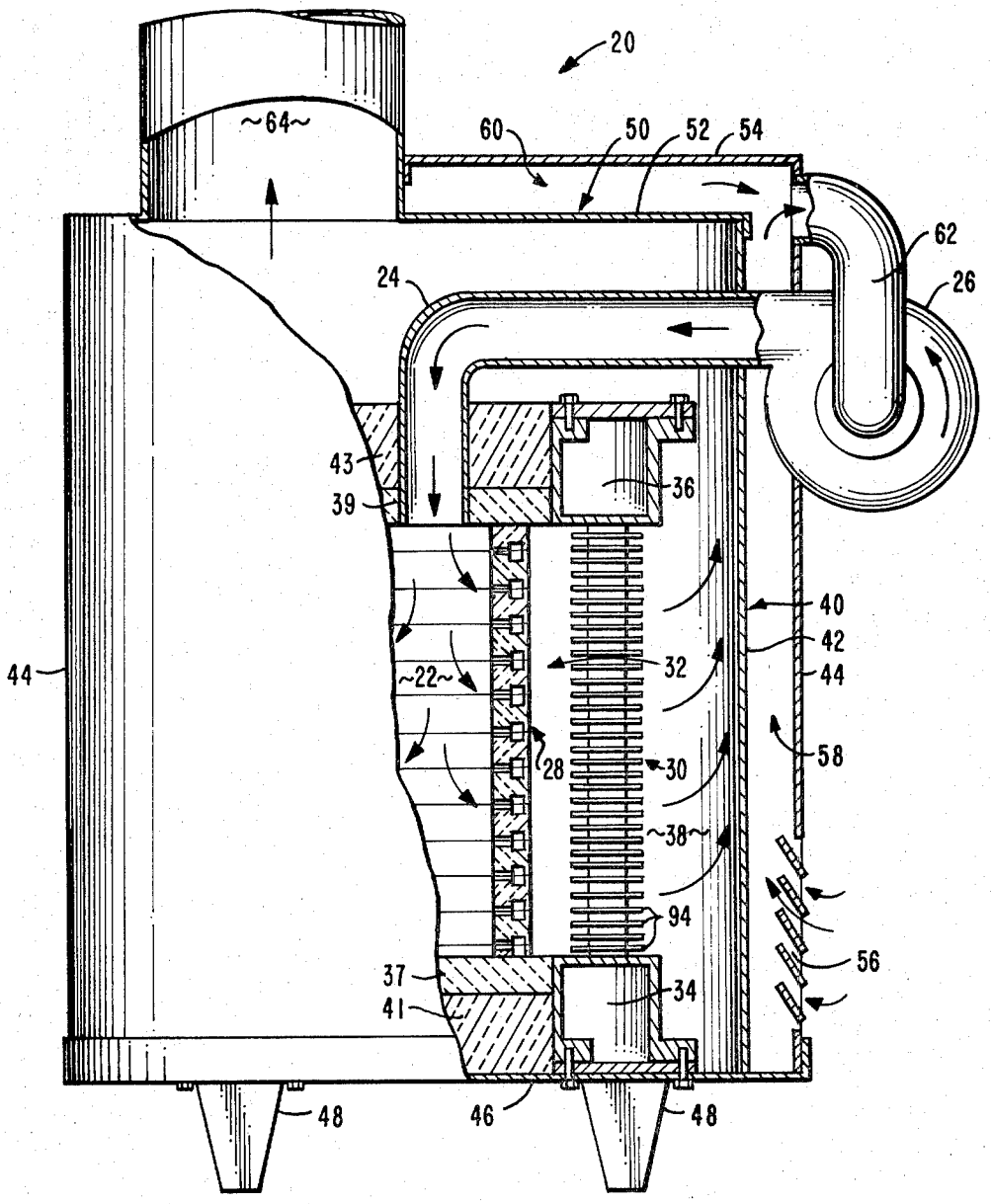


FIG.—1

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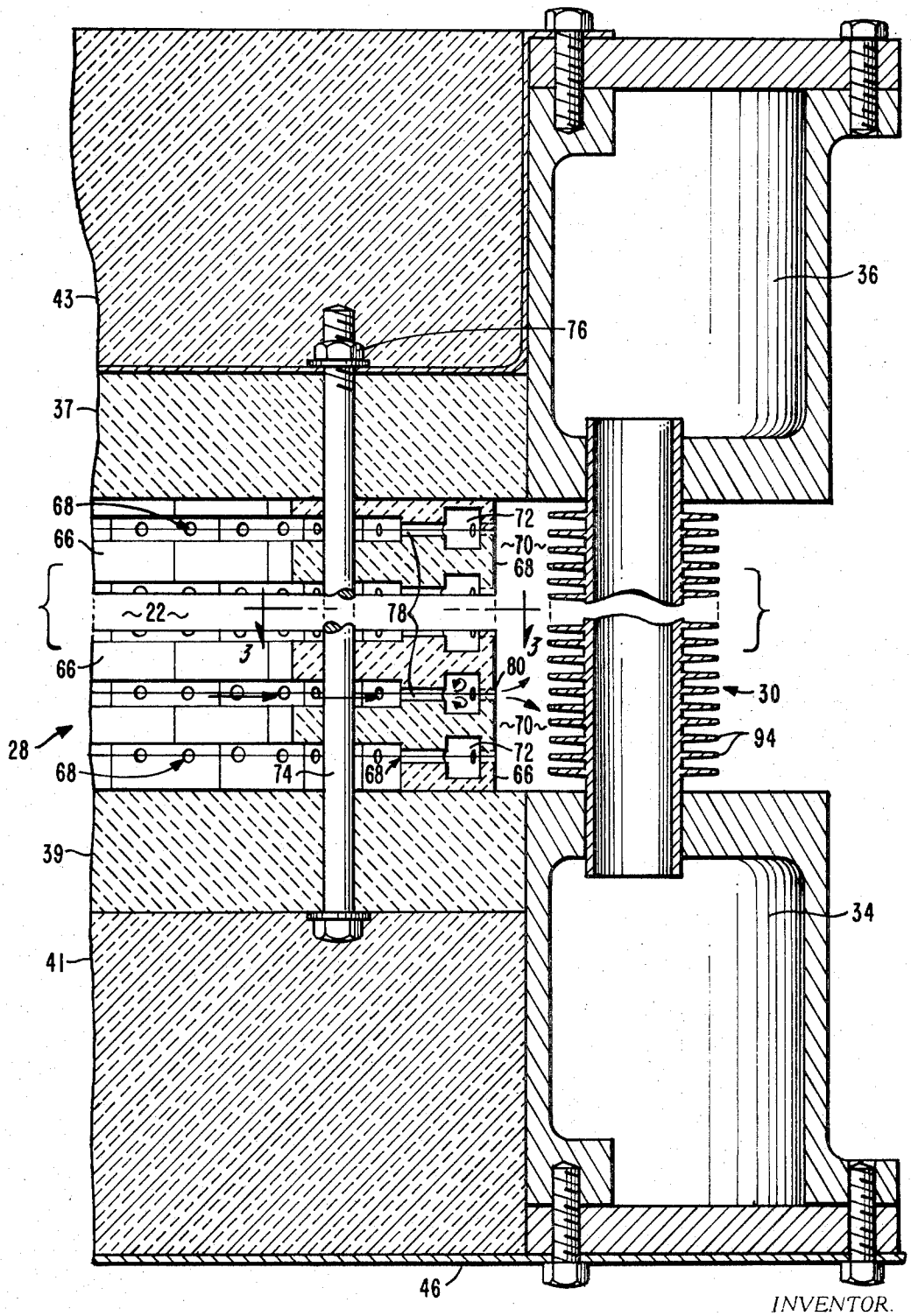


FIG.—2

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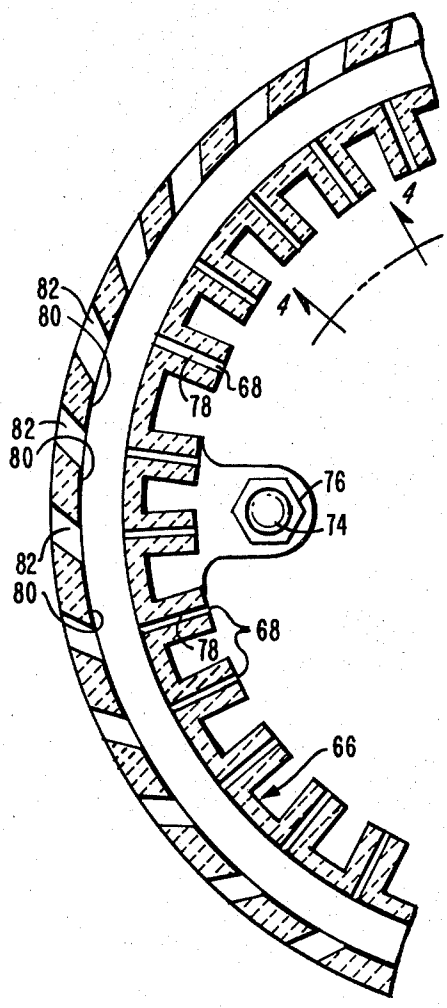


FIG.-3

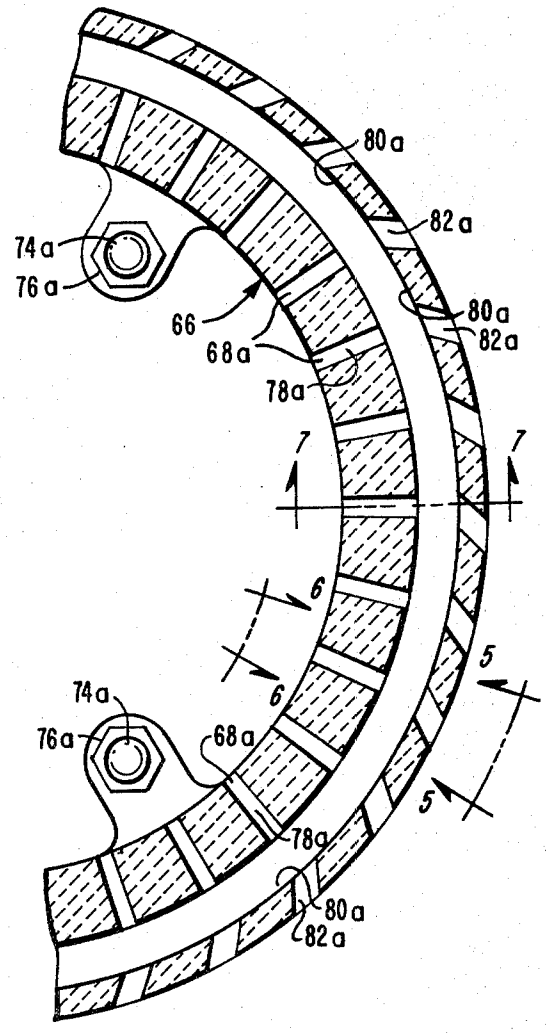


FIG.-3A

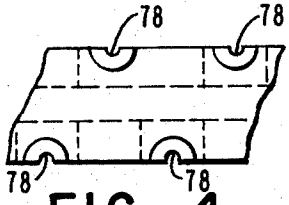


FIG.-4

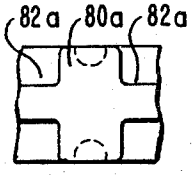


FIG.-5

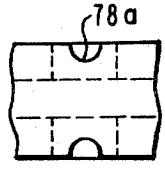


FIG.-6

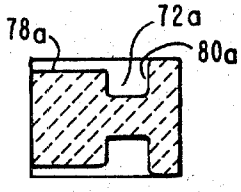


FIG.-7

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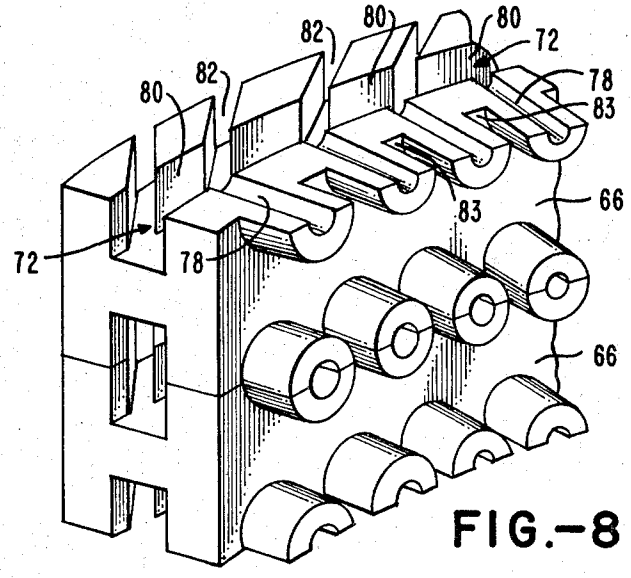


FIG.-8

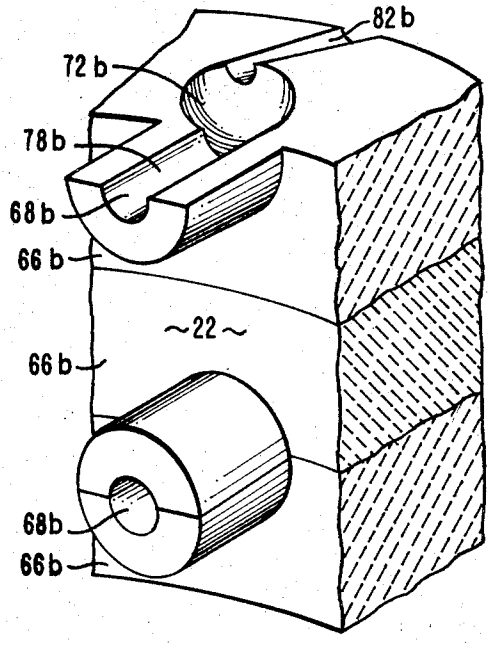


FIG.-9

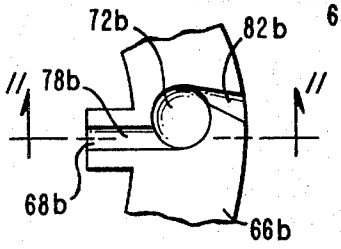


FIG.-10

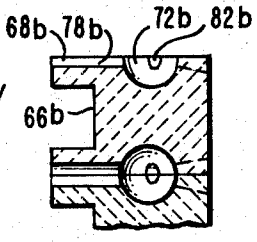


FIG.-11

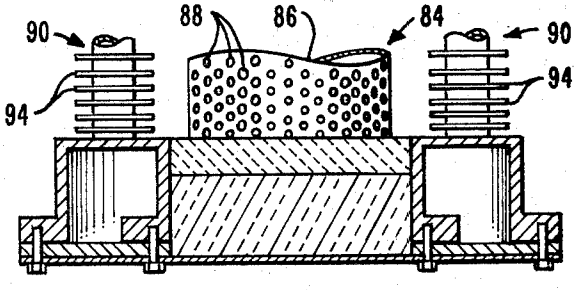


FIG.-12

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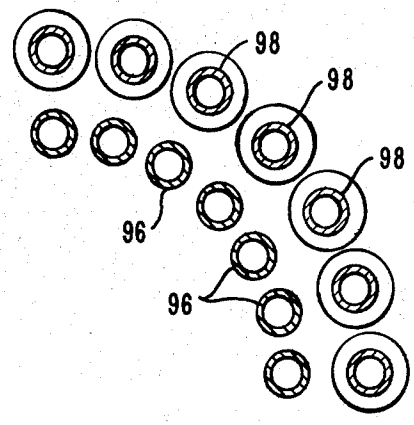


FIG.—13

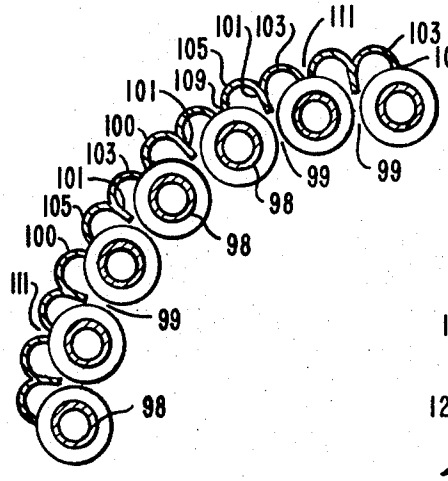


FIG.—14

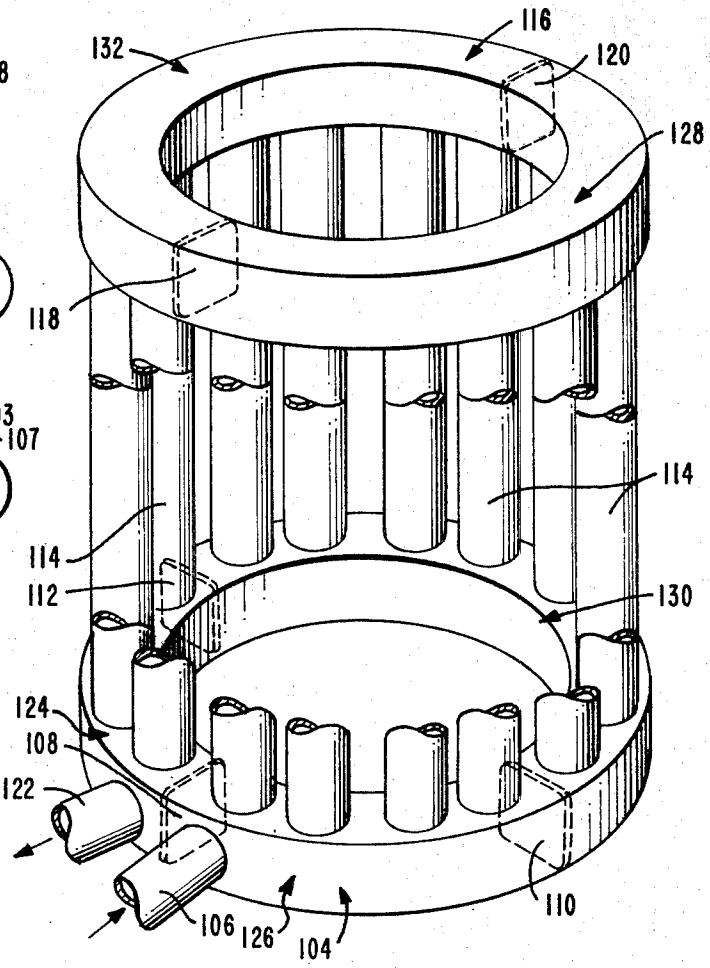


FIG.—16

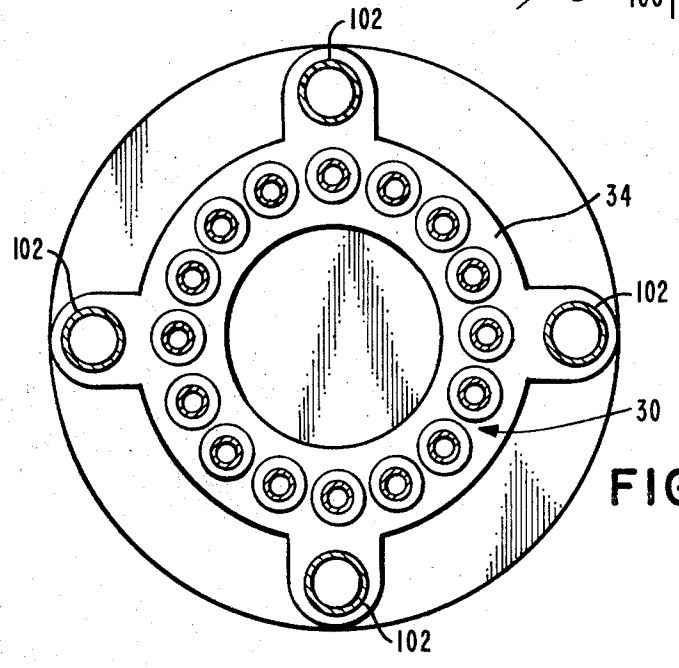


FIG.—15

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HEATING SYSTEM

BACKGROUND

1. Field of Invention

The present invention is directed to heating systems, particularly systems for heating water and generating steam, and components thereof.

2. Prior Art

Conventional systems for heating water and generating steam are relatively bulky in relation to their B.T.U. output. Certain advanced types of such systems impel combustible and combusted gases therethrough at high velocity and, accordingly, can be made much smaller and more compact. However, there has been a practical limitation on how small such units can be and still be economical to make and efficient to operate so as to provide a suitably high B.T.U. output while retaining advantages of the larger types, including easy access for cleaning of heat exchange tubes, ready replacement thereof and simple sludge removal. There has been a particular need for a new generation of more compact heaters which can be made inexpensively and which have the aforesaid advantages of the larger types of heaters.

SUMMARY OF THE INVENTION

The Abstract herein summarizes certain features of the invention. The described heating system, although particularly adapted as a water heating system, is also applicable to heating of other liquids and generating of steam.

Such system is characterized, in part, by being extremely compact, and being capable of utilizing a high velocity stream of combustible gases to provide a very high B.T.U. output over a wide range. Blower means are provided to force the gases through the hollow porous burner element, past the heat exchanger elements and out of the system. Such burner element provides a multitude of combustion and combustion zones and in one embodiment, baffles are provided in the pathways to increase their length and number, to promote turbulence and mixing and to radiate heat back into the multitude of combustion zones, thereby reducing the the volume necessary to complete combustion. Preferably, the channels are angled so that the combustion gases intersect the heat exchanger elements (surrounding the shield) at an angle or tangentially to increase the heat exchange flow path and efficiency. The elements may be finned and with or without baffle elements. It is a part of the invention to provide baffles for heat exchanger elements, which baffles are of improved configuration, to provide increased gas turbulence. Return conduits may be disposed peripheral of the elements and interconnected therewith through headers to provide thermal circulation for the heat transfer medium (water), particularly suitable where external pump means are not provided. Moreover, the system provides easy access for cleaning of the heat exchanger elements, ready replacement thereof and easy access for sludge removal.

DRAWINGS

FIG. 1 is a schematic side elevation of a preferred embodiment of the heating system of the invention, with portions broken away to illustrate the internal construction thereof;

FIG. 2 is an enlarged fragmentary sectional view of the heating system of FIG. 1;

FIG. 3 is a fragmentary section taken along the section line 3—3 of FIG. 2;

FIG. 3*a* is a fragmentary section of a further embodiment of the stack of burner element discs;

FIG. 4 is an enlarged section taken along the section line 4—4 of FIG. 3;

FIG. 5 is an enlarged section taken along the section line 5—5 of FIG. 3*a*;

FIG. 6 is an enlarged section taken along the section line 6—6 of FIG. 3*a*;

FIG. 7 is an enlarged section taken along the section line 7—7 of FIG. 3*a*;

FIG. 8 is an enlarged fragmentary perspective of a portion of the burner element of FIG. 1;

FIG. 9 is an enlarged fragmentary perspective of a modified form of a portion of the burner element of the present system;

FIG. 10 is a plan view of a portion of the burner element of FIG. 9;

FIG. 11 is a section taken along the section line 11—11 of FIG. 10;

FIG. 12 is a schematic fragmentary perspective of a further embodiment of the burner element of the system of the invention;

FIG. 13 is a schematic fragmentary section of a double row of finned and unfinned heat exchanger elements in the system of the invention;

FIG. 14 is a schematic fragmentary section of heat exchanger elements employing baffles of improved configuration;

FIG. 15 is a schematic section illustrating the use of return conduits in association with heat exchanger elements in the present system; and

FIG. 16 is an enlarged fragmentary schematic perspective of a modified arrangement of heat exchanger elements and header rings with baffles for closed loop multi-pass circulation of water or other fluid in the present system.

DETAILED DESCRIpTION

The System in General

Now referring to the drawings, FIG. 1 schematically illustrates in side elevation, partly broken away, a preferred embodiment of the heating system of the invention. As shown in FIG. 1, a heater **20** is provided, which includes a central gas supply zone **22** to which is connected a gas supply duct **24** leading from a blower **26**. Zone **22** is defined by a burner element **28**, preferably cylindrical in configuration. An array of heat exchanger elements **30** preferably surrounds element **28** and is spaced outwardly therefrom to provide therewith a gas combustion chamber **32**. Annular headers **34** and **36** interconnect elements **30** and are in turn connected to water supply means (not shown) through header **34** and hot water removal means (not shown) through header **36**. Refractory (such as silica, etc.) layers **37** and **39** are disposed at the lower and upper ends, respectively, of burner element **28** within headers **34** and **36**, respectively, layer **39** having an aperture through which duct **24** extends. Layers **37** and **39** are backed by heat insulative layers **41** and **43**, respectively, fabricated of, for example, mineral wool or the like.

A space **38** is provided between elements **30** and an insulated jacket **40** comprising two spaced walls **42** and **44** connected at their lower ends to a base plate **46** resting on support legs **48** and connected at their upper end to a similarly constructed jacket **50** comprising walls **52** and **54**. An air inlet **56** communicates with a passageway **58** between walls **42** and **44** and an interconnected passageway **60** between walls **52** and **54**, those passageways in turn being connected to an inlet duct **62** leading to blower **26** disposed outside jackets **40** and **50**. Combustion ignition means (not shown) are also provided. A gas outlet duct **64** is also provided, as shown in FIG. **1**.

Jackets **40** and **50**, base plate **46**, legs **48**, ducts **24**, **62**, **64** and blower **26** can be fabricated of any suitable conventional materials such as steel, iron, etc., in a conventional manner. Blower **26** can be powered in any suitable manner. It delivers combustible gases (air or oxygen and natural gas, etc.) at a high velocity, for example, 0.277 cubic feet/second for a unit having a total contained volume of 4.4 cubic feet and capable of putting out 800,000 B.T.U./hour.

Burner Element

Element **28** is more particularly illustrated in enlarged fragmentary view in FIG. **2**. Such element can, for example, comprise a plurality of stacked refractory blocks which form discs **66** defining a plurality of combustion channels **68** communicating between zone **22** and the space **70** between shield **28** and elements **30**, as shown in FIGS. **1** and **2**. Alternatively, element **28** can be fabricated of a single piece of refractory material, suitably apertured in accordance with the succeeding description. Discs **66** can be fabricated of any suitable refractory material such as hardened brick, silica blocks, etc.

Channels **68** are provided with enlarged combustion zones **72** wherein combustion is initiated, as by conventional electrical ignition means (not shown) or the like. Discs **66** are held together in vertical stacked relation, as by bolts **74** passing therethrough (FIG. **3***a*, bolts **74***a*), and secured thereto by nuts **76** (in FIG. **3***a* nuts **76***a*). FIGS. **3** and **3***a* combined show a typical spacing for such securing means. Although channels **68** can be provided in any suitable manner, as by drilling out the centers of each block or disc in the stack, it is preferred to cast or otherwise form discs **66** such that the upper and lower surfaces of each disc cooperate with the adjoining surfaces of adjacent discs **66** in the stack to provide channels **68** and zones **72**.

Preferably, burner element **28** is hollow and cylindrical, as shown in FIGS. **3** and **3***a* with channels **68** (**68***a* in FIG. **3***a*) distributed uniformly therearound. Also, preferably, each such channel is configured to provide (in FIG. **3**) a narrow inner passageway **78** between zone **22** and zone **72** (in FIG. **3***a* passageway **78***a*, zone **22***a* and zone **72***a*). The outer periphery of each zone **72** (or **72***a*) is defined by a buffer plate **80** (or **80***a*, as in FIG. **3***a*) positioned such that combustion gases flowing outwardly are deflected into a plurality of streams passing from element **28** tangentially through angled passageways **82** between plates **80** (as shown in FIG. **3**) for contact with heat exchanger elements **30** at an acute angle or tangentially in order to increase the flow path of such gases, increase turbulent mixing, eliminate laminar flow, and increase heat exchange efficiency with elements **30**.

FIG. **4** shows narrow passageways **78**; FIG. **5** shows angled passageways **82***a* and buffer plates **80***a*; FIG. **6** shows passageways **78***a* of larger diameter than passageway **78** (of FIG. **3**); and FIG. **7** shows passageways **78***a*, zone **72***a* and buffer plate **80***a*. A schematic fragmentary perspective view is shown in FIG. **8** of passageways **78** and **82** and buffer plates **80** along with combustion zones **72**. It will be noted that disc **66** is, as shown in FIG. **8** and in FIG. **3**, recessed around that portion **83** containing passageway **78** such that portion **83** in each instance assumes the shape of an inwardly directed nozzle. It is necessary to have passageway **78** relatively long and of sufficiently small diameter to assure that any combustion gases attempting to pass back therethrough are cooled by contact with the relatively large surface area of portion **83** defining passageway **78** to a point below that which would cause ignition of gases in zone **20** and an explosion therein.

A modified form of a portion of a pair of discs comprising part of the burner element is shown in schematic perspective view in FIG. **9**. Each such disc **66***b* forms with the next adjoining disc **66***b* in the stack, a channel **68***b* comprising a narrow inner passageway **78***b* (to prevent combustion from migrating back into gas supply zone **22** and initiating an explosion), an enlarged combustion zone **72***b* generally of spherical configuration and an exit passageway **82***b* angled from the direction of flow of passageway **78***b*, as shown more particularly in FIGS. **10** and **11**. Passageway **78***b* preferably connects with zone **72***b* along only a small portion thereof and the walls defining passageway **78***b* preferably diverge outwardly. Accordingly, a swirling motion of hot gases is set up in zone **72***b* to increase combustion, while the shape of passageway **82***b* is such as to increase gas velocity.

The described improvements all contribute to increased burning of the gases in chamber **32** so as to minimize the necessary volume thereof for a given B.T.U. output and they also contribute to increased efficiency of heat transfer through elements **30** by improving gas turbulence, mixing, suppression of laminar flow, increasing the contact of hot gases with the heat exchanger elements, etc.

The burner element of the system of the invention may also be of somewhat different form, such as that shown in FIG. **12**, wherein a perforated, hollow cylindrical high temperature metal element **84** (for example, steel) is schematically illustrated. Element **84** channels gases from gas supply zone **86** therein through spaced holes **88** so as to provide, taken with array of heat exchanger elements **90** spaced outwardly therefrom, a plurality of combustion foci. Such element **84** is of substantially simpler design than that of element **28** and does not offer some of the advantages of element **28** (e.g. tortuous gas flow path, radiation deflection, gas deflection with angled gas contact with elements **90**, etc.).

It will be understood that element **84** can, if desired, be in the form of any high temperature metal, ceramic or the like hollow porous (or perforated) self-supporting structure, for example, a steel grid or mesh screen hollow cylinder or the like. It will be also understood that although a hollow cylindrical configuration for this element is most desired, with the array of heat exchanger elements spaced outwardly therefrom and

entirely surrounding the same, hollow square, polygonal or other configurations for the burner element will perform satisfactorily. Moreover, the array of heat exchanger elements need not entirely enclose the burner element, although such array is the most efficient and the most compact.

Heat Exchanger Elements

Regarding the heat exchanger elements, such elements **30** are shown in FIGS. **1** and **2** as hollow tubular members containing fins **94** to increase the efficiency of heat exchange with combustion gases in space **70**.

As schematically illustrated in fragmentary section in FIG. **13**, such array may be modified to include an inner circular array of spaced unfinned hollow tubular members **96**, backed by an outer circular array of more closely spaced finned hollow tubular members **98** spaced outwardly from members **96**. With such an arrangement, initial heat exchange is accomplished between the combustion gases and the unfinned member **96** when the gases are hottest. In the area of unfinned members **96** the temperature of the combustion gases is very high (e.g. 2,600°F.). Water or other heat exchange medium is passed (e.g. forced) through tubes **96** at a high enough flow rate to prevent conversion into steam or other gases. For this purpose, a water impeller pump or the like of conventional design can be used (not shown).

By the time the combustion gases pass out of heat exchange relationship with tubes **96**, such gases have decreased in temperature a considerable extent (to e.g. 1,200°F. or the like). Such cooler gases then contact finned tubes **98** where, because of the greater surface area of such tubes due to the fins, improved heat exchange efficiency is accomplished so as to extract most of the remaining heat from the combustion gases and transfer the same to the heat transfer medium e.g. water flowing rapidly through tubes **98**, as by an impeller pump or the like (not shown). The cooled gases which may be at about 400°–500°F., for example, or less, but in any event above the dew point to eliminate corrosion problems in the exhaust gas ducts then pass into space **38** and exit the system through outlet duct **64**. With such a double array, finned and unfinned steel tubes can be used efficiently, thus providing a saving in cost. Steel finning on tubes, due to its lower heat transfer efficiency, as opposed to copper, tends to heat up high enough to cause it to flake away over a period of time, if such finning is used on tubes without an inner buffer array of unfinned tubes to first drop the temperature to below a level which causes excess heating of the finning.

Heat exchange efficiency with elements **30** or tubes **96** and **98** is particularly high if such gases strike the heat exchanger elements at an angle, such as is effected by angling passageways **82** as previously described. A longer heat transfer pathway results, laminar flow is prevented and turbulent mixing of combustion gases occurs, all of which improve efficiency of heat transfer. Such heat transfer is further enhanced by the use of the double row of members **96** and **98** and appropriate positioning of individual members **96** and **98**, such that the path of the combustion gases is further segmented and each path lengthened.

Increases in heat exchange efficiency can also be provided by providing elements **30** or elements **98** with baffles **100**, such as are schematically illustrated in section in FIG. **14**. It will be understood that unfinned elements **96** can also be provided with similar baffles instead of or in addition to those provided elements **30** or **98**. Baffles **100** can be of any suitable configuration to bridge partially or wholly the spaces **99** between adjacent elements **30**, as shown in FIG. **14**, and spaced therefrom on the side of the array away from burner element **28**. The baffles are configured to lengthen and, preferably, divide the combustion gas flow path for increased length of intimate contact with elements **30**, particularly fins **94**, and to also induce turbulent mixing to decrease further the possibility of laminar flow. In this regard, it will be noted that with baffles **100** in place, the side of the finned elements **30** away from burner element **28** is now exposed fully to the combustion gases, since they are deflected thereto, for increased heat transfer. Moreover, baffles **100** are preferably of the special configuration shown in FIG. **14**. Thus, baffles **100** may each comprise an elongated configured plate of durable high temperature metal, such as copper or the like, and comprising a central spine **101** and a pair of laterally and rearwardly extending curved wings **103** and **105** interconnected at spine **101**. Tips **107** and **109** of wings **103** and **105**, respectively, are reflected forwardly, so that each wing is configured as a semi-closed loop. Gases passing through spaces **99** strike spine **101** and are divided into two paths, one along each wing. As the combustion gases follow each such path, the wing and tip not only cause them to intersect the adjoining surfaces of the heat exchanger elements **30** and their fins, but force the gases back into the spaces **99** to cause turbulent mixing with further combustion gases in those spaces, thus increasing heat transfer. Gaps **111** between adjacent baffles **100** permit the combustion gases to exit the area. Baffles **100** account for substantial increases in heat transfer efficiency, maximizing the intimate contact between elements **30** and such gases over the entire surface of elements **30**. Such heat exchanger baffles can improve heat transfer efficiency as much as **30** percent or more.

Elements **30**, **96** and **98** can be fabricated of any suitable durable high temperature heat transfer material, such as copper, as can fins **94** and baffles **100**. Obviously, the material selected must be capable of withstanding the impingement of hot combustion gases over a long period of time while providing for efficient heat transfer. Resistance to corrosion by the combustion gases and also the heat transfer medium, such as water, passing therethrough is essential.

Return Conduits

As previously described, elements **30** are interconnected through headers **34** and **36** adjacent the bottom and top, respectively, of heater **20**. With such an arrangement, system **20** is enclosed in a water jacket, except for the insulative layers **37**, **39**, **41** and **43** within the annular headers. A preferred arrangement of components is also schematically illustrated in section in FIG. **15** wherein return conduits **102** are shown spaced outwardly from the array of finned elements **30** but in the flow path of combustion gases after the latter pass by elements **30**. Conduits **102** conduct a heat transfer medium, such as water, between headers **34** and **36** and can be fabricated of any suitable high temperature

material such as that described for elements **30**. With such an arrangement, the combustion gases, after cooling by heat exchange with elements **30**, impinge on conduits **102** and heat the heat transfer medium therein to a lesser extent than that in elements **30**.

Accordingly, thermal circulation of the heat transfer medium within elements **30** and conduits **102** can be readily established such that the medium, due to the temperature differential between that in elements **30** and that in conduits **102**, flows up through elements **30**, then through header **36** then down through conduits **102**, then through header **34** and finally up again through elements **30**. This thermal circulation system effectively channels any pockets of steam formed in the liquid medium, (steam from water) to the cooler headers where the steam is eliminated.

A further particular embodiment of the described closed loop thermal circulation system is schematically illustrated in FIG. **16** in isolated perspective view. With the arrangement shown in FIG. **16**, rapid flow of the heat transfer medium in the heat exchange tubes prevents build-up scale on the tubes and simplified maintenances of the system. As shown in FIG. **16**, an annular hollow tubular bottom header **104** is connected to a water inlet tube **106** and is provided with three internal baffles **108**, **110** and **112** which divide header **104** into two equal semi-circular compartments and further divide one of these compartments into two equal subcompartments. A plurality of hollow heat exchanger tubes **114** are spaced along the upper surface of header **104**, are in connection with the interior thereof and extend upwardly therefrom into contact with the lower surface and also the interior of a top header **116** of like configuration to header **104**. Header **116** is divided into two equal semi-circular compartments by means of baffles **118** and **120**. Baffle **118** is aligned with baffle **108**. A water outlet tube **112** is secured to header **104**, also as shown in FIG. **16**, within subcompartment **124** while water inlet **106** is disposed within subcompartment **126**.

With such an arrangement occupying a location in heater system **20** comparable to that of elements **30** and headers **34** and **36**, an essentially closed loop multi-pass flow system for the heat transfer medium is provided. Thus, water (or other heat transfer medium) entering through inlet tube **106** rises in the tubes in subcompartment **126** passes through compartment **128** of header **116** and down the downflow tubes therein, passes through compartment **130** of header **104**, up through the upflow tubes therein, then through compartment **132** of header **116** and down through the downflow tubes therein to subcompartment **124** where it exits the system through outlet tube **122**.

Accordingly, with such an arrangement, the heat transfer medium, for example, water, is caused to flow up and down within the heat exchanger elements through an elongated path at a rapid flow rate, due to the few number of tubes involved at any point in the flow path of the medium. Accordingly, scale deposit in the tubes is prevented. It will be understood that any other comparable array of multi-baffled headers can be used to create and up-down multiple pass flow path involving such equipment and providing comparable advantages.

Heat System

It will be noted that positioning of the multi-combustion zone-forming burner element within and spaced from the array of heat exchanger elements **30** to form therewith the combustion chamber **32** of controlled configuration (including elongated channels with multiple combustion zones, baffles, angled flow paths, etc.) without having to provide a separate such combustion chamber maximizes heat transfer and combustion efficiency per unit volume. High flow through velocities for combustion gas and water or other heat transfer medium are possible, so that multi-million B.T.U./hour outputs can be provided with the present small, light compact units while still providing easy access and repair for the heat exchange tubes (since they surround the burner element and have their bottom and top ends connected to the headers through which access is gained) and permitting sludge removal from the system through the heat exchanger tubes and headers and replacement of such tubes as necessary. For example, a water heating unit of the present design having the following dimensions and operated within the following parameters, can produce B.T.U./hour very efficiently:

IMPROVED HEATER

Burner Element
Height - 21 inches
O. D. - 7 inches
I. D. - 5 inches
Construction material - ceramic refractory
Heat Exchanger Tube Array
Spacing from burner element - 11/16 inch
Number and spacing of tubes - 18 tubes spaced with 1/16 inch gaps
O. D. of tube and length - 1 inch 21 inches
I. D. of tube - ⅞ inch
Radius of fin - 5/16 inch, 7 fins per inch
Construction material - copper
Heater Dimensions (O.D.) 20 inches × 24 inches
Combustion Gas Flow Rate - 1000 cu.ft. of natural gas/hour.
Water Flow Rate - 100 gals./min.
B.T.U. Output - 800,000 B.T.U./hour

The present improved heater is inexpensive to build, operate and maintain, can be run continuously over long periods of time on bottled gas, natural gas, propane or other combustible gas mixture without clean-up or maintenance and because of the high flow rate of water or other heat transfer medium therethrough, resists build-up of scale or corrosion of components. Moreover, the components thereof are few and are durable, and access thereto for inspection, maintenance and replacements and removal of sludge is simple. The heater is ideal for such uses as pool heating and the like where space is at a premium. Because of its small size, it can be shipped assembled or in fewer subassembled components at less cost and can be installed and run at a lower than conventional price. Its components can be constructed of readily available materials in an inexpensive manner. Such heater fills a long-felt need for improved heating efficiency and compactness in the water heating and allied fields. Thus with the present system, B.T.U. outputs comparable to those of the most compact and efficient commercial units can be obtained utilizing a volume one fourth

to one fifth as large as such units. Moreover, the present system requires less excess air than certain commercial units and provides increased efficiency. Accordingly, the present system has many advantages over commercial units.

What is claimed is:

1. An improved compact heating system comprising in combination;
   a. A generally centrally disposed combustible gas supply zone;
   b. A peripheral combustion chamber comprising:
      1. A hollow porous walled burner element comprising a plurality of stacked refractory hollow discs adjacent said gas supply zone and defining a plurality of spaced generally radially disposed channels between at least some of adjacent discs wherein combustion is initiatable;
      2. Combustion ignition means in communication with said channels;
      3. A plurality of heat exchanger elements disposed around said burner element in an array spaced outwardly from said channels but in heat exchange relationship therewith;
   c. Means for conducting a heat transfer medium into and through said heat exchange elements and out of said system;
   d. Blower means for introducing combustible gases to said gas supply zone and exhausting combusted gases at a high flow rate from said system; and,
   e. An outer heat insulative shield disposed around and spaced outwardly from said combustion chamber to define a gas collection space, said spacing being sufficient such that said shield is relatively thin and said system is relatively light and compact.

2. An improved compact heating system comprising in combination;
   a. A generally centrally disposed combustible gas supply zone;
   b. A peripheral combustion chamber comprising:
      1. A hollow porous walled burner element comprising stacked refractory discs adjacent said gas supply zone and defining a plurality of spaced generally radially disposed channels between at least some of adjacent discs wherein combustion is initiatable;
      2. Combustion ignition means in communication with said channels;
      3. A plurality of heat exchanger elements disposed around said burner element in an array spaced outwardly from said channels but in heat exchange relationship therewith;
   c. Means for conducting a heat transfer medium into and through said heat exchange elements and out of said system;
   d. Blower means for introducing combustible gases to said gas supply zone and exhausting combusted gases from said system at a high flow rate; and
   e. An outer heat insulative shield disposed around and spaced outwardly from said combustion chamber, at least a portion of said channels being angled such that the combustion gases passing therefrom intersect said heat exchanger elements tangentially, thereby facilitating turbulent mixing and heat transfer.

3. The improved heating system of claim 2 wherein baffles are disposed within said channels in said burner element whereby gas combustion is facilitated.

4. The improved heating system of claim 2 wherein said channels include elongated narrow inner passageways, enlarged zones wherein combustion is initiated connected to said inner passageways and to said angled exit channels.

5. The improved heating system of claim 4 wherein each of said enlarged zones is generally spherical and wherein the portion of said channel between said zone and the outer periphery of said burner element communicates with said zone over a limited area and is defined by outwardly diverging walls.

6. The improved heating system of claim 1 wherein said heat exchanger elements are disposed around said burner element in a first series comprising spaced generally tubular non-finned elements adjacent said shield and a second series comprising spaced generally tubular finned elements separated from said shield by said first series.

7. The improved heating system of claim 6 wherein said finned and unfinned elements are fabricated of steel.

8. An improved compact heating system comprising in combination;
   a. A generally centrally disposed combustible gas supply zone;
   b. A peripheral combustion chamber comprising:
      1. A hollow porous walled generally cylindrical burner element comprising stacked refractory discs, disposed around said gas supply zone and defining a plurality of spaced generally radially disposed channels wherein combustion is initiatable;
      2. Combustion ignition means in communication with said channels;
      3. A plurality of heat exchanger elements disposed around substantially the entire periphery of said burner element in a generally cylindrical array spaced outwardly from said channels but in heat exchange relationship therewith;
   c. Means for conducting hot water into and through said heat exchange elements and out of said system;
   d. Blower means for introducing combustible gases to said gas supply zone and exhausting combusted gases at a high flow rate from said system;
   e. An outer heat insulative shield disposed around said combustion chamber; and,
   f. Baffles disposed in said channels to elongate and divide gas flow paths in said burner element, at least a portion of said channels being angled to cause said combustion gases to intersect said heat exchanger elements at an angle.

9. The improved heating system of claim 8 wherein said heat exchanger elements are interconnected through spaced headers at opposite ends thereof, and wherein a plurality of water return conduits are disposed peripheral of said heat exchanger elements and interconnected therewith through said headers, whereby steam entrainment in said heat exchanger elements is avoided.

10. The improved heating system of claim 8 wherein said heat exchanger elements are spaced about

uniformly along the surface of and interconnected through first and second spaced annular headers at opposite ends thereof, wherein each said header includes a plurality of baffles dividing said header into separate compartments, wherein said header baffles of said first header are positioned with respect to said baffles of said second header and wherein said first header is connected to a water inlet and a water outlet in separate compartments of said headers whereby a multi-pass high velocity flow path between said headers through said heat exchanger elements is provided.

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