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METHOD OF OPERATING A SPECTROCHEMICAL BURNER

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FIG. 2.

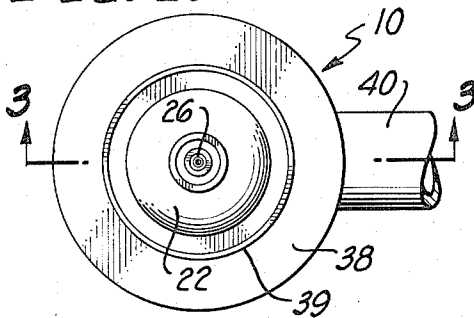


FIG. 3

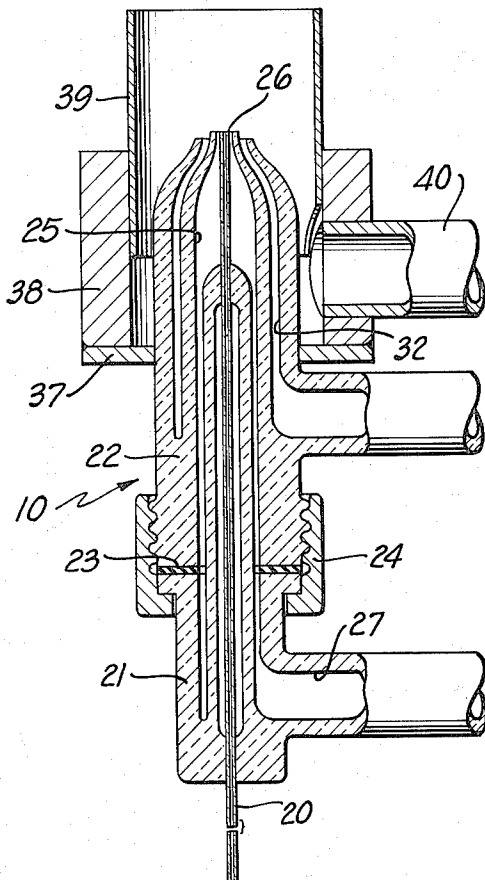
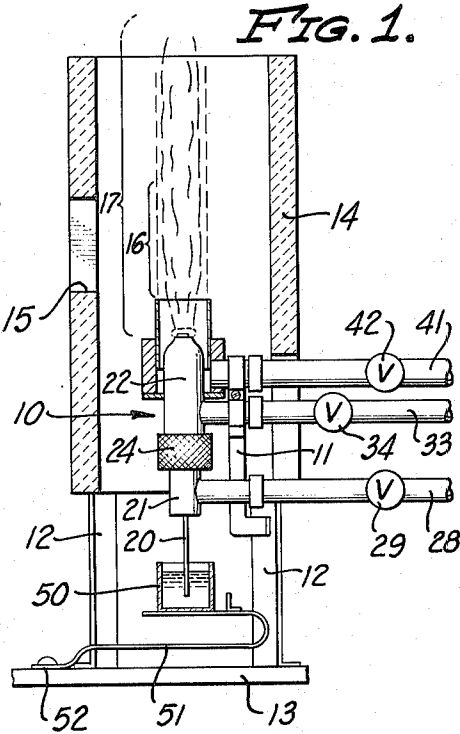


FIG. 1.



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METHOD OF OPERATING A SPECTRO-CHEMICAL BURNER

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Continuation of application Ser. No. 64,573, Oct. 24, 1960. This application Apr. 10, 1963, Ser. No. 272,507

1 Claim. (Cl. 88—14)

This invention relates to atomizer-burners for spectrochemical measurements and the like and, in particular, to a new form of burner providing an improvement in performance and an advance in reliability and ease of operation.

This application is a continuation application of my copending application Serial No. 64,573, filed October 24, 1960, assigned to the same assignee as the present application, now abandoned.

A typical atomizer-burner and the use thereof in spectral measurements is shown in my Patent No. 2,714,833. The present invention relates to the burner itself which produces the spectral flames for analysis. The materials which can be analyzed by this method and the accuracy and reproducibility of the analysis is often limited by conflicting burning requirements and by turbulence and entrainment of air at the burner orifice. Fuel and combustion supporting gases should be selected and mixed to maintain combustion at a uniform rate, which often calls for flame temperatures and mixtures which do not produce the maximum spectral emission from the sample. Flame stability in many mixtures requires pressure regulation of the gas sources and limits the gases which may be used. For best performance, a different burner design is preferred for each combustion mixture.

It is an object of the invention to provide a new atomizer-burner which produces a marked increase in flame stability and which may be operated under conditions affording the best emission characteristics while maintaining stable burning. Another object is to provide such a burner which may utilize various gas mixtures while producing intensified and more stable flames. Another object is to provide a new burner of a single design which may be used with many different fuel-oxidant combinations. A specific object is to provide a burner in which fuels having lower burning velocities than either hydrogen or acetylene can be burned such as natural gas, commercial home gas and bottled hydrocarbon gas and in which cooling and premixing of the gases is not essential. A further object is to provide such a burner which performs equally well with oxyacetylene, oxyhydrogen and air-hydrogen mixtures.

It is an object of the invention to provide an atomizer-burner which will produce larger, thicker and more homogeneous flames than conventional burners, simplifying mirror focusing and operation of analysis equipment.

It is an object of the invention to provide an atomizer-burner which produces three concentric gas flows about the sample conduit with the inner gas flow providing the aspirating and atomizing action and with the outer gas flow functioning as a sheath separating the flame from the surrounding atmosphere.

It is an object of the invention to provide an atomizer-burner for spectrochemical measurements or the like including a sample conduit and means for producing three concentric gas flows about the conduit. A further object is to provide such an apparatus including a sample conduit having an orifice, three concentric tubes positioned about the sample conduit with the inner and intermediate tubes terminating adjacent the orifice and the outer tube projecting beyond the orifice, and means for

connecting a gas to each of said tubes for flow past the orifice. It is an object of the invention to provide an atomizer-burner having first and second gas inlets and a sample inlet and nozzle means for directing a mixture of gas and sample away from the burner in a stream, and means for directing a sheath of gas concentrically about the nozzle means in the direction of the stream separating the stream from the surrounding atmosphere. A further object is to provide such a structure incorporating a sleeve positioned about the nozzle means with an end of the sleeve extending beyond the nozzle means, and a gas flow line coupled to the interior of the sleeve for generating the sheath of gas flowing from the sleeve concentrically about the nozzle means. Another object of the invention is to provide such a structure including means for supporting the sleeve for motion along the axis of the nozzle means relative to the nozzle means.

The invention also comprises novel details of construction and novel combinations and arrangements of parts, which will more fully appear in the course of the following description. The drawing merely shows and the description merely describes a preferred embodiment of the present invention which is given by way of illustration or example.

In the drawing:

FIG. 1 is a side elevation, partly in section, showing a preferred form of the invention;

FIG. 2 is an enlarged top view of the burner of FIG. 1; and

FIG. 3 is a sectional view taken along the line 3—3 of FIG. 2.

FIG. 1 shows a typical installation of an atomizer-burner 10 for spectrochemical measurements. The burner 10 is supported from a bracket 11 carried on a vertical leg 12. A plurality of such legs rest on a base 13 and support a muffle or light shield 14 about the burner 10. A port or opening 15 in the chimney 14 defines an optical path which is substantially at right angles to the longitudinal axis of the burner 10. As seen in FIG. 1, the zone 16 of flame 17 which is utilized for spectrochemical analysis lies in said optical path defined by opening 15.

The construction details of a burner are shown in FIGS. 2 and 3. A sample conduit 20 is carried in a lower body member 21 which is clamped to an upper body member 22 with a gasket 23 therebetween by a clamp nut 24. The sample conduit 20 projects upward through a central opening 25 in the upper body member, terminating at an orifice 26. A passage 27 in the lower body member communicates with the passage 25 in the upper body member forming an inner concentric gas flow path about the sample conduit. The inner flow path is normally used for the combustion-supporting gas which also aspirates the sample up the conduit 20 and atomizes the sample at the orifice 26. A gas source is connected to the passage 27 in the lower body through a line 28 having a control valve 29 therein.

A passage 32 is provided in the upper body member 22 concentrically around the passage 25 creating another concentric gas flow path. A gas source is connected to the passage 32 through a line 33 having a control valve 34 therein. The passage 32 normally carries the fuel gas which is combined with the combustion-supporting gas above the orifice 26 to provide the flame in which the sample is burned, the upper body member functioning in the nature of a nozzle.

Means for directing a tube or sheath of gas concentrically about the flame is carried on the upper body member. A cup-shaped structure comprising a disc 37 fitted around the upper body member 22 and a sleeve 38 mounted on the disc provides an annular flow passage about the nozzle end of the burner. Another sleeve 39 is positioned within the sleeve 38 and, as seen in FIG. 1,

its outer or upper end is disposed short of the zone 16 of the flame which is adapted for spectrochemical analysis and, hence, below the lower boundary of the optical path defined by opening 15. Sleeve 39 is slidable in sleeve 38 so that the upper end of sleeve 39 may be moved into any desired position short of zone 16 of the flame. A tube 40 is fixed in the sleeve 38 and is coupled to a gas source through a line 41 having a control valve 42 therein.

A container 50 for the sample to be analyzed may be positioned on a resilient member 51 fixed at one end 52 to the plate 13. In a typical analysis, a supply of oxygen is connected to the line 23 to serve as the atomizing and combustion supporting gas. A supply of hydrogen is connected to the line 33 to serve as the fuel gas. A supply of oxygen is connected to the line 41 to serve as the sheath gas. The rates of flow of the various gases are adjusted to provide the desired flame. Then the member 51 is depressed and a container of the sample is placed thereon, the member 51 is released and the sample is raised to immerse the lower end of the conduit 20 therein. The sample is aspirated up the conduit 20 and burned in the flame. Minor adjustments in the gas flow rates may be made, after which the customary spectral analysis is carried out.

The burner of the invention provides three concentric gas flow paths about the orifice of the sample conduit. The gas in the inner flow path functions as the atomizer gas while the gas in the outer flow path functions as a sheath to separate the flame from the surrounding atmosphere. Ordinarily, the inner gas is also the combustion-supporting gas and the intermediate gas is the fuel gas. The fuel gas can be supplied to the inner gas flow path to also function as the atomizer gas if desired. Also, an inert gas, such as argon, can be used as the atomizer gas in the inner flow path with the gas in the outer flow path performing both the combustion-supporting function and the sheath function.

The outer sheath gas protects the flame from contact with the surrounding atmosphere in the zone utilized for spectral analysis and provides a number of significant improvements in this type of analysis.

The use of a sheath gas in an atomizer-burner produces an increase in intensity of spectra in the order of five times or greater. This intensification permits use of narrower slits and increases sensitivity of the measurements by a factor of two or more. A much more stable flame is produced by the burner utilizing the sheath gas. The flicker as recorded in the spectrophotometer output is reduced by a factor of two or greater. This improvement is particularly noted in analyses wherein the normal flame is exceptionally unstable and unreproducible under mixture conditions which produce the best emission characteristics. Alcoholic samples in an air-hydrogen mixture are a typical example. Using air as the sheath gas, the flame in this situation is highly stable and permits an improvement in detection sensitivity in the order of five times.

Acetylene and hydrogen are the fuel gases used in most burners at the present time, with oxygen as the combustion-supporting gas. A number of difficulties are encountered with the use of these fuels, one being that different sizes of fuel orifices are necessary for optimum performance. Also, close pressure regulation, particularly with acetylene, is necessary in order to obtain optimum emission characteristics and reduce variations in flame intensity, white luminous streaks and rapidly rising backgrounds. Some conventional burners require pre-mixing of acetylene and oxygen and water cooling to

achieve satisfactory performance. The burner of the invention utilizing a sheath gas around the flame permits burning of acetylene as a fuel and hydrogen as a fuel in the same burner while providing the increased intensity and flicker reduction discussed above. Also, a lower burning velocity fuel such as natural gas can be burned with oxygen in the sheath gas to provide the results equal to those yielded by a conventional oxyacetylene burner. The natural gas flame is exceptionally smooth, steady and quiet and is easily adjusted for optimum emission. Also, the natural gas fuel provides a broad maximum of emission versus gas flow and eliminates critical flow regulation control. In many applications, commercial fuel gas can be used directly without a regulator.

The use of a sheath gas of oxygen results in a larger, thicker flame than normal resulting in greater flame-to-sample ratios and increasing the flame temperature. The exclusion of nitrogen from the surrounding atmosphere by the sheath gas also materially increases the flame temperature, since nitrogen severely cools regular unprotected flames.

Although an exemplary embodiment of the invention has been disclosed and discussed, it will be understood that other applications of the invention are possible and that the embodiment disclosed may be subjected to various changes, modifications and substitutions without necessarily departing from the spirit of the invention.

What is claimed is:

In a method of operating an atomizer-burner having first and second gas outlets adjacent to one another, a sample tube in said burner having an outlet terminating adjacent to said first and second gas outlets whereby said gas and sample outlets provide a nozzle for directing gas and sample aspirated from said sample outlet away from said burner in a stream, and said burner having no facility for cooling the gases supplied to said first and second gas outlets, said burner being operable for spectrochemical analysis, the steps comprising:

delivering, separate from any combustion supporting gas, a fuel gas having a lower burning velocity than either hydrogen or acetylene to said first gas outlet; simultaneously delivering a combustion supporting gas unmixed with said fuel gas to said second gas outlet whereby said gases aspirate the sample through said sample outlet into a flame produced by said gases at said outlet; and simultaneously enveloping said flame in a flowing sheath of oxygen.

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