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C. S. FLYNN

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GAS BURNER

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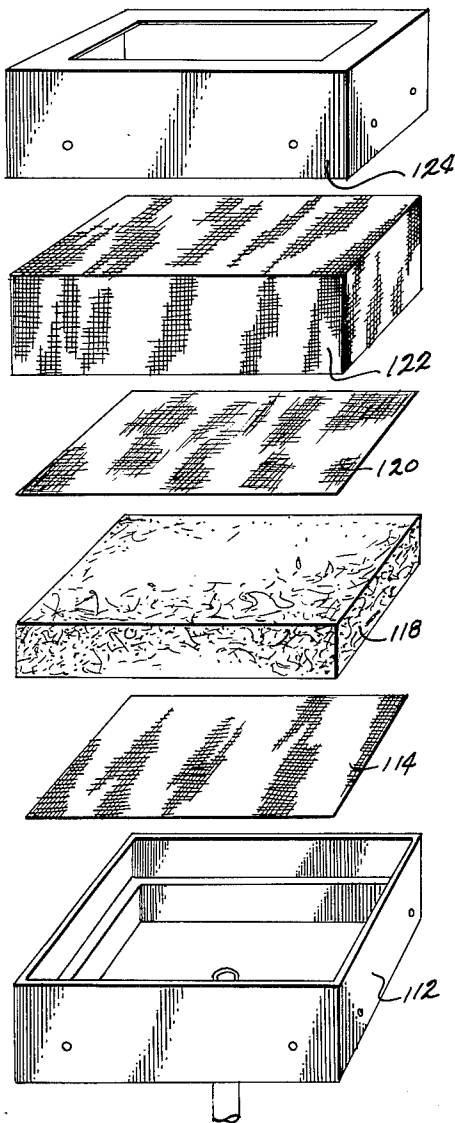


FIG. 1

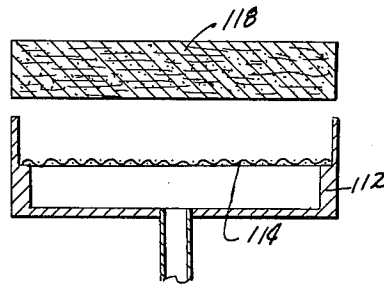


FIG. 2

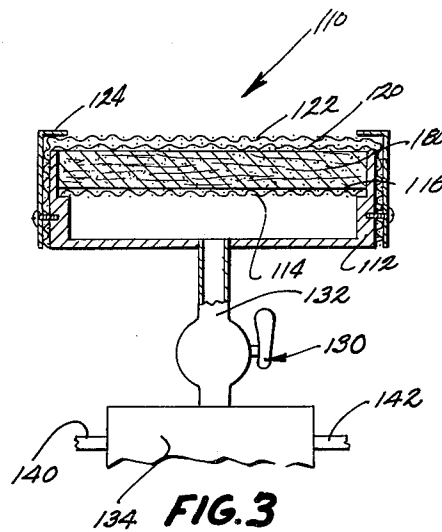


FIG. 3

INVENTOR.
CHARLES S. FLYNN
BY *Price & Hennel*
ATTORNEYS

1

3,199,573

GAS BURNER

Charles S. Flynn, 2991 Sherwood Court,
Muskegon, Mich.

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3 Claims. (Cl. 158—116)

This application is a continuation-in-part application of my application entitled Combustion Burner, filed Jan. 17, 1962, Serial No. 166,790, now abandoned.

This invention relates to pressure combustion burners, and more particularly to a pressure burner providing a surface area of any desirable size and configuration with a uniform, continuous high temperature heat.

One serious limitation of conventional combustion or gas burners is the lack of ready adaptability to special use. The limitations involved with casting a porous ceramic block in unusual configurations and sizes are many. Other constructions than the fused ceramic block have not really gained commercial acceptance due to their unreliability and general inoperativeness. For example, burners with a bed of unfused particles tend to shift about with any appreciable gaseous pressure so that the gases "breakthrough" in large streams. This causes large spurts or jets of flame. Further, the materials must be able to withstand normal operating temperatures of around 2000° F. and higher.

Another limitation with the conventional porous ceramic block burner is the temperature limitation imposed by the heat conductance problems back through the ceramic. Excessive heat conductance toward the mixing chamber causes flash-back if the temperature near the mixture chamber becomes slightly too high. Further, if the pressure drops substantially at any time during operation, flash-back will occur in the ceramic block type as is well-known. Not only must the pressure be maintained above a critical minimum with such burners for flash-back prevention, but conventional ceramic block burners also have a maximum gaseous pressure which is substantially close to the minimum pressure, thereby defining a narrow operating range. Such burners are manufactured either for a high gas pressure application, or for a low gas pressure application, with the operating range being narrow. If low gas pressures occur with a high pressure burner, flash-back occurs. If a high gas pressure is imposed upon a low pressure burner, portions of the burner may actually blow-out due to lack of structural strength for the high flow resistance, and also, the flame will readily "blow-off" (i.e. extinguish) with the high pressure.

It is also of significance that, although the best porous ceramic block burner devised today is somewhat safe from flashback when properly manufactured and when carefully adapted to use within specific operating pressures, it will readily flash-back when operated outside these special preset conditions.

Another serious limitation with respect to conventional burners is the inability to uniformly heat a large area without complex distribution baffles and partitions. Even with such baffles, attempts to create a uniform heat over a large surface area have been only slightly successful. Thus, for example, the concept of providing one burner covering an entire wall area of a drying room and giving uniform heat over the area is regarded as practically impossible with present burner technology due (1) to the

2

tremendous expense of providing proper porous ceramic block of that size, (2) to the uneven heat output from such a burner, (3) to the complex baffling and multiple gaseous inlets required, and (4) to other problems inherent with present burners. Even if a burner with a relatively large surface area were devised, the temperature of operation would be relatively low since pressures behind a large surface area would be critical. Further, a slight drop below the preset minimum in any portion of the burner could cause dangerous flash-back in the entire mixing chamber area.

Another important factor involving burner technology today involves the expanding market in plastics. It is often desired to heat the surface of a plastic sheet or plastic film coating to soften the plastic and enable it to be heat sealed, bonded or the like. Present burners are not capable of accomplishing this at a rapid pace in a safe, reliable manner due to temperature limitations, presence of flames (especially uneven flames over the burner surface) sometimes due to the presence of infrared heat, due to oxidation of the plastic, and other factors. The material obviously cannot safely be passed within fractions of an inch from the burner surface.

Present burners are further not capable of applying intense heat to a local area of an article without heating adjacent article portions by radiation, and conductance.

Further, present burners simply are not readily and inexpensively formable to a variety of configurations—for example in the shape of a horeshore, or with an unusual pattern on the burner surface, or using three walls of a burner housing as the hot surfaces, or in the form of an undulating burner surface, among others. The difficulty, and often the impossibility, of uniform gaseous distribution over the burner surface or surfaces, also prevents such adaptations of burner structures known today. These limitations prevent liberal use of burners to conform closely to unusual article configurations for soldering, pre-weld heating, shell mold curing, heat treating, drying and many others, without overheating any local portions of the article.

It is an object of the invention to provide a pressure-type gas burner capable of providing completely uniform heat over any desired surface, and only in the surface, whether it be a fraction of a square inch or several square feet in area. The surface may further be provided with patterned hot areas and intermediate cool areas if desired. The burner does not need any baffling.

It is another object of this invention to provide a burner providing uniform heat over an entire area of any desired configuration, even if peculiar. The surface may be curved in two or three dimensions, may be undulating, may comprise one, two, three or more walls of a burner housing, may be hemispherical in nature, or any other desired configuration. The burner emits uniform heat over all the surface area of whatever configuration without baffling and without projecting flames.

It is still another object of this invention to provide a burner capable of unusually large ranges of temperature and heat output since operable under unusually large pressure ranges. The structure is capable of operating at very high pressures and flow rates without blow-off, or structural failure. It is also capable of operating at a low pressure without flash-back. In fact it has been found that after repeated experiments and weeks of rugged testing of every sort with the novel structure, it has been im-

possible to cause a flash-back with the burner. No other burner is known that possesses this remarkable characteristic. The burner simply extinguishes when the pressure falls below the low minimum. Other than the high temperature surface, the burner is cool over the remainder of the structure. The back and sides of the structure can even be touched with the hand without discomfort when the hot surface is at a temperature of up to 2000° F. It does not conduct heat more than a small fraction of an inch into the porous element away from the hottest surface due to the unique characteristics thereof.

It is another object of this invention to provide a novel burner capable of carefully controlled operation in a flameless fashion, with or without infrared heat as desired, even at temperatures up to 2000° F. Articles may be passed closely to the burner surface without scorching or danger or disfiguration. The burner is capable of providing a high temperature, continuous, protective mantle of flue gases extending from up to about 1 inch from the burner surface, thereby enabling rapid, protected heating of materials.

Another important object of this invention is to provide a burner having the above attributes and which is also remarkably inexpensive and relatively simple to fabricate.

These and other objects will be apparent upon studying the following specification in conjunction with the drawings in which:

FIG. 1 is a perspective exploded view of an embodiment of the inventive surface burner apparatus;

FIG. 2 is a partial, sectional, elevational view of portions of the combustion burner in FIG. 1; and

FIG. 3 is a sectional side elevational view of the burner assembly in FIGS. 1 and 2.

Basically, the inventive pressure burner comprises a housing pressurized gas and air mixture inlet means in the housing, at least one opening in the wall or top of the housing with a peripheral retaining means, and a layer of fibrous refractory insulating material compressed into a felt-type substance, placed in the housing, retained firmly in position, and sealed over the opening, thereby forming a wall of a pressure chamber therebeneath within said housing. The layer has an integral, self-supporting nature, formed from millions of short fibers (e.g. $\frac{1}{16}$ inch to $\frac{1}{2}$ inch long) of refractory material of minute diameter to provide myriads of passages having a size in the micron range to provide a surface having myriads of adjacent minute interstices in the micron diameter range, i.e. normally invisible to the naked eye. It preferably is composed of refractory fibers of alumina and silica, e.g. 50% alumina and 50% silica fibers having a diameter of a few microns (e.g. $3\frac{1}{2}$). The fibers are randomly dispersed in the layer and integrated by compression of the fibers and adhering them together with a binder of up to approximately 3% by weight. It is compressed (as by rolling) to the desired density, porosity and thickness for the use involved. The density may vary according to the ratio of the materials, the gas pressure utilized, and thickness. The important criterion is the uniform porosity, and consistency without surface defects, and the minute pore size, rather than the density, but since these factors are for all practical purposes extremely difficult to accurately determine and define, the density is given in relation to the dimensions and materials involved. With this information as a basis, the substitution of other equivalent materials can be readily determined by one skilled in the art from this data and the description of the principles of operation given. The thickness may be varied from about $\frac{1}{16}$ inch to about 2 or more inches. The density of silica-alumina mixtures may be varied e.g. about 2 pounds per cubic foot to about 12 or so pounds per cubic foot. The ratio of alumina to silica may be varied and in certain instances only one of these materials need be used. Additional materials of like characteristics could conceivably be

added to a felt of silica, or of alumina, or both. The felt must be completely sealed over the housing opening, and is preferably substantially coextensive therewith. A pressurized combustible gaseous mixture, e.g. a hydrocarbon gas and an oxygen-containing gas such as compressed air is used in the burner. These gases may be mixed prior to injection by any conventional means such as a blower, concentric tubes with adjacent jets, etc. Each of the burner surfaces includes an integral layer of self-supporting, felt-type material formed from short refractory fibers, preferably alumina and silica as in 50-50 ratio. The felt layer includes an outer surface having myriads of adjacent minute interstices in the micron range size, i.e. so small as to be normally invisible to the naked eye. The felt is integrated into a body with a small amount of binder, up to about 3% by weight. The fibers are randomly dispersed. The mixture of fibers with binder is compressed to the proper thickness and density as by rolling.

The binder may be of different types, e.g. ceramic or resinous. The specific binder substance is not critical as long as it does not flow under heat to plug the minute interstices. The fact that a resinous binder, e.g. a phenolic resin such as phenol formaldehyde tends to break down at 400-600° F. does not detract from its usefulness since the felt is subjected to very high temperatures (up to 2000°F.) at only its very outer surface due to its excellent insulating qualities.

The alumina and silica may be fiberized from the molten material by a steam blast in a conventional manner to produce a fiber which is approximately $3\frac{1}{2}$ microns in diameter about $\frac{1}{8}$ to $\frac{1}{2}$ inch in length. The diameter or length may vary providing the resulting felt is imparted with the stable body and gaseous flow characteristics explained hereinafter. As stated, density of the 50-50 alumina-silica felt may vary depending upon the thickness used, the gaseous pressure, the ratio of substances, and the like. Thus, this mixture can range from about two pounds per cubic foot to about twelve or more pounds per cubic foot for different applications. Preferably the resulting felt body is approximately $\frac{1}{2}$ inch thick but this also may be varied, e.g. from $\frac{1}{16}$ to 2 or more inches or so, depending upon the factors involved such as pressure desired, temperature of operation desired, porosity and density of the material, area of the burner to be covered, and rigidity or flexibility of the felt body. A satisfactory material is "Cerafelt," sold by Johns-Manville of Manville, New Jersey.

The felt must be tightly and completely sealed over the housing opening. Any seal leaks around the edge create flame jets which cause the burner to be undependable for many uses. For example, if it is desired to fuse a plastic coating on a paper sheet by passing it close to the burner, flame jets would ignite the paper or plastic and ruin the product.

The felt is cut to be substantially coextensive with the opening forming the burner surface. It has been found that if the felt is larger than the opening i.e. overlaps the edges of the opening, the felt edges should be enclosed or else gases tend to be emitted in larger quantities around the edge of the opening due to less flow resistance to the pressurized gases across the upper corner of the felt. This can thereby, cause a peripheral rim of flame which may project $\frac{1}{4}$ inch or so from the burner surface. This is undesirable for many uses where the article is placed very close to the burner. This feature may not always be objectionable, however.

Within the housing beneath the felt layer is a pressure chamber where the pressurized mixture of combustible gases is introduced. The felt material has a substantial resistance to gaseous flow due to the fact that the gas must pass through myriads of minute tortuous passages having a diameter in the low micron range. Therefore, the pressurized gaseous mixture within the chamber is automatically uniformly distributed over the back of the

fibrous layer without any baffling or partitions being necessary. The gases when passing through the layer do so in a finely dispersed, uniformly distributed manner in the form of myriads of tiny adjacent streamlets at a considerable velocity. If the felt layer is not compressed to cause a high pressure drop, the combustion may occur just prior to the emission of the gases from the outer surface of the layer to effect an extremely high infrared heat. This infrared heat is eliminated completely by compressing the material to create a large pressure drop across the layer. By so doing, only an extremely thin, blue flame can be seen on the surface and only by looking carefully across the burner surface. The pressurized combustion gases or flue gases are emitted at a substantial velocity from the entire surface of the burner and at temperatures of up to 2000° F. or so. Since the entire area supports combustion at each of the minute orifices, the flue gases merge and form a continuous, air excluding, high temperature mantle of gases. The layer of flue gas may vary from ¼ of an inch or so to about 1 inch or more from the surface of the burner.

It is very important in the operation of the novel burner not only that all edges are absolutely sealed, but also that no "pin-holes" of a substantial diameter and depth exist in the surface of the felt. Such pin-holes or surface defects (which are normally visible) cause the creation of a gas jet with a flame being ejected a substantial distance from the surface. This prevents its proper and effective utilization and destroys the uniform heating effect. These can normally be visibly spotted before operation. They are clearly detectable during operation due to the creation of flame pimples or spurts. These pin-holes must be carefully plugged when they occur or preferably, the felt having pin-holes is replaced by one having none. Thus, it is significant that the felt material be uniform throughout, and that the fibers be securely integrated into the layer to be stable in their position when subjected to a substantial pressure in the pressure chamber. If the pressure in the pressure chamber is only that caused by a mixture of atmospheric air with a gas jet, the pressure drop across the felt will entirely prevent flow of any significant amount, and the burner will extinguish. This large pressure drop is important to the burner operation. Therefore, the gases must be pre-mixed, i.e. air or oxygen with fuel gas to form an explosive mixture which is forced in a mixed state into the chamber under pressure.

It has been found that the pressure may be varied over a wide range, relatively speaking, with the burner merely responding with a different heat output and surface temperature rather than reacting undesirably. For example, the pressure on burners has been varied between a pressure equivalent to ½ inch of water per square inch up to 15 and more inches of water per square inch without interrupting the operation of the burner. With a ½ inch thick layer of 50-50 silica-alumina felt having a density of approximately 3 pounds per cubic foot, pressures below ½ inch of water cause the velocity of the gases passing through the refractory felt to decrease to the extent where the burner extinguishes. This minimum pressure varies with different size and density layers. Normally the burner is never operated at such a small pressure, but these figures are given to illustrate the complete lack of any tendency to flash-back under extreme conditions, and to show the great range of potential operating pressures. A valve placed on the gaseous inlet containing the pressurized explosive mixture can be throttled down without a second thought, in sharp contrast to the great danger of throttling a valve on a conventional burner as is known to everyone in the combustion burner field. Even with such low pressures, no flash-back has ever occurred, in fact the inventor has not been able to cause flash-back, try as he might. During normal operation the pressures would ordinarily be very

substantial and considerably above this noted ½ inch. water pressure for efficient operation as a pressure burner, as noted above, but it is of significance to note that even if line pressures on the gaseous mixture should accidentally fall to this low value near the pressure of an atmospheric type burner, the pressure burner will not back-flash like conventional pressure burners. There are probably several cooperative factors preventing flash-back with the novel burner. One reason is due to the excellent insulating quality of the layer due to the minimal conductance through fibers a few microns in diameter, especially when only a fraction of an inch long, and the inability to conduct heat between the fibers having a minimal contact. Also, the chemical nature of the refractory fibers substantially reduces their tendency to conduct heat. Thus, the back part of the layer is always cool no matter what temperature exists at the outer of front surface. Further, since the passages through the felt are tortuous and so minute (i.e. low micron range) and the felt is compacted to a state where gaseous flow back through the layer is impossible without a substantial negative pressure differential reverse hot gaseous flow is never experienced. Moreover the lack of infrared or radiant heat forestalls any possible heat reflectance inside the pressure chamber.

With the novel type construction, a burner may be formed with a patterned hot surface rather than a rectangular area.

Instead of a flat surface, the novel type burner may be formed with curved surfaces.

Not only is the burner unlimited in its possibilities as to unusual configurations, but it also may be made to span a large area of many square feet. When manufacturing the burner for commercial sale, certain structure was discovered which enables the novel burner to be made more quickly, dependably, less expensively, and with a longer life.

One factor which showed up after many days of use was the loss of tiny fibers from the surface of the burner when using coarse screen, e.g. about 10 mesh Inconel (0.025" or so openings) as the covering or retention layers. The gaseous pressure tended to "blow" the fibers out one by one over a long period of time to create a pin-hole type defect in localized areas. This creates visible flame pimples which detract from the burner usefulness. Where fine mesh screen was used to retain the fibrous layer, e.g. 40 mesh (0.010" openings) the fibers did not "blow off" as before, but the fine screen when heated, lacked rigidity and tended to bow outwardly away from the fibrous layer a fraction of an inch. As soon as this occurred, portions of the screen bowed into the very hot gaseous areas just off the burner surface and glowed red to thereby seriously detract from burner quality by creating infrared heat and glowing. Further, when so bowed, it did not return when cooled off. It no longer served to retain the fibers in position.

The structure in FIGS. 1-3 removed both of these weaknesses as well as providing an edge seal to the fibrous layer without the use of adhesives. The assembly 110 comprises the components of the main housing 112 with a gaseous inlet for combustible gas and oxidizing gas, a lower coarse mesh support screen 114 resting on the peripheral housing shoulder 116, a fibrous ceramic layer 118, a compressing, retention, fine mesh screen 120, a rigid, coarse mesh screen 122 covering and retaining the fine mesh screen and if desired, a retention ring 124.

The actual mesh of each screen may vary slightly to suit the density of the ceramic felt layer. Preferred rigid coarse mesh screen material for screens 114 and 122 is about 10 mesh. Preferred fine mesh screen material for screen 120 is about 40 mesh.

The fine screen serves to help compress the fibrous layer and to keep the individual fibers from blowing out. The rigid coarse screen serves to hold all portions of the

fine screen in place to stop any bowing tendency, and also remove the necessity of wrapping the fine screen inside the housing wall 114 as previously done. The coarse screen is wrapped around the outside of housing 112 to eliminate any tendency for it to create leakage problems around the edge of the felt inside the housing. It may be directly retained as by screws, or may be retained by an outer housing ring 124 held to housing 112 by screws or the like.

The felt layer with its burner, is pre-cut to a width and breadth slightly larger than that of the upper rim of housing 112. Each dimension may be about $\frac{1}{16}$ inch larger on a burner of about 3 inches square, for example. Thus the layer is laterally compressed in two dimensions as it is placed in the housing. Also the layer is slightly thicker than the corresponding height of the housing between shoulder 116 and screen 120 on top of the housing. For example, a $\frac{1}{4}$ inch layer may be about $\frac{1}{32}$ inch thicker, i.e. about 10%, so that it is compressed this amount when placed in the housing. It has been found that by compressing the felt in these three dimensions, when the felt fits directly against the walls of the housing without an intermediate screen being therebetween the peripheral area is properly sealed or tightly held to effectively prevent excessive edge leakage under gaseous pressure. Thus even without an adhesive, the burner does not flame up at the edge but rather the entire surface is at a uniform heat without a projecting flame. In operation, the surface burner actually does not even appear to be hot. The front surface is completely black or brown in appearance, no glow is visible, and except for air disturbance visible in the light, no conventional signs of burning are even visible. The hand can be placed with complete confidence on the back of the burner since it is only slightly above room temperature, while in front the burner surface, the temperature can be up to or well over 2000° F., as tested by a Temple stick, for example. This high temperature zone is invisible and extends to an inch or more away from the front surface, depending on gaseous pressure, felt thickness and felt density. A curious fact is that by-standers have to be warned that the area in front of the burner is extremely hot and not to be approached since one is tempted to place a hand adjacent the front since it appears completely cool. As with the other forms of the burner, the inventor has actually been unable to create a "flash-back," even when purposefully trying to do so for test purposes. This factor alone is absolutely unique in the surface combustion burner field, not to mention its many other advantages. Since the danger of flash-back is eliminated a throttling control valve 130 may be inserted directly in the conduit 132 which conducts the explosive gaseous mixture from the mixing manifold 134 to the pressure chamber 115 inside the burner housing. This valve can be controlled with complete ease and without worry that the entire apparatus will explode as previously would have occurred if someone had the audacity to install a valve at this location rather than only on the individual air line 140 and gas line 142 leading into the manifold.

The novel burner has been found to be very rapid in heating and very safe since delicate materials may be placed within fractions of an inch of its surface without damage. It may be used for heating plastic coatings on paper backings, for heating plastic materials per se, for drying paint, heating metal sheets, and many other purposes to which burners are now utilized, and for many other purposes for which gas burners have not been adaptable heretofore.

No catalysts are needed or used in the fibrous layer, nor is any auxiliary igniter system employed to maintain constant combustion, because the pressurized gases, once initially ignited, achieve self-propagating continuous combustion over the surface of the burner without auxiliary means. It is possible that certain obvious modifications may occur to those in the art upon studying the above

specification and the forms of the invention illustrated. Such modifications within the principles taught are deemed to be part of his invention which is to be limited only by the scope of the appended claims and the reasonably equivalent structures thereto.

I claim:

1. A non-glowing pressure-type high temperature combustion burner comprising: a housing; conduit inlet means into said housing adapted to introduce pressurized combustible gaseous mixture; an opening means in the wall of said housing; a relatively coarse metal screen mesh in said housing covering said opening and overlapping the peripheral edge thereof; an integral felt layer of compressible, fibrous, refractory insulating material in said housing substantially coextensive with said opening means, said material being free of any catalyst; said layer having a uniform porosity and a surface of myriads of adjacent minute orifices free from any pin-holes; the fibers of said layer being compacted to an interengaged and integrated state capable of withstanding pressures equivalent to several inches of water per square inch without shifting of said fibers; said felt layer having uniformity of porosity completely therethrough to its outer surface; a sheet of relatively fine mesh screen coextensive with and over said felt layer to retain the individual fibers on the surface of said layer from projecting up and blowing off; a relatively coarse mesh, rigid metal screen wrapped over said fine mesh screen and fastened around portions of the outside of said housing to hold said fine mesh screen in place and prevent it from blowing outwardly under operational heat; and said felt layer fitting into engagement on its periphery against said housing, and being initially slightly larger in diameter than said opening in said housing, to seal against said housing and prevent edge leakage.

2. A non-glow pressure-type combustion burner comprising: a housing; conduit inlet means in said housing adapted to provide a pressurized combustible gaseous mixture; an opening means in the wall of said housing; a mesh in said housing covering said opening and overlapping the peripheral edge thereof; an integral felt layer of fibrous, refractory insulating material in said housing substantially coextensive with said opening means, said material being free of any catalyst; said layer having a uniform porosity and a surface of myriads of adjacent minute orifices free from any pin-holes; the fibers of said layer being compacted to an interengaged and integrated state capable of withstanding pressures equivalent to several inches of water per square inch without shifting of said fibers; a layer of relatively fine mesh screen coextensive with and over said layer to retain the individual fibers on the surface of said layer from blowing off; a relatively coarse mesh, rigid screen wrapped over said fine mesh screen and fastened around the outside of said housing to hold said fine mesh screen in place and prevent it from bowing outwardly under operational heat; and said layer fitting directly into sealed engagement on its periphery with said housing.

3. A non-glow pressure-type combustion burner comprising: a housing assembly forming a chamber and including and inner member and an outer member adjacent the periphery of said inner member; conduit inlet means into said chamber adapted to provide a pressurized combustible gaseous mixture thereto; said inner member having a peripheral edge encompassing an outlet opening in the wall of said housing assembly; a supporting screen mesh in said housing covering said opening; an integral compressible felt layer of fibrous, refractory insulating material over said opening substantially coextensive therewith; said layer having a uniform porosity throughout, being free of catalytic agents, and having a surface of myriads of adjacent minute orifices free from any pin-holes; the fibers of said layer being compacted to an interengaged and integrated state capable of withstanding pressures equivalent to several inches of water

pre square inch without shifting of said fibers; a layer of relatively fine mesh screen coextensive with and over said layer to retain the individual fibers on the surface of said layer from projecting from said surface and from blowing off; a relatively coarse mesh, rigid screen wrapped over said fine mesh screen and fastened around the outside of said inner member to hold layer and said fine mesh screen in place and prevent it from bowing outwardly under operational heat; and said outer member being removably secured to said inner member against the peripheral edge of said coarse screen to secure the entire burner assembly.

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10 JAMES W. WESTHAVER, *Primary Examiner*.MEYER PERLIN, *Examiner*.