July 17, 1928. 1,677,156

S. P. VAUGHN

APPARATUS FOR BURNING EXPLOSIVE GASEOUS MIXTURES

Filed Dec. 23, 1925

Fig - 1

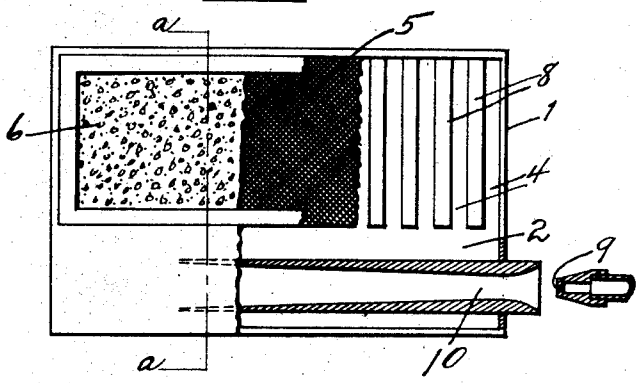


Fig - 2

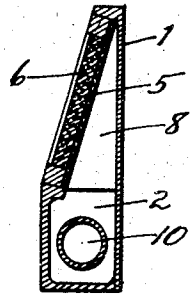


Fig - 3

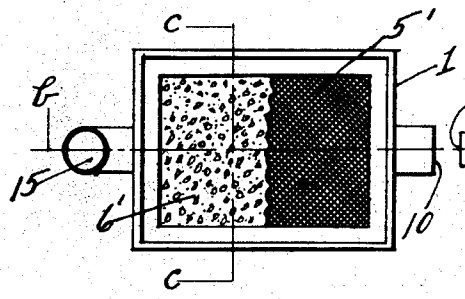


Fig - 4

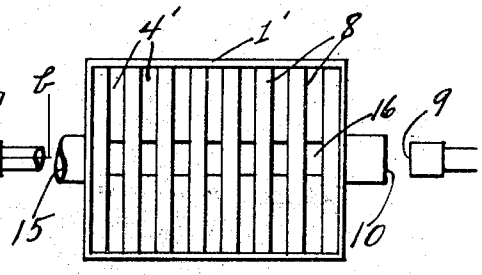


Fig - 5

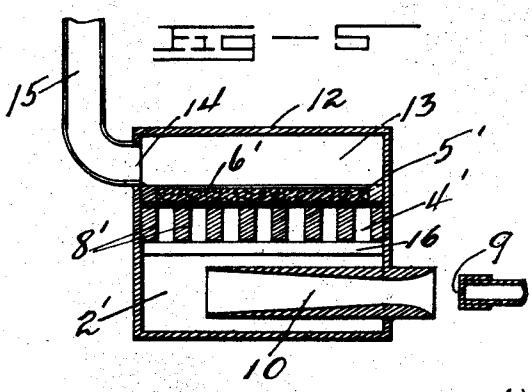
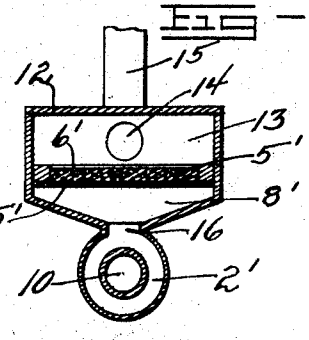


Fig - 6



Sidney P. Vaughan INVENTOR

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UNITED STATES PATENT OFFICE.

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APPARATUS FOR BURNING EXPLOSIVE GASEOUS MIXTURES.

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This invention relates to apparatus for burning explosive gaseous mixtures by which localized and continuous or non-explosive combustion of the mixture is secured. To accomplish such continuous and localized combustion of explosive gaseous mixtures it is necessary to prevent "back flash" or backward propagation of the flame through the advancing mixture toward the source of supply. Back-flash may be prevented either by causing the explosive mixture to flow toward the combustion zone with a velocity greater than the rate of propagation of inflammation, or, when the velocity of the explosive mixture is less than the rate of propagation of inflammation, by interposing a flame interrupting screen between the combustion zone and the source of explosive mixture supply, and maintaining the flame interrupting qualities of such screen. This invention relates particularly to apparatus for burning explosive mixtures under the latter conditions, that is, burning mixtures of combustible gas and air in proper proportions where the gas is supplied under comparatively low pressure, and where the flow velocity of the resulting mixture through the flame interrupting screen is less than the rate of propagation of inflammation.

It will be understood that by the term "explosive gaseous mixture" as used herein is meant a mixture of suitable combustion supporting gas, such as oxygen or air, with combustible matter in a gaseous state or other finely divided state in proper proportions for complete combustion or such that the mixture will have the property of self propagation of inflammation. The mixture may be varied according to the desired character of the products of combustion.

It will be understood also that by the term "flame interrupting screen" as used herein is meant, one or a plurality of flame interrupting passage ways formed in an apparatus for burning explosive gaseous mixtures for the passage of an explosion gaseous mixture from the source of supply to the zone of combustion. The passage ways to be such size that they will have the property of flame interruption when the walls of the passage ways are below the temperature of ignition of the explosive gaseous mixture.

The object of this invention is to provide a low pressure burner or apparatus for burning explosive gaseous mixtures in which back-flashing shall be prevented by means for cooling a flame interrupting screen, forming a part of the burner, to a temperature below the ignition temperature of the mixture. In order to secure a relatively high efficiency it is necessary that a comparatively large number of orifices or supply passages, having dimensions sufficiently small to prevent back-flashing when cool, be provided in the flame interrupting screen, and for this purpose I prefer using a wire mesh with the required number of meshes per square inch as the flame interrupting screen. In burning explosive gaseous mixtures when the gaseous fuel supply issuing from an orifice under low pressure is required to entrain in a mixing tube the air required for combustion the best results are obtained in burning the mixture at a relatively low rate of combustion per square inch area in the flame interrupting screen, for the reason that the greater the aggregate area of the passages in the flame interrupting screen relative to the quantity of fuel burned, the less will be the resistance to the flow of the mixture through the flame interrupting screen. Another advantage in burning explosive gaseous mixtures at a low rate of combustion per square inch area in the flame interrupting screen is that it is very easy to maintain the flame interrupting qualities of the screen due to the large area over which the heat is spread. The preferred means of withdrawing the heat absorbed by the flame interrupting screen, and which is the essence of this invention, is a plurality of heat conducting metal bars or partitions arranged parallel beneath the screen on which the screen rests, and extending from the screen to the back of the burner casing. The metal bars or partitions should be in thermal contact with both the flame interrupting screen and the back of the casing and of such heat conducting capacity that the screen will be kept at the required temperature to maintain its flame interrupting properties. The heat absorbed and conducted by the metal bars or partitions will be dissipated through the back of casing into the surrounding air.

Another object is to reduce the resistance to flow of the explosive gaseous mixture in passing from the mixture chamber to the

place of combustion to a minimum with a resulting reduction in the pressure required in the mixture chamber. I accomplish this by forming the flame interrupting screen of the burner of wire mesh as stated above, and by spacing the heat conducting bars or partitions, provided to maintain the flame interrupting properties of the screen, in such a manner and such distance apart that they form comparatively large passage ways for the passage of the explosive mixture from the mixing chamber to the flame interrupting screen. In no way is it intended that the passage ways so formed between the heat conducting bars or partitions be flame interrupting passage ways, but rather the opposite and so spaced that they offer little resistance to the flow of the mixture.

Another object is to provide a burner for converting the heat of combustion into radiant energy and for this purpose I place on the exit side of the flame interrupting screen a thin porous and permeable refractory combustion bed in loose or bonded form and having intercommunicating passage ways formed therein for the passage of the explosive gaseous mixture to the zone of combustion. Combustion of the mixture will be localized on the exit side of the refractory bed or in the refractory bed, depending upon the rate of combustion, and the heat of combustion will cause the refractory bed to become highly incandescent and radiate heat. In burners where a very low rate of combustion and a maximum radiating efficiency are desired a perforate screen or diaphragm may be provided in lieu of the refractory bed and placed a short distance beyond the outlet side of the flame interrupting screen to become heated to incandescence by the highly heated products of combustion.

Another object is to provide a simple means for obtaining the quantity of air required for high rates of combustion when using gaseous fuels at low pressures and when a large jet volume of such gaseous fuel would not ordinarily entrain a sufficient amount of air in the Venturi or mixing tube for complete combustion in a refractory bed such as described above. I attain this object by completely enclosing the refractory combustion bed and forming a chamber above it with an opening connected with a chimney or pipe which creates a draft through the refractory combustion bed and draws in the required amount of air for complete combustion through the Venturi or mixing tube.

Another object is to keep the explosive gaseous mixture as cool as possible while being mixed in the mixture chamber and while flowing to the place of combustion, especially in apparatus where a jet of gaseous fuel entrains the proper proportions of air in a Venturi or mixing tube. A change in the temperature of the mixture in the mixture chamber will cause a change in the quantity of air entrained by the fuel jet entering the Venturi or mixing tube, which is not desirable where a perfect combustion is required. By keeping the mixture at a uniform temperature a uniform pressure is maintained in the mixture chamber which makes it possible to keep the proportions of air entrained uniform without requiring further adjustment of an air register after it is once set for a predetermined mixture. A cool mixture assists in keeping the flame interrupting screen at a temperature low enough to maintain its flame interrupting properties which prevents back-flash. To accomplish this I keep the mixture chamber as far as possible from the zone of combustion and cause the mixture to flow from the mixture chamber to zone of combustion as quickly as the pressure used will allow. In such an apparatus as described herein the walls of the mixture chamber should be made very thin and have a very small heat conducting capacity which will result in very little heat being transmitted to the mixture in the mixture chamber.

I attain the above objects in the manner described herein and as illustrated in the accompanying drawings showing two forms of the apparatus made in accordance with the present invention. In said drawings like numerals refer to like parts throughout the several views, and:

Fig. 1 is a front view of one form of burner formed as a radiator of heat for household use and cut away in sections to show the general arrangement.

Fig. 2 is a sectional view on line *a—a* Fig. 1.

Fig. 3 is a plan view of another form of burner with the top removed and cut away in sections.

Fig. 4 is a plan view of the burner shown in Fig. 3 with the top, refractory bed, and flame interrupting screen removed to show the general arrangement of the heat conducting bars or partitions provided to maintain the flame interrupting properties of the screen.

Fig. 5 is a vertical sectional view on the line *b—b* of the view shown in Fig. 3.

Fig. 6 is a vertical sectional view on line *c—c* of the view shown in Fig. 3.

In Fig. 1 I show a form of apparatus particularly adaptable for use as a radiator of heat for household use, but which may be used for many other purposes with slight modification in design. It comprises a metal body or casing 1 formed to provide a burner in the front of the upper part of the casing and a gas mixture chamber 2 in the lower part of the casing. The form of burner used comprises a flame interrupting screen 5 made of a metal wire mesh and a porous and

permeable refractory combustion bed 6, in loose or bonded form, placed on the exit side of the flame interrupting screen, in which the explosive gaseous mixture burns and raises the refractory to an incandescent state. The flame interrupting screen 5 is kept at the proper temperature to maintain its flame interrupting properties by a series of heat conducting bars or partitions 8, having the necessary heat conducting capacity, extending from the screen to the back of the casing and in thermal contact with both so that the heat may be conducted from the screen 5 to the back of the casing 1 through which it is dissipated into the surrounding air. The heat conducting metal bars or partitions are spaced parallel and form a series of passages 4 connecting the gas mixing chamber 2 with the passages in the flame interrupting screen 5 through which the explosive gaseous mixture passes to zone of combustion. To reduce the quantity of heat conducting metal required in the bars or partitions 8 to a minimum they are formed in the shape of a triangle or right triangle with the base end extending to the mixing chamber 2 and forming the entrance to the passages 4. One edge of the bar is kept in thermal contact with the back of the casing 1, and the other edge of the bar forms the exit of the passages 4 and is kept in thermal contact with the flame interrupting screen 5. In such construction the cross sectional area of the passages 4 formed by the parallel heat conducting bars or partitions 8 gradually decreases from the mixture chamber toward the outer end of the bars or partitions. The ratio of the entrance area of the passages 4 to that of the discharge or exit area should be such that the entrance to the passages will not in any sense be so constricted as to cause any undue resistance to the flow of the explosive gaseous mixture through the passages. In practice I have found that passages formed by iron heat conducting bars or partitions $\frac{1}{8}''$ thick and spaced $\frac{1}{8}''$ apart and having a discharge area about twice the entrance area give very satisfactory results as to low resistance to flow of the mixture, and heat dissipation by the bars when gaseous fuel such as city gas under low pressures is used. If a gaseous fuel under relatively high pressures is used the entrance area to the passages may be reduced with a consequent reduction in the amount of metal used in the heat conducting bars or partitions. The heat conducting bars or partitions may be moulded as an integral part of the casing 1 or they may be assembled separately as a unit and placed in position in the casing.

In the particular form of apparatus shown in the drawings the explosive gaseous mixture is obtained by injecting a fuel in a gaseous or vapor state, such as ordinary city gas or vaporized gasoline, through a gas orifice 9 into a Venturi or mixing tube 10 where it entrains air in sufficient quantity to form an explosive mixture. The resulting mixture enters the mixture chamber 2 and flows to the zone of combustion through the passage ways 4, formed by the heat conducting bars or partitions 8, and the passages formed in the flame interrupting screen 5. I have found it advisable to keep the mixture chamber 2 as far away from the zone of combustion as structural features permit so that the walls of the mixture chamber will be kept cool. If the walls of the mixture chamber 2 become heated by conductance or radiation of heat from the zone of combustion, the gaseous mixture becomes heated, expands, and causes a variation in the amount of air entrained by the gaseous fuel, which is not desirable as explained heretofore.

In Figs. 3, 4, 5, and 6, I show different views of another form of apparatus embodying the principles of this invention in which the burner is horizontal instead of vertical as shown in Fig. 1. In such an apparatus the casing 1 may be considered as formed into two sections, the upper section forming the burner chamber 13 and the lower section forming the mixture chamber 2′, with a constricted passage 16 connecting the two chambers. In such a construction the mixture chamber is placed beneath the burner chamber and the walls of the mixture chamber should be of such thickness as to have a very small heat conducting capacity so that little if any heat is transmitted from the burner to the gaseous mixture in the mixture chamber. In the burner chamber formed by the upper part of the casing is a multiplicity of heat conducting bars or partitions 8′ spaced crosswise the passage 16 connecting the mixture chamber with the burner chamber and in thermal contact with the side walls and the bottom of the burner chamber. A flame interrupting screen 5′, made preferably of wire mesh or perforate screen with openings therein of such cross sectional dimensions as to have the property of flame interruption when kept below the ignition temperature of the explosive mixture, is placed on top of and in thermal contact with the heat conducting bars or partitions 8′ and forms the burner proper of the apparatus. The heat conducting bars or partitions 8′ should be of such dimensions as to have the necessary heat conducting capacity to keep the flame interrupting screen at a temperature below the ignition temperature of the explosive gaseous mixture, and should be of such shape and so spaced as shown that they form a multiplicity of non-flame interrupting passage ways 4′ with a horizontal cross sectional area that rapidly increases from bottom to top for the passage of the explosive mixture from the mixture chamber 2′ to the

openings in the flame interrupting screen 5'. The flame interrupting screen 5' supports a porous and permeable refractory combustion bed 6' in loose or bonded form in which or on the top surface of which combustion of the explosive gaseous mixture takes place and raises the refractory to an incandescent state for the radiation of heat. When an injector is used in this type of burner for supplying the explosive gaseous mixture and the gas pressure is low, it may be desirable to burn the mixture at a higher rate of combustion than would be possible when depending entirely upon the injector to supply the required amount of air for complete combustion. To meet such a condition without using mechanical appliances to supply the necessary air for combustion, the casing 1' is extended above the refractory bed 6' and provided with a top 12 which forms a closed chamber 13 above the refractory bed. The chamber 13 is provided with an outlet 14 connected to a pipe or chimney 15 extending upwardly the required distance to create a draught through the refractory combustion bed when combustion takes place. The draught results in a greater quantity of air being entrained by the gaseous fuel jet in the injector, which makes it possible to burn a relatively large quantity of fuel. The radiant heat thrown off by the combustion bed is transmitted to the top plate 12 for use for any desired purpose.

While I have shown only two forms of apparatus embodying the principles of this invention it will be understood that many other forms may be constructed without departing from or exceeding the spirit of my claims.

What I claim is:

1. In apparatus for burning explosive gaseous mixtures, the combination with a porous and permeable bed of refractory material, of a series of heat-conducting elements in thermal relation with the back of said bed for conducting away therefrom such excess heat as would cause back flash in the mixture supplied to the bed, the passage between said elements being sufficiently free and open to prevent said passage from serving as flame-interrupting passages, and a mixture supply chamber enclosing said elements.

2. In apparatus for burning explosive gaseous mixtures, the combination with a porous and permeable bed of refractory material, of a plurality of spaced partitions in heat-absorbing relation with respect to said bed for conducting away from the back, thereof, such excess heat as would cause back flash in the mixture supplied thereto, the passage between said partitions being sufficiently free and open to prevent said passage from serving as flame-interrupting passages, and a mixture supply chamber enclosing said partitions.

3. In apparatus for burning explosive gaseous mixtures, the combination with a porous and permeable bed of refractory material, of a series of heat-conducting elements in thermal relation with the back of said bed for conducting away, therefrom, such excess heat as would cause back flash in the mixture supplied to the bed and a mixture supply chamber enclosing said elements, the passage between said elements being sufficiently free and open to prevent said passages from serving as flame-interrupting passages, said elements being in thermal contact with at least one of the chamber walls, whereby the heat absorbed by said elements may be dissipated through said wall or walls.

4. In apparatus for burning explosive gaseous mixtures, the combination of a foraminous flame-interrupting screen having relatively short flow passages therethrough, a gaseous-mixture supply chamber opening directly on said screen, a porous and permeable combustion bed of refractory material positioned adjacent the outer face of said screen, and a plurality of spaced heat-conducting elements within the chamber and in thermal contact with said screen, said elements being spaced sufficiently far apart to prevent the passages therebetween from serving as flame-interrupting passages.

5. In apparatus for burning explosive gaseous mixtures, a casing, a supply chamber within said casing for supplying the explosive gaseous mixture, a zone of combustion separated from the source of supply of the explosive gaseous mixture by a screen having flame interrupting passage ways formed therein for the passage of the mixture to the zone of combustion, spaced heat conducting partitions within said casing in thermal contact with the screen and the casing, and non-flame interrupting passage ways between the spaced heat conducting partitions for the passage of the explosive mixture from the supply chamber to the flame interrupting passage ways formed in the screen.

6. In apparatus for burning explosive gaseous mixtures, a casing, a supply chamber within said casing, heat conducting partitions in contact with said casing and forming non-flame interrupting passages for the gaseous mixture, and a flame interrupting screen in thermal contact with said partitions.

7. In an apparatus for burning explosive gaseous mixtures, a casing, a supply chamber within said casing, a flame interrupting screen separating the supply chamber from the zone of combustion, spaced

heat conducting elements in thermal contact with said casing and said flame interrupting screen, and spaced to form non-flame interrupting passage ways for the passage of the explosive gaseous mixture from the supply chamber to the passage ways in the flame interrupting screen.

8. In an apparatus for burning gaseous mixtures, a casing, a gaseous mixture supply chamber within said casing, a flame interrupting screen having relatively short flow passages therethrough and separating the said supply chamber from the zone of combustion, and non-flame interrupting passage ways for the passage of the gaseous mixture from the supply chamber to the passage ways in the flame interrupting screen, said non-flame interrupting passage ways being formed by heat conducting elements in thermal contact with said casing and said flame interrupting screen and of sufficient heat conducting capacity to conduct the heat away from the flame interrupting screen and maintain its flame interrupting properties.

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