

UNITED STATES PATENT OFFICE

2,562,874

APPARATUS FOR SPECTROPHOTOMETRIC
QUANTITATIVE ANALYSISTheodore E. Weichselbaum, Normandy, Mo., as-
signor to Applied Research Corporation, a cor-
poration of Missouri

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6 Claims. (Cl. 23—253)

1

This invention relates in general to apparatus for spectro-photometric quantitative analysis and, more particularly, to a new and novel spectro-photometric flame injection burner of the type generally disclosed in my co-pending application, Serial No. 55,754, filed October 21, 1948, now Patent No. 2,532,687.

It is the primary object of the present invention to provide a flame injection burner for spectro-photometric quantitative analysis which is simple, accurate, precise, and is particularly adapted to employ acetylene and similar gas as a fuel.

It is a further object of the present invention to provide a simple, highly efficient spectro-photometric flame producing apparatus or burner which is capable of accurate, reliable, and uniform operation.

It is also an object of the present invention to provide a photometric burner having injection flame controlling means which can be readily adjusted to produce a steady uniform flame in an accurately controlled manner so as to produce a photometrically measurable flame-effect which bears a precise quantitative relation to the chemical constituency of the solution being injected thereinto.

It is an additional object of the present invention to provide apparatus of the type stated which is economical in construction and simple in operation.

With the above and other objects in view, my invention resides in the novel features of form, construction, arrangement, and combination of parts presently described and pointed out in the claims.

In the accompanying drawing—

Figure 1 is a top plan view of a photometric burner constructed in accordance with and embodying the present invention;

Figure 2 is a vertical sectional view of the photometric burner taken along line 2—2 of Figure 1; and

Figure 3 is a fragmentary vertical sectional view of a modified form of photometric burner constructed in accordance with and embodying the present invention.

Broadly speaking, the present invention resides in the use of a color-analyzing photometer in combination with an oxy-acetylene burner or so-called lamp having means for introducing a precisely constant flow of the liquid or solution to be analyzed directly into the interior portion of the flame.

Referring now in more detail and by refer-

2

ence characters to the drawing, which illustrates a preferred embodiment of the present invention, A designates a spectro-photometric quantitative analysis burner comprising a cylindrical shell 1 provided in its lower end with a transverse closure disk 2 peripherally welded or brazed thereto to form a gas-tight permanent seal. Brazed or otherwise secured within, and extending radially outwardly from, the shell 1 is a gas-inlet tube 3 adapted for connection by a conventional rubber hose or other similar means (not shown) to a source of acetylene or other suitable fuel gas. Between the gas-inlet tube 3 and its upper open end 4, the shell 1 is provided with an external taper, so that its external diametral size adjacent such upper end 4 is several thousandths smaller than its external diametral size just above the gas-inlet tube 3. Slip-fitted on, and extending down over, the shell 1 and having a complementary internal taper is an outer shell 5 provided at its upper end with a top wall 6 having a relatively large concentric aperture 7.

Projecting at its lower end through and being brazed into the closure disk 2 and extending axially upwardly through the shell 1 is a nozzle tube 8 having an integral lower end wall 9 and forming a gas chamber 10 within the shell 1. At its upper end, the tube 8 terminates just below the aperture 7 in the provision of an annular gas-outlet orifice 11 and in such upper end is threadedly provided with a nozzle 12 having a frusto-conical upper face 13 and a central or axial bore 14 which flares out at its upper and lower end, as at 15 and 16. Welded in the upper end of the nozzle tube 8, in downwardly spaced relation to the nozzle 12, is a collar 17 having an annular series of apertures 18 and a central bore 19. Brazed into and extending radially outwardly from the lower projecting end of the nozzle tube 8 is a tubular lateral off-take 20 for connection to a conventional oxygen line (not shown). Similarly welded at its lower end in the nozzle-tube end wall 9 is a fine-bore liquid-tube or capillary 21 which extends axially therethrough and projects downwardly at its lower end for a substantial distance so as to dip down into the liquid sample held within a conventional beaker (not shown). Adjacent its upper end, the capillary 20 extends through and is snugly held in the collar 17, and, at its upper end, the capillary 20 extends through and is of substantially smaller diameter than the bore 14 of the nozzle 12 so as to provide an annular space therebetween and thus create a Venturi effect at the mouth of the nozzle 12. It should be noted in this con-

nection that the upper end of the capillary 20 should preferably be precisely concentric with the bore 13 to insure maximum uniformity and accuracy of analytical results.

The outer shell 5 may be adjusted vertically up or down as a result of interfitting friction of the complementary tapers, so that its upper or orifice end will be located at an optimum position in relation to the upper or discharge end of the nozzle tube 8, since it has been found that this orifice adjustment is somewhat critical for gases, such as acetylene and the like. Once set, changes are only necessary at infrequent intervals or when the quality of the fuel gas changes substantially.

In use, the burner A is set in operation by first turning on the acetylene supply and the gas fills the chamber 10 exiting through the annular space s between the aperture 7 and the upper end of the nozzle tube 8. The burner A may then be lit by applying a match or other conventional pyrophoric means to the stream of gas issuing therefrom. The oxygen is then turned on and the gas pressures are adjusted by conventional pressure regulators (not shown) until the gases burn steadily and evenly in a light blue practically colorless flame. Under these conditions, the flame will burn "straight up," so to speak, in the form of a vertical cylinder.

The stream of oxygen will flow upwardly through the nozzle tube 8 and issue in a high-pressure blast through the constricted orifice formed between the nozzle-bore 13 and the upper end of the capillary 20, causing the flame to taper down to an intensely hot conical blast and also creating a Venturi effect directly upon the capillary 20. Thereupon, a suitable quantity of the liquid sample is placed in a carefully cleaned beaker (not shown) and the latter set up under the lower or intake end of the capillary 20, so that such intake end of the capillary 20 will dip down into the liquid. The suction capillary 20 draws the liquid sample upwardly in a constant flow. As the liquid leaves the upper end of the capillary 20, it is immediately atomized or volatilized and projected into the interior of the flame for immediate ionization. It should be noted that the volatilization and ionization of the solution are practically simultaneous.

As the sample is ionized in the flame, a characteristic color will be imparted thereto, such as yellow for sodium, red for lithium, and so on. Furthermore, the degree of intensity of coloration is directly proportional to the percentage of such cation in the sample. This degree of color intensity can be analytically measured as more fully described in my co-pending application, Serial No. 55,754. During analytical procedure, the pressures of entering gases should be held constant within very close limits.

If desired, I may also provide a modified form of flame burner A', which is substantially identical with the previously described flame burner A except that it is provided with a shell 1' of uniform outer diametral size having an enlarged threaded section 21 of rather coarse pitch for engagement with a complementarily threaded section 22 on the interior face of an outer shell 5'. It should be noted in this connection that, above the threaded sections 21, 22, the shells 1', 5', fit rather snugly, so that no appreciable amount of air will be drawn into the flame. Thus, by turning the shell 5' with respect to the shell 1', a vertical adjustment of the orifice may be obtained.

With apparatus of the present invention, variations in ambient temperatures and atmospheric conditions have no adverse effect upon the analytical results. The burner of the present invention furthermore obviates all side effect due to condensation of volatilized liquid, inasmuch as a constant amount of liquid per unit of time is delivered directly into the flame.

It should be understood that changes and modifications in the form, construction, arrangement and combination of the several parts of the apparatus for spectro-photometric quantitative analysis may be made and substituted for those herein shown and described without departing from the nature and principle of the present invention.

Having thus described my invention, what I claim and desire to secure by Letters Patent is:

1. In a spectro-photometric analytical apparatus, a flame generating burner comprising an elongated cylindrical shell chamber having an inlet tube adjacent one end for introducing a combustible gas into the chamber, said cylindrical shell chamber being provided at its other end with a diametrically reduced substantially circular aperture, a nozzle-tube of substantially smaller diameter extending through said cylindrical shell chamber and having at one end a discharge nozzle adjacent to and substantially concentrically within and spaced from the substantially circular aperture producing an annular flame port therewith and being provided with a portion having a constricted passage opening adapted to create therewith a Venturi effect, said nozzle-tube being provided adjacent its other end with an inlet tube for receiving a high-pressure combustion-supporting gas, and a liquid-sample intake tube of smaller diameter disposed within and extending coaxially through the nozzle-tube, said liquid-sample intake tube terminating at one end substantially concentrically within the constricted passage opening and at its other end projecting outwardly from the burner for insertion into a body of liquid to be analyzed.

2. In a spectro-photometric analytical apparatus, a flame generating burner comprising an elongated cylindrical shell chamber having an inlet tube adjacent one end for introducing a combustible gas into the chamber, said cylindrical shell chamber being provided at its other end with a diametrically reduced substantially circular aperture, a nozzle-tube of substantially smaller diameter extending through said cylindrical shell chamber and having at one end a discharge nozzle adjacent to and substantially concentrically within and spaced from the substantially circular aperture providing an annular flame port therewith and being provided with a portion having a constricted passage opening adapted to create therewith a Venturi effect, said nozzle-tube being provided adjacent its other end with an inlet tube for receiving a high-pressure combustion-supporting gas, and a substantially straight liquid-sample intake tube of smaller diameter disposed within and extending coaxially through the nozzle-tube, said liquid-sample intake tube terminating at one end substantially concentrically within the constricted passage opening and at its other end projecting outwardly from the burner for insertion into a body of liquid to be analyzed.

3. In a spectro-photometric analytical apparatus, a flame generating burner comprising a first tubular member being closed at one end and being constricted at its other end to provide a

5

substantially circular aperture; a gas inlet means opening into the interior of the first tubular member adjacent the closed end thereof for introducing a combustible gas thereinto; a second tubular member disposed within, and being of substantially smaller diametral size than the first tubular member and being closed at one end adjacent to the closed end of the first tubular member and terminating at its other end in concentric relation to the aperture for providing in cooperation therewith an annular flame orifice, an inlet tube opening into the second tube adjacent the closed end thereof for introducing thereinto a flame supporting gas, and a substantially straight liquid-sample intake tube extending coaxially through the second tubular member, said liquid-sample intake tube being of substantially capillary dimensions and terminating at one end adjacent to the annular flame orifice providing a discharge opening, said liquid-sample intake tube projecting outwardly from the closed end of the second tubular member for insertion into a body of liquid to be analyzed, said second tubular member further being provided at its other end with means having a constricted passage opening around the upper end of the liquid-sample intake tube providing a Venturi constriction for producing suction around the upper end of the liquid-sample intake tube whereby to cause the liquid sample to flow upwardly through the liquid-sample intake tube and through the discharge opening thereof.

4. In a spectro-photometric analytical apparatus, a flame generating burner comprising a first tubular member being closed at one end and being open at its other end, a tubular cap disposed upon and extending over the open upper end of said first tubular member, said cap being provided at its upper end with a diametrically reduced substantially circular aperture, a gas inlet means opening into the interior of the first tubular member adjacent to the closed end thereof for introducing a combustible gas thereinto, a second tubular member disposed within, and being of substantially smaller diametral size than the first tubular member and being closed at one end adjacent to the closed end of the first tubular member and terminating at its other end in concentric relation to the aperture for providing in cooperation therewith an annular flame orifice, an inlet tube opening into the second tube for introducing thereinto a flame supporting gas, and a substantially straight liquid-sample intake tube extending coaxially through the second tubular member, said liquid-sample intake tube being of substantially capillary dimensions and terminating at one end adjacent to the annular flame orifice so as to discharge sample liquid directly into the flame, said liquid-sample intake tube projecting outwardly from the closed end of the second tubular member for insertion into a body of liquid to be analyzed, said second tubular member further being provided at its other end with means having a constricted passage opening around the upper end of the liquid-sample intake tube providing a Venturi constriction for producing suction around the upper end of the liquid-sample intake tube whereby to cause the liquid sample to flow upwardly through the liquid-sample intake tube and into the flame produced by the burner.

5. In a spectro-photometric analytical apparatus, a flame generating burner comprising a first tubular member being closed at one end and

6

being open at its other end, a tubular cap slip-fitted upon and extending over the open upper end of said first tubular member, said cap being provided at its upper end with a diametrically reduced substantially circular aperture, said slip-fitted connection being sufficiently tight so that the relative distance between the aperture of the cap and the closed end of the first tubular member may be adjusted to any position within predetermined limits, a gas inlet means opening into the interior of the first tubular member adjacent the closed end thereof for introducing a combustible gas thereinto, a second tubular member disposed within, and being of substantially smaller diametral size than the first tubular member and being closed at one end adjacent to the closed end of the first tubular member and terminating at its other end in concentric relation to the aperture for providing in cooperation therewith an annular flame orifice, an inlet tube opening into the second tube adjacent the closed end thereof for introducing thereinto a flame supporting gas, and a substantially straight liquid-sample intake tube extending coaxially through the second tubular member, said liquid-sample intake tube being of substantially capillary dimensions and terminating at one end adjacent to the annular flame orifice so as to discharge sample liquid directly into the flame, said liquid-sample intake tube projecting outwardly from the closed end of the second tubular member for insertion into a body of liquid to be analyzed, said second tubular member further being provided at its other end with means having a constricted passage opening around the upper end of the liquid-sample intake tube providing a Venturi constriction for producing suction around the upper end of the liquid-sample intake tube whereby to cause the liquid sample to flow upwardly through the liquid-sample intake tube and into the flame produced by the burner.

6. In a spectro-photometric analytical apparatus, a flame generating burner comprising a first tubular member being closed at one end and being open at its other end, a tubular cap threadedly fitted upon and extending over the open upper end of said first tubular member, said cap being provided at its upper end with a diametrically reduced substantially circular aperture, said threaded connection being sufficiently tight so that the relative distance between the aperture of the cap and the closed end of the first tubular member may be adjusted to any position within predetermined limits, a gas inlet means opening into the interior of the first tubular member adjacent the closed end thereof for introducing a combustible gas thereinto, a second tubular member disposed within, and being of substantially smaller diametral size than the first tubular member and being closed at one end adjacent to the closed end of the first tubular member and terminating at its other end in concentric relation to the aperture for providing in cooperation therewith an annular flame orifice, an inlet tube opening into the second tube adjacent the closed end thereof for introducing thereinto a flame supporting gas, and a substantially straight liquid-sample intake tube extending coaxially through the second tubular member, said liquid-sample intake tube being of substantially capillary dimensions and terminating at one end adjacent to the annular flame orifice so as to discharge sample liquid directly into the flame, said liquid-sample intake tube projecting

outwardly from the closed end of the second tubular member for insertion into a body of liquid to be analyzed, said second tubular member further being provided at its other end with means having a constricted passage opening around the upper end of the liquid-sample intake tube providing a Venturi constriction for producing suction around the upper end of the liquid-sample intake tube whereby to cause the liquid sample to flow upwardly through the liquid-sample intake tube and into the flame produced by the burner.

THEODORE E. WEICHSELBAUM.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
391,865	Schutte	Oct. 30, 1888

Number	Name	Date
932,739	Wiss	Aug. 31, 1909
1,252,210	White	Jan. 1, 1918
1,536,046	Anthony	May 5, 1925
1,561,848	Green	Nov. 17, 1925
1,617,166	Schoop	Feb. 8, 1927
2,270,442	Jares	Jan. 20, 1942
2,532,687	Weichselbaum	Dec. 5, 1950

FOREIGN PATENTS

Number	Country	Date
166,264	Germany	Dec. 11, 1905
679,452	Germany	Aug. 5, 1939

OTHER REFERENCES

Cholak et al.: Industrial and Engineering Chemistry, Analytical ed., vol. 16, Dec. 1944, pages 728-734.

Lundegardh: Zeitschrift fur Physik, vol. 66 of 1930, pages 109-114.