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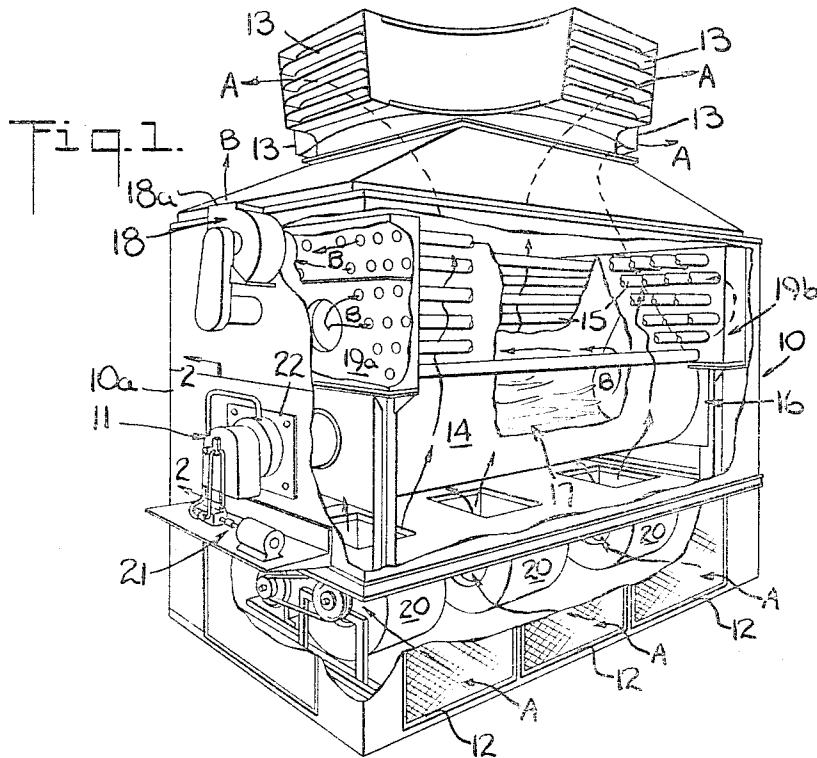
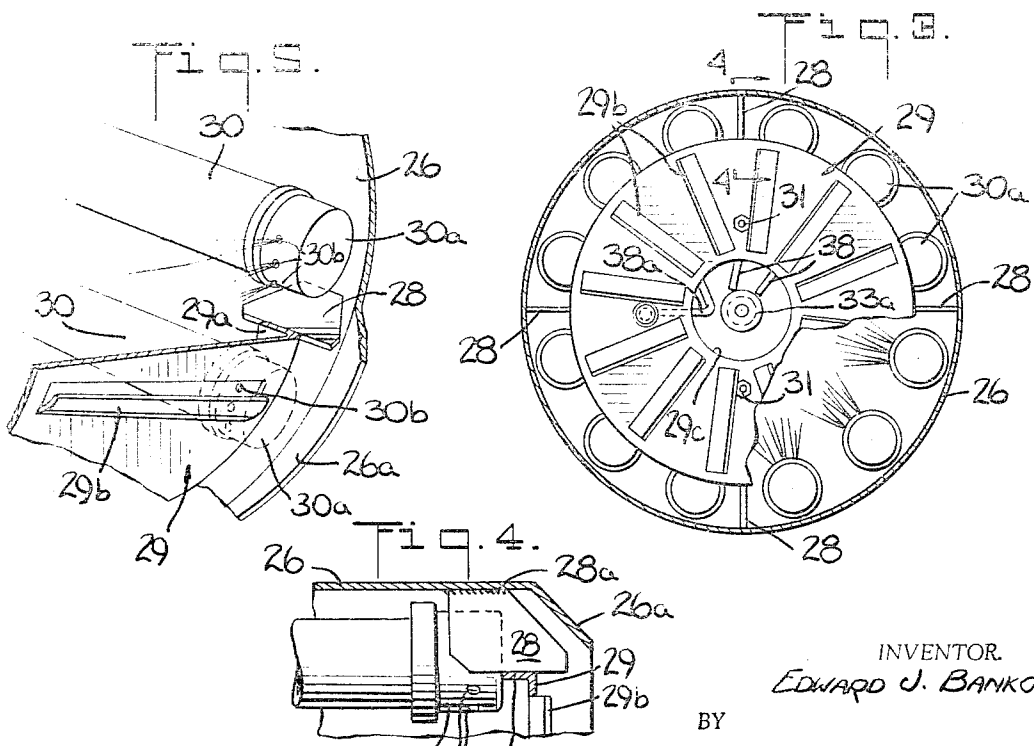
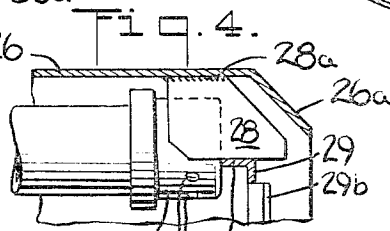
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COMBINATION GAS AND LIQUID FUEL BURNER

Filed April 15, 1965

2 Sheets-Sheet 1



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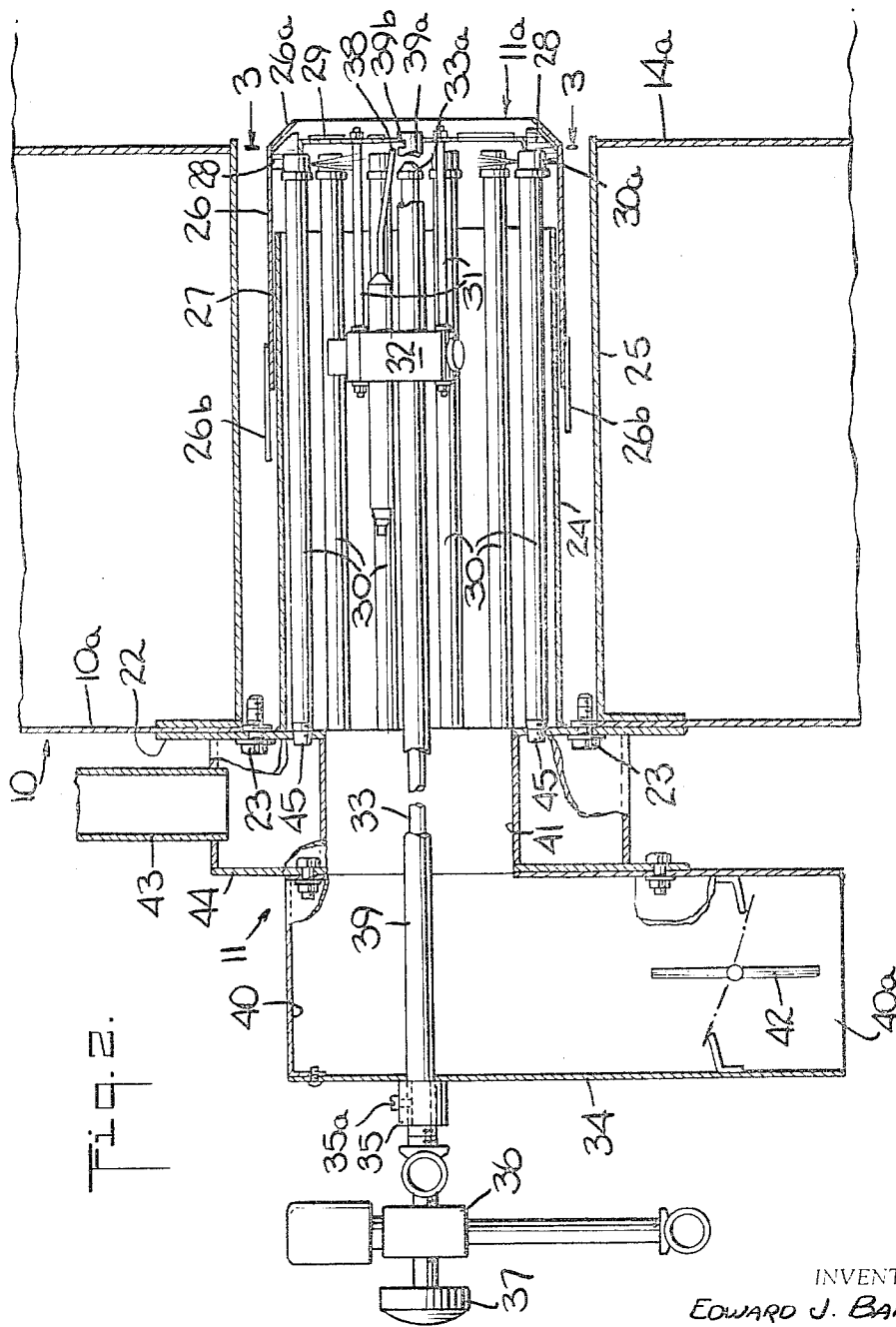
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COMBINATION GAS AND LIQUID FUEL BURNER

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2 Sheets-Sheet 2



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COMBINATION GAS AND LIQUID FUEL BURNER
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10 Claims. (Cl. 158—11)

This invention relates to fuel burner elements as used for firing space heaters or the like. More particularly, the invention relates to improvements in so-called combination burners, i.e., those capable of feeding and firing both gas and liquid fuel into the heater.

The invention in its preferred embodiment was made in connection with an effort to improve the combustion characteristics of combination burners of the raw fuel burning, induced draft type as used in multi-pass type space heaters. Accordingly, the invention will be described with relation to such use.

Induced draft, combination type fuel burners which burn raw fuel are known. In general, their advantages are that they are capable of feeding and burning either gas or oil, or a combination of both, without the necessity for premixing the fuel with any portion of the combustion air as would require auxiliary apparatus, and without the necessity of providing further auxiliary air blowers, ancillary ducting or the like to force-feed any of the air required for combustion.

A difficulty in prior burners of the type has been that, although at higher firing rates when operated on oil the burner produces efficient and quite combustion with good flame stability and flame cleanliness, those characteristics when operating on oil fired at low rate within the intended range of fuel combustion rates have not been satisfactory. In addition, and with regard to the same characteristics, previous combination burners have not achieved wholly satisfactory operation throughout the intended range of combustion rates when operated on raw gas, or a combination of gas and oil. It is therefore an object of the invention to improve the oil burning characteristics of such burners, especially at low firing rates, and the gas burning characteristics thereof throughout the range of operation of which the burner is capable.

Possibly in an attempt to provide equivalent characteristics of flame stability, cleanliness, and efficiency when used as either a gas burner or an oil burner, combination burners of the prior art incorporate somewhat complicated constructions and arrangements involving the provision of separate blast tubes, separate passageways and damper controls for primary and secondary air, and other features which, in effect, provide two completely separate burners within a common housing. It is apparent that such additional air dividers, dampers and the like appreciably increases the initial cost of manufacturing the burner, and require adjustments or other control and maintenance of the burner during operation as would otherwise not be necessary. Accordingly, by the present invention it is intended to improve the operating characteristics of the burner in the manner previously described, without the need for separating the combustion air into so-called primary and secondary air, and in such manner that the combustion air will be supplied by the same route whether the burner is fired by gas or oil, or both. In this connection, and specifically, it is intended that both the gas burning and the oil burning elements will be mounted within the same blast tube without the need for partitioning or otherwise complicating the latter. Thus, the invention provides a combination fuel burner which is less expensive both to initially manufacture and the subsequently repair and maintain, and which does not unduly complicate the steps required for its proper operation.

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Briefly describing the invention in its preferred embodiment, a hollow, plainly cylindrical blast tube of the elongated type is attached to the front plate of a burner housing of simplified construction, the latter comprising a combustion air chamber at its rearward end from which air is admitted to the rearward end of the blast tube, and a gas chamber in the form of a gas distribution ring situated between the combustion air chamber and the blast tube and which encircles the wide, central passage through which the combustion air flows to the blast tube. A damper is mounted within the combustion air chamber for metering the amount of outside air admitted to the chamber. At its forward end the blast tube mounts a combustion head or shroud cap which includes a peripherally disposed angulated shroud portion immediately forward of the blast tube. A stationary turbulator is situated within the combustion head at the rearward end of the angulated shroud zone, the turbulator being in the form of a centrally apertured ring-shaped disc of diameter somewhat less than that of the shroud cap and blast tube, and having radially extending turbulator blades formed therein. The reduced diameter of the turbulator relative to the diameter of the blast tube, and the size of its central aperture permits a major portion of the air, which flows by induced draft through the blast tube, to flow around and thereby by-pass the turbulator blades. Considering the size of the air openings afforded by the latter, the ratio of by-passed air to turbulated air is about 7.5:1.

The oil feeding element of the burner is mounted centrally along the longitudinal axis of the blast tube, and includes an oil-atomizing nozzle for introducing oil in a cone-shaped spray pattern at a location just rearward of the plane of the turbulator disc, the oil-burner nozzle being at the center of the rather large diameter central aperture of the turbulator as is formed by its ring shape. Thus, the spray of oil is mixed with turbulated air for ignition forward of the turbulator.

The gas burner element comprises an annular pattern of twelve longitudinally extending gas distribution pipes which are equally spaced apart in annular direction and mounted substantially adjacent the interior periphery of the cylindrical blast tube. The rearward ends of the gas distribution pipes are connected to the aforementioned gas distribution ring of the burner housing to receive gas therefrom, and their forward ends are respectively provided with caps having gas orifices which feed and distribute the gas in radially inward direction, within a transverse plane of the blast tube, at a location just rearward of the plane of the turbulator disc. Thus, the gas is admitted to be mixed with combustion air within the blast tube just prior to turbulence of at least a portion of the flowing mixture by the turbulator. Three gas-admitting orifices are provided in each gas distribution pipe at its forward end, the centermost orifice in each pipe facing inwardly and being aligned with a radius of the blast tube and the other two orifices being arcuately spaced 30° from the centermost orifice at the respectively opposite sides thereof and within the same radial plane of the gas distribution pipe.

It has been found that, in such combination fuel burners, this arrangement and location of the oil fuel nozzle and of the gas distribution pipes and orifices with respect to the turbulator effects measurably improved stability of flame, and cleanliness of combustion in the burner within the lower range of fuel combustion rates without detracting from the same characteristics at high combustion rates.

These and other objects, features and advantages of the present invention will become more fully apparent from the following detailed description of the invention

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wherein reference is made to the accompanying drawings, in which:

FIGURE 1 is a perspective showing of a multiple-pass type space heater which is fired by a combination fuel burner in accordance with the invention;

FIGURE 2 is an enlarged cross-sectional side view of a combination fuel burner in accordance with the invention as installed in the space heater and as generally seen from lines 2—2 of FIGURE 1, only a fragmentary portion of the heater being illustrated;

FIGURE 3 is a cross-sectional front end view of the fuel burner, as seen from line 3—3 of FIGURE 2, the view being to a somewhat further enlarged scale;

FIGURE 4 is a still further enlarged fragmentary sectional view taken at lines 4—4 of FIGURE 3 to illustrate certain details of the burner; and

FIGURE 5 is a fragmentary perspective view approximately to the scale of FIGURE 4, showing the front end of the burner to illustrate other details thereof.

Referring to the drawings, FIGURE 1 shows a multiple-pass type space heater 10 in which a combination fuel burner 11 in accordance with the invention may be installed for the purpose of heating air, indicated by arrow A, which flows through the heater from the air inlets 12 to the air outlets 13 thereof. The air A is drawn through the heater by three air blowers 20. As generally indicated on the drawing, the air A in its course through the heater 10 passes over and impinges upon the exterior walls of the combustion chamber 14 and economizer tubes 15 which are situated within the heat exchanger section 16 of the heater 10. The fuel burner 11 feeds either gas or oil fuel, or both, which is ignited to produce a flame, generally indicated by reference numeral 17, within the combustion chamber 14. An induced draft fan 18 draws the hot combustion gases through the heat exchanger section 16 in the path indicated by the arrow B to discharge via a stack (not illustrated) which is situated above the fan 18 at the location 18a. That is, the hot combustion gases double back within the combustion chamber 14 to emerge from the upper region thereof into the tube header space 19a at the front end of the heater 10, then flow through the lowermost series of the tubes 15 and into the header space 19b at the opposite or rearward end of the heater, thereafter flow through the upper series of the tubes 15 into an upper section of the front end header 19a, and thence through the fan 18 to discharge at the location 18a, all as indicated in FIGURE 1. These multiple passes of the combustion gases afford a high degree of heat exchange economy, as is well known.

FIGURE 1 also generally illustrates a fuel pumping valving, and gas and oil modulation arrangement 21 which is associated with the fuel burner 11 for feeding either natural gas or oil (either light or heavy), or a combination of both, to the burner from gas and oil sources (not shown). This arrangement 21 is of a conventional type known to those having skill in the art and need not be further described.

Referring now to FIGURE 2, the combination fuel burner 11 in accordance with the invention has a front plate 22 for attaching the burner to the front wall 10a of the heater 10, as by bolts 23. The burner 11 includes a single, elongated and cylindrical-shaped blast tube 24 which is attached, as by welding, to the front plate 22 to project from the forward side thereof, as shown. The blast tube 24 extends through a cylindrical shaped burner receiving tube 25 of the heater 10 so that the forward, or combustion end 11a of the burner is disposed at the forward wall 14a of the heater combustion chamber 14.

The combustion end 11a of the burner is formed by the cylindrical combustion head or shroud cap 26 which along its rearward end length engages the forward end of the blast tube 24 in a slip fit, as indicated by reference numeral 27. At the forward end of the shroud cap 26 there is a peripherally extending and radially inward angulated shroud portion 26a, the angle of the shroud portion being 45° and the shroud cap being otherwise

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open at its forward end. When finally assembled as shown, the overall length of the blast tube 24 and shroud cap 26 is about twice the diameter of the blast tube. For example, where the blast tube diameter is 6¼", the length of the blast tube to the end of the shroud cap 26 is 12", the length of the 45° shroud portion being ¾".

As shown in FIGURES 2—5, inclusive, the shroud cap 26 has four quadrantly spaced apart and radially inwardly projecting turbulator positioning vanes 28, these being welded to the interior wall of the shroud cap, as at 28a (FIGURE 4). These are for assuring accurate central positioning of a stationary type turbulator 29 within the forward end opening of the shroud cap, the outer surface of the inwardly turned peripheral flange portion 29a of the turbulator being merely in contact engagement with the respective inwardly facing edges of the vanes 28. The positioning of the turbulator 29 in longitudinal direction is determined by the fixed location of the tops of the gas distribution pipe caps 30a (to be more fully described hereafter), against all of which the end edge of the turbulator flange portion 29a rests, as shown. The turbulator 29 is attached, as by the rod and bolt means 31 (FIGURES 2 and 3), to the electrode ignition assembly 32 which is of a conventional type and which, in turn, is attached to the centrally located oil fuel feed pipe 33. Thus, the turbulator 29 is firmly positioned at a fixed location with respect to both the gas distribution pipe caps 30a and the oil spray nozzle 33a at the end of the oil pipe 33 when the burner is assembled. Because of the sliding connection 27 between the shroud cap 26 and the blast tube 24, the positioning and therefore the amount of forward extension of the shroud portion 26a with respect to the turbulator 29 is subject to manual adjustment. Adjustment of the position of the shroud cap 26 is conventional in such burners for the purpose of adjusting flame length, the adjustment being made using the shroud cap adjustment rods 26b (FIGURE 2) which project rearwardly and out from the back of the burner in a conventional manner not shown in the drawing.

At its rearward end, the oil fuel feed pipe 33 is attached to the back plate 34 of the burner 11, as by a set screw 35a through a block 35 which is attached to the back plate and through which the feed pipe 33 extends. Introduction under pressure of raw fuel oil to the pipe 33 is by conventional means, such as the solenoid valve 36 having an attached pressure gauge 37, and it will be understood that either light or heavy oil may be used as fuel, and that adjustment means (not shown) are provided to vary the oil flow rate as desired. At its forward end the oil fuel pipe 33 has a nozzle 33a for atomizing and spraying the oil in a cone pattern. In the specific example being described, the location of the spray is ¾" rearward of the plane of the turbulator 29, as shown. The oil is ignited by conventional ignition electrodes 38.

As will be perhaps more clearly understood from FIGURE 3, a gas pilot pipe 39 extends in parallel spaced relationship with respect to the oil fuel pipe 33 within and throughout the length of the blast tube 26, the gas pilot pipe 39 being mounted on the block 35 at the back plate of the burner and on the electrode ignition assembly 32. Its forward closed end 39a projects through a suitable aperture of the turbulator 29 as shown, and includes an arcuate slot 39b (FIGURE 2) for emitting pilot gas which is ignited in conventional manner by one of the ignition electrodes 38a (FIGURE 3). The slot 39b is located just within or forward of the plane of the turbulator 29, although its position is adjustable.

All of the air for combustion of the fuel oil is drawn through the blast tube 24 from the combustion air chamber 40 at the rearward end of the burner 11, the cylindrically shaped air passage 41 connecting the two. Negative pressure at the combustion end of the burner which establishes the flow of combustion air therethrough is created by the inducted draft fan 18 (FIGURE 1) of the heater 10. However, the combustion air chamber 40 in-

cludes an adjustable damper 42 at the air inlet opening 40a of the chamber for metering the rate of combustion air entering the chamber from the atmosphere. By adjusting the damper 42 between its fully closed position (dotted lines, FIGURE 2) and its open position (full lines), the flow rate of combustion air into the chamber 40 and thence through the blast tube 24 may be matched to the flow rate of the fuel oil so as to provide efficient combustion of the fuel forward of the nozzle 33a.

At the combustion head of the burner a portion of the combustion air flows through the turbulator blades 29b (FIGURES 3 and 5), another portion of the combustion air flows through the central aperture 29c of the turbulator 29, and a further portion of the combustion air flows past the outside periphery of the turbulator as established by the flange 29a thereof, this last mentioned portion of the combustion air flowing between the turbulator 29 and the shroud portion 26a of the shroud cap as will be apparent from the drawings. The turbulator blades 29b impart a spinning motion to the combustion air flowing therethrough so that the air will thoroughly mix and burn properly with the fuel oil emitted at the nozzle 33a.

Raw gas fuel, such as natural gas, is introduced into the burner via a gas connection pipe 43 as shown in FIGURE 2, the gas having first passed through a valve arrangement (not shown) which is adjustable to meter the rate of gas flow. From the pipe 43 the gas enters a gas distribution chamber or ring 44 which surrounds the combustion air passage 41. The raw gas is conducted to the combustion end of the burner by a series of twelve longitudinally extending gas distribution pipes 30, these being attached at their respective rearward ends to the front plate 22 of the burner, as by threaded connections 45, so as to extend into the gas distribution ring 44. Thus, gas which is introduced under pressure into the gas distribution ring 44 flows through all of the gas distribution pipes 30 and emerges at the respective pipe caps 30a thereof. As perhaps more clearly shown in FIGURES 4 and 5, each gas distribution pipe cap 30a has three gas emitting orifices 30b for introducing the gas in transverse direction with respect to the direction of combustion air flow through the blast tube. As shown in FIGURE 3, the twelve gas distribution pipes 30 are annularly and equally spaced apart about the interior periphery of the blast tube and shroud cap and, as indicated in FIGURES 2, 4 and 5, the centermost of the three gas emitting orifices 30b faces inwardly and is aligned with the radius of the latter. The other two gas emitting orifices 30b are situated in the same radial plane, and are arcuately spaced 30° away from the first on the respective opposite sides thereof.

All of the combustion air to be mixed with the emitted gas is induced through the burner 11 by the action of the induced draft fan 18 of the heater 10 in the same manner as has been described in connection with the oil burning operation. That is, the fan 18 creates a negative pressure at the combustion end of the burner 11 which induces a draft of atmospheric air through the damper 42 and into the combustion air chamber 40, thence through the air passage 41 and blast tube 24. As will be noted from the drawings, a small portion of the combustion air flows around the outside of the pipe caps 30a, between the pipe caps and the shroud portion 26a, and thus bypasses the turbulator 29. However, the number, disposition and arrangement of the gas emitting orifices 30b is such that the gas is distributed uniformly throughout the circular area of the combustion head which extends between the gas distribution pipe caps 30a, and is mixed with combustion air at the inlet side, rather than the outlet side, of the turbulator and immediately prior to the air and gas mixture flowing through, and being turbulated by, the turbulator blades 29b. Of course, by regulation of the position of the combustion air damper 42, the rate of flow of combustion air which will mix with the gas fuel may be adjusted to match the

rate of flow of gas through the gas distribution pipes 30. Gas flowing from the pilot gas pipe aperture 39b is initially ignited as previously mentioned, whereupon the gas flowing from all of the gas distribution pipes 30 is ignited as the same mixes with the blast tube air.

Specifically, in the embodiment of the burner 11 being described, each of the twelve gas distribution pipes 30 is a length of $\frac{1}{4}$ " diameter pipe, and each of the gas emitting orifices 30b in the pipe cap 30a thereof is formed by a $\frac{5}{64}$ " diameter drilled hole. The centers of the orifices 30b are in alignment with each other within a transverse plane of the burner and are located $\frac{3}{16}$ " from the respective head ends of the pipe caps 30a. The length of the turbulator flange 29a is $\frac{3}{4}$ ", so that the orifices 30b are located $\frac{1}{16}$ " behind the plane of the turbulator 29. The length of the shroud cap portion 26a is $\frac{9}{16}$ " and, when the burner is assembled, its forward end is located $\frac{1}{16}$ " forward of the turbulator 29, although its position is adjustable as aforesaid.

The turbulator 29 may be generally classified as a "restricted type" in view of the relatively small total area of passage therethrough which is provided by its turbulator vanes or blades as compared with its projected area and the area of the blast tube. These size relationships and the positioning of the turbulator with respect to the gas fuel emitting orifices and the oil fuel nozzle effect substantial improvement of burner characteristics throughout the range of its intended operation and particularly at low firing rates.

As a specific example of the turbulator size relationships relative to the referred to blast tube opening of $\frac{6}{16}$ " and its positioning with respect to the gas emitting orifices and oil nozzle, a twelve-vane restricted type turbulator is provided, having outer diameter of $5\frac{1}{8}$ " and a central aperture diameter of $1\frac{1}{16}$ ". The length of each of its turbulator vanes 29b is $1\frac{3}{16}$ ", and the width of each turbulator vane is $\frac{5}{32}$ ". The distance of opening of each vane 29b from the general plane of the turbulator is $\frac{5}{32}$ ". The referred to size relationships of the turbulator 29 with respect to the transverse area of the blast tube 26 produces a ratio of bypassed air to turbulated air of 7.5:1. The general plane of the turbulator 29 is located $\frac{3}{8}$ " forward of the oil fuel nozzle 33a, the latter being substantially within the transverse plane of the gas emitting orifice 30b, as will be noted. It is found that such arrangement and positioning provides high combustion efficiency, flame cleanliness, flame stability, and quiet operation at low-rate firing without adverse effect upon the same characteristics at higher firing rates.

In the space heater 10, the draft induced by the fan 18 is relatively high for best results. That is, whereas conventionally the draft produced is equal to about 1" of water, the fan 18 is rated to produce vacuum equal to 3" of water within the heat exchanger section 16 of the heater.

Whether burning gas or oil, or a combination of both, the combination fuel burner 11 as described provides improved combustion efficiency, flame cleanliness, and flame stability at variable fuel flow rates over a range of burner heat output of from about 200,000 B.t.u. per hour to about 1,000,000 B.t.u. per hour. The burner is as efficient when operating within the lower end of the range of oil or gas combustion rates as it is when operating at the higher end of the range, the combustion efficiency of oil being about 84% throughout the entire range, and the combustion efficiency of natural gas being about 80% throughout the entire range.

Thus, a combination oil and gas fuel burner has been described which achieves all of the objects of the invention.

What is claimed is:

1. A combination gas and liquid fuel burner of the induced draft type comprising an elongated and plainly cylindrical blast tube for conveying combustion air in a linear flow pattern towards a combustion end thereof, a

centrally apertured turbulator mounted at said combustion end of the blast tube within the path of said combustion air, said turbulator being substantially disc-like in shape having outer diameter less than the inside diameter of said cylindrical blast tube and being mounted concentrically within said blast tube to provide by-pass air spacing between the outer periphery of said turbulator and the interior surface of said blast tube, said turbulator further including blade means providing openings for turbulating combustion air passing therethrough, the area of said centrally apertured turbulator relative to the transverse area of said cylindrical blast tube being such that the ratio of the amount of air by-passing said air spacing, to the amount of air passing through its said blade means openings is on the order of 7.5:1, said blade means having an air inlet side facing the interior of said blast tube, liquid fuel feeding means including a nozzle for emitting liquid fuel at a location adjacent to the central aperture of said turbulator at said air inlet side of its said blade means, and gas fuel feeding means including gas emitting orifice means disposed within said blast tube adjacent to said inlet side of the turbulator blade means, said gas emitting orifice means being oriented to direct emitted gas in direction transversely of said direction of flow of combustion air through said blast tube.

2. A combination gas and liquid fuel burner according to claim 1 wherein said gas fuel feeding means comprises a plurality of longitudinally extending and annularly spaced apart gas distribution pipes within said blast tube substantially adjacent to the interior surface thereof, each said gas distribution pipe having a closed end disposed substantially immediately adjacent to said turbulator at said air inlet side of said blade means thereof, said gas emitting orifice means comprising means defining at least one aperture of each said gas distribution pipe disposed closely adjacent to said closed end thereof and facing in radially inward direction with respect to said blast tube, all of said gas distribution apertures being substantially within the same transverse plane of the blast tube.

3. A combination gas and liquid fuel burner according to claim 2 wherein said nozzle of the liquid fuel feeding means is disposed substantially within said transverse plane of the blast tube.

4. A combination gas and liquid fuel burner according to claim 2 wherein said gas emitting means comprises means defining three apertures of each said gas distribution pipe, said three apertures being adjacent to each other and being disposed on that side of their said associated gas distribution pipe which faces in inward direction with respect to said blast tube.

5. A combination gas and liquid fuel burner of the induced draft type comprising a housing defining a combustion air chamber and a separate gas distribution chamber, an elongated and plainly cylindrical blast tube having a forward open end and a rearward open end, said rearward end of the blast tube being connected to said combustion air chamber to receive combustion air there-through, a longitudinally adjustable shroud cap mounted on said forward end of the blast tube to form an extension thereof and having a peripherally disposed and inwardly angulated shroud portion defining the combustion end of said burner, a turbulator mounted in fixed position centrally of, and disposed transversely of said blast tube substantially adjacent to said shroud portion of the shroud cap, said turbulator having blade means including an air inlet side facing towards the interior of said blast tube, raw liquid fuel feeding means mounted in fixed position within said blast tube and including nozzle means for emitting liquid fuel at a location closely adjacent to said air inlet side of the turbulator blade means, and raw gas fuel feeding means mounted within said blast tube, said gas fuel feeding means comprising a plurality of longitudinally extending, and annularly and equally spaced apart gas distribution pipes disposed substantially adjacent to the interior surface of said blast tube and shroud cap, each

said gas distribution pipe having a rearward end connected to said gas distribution chamber for receiving raw gas fuel therefrom and a forward closed end disposed substantially adjacent to said turbulator at said inlet side of the turbulator blade means, and each said gas distribution pipe further having gas emitting orifice means disposed closely adjacent its said closed forward end and facing in radially inward direction with respect to said blast tube and shroud cap whereby said raw gas fuel is emitted substantially uniformly throughout a circular area of said shroud cap at a location closely adjacent to said inlet side of said turbulator blade means.

6. A combination gas and liquid fuel burner according to claim 5 wherein said gas emitting orifice means of each said gas distribution pipe comprises three gas emitting orifices aligned within the same radial plane of said shroud cap, the outermost of said three orifices being arcuately spaced 30° at respectively opposite sides of the middle orifice and the middle orifice being aligned with a radius of said shroud cap.

7. A combination gas and liquid fuel burner according to claim 5 wherein the diameter of said turbulator is substantially equal to about four-fifths ($\frac{4}{5}$) of that of said blast tube and shroud cap whereby a portion of said combustion air bypasses said turbulator blade means by flowing around the turbulator, said turbulator having means defining a central aperture thereof having diameter substantially equal to about two-thirds ($\frac{2}{3}$) of said diameter of the turbulator whereby a further portion of said combustion air bypasses said turbulator blade means by flowing through said aperture, and said turbulator blade means providing air openings whereby the remainder of said combustion air is turbulated upon passing therethrough, the total area of said blade means openings being such that the ratio of the total of said bypassed combustion air portions to said turbulated combustion air portion is substantially 7.5:1.

8. A combination gas and liquid fuel burner according to claim 7 wherein said liquid fuel nozzle means and said gas emitting orifice means are located substantially within the same transverse plane, said nozzle means being situated centrally of said turbulator.

9. A space heater comprising a combustion chamber, fan means for inducing negative pressure within said combustion chamber, and a combination gas and liquid fuel burner of the induced draft type mounted in said combustion chamber, said burner comprising an air inlet chamber including means for opening the same to the atmosphere, a blast tube having an open rearward end attached to said air inlet chamber and an open combustion end facing the interior of said combustion chamber, a restricted type turbulator mounted in fixed position within said blast tube substantially adjacent said combustion end of the latter, said turbulator having vanes defining turbulence openings, and further having size relative to said blast tube and central aperture means defining bypass openings, the ratio of the areas of said bypass openings to the areas of said turbulence openings being on the order of about 7.5:1, liquid fuel feeding means including a nozzle in fixed position within said blast tube for emitting liquid fuel in direction towards said combustion chamber from a location substantially adjacent to said turbulator on that side thereof which faces said rearward end of the blast tube, and raw gas feeding means including gas orifice means mounted in fixed position within said blast tube for emitting gas fuel in radially inward direction with respect to said blast tube within a transverse plane of the latter located substantially adjacent to said turbulator on that side thereof which faces said rearward end of the blast tube.

10. A space heater according to claim 9 wherein said fan means is adapted for inducing negative pressure on the order of about three inches (3") of water within said combustion chamber.

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