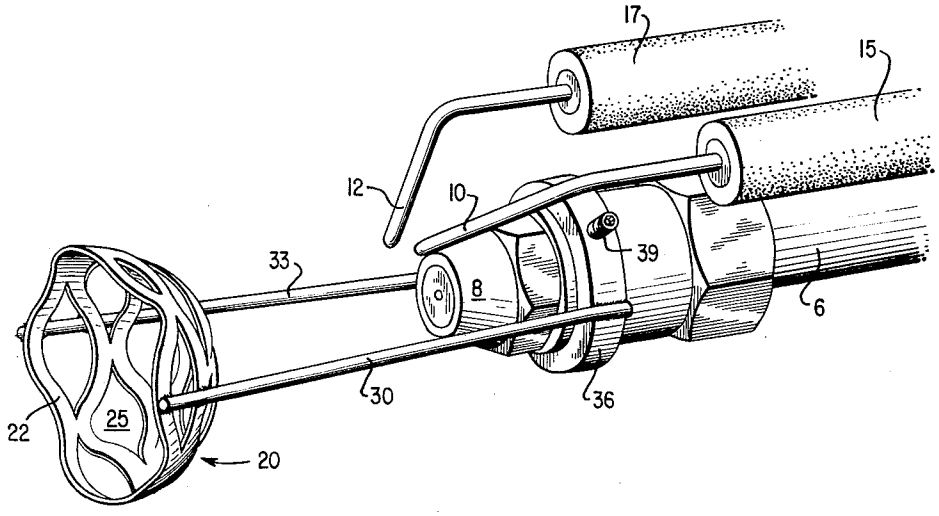
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LIQUID FUEL BURNER WITH COMBUSTION AID

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LIQUID FUEL BURNER WITH COMBUSTION AID

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This invention is a novel combustion aid for use with a liquid fuel burner. In liquid fuel burners, such as the ordinary gun-type domestic fuel oil burner, the invention serves to insure proper contact of fuel and combustion supporting gas and to steady or stabilize the combustion.

The gun-type liquid fuel burner has for many years been accepted as the standard domestic fuel oil burner. This type of burner generally comprises a fuel oil pump and line ending in an atomizing nozzle and an air pump which supplies combustion-supporting gas to the atomized fuel. Generally, a barrel-type conduit is supplied for the air and the fuel conduit is arranged concentrically within the air barrel, with the fuel nozzle recessed slightly within the exit end of the air barrel. In operation, it is conventional to so proportion the flow of liquid hydrocarbon fuel and combustion-supporting gas that little, if any, surplus gas is supplied. In this way pumping costs and the size of equipment are reduced and the cooling effect of excess gas is minimized. This control over the proportions of fuel and gas makes good mixing of the fire components essential and almost universally the air barrel is provided with a nose cone or its equivalent flow director. The flow of air and fuel within the conduits provided is generally parallel, but downstream of the nozzle the flow of each fluid is generally altered to provide a mixing and combustion zone. Such mixing may be brought about by the use of an atomizing fuel nozzle which sprays the fuel into the mixing zone perhaps somewhat in the form of a cone. The constriction of the end of the air barrel by an end cone serves to deflect the air flow inwardly into admixture with the cone-shaped fuel spray. Ignition can be performed by electrodes which are within the mixture of air and atomized fuel. The gun directs the resulting flame into a combustion chamber or furnace where indirect heat exchange between the hot combustion products and the domestic heat exchange fluid is performed.

Such gun-type fuel-oil burners, which operate with air at or near atmospheric pressure, provide good efficiency to a domestic system in at least two respects; viz, in needing only the two pumps as moving parts and keeping most elements of the burner out of the way of the hot flames, and in producing a good deal of heat in the combustion chamber very quickly upon demand. The combustion efficiency of the gun-type burner, however is susceptible to improvement; for example, the position of the flame may pulsate and even though the nozzle may be finely adjusted to give the proper degree of atomization, momentary fluctuations in the oil supply may occur, either condition tending to create a less-than-ideally dispersed supply of fuel along the axis of the cone of spray. Whether caused by flame pulsation or faulty atomization, this over-supply of fuel is likely to pass through the combustion zone incompletely vaporized and therefore incompletely burned, cutting down on the combustion efficiency of the burner and leading to smoke problems.

Ordinarily the domestic fuel oil burner provides for ignition of the fuel-air mixture by means of an electrode arc which operates on a thermostatic principle. Thus, the electrode circuit is provided with sensing means which, on perception of the heat from a burner flame, cuts off

the electrode current. If a momentary over-supply of air to the burner occurs, perhaps due to the action of strong air currents from outside the furnace, the resulting lowering of temperature may cause loss of the flame. The sensing means in this situation will reestablish the electrode current to reignite the fuel and gas mixture, but fuel values will be lost during the time that combustion is interrupted.

This invention aids combustion in a number of ways: it focuses the flame and assures better mixing of the fuel with combustion-supporting gas. It overcomes the effects of momentary over- or under-supplies of fuel or combustion supporting gas by acting both as a fuel and a heat reservoir. The combustion aid of this invention provides a surface on which the flame can locate and spread out and on which fuel from momentary floods of unvaporized liquid particles or small clouds of vapor supersaturated with fuel may coalesce. The invention provides a further surface, downstream, to which the coalesced fuel may travel to be vaporized and mixed with further amounts of combustion supporting gas and burned. By thus spreading fuel out into a greater area of the combustion zone, this invention serves for better utilization of all available air, allowing the coalesced fuel to revaporize more homogeneously in the combustion-supporting gas and burn more completely.

The combustion aid of this invention comprises a hemispherical member with a discontinuous surface placed just downstream from the zone, at the end of the air barrel, where the most vigorous mixing of the fuel and combustion supporting gas occurs. Preferably the member is coaxial with the nozzle of the fuel burner and covers only a minor portion of the cross-section of the combustion zone of the burner that is, the total surface of the member exposed to the mixed stream is less than half, advantageously less than about one-third of the flow space downstream of the fuel nozzle. The solid member is advantageously made of metal but may comprise other non-porous solid materials, such as ceramics, which will withstand deformation at the temperatures of the combustion.

The combustion aid generally has a spherical, discontinuous surface in which the open discontinuities may comprise up to about one-half of the total surface defined by the member, and the convex or "outside" surface is generally the surface directed toward the burner nozzle. The device serves to enlarge and stabilize the flame area and by directing this spherical combustion device at the fuel nozzle, the combustion aid of this invention appears to intercept imperfectly atomized droplets of liquid fuel, probably causing them to coalesce on the convex surface. It is reasoned that the coalesced fuel, under the influence of continued gas flow from the nozzle and air barrel, is pushed around to the concave surface of the combustion aid where, under the influence of heat absorbed on the leading surface of the sphere and conducted to the downstream surface, and also under the influence of reduced pressure due to the venturi effect of the obstruction of the gas stream, this fuel may be vaporized uniformly into the still-hot gas stream for quick and complete combustion. Generally the discontinuities or holes in the combustion device will be bounded by other than straight i.e. curved lines in order to give a greater path to coalesced droplets affected by gravity. This longer path delays further coalescence of drops, providing a longer time for revaporization of the liquid and helping to avoid dripping of coalesced fuel from the device.

The device of this invention gives a better combustion effect than the so-called "flame-holders" known to the art. These prior devices serve as heat reservoirs during

momentary interruptions of fuel flow; however, they also serve to coalesce improperly atomized fuel and hold it within the primary gas stream. In operation, hydrocarbon fuel coalesced on such devices and held in the main combustion stream frequently serves to reduce the carbon monoxide or carbon dioxide combustion gases, converting both gas and fuel to water and free carbon. This free carbon is usually wasted in the gas stream and, further, creates a smoke nuisance. The combustion aid of this invention avoids this effect by providing for conducting away the coalesced fuel from the main combustion zone. It can be seen that the combustion aid of this invention besides serving to assure combustion of over-supplies of fuel, also serves as a heat reservoir and flame stabilizer during momentary under supplies of fuel.

The solid member is generally supported by arms which extend from the fuel nozzle. For ease of replacement, the arms will generally be rigidly fastened to an adapter; e.g., a collar which fits around the standard fuel nozzle assembly and which may be supported thereby. Such an arrangement provides for ease in installing and replacing the combustion aid. The hemispheric member of this invention will generally be used in combination with a nozzle which dispenses fuel in a cone-shaped spray.

The invention will be better understood by reference to the accompanying drawing which is to be considered illustrative only and not limiting. The drawing shows a liquid fuel burner, without the air barrel, to which the combustion aid of this invention is attached.

Conventionally, the liquid fuel burner will consist essentially of the fuel line **6**, the nozzle **8** and the electrodes **10** and **12**, which have the insulated leads **15** and **17** respectively. The member **20**, as can be seen, is hemispherical and its convex surface is directed toward the fuel burner nozzle. The member **20** comprises essentially a network of flattened strips **22** which intersect each other to leave the voids **25**. This device can preferably be manufactured, for example, by shaping a piece of expanded metal. Such manufacture generally gives wavy boundaries to the voids **25** which as explained above, increase the length of the downward flow path for coalesced particles giving droplets more time to vaporize without dripping. The combustion aid **20** generally is supported on the nozzle assembly **8** by means of the arms **30** and **33** which extend between the member and the collar **36**, which may be affixed to the nozzle **8** by means of the set screw **39**.

As can readily be seen, the device of this invention can easily be installed on existing gun-type liquid fuel burners by putting the collar around the nozzle assembly and fastening it with the set screw. The length of the arms supporting the solid member is often sufficient to place the member just beyond the zone of greatest turbulence which occurs immediately downstream of the fuel nozzle. Generally, this length will place the solid member a distance in front of the fuel nozzle at least about twice the distance from the fuel nozzle to the exit edge of the end cone, preferably about 2 to 3 times the distance from the fuel nozzle to the exit edge. For example, the solid member of this invention is found effective when placed about ⅞" downstream from the fuel nozzle of a burner wherein the nozzle is set ⅜" back of the exit edge of the end cone.

As described above, the member usually extends outwardly from the axis of the nozzle a distance sufficient to intercept unmixed combustion supporting gas in a zone annular to the fuel-rich zone. In general, the lateral extent of the solid member will be almost equal to the opening in the end cone.

In operation, the adapter is placed around the nozzle assembly, the member is set the proper distance from the fuel nozzle and flow of air and fuel is begun. High voltage current is sent to the electrodes which arc in the mixture of fuel and air. Current is cut off after ignition is assured. Uncombusted fuel and air impinge on the solid member, causing coalescence of excess fuel. The fuel spreads along the surface of the solid member and is vaporized in further amounts of combustion supporting gas which reach the solid member.

It can be readily seen that this invention aids combustion by assuring a steady flame and better mixing of the fuel with combustion supporting gas downstream of the zone of greatest mixing where the ordinary gun-type burner, despite the atomizing effect of the nozzle and the agitating effect of the nose cone, may still allow the flame to pulsate or provide too rich a fuel mixture. The invention serves to give stabilized and steady combustion by acting as a heat reservoir to give uniform combustion despite the fluctuations in fuel or combustion gas flow or vaporization, and also serves to spread out the combustion zone.

It is claimed:

1. In a gun-type liquid fuel burner having a nozzle and ignition means adjacent said nozzle, said nozzle being adapted to spray fuel into a mixing zone containing a combustion-supporting gas, the improvement which comprises a member in the path of the fuel flow downstream of said nozzle and said ignition means, said member having a discontinuous convex surface facing such nozzle and comprising a net-work of flat strips which intersect each other to form said surface and leave voids forming said discontinuities, said discontinuities being bounded by curved lines, and support means for attachment of said member to said nozzle.

2. A burner as defined in claim **1**, wherein said support means includes collar means secured to said nozzle and arms supporting said member and secured to said collar means.

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