June 17, 1958 E. J. SCHWEITZER ET AL 2,839,128

BURNER

Filed March 25, 1953 2 Sheets-Sheet 1

FIG. 1

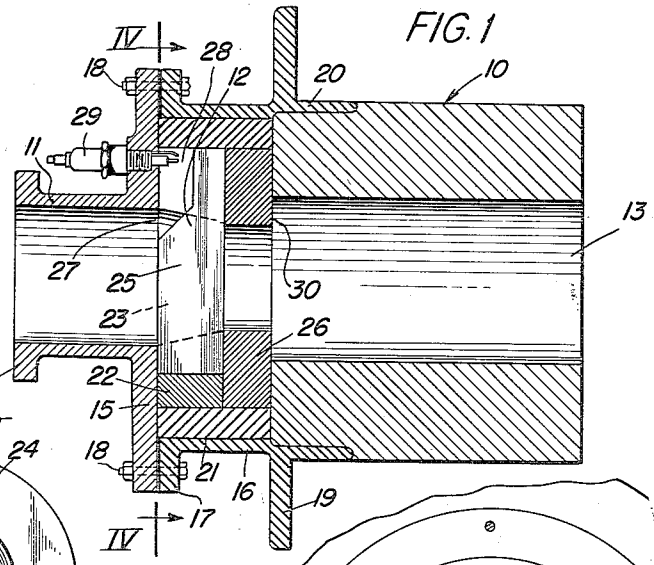


FIG. 3

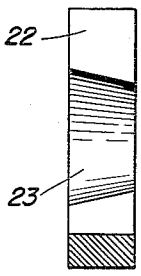


FIG. 2

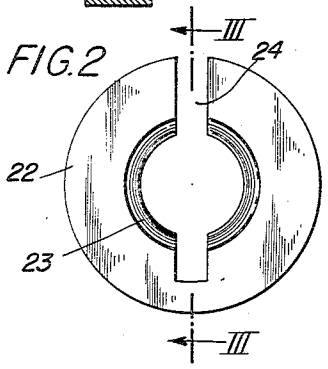


FIG. 4

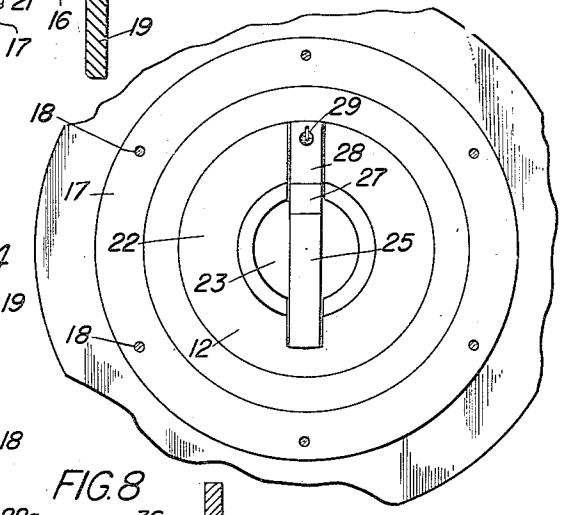


FIG. 7

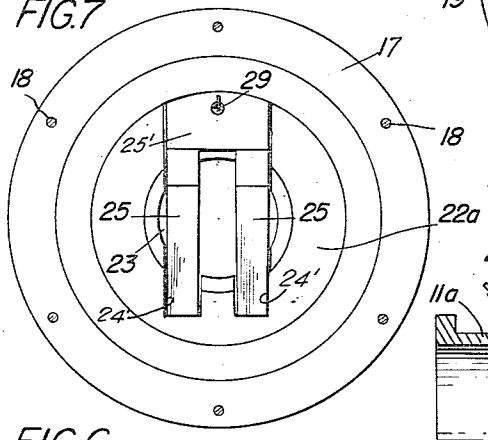


FIG. 8

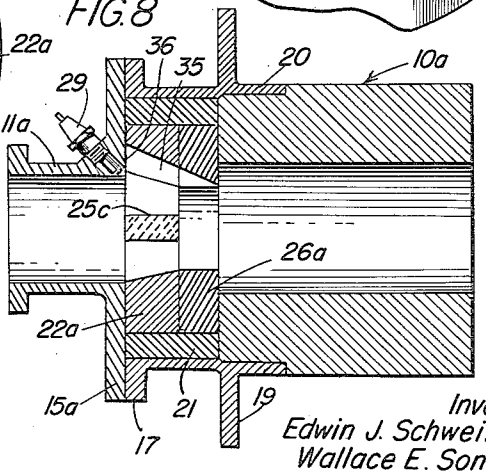


FIG. 6

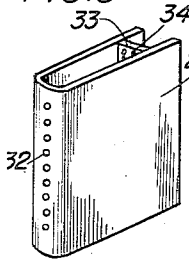
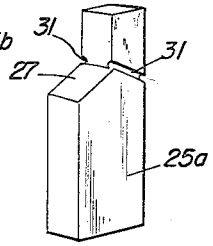


FIG. 5



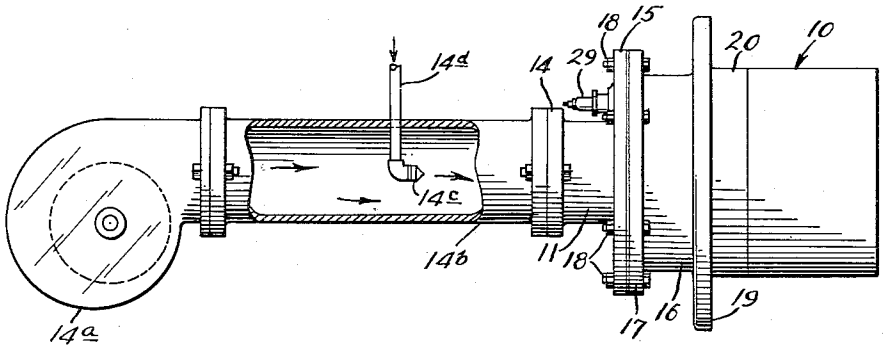
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BURNER

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FIG. 9.



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2,839,128

BURNER

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Application March 25, 1953, Serial No. 344,512

2 Claims. (Cl. 158—7)

This invention relates to a burner, and more particularly a burner for receiving a combustible mixture of fuel and air moving at high velocity and burning the mixture at a maximum rate of heat release and in a minimum space. The invention is especially useful in its application to the combustion of gas as a fuel, to which use, however it is not restricted.

In the co-pending patent application of John A. Johnson, Serial No. 209,293, filed February 3, 1951 for Burner, now Patent No. 2,701,608, granted Feb. 8, 1955 there is disclosed a burner in which fuel and air are mixed and preheated in a mixing section and burned in a combustion section. An abrupt enlargement of the burner at the entrance of the mixing section into the combustion section provides a peripheral shoulder which protects a portion of the fuel-air mixture within the combustion section against turbulence caused by the rapid movement of the mixture into the combustion section. This shoulder provides an open flame holder where the flame is continuously maintained within the combustion chamber and from which area combustion progresses inwardly toward the center of the stream of fuel-air mixture to cause combustion of the entire fuel-air stream within the combustion chamber.

An important feature of the invention disclosed in this copending patent application is the fact that it makes possible rapid combustion with high heat release in a combustion chamber of minimum size. However, when burning large quantities of fuel and with fuel-air mixture velocities of great magnitude the progress of ignition inwardly from the flame holder may require such time that an unduly long combustion chamber becomes necessary if combustion is to be completed within the combustion chamber.

We have now found that it is possible to increase the rate of complete combustion of the fuel-air mixture column by very simple means, while maintaining the advantages of the open peripheral flame holder of the aforesaid Johnson patent application. Thus, the length of the combustion chamber may be made shorter than would otherwise be necessary. To this end the present invention contemplates addition to the apparatus of an ignition chamber disposed between the fuel-air mixture supply section and the combustion chamber, together with means in the ignition chamber having a surface facing downstream of the burner centrally of the stream of fuel-air mixture which protects a portion of the fuel-air mixture adjacent said downstream surface against turbulence caused by the rapid movement of the mixture into the combustion chamber and provides, as in the case of the peripheral shoulder, a flame holding surface facing downstream of the burner for continuously maintaining an open flame adjacent to said surface for igniting substantially centrally the column of fuel-air mixture passing therethrough. Such central ignition of the fuel-air mixture stream caused by the above-mentioned flame holding surface, added to the peripheral ignition effected by the peripheral flame holding shoulder within the combustion

section, causes more rapid complete combustion of the mixture and therefore makes possible a smaller burner than would otherwise be required for a given rate of heat release.

The invention is shown by way of illustration in the accompanying drawings in which:

Fig. 1 is a longitudinal mid-section through a burner constructed and arranged according to the invention;

Fig. 2 is an end view of a container ring for use within the ignition section of the burner illustrated in Fig. 1;

Fig. 3 is a cross-section taken on the line III—III of Fig. 2;

Fig. 4 is a broken cross-section taken on the line IV—IV of Fig. 1;

Fig. 5 is a perspective view of an igniter block or central flame holder generally similar to that shown in Fig. 1;

Fig. 6 is a perspective view of another type of central flame holder;

Fig. 7 is a view similar to that shown in Fig. 4 illustrating an alternative arrangement of central flame holders within the ignition chamber shown in Fig. 1;

Fig. 8 is a longitudinal mid-section, similar to that illustrated in Fig. 1, illustrating a different initial ignition arrangement and a different position of central flame holder; and

Fig. 9 is a side elevational view partially in section of the apparatus of the present invention.

In the embodiment of the invention illustrated in Figs. 1 to 4, there is shown a burner **10** comprising in sequence a fuel-air mixture supply section **11**, an ignition chamber **12** and a combustion chamber **13**. Thus a combustible mixture of the fuel and air enters the burner **10** through its supply section **11**, passes thence through its ignition chamber **12** where it is initially ignited, and thence enters the combustion section **13** of the burner where its combustion is completed.

The supply section **11** is formed as a flanged tube, here a cylindrical tube having an anterior flange **14** for connection with a fuel-air mixture delivery conduit and a larger posterior flange **15** for connection with the ignition chamber **12**. Air is supplied to the supply section at a high velocity, for example, by means of a blower **14***a* as illustrated in Fig. 9 which is interconnected with the entrance to the supply section through a duct **14***b*. The fuel may be supplied in any desired manner; for example, the fuel may be injected into the air supply to form the fuel-air mixture by means of an injection nozzle **14***c* supplied by a pipe **14***d* through which the fuel passes under pressure.

The ignition chamber **12** is of generally cylindrical shape and comprises an outer flanged member **16** having a forward outwardly turned flange **17** which is connected to the posterior flange **15** of the supply section **11**, as by bolts **18**. At the opposite end of the member **16**, there is formed a rear outwardly turned flange **19** by which the entire burner **10** may be fixed in operative position, as to a furnace wall (not shown). Beyond the rear outwardly turned flange **19** a cylindrical rear extension **20** of the outer flanged member **16** extends co-axially with the member **16** for supporting the combustion chamber **13**, to which it is joined, as by welding, cementing or other fixing means.

Within the outer flanged member **16** a ring **21** is closely positioned in order to provide a proper fit between the member and certain parts within the ignition chamber, and also to insulate and strengthen the construction. Inside of the ring **21** a container ring **22** is fitted for a purpose which will presently appear. The container ring has a conical central opening **23** therein, the base of which is of the same diameter as the internal diameter

of the supply section 11. The container ring is radially slotted, as at 24, from its periphery, through the conical opening 23 and partly through the opposite portion thereof. See Fig. 2. The container ring 22 fits closely inside of the ring 21 where it is held from turning by friction with the latter ring, preferably with the slot 24 extending vertically.

The container ring 22 serves to hold in place an igniter block or central flame holder 25 extending diametrically across the stream of fuel-air mixture which protects a portion of the fuel-air mixture adjacent thereto and creates adjacent the downstream surface of the central flame holder a generally quiescent zone of burning fuel-air mixture. See Figs. 1 and 4. The central flame holder may take different forms, depending upon the nature and condition of the fuel-air mixture which enters the burner 10 through the supply section 11. In the embodiment illustrated in Figs. 1 and 4 the central flame holder is formed of refractory material, for example a ceramic material, and is of solid construction. Fig. 5 shows, in perspective, a modified form of such central flame holder, indicating further its general construction. The central flame holder 25 has a length equal to the distance between the periphery of the container ring 22 and the bottom of the slot 24 in which it is held in position; and its breadth is such that it fits snugly within the slot. The remaining dimension of the central flame holder is such that its front end bears against the inner flange of the supply section 11 where the central flame holder fits into the bottom of the slot 24, and the opposite base of the central flame holder bears against a terminal ring 26 of the ignition chamber, later to be described.

The forward part of the upper end of the central flame holder is cut away as at 27 to provide an initial ignition space 28 between the upper part of the slot 24, the ring 21 and the inner flange 15 of the supply section. The cut-away portion 27 of the central flame holder 25 is sufficiently deep to permit communication between the initial ignition space 28 and the supply section 11. A spark plug 29 projects through the inner flange 15 of the supply section into the initial ignition space 28 in order to ignite the fuel-air mixture in the ignition chamber when operation of the burner 10 is started. It will be recognized, however, that the initial ignition space 28 is relatively protected and that the force of the on-rushing combustible mixture will not blow out the flame therein. The fuel-air mixture passing from the supply section 11 into the ignition chamber 12 is thus ignited when the burner 10 is put into operation.

The terminal ring 26 is a somewhat flat ring which is positioned rearwardly in the ignition chamber 12, being held in place by friction between its peripheral surface and the inner surface of the ring 21. Upon the forward face of the terminal ring 26 the rear surface of the central flame holder 25 and the rear surface of the container ring 22 bear in frictional contact. The rear face of the terminal ring 26 is in frictional contact with the forward surface of the combustion chamber wall, as will later be explained. The central opening through the terminal ring 26 is cylindrical in form and coincides in diameter with that of the conical opening 23 of the container ring 22 when the two rings are in position. See Fig. 1. It will be evident that the central opening through the terminal ring 26 forms a connecting passage between the ignition chamber 12 and the combustion chamber 13.

The combustion chamber 13 is held firmly in place against the ignition chamber 12 by the cylindrical rear extension 20 of the outer flanged member 16. The forward end of the combustion chamber bears upon the rear surfaces of the ring 21 and the terminal ring 26, thus making a tight joint between the ignition chamber and the combustion chamber. It is to be noted that the interior cross-section of the combustion chamber 13 is greater than the opening through the terminal ring 26 thereby providing a flame holding shoulder 30 within the combustion chamber immediately surrounding the opening in the terminal ring 26. Accordingly, the shoulder 30 provides a peripheral pocket of ignited mixture which is protected from the turbulence caused by entrance of the fuel-air mixture into the combustion chamber.

From the foregoing, operation of the apparatus will be easily understood. A combustible mixture of fuel and air is projected into the supply section 11 of the burner at high velocity. The fuel-air mixture passes thence into the ignition chamber which it fills, including the relatively protected initial ignition space 28. Thence the fuel-air mixture, passing through the conical opening 23 in the container ring 22 and through the opening in the terminal ring 26, enters the combustion chamber 13. To start operation of the burner the spark plug 29 first ignites the combustible fuel-air mixture in the initial ignition space 28, whence ignition passes to the downstream end of the supply section 11 and thence through the conical opening 23 past the central flame holder 25. As the ignited fuel-air mixture passes the central flame holder 25 some of this burning mixture remains behind the trailing face of the central flame holder 25 where it continues to burn and continues to ignite transversely and centrally the column of fuel-air mixture passing the central flame holder. Thereupon, the spark plug need no longer be used.

It has been found that a very thin trailing face of central flame holder will afford sufficient protection to a ribbon of burning fuel-air mixture to maintain the latter in a semiquiescent state at that point. This burning ribbon of fuel-air mixture continuously augmented by increments from the fuel-air mixture passing on either side of the central flame holder, acts to provide central ignition of the stream of fuel-air mixture during the entire operation of the burner.

At the same time a flame is held immediately behind the shoulder 30 formed within the combustion chamber by the difference in cross-sectional area between the combustion chamber and the terminal ring 26. The peripheral flame holding surface formed by the shoulder 30 creates circumferentially of the high velocity stream of fuel-air mixture entering the combustion chamber a substantially quiescent zone of burning fuel-air mixture at the downstream side of the peripheral flame holding surface which operates to continually ignite the fuel-air mixture peripherally as it enters the combustion chamber. Thus the fuel-air mixture is transversely and centrally ignited in the ignition chamber 12 and is peripherally ignited in the combustion chamber 13, for which reason the fuel-air mixture burns rapidly and completely in a combustion chamber, the size and length of which may be held to a minimum.

In order to secure more thorough ignition across the fuel-air mixture passing through the ignition chamber, a pair of central flame holders 25, 25 may be employed. One arrangement of such pair of central flame holders is illustrated in Fig. 7 of the drawings. In the embodiment illustrated in Fig. 7, the pair of flame holders 25, 25 are formed as a unitary structure, being connected by means of a top cross member 25'. With this arrangement, the upper portion of the container ring 22*a* is cut out to receive the cross member 25' and a pair of slots 24', 24' is provided in the container ring to receive the pair of central flame holders, as illustrated in Fig. 7.

The means employed in the ignition chamber for igniting the fuel-air mixture centrally is not necessarily a central flame holder such as that which has heretofore been described. A different form of central flame holder 25*a* is illustrated in Fig. 5. This form of central flame holder is provided with side grooves 31, 31 which extend forwardly and downwardly along the sides of the central flame holder 25*a* from the cut-away portion 27 to the forward face of the central flame holder. Thus, when the central flame holder 25*a* is positioned as is the central flame holder 25 shown in Fig. 1, the grooves 31, 31 con-

nect the initial ignition space **28** with the opening in the terminal ring **26** on either side of the central flame holder. Continuous central ignition is thereby provided at the forward face of the central flame holder independently of the protection given to a central ribbon of ignited mixture by that face.

Furthermore, an igniter **25***b* such as that illustrated in Fig. 6 may replace the central flame holder **25** or the central flame holder **25***a*, and is of particular advantage in cases where the fuel-air mixture is not preheated. The igniter **25***b* is positioned in the slot **24** exactly as is the central flame holder **25**, but does not extend at its top to the ring **21**, thereby leaving an initial ignition space which extends completely along its top.

The igniter **25***b* is horse-shoe shaped in longitudinal cross-section, the base of the horse-shoe providing its leading face. A series of orifices **32** are formed in this leading face for admission into the interior of the igniter of a portion of the un-ignited fuel-air mixture from the supply section **11**. A plate **33** extends transversely across the interior of the igniter **25***b* near its trailing face and a series of orifices **34** are formed in the plate **33** for outward passage of the ignited mixture. Within the igniter **25***b* there is therefore provided a comparatively sheltered chamber which offers protection from the force of the on-rushing fuel-air mixture in the supply section **11**. The mixture within the igniter **25***b* is initially ignited following ignition of the mixture above the igniter by the spark plug **29**; and the sheltered ignited mixture continues to burn in the igniter, flame issuing through the orifices **34** to ignite centrally the mixture passing through the opening in the terminal ring **26**. Thus the action of the igniter **25***b* is substantially the equivalent of the action of the central flame holder **25** heretofore described.

In the embodiment of the invention which is illustrated in Fig. 8, a substantially completely rectangular central flame holder **25***c* is positioned horizontally across the opening in the terminal ring **26***a*. The spark plug **29** extends through the wall of the supply section **11***a* in a position wherein its electrodes are cooled by the on-rushing unignited combustible mixture. Immediately behind the spark plug **29** the container ring **22***a* and the terminal ring **26***a* are cut-away to form a chamber **35** behind a shoulder **36** which protects a continuing flame, such flame being carried through the chamber **35** to the opening in the terminal ring **26***a* behind the central flame holder **25***c*.

From the foregoing it will be evident that the invention provides means for continuously igniting the high-velocity column of fuel-air mixture both centrally and peripherally, with the result that extremely rapid combustion occurs in the combustion chamber of the burner. The burner may therefore be given a minimum size, and will provide an exceedingly high rate of heat release.

Burners constructed in accordance with the invention may be employed with a variety of such fluid fuels as may be mixed with and carried along by a column of air moving at high velocity. Such fuels may be gases, vapors, dispersed liquids, or finely divided solids. In all cases ignition of the hight velocity stream of fuel-air mixture entering the combustion chamber is maintained transversely and substantially centrally and is simultaneously maintained circumferentially of the stream of fuel-air mixture. The length of the flame required for substantially complete combustion is thus shortened and the time required for combustion is reduced to a minimum. Compact burners of small size and high capacity are thereby made possible.

The forms of the invention here described and illustrated are presented merely as examples of how the invention may be applied. Other forms and embodiments of the invention coming within the proper scope of the appended claims will, of course, suggest themselves to those skilled in the combustion art.

We claim:

1. A burner for a fuel-air mixture comprising a supply chamber, a combustion chamber in which combustion is substantially completed, and an ignition chamber intermediate said supply and combustion chambers, means to supply the fuel-air mixture at a high velocity to said supply chamber and cause said fuel-air mixture to pass at a high velocity in a stream through the ignition chamber and into the combustion chamber, an igniter positioned in said ignition chamber out of the path of travel of the stream of fuel-air mixture operable to initially ignite the fuel-air mixture at the start of operation of the burner, a terminal ring adjacent the inlet end of the combustion chamber having a central opening through which the stream of fuel-air mixture is discharged into said combustion chamber, said central opening in the terminal ring being of smaller diameter than the combustion chamber and supply chamber and defining an annular flame retaining wall at the entrance to the combustion chamber operable to maintain a substantially quiescent zone of burning fuel-air mixture at the downstream side of said flame retaining wall and circumferentially of the high velocity stream of fuel-air mixture entering the combustion chamber, a container ring positioned about said ignition chamber intermediate said supply chamber and said terminal ring and having a central opening therein through which the stream of fuel-air mixture passes, said container ring central opening converging inwardly from said supply chamber to the central opening of said terminal ring, a central flame holder in the ignition chamber carried within the container ring and positioned adjacent the upstream side of the terminal ring, said container ring having alined slots extending radially of said container ring central opening, one of which slots is located adjacent said igniter, said central flame holder being positioned within said slots and extending diametrically across said container ring central opening and being cut away at said one of said slots adjacent said igniter to provide communication between said igniter and said container ring central opening, said central flame holder having at the downstream side thereof a flame holding surface extending diametrically at least partially across the stream of fuel-air mixture passing through said terminal ring and creating at the downstream side of said central flame holder and within the central opening of said terminal ring a substantially quiescent zone of burning fuel-air mixture substantially removed from the path of high velocity fuel-air mixture passing thereby, and said quiescent zones of burning fuel-air mixture downstream of the central flame holder and the annular flame retaining wall operating to ignite the high velocity stream of fuel-air mixture entering the combustion chamber through the central opening in said terminal ring.

2. A burner for a fuel-air mixture comprising a supply chamber, a combustion chamber in which combustion is substantially completed, and an ignition chamber intermediate said supply and combustion chambers, means to supply the fuel-air mixture at a high velocity to said supply chamber and cause said fuel-air mixture to pass at a high velocity in a stream through the ignition chamber and into the combustion chamber, an igniter positioned in said ignition chamber out of the path of travel of the stream of fuel-air mixture operable to initially ignite the fuel-air mixture at the start of operation of the burner, a terminal ring adjacent the inlet end of the combustion chamber having a central opening through which the stream of fuel-air mixture is discharged into said combustion chamber, said central opening in the terminal ring being of smaller diameter than the combustion chamber and supply chamber and defining an annular flame retaining wall at the entrance to the combustion chamber operable to maintain a substantially quiescent zone of burning fuel-air mixture at the downstream side of said flame retaining wall and circumferentially of the high velocity stream of fuel-air mixture entering the combustion chamber, a container ring

positioned about said ignition chamber intermediate said supply chamber and said terminal ring and having a central opening therein through which the stream of fuel-air mixture passes, said container ring central opening converging inwardly from said supply chamber to the central opening of said terminal ring, said container ring having a pair of slots equally spaced at opposite sides of a radial line of said container ring, and a slot in said container ring located diametrically opposite said pair of slots, said last mentioned slot being located adjacent said igniter, a pair of central flame holders carried by said container ring positioned within said slots and extending across said container ring central opening, said central flame holders having at the downstream side thereof a flame holding surface extending diametrically at least partially across the stream of fuel-air mixture passing through said terminal ring and creating at the downstream side of said central flame holders and within

the central opening of said terminal ring a substantially quiescent zone of burning fuel-air mixture substantially removed from the path of high velocity fuel-air mixture downstream of the central flame holders and the annular flame retaining wall operating to ignite the high velocity stream of fuel-air mixture entering the combustion chamber through the central opening in said terminal ring.

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