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2,752,912

FORCED AIR FLOW AIR HEATING FURNACE

Filed June 8, 1954

2 Sheets-Sheet 1

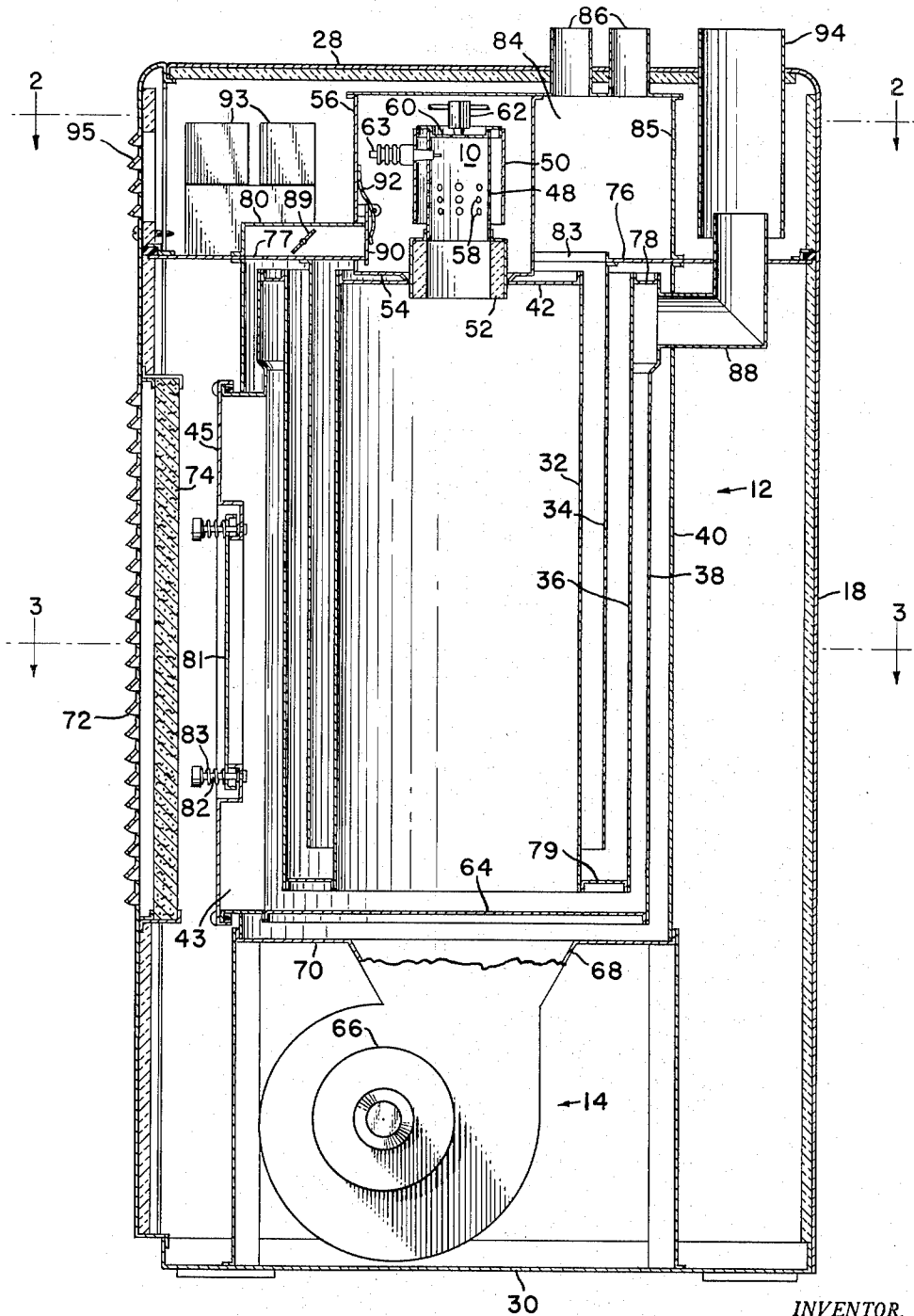


Fig. 1.

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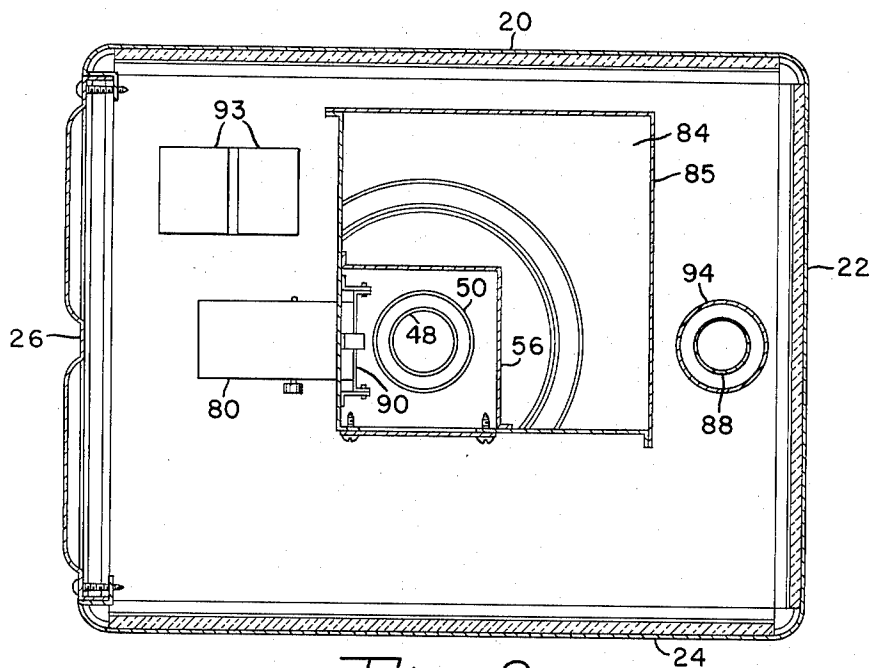


Fig. 2.

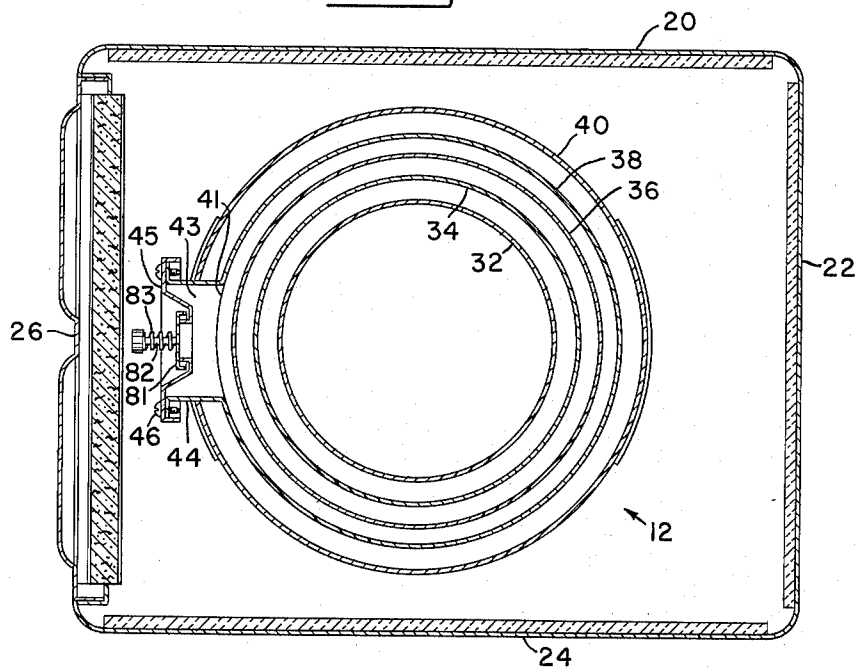


Fig. 3.

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FORCED AIR FLOW AIR HEATING FURNACE

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Application June 8, 1954, Serial No. 435,313

10 Claims. (Cl. 126—110)

This invention relates to improvements in heating apparatus, and particularly to an improved forced-air heating apparatus supplying air at relatively high temperatures and pressures.

In U. S. Patent No. 2,488,548, there is described and claimed a forced-air heating apparatus for a heating system in which relatively small quantities of high-temperature air are distributed through small ducts, to be mixed with lower temperature air at the point of use. The apparatus described in the foregoing patent includes a pair of substantially cylindrical shells concentrically arranged to provide therebetween a hollow annular space within which is placed a spiral heat exchanger element. Inside the inner shell, a fuel burner is mounted to discharge hot gaseous combustion products, in a direction at right angles to the shell axes, directly into an opening in the inner turn of the spiral heat exchanger. An air compressor at one end of the shells supplies air both to the fuel burner and to the space between the shells to flow in heat exchange relationship over the spiral surfaces of the heat exchanger, thereby providing for heating of the air.

While the apparatus just described has many advantages over other previously known heating systems, it has been found that the orientation of the fuel burner and the air flow arrangement has certain shortcomings. The location of the fuel burner at right angles to the shell axes results in a concentrated discharge of hot gaseous combustion products directly onto a limited-surface-area portion of the innermost turn of the heat exchanger. Even though the metal utilized in the heat exchanger be fully capable of withstanding the relatively high temperatures encountered, the impingement of hot gases on a localized portion of the heat exchanger wall may create a condition of uneven expansion and contraction which eventually may cause failure due to bending of the metal. Furthermore, it is not entirely practical to direct cooling air onto this localized area of extreme temperature changes, because the area in question is at the high temperature end of the path of the air being heated.

It is, therefore, a general object of the present invention to provide an improved air-heating apparatus, wherein the problems just mentioned are overcome while retaining and adding to the advantages of the apparatus described in the above-mentioned patent. In accordance with a preferred embodiment of the present invention, the foregoing and other related objects and advantages are obtained in an apparatus wherein the heat exchanger structure is modified and reoriented, with respect to the burner, to expose a different and much greater area portion of the heat exchanger structure to the initial high temperature combustion products, thereby eliminating the localized expansion and contraction problem. Provision also is made to insure a flow of cooling air directly onto a surface that is or may be the target of flame from the burner, thereby limiting temperature variations of this target surface. Whereas in the apparatus of the

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above patent the heat exchanger is oriented horizontally, in the present case a vertical configuration is preferred which, together with the modification in heat exchanger design, greatly facilitates cleaning of the combustion gas passages as is explained fully hereinafter.

A more complete understanding of the invention, and of further objects and features thereof, can be had by reference to the following description of an illustrative embodiment thereof, when considered in connection with the accompanying drawing, wherein

Figure 1 is a sectional elevation of an air heating device embodying the invention,

Figure 2 is a section view of the apparatus shown in Figure 1, taken on the line 2—2 in Figure 1, and

Figure 3 is a view similar to Figure 2, taken on the line 3—3 of Figure 1.

In Figure 1 of the drawing, the principal elements of a heating apparatus embodying the invention are shown to comprise a fuel burner 10 for supplying hot gaseous combustion products to a heat exchanger 12, and a compressor or blower 14 for supplying air both to the burner 10 and to the heat exchanger 12. The elements 10—14 are housed in an elongated, upright, substantially rectangular casing 18.

The casing preferably is made up of insulated side panels 20, 22, 24, 26, an insulated top panel 28 and a bottom pan 30, all assembled into a substantially airtight structure (except as hereinafter noted) by sheet metal screws or the like.

The heat exchanger 12 is made up of five vertically disposed concentric cylinders 32, 34, 36, 38, 40 of unequal radius, mounted coaxially one within another in the central part of the casing to provide radial spacing therebetween. Selected pairs of the cylinders are joined at their upper and lower ends to define closed paths for the flow of ventilating air and gaseous combustion products through the heat exchanger, as explained hereinafter.

The upper end of the innermost cylinder 32 is closed by an end wall 42, above which is mounted the fluid fuel burner 10. This burner 10 preferably is of the high velocity type, which is intended to designate a burner adapted to deliver hot gaseous combustion products at a velocity substantially in excess of the velocity of flame propagation of the fuel supplied to the burner. Such a burner has the advantage that it can be used with a compact, narrow flue gas passage heat exchanger without requiring abnormally high natural draft. A preferred burner of this type comprises a pair of concentrically disposed metal sleeves 48, 50. The inner one (48) of these sleeves surrounds and defines a combustion space which is extended into the space inside the cylinder 32 by a sleeve 52 of refractory material which forms a continuation of the inner sleeve 48. The refractory sleeve 52 extends through a central opening in the end wall 42 and a similar opening in the bottom wall 54 of a housing 56 which encloses the burner 10.

The inner sleeve 48 is provided with a plurality of laterally aligned holes 58 through which combustion air can enter the combustion space from the space between the sleeves 48, 50. The sleeves 48, 50 are closed by an end wall 60 at the end remote from the refractory sleeve 52, and a fuel supply means, such as an atomizing fuel nozzle 62, is mounted to discharge fuel into the combustion space. Ignition means, such as a spark plug 63 or the like, projects through the sleeves 48, 50 into the combustion space to ignite the fuel which enters through the supply means 62. It will be understood that the burner 10 can as well be arranged to burn gaseous fuel, by substitution of a suitable fuel supply means.

The burner head assembly just described constitutes a

high velocity unit, capable of delivering hot gaseous combustion products at a rate substantially in excess of the rate of flame propagation of the fuel supplied thereto. Air from the blower 14 will flow into the burner housing 56 as hereinafter explained, then down along the outside of the outer sleeve 50, then up into the space between the sleeves 48, 50 and will enter the combustion chamber in discrete, radially directed jets through the large holes 58 in the inner sleeve 48. As these jets of air impinge on each other at the center of the combustion chamber, some of the air will flow up toward the end wall 60, then radially outward along the end wall 60, and then downward along the inside surface of the inner sleeve 48. This air flow pattern will create a vortex or ring in the area between the inlet ports 58 and the closed end 60 of the combustion chamber. By virtue of the reversal of direction of air flow, an area of substantially zero velocity air flow is created within the toroidal flow area, and the nozzle 62 is arranged to discharge fuel into this relatively dead air space. By burning the atomized fuel in this low velocity region, it becomes possible to have gases (air and combustion products) flow into and out of the combustion chamber at a velocity much greater than the velocity of flame propagation of the fuel being burned, without blowing out the flame.

It can be seen that the burner 10 is arranged to discharge combustion gases downwardly into the cylinder 32, so that the entire inner surface of the cylinder 32 will be exposed to the radiant heat from the flame. The flame itself may impinge on an end wall 64 which closes the lower end of the next-to-outermost cylinder 38 and faces the refractory sleeve 52 from which the combustion gases issue.

The air compressor or blower 14, disposed at the lower end of the casing, is driven by a motor 66. As the blower 14 forms no part of the present invention per se, it is not shown in detail. The blower is connected by an outlet duct 68 to deliver air through an opening in a plate 70 which extends across the lower end of the outermost heat exchanger cylinder 40. The blower output supplies both combustion and ventilating air, and the flow of air to the blower is directed over the blower motor 66 for cooling purposes, as will now be described.

A louvered inlet opening 72 in one of the casing side panels 26 is covered by an air filter 74 through which air enters the casing 18. From the filter, the inlet air path extends downwardly between the casing and the outermost cylinder 40. This flow of air over the outside of the heat exchanger serves to minimize heat losses, to keep the casing temperature very low and to reduce blower noise outside the apparatus.

Upon reaching the lower end of the casing, the air flows over the motor 66 and into the blower 14, to be discharged through the duct 68 against the plate 64 which closes the lower end of the next-to-outermost cylinder 38. As this plate 64 faces the burner, it comprises the target toward which high temperature combustion products are directed by the burner. Thus, the low temperature air coming from the blower will prevent overheating of the target plate 64.

In addition to the end plates 42, 64, 70 previously referred to, additional end walls are provided at the upper end lower ends of the heat exchanger cylinders to co-operate therewith in defining the fluid flow paths through the heat exchanger. The upper ends of the outermost and next-to-innermost cylinders 40, 34 are joined by an end wall 76 which is part of a partition extending entirely across the casing. The upper ends of the third and the next-to-outermost cylinders 36, 38 are joined by an end wall 78. Also, the lower ends of the third and the innermost cylinders 36, 32 are joined by a connecting end wall 79.

At the beginning of their travel through the heat exchanger, the combustion-supporting air and the ventilating air (or air-to-be-heated) follow the same path, which extends from the blower duct 68 across the underface of the

plate 64 and thence upwardly through the space between the outermost and the next-to-outermost cylinders 38, 40.

At the end wall 76, the combustion-supporting air and the ventilating air separate. The combustion air, which may amount to, say, one-eighth of the total, will flow through an opening 77 in the wall 76 into a duct 80 which extends into the burner housing 56, and thence into the burner head 48, 50.

The ventilating air, on the other hand, will be deflected by the end wall 76 to flow downwardly through the space between the third and the next-to-innermost cylinders 36, 34. Upon reaching the lower ends of these cylinders, the ventilating air will be deflected by the end wall 79 to flow upwardly between the innermost and next-to-innermost cylinders 32, 34. At the upper end of these cylinders 32, 34, the ventilating air will flow through an opening 83 into a plenum chamber 84 defined by walls 85 adjacent the burner housing, to be distributed through outlet ducts 86 and conduits (not shown) connected thereto.

The high temperature combustion products leaving the burner 10 will flow downwardly through the inner cylinder 32 to the target plate 64, thence upwardly through the space between the third and the next-to-outermost cylinders 36, 38, and out through an exhaust duct 88 which is joined to the cylinder 38.

It is, of course, important that there be no leakage of the combustion gases into the ventilating air stream. While it is intended that the combustion gas path and the ventilating air path be carefully sealed to prevent such leakage, there is always a possibility that a leak may exist at some point where the two paths are contiguous, say, at the juncture of the end wall 78 and the third cylinder 36.

To insure that any leakage between the two paths will be in a safe direction, which would be from the ventilating air path to the combustion products path and not vice versa, it is preferable to maintain a lower operational fluid pressure at all points along the combustion products path than at adjacent points along the ventilating air path. To this end, there is preferably provided a restrictor, such as a damper 89, in the duct 80 leading to the burner, to reduce the pressure of the air going to the burner. Also, the spacing of the cylinders 32-38 must be properly selected with reference to the distribution system into which the ventilating air is distributed to maintain adequate pressure in the ventilating air path through the heat exchanger.

In accordance with a further feature of the invention, means are preferably provided to prevent any possibility of impure gases feeding back from the burner 10 into the heat exchanger 12 when the apparatus is shut down. At the end of a period of heat delivery, for example, there may be some traces of combustion gas in the heat exchanger for a short time after the blower 14 is shut off. To prevent fumes from finding their way back into the ventilating air system through the duct 80, a one-way valve 90 is provided at the burner end of the duct 80 and hinged to open in response to air pressure in the duct 80. When the blower 14 is off, the valve 90 will close by gravity, or may be closed more reliably by a spring 92.

In accordance with a further feature of the invention, means are provided for drawing a small quantity of air through the upper end of the casing to avoid overheating of controls 93 normally mounted in this portion of the casing. To isolate this portion of the casing, the partition 76 extends across the casing above the heat exchanger. The exhaust duct 88 is led upwardly through this partition 76 and communicates with the chimney or exhaust stack (not shown) through an aspirator comprising an outlet duct 94 which is of larger diameter than the exhaust duct and overlaps the end thereof, as shown. When combustion gases flow through the aspirator from the duct 88 to the duct 94, there will be a flow of air into the duct 94 from the space around the burner com-

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partment which will draw in cooling air through louvers 95 in the upper end of the casing.

One of the difficulties frequently encountered with multi-pass heat exchangers of compact configuration, such as in the apparatus described herein, is the difficulty of cleaning the flue gas passages. In the apparatus of the present invention, the parts of the heat exchanger through which the flue gases pass are readily accessible for cleaning, as will now be described.

A cleanout opening 41 is provided in the next-to-outermost cylinder 38, extending from the lower end of the cylinder 38 nearly to the upper end. Access to this opening 41 is had through a compartment 43 defined by walls 44 which extend from the opening 41 through a similar aligned opening in the outer cylinder 40. The compartment 43 is closed by a removable panel 45 held in place by sheet metal screws 46 or the like. In order to clean the flue gas passage between the third and next-to-outermost cylinders 36, 38, a flexible handled brush (not shown) can be inserted readily upon removal of the access panel 45, to scrape off any soot accumulated on the cylinders 36, 38. The soot will drop down onto the end wall 64, from which it can be removed readily through the opening 43.

To clean the inside of the inner cylinder 32, and for servicing of the burner 10, the top panel 28 and housing panel 56 can be removed to expose the burner, which can then be withdrawn to give access to the inside of the cylinder 32. As before, any soot brushed from the inner surface of the cylinder 32 will drop onto the end plate 64, to be removed through the opening 43.

In accordance with a further feature of the invention, a "blow-out" panel 81 is provided on the access panel 45 to relieve excess pressure developed by delayed ignition or the like, thereby to preclude damaging the heat exchanger. The panel 81 is mounted to move on guide pins 82, and is normally held in place by springs 83, so that the panel 81 can be forced outwardly to relieve excess pressure but will immediately return to its normal position tightly sealing the blow-out opening.

What is claimed is:

1. In a warm air furnace, a heat exchanger comprising five cylinders mounted one within another with radial spacing therebetween, a blower below said heat exchanger, means cooperating with said cylinders to define a first closed path from said blower for delivering into said heat exchanger both combustion air and air to be heated, said path extending from said blower into the space between the outermost and the next-to-outermost of said cylinders and terminating at the top of said last-mentioned cylinders, an end wall closing the upper end of the innermost of said cylinders, a fluid fuel burner mounted above said end wall and having a discharge tube extending downwardly into said innermost cylinder through said end wall, a housing enclosing said burner, means cooperating with said cylinders and said housing to define a second closed air path for conducting a combustion supporting air into said burner and gaseous combustion products away from said burner, said second path extending from the termination of said first path into said housing, through said burner, downwardly through the space inside said innermost cylinder and upwardly through the space between the third and the next-to-outermost of said cylinders, means cooperating with said cylinders to define a closed path for air to be heated and extending from the termination of said first path downwardly through the space between the third and the next to innermost of said cylinders and then upwardly through the space between the innermost and the next-to-innermost of said cylinders, means communicating with the space between the upper portions of said third and said next-to-outermost cylinders for conducting combustion gases out of said heat exchanger, and means communicating with the space between the upper portions of said

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innermost and said next-to-innermost cylinders for conducting heated air out of said heat exchanger.

2. A warm air furnace comprising an elongated, upright casing, a heat exchanger comprising five vertical cylinders mounted in said casing one within another with radial spacing therebetween, a blower in said casing below said heat exchanger, means cooperating with said cylinders and defining a first closed path from said blower for delivering into said heat exchanger both combustion air and air to be heated, said path extending from said blower upwardly into the space between the outermost and the next-to-outermost of said cylinders and terminating at the top of said last named cylinders, an end wall closing the upper end of the innermost of said cylinders, a high-velocity fluid fuel burner mounted above said end wall and having a discharge tube extending downwardly into said innermost cylinder, a housing enclosing said burner, means cooperating with said cylinders and said housing to define a second closed air path for conducting combustion supporting air into said burner and gaseous combustion products away from said burner, said second path extending from the termination of said first path into said housing, through said burner, downwardly through the space inside said innermost cylinder, upwardly through the space between the third and the next-to-outermost of said cylinders and then outwardly through said casing, means cooperating with said cylinders to define a third closed path for air to be heated and extending from the termination of said first path downwardly through the space between the third and the next to innermost of said cylinders and thence upwardly through the space between the innermost and the next-to-innermost of said cylinders and thence outwardly through said casing, said second air path being restricted upstream of said burner to maintain at all points along said second path a lower operational fluid pressure than the air pressure at adjacent points along said third path whereby to preclude fluid leakage from said second path to said third path.

3. A warm air furnace comprising an elongated, upright, insulated casing closed at top and bottom, a heat exchanger comprising five vertical cylinders mounted in said casing one within another with radial spacing therebetween, a blower in said casing below said heat exchanger, means cooperating with said cylinders and defining a first closed path from said blower for delivering into said heat exchanger both combustion air and air to be heated, said path extending from said blower upwardly into the space between the outermost and the next-to-outermost of said cylinders and terminating at the top of said last named cylinders, an end wall closing the upper end of the innermost of said cylinders, a high-velocity fluid fuel burner mounted above said end wall and having a discharge tube extending downwardly into said innermost cylinder through said end wall, a housing enclosing said burner, means cooperating with said cylinders and said housing to define a second closed air path for conducting combustion supporting air into said burner and gaseous combustion products away from said burner, said second path extending from the termination of said first path into said housing, through said burner, downwardly through the space inside said innermost cylinder, upwardly through the space between the third and the next-to-outermost of said cylinders and then outwardly through said casing, and means cooperating with said cylinders to define a closed path for air to be heated and extending from the termination of said first path downwardly through the space between the third and the next to innermost of said cylinders and thence upwardly through the space between the innermost and the next-to-innermost of said cylinders and thence outwardly through said casing.

4. In a warm air furnace, a heat exchanger comprising five vertical cylinders of unequal radius mounted one within another with radial spacing therebetween, a blower below said heat exchanger, end walls closing the lower

ends of the outermost and next-to-outermost of said cylinders, said outermost cylinder end wall having an opening therein, a duct communicating said blower with said opening, a third end wall joining the upper ends of the outermost and the next-to-innermost of said cylinders and having an opening therein, a fourth end wall closing the upper end of the innermost of said cylinders, a fluid fuel burner mounted above said fourth end wall and having a discharge tube extending downwardly into said innermost cylinder through said fourth end wall, a housing enclosing said burner, a duct communicating said third end wall opening with said housing, an end wall joining the upper ends of the third and the next-to-outermost of said cylinders, an end wall joining the lower ends of the third and the innermost of said cylinders, means communicating with the space between the upper portions of said third and said next-to-outermost cylinders for conducting combustion gases out of said heat exchanger, and means communicating with the space between the upper portions of said innermost and said next-to-innermost cylinders for conducting heated air out of said heat exchanger.

5. In a warm air furnace, a heat exchanger comprising five vertical cylinders of unequal radius mounted one within another with radial spacing therebetween, a blower below said heat exchanger, means cooperating with said cylinders and defining a first closed path from said blower for delivering into said heat exchanger both combustion air and air to be heated, said path extending from said blower upwardly into the space between the outermost and the next-to-outermost of said cylinders and terminating at the top of said last-mentioned cylinders, an end wall closing the upper end of the innermost of said cylinders, a fluid fuel burner mounted above said end wall and having a discharge tube extending downwardly into said innermost cylinder through said end wall, a housing enclosing said burner, a duct extending from the termination of said first path into said housing, means closing said duct to prevent fluid flow from said housing into said duct and adapted to open in response to flow of pressurized air into said duct from said first path, means cooperating with said cylinders to define a second closed path for conducting gaseous combustion products from said burner, said second path extending downwardly through the space inside said innermost cylinder and upwardly through the space between the third and the next-to-outermost of said cylinders, means cooperating with said cylinders to define a closed path for air to be heated and extending from the termination of said first path downwardly through the space between the third and the next-to-innermost of said cylinders and thence upwardly through the space between the innermost and the next-to-innermost of said cylinders, means communicating with the space between the upper portions of said third and said next-to-outermost cylinders for conducting combustion gases out of said heat exchanger, and means communicating with the space between the upper portions of said innermost and said next-to-innermost cylinders for conducting heated air out of said heat exchanger.

6. A warm air furnace comprising an elongated, upright, insulated casing closed at top and bottom, a heat exchanger comprising five vertical cylinders mounted in the central part of said casing one within another with radial spacing therebetween, a first end wall closing the lower end of the next-to-outermost cylinder, a second end wall joining the lower ends of the innermost and the third of said cylinders, a third end wall joining the upper ends of the next-to-outermost and the third of said cylinders, a fourth end wall joining the upper ends of the outermost and the next-to-innermost of said cylinders, a fifth end wall closing the upper end of the innermost of said cylinders, a high velocity fluid fuel burner mounted above said fifth end wall and having a discharge tube extending downwardly into said innermost cylinder, a housing enclosing said burner, said housing having an opening therein, said fourth end wall having an opening therein,

a duct communicating said fourth end wall opening with said housing opening, a valving element normally closing said duct at the housing end thereof and adapted to open into said housing in response to flow of pressurized air into said duct, a sixth end wall closing the lower end of the outermost of said cylinders, said sixth end wall having a central opening therein, a blower in the lower part of said housing, a duct communicating between said blower and said sixth end wall opening for directing pressurized air from said blower against the underside of said first end wall, said casing having air inlet openings in the upper part thereof for admitting air to said blower through the space between said casing and the outermost of said cylinders, means for conducting heated air from the space between the upper ends of said innermost and said next-to-innermost cylinders to the outside of said casing, and means for conducting combustion gases from the space between the upper portions of said third and next-to-outermost cylinders to the outside of said casing.

7. In a warm air furnace, an elongated, upright, insulated casing closed at top and bottom, a heat exchanger comprising five cylinders mounted vertically one within another in said casing with radial spacing therebetween, a first end wall closing the lower end of the next-to-outermost cylinder, a second end wall joining the lower ends of the innermost and the third of said cylinders, a third end wall joining the upper ends of the next-to-outermost and the third of said cylinders, a partition separating said heat exchanger from the upper portion of said casing and joining the upper ends of the outermost and the next-to-innermost of said cylinders, a fourth end wall closing the upper end of the innermost of said cylinders, a fluid fuel burner mounted in said upper portion of said casing and having a combustion discharge tube extending downwardly into said innermost cylinder through said partition and said fourth end wall, a housing enclosing said burner, said housing having an opening therein, a duct communicating through said partition from said housing opening to the space between said outermost and next-to-innermost cylinders, a fifth end wall closing the lower end of the outermost of said cylinders, said fifth end wall having a central opening therein, a blower in the lower end of said casing, a duct communicating between said blower and said fifth end wall opening for directing pressurized air against the underside of said first end wall, an exhaust duct extending through said partition from the space between the upper ends of the third and the next-to-outermost of said cylinders into said upper portion of said casing, an outlet duct leading from said upper casing portion to outside said casing, said outlet duct having an inlet portion surrounding the outlet end of said exhaust duct to form an aspirator for drawing air from said upper casing portion in response to gas flow through said exhaust and outlet ducts, and means for conducting heated air from the space between the upper ends of said innermost and said next-to-innermost cylinders to the outside of said casing.

8. In a warm air furnace, a heat exchanger comprising five cylinders mounted one within another in radially spaced relation, a first end wall closing the lower end of the next-to-outermost cylinder, a second end wall closing the upper end of the innermost of said cylinders, a fluid fuel burner mounted above said second end wall and having a discharge tube extending downwardly into said innermost cylinder, means cooperating with said cylinders to define a closed path for gaseous combustion products to pass through said heat exchanger, said path extending from inside the innermost of said cylinders into the space between the third and the next-to-outermost of said cylinders and thence laterally outwardly through the outermost of said cylinders, means cooperating with said cylinders to define a second closed path for air being heated to pass through said heat exchanger, said second path extending through said first end wall upwardly into the space between the outermost and the next-to-outermost

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of said cylinders and then downwardly through the space between the third and the next-to-innermost of said cylinders and thence upwardly through the space between the innermost and the next-to-innermost of said cylinders, a housing enclosing said burner, a duct communicating from the space between the upper ends of the outermost and the next-to-innermost of said cylinders and extending into said housing, a third end wall closing the lower end of the outermost of said cylinders, said third end wall having a central opening therein, a blower below said third end wall, a duct communicating between said blower and said third end wall opening for directing pressurized air against the underside of said first end wall, said next-to-outermost and outermost cylinders having aligned openings therein extending from adjacent said first end wall throughout a substantial portion of the lengths of said last-mentioned cylinders, walls defining a cleanout access compartment extending through said last-mentioned openings, a removable access panel secured to said last-mentioned walls and closing said compartment outside said outermost cylinder, and means for conducting heated air from the space between the upper ends of said innermost and said next-to-innermost cylinders to the outside of said casing.

9. A warm air furnace as defined in claim 8 wherein said access panel has an opening therein, and means for relieving excessive pressures comprising a second panel covering said access panel opening, said second panel being held in position over said access panel opening by springs adapted to allow said second panel to uncover said access panel opening in response to excessive pressure in the space between said third and said next-to-outermost cylinders.

10. In a warm air furnace, a heat exchanger comprising five cylinders mounted one within another with radial spacing therebetween, a blower below said heat exchanger, means cooperating with said cylinders to define a path from said blower for air to be heated, said path extend-

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ing from said blower into the space between the outermost and the next-to-outermost of said cylinders and upwardly through said space, and then downwardly through the space between the third and the next-to-innermost of said cylinders, and then upwardly through the space between the innermost and the next-to-innermost of said cylinders and then out of said heat exchanger, an end wall closing the upper end of the innermost of said cylinders, a fluid fuel burner mounted above said end wall and having a discharge tube extending downwardly into said innermost cylinder through said end wall, air supply means communicating with said burner for supplying combustion supporting air to said burner, means cooperating with said cylinders to define a second path for conducting gaseous combustion products away from said burner, said second path extending from said burner downwardly through the space inside said innermost cylinder, and then upwardly through the space between the third and the next-to-outermost of said cylinders, and then out of said heat exchanger.

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