

March 4, 1969

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3,430,864

HYDROGEN-ENTRAINED AIR TOTAL CONSUMPTION ASPIRATOR BURNER

Filed May 26, 1967

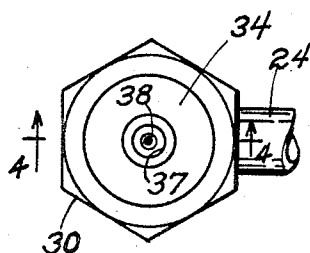


FIG. 3

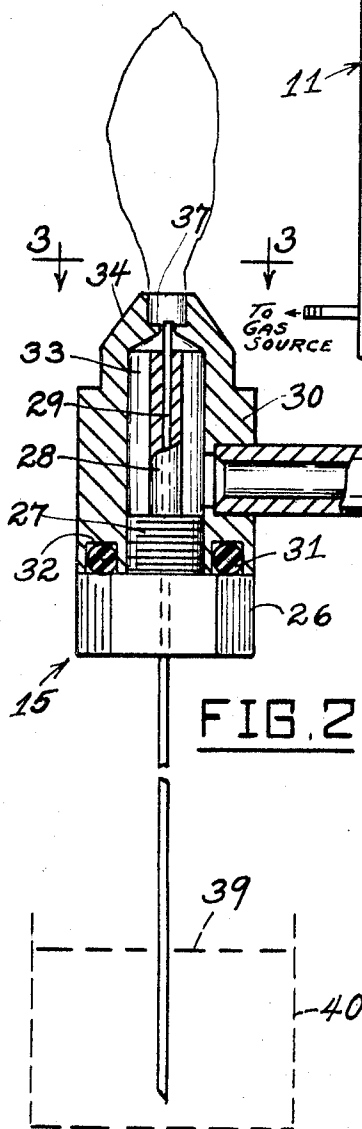


FIG. 2

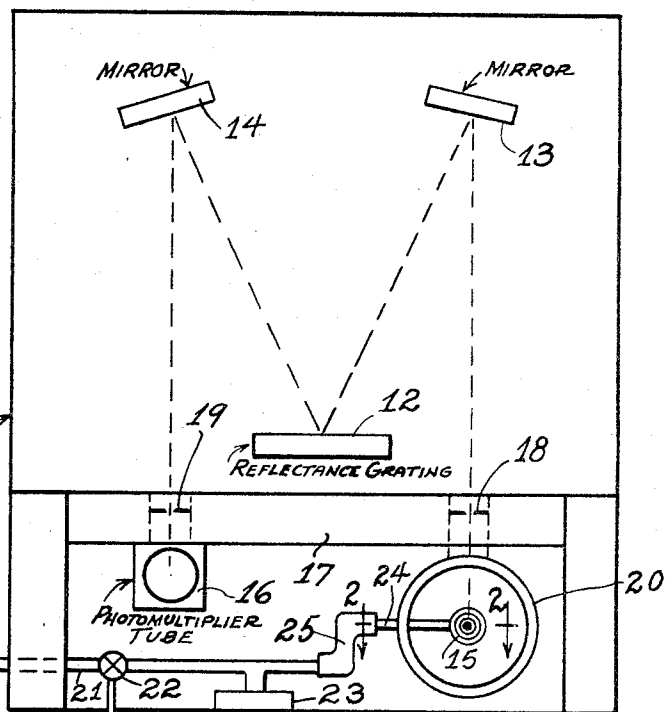


FIG. 1

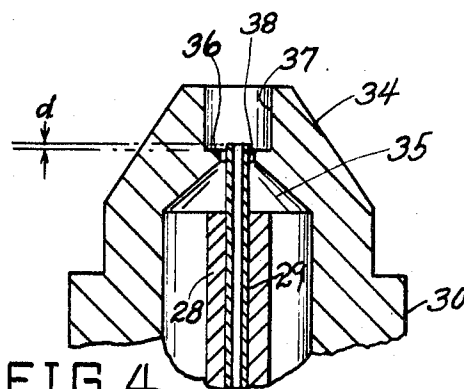


FIG. 4

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HYDROGEN-ENTRAINED AIR TOTAL CONSUMPTION ASPIRATOR BURNER

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Filed May 26, 1967, Ser. No. 641,523

U.S. Cl. 239—424

10 Claims

Int. Cl. B05b 7/06

ABSTRACT OF THE DISCLOSURE

An aspirating burner consisting of a chamber connected to a single source of pressurized fuel gas, such as hydrogen. The chamber has a top aperture centrally located in a counterbore in the top of the chamber body. An aspirating tube is supported in a center post in the chamber, the top end of the tube extending centrally through the top opening and terminating slightly above, defining an annular gas nozzle orifice. The lower end of the tube is received in a vessel containing a sample liquid to be spectrometrically analyzed by the flame method. The passage of the pressurized fuel gas through the annular nozzle orifice effects aspiration of the sample through the tube and partially collimates the stream of aspirated liquid forming the flame structure.

This invention relates to burners, and more particularly to an aspirating burner for use in spectrometrically examining materials by the flame method.

A main object of the invention is to provide a novel and improved aspirating burner for use in a flame spectrometer, said burner being simple in construction, being convenient to use, and requiring the connection thereto of only a single source of pressurized gas, thereby minimizing the need for associated gas-control apparatus.

A further object of the invention is to provide an improved aspirating burner for a flame spectrometer, the burner requiring no internal or external adjustments, operating with a minimum of noise, having dependable aspiration properties, being unlikely to clog, and being economical to operate.

A still further object of the invention is to provide an improved aspirating burner which is rugged in construction, which is inexpensive to fabricate, which provides a low background level of flame, which has a higher flame signal-to-noise ratio for many elements, and more freedom from drift, as compared with an oxy-hydrogen burner, and which produces lower spectral interference for certain elements than that present with burners of the prior art.

A still further object of the invention is to provide an improved aspirating burner which forms a flame with a hydrogen central core, thus retarding refractory oxide formation, which is easy to clean, which is capable of aspirating sample solution into a flame by only the use of a single pressurized fuel gas, such as hydrogen, which provides a flame suitable for sensitive reproducible photometry, and suitable for use in atomic emission, atomic absorption, and atomic fluorescence studies, and which is particularly suited for use with atomic fluorescence studies using a continuum source, and for analyzing certain metals by this method, whereas such metals produce excessive scattering effects when introduced into other flames.

A still further object of the invention is to provide an improved mechanically stabilized aspirating burner capable of remaining in proper adjustment indefinitely under normal use, therefore requiring no adjustment screw.

Further objects and advantages of the invention will become apparent from the following description and claims, and from the accompanying drawings, wherein:

FIGURE 1 is a plan diagrammatic view showing a typical flame spectrometer employing an improved aspirating burner constructed in accordance with the present invention.

FIGURE 2 is an enlarged vertical cross-sectional view taken substantially on the line 2—2 of FIGURE 1.

FIGURE 3 is a top plan view taken substantially on line 3—3 of FIGURE 2.

FIGURE 4 is an enlarged fragmentary cross-sectional view taken substantially on line 4—4 of FIGURE 3.

Referring to the drawings, 11 generally designates a flame spectrometer employing an improved burner constructed in accordance with the present invention. The spectrometer 11 is of the type employing a vertically pivoted grating 12 in conjunction with a pair of stationary mirrors 13, 14, vertically mounted to define a folded optical path, shown in dotted view in FIGURE 1, between the burner, shown at 15, and a photocell or photomultiplier tube, shown at 16. The spectrometer includes a suitable slit mechanism 17, provided with an entrance slit assembly 18 and an exit slit assembly 19. The burner 15 is substantially surrounded by a suitable protective burner chimney 20. The various components of the spectrometer, with the exception of the burner 15, are of conventional construction.

The burner 15 is supplied with pressurized fuel gas, for example, hydrogen at a pressure between 4 p.s.i. and 15 p.s.i., from a suitable source through a conduit 21 provided with a needle valve 22 and a pressure gauge 23. Conduit 21 is connected to the inlet conduit 24 of burner 15 by a short length of flexible tubing, shown at 25.

Referring now to FIGURES 2, 3 and 4, it will be seen that the burner 15 comprises a base member 26, which may be hexagonal, or of any other suitable shape, integrally formed with an upstanding externally threaded stud portion 27 and a reduced upstanding central hollow post portion 28 in which is coaxially secured a hypodermic tube 29. A gas chamber 30, which may also be of hexagonal external shape, is threadedly secured on the stud portion 27 and is sealed relative to base member 26 by the provision of a resilient deformable O-ring 31 in a downwardly facing annular groove 32 formed in the bottom rim of chamber 30.

The gas inlet conduit 24 is connected to the chamber 30 at the lower portion of the interior space 33 of said chamber. The top end of chamber 30 is formed with the frusto-conical, upwardly tapering burner tip 34, with the inside of the tip having a frusto-conical cavity 35. The hypodermic tube 29 projects upwardly from the top end of post member 28 centrally through a circular aperture 36. The top portion of tip 34 is formed with a cylindrical center counterbore 37, with the aperture 36 located accurately at the center of the bottom wall of the counterbore. Tube 29 terminates a short distance *d*, of the order of between 0.0005 in. and 0.0025 in., above the top plane of aperture 36. The aperture 36 is dimensioned to provide an annular orifice 38 around the top end of the tube 29. In accordance with the present invention, the aperture 36 is of sufficient diameter to provide an annular orifice of approximately 0.0025 inch in radial width. This may be varied within reasonable limits. The size of the cylindrical counterbore 37 is quite critical in relation to the size of the annular orifice 38. In a preferred form of the invention, the counterbore height is approximately equal to its diameter, and the counterbore diameter is approximately four times the outside diam-

eter of the annular orifice 38. Thus, in a typical design, the following dimensional values were employed:

	Inches
Diameter of hypodermic tube 29 -----	0.028
Diameter of aperture 36 -----	0.033
Diameter of counterbore 37 -----	0.132
Height of counterbore 37 -----	0.129
Thickness of rim of aperture 36 -----	0.015

The tube 29 must be accurately concentric (within about 0.0005 inch) with relation to aperture 36. The concentricity of said tube is maintained by supporting it in the upstanding relatively thick rigid post member 28, which extends substantially to the bottom plane of the burner tip cavity 35, so that only a short length of the tube 29 extends upwardly from the top end of post member 28.

In operation, the burner 15 is mounted with the lower end of tube 29 immersed in a quantity of sample liquid 39 contained in a suitable receptacle 40 positioned below the burner. The fuel gas, for example, hydrogen, is admitted into the burner cavity 33 at a pressure between 4 p.s.i. and 15 p.s.i. The fuel gas passes through the annular orifice 38 into the cylindrical counterbore 37, above which combustion takes place. The release of the pressurized fuel gas through the annular restriction 38 with resultant venturi effect generates a low pressure region in the bottom of the counterbore which causes aspiration of the liquid sample up through the tube 29 and discharge thereof into the burning fuel gas and entrained atmospheric air above the tip 34.

The discharge of the aspirant-fuel gas mixture into the bottom of the cylindrical enclosure 37, open at its top end, has the effect of increasing the aspiration rate, due to contouring of the flow stream lines, and also has the effect of partially collimating the stream of aspirated liquid.

In the typical design above described, it was found that the minimum fuel gas pressure to provide adequate aspiration was about 4 p.s.i. The maximum fuel gas pressure to provide a proper spectrographic flame was about 15 p.s.i. The fuel flow rate was approximately 7.5 liters per minute.

Other fuel gases may be employed, with suitable dimensional changes in the burner. Among such other gases possibly capable of use are methane, ethane, acetylene or LPG. In all cases, the oxidant consists of entrained air which mixes with the fuel gas after it leaves the burner.

Because of the fact that the concentricity of the tube 29 and annular orifice 38 is rather critical, the supporting post 28 should be of sufficient length so that not more than about 1/8 inch of tube 29 extends past the upper end of the post. If the burner is properly aligned during assembly, no further alignment is necessary during the life of the burner.

While a specific embodiment of a burner for use in a flame spectrometer has been disclosed in the foregoing description, it will be understood that various modifications within the spirit of the invention will occur to those skilled in the art. Therefore it is intended that no limitations be placed on the invention except as defined by the scope of the appended claims.

What is claimed is:

1. In a flame spectrometer, a source of pressurized fuel gas, a burner chamber connected to said source, said burner chamber having a burner tip at its top end, said tip being formed with a counterbore and with an aperture located substantially centrally in the bottom of said counterbore, and an aspirating tube mounted substantially centrally in said burner chamber, the top end of the aspirating tube extending centrally through said aperture and terminating a relatively short distance above the aperture, defining an annular relatively restricted gas nozzle orifice between the aspirating tube and the aperture.

2. The structural combination of claim 1, and wherein the annular orifice has a radial width of between 0.002 inch and 0.003 inch and the aperture has a diameter approximately one fourth that of the counterbore.

3. The structural combination of claim 2, and wherein the pressure of the fuel gas is between 4 pounds per square inch and 15 pounds per square inch.

4. The structural combination of claim 3, and wherein the fuel gas is hydrogen.

5. The structural combination of claim 4, and wherein the height of the counterbore is substantially equal to its diameter.

6. The structural combination of claim 2, and wherein the diameter of the counterbore is approximately 0.13 inch and the fuel gas comprises hydrogen at a pressure between 4 pounds per square inch and 15 pounds per square inch.

7. The structural combination of claim 1, and a rigid post element in the chamber closely surrounding and supporting the aspirating tube and terminating a short distance below said aperture.

8. The structural combination of claim 7, and wherein the top end of said post element is spaced approximately one eighth inch below said aperture.

9. The structural combination of claim 8, and wherein the counterbore diameter and height are approximately equal to 0.13 inch, the aperture has a diameter approximately one fourth that of the counterbore, the annular orifice has a radial width of between 0.002 inch and 0.003 inch, and the fuel gas comprises hydrogen at a pressure between 4 pounds per square inch and 15 pounds per square inch.

10. The structural combination of claim 9, and wherein the interior of the tip tapers upwardly in shape substantially from the top end of said post element up to said aperture.

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U.S. Cl. X.R.

88—145; 23—253