March 24, 1953 W. BRZOZOWSKI 2,632,300

COMBUSTION STABILIZATION MEANS HAVING IGNITER GRILL HEATED BY PILOT BURNER

Filed Aug. 3, 1949 2 SHEETS—SHEET 1

FIG. 1

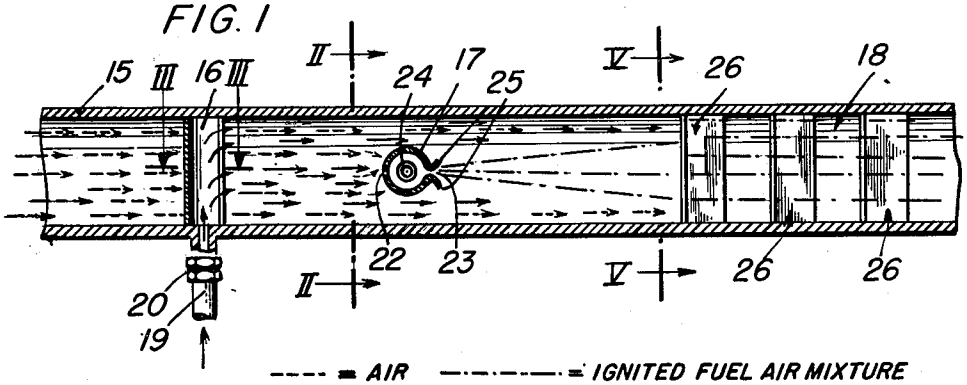


FIG. 2

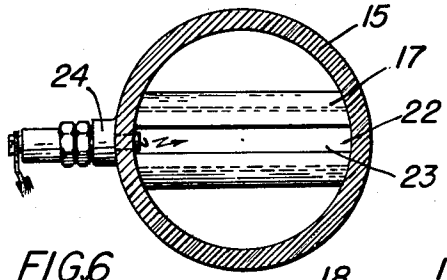


FIG. 3

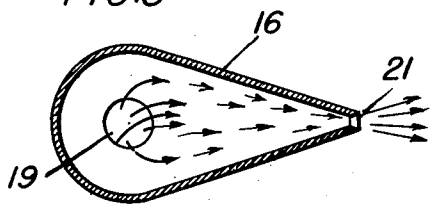


FIG. 6

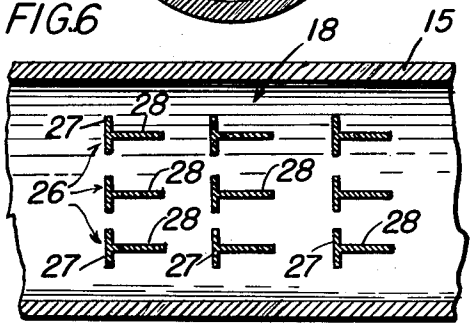


FIG. 4

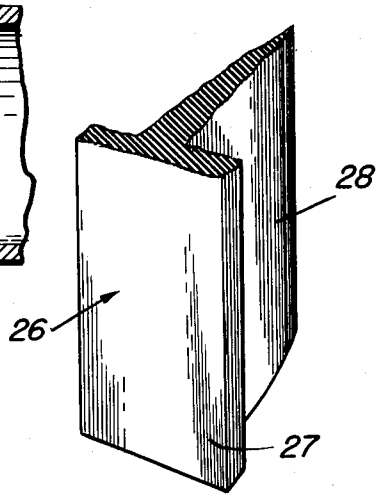
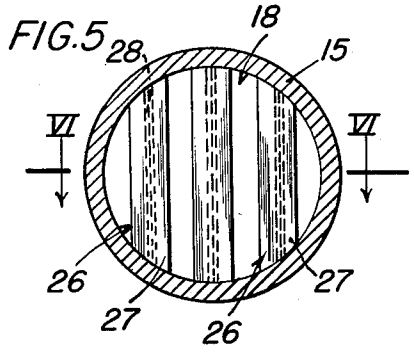


FIG. 5



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Filed Aug. 3, 1949 2 SHEETS—SHEET 2

FIG. 8

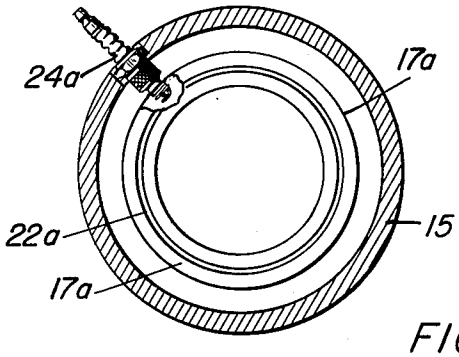


FIG. 9

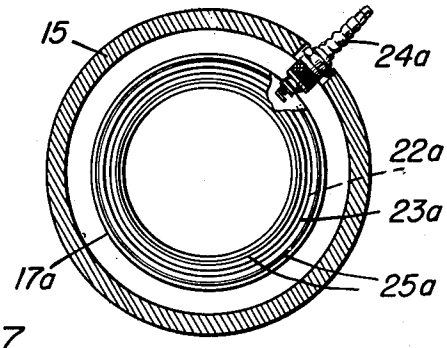


FIG. 7

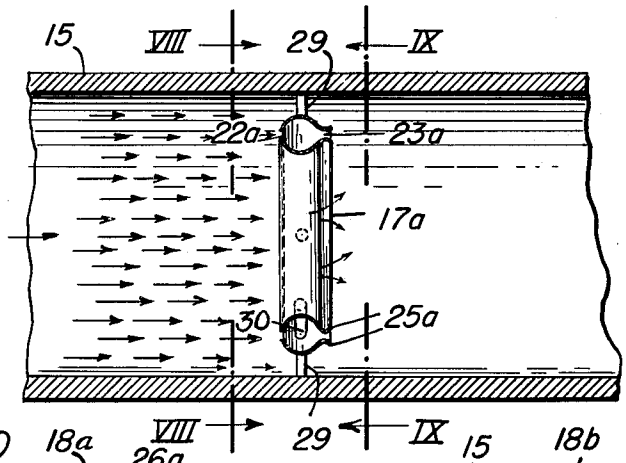


FIG. 10

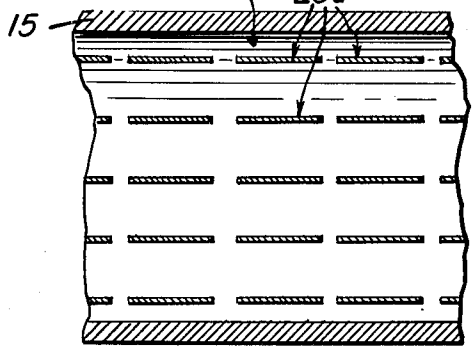


FIG. 11

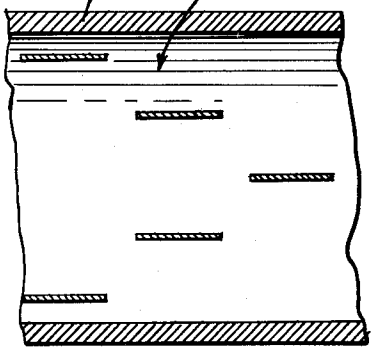


FIG. 12

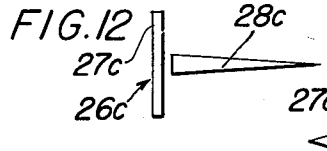
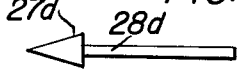


FIG. 13



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UNITED STATES PATENT OFFICE

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COMBUSTION STABILIZATION MEANS HAVING IGNITER GRILL HEATED BY PILOT BURNER

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Application August 3, 1949, Serial No. 108,316

12 Claims. (Cl. 60—39.72)

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This invention relates to a burner, and more particularly, a burner wherein fuel in fluid form is mixed with a column of air, moving therethrough under pressure, and burned therein. The invention is especially useful in its application to jet propulsion, to which use, however, it is not restricted.

The present application is a continuation in part of my copending application, Serial No. 650,305, filed February 26, 1946, now Patent No. 2,625,795.

An important problem in designing apparatus for burning fluid fuel diffused in a column of air moving through a chamber or tube, is that of maintaining ignition of the fuel. The difficulty of solving this problem is augmented as the velocity of the fuel-air mixture increases. Another important problem is that of completing combustion of the fuel in a reasonable length of chamber or tube. In my said copending application, Serial No. 650,305, there is disclosed an apparatus comprising a tube through which air passes at high velocity. Within the tube are disposed, in order along the path of the moving air column, a fuel-supply element, a flame preserver in the form of a shell extending transversely across the interior of the tube, and an igniter grill comprising a plurality of substantially parallel stream-lined igniter webs extending in line across the tube, each at right angles to the major axis of the flame preserver shell. The igniter webs are heated to incandescence by the fuel-air mixture, and in turn, spread the flame, make possible complete combustion of the fuel-air mixture in a space of restricted length, and reignite the mixture if its combustion becomes interupted.

I have now found that, under certain conditions, a different type of flame preserver from that disclosed in my aforesaid copending patent application may be advantageously employed. Under such conditions, I have also found it of advantage to employ a different design of igniter web, and to space and arrange these igniter webs within the chamber or tube in different manner from that disclosed in my aforesaid copending patent application.

According to the present invention, the fuel-supply element may take the form of a stream-lined conduit extending across the chamber or tube in the path of the moving column of air, and the outlet of this element may be along its downstream side. Also, in accordance with the invention, the flame preserver shell may extend across the chamber or tube at right angles to

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the major axis of the fuel-supply element; or the flame preserver shell may be annular in form and disposed in the tube coaxially therewith. Finally, the present invention contemplates an igniter grill formed by disposition of the igniter webs in a succession of ranks each in line across the chamber or tube. Special designs of igniter webs may be employed to advantage.

The invention is illustrated by way of example in the accompanying drawings, in which—

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

Fig. 2 is a cross-section taken on the line II—II of Fig. 1, the section being shown on an enlarged scale;

Fig. 3 is an enlarged section taken on the line III—III of Fig. 1;

Fig. 4 is an enlarged perspective fragmental view of one of the igniter webs shown in Fig. 1;

Fig. 5 is a cross-section taken on the line V—V of Fig. 1, the section being shown on an enlarged scale;

Fig. 6 is a broken longitudinal mid-section taken on the line VI—VI of Fig. 5, showing in cross-section one type of igniter grill and one arrangement of a plurality of igniter webs;

Fig. 7 is a fragmental longitudinal mid-section through another burner having therein a different type of flame preserver;

Fig. 8 is a cross-section taken on the line VIII—VIII of Fig. 7;

Fig. 9 is a cross-section taken on the line IX—IX of Fig. 7;

Fig. 10 is a broken longitudinal mid-section similar to that illustrated in Fig. 6 showing in cross-section another type of igniter grill and one arrangement of a plurality of igniter webs having a different form;

Fig. 11 is a broken longitudinal mid-section similar to those illustrated in Figs. 6 and 10, showing another type of igniter grill arrangement, the igniter webs which form the grill having the form of those shown in Fig. 10;

Fig. 12 is a cross-section through a single igniter web of a different type from those illustrated in Figs. 6, 10 and 11; and

Fig. 13 is a cross-section through an igniter web of still a different type.

Referring now to the drawings, and particularly to the embodiment illustrated in Figs. 1 to 6 inclusive, there is provided a chamber, here shown as a tube 15, through which a column of air is moved at high velocity. In order to form the burner, there are disposed within the tube

15 in downstream succession, a fuel supply element 16, a flame preserver 17, and an igniter grill 18.

The fuel-supply element comprises a streamlined conduit extending transversely within the tube 15. A pipe 19 suitably coupled, as at 20, to the fuel-supply element, carries thereto a fluid fuel which is discharged into the moving air column through a constricted opening 21 extending longitudinally of the element along its downstream side. Since the fuel is discharged into the moving air column substantially completely across the tube 15, diametrically thereof, the fluid fuel is diffused within the moving column of air to provide a fuel-air mixture, which continues to move along the tube 15 at a high velocity.

Within the chamber, or tube 15, downstream from the fuel-supply element 16 and extending transversely of the tube, is positioned the flame preserver 17. Because the velocity of the fuel-air mixture may be greater than the rate of flame propagation, the flame preserver 17 is designed to emit a flame continuously for constantly igniting the mixture. The flame preserver is illustrated as being positioned diametrically of the tube 15 and at right angles to the major axis of the fuel-supply element. The flame preserver 17, here illustrated comprises a cylindrical shell having a comparatively narrow longitudinal entrance opening or slot 22 extending along its upstream side and a similar longitudinal exit opening or slot 23 extending along its downstream side. Obviously, the openings 22 and 23 need not be continuous but may be formed as a series of juxtaposed holes or orifices. Thus the fuel-air mixture passing through the longitudinal opening 22 in the flame preserver has its velocity materially decreased as it enters the protected and comparatively quiet area within the unit. The longitudinal opening 23 on the downstream side of the flame preserver permits the ignited fuel-air mixture to leave the burner and to enter the moving unignited fuel-air mixture column beyond the burner. The cross-section of the longitudinal opening 22 is so related to the volume within the burner that the flame will not be blown out by the rapidly moving mixture external to the flame preserver. Igniting means is provided within the unit. Thus, in the illustrated embodiment, a spark plug 24 projects through the tube 15 and into one end of the flame preserver 17 for igniting the fuel-air mixture therein.

Because of the reduced velocity of the fuel-air mixture within the flame preserver, it is possible to maintain combustion therein continuously despite the high velocity of the external fuel-air mixture. Consequently, the ignited fuel-air mixture which leaves the flame preserver through its downstream longitudinal exit opening or slot 23 mixes with the unignited fuel-air mixture and constantly serves to ignite it across the diameter of the tube.

As indicated by the dot-dash lines in Fig. 1, the flame issuing in a ribbon from the downstream longitudinal opening 23 across the width of the burner, expands in wedge formation as the fuel-air mixture is progressively ignited. Because of the high velocity of the fuel-air mixture, this ignition wedge expands at a small angle having its apex at the longitudinal exit opening or slot 23. This is the case even when the velocity of the mixture is not in excess of the rate of flame propagation. In consequence, a very substantial length of tube would be required to permit complete combustion of the fuel-air mixture therein, unless special provision were made for spreading the flame at a point near the burner.

Accordingly, the edges 25 of the longitudinal exit opening 23 may be spread apart to reduce the velocity of the fuel-air mixture immediately adjacent the downstream opening 23, and thus to widen the ignition wedge at the flame preserver. Such arrangement is shown in Fig. 1. Furthermore, and of greater importance, the igniter grill 18 is positioned in the path of the ignition wedge to receive heat from the burning fuel-air mixture and to transfer such heat outwardly in the tube 15 beyond the normal outline of the ignition wedge. Thus the flame may be spread more rapidly and nearer to the flame preserver than would otherwise be the case; and the required length of tube for effecting complete combustion may be materially reduced.

In the embodiment illustrated in Figs. 1 to 6 the igniter grill 18 is formed of a plurality of T-shaped igniter webs 26, positioned in the tube 15 at right angles to the longitudinal axis of the flame preserver, with their heads 27 toward the oncoming fuel-air mixture. Although the heads 27 of the T-shaped igniter webs 26 are shown as being continuous, such is not necessarily the case. The igniter webs here shown are positioned in successive ranks, each rank comprising a plurality of webs in parallel spaced relationship across the tube. Three such ranks are illustrated in Fig. 6, although more or fewer may be employed. Accordingly, when the ignited fuel-air mixture meets the first rank of igniter webs, it impinges upon the heads of the T-shaped webs, heating the webs to incandescence. The heat received by each head is conducted outwardly from the central portion of the head into the path of the unignited fuel-air mixture, which it ignites. The tail 28 of the T-shaped web 26 is protected by its head 27 from the cooling action of the unignited fuel-air mixture which strikes the web. The tail, therefore, acts efficiently to conduct heat away from the center of the web and to ignite the unignited mixture which comes in contact with it. The successive ranks of webs act similarly. Also, the T-shaped igniter web increases the boundary layer of both ignited and unignited fuel-air mixture in contact with the web. In other words, a greater surface of the fuel-air mixture column meets the surface of the igniter web than would be the case if it were of stream-lined shape, and the effectiveness of the web is thus increased by its shape. Accordingly, the entire fuel-air mixture may be ignited considerably nearer to the flame preserver 17 than would otherwise be the case, and a shorter tube 15 suffices to effect complete combustion of the mixture.

It is further noted that, if for any reason surges of pressure or of flame occur in the tube, the igniter grill will act to maintain continuing combustion.

Applicant's invention is not limited to a flame preserver comprising a cylindrical shell and extending diametrically across the tube 15. Another type of flame preserver which has been operated successfully is illustrated in Figs. 7, 8 and 9. This unit 17*a* is constructed in the form of a hollow annulus, and is disposed concentrically within the tube 15 where it is supported as by fins 29. The flame preserver 17*a* has a narrow circular entrance opening or slot 22*a* in its upstream side and a similar circular exit opening or slot 23*a* in its downstream side, and spacers 30 within the unit may serve to hold its two annular parts to-

gether. The edges 25*a* of the exit opening or slot 23*a* are preferably spread apart in the same manner and for the same purpose as the edges 25 illustrated in Fig. 1. Thus an expanding ring of burning fuel-air mixture leaves the annular flame preserver 17*a* and tends to ignite a large proportion of the unignited fuel-air mixture in the immediate vicinity of the unit.

Nonetheless, it is found desirable to employ an igniter grill downstream within the tube 15 from the flame preserver 17*a*, in order to keep the necessary length of the tube at a minimum.

It is also noted that the invention contemplates igniter grills which are formed of webs differing from the T-shaped igniter webs illustrated in Figs. 1, 4, 5 and 6. Thus, in the embodiment illustrated in Fig. 10, the igniter webs are formed as plane plates 26*a* disposed in parallel spaced relationship across the tube and positioned in successive ranks along the tube 15. Fig. 11 illustrates another arrangement of plane plates in which the individual webs are symmetrically spaced in successive ranks which define a V-formation. Thus, whether headed or not, the individual webs are positioned with edges thereof directed toward the oncoming fuel-air mixture.

Instead of employing the continuous T-formation of the igniter webs 26 illustrated in Figs. 1, 4, 5 and 6, the webs may be formed in two parts as illustrated in Fig. 12. Such webs are formed with their heads 27*c* completely separated from their tails 28*c*, the head and tail of each web being positioned in T-formation within the tube 15 in the manner illustrated in Fig. 6. The advantage of this arrangement is that the tails are not cooled by the heads which are in contact with the unignited fuel-air mixture. The separate tails 28*c* may, therefore, attain and conduct to the unignited mixture a higher degree of heat than is possible in the webs 26. The head 27*c* of such a web is alone cooled by the unignited fuel-air mixture which impinges upon it, and the tail 28*c* is completely heated by the burning mixture with which it comes in contact. More efficient operation of the tail in spreading the flame is accordingly effected. Furthermore, the boundary layer of both ignited and unignited fuel-air mixture in contact with the web is increased by this construction as explained above.

Still a different construction is illustrated in Fig. 13 wherein an arrow-shaped head 27*d* is provided on the upstream side of a plate-like tail 28*d*. An igniter web of this form increases the boundary layer of ignited and unignited fuel-air mixture in contact therewith, but offers little obstruction to passage of the fuel-air mixture through the tube 15.

Admittedly, the igniter grill 18 offers some little obstruction to passage of the fuel-air mixture along the tube 15. However, the early and complete combustion of the mixture which is effected by the grill more than offsets this disadvantage.

It is to be understood that the phraseology and terminology herein is employed for the purpose of description and not of limitation. Furthermore, the particular forms of the invention here described and illustrated in the accompanying drawings are presented merely as examples of how the invention may be applied. Other forms, embodiments and applications of the invention, coming within the proper scope of the appended claims, will readily suggest themselves to those skilled in the burner art.

I claim:

1. A burner for burning a column of a fuel-air mixture moving at high velocity, said burner comprising a tube through which a column of air passes; a fuel-supply element in said tube for diffusing fuel into the column of air to provide a fuel-air mixture; a flame preserver within said tube downstream from said fuel-supply element for continuously igniting the fuel-air mixture; and a plurality of separate parallel igniter webs disposed downstream from said flame preserver in a succession of ranks each in line extending transversely completely across said tube, said webs being formed with heads directed toward the oncoming fuel-air mixture in said tube to increase the boundary layer of both ignited and unignited fuel-air mixture in contact therewith and acting to receive heat from the burning fuel-air mixture and to give up heat to ignite the unignited fuel-air mixture adjacent said webs.

2. A burner for burning a column of fuel-air mixture moving at high velocity, said burner comprising a tube through which a column of air passes; a fuel-supply element in said tube for diffusing fuel into the column of air to provide a fuel-air mixture; a flame preserver within said tube downstream from said fuel-supply element for continuously igniting the fuel-air mixture; and a plurality of T-shaped igniter webs disposed downstream from said flame preserver in substantially parallel spaced relationship across said tube, said T-shaped webs being positioned with their heads upstream to protect their tails by their heads from being cooled by the unignited fuel-air mixture adjacent said webs.

3. A burner for burning a column of fuel-air mixture moving at high velocity, said burner comprising a tube through which a column of air passes; a fuel-supply element in said tube for diffusing fuel into the column of air to provide a fuel-air mixture; a flame preserver within said tube downstream from said fuel-supply element for continuously igniting the fuel-air mixture, said flame preserver having a narrow entrance slot on its upstream side and a similar exit slot on its downstream side, the edges of the exit slot of said flame preserver being spread apart outwardly of said flame preserver; and a plurality of T-shaped igniter webs disposed downstream from said flame preserver in substantially parallel spaced relationship across said tube, said T-shaped webs being positioned with their heads upstream to protect their tails by their heads from being cooled by the unignited fuel-air mixture adjacent said webs.

4. A burner for burning a column of a fuel-air mixture moving at a high velocity, said burner comprising a tube through which a column of air passes; a fuel-supply element in said tube for diffusing fuel into the column of air to provide a fuel-air mixture; a flame preserver within said tube downstream from said fuel-supply element for continuously igniting the fuel-air mixture, said flame preserver comprising a hollow substantially annular unit disposed within said tube concentrically therewith having a narrow circular slot on its upstream side and a similar slot on its downstream side; and a plurality of parallel igniter webs disposed downstream from said flame preserver each web extending transversely completely across said tube, said webs being disposed in a succession of ranks each in line across said tube, said webs acting to receive heat from the burning fuel-air mixture and to give up heat to ignite the unignited fuel-air mixture adjacent said webs.

5. A burner for burning a column of a fuel-air mixture moving at high velocity, said burner comprising a tube through which a column of air passes; a fuel-supply element in said tube for diffusing fuel into the column of air to provide a fuel-air mixture; a flame preserver within said tube downstream from said fuel-supply element for continuously igniting the fuel-air mixture, said flame preserver comprising a hollow substantially annular unit disposed within said tube concentrically therewith having a narrow circular slot on its upstream side and a similar slot on its downstream side, and a spark plug extending through said tube into said flame preserver for igniting therein the fuel-air mixture entering said flame preserver through its upstream slot; and a plurality of parallel igniter webs disposed downstream from said flame preserver, each web extending transversely completely across said tube, said webs being disposed in a succession of ranks each in line across said tube, said webs acting to receive heat from the burning fuel-air mixture and to give up heat to ignite the unignited fuel-air mixture adjacent said webs.

6. A burner for burning a column of a fuel-air mixture moving at high velocity, said burner comprising a tube through which a column of air passes; a fuel-supply element in said tube for diffusing fuel into the column of air to provide a fuel-air mixture; a flame preserver within said tube downstream from said fuel-supply element for continuously igniting the fuel-air mixture, said flame preserver comprising a hollow substantially annular unit disposed within said tube concentrically therewith having a narrow circular slot on its upstream side and a similar slot on its downstream side, and a spark plug extending through said tube and into said flame preserver for igniting therein the fuel-air mixture entering said flame preserver through its narrow upstream slot; and a plurality of T-shaped igniter webs disposed downstream from said flame preserver in substantially parallel spaced relationship across said tube, said T-shaped webs being positioned with their heads upstream to protect their tails from being cooled by the unignited fuel-air mixture, and said webs acting to receive heat from the burning fuel-air mixture and to give up heat to ignite the unignited fuel-air mixture adjacent said webs.

7. A burner for burning a column of fuel-air mixture moving at high velocity, said burner comprising a chamber through which a column of air passes; a fuel-supply element in said chamber for diffusing fuel into the column of air to provide a fuel-air mixture; a flame preserver within said chamber downstream from said fuel-supply element for continuously igniting the fuel-air mixture, said flame preserver comprising a hollow substantially annular unit disposed within said chamber in the path of the unignited fuel-air mixture having a narrow circular slot on its upstream side and a similar slot on its downstream side; and a plurality of T-shaped igniter webs disposed downstream from said flame preserver in substantially parallel relationship across said chamber in the path of the ignited and unignited fuel-air mixture, said webs being positioned with their heads upstream to protect their tails from being cooled by the unignited fuel-air mixture, the tails of said T-shaped igniter webs being separated from the heads thereof to prevent direct conduction of heat from the tails by the heads of said webs, and said webs acting to receive heat from the burning fuel-air mixture and to give up heat to ignite the unignited fuel-air mixture adjacent said webs.

8. A burner for burning a column of a fuel-air mixture moving at high velocity, said burner comprising a tube through which the air passes; a fuel-supply element in said tube for diffusing fuel into the column of air to provide a fuel-air mixture; a flame preserver within said tube downstream from said fuel-supply element for continuously igniting the fuel-air mixture, said flame preserver comprising a hollow substantially annular unit disposed within said tube concentrically therewith having a narrow circular slot on its upstream side and a similar slot on its downstream side; and a plurality of T-shaped igniter webs disposed downstream from said burner in substantially parallel spaced relationship across said tube, said webs being positioned with their heads upstream to protect their tails from being cooled by the unignited fuel-air mixture, the tails of said T-shaped igniter webs being separated from the heads thereof to prevent direct conduction of heat from the tails by the heads of said webs, and said webs acting to receive heat from the burning fuel-air mixture and to give up heat to ignite the unignited fuel-air mixture adjacent said webs.

9. A burner for burning a column of a fuel-air mixture moving at high velocity, said burner comprising a tube through which a column of air passes; a fuel-supply element in said tube for diffusing fuel into the column of air to provide a fuel-air mixture; a flame preserver within said tube downstream from said fuel-supply element for continuously igniting the fuel-air mixture, said flame preserver comprising a hollow substantially annular unit disposed within said tube concentrically therewith having a narrow circular entrance slot on its upstream side and a similar exit slot on its downstream side, the exit slot of said flame preserver having its edges spread apart outwardly, and a spark plug extending through said tube and into said flame preserver for igniting therein the fuel-air mixture entering said flame preserver through its upstream slot; and a plurality of T-shaped igniter webs disposed downstream from said flame preserver in substantially parallel spaced relationship across said tube in the path of the ignited and unignited fuel-air mixture, said T-shaped webs being positioned with their heads upstream to protect their tails from being cooled by the unignited fuel-air mixture, and said webs acting to receive heat from the burning fuel-air mixture, and to give up heat to ignite any unignited fuel-air mixture adjacent said webs.

10. In a burner for burning a fuel-air mixture moving at high velocity through a chamber and having a flame preserver within the chamber for continuously igniting the fuel-air mixture: a plurality of T-shaped igniter webs disposed downstream from the flame preserver across the chamber in the path of the ignited and unignited fuel-air mixture, said webs acting to receive heat from the burning fuel-air mixture and to give up heat to ignite the unignited fuel-air mixture adjacent said webs.

11. In a burner for burning a column of a fuel-air mixture moving at high velocity which comprises a chamber through which the air passes, a fuel-supply element in the chamber for diffusing fuel within the column of air to provide a fuel-air mixture, and a flame preserver within the chamber downstream from the fuel-supply

element for continuously igniting the fuel-air mixture: a plurality of T-shaped igniter webs disposed downstream from the flame preserver in a succession of ranks each in line across the chamber in the path of the ignited and unignited fuel-air mixture, said webs acting to receive heat from the burning fuel-air mixture and to give up heat to ignite the unignited fuel-air mixture adjacent said webs.

12. A burner for burning a column of fuel-air mixture moving at high velocity, said burner comprising a chamber through which a column of air passes; a fuel-supply element in said chamber for diffusing fuel into the column of air to provide a fuel-air mixture; a flame preserver within said chamber downstream from said fuel-supply element for continuously igniting the fuel-air mixture; and a plurality of separate parallel igniter webs disposed downstream from said preserver in a succession of ranks each in line extending transversely completely across said chamber, said webs being positioned with their

major cross-sectional dimensions extending in substantial alignment with the direction of the combustion stream to receive heat from the burning fuel-air mixture and to give up heat to ignite the unignited fuel-air mixture adjacent said webs.

WITOLD BRZOZOWSKI.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,574,545	Bear	Feb. 23, 1926
1,839,880	Hyatt	Jan. 5, 1932
2,142,601	Bleecker	Jan. 3, 1939
2,410,881	Hunter	Nov. 12, 1946

FOREIGN PATENTS

Number	Country	Date
384,939	France	Feb. 21, 1908