

[54] **TWO CHAMBER FUEL BURNER**

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Related U.S. Application Data

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[52] U.S. Cl. **263/19 A, 431/9, 431/173**

[51] Int. Cl. **F23I 9/04**

[58] Field of Search **431/5, 9, 173, 10, 265; 263/19 A; 60/39.65**

[56] **References Cited**

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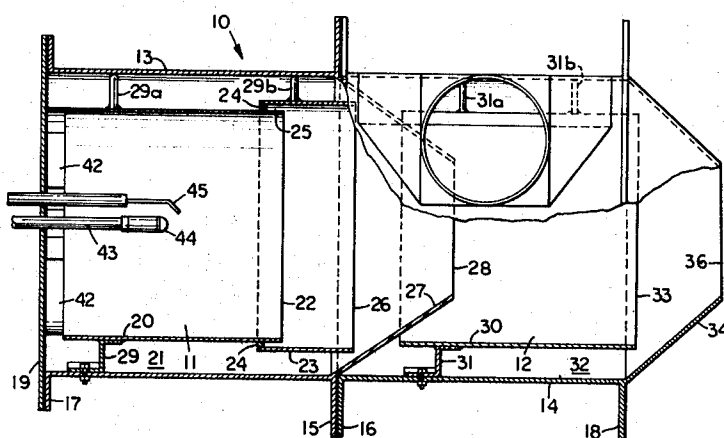
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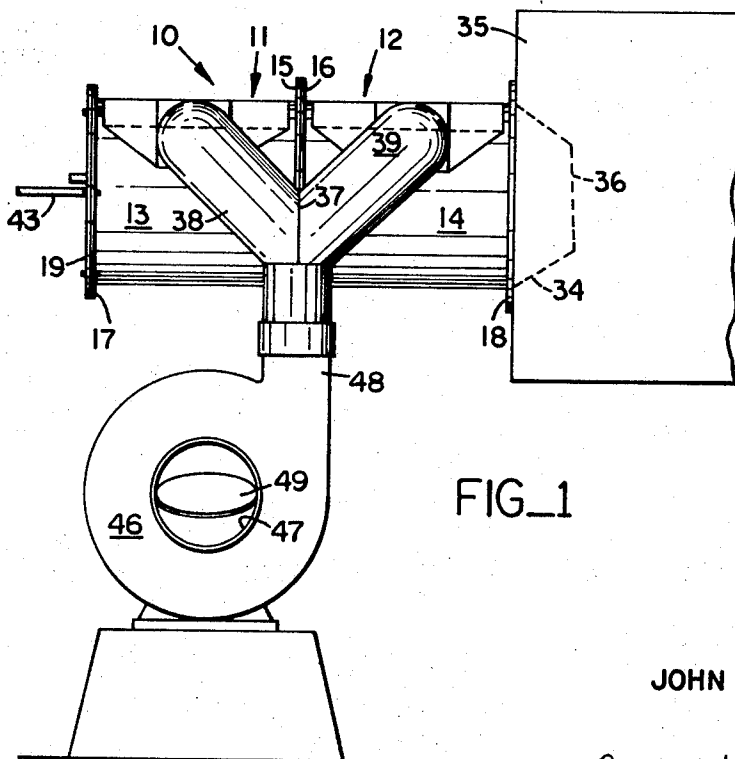
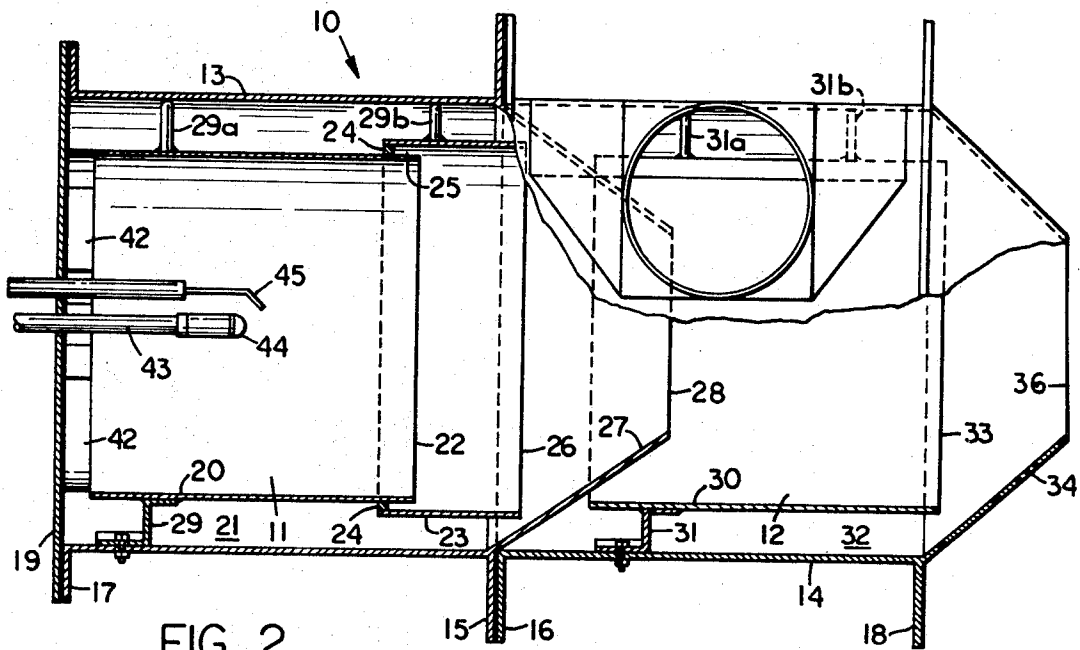
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ABSTRACT

This two-chamber burner delivers completed combustion. Two flanged housings are joined together, one for each chamber, and both chambers have long narrow rectangular tangential air inlets into their cylindrical housing. The first chamber has a fuel inlet for gas or oil and a first cylindrical baffle spaced axially from the end wall and radially from the housing to provide an annular air inlet chamber. Air scoops connect air from the space between the housing and baffle into the interior space inside the baffle. When using oil as the fuel, a second baffle is spaced near the end of this first baffle, with an overlap, and is of greater diameter. It terminates near a first conical shell that leads into a second chamber, where it is surrounded by a further cylindrical baffle, also spaced from the housing to provide an annular chamber, into which the air inlet for that chamber opens. This further baffle terminates near a second frustoconical shell that leads into a boiler or other such device.

5 Claims, 6 Drawing Figures





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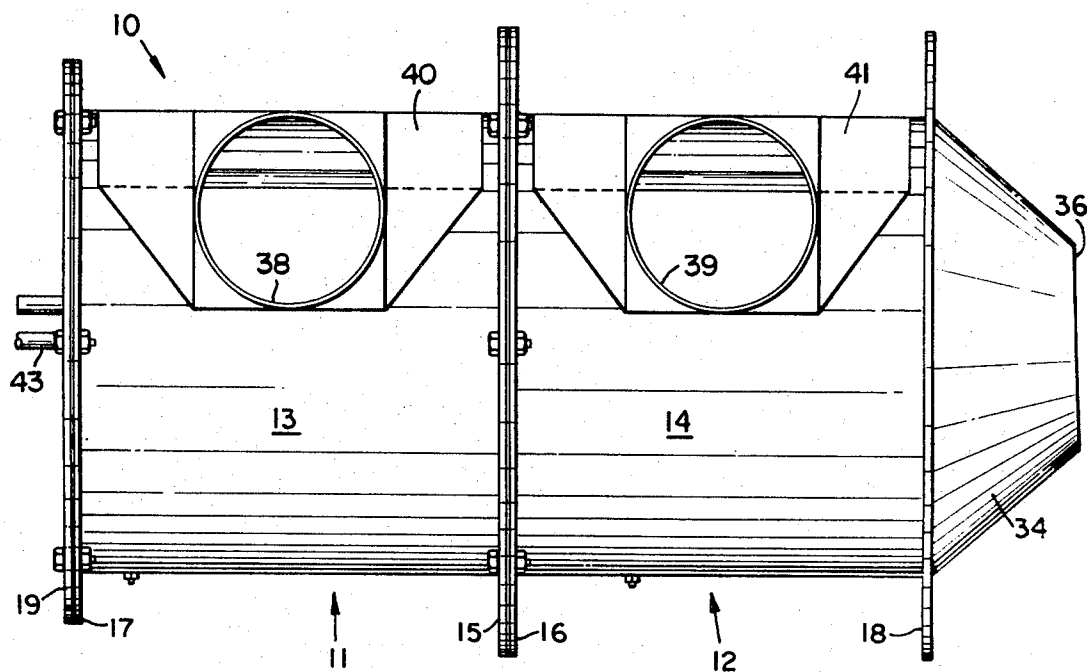


FIG. 3

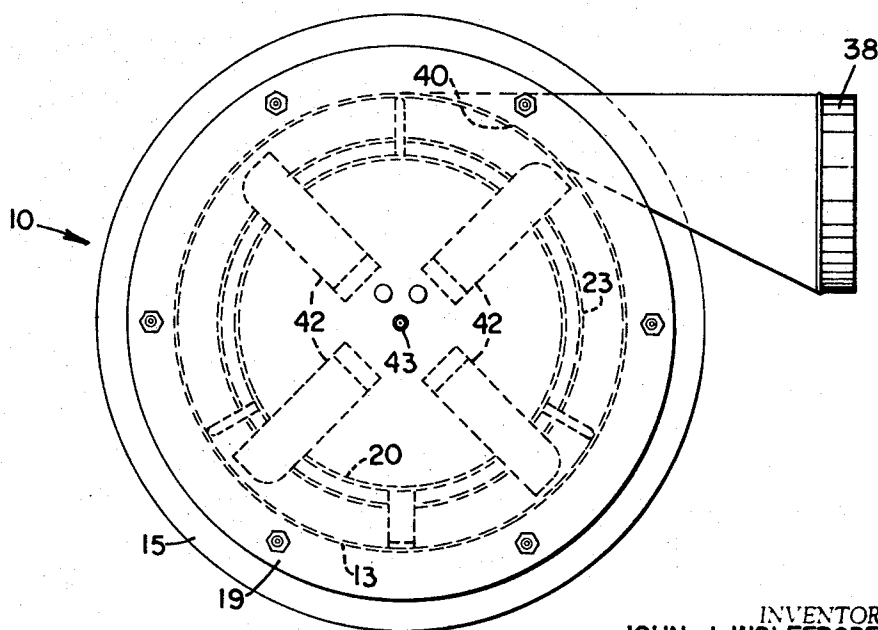


FIG. 4

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FIG_5

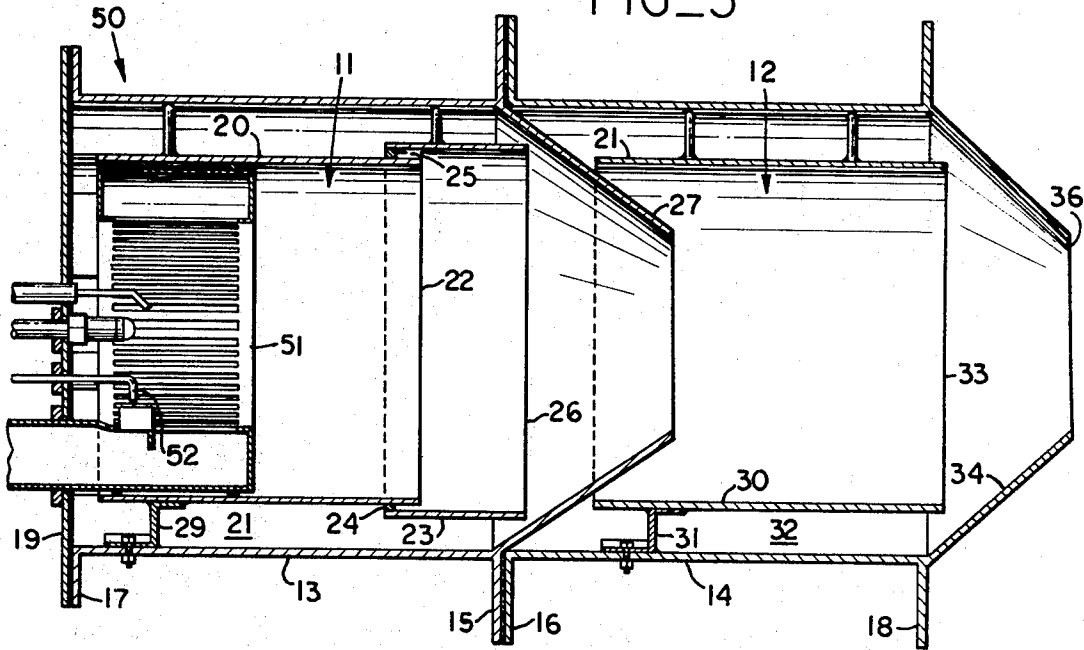
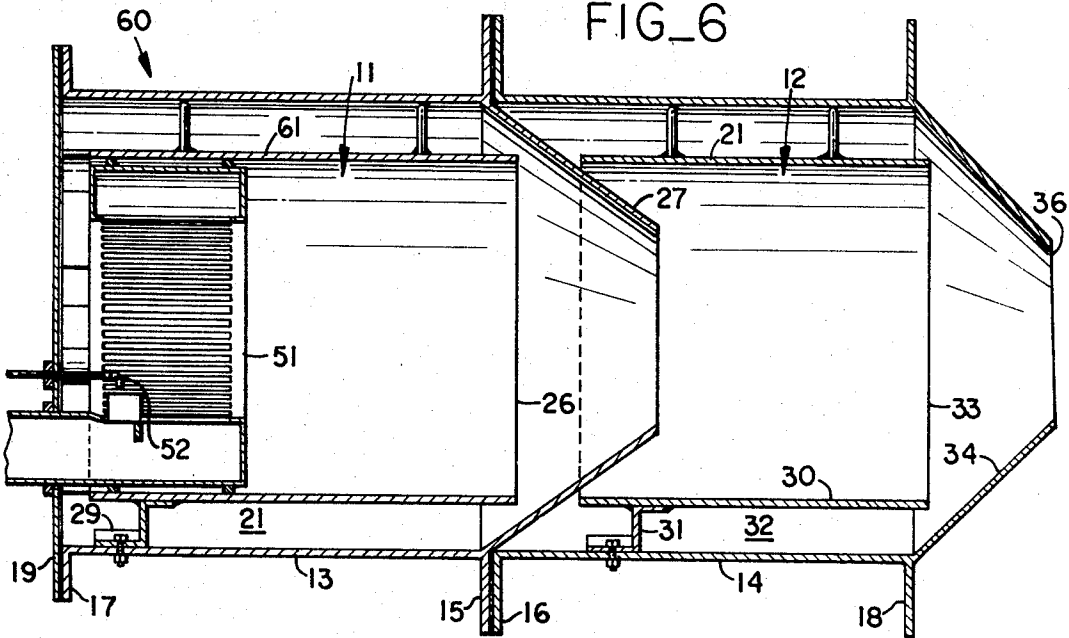


FIG_6



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TWO CHAMBER FUEL BURNER

This application is a division of application Ser. No. 806,357 filed Mar. 12, 1969, now U.S. Pat. No. 3,539,284.

This invention relates to an improved burner; one form is used for burning oil, another for burning gas, and a third form for burning either oil or gas.

The invention may be considered as constituting an improvement over the burner shown in my U. S. Pat. No. 2,787,318 and also as an improvement over the burners shown in my U.S. Pat. No. 3,266,549 and No. 3,276,693.

The previous burners, which are very good ones, have in some instances encountered problems for which they were not adapted and which the present invention solves. For example, the two-chamber burner of U. S. Pat. No. 2,787,318 was primarily designed for use in drying forage crops and vegetables. These materials required that a large volume of excess air be mixed with the hot products of combustion in order to cool the products of combustion, so that the material being dried would not catch fire or be burned or scorched. Hence, the volume of the flame discharged from the first chamber into the second chamber was only a small fraction of the volume of the excess air that was introduced into the second chamber; the result was that in the second chamber the spirally flowing air thoroughly enveloped the flame until the flame and the air were finally thoroughly mixed and were combined in passing through the outlet throat. When attempts were made to use the two-chamber burner of U. S. Pat. No. 2,787,318, in conjunction with a boiler where the desirable maximum of excess air for good efficiency does not exceed 20 percent to 30 percent, it was found that the amount of air that could be spared from the first chamber for introduction into the second chamber was so small that its spiral flow was immediately nullified by the larger volume of fast centrally flowing flame, and that this small flow of spirally moving air passed through the chamber outlet stratified on one side of the flame, whereas on the other side of the flame a carbon deposit was built up on the tube sheet. The present invention solves this problem and gives, without any further addition of air and therefore without any interference with complete combustion, an operation which does not cause any carbon deposit to build up on the tube sheet or in the tubing of the succeeding boiler or heat exchanger.

In my U. S. Pat. No. 2,787,318 there were a circular tangential air inlet to the first chamber and a rectangular tangential air inlet to the second chamber; each of these inlets was close to the rear end of its chamber and delivered spirally flowing air which enveloped the flame, but with a diminishing velocity toward the forward end of the burner tubes. This weaker velocity was satisfactory with the distilled fuel oil formerly in use, but with currently available fuel oils it is not strong enough to prevent the deposition of catalyst slag in the forward portion of the first chamber sleeve. Also, in the second chamber this diminished velocity was not strong enough at the forward end of the chamber to insure proper mixture of the air and the fuel needed for final completion of the combustion. In the present invention the air is delivered at maximum velocity for the full length of each chamber and these difficulties have been overcome.

In addition, there is easier access to the inside of each chamber and adjustment is simplified.

A single chamber oil burner, such as shown in my U. S. Pat. No. 3,276,693 will burn completely all the older types of conventional fuel oil, and it will burn completely what is known as No. 1 diesel oil, if this oil is atomized at a pressure of 250 to 300 psi. However, the single chamber burner will not properly accommodate No. 2 diesel oil, (even at a higher 300 psi atomizing pressure). The two-chamber burner of this invention will burn all of these fuel oils completely and will discharge products of complete combustion that are thoroughly mixed with high percentages of excess air, a cooled mixture that can be used to dry combustible material by direct contact without heat damage to the materials. By delivering complete combustion, the burner of this invention makes it

possible to obtain a 100 percent utilization of a single-pass dryer drum.

One of the main features of the two-chamber burner of this invention is that practically all the heat developed by the combustion that takes place in the second chamber, is augmented by practically all the heat developed in the first chamber, and none of this total is spread out and transferred to water until all combustion is completed and passed through the second chamber outlet throat. This makes all the heat available to be utilized for complete burning of the heavier and harder-to-burn oils. With the single chamber burner, the flame and hot gases, after passing through the restricted outlet throat, are spread, and some heat (mostly radiant heat) is transferred through the water-jacketed walls of a combustion chamber during completion of combustion. The lighter, easier-to-burn oils can spare this heat efficiently because they are volatile at lower temperatures.

A further advantage of the two-chamber burner of this invention is that it is not limited, in conversion use, to conventional fire-tube boilers, for it can be beneficially used in greatly increasing the capacity of all types of water-tube boilers and all types of unconventional oil-fired and gas-fired boilers and heaters.

Also, my gas burner of U. S. Pat. No. 3,266,549 and my combination oil and gas burner of U. S. Pat. No. 3,276,693, while generally giving excellent results cannot give the improved results obtainable by the burning of the present invention, especially where space is at a premium.

In the oil burner and in the combination burner of this invention, the baffle sleeve of the first chamber is modified along the lines of the split sleeve design of my U. S. Pat. No. 3,276,693 to give a new result in a two-chamber burner. Then, an important new baffle sleeve is added in the second chamber of the two-chamber burner of this invention. This new baffle sleeve is spaced to take about one-third of the air passing through the second chamber inside the sleeve and about $\frac{2}{3}$ around its outer surface. Thereby, a strong velocity of flow, entering the conical outlet fitting, breaks up the stratified flow and solves the problem already noted, so that no carbon deposits build up on the tube sheet or in the tubing.

The tangential air inlets of the first and second chambers are both made to extend practically the full length of their burner tubes, in order to deliver the highest velocity air around the flame at each end of the baffle sleeves. The vertical measurements of these air inlets are made such that the air from the fan is split and is delivered in the volumes desired for each chamber. Thus, dampers can be eliminated from the Y-fitting connecting the fan to the two chambers, and the air in both chambers can then be adjusted by a single damper in the fan inlet. Two separate burner tubes, joined together with flanges, take the place of the continuous single burner tube of former burners.

With oil burners and with combination burners when oil is being burned, these improved air inlets cooperate with a baffle sleeve modification in the first chamber that delivers high-maximum velocity air around the inside of the forward auxiliary sleeve, to prevent catalyst slag deposition on the inside surface of the auxiliary sleeve, thereby solving that problem too.

Other objects, advantages and features of the invention will appear from the following description of a preferred embodiment.

FIG. 1 is a view in side elevation of a burner embodying the principles of the present invention and connected to a boiler housing, of which only a fragment is shown.

FIG. 2 is an enlarged view in elevation and part section of the oil burner unit proper of FIG. 1.

FIG. 3 is a view in the scale of FIG. 2 in side elevation of the burner unit.

FIG. 4 is a view in end elevation looking from the left-hand end of FIG. 3.

FIG. 5 is a view in side elevation and in section of a modified form of burner embodying the principles of this invention, namely, a combination for burning either gas or oil.

FIG. 6 is a view similar to FIG. 5 of another modified form of burner embodying the principles of this invention for burning only gas.

A burner 10 of this invention in essence employs two combustion chambers 11 and 12 and may have separate cylindrical housings 13 and 14 therefor, so that a housing 14 may be assembled to a housing 13 to convert a standard single combustion chamber burner unit 11 into the double-chamber burner 10 of this invention, but the housing may instead be made in a single piece if that is desirable, though it is certainly less efficient. Thus, the housing 13 for the first chamber 11 is preferably joined by a flange 15 to a flange 16 of a housing 14 for the second chamber 12, and each of these chambers 11 and 12 have their respective end flanges 17 and 18. The first chamber 11 has its end flange 17 joined to an end member 19.

Inside the first chamber 11 (See FIG. 2) is a first cylindrical baffle or sleeve 20, which is spaced from the end plate 19 and also is spaced by an annular chamber 21 from the outer housing 13; the spacing may be provided by an anchor strap 29, welded to the sleeve 20 and bolted to the housing 13 and by a plurality (preferably three) of round steel spacer 29a welded at one end to the sleeve 20 only. At the far end 22 of the sleeve 20, a second annulus, baffle or sleeve 23 is spaced from the sleeve 20 by a plurality (preferably four) short, round spacers or supporting members 24, which are preferably welded to both sleeves 20 and 23 and provide a passage 25 in between the two sleeves 20 and 23 where they overlap. A plurality (preferably three) of round steel spacing rods 29b are welded to the outer surface of the sleeve 23 to continue the annular space 21 between the sleeve 23 and the housing 13. At the far end, the second sleeve 23 terminates at an edge 26 near, but spaced from the frustoconical shell or baffle 27 which leads into the second chamber 12 and terminates at an end 28 well inside another long sleeve 30, a third cylindrical sleeve or baffle from which it is spaced.

An additional cylindrical baffle or sleeve 30 is the single sleeve in this chamber 12 and is spaced from the housing 14 by an anchor strap 31 and a plurality (preferably two sets of three each) of round steel spacers 31a and 31b near each end to provide an annular air passage 32 around the sleeve 30. At the far end 33 of the sleeve 30 is another frustoconical shell 34 leading into the head of a boiler 35 and terminating well inside at an end 36.

An air compressor or fan 46 may be used to supply the air, having an inlet 47 and an outlet conduit 48. The outlet conduit 48 is provided with a Y-fitting 37 that is fully open and contains no dampers or other obstruction. The Y-fitting 37 branches into two, also unobstructed, conduits 38 and 39 which lead by two long rectangular inlets 40 and 41 (see FIG. 3) into the annular spaces 21 and 32 (see FIG. 2) around the respective shells 20 and 30 of the first and second chambers. These inlets 40 and 41 send the air in whirling because they are tangential. Both inlets 40 and 41 are substantially rectangular in cross section at the inlet port and extend almost the full length of their respective housings 13 and 14 and the full width of their respective air-inlet fittings. A series of air scoops 42 like those of U. S. Pat. 3,266,549 carry fractional splits of the air from the space 21 into the center portion of the first burner where the oil is fed in through a conduit 43 and nozzle 44 and where an igniter 45 is provided to insure ignition.

The combination burner 50 of FIG. 5 is identical to the burner 10 of FIGS. 1-4, except that it also incorporates a gas burner 51 like that of my U. S. Pat. No. 3,266,549 and a suitable gas igniter 52.

As in my U. S. Pat. 3,276,693, the second baffle 23 in the devices of FIGS. 1-5, delivers high-maximum velocity air around the inside of the forward sleeve 23 and thereby prevents the deposit of catalyst slag on the inside surface of the auxiliary sleeve 23.

By the addition of the additional sleeve 30 in the second chamber 12 and spacing it to take about $\frac{1}{2}$ of the second-chamber air through the sleeve 30 and about $\frac{2}{3}$ around the sleeve 30, the stronger velocity of flow entering the conical

outlet fitting 34 breaks up any stratified flow and avoids carbon deposits.

The long rectangular air inlets 40 and 41 cut in the burner tube or housing 13, have narrow vertical dimensions, (e.g., about $1\frac{1}{8}$ inches by $10\frac{3}{4}$ inches long, through this may be changed to go along with different burner capacities), and they deliver the air at maximum velocity for the full length of both chambers 11 and 12. This prevents the deposition of catalyst slag from fuel oil on the inside surface of the first chamber sleeve 23. Elimination of all dampers from the fan 46 to the inlets 40 and 41 prevents formation of an undesirable turbulence in the tangential air flow. There are no dampers in the Y 37 or in any of the conduits 48, 38, and 39. This also simplifies adjusting for operating, the only adjustment then required being to obtain the known requirement in pressure for the first chamber 11, by means of an air inlet damper 49 for the fan 46. The areas of the burner tubes air inlets are correctly proportioned in each specific size of burner unit 10, to supply the needed flow required by each chamber.

By using the flanges 15 and 16 and the two housings 13 and 14, it becomes easier to get inside each of the chambers 11 and 12, should that become desirable for maintenance or repair.

FIG. 6 shows a burner 60 for gas only, differing principally in the elimination of the oil nozzle 44 and igniter 45 and in the provision of a single cylindrical sleeve 61, longer than the sleeve 20, in the first chamber 11. There is no baffle corresponding to the baffle 23. There being no catalyst that could cause a deposit of slag when gas is burned, there is no need for the baffle 23 in a gas-only burner, though it does no harm, as shown by the combination burner 50.

In textbooks and in technical journals, it has been stated that a fair average volume of combustions space is two cubic feet per boiler horsepower. In the two-chamber burner of this invention, the volume of combustion space is less than 0.04 cubic feet per boiler horsepower. This remarkable and unpredictable reduction in combustion space to only one-fiftieth of what was heretofore believed to be necessary—2 percent of what was heretofore required—is accomplished by keeping the flame and all the heat of combustion wrapped around, throughout travel through the burner, by high-velocity, relatively thin sheets of spirally flowing combustion air in pre-planned splits. At the same time, the combustion air air-cools the burner and eliminates all need for insulation and refractory linings. These impressive results point up the significance of the structural changes and method procedures that comprise this invention.

To those skilled in the art to which this invention relates, many changes in construction and widely differing embodiments and applications of the invention will suggest themselves without departing from the spirit and scope of the invention. The disclosures and the description herein are purely illustrative and are not intended to be in any sense limiting.

I claim:

1. A method for burning fuel and air comprising igniting said fuel in air, and continuing to completion the combustion of the fuel and air in an axial core, while surrounding the flame and all the heat of the developed and developing combustion, from the locus of ignition to a locus of discharge of completed combustion, with relatively thin sheets of high velocity, spirally flowing air fed in a series of pre-planned splits most of which is utilized as combustion air, said step of flowing air in pre-planned splits including flowing air in an initial set of splits preceding the locus of ignition and conducting air radially inwardly toward the center and releasing it at about said center for flow in the direction toward the locus of discharge, flowing air in a second split preceding the locus of ignition in a cylindrical stratum surrounding that from the initial series of splits,

flowing air in a third split axially beyond said locus of ignition in a cylindrical stratum surrounding that from the initial and second splits and at a greater distance from said center,

flowing air in a fourth split about half way from said locus of ignition to said locus of discharge, coming in conically from beyond the last-mentioned said stratum and extending inwardly therebeyond toward the center to a restricted throat of smaller cross section than that of the combined first and second splits, Combining with the air brought in by said first three splits into a constricted cylindrical volume,

flowing air in a fifth split immediately thereafter, and flowing air in a sixth split adjacent the locus, combining with all previous splits while causing all the air to flow together into a final frustoconical shape terminating at said locus of discharge in a second restricted throat.

2. The method of claim 1 characterized by bringing in air in two main streams, a first for the first four said splits, and a second for the fifth and sixth splits, said streams each extending for substantially half the full length of said distance between said locus of ignition and said locus of discharge, and thus for substantially the full length of burning, said air all being brought in tangentially to a cylindrical area enclosing said combustion and being distributed in planned amounts to the splits.

3. The method of claim 2 comprising feeding both said air streams from a single fan without dampening flow in either air stream, so that the air is delivered at maximum velocity.

4. In a method of burning oil and air whereby the burner delivers completed combustion and comprising the steps of spraying oil axially of an annular zone, introducing a first supply of combustion air from one axial end of said zone at about the axial centerline thereof, introducing a second supply of combustion air in a general helical path from said one end farther from the axial center and closer to the inner periphery of the annular zone, introducing a third supply of combustion air at the other end of said annular zone in a generally helical path of larger diameter than said annular zone and in the same axial direction as first and second supplies, and introducing a fourth supply of combustion air beyond the introduction of said third supply and in the same axial direction along a first frustoconical path from a larger diameter than said third

supply to a smaller diameter than said second supply, the improvement comprising:

introducing a fifth supply of combustion air past said first frustoconical path in a generally helical path of about the same diameter as that of said second supply and the same axial direction of said first, second, third, and fourth supplies, and

introducing a sixth supply of combustion air beyond the introduction of said fifth supply and in the same axial direction along a second frustoconical path and from a diameter about the same as that of said third supply to a diameter about the same as that of the end of said first frustoconical path.

5. In a method of burning gas fuel and air whereby the burner delivers completed combustion and comprising the steps of introducing gas radially inwardly from an annular zone along a substantial length and along narrow axially extending radial jets, introducing a first supply of combustion air from one axial end of said zone at about the axial centerline thereof, introducing a second supply of combustion air in a generally helical path from said one end closer to the inner periphery of the annular zone, introducing a third supply of combustion air at the other end of said annular zone in a generally helical path of larger diameter than said annular zone and in the same axially direction as said first and second supplies, and introducing a fourth supply of combustion air beyond the introduction of said third supply and in the same axially direction along a frustoconical path from a larger diameter than said third supply to a smaller diameter than said second supply,

the improvement comprising:

introducing a fifth supply of combustion air past said first frustoconical path in a generally helical path of about the same diameter as that of said third supply and the same axial direction of said first, second, third, and fourth supplies, and

introducing a sixth supply of combustion air beyond the introduction of said fifth supply and in the same axial direction along a second frustoconical path and from a diameter about the same as that of said third supply to a diameter about the same as that of the end of said first frustoconical path.

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