May 2, 1961 | R. A. ANDERSEN | 2,982,346

HIGH EFFICIENCY PORTABLE HEATER

Filed Nov. 6, 1958 | 2 Sheets-Sheet 1

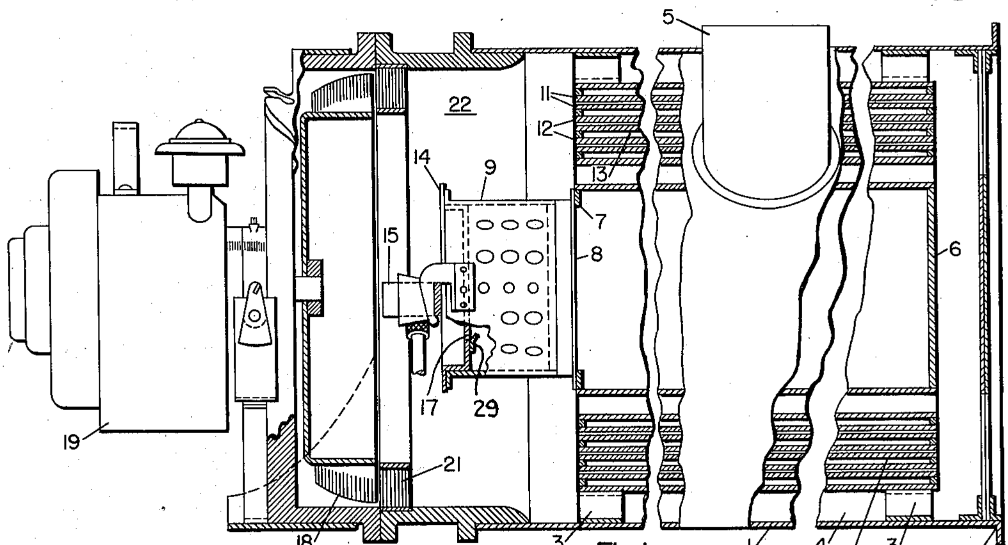

Fig. 1

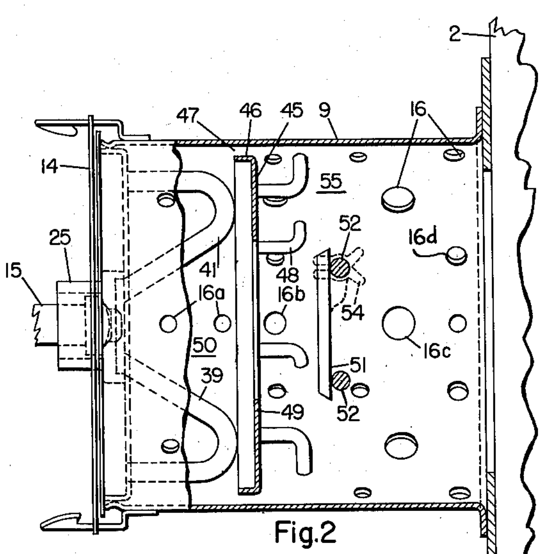

Fig. 2

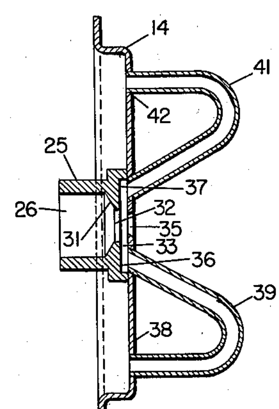

Fig. 3

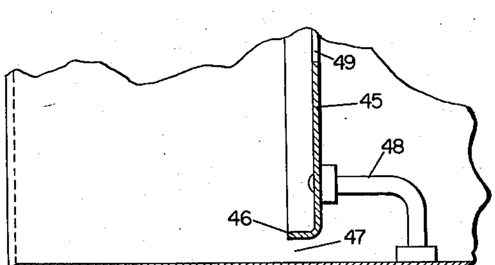

Fig. 7

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HIGH EFFICIENCY PORTABLE HEATER

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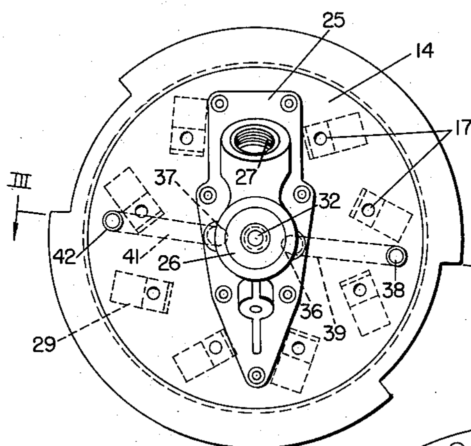

Fig.4

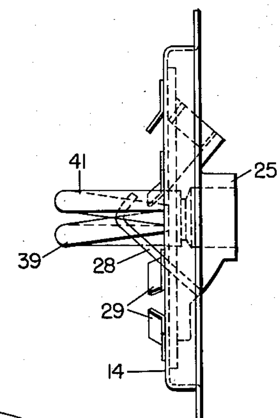

Fig.5

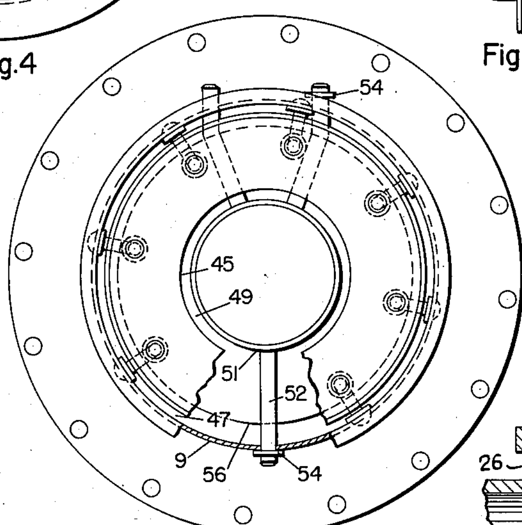

Fig.6

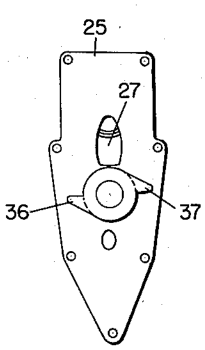

Fig.9

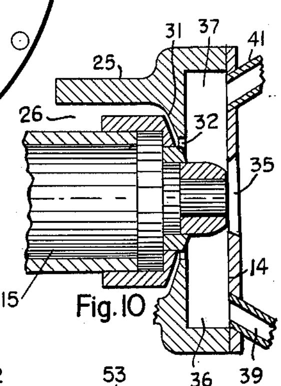

Fig.10

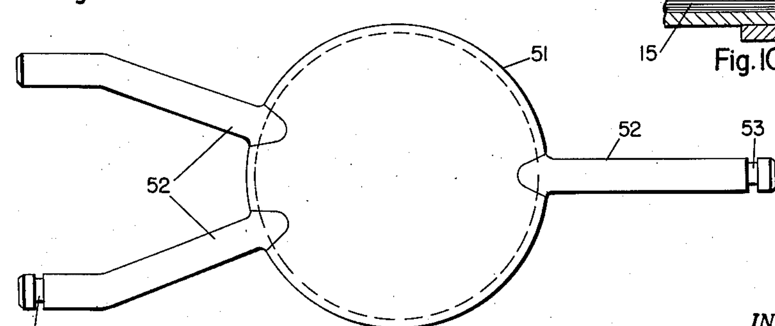

Fig.8

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HIGH EFFICIENCY PORTABLE HEATER

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Filed Nov. 6, 1958, Ser. No. 772,378

9 Claims. (Cl. 158—4)

The present invention relates to improvements in portable air heaters, particularly, of the type illustrated in the specification and drawings of the application for uatent of Arthur F. Hubbard, Serial Number 251,215, filed October 13, 1951 for Portable Heater, now Patent No. 2,744,516 granted May 8, 1956, and is a continuation in part of my application Serial No. 514,578 filed June 10, 1955 now United States Patent 2,897,814, granted Aug. 4, 1959.

Heaters of this type employ gasoline as fuel and are intended for use in Arctic climates where air temperatures as low as —65° are encountered. One difficulty encountered is that when ice crystal suspensions are present in the air at low atmospheric temperatures, ice builds up around the burner nozzle in the combustion chamber and interferes with the flow of the fuel sprayed into the chamber. Another difficulty encountered is that because the combustion chamber is short, combustion may extend into the heat exchanger so that the heat exchanger is subject to excessively high temperatures in spots and to the eroding action of the flame, which reduces its effective life, and also, carbon is deposited on the walls of the exchanger and reduces heat transfer.

An object of the present invention is to prevent heating the metal of the heat exchanger to excessive temperatures.

Another object is to confine combustion substantially to the combustion chamber so as to prevent or reduce erosion of the heat exchanger surfaces.

In accordance with one feature of the invention, combustion is improved and confined to the combustion chamber by a series of baffles. The preferred arrangement comprises an annular baffle ring spaced from the wall of the combustion chamber so as to allow flow of heated air around the exterior edge of the ring; in conjunction with a target baffle in alignment with the central opening of the annular baffle, to spread the flame, and a throttling baffle at the end of the combustion chamber. By confining combustion to the combustion chamber, erosion of the heat exchanger walls is greatly reduced or eliminated.

The invention will be described in greater detail in the following specification taken in connection with the accompanying drawing illustrating preferred embodiments of the invention by way of example, and wherein:

Figure 1 is a fragmentary view, partly in section, of a heater to which the invention pertains;

Figure 2 is an enlarged plan view, partly in section, of the combustion chamber showing the invention applied thereto;

Figure 3 is a sectional view taken on line III—III of Figure 4 with the burner nozzle omitted;

Figure 4 is an end elevation of the combustion chamber cover, as seen from the left of Figure 2;

Figure 5 is a side elevation of Figure 4, viewed from the left;

Figure 6 is a front elevational view with parts broken away, of the combustion chamber;

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Figure 7 is a detail of the annular plate;

Figure 8 is a front elevation of the baffle plate;

Figure 9 is a front elevation of the nozzle mounting casting; and

Figure 10 is an enlarged fragmentary section of the nozzle and nozzle mounting casting.

Referring to the drawing, in Figure 1 there is partly diagrammatically illustrated a type of heating apparatus to which the invention relates. The heater comprises an outer cylindrical jacket 1 having a cylindrical heat exchanger 2 within the jacket held in spaced relation thereto by U-shaped braces 3 so as to provide an air passageway 4 between the outer jacket and the outer wall of the heat exchanger. The heat exchanger has a cylindrical peripheral wall with an opening therein where the stack 5 is attached, and has end walls 6 and 7, the latter providing an opening 8 where the combustion chamber 9 is attached in any suitable manner. The heat exchanger is made up of tubes 11 extending longitudinally and lune-shaped in cross section, the tubes being arranged spirally and providing passageways 12 for flow of air to be heated through the heat exchanger. Between the tubes are spaces 13 extending spirally to the periphery so as to carry the products of combustion to the stack.

The combustion chamber 9 carries a detachable cover plate or cap 14 in which is secured a suitable burner nozzle 15, and varying sized apertures 16, and relatively small aperture 17 (Figs. 2 and 4) are provided in the cylindrical wall and cover respectively of the combustion chamber for admission of air to support combustion. The air is supplied by a fan or blower 18 (Fig. 1) driven by a suitable motor 19, the fan and motor being detachably mounted as described and claimed in the first application above identified.

The fan directs air past the straightening vanes 21 into a plenum chamber 22. From this chamber air flows into the air passages 4, 12, of the heat exchanger, and through the varying sized apertures 16, in the wall and the relatively small apertures 17 in the cover 14 of the combustion chamber. A suitable duct, not shown, may be connected to the end 23 of the heater to conduct heated air where desired.

Heaters of this type are designed to be operated in arctic regions, where atmospheric temperatures as low as —65° are encountered, and employ gasoline as the fuel. Notwithstanding the high temperature attained in the combustion chamber, the cold gasoline sprayed under pressure from the nozzle cools the nozzle so that moisture freezes thereon and builds up a cylinder of ice that interferes with the proper flow of fuel spray from the nozzle. The feature of the invention directed to preventing ice formation about the nozzle now will be described.

Referring to Figure 4, the dished cover 14 of the combustion chamber has a casting 25 riveted thereto which provides a middle opening 26 to receive the burner nozzle 15, and has an upper threaded opening 27 to receive a spark plug not shown. An electrode 28 is carried by the casting for cooperation with the spark plug. Sloping baffles 29 are welded to the inside surface of the cover to deflect air entering the relatively small holes 17, centrally toward the nozzle. The opening 26 has a tapered seat 31 (Figure 3) at its ends against which the nozzle abuts, and the nozzle passes through opening 32 and extends partly into chamber 33. The nozzle 15 terminates in a face 34 (Fig. 9) surrounding an orifice which directs a fine spray through the opening 35 in the cover into the combustion chamber. Chamber 33 has recesses 36, 37 which merge tangentially with the chamber.

The cover has an opening 38, and a generally U-shaped tube 39 has one end in this opening, secured thereto as by welding, the oher end of the tube passing through an opening in the cover into recess 36 of the chamber

33. A similar U-tube 41 extends from opening 42 into chamber 33. It will be seen that the tubes 39, 41 extend into the combustion chamber so that, air supplied by blower 18 enters the tubes by openings 38, 42 and is heated as it passes through the tubes. The air thus heated is discharged into chamber 33 to heat the fuel nozzle tip enough to prevent ice build up on the nozzle. By having the heated air enter chamber 33 more or less tangentially, the interference with the spray issuing from the nozzle is minimized, and the heated air has a better and more extensive wiping action.

Adjacent the nozzle end of the combustion chamber is mounted an annular plate 45 extending diametrically across the chamber, and having its flanged outer edge 46 spaced from the chamber wall as indicated at 47. This plate is constructed of a heat resistant alloy, such as, for example, "Hasteloy X," which is an alloy of chromium, nickel and silicon. It is supported from the wall of the combustion chamber by a series of angular rods 48 riveted at one end to the plate and at the other end to the wall of the combustion chamber 9. The plate 45 is so located, and the opening 49 in the plate is of such size as to allow part of the fuel spray to pass through, and part to impinge against the plate, so the part of the chamber between this plate and the cover provides a forward combustion zone 50 in which air entering of the relatively small holes 17 in the cover and the relatively small holes 16*a* in the forward combustion zone is mixed with the fuel.

Beyond plate 45 in alignment with the opening 49 is located a second imperforate flanged plate 51 supported from the wall of the combustion chamber by rods 52 which extend through openings in the chamber wall. The plate 51 is also constructed of a heat resistant alloy, such as, for example, the "Hasteloy X" referred to above. Certain of the rods 52 are grooved as indicated at 53, and receive a spring clip 54 to hold the rods in place. The third rod floats free to allow for temperature contraction or expansion changes.

The imperforate baffle plate 51 should preferably be of a peripheral configuration that corresponds with that of the aperture 49 in the annular baffle plate 46. Moreover, it is desirable that the extent or size of said plate 51 in dimension transverse to the longitudinal axis of the combustion chamber 9 approximate that of the aperture 49 and preferably, as illustrated in the drawings, be of a transverse dimension that is somewhat less than that of the aperture 49.

The openings 16*a* in the wall of the combustion chamber disposed intermediate the annular baffle plate 45 and the cover plate 14 are made relatively small. In contradistinction therewith, at least a plurality of the apertures disposed in the portion of the combustion chamber wall disposed on the downstream side of the baffle plate 45 are made appreciably larger, such as the illustrated (Figure 2) openings 16*b* located in the combustion chamber wall intermediate the annular baffle plate 45 and the imperforate baffle plate 51 and the openings 16*c* located in the combustion chamber wall intermediate the imperforate baffle plate 51 and the orifice plate 56 that is disposed at the junction of the combustion chamber 9 and the heat exchanger 2. The large apertures 16*b* and 16*c* thus permit the major portion of combustion air to be introduced downstream of the annular baffle plate 45.

The above described sizing and spacing of the baffle members 45 and 51 together with the number and location of the varying sized apertures 16*a*, 16*b* and 16*c* cooperate to contribute materially to the advantages and results that flow from practice of the herein described invention.

One of the advantages obtained through utilization of the above described structure and structural interrelationships is a combustion unit employing a constant flame and in which modulation of the volume of fuel is utilized for temperature control purposes. In a unit of the character described, fuel turndown ratios in the order of about 10 to 1 or greater are obtainable, thus providing a degree of control that has not been heretofore obtainable in combustion structures constructed in accordance with the teachings of the art.

In order to obtain the turndown ratios of the order specified above it is necessary to permit the introduction of sufficient air to burn the minimal amounts of fuel introduced and to introduce said air in such manner as not to snuff out a small flame. Also, since at very low temperatures gasoline will not vaporize, it is necessary to start combustion by the amount of heat produced at the spark electrode gap. If excess quantities of air are introduced adjacent the spark gap enough heat will not be generated there in opposition to the low air temperatures to vaporize the fuel as well as to ignite the same. Consequently it is also necessary to introduce the air in such manner as to permit vaporization and ignition when extremely small quantities of fuel are being introduced.

These desirable objectives are readily achieved in the disclosed structure and structural interrelationships. Inherent in the above described construction is the provision of the forward combustion zone 50 which includes that portion of the combustion chamber 9 disposed intermediate the annular baffle plate 45 and the cover plate 14. This structure serves as a means to effectively contain an extremely small flame when the amount of fuel introduction is reduced and the volume of spray emerging from the nozzle is at minimal value. Cooperating to produce the above described novel results is the selective provision of only relatively small air intake openings 16*a* in the walls of the combustion chamber 9 in said zone 50 and the provision of only relatively small air intake openings 17 in the cover plate 14 with their associated deflecting plates 29 which are positioned to direct the intake air flowing through said aperture 17 away from nozzle 15 and the conically shaped spray emerging therefrom.

The number and sizing of the apertures 16*a* and 17 serve to limit the amount of low temperature intake air selectively introduced into the zone 50 to that sufficient to support combustion of minimal amounts of fuel and additionally prevents the spark gap ignition and vaporization problems mentioned above. The deflecting plates 29 serve to direct the incoming air away from the spray cone and away from the envelope of flame produced at low firing rates thus preventing snuff out thereof and still permit introduction of sufficient air into the zone 50 to mix with the fuel during periods of maximum fuel introduction. Without the above described structure forming the forward combustion zone 50 and the selective air intake means therefore the entire unit would run cold at low rates of fuel introduction and the cover plate 14 would, in turn, also become cold and the preheating of the nozzle would be defeated with resultant ice formation thereon and consequent inoperability of the unit.

Another advantage attendant the herein described structure is the minimization of the throwing of portions of the ambient or partially burnt gases to the outside shell of the combustion chamber wherein they are subjected to cooling the thereby cause deposits of partially combusted material as a result of arrested combustion. In combustion units of the confined combustion shell type such as herein conceived, the described baffle system contributes materially to the prevention of the flame from assuming a long, tongue-like configuration or torch shape, which produces so-called wet combustion wherein actual wet particles of unburned fuel plus fly ash particles emerge from the flame at high velocity and impinge upon the heat exchanger surfaces with a resulting deleterious and destructive acid corrosion effect. The disposition of the baffle 51 serves to prevent the flame from spiraling into a long narrow torch axially to the combustion chamber.

The baffles 45 and 51 in conjunction with the apertures 16*b* and 16*c* also contribute materially to the maintenance of the desired conical spray and flame pattern and to the attaining of complete combustion within the chamber 9 at locations removed from the inner shell surfaces. Under normal rates of fuel introduction the annular baffle plate 45 will intercept the peripheral portions of the conical spray and deflect the same back into the forward combustion zone 50 to increase the rate of heat transfer to the conduits 39 and 41 and thereby provide additional quantities of heat to prevent the icing effects on the nozzle occasioned by the increased passage of low temperature fuel therethrough. The baffle 51 will intercept the inner peripheral portions of the conically shaped spray passing through the aparture 49 and deflect the same outwardly into intimate engagement with the combustion air entering through the apertures 16*b*. The air entering through the apertures 16*b* in the form of jets aids in the complete combustion of the deflected spray and also contributes to the combustion thereof at a location spaced inwardly from the shell surface.

The above described sizing and spacing of the baffles 45 and 51 permits the major portion of the conical spray to pass the baffle 51 without impingement thereon and to come into proximity with the combustion air entering through the relatively large apertures 16*b* and 16*c* to effect complete combustion thereof. The orifice plate 56 cooperates with a final row of apertures 16*d*, which serve to furnish a curtain of combustion air through which the flame must pass before emerging from the combustion chamber 9. The plate 56 serves to prevent the flame from hugging the wall of the chamber 9 by forcing it inwardly wherein the above mentioned air curtain can mix therewith for final combustion before emergence from the combustion chamber. Also as was the case with the apertures 16*b*, the relatively large apertures 16*c* on the downstream side of the baffle 51 serve to permit the introduction of relatively large quantities of air which in turn aids in minimizing flame impingement upon the inner surface of the combustion chamber 9.

The annular baffle 45, in addition to defining the above described forward combustion zone 50, serves also to define a path for counter current air flow from the zone 55 to the zone 50 in the annular space 47 intermediate the flanged edge 46 thereof and the wall of the combustion chamber 9. Although the underlying reasons are not clearly understood, the provision of this counter current flow path and the induced flow of air therethrough from the zone 55 to the zone 50, appears to inhibit the tendency of the flame to assume an undesired torch pattern during relatively high rates of fuel introduction.

Having thus described my invention, I claim:

1. In an air heater, the combination comprising an elongate cylindrical combustion chamber having a perforate circumferential outer wall for admission of air thereinto, and open at one end to provide communication with an adjacent heat exchanger, a spray burner centrally disposed at the opposite end of said chamber in substantial axial alignment with the longitudinal axis thereof for introducing a conically shaped spray of fuel into said chamber, an annular flame baffle plate disposed substantially perpendicular to the longitudinal axis of said chamber and intermediate said nozzle and the center of said chamber, said annular baffle plate shaped to provide a peripheral space intermediate its outer edge and the chamber wall and a central aperture whose defining edge is positioned to intercept and deflect the peripheral portion of said conically shaped spray of fuel and flame to maintain the same within the portion of the chamber disposed intermediate said burner and said annular baffle plate and to permit the central portions thereof to pass therethrough, a second flame baffle plate sized to approximate the size of the aperture in said annular plate disposed substantially perpendicular to the longitudinal axis of said chamber and spaced from said annular baffle plate so as to be struck by a portion of the flame passing through said aperture therein; and means for forcing air through said perforate outer wall into said combustion chamber to support combustion of the fuel introduced therein.

2. In a heater, the combination comprising an elongated hollow casing defining a combustion chamber provided with an end wall at one end, a nozzle centrally mounted on said end wall to introduce a conically shaped spray of fuel into said casing, an annularly shaped flame baffle plate disposed substantially perpendicular to the longitudinal axis of said chamber and spaced from said nozzle a distance permitting its aperture defining inner edge to intercept and deflect the outer peripheral portion of said conical spray and a flame baffle disc disposed substantially perpendicular to the longitudinal axis of said chamber and spaced from said annular baffle plate a distance permitting the same to intercept and deflect the inner portion of said spray passing through said annular baffle plate.

3. The combination as set forth in claim 2 including orifice defining means disposed at the end of said chamber remote from said end wall and adjacent air curtain forming means to insure complete fuel combustion adjacent thereto at a location removed from said combustion chamber surface.

4. In an air heater the combination comprising an elongate cylindrical combustion chamber having a perforate circumferential wall for admission of air thereinto, a cover plate closing one end of said chamber having a fuel spray burner mounted thereon for introducing a conically shaped spray of fuel into said chamber, an annular baffle plate disposed substantially perpendicular to the longitudinal axis of said chamber and in spaced relation intermediate said cover plate and the center of said chamber to define a forward combustion zone disposed therebetween, said annular baffle plate having a centrally disposed aperture therein with its aperture defining inner edge positioned to intercept and deflect the outer peripheral portion of said conical spray to maintain the same within said forward combustion zone and to permit the central portion thereof to pass therethrough, the circumferential wall of said combustion chamber having relatively small perforations therein in the portion thereof included in said forward combustion zone and relatively large perforations therein downstream of said annular plate for limiting the amount of combustion air introduceable into said zone to support selective combustion therein at relatively low rates of fuel introduction to said burner.

5. The combination as set forth in claim 4 wherein said cover plate includes a plurality of relatively small perforations therein disposed remote from said burner and means adjacent said apertures to deflect the air introduced therethrough toward the circumferential wall of said combustion chamber.

6. In an air heater, the combination comprising an elongate cylindrical combustion chamber having a circumferential wall with a plurality of apertures therein for admission of air thereinto, and open at one end to provide communication with an adjacent heat exchanger, a spray burner centrally disposed in a cover plate closing the opposite end of said combustion chamber in substantial alignment with the longitudinal axis thereof, said burner having nozzle means formed to introduce a conically shaped spray of fuel into said chamber, an annularly shaped flame baffle plate disposed substantially perpendicular to the longitudinal axis of said chamber and positioned intermediate said cover plate and the center of said chamber and defining, with said adjacent portions of said chamber, a forward combustion zone disposed therebetween, said annularly shaped baffle plate defining a central aperture sized to intercept and deflect the peripheral portion of said conical spray and permit the central portion thereof to pass therethrough, a second flame baffle plate sized to approximate the size of the

aperture in said annular baffle plate and of a similar shape therewith disposed substantially perpendicular to the longitudinal axis of said chamber and spaced from said annular baffle plate so as to be struck by the inner peripheral portion of the flame passing through said aperture therein, said combustion chamber having a plurality of relatively small apertures therein the portion thereof defining said forward combustion zone and a plurality of relatively large apertures therein in the portion thereof disposed intermediate said annular baffle plate and said open end for effecting the majority of air introduction into said chamber through said relatively large apertures and means for forcing air through said apertures to support combustion of fuel introduced into said combustion chamber.

7. The combination as set forth in claim 6 wherein said cover plate includes a plurality of relatively small perforations therein disposed remote from said burner and means adjacent said apertures to deflect the air introduced therethrough circumferentially adjacent the inner surface of said cover plate.

8. The combination as set forth in claim 6 including orifice defining means disposed at the open end of said chamber and adjacent to a plurality of apertures to insure mixture of said fuel with air introduced through said apertures and complete combustion of fuel at a location removed from said combustion chamber surface.

9. The combination as set forth in claim 2 wherein said casing is provided with a plurality of relatively small perforations in the portion thereof disposed intermediate said annularly shaped baffle plate and said end wall to admit relatively small amounts of combustion air to the portion of said chamber defined thereby and a plurality of relatively larger perforations in the portion thereof disposed intermediate said annular baffle plate and said baffle disc to admit relatively larger amounts of combustion air to the portion of said chamber defined thereby.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 2,982,346 May 2, 1961

Ralph A. Andersen

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 1, line 18, for "uatent" read -- patent --; line 30, before "flow" insert -- proper --; column 2, line 71, for "oher" read -- other --; column 4, line 63, for "the" read -- and --; column 5, line 15, for "aparture" read -- aperture --; column 7, line 7, after "therein" insert -- in --.

Signed and sealed this 17th day of October 1961.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

DAVID L. LADD
Commissioner of Patents

USCOMM-DC