Dec. 13, 1960 F. A. RYDER 2,964,103

QUIET OPERATING COMBUSTION HEATER

Original Filed Jan. 31, 1955

Fig. 1

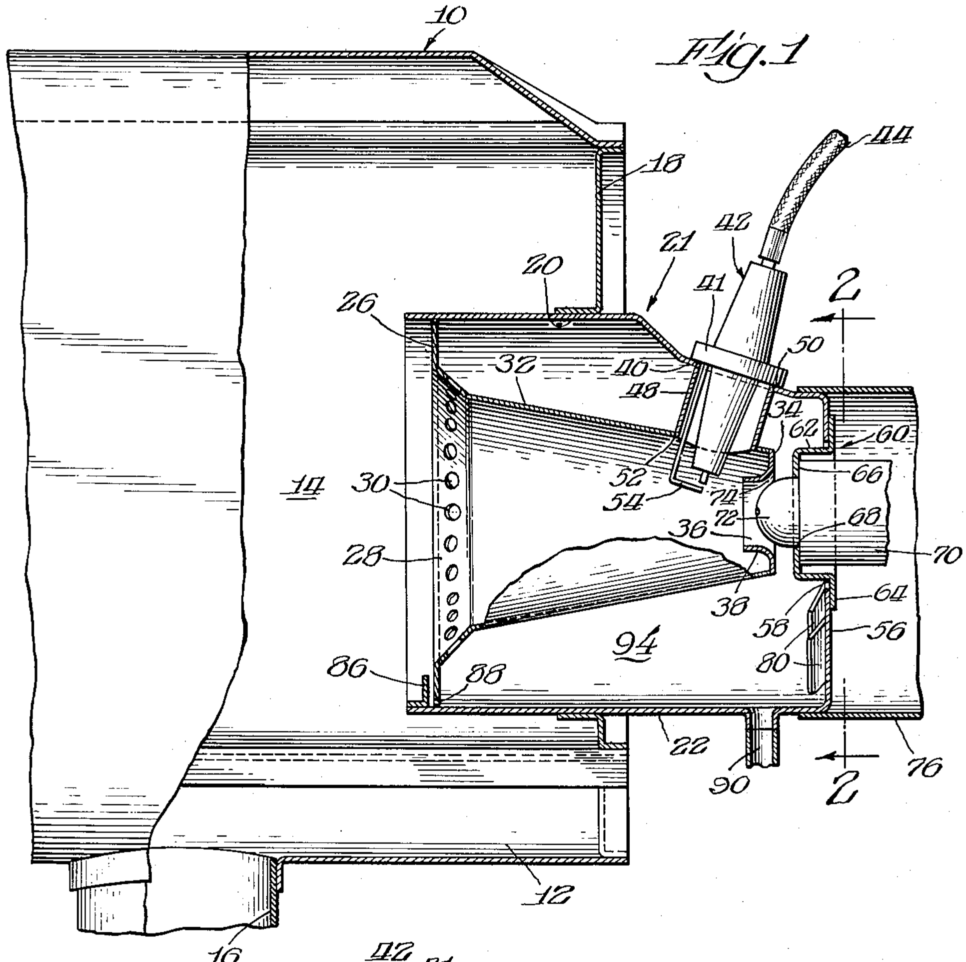


Fig. 2

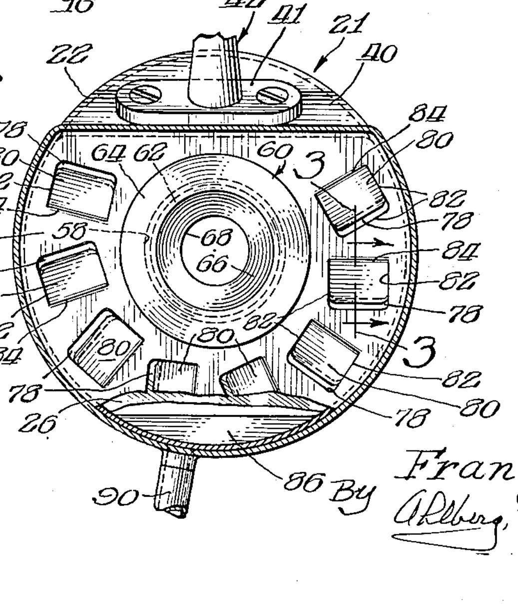
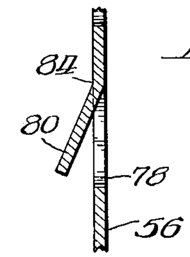


Fig. 3



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QUIET OPERATING COMBUSTION HEATER

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6 Claims. (Cl. 158—28)

This is a continuation of application Serial No. 485,018, filed January 31, 1955, now abandoned.

The present invention relates to combustion heaters, particularly lightweight, high capacity air heaters of the type used in airplanes and land vehicles.

In such heaters combustion air and liquid fuel, usually gasoline, are fed into a combustion chamber where the fuel is largely burned before the combustion gases pass through a surrounding heat exchanger. Some of the common operational problems of combustion heaters, such as pulsations and rumbling in the combustion chamber, are especially troublesome in such high capacity heaters in which prime consideration is given to obtaining the maximum heat output from heaters of the smallest possible size and weight.

Although rumbling in a combustion heater involves many complex phenomena of fluid mechanics, it seems in general to follow a cyclic pattern which may be assumed to start with combustion at an above normal rate due to unsteady flow conditions in the combustion chamber or to other causes. Combustion at the higher rate tends to elevate the pressure within the combustion chamber and slow the normal rate at which combustion air is supplied to continue the combustion process. Because of the decreased air supply or other reasons, the combustion rate may drop even below the normal or average level. A drop in temperature follows which temporarily reduces the pressure within the combination chamber thus causing a surge of a combustible mixture to enter from the fuel and air supply structure. The increased fuel mixture in the combustion chamber produces another pulse of accelerated combustion. This increases the pressure within the combustion chamber temporarily to continue the irregular or pulsating combustion cycles known as "rumbling".

One object of the invention is to provide an improved combustion heater in which rumbling is suppressed by an improved burner of extremely simple, lightweight construction suitable for economical manufacture.

Another object of the invention is to suppress rumbling in a combustion chamber by use of improved air supply means which has a resistance to reverse flow of air from the combustion chamber far greater than the resistance to normal flow of air into the combustion chamber.

A further object of the invention is to provide a very simple, lightweight combustion heater of the character recited which is well adapted to operate efficiently without the formation of soot in the burner or premature cracking of the fuel used.

Other objects and advantages will become apparent from the following description of the form of the invention shown in the drawings, in which:

Fig. 1 is a fragmentary view largely in section of an improved combustion heater embodying the invention;

Fig. 2 is a fragmentary sectional view taken along the line 2—2 of Fig. 1; and

Fig. 3 is a fragmentary sectional view on an enlarged scale taken along the line 3—3 of Fig. 2.

The lightweight combustion heater forming the illustrated embodiment of the invention comprises a sheet metal heat exchanger 10 having means forming hot combustion gas passages 12 extending around a horizontally elongated combustion chamber 14 from the upper side of the chamber to an exhaust outlet 16 on the lower side of the heat exchanger. For a specific description of the heat exchanger shown, reference may be made to my patent application Serial No. 388,096, filed in the United States Patent Office October 26, 1953, now Patent No. 2,841,134.

A header 18 on the right end of the heat exchanger 10, Fig. 1, defines a rather large opening 20 into the adjacent end of the combustion chamber 14 for the reception of a burner 21. As shown, the burner comprises a generally cylindrical shell 22 fitted horizontally into the header opening 20 so that substantially one-half of the horizontal length of the burner shell extends into the combustion chamber 14.

The inner end of the burner shell 22 is partially closed by a transverse, sheet metal annulus 26, disposed a short distance from the extreme inner end of the shell. The periphery of the annulus is welded or otherwise secured to the inner cylindrical surface of the shell. The marginal edge of the annulus 26, which encircles a central opening in the annulus, is turned outwardly at an angle to the plane of the annulus to form a short truncated cone or flange 28 having a rather wide apex angle. A series of spaced apertures 30 in the flange 28 extends all the way around the flange. The apertures 30 constitute restricted air passages (denoted by the same reference numeral 30) connecting the interior of the burner shell 22 with the adjacent space of the combustion chamber 14.

The extreme edge of the flange 28, which is turned away from the center of the combustion chamber 14, is abuttingly secured by welding or otherwise to the large end of a hollow, truncated burner cone 32 in the burner shell 22, which extends horizontally toward the outer end of the burner shell 22. The cone 32 has an apex angle much smaller than that of the cone 28 and is truncated to have a small end of approximately one-half the diameter of the large end.

A circular plate 34 fixed across the small end of the cone 32 is shaped to define a central opening 36 encircled by an inwardly extending spud 38 on the plate. The opening 36 is concentric with the axis of the cone 32.

The upper portion of the burner shell 22, which extends outwardly from the header 18, is shaped to form a flat 40 inclined downwardly toward the outer end of the shell. The flat 40 supports the base 41 of a conventional spark plug type igniter 42. The upper end of the igniter 42 is connected with a conductor wire 44. The lower end of the igniter 42 extends down into the burner cone 32 through a protective sleeve 48 connected at opposite ends into apertures 50, 52 in the flat 40 and in the cone respectively. The electrodes 54 of the igniter 42 terminate somewhat above the center line or axis of the cone 32.

A generally flat vertical member 56 on the outer end of the burner shell 22 is integral at its peripheral edge with the generally horizontal wall portion of the shell and spaced horizontally somewhat from the extreme outer end of the cone 32. A circular opening 58 in the member 56 is concentric with the axis of the cone 32 and somewhat larger in diameter than the small end of the cone.

The opening 58 receives a sheet metal fuel nozzle seat 60 comprising a short cylindrical wall 62 extending through the opening toward the cone from a radial flange 64 on the seat wall overlying the outer marginal edge of the member 56 around the opening 58. The inner end of the wall 62 is integral with the periphery of a flat vertical bottom portion 66 of the seat 60 spaced a short distance from the plate 34 on the cone 32 and defining a central opening 68 alined with the central opening 36 in the cone plate.

A fuel nozzle 70 extends horizontally into the seat 60 to rest against the bottom 66 of the seat tand hold the flange 64 slidably against the shell member 56. A tip 72 on the nozzle 70 projects through the opening 68 in the seat 60 to extend part way into the opening 36 in the burner cone member 34. A radial space left between the nozzle tip 72 and the cone member spud 38 provides a restricted annular passage 74 around the nozzle tip into the cone.

An exact alignment of the fuel nozzle 70 with the axis of the burner cone 32 is readily effected by radial adjustment of the nozzle seat 60. The larger diameter of the opening 58 in the shell member 56 in relation to that of the nozzle seat wall 62 and the slidable engagement of the nozzle seat flange 64 with the shell member 56 provides for radial adjustment of the nozzle seat in any direction.

The adjustability of the fuel nozzle 70 provided by the slidable nozzle seat 60 eliminates the necessity and expense of close manufacturing tolerances and at the same time assures proper centering of the nozzle with respect to the cone 32 and the igniter 42 to assure proper burning of fuel and eliminate the spraying of fuel directly onto inwardly protruding components 54 of the igniter such as would cause this structure to become fouled with carbon and other fuel components that might interfere with proper operation of the burner.

In aircraft installations, air to support combustion is supplied under pressure to the space within the burner shell 22 from conventional air scoop structure; otherwise a blower may be used for this purpose. This collateral structure (not shown) may be of any suitable design such as that used with conventional combustion heaters now in use. In any event a conduit 76 from the air supply means used is connected to embrace the outer end of the burner shell 22 to form a continuous impervious connection with the periphery of the vertical shell member 56.

The shell member 56, together with the structure 60, 70 which fills the central opening in the member becomes a partition in the air supply passageway to the combustion chamber 14 formed by the conduit 76 and the space within the shell 22. This partition is fashioned to suppress rumbling within the combustion chamber 14 while at the same time providing for a normal flow of air from the conduit 76 into the burner shell 22 to support combustion within the combustion chamber. To accomplish this, air passage means provided in the partition member 56 are designed to have a resistance to the reverse flow of air from the combustion chamber 14 which is much greater than the resistance to the normal flow of air from the conduit 76 toward the combustion chamber.

As shown in Fig. 2, the passageway means comprises an arcuate series of openings 78 in the partition member 56 circumferentially spaced from each other around the central opening 58 in the member from one end to the other of the flattened upper portion 40 of the burner shell 22.

To form each opening 78 a rectangular segment 80 of the member 56 is lanced along three joining edges 82 from the adjacent portion of the member thus leaving the segment attached along only one side edge 84 to the member. The edge 84 of each segment 80 which remains attached to the main portion of the member 56 runs substantially along a radial line from the center of the opening 58 in the member. From its attached edge each flaplike segment 80 extends in a clockwise direction, Fig. 2, with respect to the outer end of the burner shell 22.

As shown in Figs. 2 and 3, each segment 80 is bent inwardly toward the combustion chamber 14 to an angle of approximately 25 degrees to the plane of the main portion of the member 56 so that it in effect forms a partial shield for the adjacent opening 78.

It will be appreciated that the phenomena of fluid mechanics involved in the flow of air through the openings 78, as partially covered by the flaps or shields 80, is quite involved, particularly when consideration is given to uneven burning in the combustion chamber 14 and fluctuating pressures within the burner shell 22 which would tend to cause reverse flow through the air supply openings. However, a full understanding of these fluid flow phenomena is not necessary for practicing the invention. Whether by partially shielding the openings 78 against the reverse flow of air or otherwise, the flaplike members 80 serve in connection with the structure forming the openings to suppress undesirable rumbling in the combustion chamber 14.

In this connection it may be observed that the differential pressure across the shielded openings 78 is protected from the full impact of pressure fluctuations in the combustion chamber 14 by the pneumatic cushioning effect of a chamber formed by the space 94 in the burner shell 22 between the partition member 56 and the means defining the air passage 74 and the air passages or apertures 30. Hence, the pressure in the cushioning chamber 94 is not affected directly by pressure fluctuations in the combustion chamber 14 but only secondarily to the extent that pressure fluctuations in the combustion chamber affect the flow of air through the restricted passages 30 and 74 sufficiently to vary the cushioning chamber pressure. The suppressed pressure variations thus produced within the chamber 94 are choked at the shielded openings 78 as recited to effectively suppress rumbling in the combustion chamber.

The inclined attitude of the shields 80 together with the common (clockwise Fig. 2) orientation of the shields imparts a spiral or swirling motion to the air flowing through the opening 78 from the conduit 76 into the burner shell 22. A portion of the air in the shell 22 swirls through the annular passageway 74 around the nozzle tip 72 to mix with fuel sprayed into the cone 32 from the nozzle 70. The spiral motion of the air assures good mixing of the fuel. The air passing around the nozzle tip 72 cools the nozzle 70 to avoid premature cracking of fluel flowing through the nozzle.

The burning fuel mixture projected from the burner cone 32 into the combustion chamber 14 is mixed with secondary air issuing from the space within the burner shell 22 through the apertures 30 in the cone member 28. This secondary air also has a spiral velocity component which further improves mixing of the additional air with the burning fuel mixture. The air flowing through the apertures 30 forms a plurality of secondary zones of high temperature combustion assuring complete combustion of the fuel.

Any unvaporized fuel which for any reason drains down the burner cone 32 from the nozzle 70 is caught by a low transverse dam member 86 fixed to the lower marginal edge of the burner shell 22 which projects inwardly beyond the transverse annulus 26. Liquid fuel caught behind the dam 86 can pass through a small hole 88 in the annulus 26 to flow out through a drain tube 90 connected to the lower outer end of the shell.

While I have shown and described a preferred embodiment of my invention, it will be apparent that numerous variations and modifications thereof may be made without departing from the underlying principles of the invention. I therefore desire, by the following claims, to include within the scope of the invention all such variations and modifications by which substantially the results of my invention may be obtained through the use of substantially the same or equivalent means.

I claim:

1. In a quiet operating combustion heater, the combination of heat exchanger means including means defining a combustion chamber, a burner shell having a forward end opening into said combustion chamber, said burner shell including a transverse wall displaced rearwardly from the extreme combustion chamber end of the shell, a hollow truncated cone member mounted

in said burner shell with the larger end opening into said combustion chamber and the smaller end disposed adjacent said wall, said wall defining an opening therethrough aligned with the adjacent open end of said cone member; an annular, centrally open nozzle seat slidably adjustable on the marginal edge of said wall surrounding said opening therethrough; a fuel nozzle disposed in engagement with said slidable seat to project fuel therethrough into the small end of said cone member, said annular seat and said nozzle being positioned in relation to the adjacent small end of said cone member to provide therewith a restricted annular air passage from within said shell into said cone member, means forming a plurality of restricted passages between said combustion chamber and the space within said burner shell around said cone member, the periphery of said larger end of said cone member and the adjacent portion of said shell being joined together to limit to said last mentioned passages and to said annular passage the flow of air into said combustion chamber from the space within said shell around said cone member, an arcuate series of flaplike shields lanced from said wall and bent at acute angles thereto toward said burner cone member to form in the wall openings shielded against the reverse flow of air therethrough by said shields, and means defining a combustion air passageway extending to the side of said wall opposite from said combustion chamber and having an impervious interconnection with the wall extending continuously around the passageway; and said wall, except for said shielded openings therein, and said passageway means at the upstream side of said wall being substantially protected by said wall and shields against the flow of air from said combustion chamber into said passageway upstream of said wall.

2. In a quiet operating combustion heater, the combination of heat exchanger means including means defining a combustion chamber, a burner shell having a forward end opening into said combustion chamber, said burner shell including a transverse wall displaced rearwardly from the extreme combustion chamber end of the shell, a hollow truncated cone member mounted in said burner shell with the larger end opening into said combustion chamber and the smaller end opening toward said wall, an opening formed within said wall and aligned with the adjacent open end of said cone member, fuel nozzle means extending through said opening, gas sealing means connecting said fuel nozzle means with said wall adjacent said opening, the combustion chamber end of said nozzle means being positioned in spaced aligned relation to the adjacent small end of said cone member to provide therewith a restricted annular air passage into said cone member from within said shell, said burner cone member including a flange portion at the larger end thereof, said flange portion being rigidly secured to said burner shell in sealed relation, a plurality of apertures formed within said flange portion forming a plurality of restricted passages into said combustion chamber from the space within said burner shell around said cone member, an arcuate series of flaplike shields lanced from said wall and bent at acute angles thereto toward said burner cone member to form in the wall circumferential directed openings shielded against the reverse flow of air therethrough by said shields, said openings being directed in the same circumferential direction, passageway means defining a combustion air passageway extending to the side of said wall opposite from said combustion chamber and having an impervious interconnection with the wall extending continuously around the wall to provide a resistance to the reverse flow of combustion air from said combustion chamber into said passageway substantially greater than the resistance to the normal flow of air therethrough toward said combustion chamber.

3. In a quiet operating combustion heater employing a heat exchanger, an improved burner comprising means defining an air-supply chamber, a combustion chamber, a burner shell interposed between said heat exchanger and the air-supply chamber and formed with a tubular wall defining an open forward end communicating with said heat exchanger and a rear end communicating with said air-supply chamber, a burner cone positioned within said burner shell and having the larger end opening into said combustion chamber and the smaller end opening toward said air-supply chamber, said larger end terminating in a flange portion, the outer edge of said flange portion being secured to said burner shell in sealing relation, a plurality of apertures formed within said flange portion, said cone and said burner shell defining an annular air passage therebetween, a transverse wall disposed to the rear of said smaller end of said cone and separating said cone and at least a portion of said burner shell from said air-supply chamber, an aperture formed in said transverse wall, a fuel nozzle positioned within said air-supply chamber and projecting through said aperture and sealed therewith for delivering liquid fuel to the interior of said burner cone, said transverse wall being formed with a plurality of circumferential directed openings located in the wall portions transversely offset from the smaller end of said cone, said openings being directed in the same circumferential direction, said wall portions including a plurality of stationary shields set at acute angles to said transverse wall in adjacent partially covering relation to said respective openings therein on the annular passage side thereof to provide a resistance to the reverse flow of gas therethrough substantially greater than the resistance to the normal flow of air therethrough toward said annular air chamber.

4. In a quiet operating combustion heater employing a heat exchanger, an improved burner comprising means defining an air-supply chamber, a burner shell interposed between said heat exchanger and said air-supply chamber and formed with a tubular wall defining an open forward end communicating with said heat exchanger and a rear end communicating with said air-supply chamber, a burner cone positioned within said burner shell and having the larger end directed toward said combustion chamber and the smaller end directed toward said air-supply chamber, said larger end of said cone terminating in first wall means extending generally transversely of said burner shell, the outer edge of said wall means being rigidly secured to said burner shell in sealing relation and having a plurality of apertures formed therein, said burner shell and said burner cone defining an annular air passageway therebetween, second transverse wall means disposed at the rear of said smaller end of said cone and separating said cone and at least a portion of said burner shell from said air-supply chamber, a fuel nozzle positioned in air-tight relation within said second transverse wall means for delivering liquid fuel to the interior of said burner cone, said second transverse wall means being formed with a plurality of circumferential directed openings located in the wall portions transversely offset from the smaller end of said cone, said openings being directed in the same circumferential direction, said wall portions including a plurality of stationary shields set at acute angles to said second transverse wall means in adjacent partially covering relation to said respective openings therein on the annular air passageway side thereof to provide a resistance to the reverse flow of gas therethrough substantially greater than the resistance to the normal flow of air therethrough toward said annular air passageway whereby combustion air flows from said air-supply chamber through said transverse wall openings to the annular air passageway, into the interior of said burner cone and out the forward end of said cone into said heat exchanger.

5. In a quiet operating combustion heater, the combination of a heat exchanger including generally cylindrical means defining a combustion chamber, a first burner shell having a forward end leading into said combustion chamber, a second burner shell coaxially posi-

tioned within said first burner shell and spaced therefrom to form an annular air passageway therebetween, said second burner shell having a forward end opening into said combustion chamber and a rearward end including a central opening formed therein, means coupling said shells at their forward ends and within said combustion chamber, a transverse wall disposed across the first burner shell to the rear of said second shell and fixedly attached to the rearward end of said second shell, said wall being spaced from the area of the rearward end of the second shell adjacent said central opening, a fuel nozzle extending through said transverse wall, the combustion chamber end of said nozzle being positioned in spaced aligned relation to the adjacent rearward end of said second burner shell to provide therewith a restricted annular air opening, and a series of flap-like shields formed from said transverse wall in the wall area intermediate of said shells, said shields being bent at acute angles toward said combustion chamber to form in said wall circumferential directed openings shielded against the reverse flow of air through said passageway by said shields, said openings being directed in the same circumferential direction.

6. In a quiet operating combustion heater, the combination of a heat exchanger including generally cylindrical means defining a combustion chamber, a first burner shell having a forward end leading into said combustion chamber, a second burner shell coaxially positioned within said first burner shell and spaced therefrom to form an annular air passageway therebetween, said second burner shell having a forward end opening into said combustion chamber and a rearward end including a central opening formed therein, means coupling said shells at their forward ends and within said combustion chamber, a transverse wall disposed across the first burner shell to the rear of said second shell and fixedly attached to the rearward end of said second shell, said wall being spaced from the area of the rearward end of the second shell adjacent said central opening, a fuel nozzle extending through said transverse wall, the combustion chamber end of said nozzle being positioned in spaced aligned relation to the adjacent rearward end of said second burner shell to provide therewith a restricted annular air opening, a series of flap-like shields formed from said transverse wall in the wall area intermediate of said shells, said shields being bent at acute angles toward said combustion chamber to form in said wall circumferential directed openings shielded against the reverse flow of air through said passageway by said shields, said openings being directed in the same circumferential direction, and a casing housing said nozzle and including an air inlet, said casing being coupled to said first burner shell with the wall separating the casing and the first burner shell.

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