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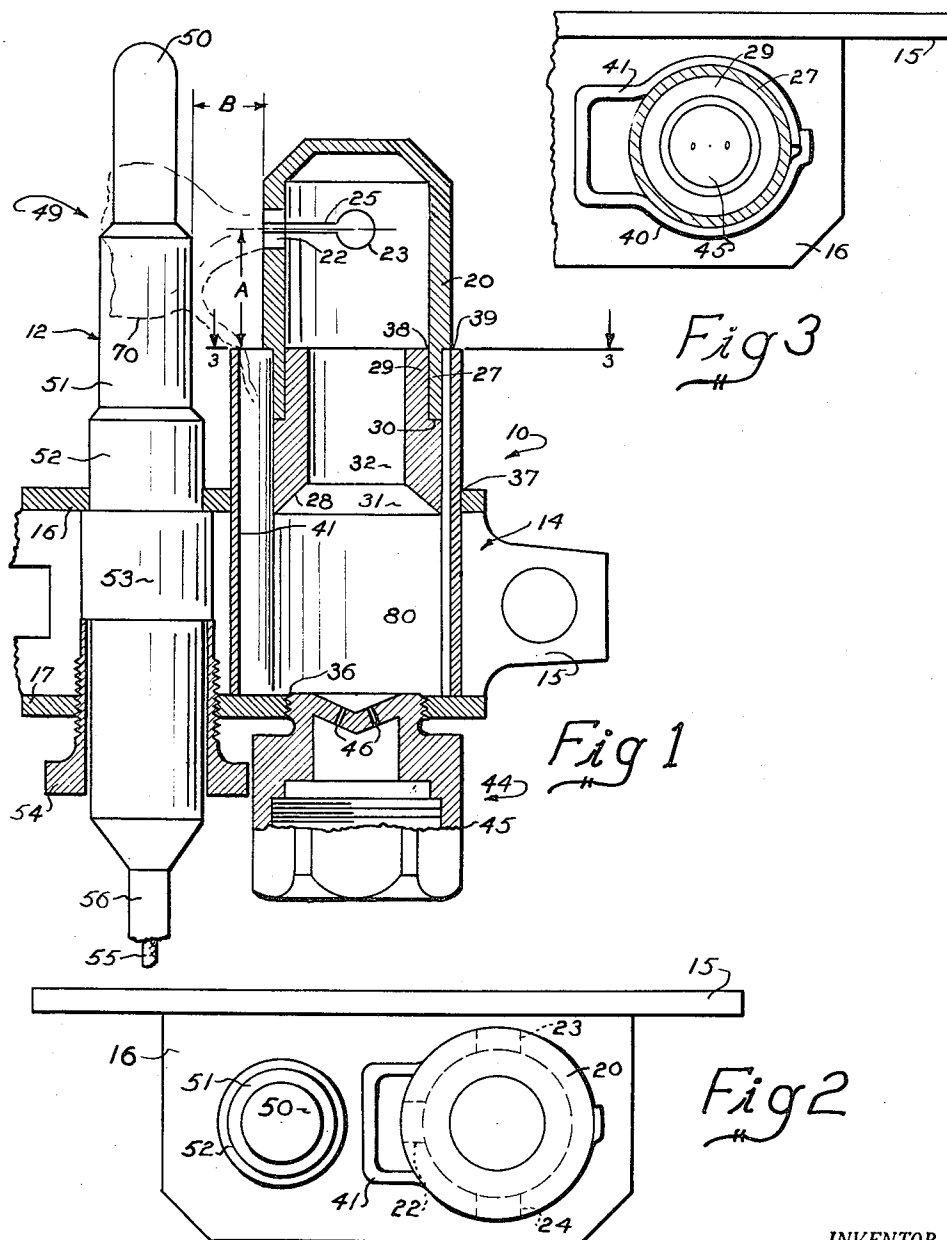
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2,920,126

FLUID FUEL BURNER

Filed July 2, 1956

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

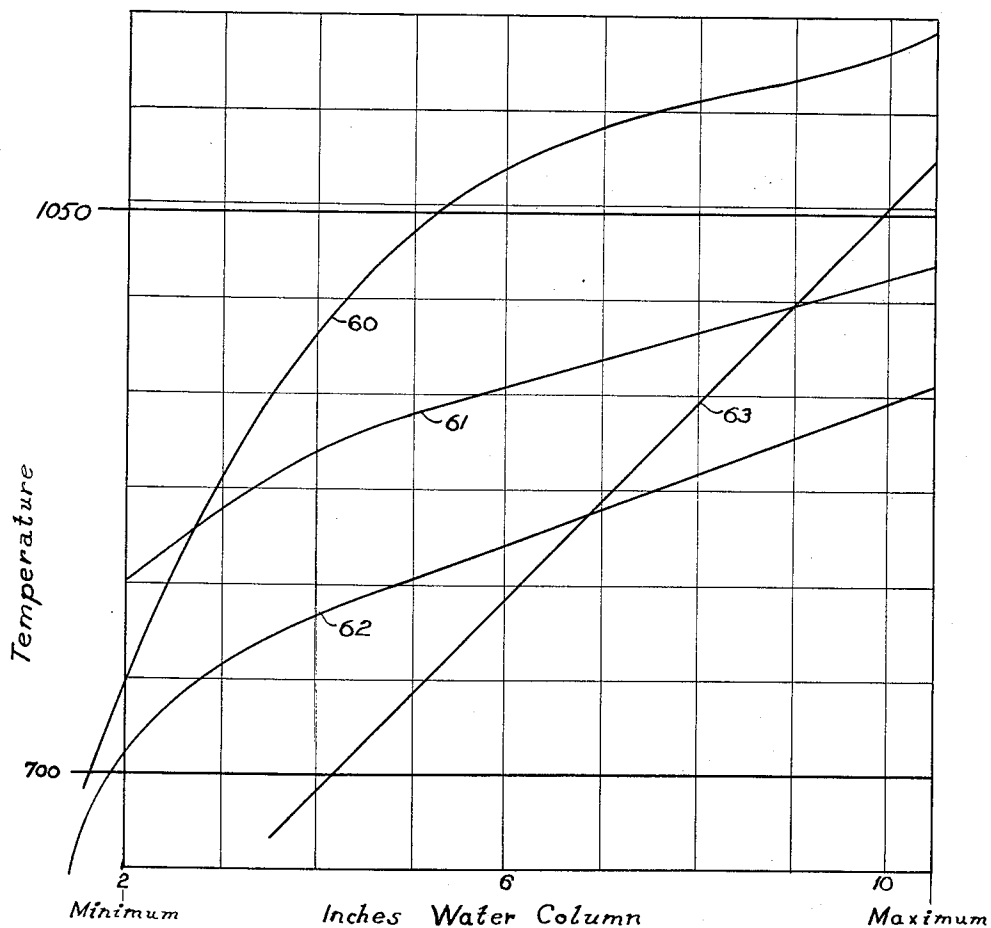


Fig. 4

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2,920,126

## FLUID FUEL BURNER

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2 Claims. (Cl. 136—4)

This invention relates in general, to a method of and apparatus for maintaining the temperature of a flame produced by ignition of fuel emitted from a burner within a predetermined range in spite of substantial variations in the pressure of the fuel supplied thereto.

Standard burners utilized for heating thermoelectric generators have the characteristic of a large fluctuation of the flame temperature impinging upon the generator since the burners supply more and more heat to the generator as the supply gas pressure goes from the low to high pressure end of the operating range. These fluctuations of flame temperature are rather large in standard systems since there is a relatively large operating range of supply gas pressures presently in commercial use. For example, in commercial use of natural gas, appliances must be operable in the rather large pressure range of 2 to 10½ inches water column of pressure. To overcome this problem the output of the burner is limited at the high end to prevent excessive flame temperature, with resultant generation of lower thermocouple voltage at normal and low pressures. It is desirable, of course, that the thermocouple hot junction temperature be kept as close to a predetermined maximum as possible at all pressure levels, but should not be allowed to exceed said predetermined maximum because of the very deleterious effects thereupon when exposed to temperature exceeding this maximum. This is particularly true of semi-metallic type generators, the maximum hot junction temperature of which is considerably below the temperature to which standard thermoelectric generators may be subjected, i.e. standard thermoelectric generators may normally be subjected to temperatures of 1300° F. and are not too deleteriously affected by temperatures below 1600° F., whereas in the new improved semi-metallic type thermoelectric generators, the predetermined maximum temperature to which it may be exposed may be in the neighborhood of 1050° F.

It is thus a general object of this invention to provide a method of maintaining the temperature of a flame produced by ignition of fuel emitted from a burner within a predetermined range in spite of a substantial variation in the pressure of the fuel supplied to said burner.

Another object of this invention is to accomplish the above-described predetermined temperature range of a burner flame by mixing with the input supply of fuel to the burner, portions of the products of combustion of said flame in an amount varying in accordance with the fuel pressure.

Another object of this invention is to provide a device which accomplishes the above-described results by the disposition of primary air inlet means so as to draw or inspire a portion of the products of combustion of the flame into the fuel air mixture in amount varying in accordance with changes in the fuel pressure.

Still another object of this invention is to provide a burner device of aforementioned characteristics having a hollow burner body with a flame port for burning of fuel thereat, fuel inlet means for said body, primary air

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inlet means for affording admittance of inspired air into said burner body for entrainment with fuel supplied from said fuel inlet means, and a thermoelectric generator so spaced from said fuel port and primary inlet means that as the input fuel pressure supplied from the fuel inlet means increases, portions of the ignited fuel emitted from the flame port are deflected from said thermoelectric generator into the primary air inlet means in amount increasing in accordance with increases in the fuel pressure.

A further object of the invention is to provide a burner device as aforementioned with dual orifice fuel inlet means whereby as the input fuel supply pressures increase and products of combustion of the flame are inspired into the fuel mixture, the hardness of the flame reduces without a substantial movement of the flame away from the flame port, thereby tending to maintain a flame of substantially stable characteristics and temperature.

Still another object of the invention is to provide a pilot burner which is compact in all three dimensions, comprises few parts, is extremely sturdy for long field life, is easily fabricated and assembled, is easily mounted adjacent a main burner, is well adapted for multiplicity of flame port orientations, is adapted for relatively low consumption uses, and is otherwise well adapted for the purposes for which it was designed.

The novel features that are characteristic of the invention are set forth with particularity in the appended claims. The invention itself, however, both as to its organization and its method of operation, together with additional objects and advantages thereof will best be understood by the following description of a specific embodiment when read in connection with the accompanying drawings, in which:

Figure 1 is a central vertical sectional view of a pilot burner associated with the coaxial thermocouple illustrating an embodiment of the invention;

Figure 2 is a top plan view of the pilot burner and thermocouple assembly shown in Figure 1;

Figure 3 is a fragmentary sectional view taken along lines 3—3 of Figure 1; and

Figure 4 is a graphic illustration of the operation of a thermoelectric generator and burner constructed in accordance with the invention as contrasted with other burners of standard design.

Referring now to Figure 1, the pilot burner assembly 10 may comprise a generally U-shaped or channel type bracket member 14 having a base portion 15 and upstanding arm portions 16 and 17. The base portion 15 may be formed with a plurality of apertures as suitable and desired for mounting said bracket adjacent a main burner. A plurality of apertures are also formed in the bracket arms 16 and 17 of such size and shape to receive portions of the pilot burner assembly 10 and the thermoelectric generator assembly 12 substantially as shown in Figures 1 and 2.

The burner 12 may be formed of a tubular shaped body member 40 having an angular offset portion 41 coextensive its length as best shown in Figures 1 and 2. The tubular body member or shield 40 may be formed for example, from sheet stock as by a stamping operation or from suitable extruded tube stock. The member 40 is adapted to be fixedly mounted in a suitable aperture in the upper bracket arm 16 as by brazing or other suitable fastening means to form an outer wall portion of the burner assembly. The lower end surface of the tubular member 40 may firmly abut upon the inner surface of the lower bracket arm 17 to form an air fuel mixing chamber 80. The abutting junction of the tubular member 40 and the lower bracket arm 17 may, if desired, be brazed so as to form an air tight junction at this point.

A suitable hollow burner tip 20 may be disposed above

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and in engagement with a portion of the other end of the tubular member 40. The tip 20 may be formed with a depending annular reduced portion 27 defining an annular shoulder 26; the reduced portion 27 telescopically and snugly fitting within the tubular member 40 to thereby abut said shoulder 26 upon the upper end surface of the latter. The burner tip 20 may be formed with a plurality of gas ports such as 22, 23 and 24 as suitable and desired, port 22 being adapted for heating the thermoelectric generator 12, and the other ports being adapted for igniting a main burner (not shown). A suitable saw slot 25 is provided to connect the ports 22, 23 and 24.

Disposed within the body member 40 in coaxial alignment with the burner tip 20 is a relatively smaller annular throat member 28 which has an upstanding reduced annular wall portion 29 which snugly and telescopically fits within the bore of the burner tip 20. An annular shoulder 30 is formed in the outer wall surface of the throat member 28 for engagement with the annular end surface of the reduced wall portion 27 of the burner tip 20. The throat member 28 is preferably formed with an axial bore 32 that forms a passageway for the fuel air mixture, said passageway being smaller than the bore of the hollow burner tip 20 and smaller than the diameter of the tubular member 40. The lower end of bore 32 is formed with a chamfered surface 31, for leading the fuel from the larger mixing chamber 80 through the passageway 32 into the hollow burner tip for burning at the burner ports 22, 23 and 24. The throat member 28, the burner tip 20, the tubular wall member 40 and the bracket 14 may be fixed relative to each other by any suitable fastening means, one such means being brazing of the parts at points 37, 38 and 39.

Threadably mounted in a suitable aperture 36 formed in lower bracket arm 17, and in coaxial alignment with tubular member 40, throat member 28, and burner tip 20, is a suitable fuel inlet means 44 here shown as a spud 45 having dual orifices 46 for purposes as shall later be explained. The spud 45 is adapted to be connected to a supply source of fuel (not shown) by suitable connection means to supply fuel to the mixing chamber 80 as well understood in the art.

The wall of the offset portion 41 of the tubular wall member 40 extends radially beyond the outer wall of the burner tip 20 as best shown in Figures 1 and 2. This defines an opening for the inspiration of primary air for entrainment with the fuel in the mixing chamber 80 interior of the tubular member 40. The inner surface of the offset portion 41 and the outer surface of the annular reduced portion 27 of the burner tip 20 together with the outer surface of the throat member 28 form an air duct or passageway for the primary air.

Mounted on bracket 14 in coaxial relation with the burner 10 is a thermoelectric generator 12 which may be detachably connected to lower bracket arm 17 by any suitable means, one such means being here shown as a nut 54 threadably engaging bracket arm 17 thereby abutting an axially offset mounting portion 53 of the generator 12 to the undersurface of arm 16 as viewed in Figure 1. The thermoelectric generator 12 may be of the semi-metallic type more fully explained in the copending application of Robert W. Fritts and Sebastian Karrer, Serial No. 500,192, filed April 4, 1955, which is assigned to the assignee of the present invention. For purposes of understanding the present invention, suffice it to say that the upper extremities of the generator 50 and 51 as viewed in Figure 1 form an outer thermoelement 49 which may be internally connected to an inner dissimilar thermoelement of suitable or desired type (not shown), to form a hot junction of the thermoelectric generator as well understood in the art. The open end of the axially larger portion 51 of the outer thermoelement 49 may be telescopically fitted within and peripherally joined at its lower extremity by a relatively larger tubular electrically conductive extension tube 52 to form one of the cold

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junctions of the generator. The other cold junction of the generator may be the internal connection (not shown) of the inner element with a suitable lead conductor such as 55 as well understood in the art. The conductor member 52 may be formed of brass and connected at its other end to a suitable outer lead conductor means 56 which may surround the inner lead conductor 55.

The operation of the above-described pilot burner and thermocouple assembly is as follows:

Fuel is supplied under pressure from a suitable source connected to the fuel inlet means 44 and enters mixing chamber 80 through the dual orifices 46. As best shown in Figure 1, the fuel coming through the orifices 46 will, because of the angular relationship of said orifices, intersect in the interior of the mixing chamber 80 creating a turbulence which is directed by the chamfered surface 31 into the passageway 32. The turbulence causes inspiration of air through the air inlet means for entrainment with the fuel, the mixture then being ignited at the burner ports 22, 23 and 24.

The fan like turbulence created by the intersecting jets of fuel from dual orifices 46 has the tendency to increase the inspiration of air at the low pressures. On the other hand, the flow rate of the fuel air mixture at the higher supply pressures, due to the increase in size of the fan shape mixture of fuel and air, causes the mixture to impinge upon the walls of the gasway 32 increasing the resistance to flow thus tending to decrease the velocity of the fuel air mixture in the gasway 32. The net effect upon the burner is a stable flame 70 at the burner ports 22, 23 and 24. This stable flame is in contrast to a single orifice type inlet means which, as variations in pressure occur in the supply of fuel to the burner, has too little air at the low pressure causing a candling yellow flame and too much air at the high pressure, the latter causing a blowing effect which moves the flame away from the burner ports.

The ignited fuel air mixture produces a flame 70 emitted from the burner port 22 which impinges upon the outer thermoelement 49. Under certain circumstances it is desired that portion of the flame 70 is deflected downwardly into the primary air inlet. At the low end of the fuel supply pressure range, it is not necessary that the flame be deflected into the inlet, so that a maximum flame temperature at the minimum pressure is obtained. In the middle and higher fuel input pressure ranges, the portion of the flame 70 deflected downwardly increases as the amount of pressure increases. Thus it is possible to entrain more and more products of combustion as the supply of pressure goes upwardly. This has the effect of diluting or changing the fuel air ratio of the flame 70, i.e. reducing the hardness of the flame thereby lowering its temperature. Inasmuch as the dual orifices 46 of spud 45 tend to create a very stable flame, the flame 70 does not have a tendency to move to and from the burner port 22 (blowing) as the supply pressure goes upwardly, rather the effect is to maintain a stable flame within fairly close temperature limits.

Heretofore, it was undesirable that the products of combustion be inspired into the primary air inlet means at any time. As shown in the graph of Figure 4, particularly the curve 61, the instant utilization of entrainment of products of combustion into the air inlet means as the supply pressure increases affords a higher flame temperature at the low end of the range of input pressures and a lower temperature at the high end of the range. This obtains because the dimension B between the flame port 22 and the thermoelement 49 may be of such a size, that with a predetermined size flame port orifice, and B.t.u. consumption rate, a high flame temperature may be obtained at the low input pressures. The size of the burner port 22, the size and type of inlet orifices 46, the dimension B between the flame port 22 and the thermoelement 51, the size of the thermoelement at the point of flame impingement, the dimension A between

the flame port 22 and the primary air opening afforded by offset 41, the size of mixing chamber 80, the diameter of bore 32, the number of burner ports, the dimensions of the burner tip 20, together with the characteristics of the fuel being burned are all variably related to each other. Any number of the above characteristics of the burner or fuel may be varied and, coupled with other changes in the system, still produce the same results. Thus it is to be understood that the dimensions of the device described below for obtaining the substantially constant flame temperature characteristics above described is of an illustrative nature only.

The size and shape of the thermoelectric generator are preferably fixed (the diameter of outer thermoelement 51 being approximately  $\frac{1}{4}$  inch), as should be the size of burner port 22 (approximately .140 inch), the diameter of orifices 46 (for natural gas approximately .0135 inch drilled 8° off center, the center lines thereof being approximately .063 inch apart on the outlet side). The size of mixing chamber 80 (diameter approximately .440 inch), the diameter of gasway 32 (approximately  $\frac{1}{4}$  inch) and the size aperture of the air inlet means (approximately  $\frac{1}{4}$  inch x  $\frac{1}{8}$  inch) are also fixed, as is the dimension B between the port 22 and the generator thermoelement 51 (at approximately .200 inch). With the foregoing dimensions determined the dimension A (approximately .333 inch) between the centerline of burner port 22 and the top of the air inlet means is found by varying the dimension A until operating characteristics as described are obtained when the input pressures are varied over the normal operating range for the fuel used.

The curves as shown in Figure 4 are illustrative only, showing the burner and generator assemblies which are constructed in accordance with the invention as contrasted with the identical generator when utilized with standard pilot burners of conventional design. Curves 61 and 62 are of the improved type assembly showing the very flat curves that may be obtained where products of combustion are inspired in accordance with increases of input pressure, thereby maintaining the flame temperature below a predetermined minimum. The difference between the curves 61 and 62 is one of B.t.u. consumption, curves 60, 61 and 63 being 600 B.t.u. pilot burners whereas curve 62 is of 350 B.t.u. pilot burner and generator assembly otherwise identical with 61. The curve 60 illustrates data of a standard pilot burner giving sufficient flame temperature at two inches water column of pressure to obtain the minimum necessary millivoltage at the low pressure range, however, at  $5\frac{1}{2}$  inches water column of pressure it has already exceeded the maximum predetermined temperature allowable. Whereas curve 63, illustrating another standard type pilot burner, which almost keeps within the predetermined upper limit of temperature at the higher pressures, nowhere near approaches the minimum desired temperature at the lower pressure ranges.

Although a specific embodiment of the invention has been shown and described it is with full awareness that many further modifications thereof are possible. The invention therefore is not to be restricted except insofar as is necessitated by the prior art and by the appended claims.

What is claimed by the invention is:

1. A burner-thermoelectric generator assembly in which the generator output is maintained within predetermined narrow limits in spite of substantial varia-

tions in fuel pressure over a predetermined range, comprising a fuel burner having a hollow burner body provided with a flame port, fuel inlet means for said burner body, air inlet means affording admittance of air into said burner body for entrainment with fuel supplied by said fuel inlet means, said air inlet means having an air inlet opening externally of said burner body, a thermoelectric generator disposed in spaced relation to said flame port in a position for impingement thereon of a flame at said flame port at all fuel pressures within said predetermined range and for deflection of a portion of said flame toward said air inlet opening at fuel pressures above a predetermined level at the lower end of said range, said air inlet opening being disposed to inspire the products of combustion of the portion of said flame deflected theretoward by said generator, the magnitude of the deflected flame portion and of the inspired portion of the products of combustion varying in accordance with variations in the fuel supply pressure above said predetermined level, whereby the amount of heat afforded by said flame and hence the electrical output of said generator is maintained within predetermined narrow limits in spite of substantial variations in fuel supply pressure within said predetermined range.

2. A burner-thermoelectric generator assembly in which the generator output is maintained within predetermined narrow limits in spite of substantial variations in fuel pressure over a predetermined range, comprising a fuel burner having a hollow burner body provided with a flame port, fuel inlet means for said burner body, air inlet means affording admittance of air into said burner body for entrainment with fuel supplied by said fuel inlet means, said air inlet means having an air inlet opening externally of said burner body, a thermoelectric generator disposed in spaced relation to said flame port in a position for impingement thereon of a flame at said flame port at all fuel pressures within said predetermined range and for deflection of a portion of said flame toward said air inlet opening at fuel pressures above a predetermined level at the lower end of said range, said air inlet opening being disposed to inspire the products of combustion of the portion of said flame deflected theretoward by said generator, the disposition of said air inlet opening being such with respect to said flame port that without deflection of the flame by said generator no substantial inspiration of the products of combustion of the flame takes place, the magnitude of the deflected flame portion and of the inspired portion of the products of combustion varying in accordance with variations in the fuel supply pressure above said predetermined level, whereby the amount of heat afforded by said flame and hence the electrical output of said generator is maintained within predetermined narrow limits in spite of substantial variations in fuel supply pressure within said predetermined range.

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