Feb. 1, 1966 C. S. FLYNN 3,232,593

OVEN

Filed Aug. 8, 1963 2 Sheets-Sheet 1

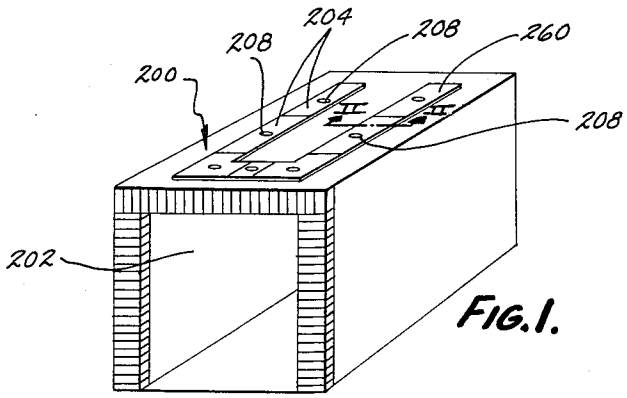


FIG. 1.

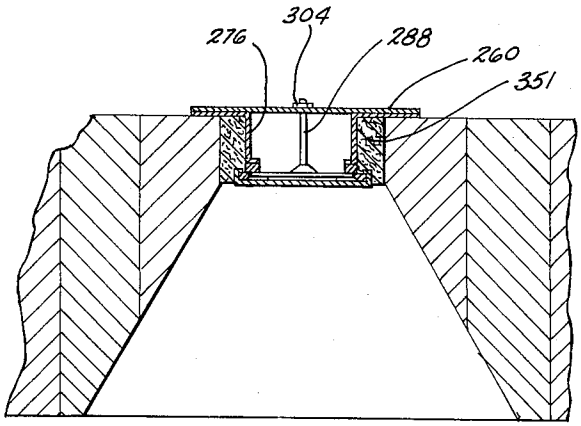


FIG. 2.

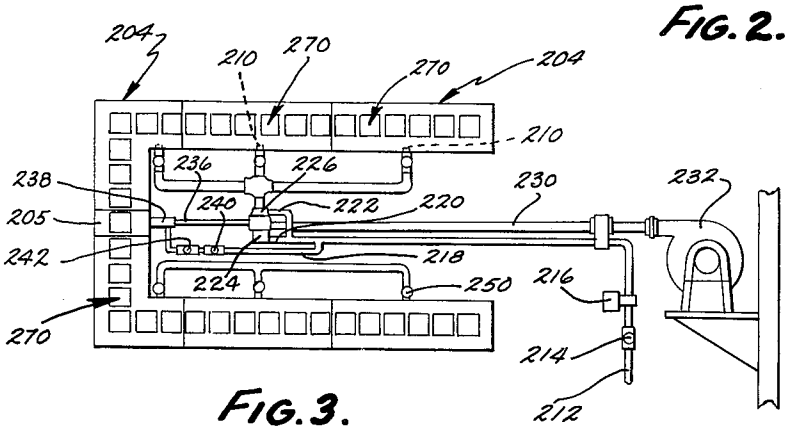


FIG. 3.

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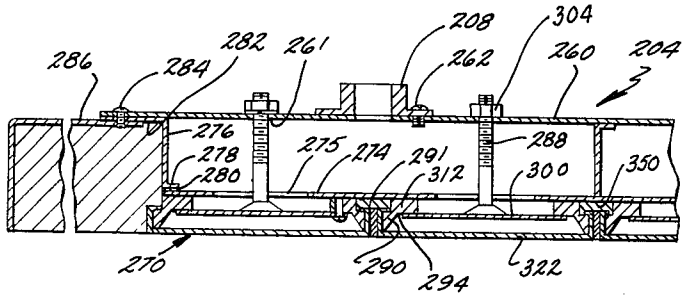


FIG. 4.

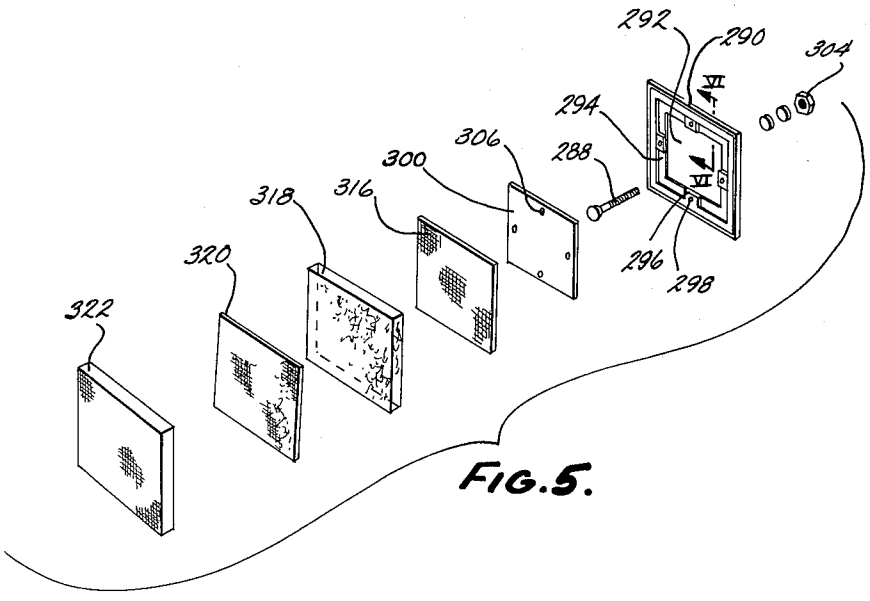


FIG. 5.

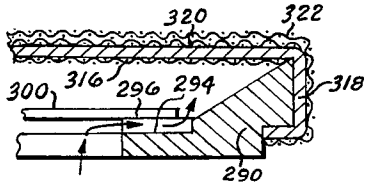


FIG. 6.

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3,232,593

OVEN

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6 Claims. (Cl. 263—43)

This invention relates to ovens and particularly to hot-air ovens employing combustion burners as the source of heat.

Ovens employing combustion burners are conventionally utilized for many purposes such as annealing, heat treating, food baking, enamel hardening, plastics curing, and countless others. Ordinarily, heat is supplied by a large number of spaced, individually mounted, and individually operated burners, usually formed of fused ceramic particles into rigid unitary castables. Each has a special individual manifold, and each is supplied with a gaseous mixture controlled by individual controls from individual sources. The bank of burners is completely enclosed and backed up by several layers of fire brick on all sides of the oven for insulating purposes. This insulating fire brick is absolutely essential, and causes the size of the oven to be five or six times the size of the useful internal chamber to be heated. Even so, the outside of the oven ordinarily radiates considerable heat and is usually too hot to touch with the hand when the inside temperature is several hundred degrees.

The hot surface of the burners is red or white hot, and notoriously contains local hot spots and adjacent cold spots over the wall area. This requires the articles being heated to be kept at a considerable distance from the burners if over-heating of local areas is to be avoided. Even so, localized over-heating and zonal variations are common. Further, portions of the article are often oxidized if operation is at very high temperatures, due to the presence of discontinuous hot flue gases interspersed with oxygen-containing gases in a discontinuous pattern.

Moreover, carriers wheeled into the ovens for placing the articles therein require periodic replacement and repair due to their ruination by the radiant heat and localized hot spots in the oven. This radiant heat also exposes the operator to considerable discomfort and danger when the oven door is open. In open end continuous ovens, the operator is constantly exposed.

Even when operating at optimum conditions, these conventional burners are constantly subject to the condition known as "flash back." This usually occurs if the gaseous pressure on any portion of a burner drops below a minimum safe value for that burner when white hot. The hot burner then supports combustion inside the plenum chamber. The potential explosive capacity is then great, as is commonly known. This is another reason why the individual burners are conventionally completely independent from each other, and why each includes its own gaseous source and control means, since if one flashes back, at least the entire bank of burners will not explode.

Ovens employing these conventional burners require a heat-up period of several hours. For example, an oven having a useful chamber of approximately 3 ft. x 4 ft. x 4 ft. normally requires a heat-up period of about 2 to 4 hours to reach a temperature between 1800° F. and 2000° F. The cooling-off period is usually even greater.

Moreover, when at peak heat, a definite percentage of heat is lost to the exterior of the oven due to the conductance through the fire brick, as is well-known.

It is therefore an object of this invention to provide an oven where an entire wall of the chamber, and if desired, several walls of the chamber comprise a continuous, uniform, burner surface, where each portion provides hot, combustion gases in like manner with the remaining portions of the surface.

It is another object to provide an oven where an entire wall area of burners can be supplied with gases from one manifold, and can be controlled by one control means, such as a common pressure valve. There are no local hot spots. Moreover, when the oven is operating at less than about 1200° F., no radiant heat is generated. In fact, the entire heated interior wall surface is cool and appears black, rather than being cherry red or white. An entire wall area is safely operable while utilizing only one gaseous manifold, without any danger of "flash back." Mixed gases from one source can be safely conducted into a plurality of burner zones and each throttled down as necessary, yet without the slightest danger of back flash or explosion. All areas operate simultaneously, efficiently, effectively, and comparably. No small areas operate at higher temperatures than others to create localized hot spots. No areas operate at reduced pressures to create a danger of explosion. Even if the gaseous pressure does drop to practically zero at any one portion of the burner, or even over the entire wall burner surface, there is no "flash back." This has been proven by deliberate and extensive safety tests conducted while the burner was operated at temperatures of 2000° F. and above, and the gaseous pressure was deliberately slowly or rapidly reduced to zero. Not once has "flash back" been experienced. In fact, the inventor was not able to cause "flash back" with deliberate repeated efforts to do so under extreme conditions. The full burner surface merely extinguishes time after time, even though operated from the common manifold, and controlled by simple throttling valves.

It is another object of this invention to provide an oven capable of operation at temperatures above 2000° F., yet without any need for thick insulating walls of fire brick or the equivalent. It has been found that when the burner surface is generating a continuous blanket of flue gases at temperatures even over 2000° F., the metal back of the burner, only a couple of inches away from the oven chamber, is so cool that one can hold his hand on it without discomfort. The heat loss behind each burner surface, whether on the sides or the top of the oven, is remarkably small. Therefore, no insulation is even needed over the back of any burner. In view of this factor, the over-all size of the oven, for the same operating chamber size as a conventional oven, operating at the same or a higher temperature as the conventional ovens, and actually operating at an improved efficiency, is physically only about ¼ to ⅓ the over-all size of the conventional oven. Moreover, since only one source and one control means is required for a plurality of burner units over the entire wall surface, the over-all space required for the novel oven and accessories is phenomenally small in comparison. Yet, it has been found that the efficiency of gaseous combustion is actually far greater, since, for one reason, there is only a fraction of the heat lost to the outside that was lost before. For another reason, the burner construction actually causes a more efficient combustion of the gases.

It is another object of this invention to provide an oven having a front wall area, and if desired, a rear wall, automatically kept at a relatively low temperature by utilizing the incoming cool combustion gases to reduce the wall temperature, while simultaneously preheating the combustion gases. The flow path also serves in a unique manner to help dissipate the gases uniformly over the burner surface, which is especially helpful during initial ignition of the burner.

It is another object of this invention to provide an oven capable of preheating to very high temperatures in only minutes, for example, about 15 minutes when having a chamber size of about 3 ft. x 4 ft. x 4 ft. The heat-up time is approximately 5% to 10% of that conventionally

required. Further, the cooling-off period requires only a matter of minutes where previously, many hours were required. Therefore, the oven can be shutdown by workmen at the end of the day, and quickly heated up the first thing in the morning when the workmen come on the job. Consequently, it need not be operated all night to be ready in the morning, or started by a watchman or a special workman several hours prior to working hours.

These and several other objects of this invention will be readily apparent upon studying the following specification in conjunction with the drawings in which:

FIG. 1 is a perspective view of a second form of the novel oven;

FIG. 2 is an enlarged sectional view taken on plane VII—VII of the oven in FIG. 1;

FIG. 3 is a plan schematic view of the oven in FIG. 1 showing the gaseous conduit and flow control manifold system;

FIG. 4 is an enlarged sectional view through the burner area in the top of the oven;

FIG. 5 is an enlarged, exploded, perspective view of a second form of the burners, employed in the oven in FIG. 1;

FIG. 6 is a fragmentary enlarged sectional view of a portion of the burner in FIG. 10, as assembled, and generally taken on plane XI—XI.

The term "wall" is used herein to designate an enclosing surface whether it be on top, on the sides, or on the ends. In actual practice, rarely will more than two walls (usually one), have active burner area when using the novel burner construction since the amount of heat output with it is tremendously large.

The particular construction of each burner unit is important to the proper operation as well as the assembly thereof. Each burner includes a generally square or rectangular burner housing formed of sheet metal or cast metal, and defining an internal chamber having the inner side open. The chamber communicates with a gaseous inlet at the rear of the housing. Closing the open side of the chamber is a fibrous, gas-dissipating refractory layer, a coarse support screen, a coarse retention screen, and a fine fiber retention screen. Like the burner unit, each screen is generally square in construction, as is fibrous felt element.

This fibrous felt is a self-supporting layer formed from short refractory fibers, preferably of alumina and silica (e.g., in a 50–50 ratio) and integrated into a body. A small amount of binder may be used if desired, either resinous or ceramic, and ordinarily present in a quantity of 3% by weight. This binder need not be used in many instances, however. The randomly dispersed fibers in the integrated structure are compressed to the desired thickness and density as by rolling. The alumina and silica may be fiberized from a molten material by a steam blast in a conventional manner to produce a fiber which is approximately 3½ microns in diameter and about ½ to 1½ inches in length. These dimensions are variable. The felt is imparted with a stable body and sufficient resistance to gaseous flow to cause uniform gaseous dissipation therethrough. The density of the felt may vary depending upon the thickness used, the fiber diameter, the ratio of substances, and the like. It may range, for example, from about two pounds per cubic feet to about twelve pounds per foot for different applications. The felt body is 1/16 to ½ inch thick, more or less, depending upon factors involved such as the operating pressure, operating temperature desired, velocity of gases, width of the burner, density of the material, area of burner to be covered, and desired rigidity of flexibility of the felt body. The felt must be free from any gaseous leaks or pinholes either around the edge of the felt segment or through the surface. Gaseous leaks are those which enable the gases to flow through in a stream with only slight resistance. If gaseous leaks are present, flame jets or pimples will project from the surface in an undesirable manner. Thus, the presence of leaks can be normally readily ascertained by the presence of these pimples. The felt material has a substantial resistance to gaseous flow therethrough due to the fact that the gas must pass through millions of minute tortuous passages having a diameter in the low micron range. Therefore, the pressurized gaseous mixture is automatically uniformly distributed over the entire back of the fibrous layer.

The gases, when passing through the layer, do so in a finely dispersed uniformly distributed manner in the form of myriads of like, very tiny merging streamlets forming a continuous gaseous mantle of flue gases over the burner surface. Since the entire area supports combustion uniformly, the flue gases merge completely to form a continuous, air-excluding, high-temperature mantle or blanket of gases which may extend from ¼ of an inch to several inches away from the surface of the burner depending upon the pressure of the gases, the volume being burned, the density of the felt, and other related variable controllable factors. The short tiny fibers in the felt are individually flexible, but not shiftable to allow localized excessive gaseous escape. The integral felt body itself is somewhat resilient and flexible in nature. When made very thin it has some characteristics of paper-like materials.

The supporting screen is relatively coarse, self-supporting and quite rigid. A 10 mesh screen (0.025 inch mesh diameter) of steel works excellently although the exact mesh may vary, providing the screen is relatively rigid. The fine screen is a fine mesh material, for example, with a mesh of about 40 (0.010 inch mesh diameter) and is very important for the continued dependable operation of each burner unit. It has been found that the individual fibers tend to blow out of the burner surface under pressure with an extended usage period, unless this fine screen is employed to retain them in position. It has also been found that the fine screen, when heated, tends to bow outwardly away from the burner, thereby becoming ineffective over a large portion of its area to retain the fibers in position, unless supplemented by the additional stiff retention screen. This coarse screen does not bow outwardly under the heat due to its rigidity, and will hold the fine screen against the fibers of the layer. The coarse screen alone has mesh openings slightly too large to prevent fiber blow off. Conceivably, a screen with a stiff, non-bowing characteristic could also have fine openings to achieve both functions. The screens must be of an "open" characteristic so as not to interfere with the continuous combustion over the entire burner surface.

The bottom of the oven may be formed of brick or equivalent as the situation requires.

This assembly enables any individual one of the ensembles to be removed from the oven separately and quickly. Then any individual burner can be removed, if, for example, it happens to be malfunctioning. Replacement can be achieved within a matter of minutes. With conventional ovens, many hours are required to cool the structure down. Then the unit must be removed from the inside of the oven by workmen entering it. With this novel construction, a workman on the outside of the oven may remove a burner unit without ever being exposed to the interior. Cooling down requires only minutes. In fact, it has been found by experience, that a particular burner unit can actually be replaced while the remaining portions of the oven are still in operation. All that needs to be done is that the valve for that particular ensemble be closed off, the ensemble removed, the burner removed, and then the assembly replaced as necessary. There is no danger from throttling down such a valve. Such action would be absolutely impossible with conventional type oven burners due to the extreme danger of explosion and flash back from the hot ceramic burners back into the plenum chamber. This process of shutting off a burner either rapidly and slowly by throt-

tling down the valve has been repeated time and again by the inventor herein, under extreme operating conditions, in efforts to determine the limits of operation before flash back occurs. It has been the experience of the inventor that regardless of the conditions and his positive efforts to create flash back, not one occurrence of such a flash back has been possible with this novel construction. Therefore, the multiple branched lead-in conduit with separate throttling valves is completely practical.

Another important factor is that, with this construction, the expense involved with accessories to provide the gaseous mixture and distribution is only minor compared to prior types. With the prior type oven wherein heat is formed by gaseous combustion, a separate manifold and control is necessary for each and every burner element. This is for safety purposes due to their ever present flash back capacity. However, with this construction not only one burner, but in fact, almost any number of burners is provided with a gaseous mixture from the same manifold mixing equipment and a few control valves for individual ensembles.

It has also been found that with the novel construction, the gaseous pressure applied to the units may be varied over an extremely wide range in contrast to prior type burners where each burner is manufactured for a specific, narrow range of gaseous pressures. For example, it has been found with experimentation that the gaseous pressure may be increased from a couple inches of water pressure right up through 50 or more inches of water pressure without difficulty. The wall burners are also free from thermal-shock weakness. Water can be thrown directly on the hot burner surface without any detrimental results occurring. This is in sharp contrast to the sensitivity of prior type oven walls.

During operation, the inventor has actually increased the temperature of the output from the burner surface area to well over 2000° F. in experiments. When so doing, it is possible for anyone to lay his hand directly on the outer metallic housing behind the burners with no discomfort. Thus, no insulation brick or the like is needed to back up the burners as is usually essential.

In FIGS. 1 through 6, a specific form of the inventive oven is illustrated. This oven **200** may be converted from a conventional gas fired oven, has two side walls, a bottom, a back, and a top, all forming the internal chamber **202**. Mounted in one wall, i.e. the top of the oven as shown, is a plurality of burner ensemble units **204** arranged in a heating pattern resembling a U to make a heating wall in the oven. The burner surface area is therefore a continuous surface along this particular U-shaped configuration. This configuration of the burners employed has been found to supply a tremendous amount of heat at high temperatures, thereby eliminating the necessity for covering the entire wall area with burner surface in many instances. Each of the ensembles **204** includes a gaseous inlet **208** communicating with one branch of the inlet conduit **210** for the particular ensemble.

The gaseous mixture is obtained by introducing the combustible gas through an inlet conduit **212** having a main shut off valve **214** and a safety valve **216**, and having branches **218** to the pilot burner, and **220** and **222** to the gas and air mixers **224** and **226**, respectfully. The air is introduced through a conduit **230** from a blower **232** for entry into the mixers **224** and **226**. Air is also sent through the conduit **236** to the pilot burner mixer **238** for mixing with the gas passing through conduit **218**, shut-off valve **240**, and regulator **242**. After it passes through the small scale mixing tube **238**, it passes into the pilot burner **205** located in the center of the several ensembles **204**.

It will be noted that four of the ensembles in this particular embodiment are linear in configuration, while the two astraddle pilot burner **205** are generally L-shaped. These ensembles may have different configurations.

The mixer **224** supplies the conduits to three of the ensembles through the gas cock valves **250**, while the mixer **226** supplies the other three through like gas cock valves.

Each ensemble **204** includes a main support plate **260** which is generally elongated in configuration to which the inlet **208** for the gas mixture is mounted as by screws **262**. The burners are suspended from this plate inside the oven wall through an accommodating opening. Each ensemble includes a plurality of individual burners, here shown to be six in number. Each of these individual burners **270** is backed up against a mounting and baffle plate **274**. This baffle and mounting plate is in turn supported in a spaced manner from the suspension plate **260**. It is spaced by a peripheral ring **276** having a small flange **278** abutting the plate **274** with a sealer **280** therebetween, and having an outer flange **282**. This outer flange overlaps the peripheral outer edge of the opening into which the ensemble is fitted for attachment by screws **284** to the outer suspension plate **260** and the adjacent wall surface **286** of the oven. Plate **274** is held against these spacers by the attachment of the individual burners **270**, using the elongated bolts **288**.

The construction of each of the individual burners is best illustrated from the exploded view in FIG. 5. The main support of the burner is an insert housing **290** of generally square configuration (in the form shown) and formed of cast aluminum or the equivalent for rigid support. The cast housing ring includes a central opening **292** defined by a peripheral ledge **294**, with four upstanding bosses **296**, each having a protruding nipple **298** for attachment of the baffle plate **300**. The enlarged head of the bolt **288** is welded or otherwise secured to the bottom of plate **300** for extension through this central opening **292**, through the respective suspension plate **260**, for attachment of a nut **304**. Opening **306** may be provided in the baffle plate for receiving the nipples **298**, after which the nipples are peened to hold the baffle in the aluminum housing insert **290**. Referring to FIG. 4, the ledge **294** of the housing insert **290** includes passageway **312** for allowing the gases to flow around the baffle plate **300**. The surface of each burner is formed by the supporting insert screen **316**, the refractory fibers felt dissipator **318**, the fine mesh fiber-compressing and retainer screen **320**, and the coarse mesh retention screen **322**.

As discussed above with respect to the first modification of the burner, the insert screen **316** may have a relatively coarse mesh, i.e. about 10 mesh (0.025 gauge wire). The fibrous felt lining **318** is of the type described with respect to the first modification, and in this form of the invention preferably includes a flat main surface and a peripheral flange protruding downwardly to be coextensive with the cover screen **322**. The fiber retention screen **320** is a relatively fine mesh, for example about 40 mesh, and about 0.010 gauge material, high temperature resistant screen. The main retention screen **322** for the fine screen and the dissipator felt, includes a flat surface area and a peripheral flange which protrudes backwardly transverse to the flat surface area. It is wrapped around a portion of the housing insert **290** and an extending shoulder as illustrated in FIG. 4. This screen is relatively rigid so that when so wrapped and when mounted, it retains the burner in a generally flat surface configuration and secures the dissipator felt in a sealed condition against the peripheral edge of the housing **290**. In the relatively small space between adjacent burners **270** is an insulating material **350** to form an insulating material **350** to form an insulating seal. Actually, these burner edges are so close that the flame propagated is essentially coextensive over the particular surface area configuration formed by the several ensembles.

To assemble one of the ensembles, the six individual burners are first assembled by tack welding bolt **288** to the bottom of plate **300**, inserting the baffle plate **300** within the housing **290**, and preferably tacking it thereto to form the passageway area around the surface of the plate be-

tween the bosses 296, placing the lower screen 316 against the peripheral edge of the housing 290, overlapping the fibrous felt material over the screen and the periphery of the housing, placing the fiber-retention, fine mesh screen over the dissipating felt 318, and then extending the coarse mesh screen 322 over the fine screen 320, the felt 318, the screen 316, and securing its edges around the edge 291 of the housing to hold the several elements in place. Each burner is then placed against the support plate 274, with the bolt 288 extending through the enlarged opening 275 and through an opening 261 and the suspension plate 260. The nut 304 and suitable washers are then attached to clamp the burners tightly against the plate 274, with suitable insulation sealer 350 placed between the individual burners. The outer plate 250 of the ensemble is then attached to the adjacent wall 286 of the oven after insertion of the burners within the opening, as by screws 284. A sealant 351 is inserted between the sides of the burners and the oven.

The conduit connections are then made to the inlets 208 to each ensemble from the gas and air supply mixture system as shown in FIG. 3, and then the pilot burner 205 is connected with its inlet mixture means and conduit in a manner illustrated in FIG. 3. The system is then ready for operation. It will be noted that several burners are operated from the same inlet, and that stop valves 250 are placed on each ensemble since, with this novel construction, gas may be cut off from any ensemble as desired.

If at any time it is desired to replace anay of the individual burners because of malfunction, or for other reasons, screws 284 for the particular ensemble concerned are merely removed, and the ensemble is removed simply and easily as a unit. Then the nut 304 for the particular burner concerned is loosened and the burner is taken off and replaced by another, all in a matter of minutes. The ensemble is then inserted back into the oven, the conduit connection is made, and the apparatus is ready for operation. A replacement such as this can be made in a few minutes as contrasted to the extensive operation required for prior apparatuses.

In brief, the advantages resulting include large internal oven chamber size for the external dimensions, few accessories due to the operation of several ensembles of individual burners from the same manifold, ability to throttle down the burners without back flash, wide variation of gaseous pressures possible, uniform heat distribution over the entire wall area of the oven, incremental expansion absorption, lack of hot spots, lack of infrared heat at the burner surface, ability to remove an entire ensemble and replace an individual burner in a very short time, even while the oven is in operation, inexpensive manufacture of individual burner components, high efficiency of gaseous usage, rapid heat-up time and cooling down time, and other advantages which will readily occur to those in the art upon studying the foregoing form of the invention, and upon adapting it to particular uses. Also, certain obvious structural modifications may be made of the illustrated structure without departing from the principles taught. These obvious modifications are therefore deemed to be part of this invention which is to be limited only by the scope of the appended claims and the reasonably equivalent structure to those defined therein.

I claim:

1. In an oven having a housing formed of side, top, bottom and end walls; at least one of said walls having a substantially continuous burner surface area; said surface area being formed of a plurality of ensembles, each formed of a plurality of burner units; each of said ensembles including a suspension element attached to the oven wall, and a support element spaced from said suspension element to form a plenum chamber; each of said burner units including a housing having a peripheral edge, a fibrous refractory felt gaseous dissipator over the face of the housing, and retention screen means extending over said felt and around said housing edge; and each of said burner units being supported on said support element and secured to said suspension element by elongated releasable tie means.

2. The oven in claim 1 wherein each of said burner housings has a baffle plate retained therein, said tie means is a bolt extending through said suspension plate, and said screen means comprises a fine mesh screen over said felt to retain the fibers in place, and a coarse mesh rigid screen to prevent bowing of said fine mesh screen and felt at high temperatures and under operating pressures.

3. The oven in claim 2 wherein a gaseous inlet manifold supplies said ensembles with each of said ensembles having a separate valved inlet from said manifold, and said manifold having air and combustible gas inlet means and gaseous mixture means.

4. A heating assembly comprising: housing means defining a space to be heated, and having inner wall area adjacent said space; a portion of said wall area having a substantial combustion burner surface capable of creating a continuous blanket of hot gases in said space; a plurality of burner units collectively forming said burner surface; each of said burner units including a peripheral housing having a peripheral edge and an extending shoulder; said housing having an open front and gas inlet means; a layer of fibrous, refractory, gas dissipator and insulating felt extensive over said open front and over said peripheral edge, forming myriads of tiny gas passages; a fine mesh screen over said felt to hold the fibers in place; and a stiff coarse mesh screen extensive over said fine mesh screen and said felt, and crimped around said peripheral edge and shoulder to seal said felt against said edge, secure the felt and fine mesh screen to said housing, and keep said fine mesh screen from bowing away from said felt during operation.

5. A heating assembly comprising: an enclosure having inner surface area, a portion of which is formed of combustion burner surface means; said burner surface means being formed of at least one burner unit; said burner unit having a peripheral metal housing with a gas inlet in the back side, an open front side, and a peripheral edge around said open front side including an undercut shoulder; a support screen in said open side; a layer of fibrous, refractory, gas dissipator and insulating felt on said support screen and extending over said open side and around said shoulder; a fine mesh screen over said felt layer to retain the tiny fibers in place; and a coarse mesh, stiff screen over said fine screen and felt and crimped around said shoulder to hold said stiff screen, fine screen, and felt to said housing, and to prevent bowing of said fine screen when heated; and a baffle plate inside said housing, spaced from said support screen, and leaving gaseous passage means between it and said housing.

6. A heating assembly comprising: housing means defining a space to be heated, and having inner wall area adjacent said space; a portion of said wall area having a substantial combustion burner surface capable of creating a continuous blanket of hot gases in said space; a plurality of burner units collectively forming said burner surface; said units being in edge to edge relation to cooperatively form said continuous blanket; a common manifold in communication with the back of said units; each of said burner units including a peripheral housing having a peripheral edge and an extending shoulder; said housing having an open front and gas inlet means communicating with said manifold; a layer of fibrous, refractory, gas dissipator and insulating felt extensive over said open front and over said peripheral edge, forming myriads of tiny gas passages; a fine mesh screen over said felt to hold the fibers in place; and a stiff coarse mesh screen extensive over said fine mesh screen and said felt, and crimped around said peripheral edge and shoulder to seal said felt against said edge, secure the felt and fine

mesh screen to said housing, and keep said fine mesh screen from bowing away from said felt during operation.

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